APPLICATION DEVELOPMENT EXTRA

JULY 1995

BYTE

THE MAGAZINE OF TECHNOLOGY INTEGRATION

20 Years 1975-1995

First PCI Power Macs

Virtual-Reality Views into Business Data PAGE 111

New on Your Notebook: Gigabytes of Storage PAGE 25

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May 30, 1995
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PC MAGAZINE EDITORS' CHOICE
May 30, 1995
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June 28, 1994
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PC MAGAZINE EDITORS' CHOICE
April 26, 1994
MAGNUM

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May 16, 1995
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PC WORLD BEST BUY
February 1995
P90 HOME MPC

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P90PCI POWERSTATION

intel inside
pentium

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intel inside pentium

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May 16, 1995
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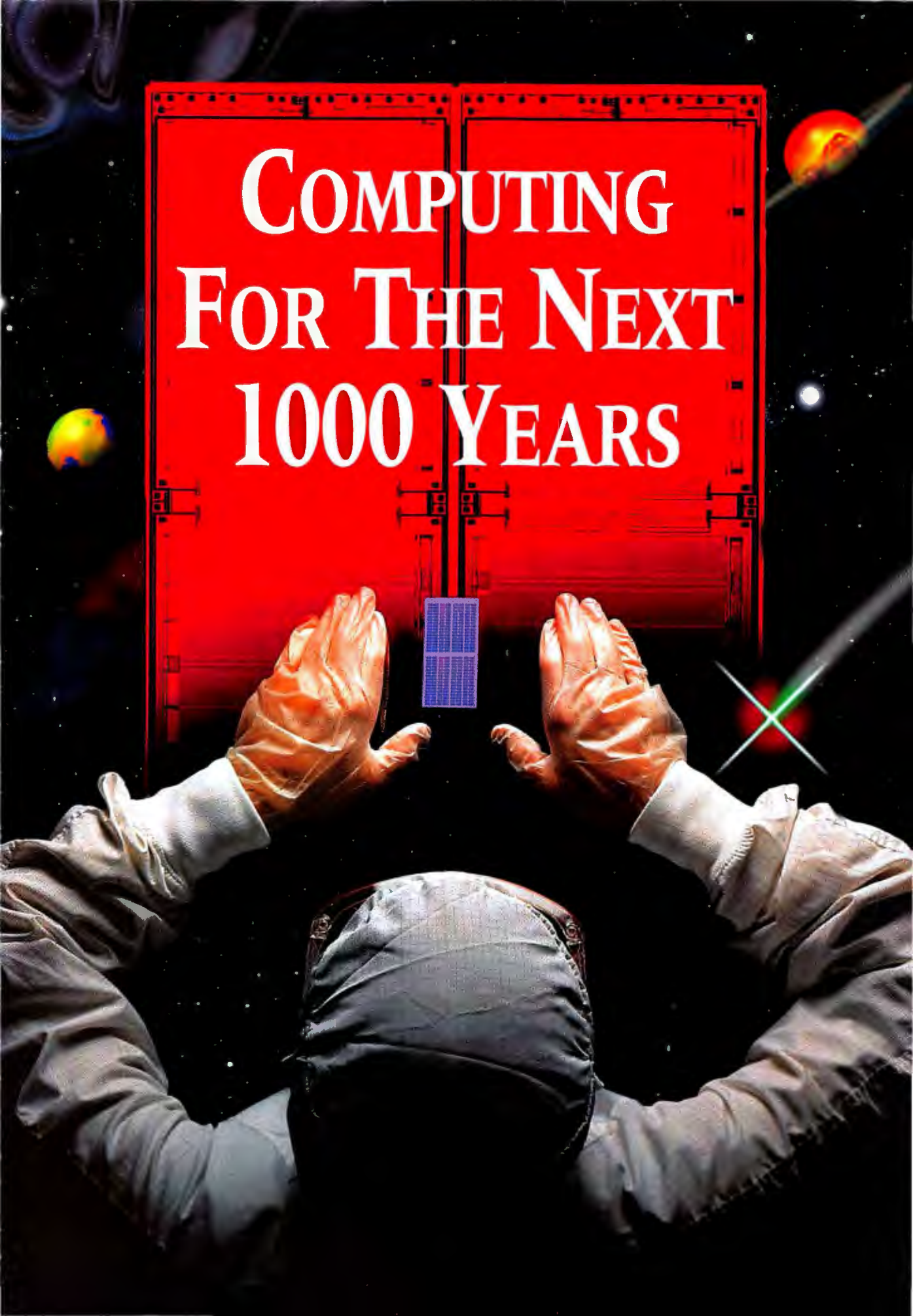
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PC World, February, 1995

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"The Millennia is nothing short of the best all-around PC available on the Market today."
PC Magazine, April 25, 1995

PC MAGAZINE EDITORS' CHOICE
May 30, 1995
P120 MILLENNIA

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intel inside
pentium PROCESSOR

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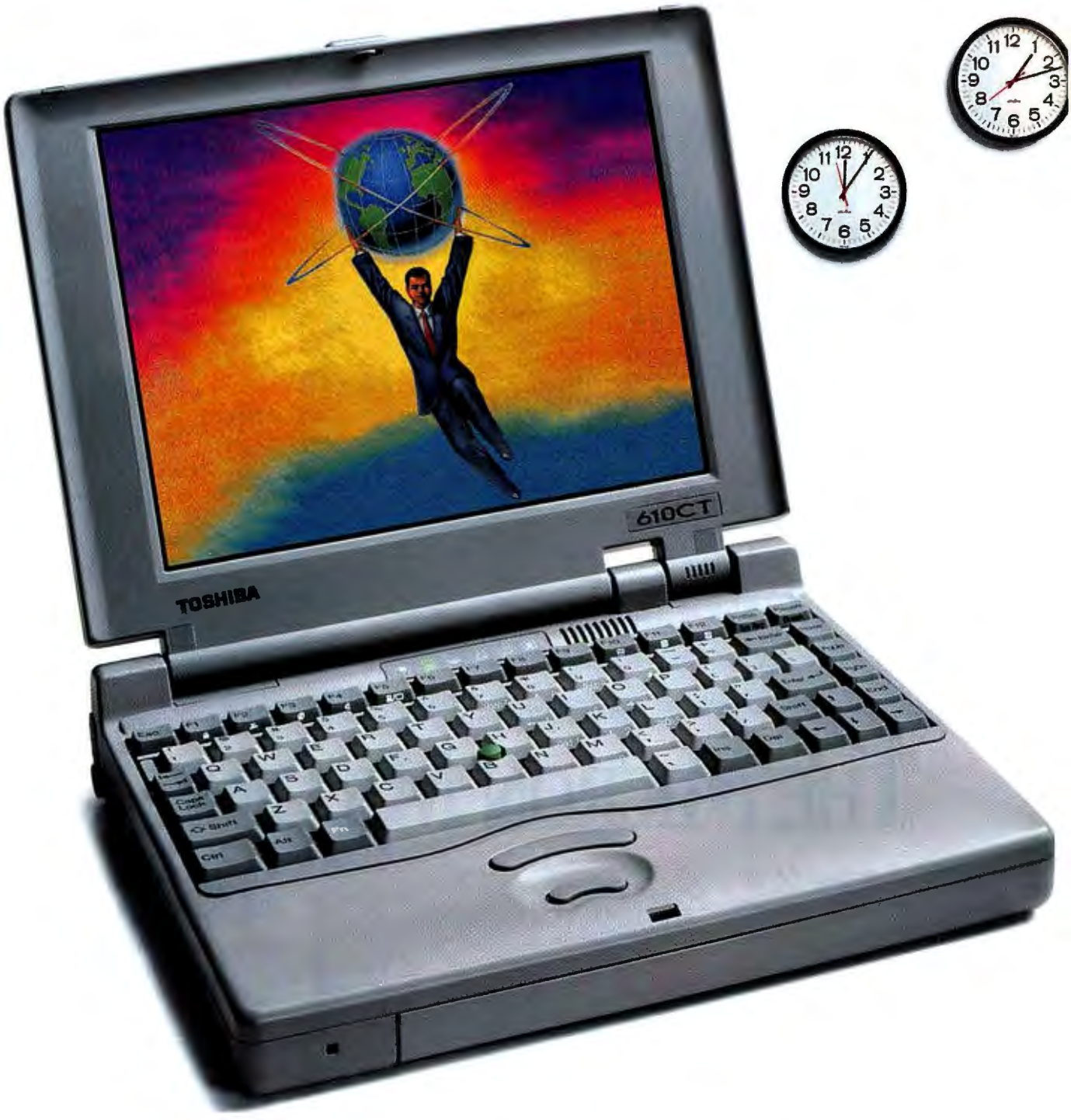

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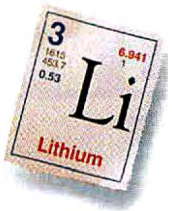

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intel inside pentium PROCESSOR

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BYTE

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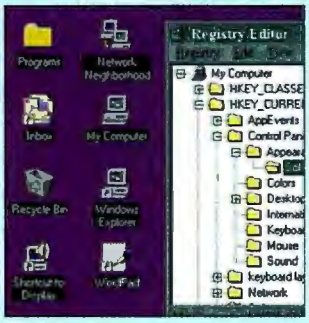

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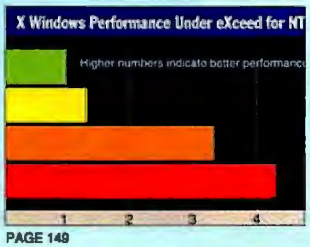

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3-D Graphics Technology 101
BY EDMUND X. DEJESUS
3-D graphics is becoming essential in applications from financial analysis to entertainment, and new standards support the trend.

Desktop Hollywood F/X 103
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Hollywood-style computer-generated 3-D special effects are no further than your desktop computer.

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Financial traders can operate almost anywhere with new data-analysis software and virtual-reality interfaces.

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PROGRAM LISTINGS

From BIX: Join "listings/frombyte95" and select the appropriate subarea (i.e., "jul95").

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

From the BYTE BBS at 1200-9600 bps: Dial (603) 924-9820 and follow the instructions at the prompt.

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Core Technologies

BYTE Contents by Platform

This page presents the articles in this issue according to computing platform.

DOS/WINDOWS

OS/2

MACINTOSH

UNIX

NETWORKS

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See The Future Of Storage.

Pinnacle Micro. The optical storage leader.

TAHOE 230

The Tahoe 230 MB is the world's first portable optical drive, weighing only 1.8 lbs. It offers quick access time and fast data throughput, with each rewritable 3.5"disk storing 230 MB of data. With its optional travel case and battery pack, the Tahoe is the perfect solution for users on the go. *$795*

SIERRA 1.3 GB

The Sierra 1.3 GB is the industry's fastest optical drive. It can be used as both a hard disk replacement and an on-line archiving system. Each 5.25" cartridge holds 1.3 Gigabytes of data, and boasts a 30-year shelf life. It is ideal for data-intensive applications such as graphics, CAD/CAM, multimedia or data archiving. *$2,495*

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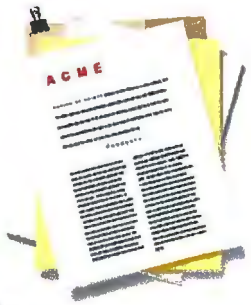
A YEAR IN THE LIFE OF A FRAMEMAKER DOCUMENT.

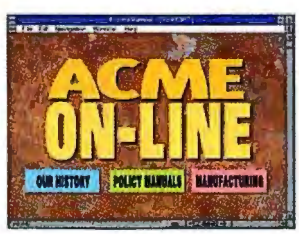


JAN 14 *It was a historic day for the Acme Development Company's marketing department. Not only did they create their first marketing plan, but they worked as a team in the process. Everyone contributed, each using FrameMaker's text, graphics, layout, formatting, and long document features. The end result was a marketing plan that compared to no other in Acme history.*

FEB 9 *The notorious VP of Marketing went ballistic and demanded a complete reorganization of the marketing plan. Pronto. Fortunately, FrameMaker makes seemingly complex tasks like swapping chapters fast and easy. It automatically updates everything involved, including running headers and footers, cross references, and auto numbering — all the easy to forget details.*

JUL 1 *Oh, the joys of red tape. Leave it to the government to issue a whole slew of new safety regulations right before Acme's publication deadline. Sound like a nightmare? Not with FrameMaker. The document jockeys at Acme appended the document with a regulation directory in standard government format, complete with cross references, side-heads, and straddles.*

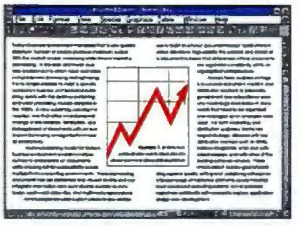
AUG 21 *The buyout of a competitor, Maxco, meant suddenly the two rivals had to find a way to work together. But since FrameMaker supports industry standards in mixed environments, compatibility was not an issue. A selection of filters made converting Maxco's documentation into FrameMaker format a breeze. Including import and export of both text and graphics.*



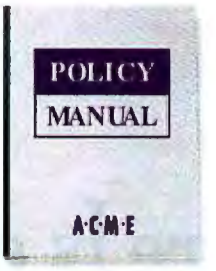
SEP 27 *Acme was suddenly twice as big. But document distribution had to remain timely, fast, and ubiquitous. Saving a few trees couldn't hurt either. So Acme employed FrameViewer™ for automatic online distribution and viewing, with no additional post-processing or conversion required. FrameViewer supports FrameMaker's hypertext links for access to more detailed information at the touch of a button.*

OCT 18 *"The original drawings? Uh, my dog ate them," said the architect. He wasn't kidding either. But the people assembling Acme's latest manual showing their new facility were in luck. FrameMaker not only supports popular graphics file formats, but also creates live links between other applications. So imported renderings are updated automatically as changes are made in their native CAD application.*

MAR 28 *This year there wasn't quite enough green stuff to go around at Acme. Which meant several marketing programs were cut from the budget and the marketing plan. No problem. FrameMaker instantly updated the table of contents and index accordingly. And WYSIWYG table editing ensured all the tables broke properly across multiple pages, and details like periodic ruling and shading remained intact.*



APR 5 *Acme's marketing plan worked like a charm. Business was booming. In fact, it was so good, Acme decided to include their skyrocketing sales figures in the next marketing plan. FrameMaker not only imported the new sales graphic, but was able to flow the text neatly around it with the help of the new auto text wrap feature.*



MAY 10 *FrameMaker fever struck at Acme Development. Other departments were so impressed with the marketing materials that FrameMaker began spreading throughout the company. Soon all of Acme's most critical documents were converted to FrameMaker. What's more, FrameMaker is the only application that runs seamlessly across the company's mix of computing platforms — Macintosh, UNIX, and Windows systems.*

JUN 6 *After a wildly successful IPO, Acme became Acme Corporation. Which required company-wide distribution of all the gory details of the IPO, stock options and profit sharing. FrameMaker's new text and graphics by reference feature saved time by instantly retrieving frequently used boilerplate information — whether created in FrameMaker, imported from other applications, or simply ASCII text.*

NOV 11 *It was only a matter of time before Acme went worldwide. Which meant there were hundreds of eager new employees all over the world just dying to use Acme's latest materials created in FrameMaker. Not to worry, multiple language versions of the FrameMaker interface enabled users worldwide to operate FrameMaker in their native tongues.*

DEC 3 *The rest of the planet jumped onto the information superhighway, and so did Acme. Soon Acme had its very own Web site to help disseminate company information. So they naturally made extensive use of FrameMaker's new HTML capabilities. Now all its material could be published directly to the Internet, and made available to customers and employees all over the world.*

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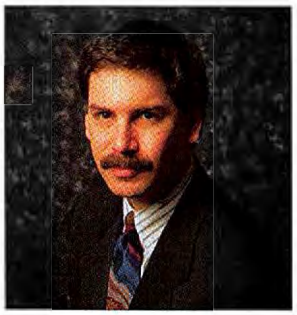
The Future Is on the Line



Today's visionaries understand emerging networked businesses and the new culture they empower

When this magazine was founded nearly 20 years ago, computer users were pioneers. We took off for the open spaces of the new technologic frontier, driven by the vision of wide-open adventure and the inkling that there was a better life out there.

We had to build our own tools—there were no towns, no roads. We had to invent the infrastructure as we went along. And we had to dig deep into the dirt to eke out the barest technological existence, programming Mits Altair machines through front-panel interfaces, soldering our own circuit boards for basic I/O functions.

In those days, BYTE was the journal of the frontier. We told you how to program in assembly, how to install components, how to solder together a processor board. Ciarcia's Circuit Cellar was one of the most popular series of articles we ever ran.

But we don't live at the fringes of society anymore. We're not wiring robots together in our basements these days. And there are entire industries now alive and thriving on what was once the remotest outpost of civilization. Finally, it's cool to be a nerd.

Does this signify the end of an era? Have we all gone, heaven forbid, *mainstream*? Worse, is computer technology finally boring?

No way. Ask anybody who once saw the future on a chip. They will tell you, yes, the frontier spirit is alive and well. It's just that, today, the new world is made up of communications protocols, on-line business offerings, internetworked information, and new ways for people to share ideas. Exploring technology was once a solitary venture—best embodied by the task of building a personal computer—but today it is a way to explore, and perhaps help design, new forms of social interaction.

That is why, in this issue, we're thrilled to launch a new feature called "The BYTE Network Project." Authored by our very own Jon Udell (recently promoted to executive editor of new media, by the way), it begins on page 87. Each month, the "Network Project" will explore and explain the technologies and products necessary to develop an Internet presence. We're basing this feature on BYTE's own need: To develop a WWW (World Wide Web) home page that provides additional information beyond those articles that appear in our magazine each month.

The "Network Project" starts small: We try out a bunch of different ways to connect our PCs to the Internet and to launch a rudimentary home page. Of course, there's a lot more to building a networked business than just posting a bunch of stuff on the Net. In future issues, we'll be exploring tools that automatically format our existing content for on-line publishing, products that let us collect data from our readers, and methods to connect you to the most up-to-date information about the products we cover in the magazine. If we find electronic cash technology robust enough, we will also explore tools to let you process your subscription through the Internet. Truth be told, the technology to get a business on-line is not that complicated. However, the thinking behind it is. Our business (publishing) has been based on nearly the same business model for countless years. What happens to the business when we throw the Internet into the mix? Can we—can you—manage the transition to this new frontier?

To clarify the issues you need to address when you think about your growing Internet business, we've put together a Special Report (see "The Greatest Show on Earth" on page 69) that covers the 10 most contentious and interesting factors facing Internet users. Among them: the current blend of incompatible security protocols, the lack of decent Internet search tools, and the looming hulk of Microsoft, now poised to put every single Windows user on-line. We may think that the Internet land-rush is now in full swing, but in reality it's barely begun.

"The BYTE Network Project" may never be done—we'll continue to expand our system as new technologies emerge and as we figure out better ways to exploit the capabilities of the Net. Maybe we'll build a video-conferencing network. Or maybe, in a few years, you'll find us down in our cellar again, soldering together the machines that will carry the next explorers into the wild West. ■

RAPHAEL NEEDLEMAN, EDITOR IN CHIEF
(rafe@bix.com)

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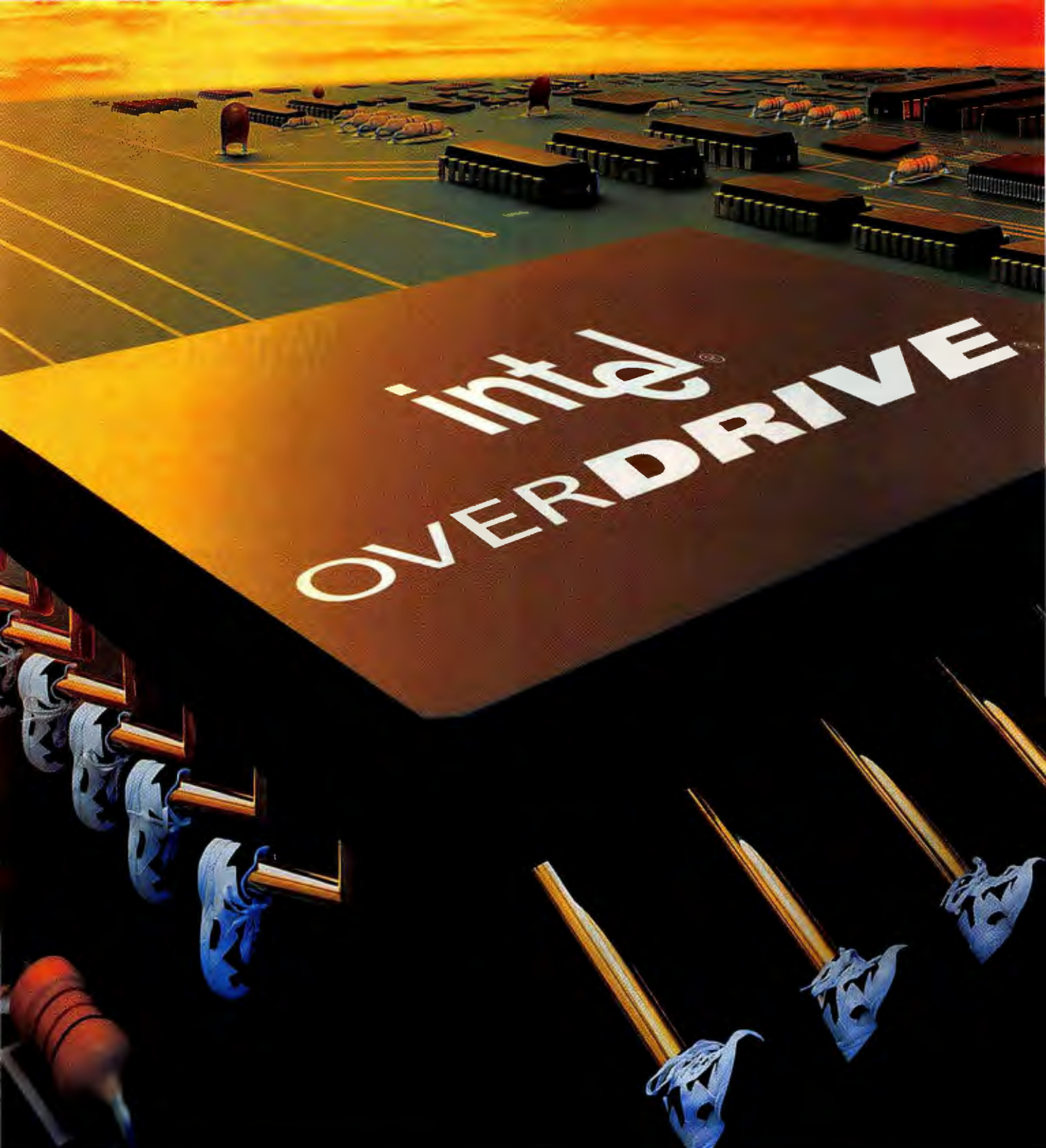

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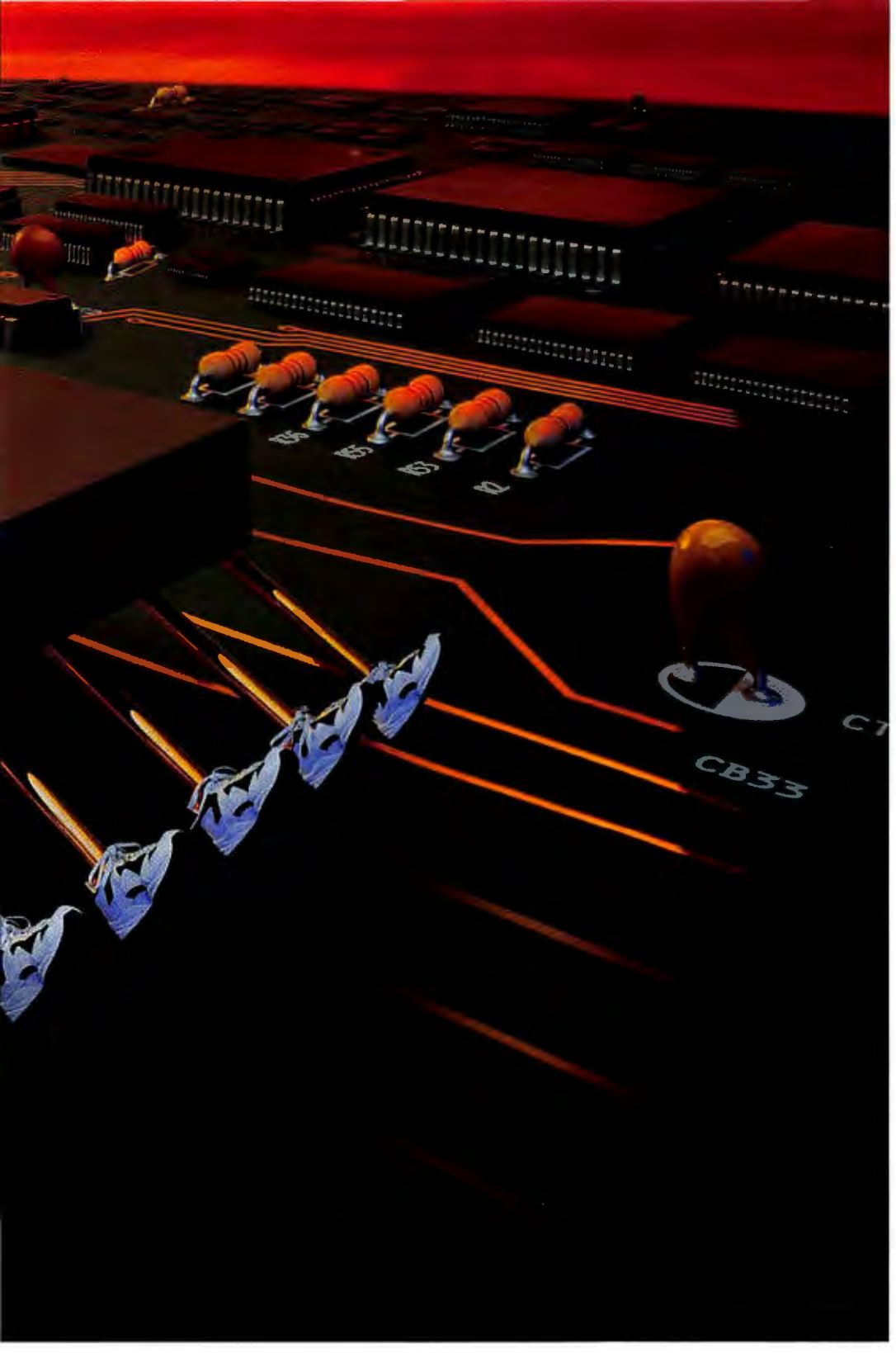

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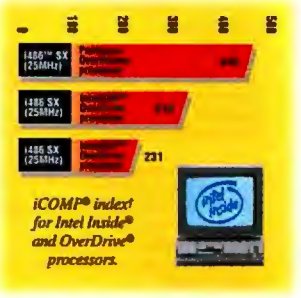

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Circle 66 on Inquiry Card (RESELLERS: 67).

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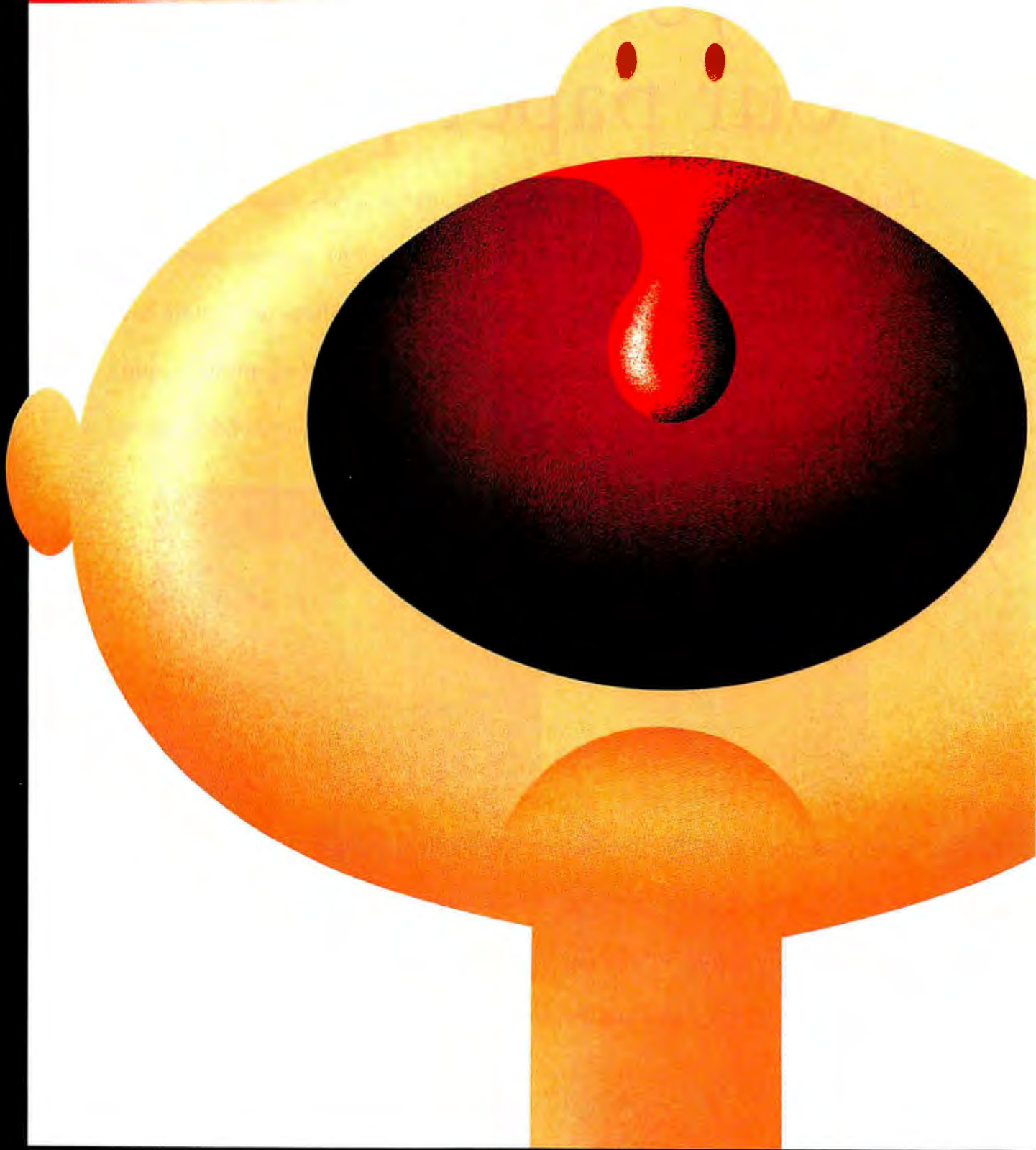
I/O Bandwidth	1200MB/s	256MB/s	620MB/s
I/O Slots	144 PCI	112 HPPB	40 Sbus



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Letters

P6 Pointers?

I read your cover story entitled "Intel's P6" (April) and was hoping to get some additional references from you. The only information I've been able to find on the P6 is in your article and in Intel's home page.

Mark Brehob
East Lansing, MI

As far as I know, my story on the Intel P6 is the most detailed information available in a general magazine. The only source for more information is the February 16 issue of Microprocessor Report, *a newsletter that covers the semiconductor industry. It's not available on newsstands, and subscriptions cost $495 a year. Intel will eventually publish a manual on the P6, but it's not available yet, either.—Tom Halfhill*

Back to School

I am head of the mathematics department at Eton College in the U.K. Your article "New Ways to Learn" (March) is arguably the most important information the magazine has published in all the time I have been reading it. It not only was clear and inspiring but also dealt with fundamental issues of long-term importance rather than the necessarily ephemeral things that new technology is usually about.

I don't like the implications of "just-in-time" learning. Maybe most employees are a kind of robo-extension to their employers, consumables to be thrown away when no longer useful. However, there is life outside work, and education is about that life as much as it is about employment.

I hope that we can look forward to regular updates on this vital theme.

John C. Puddefoot
pudepied@dircon.co.uk

BYTE Bashing

I have to give you credit for not editing out Jessica Keyes' flames concerning some aspects of computer-related trade publications (May Commentary). As someone who has worked around telecommunications and microcomputers for 25 years, I have to say she "hit the nail on the head." I agree with her comments about the lack of a technology background for most writers being published in computer industry publications (BYTE included). I myself have written E-mail to several journalists—nicely pointing out errors in their articles—and not a single response. Maybe it's the technical background of the editors?

Anyway, I have to say her commentary was refreshing and unfortunately true for BYTE, too (e.g., on page 115 of the May issue, the *D* in 2B+D should be data channel, not delta channel). But keep trying....

Paul A. Sadowski
73562.1574@compuserve.com

Mr. Sadowski is correct in pointing out the mistake. The D *in 2B+D is indeed data channel. We regret the error.—Eds.*

More Kudos for Keyes

Jessica Keyes' May Commentary should be framed and hung on the walls of every business that intends to buy into any IT (information technology) solution. BYTE should heed what it prints; why go through the pain of setting up "BYTE's Video Workshop" (May) using a collection of conflicting PC technology and then print, "but it isn't yet plug and play" when plug-and-play systems exist? Keyes makes the point that we MIS types lean heavily on the advice of trade publications. True—so perhaps if BYTE dedicated more space to those systems that *are* plug and play rather than writing about the hoops one will jump through to simulate it, the industry and the end user would be better off.

Brent Daviduck
University of Lethbridge
Lethbridge, Alberta, Canada

Pentium Bug

I read Raphael Needleman's Editorial (March) with great concern. To pass off the Pentium bug (and generalizing this concept) as a fact of life is troubling. To me, there's a big difference between application software and fundamental building blocks (i.e., the CPU). If you look at any piece of complex software and break it down into its layers, then the bottom layer (the CPU) must be the most rigorous. Bugs in the lower layers will have a much more devastating effect than bugs in the top layers (which may only affect one option as opposed to the entire application).

This is one of the worst editorials I have read from BYTE in the last 15 years of reading the magazine and the only one that has prompted me to reply.

I've been very pleased with the refocus on core technology over the last two years (which is what the orientation of the magazine was in the early 1980s). I stopped buying the magazine in the latter half of the 1980s when it became another IBM-compatible magazine.

Trevor Coulson
Frewville, Australia
maptek@wattle.itd.adelaide.edu.au

I am sorry you did not like my Editorial. But I do think I was misunderstood (as a writer, that's my fault, not yours). To expect and understand how a bug can crop up in foundation technology (a CPU) is not the same as to forgive it, which I do not do. Thanks for reading and for the candor of your letter.

—Rafe Needleman

Anything but a PC

Why is it that you completely ignore practically *all* other computers other than the PC compatibles? The PC's do have good qualities. But as a software developer, I plan to support "non-PCs," even if some of my associates think those "other" computers just don't fit their idea of a "real" computer.

Terry Miller II
Bartlesville, OK

Remember the Macintosh

As a loyal Mac user, I usually just bite my tongue at what often seems like uneven coverage. In the May issue, however, the bias was too egregious for me to ignore. [The worst example] was the "BYTE's Video Workshop" report. Despite laments about the lack of plug and

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Circle 75 on Inquiry Card (RESELLERS: 76).

play, the difficulty of getting components to work together with the Gateway system, there was absolutely no mention of Macintosh video possibilities, despite the well-known "plug-and-play" abilities of that platform.

Deborah Yeager
73347.2452@compuserve.com

Wow! A six-page article on implementing digital and analog video-editing systems on the desktop. And not one tiny mention of QuickTime, Apple, or Macintosh—incredible. An obviously well-researched article, with no prior bias toward a particular platform. Perhaps this shows in the various configuration problems described in the article. The line, "Plug the network card in last and use the 3Com Etherlink III...it's the closest thing to true plug and play that we've ever come across" tells it all. Mac users reading this article don't know whether to laugh hysterically or to groan in frustration.

Mel Martinez
mem@pha.jhu.edu

The article focused on building desktop video systems on the Windows platform. BYTE has covered other platforms for desktop video in the past and will continue to do so. But this specific project covered the issues and requirements of building a system on the PC platform.—Stanford Diehl

Beyond Cute PDAs

Your article on Dracon was very interesting. In particular, I liked that it dealt with how PDA technology was being used to solve business problems rather than just how cute PDA technology is.

Chris Curnow
South Melbourne, VIC, Australia

BYTE Deck

I recently received the May edition of BYTE. On skimming the articles, I noticed on page 36 in the News & Views section an article on Brooktrout's IP/FaxRouter. I wasn't impressed that this was presented as a "news" article, because a few days prior to getting the May edition, I received the BYTE Deck, and it showed the exact copy and graphics that are in the Brooktrout article. When you don't distinguish between industry news and paid advertising, it makes me doubt the objectivity of your articles.

Chris Cowles
Houston, TX

The BYTE Deck includes a reprint of an article from the magazine as an added service to our readers. I understand the confusion, but the article was written by our author and then included in the BYTE Deck. It was not written by any of the advertisers.—Dave Andrews

PGP URL?

In your August 1994 issue, you included an article on PGP (Pretty Good Privacy). I have just gained access to the Internet and would like to find PGP. However, I don't know where it is, and your article didn't include an Internet address for the PGP files. Could you tell me where I might find it?

John Alexander
76762.3310@compuserve.com

The official MIT site is http://bs.mit.edu:8001/pgp-form.html. Remember that this software is export controlled and cannot be downloaded to computers outside the U.S.—Eds.

Where's the CD-ROM?

On February 5th, I sent in my subscription for BYTE on CD-ROM. I have not, after almost 3 months, yet received it. Now, I recall that the subscription form said something about allowing 3 to 6 weeks for delivery—or was it 4 to 8 weeks or maybe 6 to 12?

Perhaps, despite whatever federal regulations are about mail-order delivery time, you covered yourself on the subscription form (which, in the future, I will photocopy). But how about a message saying, "Thank you for holding, all customer-service lines are busy, somebody will be with you shortly" or an explanatory letter or something?

Louis Leon
louis@cia.cc.emory.edu

We apologize for the delay in processing the initial rush of orders for our CD-ROM. You should have received a letter explaining the delay, and by now, we should be caught up on all backlogged orders. However, if you still haven't received BYTE on CD-ROM, please call our customer-service line at (800) 232-2983.—Eds.

BYTE Benchmarks Redux

Over a week ago, I sent two messages requesting a copy of the BYTE Native-Mode benchmarks. I have not gotten any response.

David Zhang
dzhang@mipos2.intel.com

After reading Rick Grehan's article about the BYTE benchmarks in March, I would like to know how I can obtain a copy of the benchmarks.

Jaap van Milgen
L'Hermitage, France

We apologize for the slow response. Requests for the BYTE Native-Mode benchmarks have overwhelmed our staff, especially since, until now, we were sending out the benchmarks on floppy disks. We are pleased to announce that the benchmarks are now available via ftp at ftp.byte.com.—Eds.

FIX

In May, on page 206 of the What's New Software section, the price for OfficeTalk for Windows should have been listed as US$1395. ■

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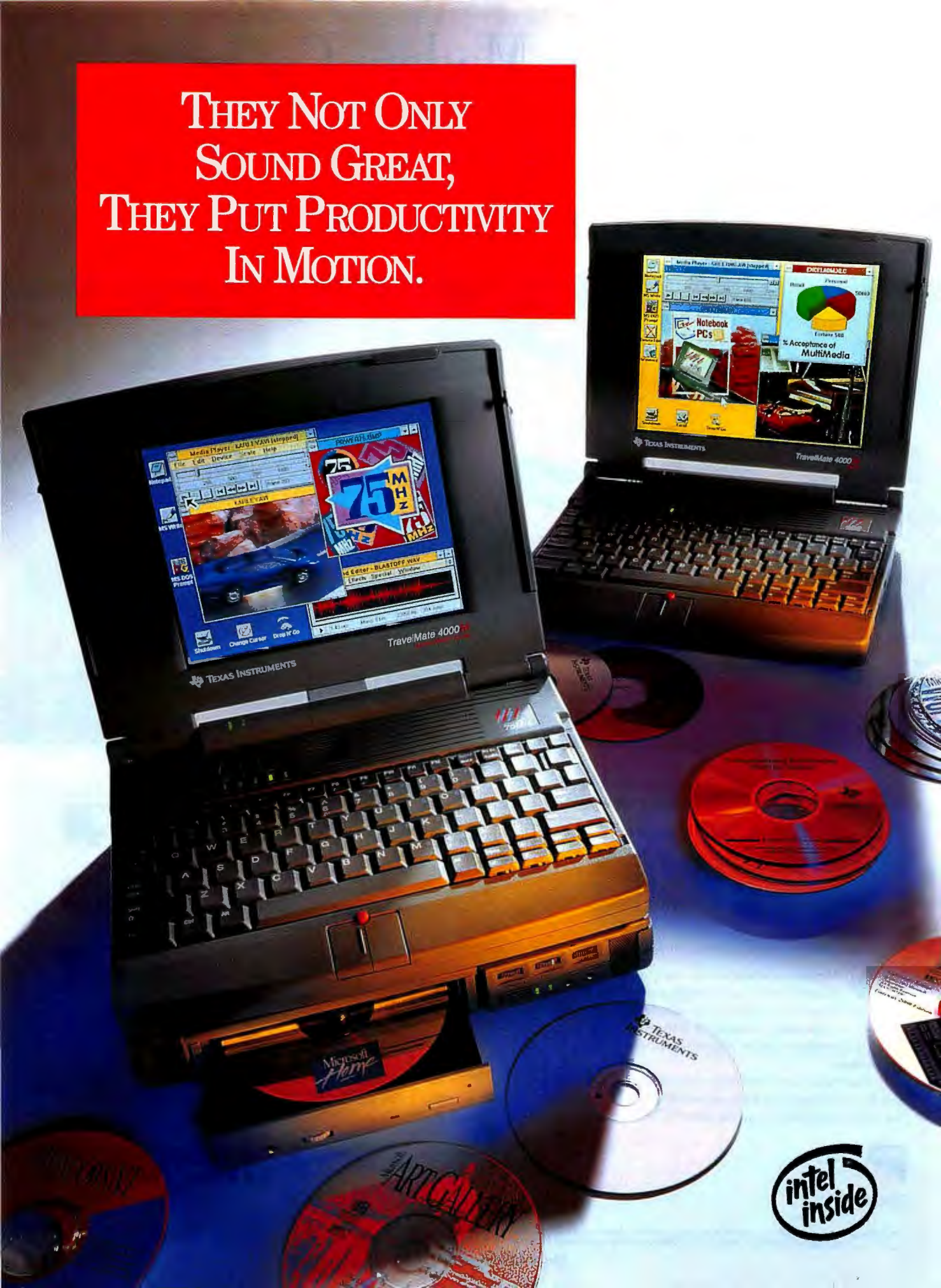

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Circle 99 on Inquiry Card (RESELLERS: 100).

News & Views

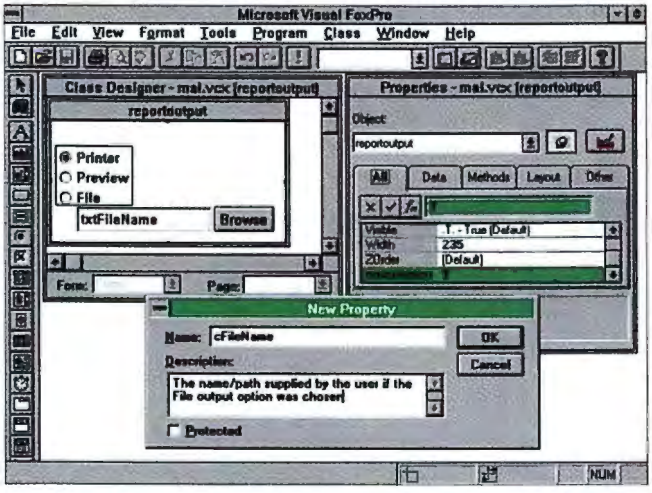
NEW VERSIONS OF DBASE AND FOXPRO

RADical Databases

The latest version of Microsoft's FoxPro confirms that Windows databases must compete with each other as well as with rapid application development tools.

BY RICK DOBSON

The next version of Microsoft's FoxPro represents a major overhaul that brings the relational database development package into the realm of RAD (rapid application development) tools. The RAD category encompasses tools ranging from dBase for Windows and Delphi from Borland (Scotts Valley, CA, (408) 431-1000; fax, (800) 408-0001) to PowerBuilder Enterprise from Sybase's PowerSoft subsidiary (Burlington, MA). Visual FoxPro 3.0, which is expected to be released this summer, offers capabilities typically found in RAD tools, such as event-driven programming, the ability to visually create reusable components, and integrated client/server database connectivity. Version 3.0's object model supports inheritance, subclassing, encapsulation, and polymorphism. But Microsoft's (Redmond, WA, (206) 882-8080; fax, (206) 936-7329) VFP should also find renewed competition from Visual dBase 5.5 (code-named Voyager), Borland's next version of dBase for Windows, which is also slated for a summer release.



Visual FoxPro's Class Designer simplifies the process of constructing visual classes, such as the reportoutput class, which is a tool for controlling report output. This class contains several control classes including the text box, txtFileName. The lower portion of the screen reveals the creation of a new property for txtFileName. The properties settings sheet shows noutputoption, the option group above txtFileName, set to a default value of 1.

Three areas meriting special attention from VFP developers include the Class Designer, new client/server functionality, and a Visual Basic–style event model. Microsoft has extended VFP's Xbase language to let developers create objects, classes, and subclasses. You can create classes with code or use the new Visual Class Designer to create classes without having to learn the new object model's syntax. Developers can group, store, and reference custom classes from class libraries.

For client/server developers, VFP integrates the Visual FoxPro Connectivity Kit. A new Upsizing Wizard simplifies the conversion of VFP file-server applications into Microsoft SQL Server client/server applications. A new Remote View Wizard simplifies access to SQL back-end data. Also, views based on local tables function within VFP just like those on back-end servers, which makes the migration of a prototype file-server VFP application to a client/server application easier. New 32-bit ODBC (Open Database Connectivity) drivers shipping with VFP are faster than the currently available 16-bit versions. VFP itself is a Win32s application, which means it runs as a 32-bit application in Windows 95. Finally, welcome support for VB-style events eliminates the need to use the clumsy Read command for event-driven programming. VFP lets the programmer access the usual set of Windows events, such as a mouse-click. Developers transitioning to VFP will find many more granular events than are available in older versions of FoxPro.

An important feature for RAD tools is the ability to create Custom classes, which ease the task of ensuring a consistent look and feel within and across applications and to guarantee consistently correct results when processing complicated business measures. VFP's Class Designer looks like a form designer, but it generates classes of reusable code. Even more intriguing, you can subclass commercial OLE 2.0 controls for specialized requirements. Microsoft's Access and Borland's Paradox do not as yet allow the creation of class constructs. The previous version of dBase, dBase 5.0 for Windows, can generate classes through its form designer and menu designer.

VFP's most obvious competitor is Visual dBase 5.5, which will be a 16-bit Windows application. Borland says this next version of dBase will offer several improvements, including the ability to save a control on a customized form as a class, which the current version cannot do. Highlights of other planned additions include performance enhancements, such as faster table

VISUAL WINDOWS DATABASES AT A GLANCE

Borland says a new 32-bit version of Paradox will ship within 90 days of Windows 95's commercial release and will support OLE controls. Visual dBase 5.5 has been demonstrated under the code name of Voyager. All four products support OLE Automation.

	VISUAL FOXPRO 3.0	VISUAL DBASE 5.5	ACCESS 2.0	PARADOX 5
Classes	Can create custom classes and subclasses in code and visually with a class designer	Can create classes and subclasses through visual designers	Cannot create custom classes	Cannot create custom classes.
Client/server	Upsizing Tool and Remote View Wizard for ODBC-compliant SQL databases	SQL Links to Oracle, Sybase, InterBase, and MS SQL Server; ODBC drivers	Upsizing and Browse Tools for Access-to-SQL Server table conversion; ODBC drivers	SQL Links to Oracle, Sybase, MS SQL Server, Informix, InterBase; ODBC drivers
dBase for DOS compatibility	Opens and joins with dBase tables (reads native dBase, converts to FoxPro format)	Runs dBase for DOS applications in command window	Opens and joins with dBase tables through ODBC	Opens and joins with dBase tables through Borland database engine
OLE Support	OLE 2 client	OLE 1 client	OLE 2 client	OLE 2 client and server
Macros	Records keystroke macros from user interface and attaches to function keys	None	Simple and powerful way for beginners to automate applications	None

browsing, more visual development tools and experts, support for such Windows 95 conventions as long filenames, the ability to embed ANSI-92 SQL commands directly in dBase instead of relying only on pass-through SQL or ODBC, an EXE compiler for distributing finished applications, support for OLE Automation, and the ability to call SQL stored procedures from dBase code.

Longtime FoxPro developers should find much to like in VFP. However, they won't find features in this version that are available in other RAD products. Some developers of client/server applications will prefer the more advanced data repository features of other popular client/server development tools. VFP also lacks features found in other client/server databases, such as the ability to back up files while the server is running.

Despite these drawbacks, the precommercial version of VFP that BYTE tested bodes as good news for FoxPro developers. No longer should FoxPro programmers have to be content with a Windows version (FoxPro for Windows 2.6) that is a mere port from the DOS version. With their RAD capabilities and improved client/server features, the new versions of these Windows databases exemplify an evolution from a desktop and small workgroup focus to much better support for enterprise database needs.

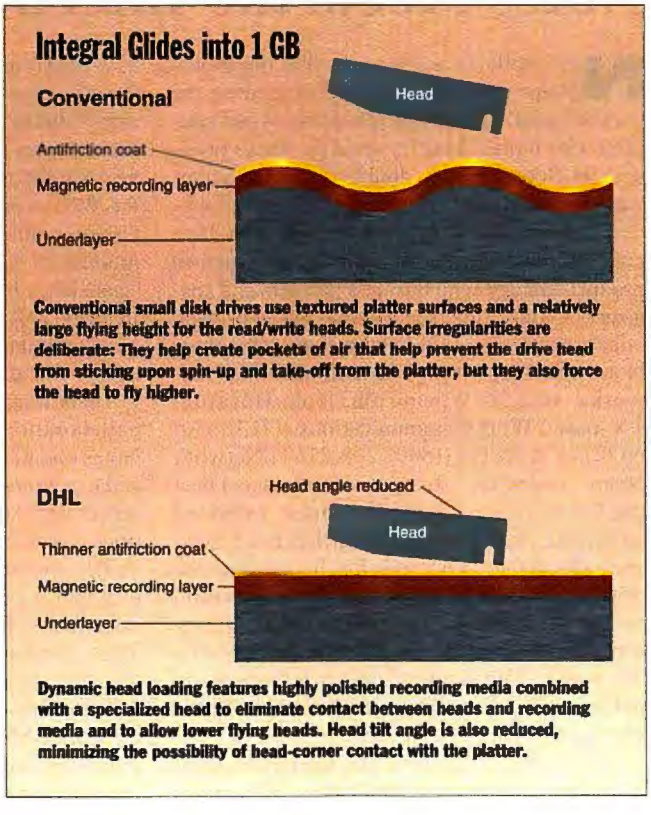
(Michael Levy and Dave Andrews also contributed to this story).

STORAGE TECHNOLOGY

Notebook Hard Drives Hold More

Hard drive manufacturers are using several technologies to satisfy the demands of notebook users who want smaller, lighter, more powerful machines. IBM's latest 17 mm high, 2.5-inch hard drive, the TravelStar XP (AT interface version expected to ship in June; SCSI version in July), uses a number of technologies, including magnetoresistive heads (instead of thin-film heads), to get increased areal density. The result is a 1.2-GB hard drive for notebook computers. In August, another hard drive manufacturer, Toshiba America, is expected to announce a 1-GB hard drive designed especially for the notebook market.

The most intriguing announcement this spring might come from Integral Peripherals (Boulder, CO). Its Platinum/SL drive, which is expected to start volume shipments in the third quarter of 1995, will offer a native capacity of 1 GB in a 12.7 mm high, 2.5-inch drive. Price for the drive to manufacturers will be about $795 (compared to about $790 for IBM's 1.2-GB AT interface TravelStar XP drive), and Integral says this price will drop over time. The 1-GB capacity is a giant leap for small notebooks such as Digital Equipment's HiNote Ultra, which uses 12.7-mm hard drives, with a current maximum storage capacity of 340 MB. Integral uses a number of technologies, including dynamic head loading (see the figure "Integral Glides into 1 GB"), to allow these higher capacities.



Rich Liguori, program manager in Digital's mobile computing group (Acton, MA), explains that these hard drives typify the industry's move to smaller, lighter systems that minimize compromises. He also notes that although the difference between a 12.7-mm drive and a 19-mm drive used in a desktop system might appear to be minute—it's roughly equivalent to the width of your pinkie fingernail—the difference is enormous to engineers developing small notebooks. As Liguori says, "Every millimeter counts."

—Dave Andrews

PCI POWER MACS

Apple's Tsunami: PCI Power

Apple will release a PowerPC-based notebook and other systems, including the top-of-the-line Power Mac 9500 (code-named Tsunami) this summer. The 9500 centers around a PowerPC 604, clocked at 120 or 132 MHz, with a 512-KB cache. The processor sits on a processor card. Because DRAM and the L2 cache reside on the main logic board, upgrading to a faster CPU will require a mere card swap. The memory bus is self-configuring to a maximum of 50 MHz, allowing it to support different-speed processors.

The 9500's base memory features 16 MB of 70-nanosecond DRAM (expandable to 768 MB). The L2 cache RAM is soldered on the main logic board, but the rest of the 9500's RAM resides in sockets. The 9500 uses 168-pin JEDEC DIMMs (dual inline memory modules) instead of the 72-pin SIMMs found in existing Power Macs.

The 9500's PCI bus operates at 33 MHz, and it's clocked independently of the processor. Many of the internal I/O subsystems in the 9500 use Open Firmware and the PCI bus for start-up configuration and data transactions. Apple built its own Rev 2.0–compliant PowerPC-to-PCI bus bridge chip for these systems. Apple's chip supports up to four multiple bridge chips and implements PCI bus masters and 96-MBps data streaming.

A number of improvements (see the text box"Power Mac at a Glance") in the 9500's architecture boost hard disk I/O. Improvements to the 9500's memory subsystem, including the use of memory interleaving to generate 128-bit wide memory accesses, resulted in performance increases of up to 16 percent. The 9500 also employs 14 DMA channels that manage I/O transfers and frees the 604 to handle more important tasks.

The 9500 and its siblings' new system architecture let them manage system resources more efficiently than previous designs, while unfettering the 604 to tackle more computer-intensive jobs. The 132-MHz Power Mac 9500, with 16 MB of RAM, a 2-GB hard drive, and quad-speed CD-ROM drive, will cost $5399.

—Tom Thompson

POWER MAC 9500 AT A GLANCE

CPU: PowerPC 604 (120- or 132-MHz) with 512-KB cache.

Standard Peripherals: Six PCI bus slots, a 1- or 2-GB fast SCSI drive, a quad-speed CD-ROM drive, two GeoPort serial ports, built-in 24-bit video, two Ethernet ports (a 10Base-T and an AUI port for other Ethernet connections), and two SCSI buses (one external and one internal bus that supports SCSI-2 fast transfers).

Power Supply: 220-W (ample power for slots and peripherals).

Improved hard drive I/O: Fast SCSI-2 internal SCSI bus and internal drive; SCSI driver now native, not emulated 680x0 code; new driver lets a SCSI peripheral's device controller use its on-board cache to optimize data transfers.

System 7.5.2: Faster dynamic recompilation emulator and other optimizations, including more native code (Resource Manager, SCSI Manager, device drivers, and network protocol stacks are native) along with enhanced native code and improved emulated code. Existing 680x0 code runs up to 50 percent faster.

POWER MAC 9500 PERFORMANCE RESULTS

BYTE's Native Benchmarks indicate that the better processor, higher clock speed, new software libraries, and improved memory subsystem give a 132-MHz, PowerPC 604-based Power Mac 9500 system much improved integer and dramatic floating-point performance over a 100-MHz, PowerPC 601–based Power Mac 8100.

	POWER MAC 8100/100	POWER MAC 9500/132
Integer Index	1.067	1.81
Floating Point Index	.375	1.74

(1 = 90-MHz Dell Pentium)

GROUPWARE

Notes Meets the Internet

New products and services that link Lotus Notes to the Internet are expanding the uses of Lotus's groupware platform. When coupled with Notes' built-in security, these products let Notes perform double duty as a groupware platform and an Internet publishing tool.

Companies typically use Lotus Notes to share confidential electronic communication such as product strategy with business partners and customers. Notes' tight security has eased privacy concerns of companies who outsource their Notes management to international Notes networks, such as WorldCom, from Houston, TX–based Wolf Communications ((713) 650-6522) or AT&T's ((800) 204-2764) Network Notes. "Notes has a stronger security model than the Internet," says Todd Ostrander, extended enterprise product manager at Egghead Software (Issaquah, WA), which is beta testing the AT&T Network Notes slated for commercial rollout in June. That desire for confidentiality can relegate the Internet—where practically anyone with a Web browser can retrieve data—to public information dissemination tasks. That's starting to change, however.

Notes add-on products like InterNotes from Lotus Development (Cambridge, MA, (617) 577-8500) and Tile from the Walter Shelby Group (Bethesda, MD, (301) 718-7840; info@shelby.com) can already convert designated Notes databases to a WWW page. The next step is to populate Notes databases from the Web, which is what a future version of InterNotes and the Walter Shelby Group's Tgate module in Tile do. Expected to ship in June, Tgate takes information that someone filled out in an HTML form (e.g., a purchase order) and converts it into data that adds a new document to a Notes database.

Tgate's appeal is that unlike the classic Notes collaboration method, in which users have a Notes client, anyone with a Web browser could add to a Notes database. If deployed on a WWW server with support for encrypted communications, Tgate can be used for secure transactions.

Tile does not provide a full Notes client. For example, it can't update or delete existing Notes documents. But products like InterNotes and Tgate increase the potential number of users that can interact with your company's Notes data and network. Says John Buckman, president of Walter Shelby, "You can't ask all of your potential customers to buy Notes so they can look at your advertising."

—Dave Andrews

"All in all, this is a must-have package for anyone serious about C++."

PC Magazine

Watcom C/C++ simplifies and accelerates development of high-performance, multi-platform 16- and 32-bit applications. Watcom C/C++ delivers productivity and performance, combining our state-of-the-art compiler technology with an integrated development environment (IDE) and comprehensive set of tools.

"...target a huge range of 16-bit and 32-bit platforms." *PC Magazine*

Watcom C/C++ supports development of applications targeting an incredible array of 16- and 32-bit PC platforms including: Windows NT, Win32s, 32-bit extended DOS (with royalty-free DOS extender), OS/2 2.x and Warp, Novell NLM, Windows 3.x, DOS and OS/2 1.x.

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"The clear cross-platform leader is Watcom C/C++ ..." *PC Magazine*

The extensive multi-platform support is amplified by the cross-platform capabilities of the IDE and tools, which enable building applications for a wide range of target environments from any of the host systems. Thus, you can standardize on a single host environment and toolset for application development across a wide range of target systems.

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Watcom C/C++ advances C++ optimizer technology with a superscalar optimization strategy which uses "riscification" and instruction scheduling to deliver improved performance on 486 and Pentium processors. The compiler can create a single, high-performance executable which runs on 386, 486 and Pentium processors.

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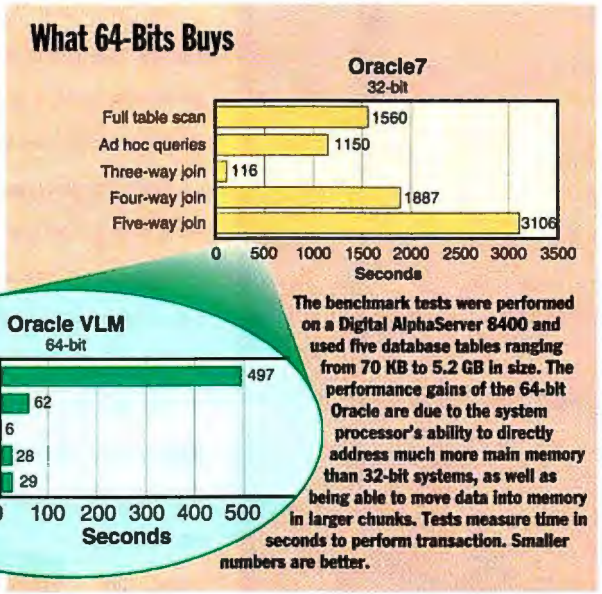
ENTERPRISE COMPUTING

Oracle Releases 64-Bit Database Bullet

When running large database applications, mainframe computers have traditionally offered impressive performance advantages over their client/server counterparts. Not any longer, say Digital Equipment, Oracle, and analysts. Such high-end network servers as Digital's new AlphaServer, when combined with new 64-bit RDBMS (relational database management system) software, now offer an alternative to mainframe systems. But the success of 64-bit database servers will rely on a number of factors: Don't expect to see a mass migration from the mainframe any time too soon.



A 64-bit system can deliver a performance improvement of between one and two orders of magnitude over a 32-bit system, according to analysts at the Aberdeen Group (Boston, MA, (617) 723-7890), which makes client/server database performance comparable to that of many mainframe systems. The combined efforts of Digital Equipment (Maynard, MA, (508) 493-5111) and Oracle (Redwood Shores, CA, (415) 506-7000) mark the first entry into this 64-bit area, which Aberdeen calls the LIMD (Large-scale In-Memory Database).

Oracle rewrote its 32-bit RDBMS, Oracle7, into a 64-bit version called Oracle VLM (very large memory). Oracle VLM, when run atop an OS like the 64-bit version of Digital Unix, lets you load much more of a large database into memory than is possible with a 32-bit program.

Typically, 32-bit systems are limited to main memory database usage of 2 GB. With Oracle VLM, the amount of addressable main memory is essentially unlimited, according to Larry Ellison, Oracle president and CEO. For example, Digital's new AlphaServer 8400, an enterprise server, and the 8200, a departmental server (both of which are the first to use the 64-bit, 300-MHz Alpha 21164 chip), can support up to 14 GB of main memory.

Additionally, compared to the 32-bit version, Oracle VLM takes fewer operations to move the same amount of data into memory. Oracle7 allows data transfers from disk to memory in 2 KB blocks (8 KB–size transfers were supported, but Ellison says that size was seldom used). In contrast, Oracle VLM moves data from disk into memory in 32 KB blocks (called Big Oracle Blocks or BOB for short). The increase in performance is compelling (see the accompanying chart).

The acceptance of 64-bit database systems, whether from Oracle or some other database vendor, depends on several factors. One important one is the availability of less expensive memory, which should start occurring in late 1995 with the arrival of low-cost 16-Mb memory chips.

A second factor is the mainframe's lower support cost per user. An official at IBM points out that when companies like Oracle tout the price/performance advantage of a client/server solution to a mainframe, they are only quoting cost of purchase and neglect to mention the hidden costs of user support.

A 1994 report produced by Forrester Research (Cambridge, MA) says that it costs three times more to support a 5000-user network ($6.4 million a year) than it does to support an equal number of users on a traditional IBM mainframe ($2.3 million). A third factor is the pace at which all applications that an organization typically runs on a mainframe—including administrative, financial, and other mission-critical applications—are ported to a given 64-bit application.

Aberdeen's analysts say it's not likely that mainframe customers will abandon their big iron unless their important applications—not just their databases—can move to client/server systems.

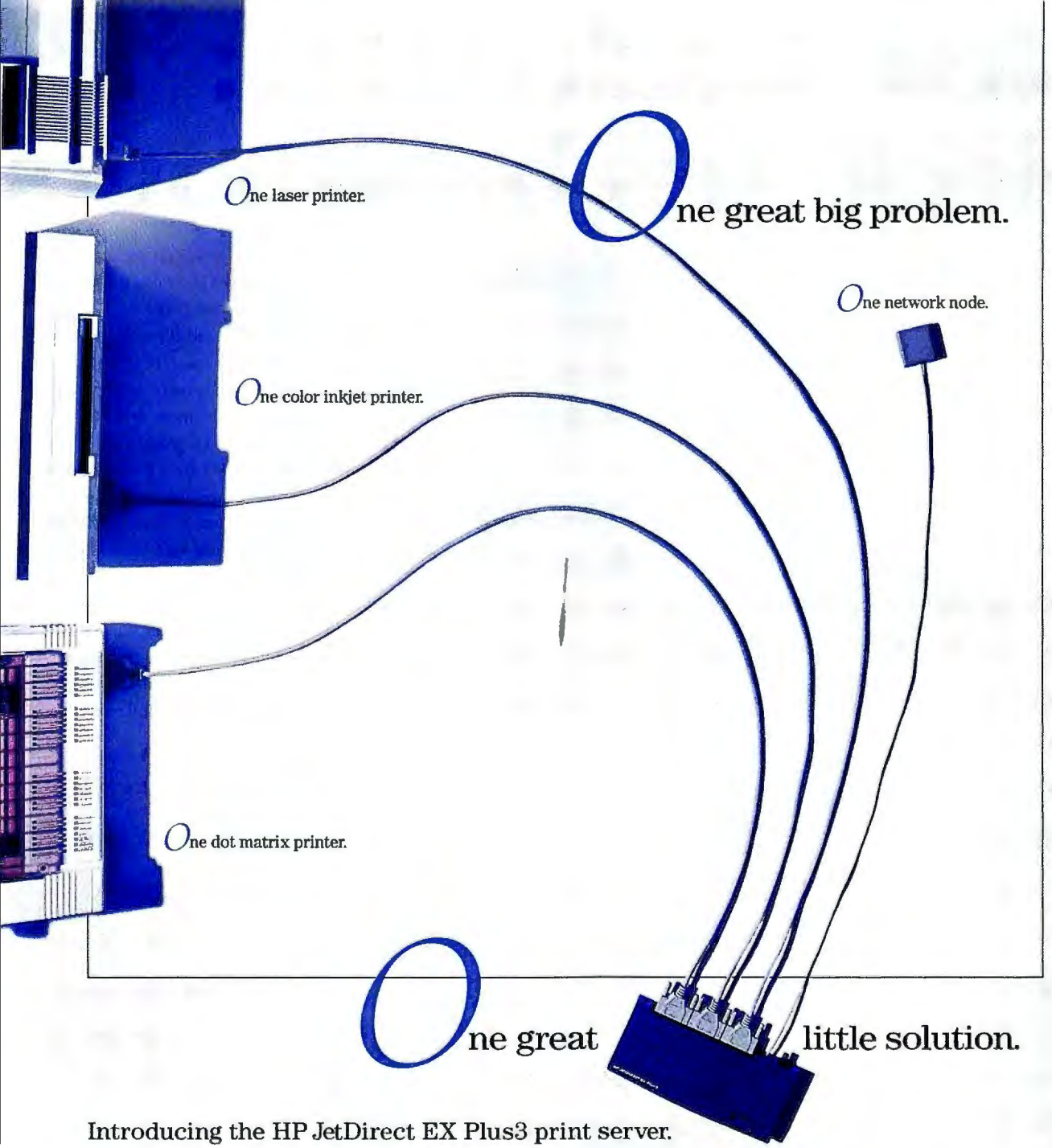
—Salvatore Salamone

Microsoft At Work?

In the summer of 1993, Microsoft announced a new architecture called At Work to enable connectivity between Windows PCs and office devices. For example, a Windows user would issue commands to a copy machine from the PC, and the copy machine would send back various status reports.

Few products bearing the Microsoft At Work moniker have come to market. Microsoft's Personal Systems Division continues to work on a hand-held PC companion. At Work printers based on the Windows Printing System have been released, but they only send bidirectional feedback to a directly connected PC (not across the network), unless you use the JetAdmin utility included in the CD-ROM version of Windows 95 with HP printers or print servers. But, Microsoft says Microsoft At Work is still alive and well. Josh Herst, a product manager at Microsoft, says the basic goals of Microsoft At Work still exist, but they've been distributed into different product groups (originally, Microsoft At Work was a separate entity at Microsoft). For example, Herst's group is working on a Windows 95 component called Microsoft Fax that will integrate with Microsoft Exchange, the universal in-box utility in Windows 95. West Caldwell, NJ–based Ricoh says it will ship its long-awaited IFS-66 At Work fax machine, which supports binary file transfer and inbound fax routing with other At Work fax machines, this fall. Microsoft says it currently doesn't plan to port the At Work kernel to non-x86–compatible processors.

—Nick Baran



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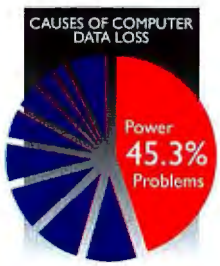


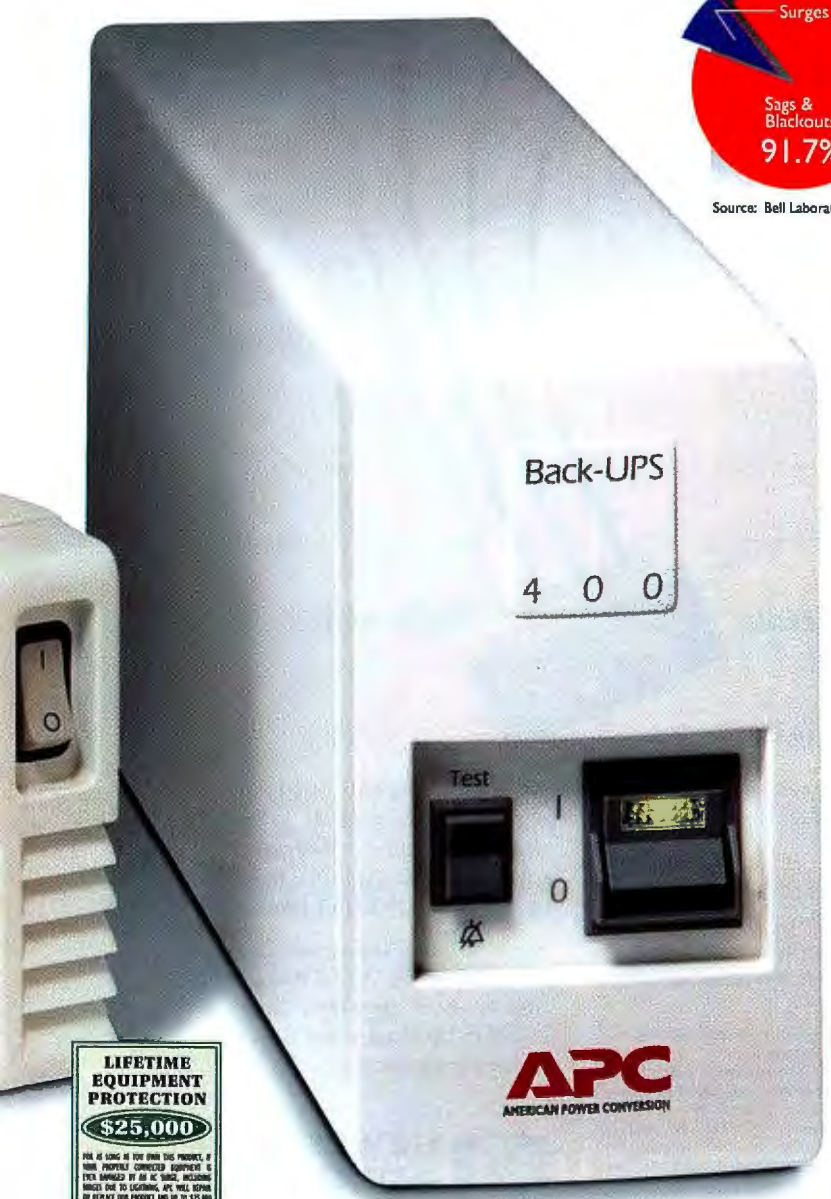
Source: Contingency Planning

Source: Bell Laboratories

IN THE NEXT THREE MONTHS, MORE THAN 30,000,000 PCs WILL BE HIT BY POWER PROBLEMS...

Who needs power protection? If you use a computer, you do. A study in a recent *PCWeek* showed that the largest single cause of data loss is bad power, accounting for almost as much data loss as all other causes combined. Every PC plugged into an outlet is vulnerable. In fact, you have better odds of winning the lottery than of escaping the sting of power problems. One study found a typical PC is hit over 100 times a month, causing keyboard lockups, hard drive damage, and worse.

Simply put, if power problems are the least of your troubles, you've got one chance to keep it that way. You insure your car and home with the best policy you can afford. It just doesn't make sense to leave your PC (which is at far greater statistical risk) vulnerable to loss or damage.



WHY A $119 APC UPS COSTS LESS THAN A $9.99 "SURGE PROTECTOR"...

Contrary to most people's belief, a PC alone already has more protection built into it than a low-end "surge suppressor," which is usually nothing more than a well-packaged extension cord. In other words, going without any protection is just as good as underspending on one of the most important PC decisions you'll make.

And since sags and blackouts represent more than 90% of power problems likely to hit your computer, even quality, high-performance surge suppressors are literally powerless to protect you from data loss.

That's why you need instantaneous battery backup power from an APC Uninterruptible Power Supply to prevent

PC World Top 20 Upgrade

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PC MAGAZINE UK

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protection against and other trials by fire

More than 3,000,000 satisfied customers count on APC reliability that goes above and beyond the call of duty

After a raging fire which took 18 trucks to subdue, Michael Benolkin, director of the Systems Division at Correa Enterprises, Inc. didn't expect much. "While rummaging through the ashes, we heard something beeping. Our four APC units were still in action, while two UPSes from another brand were history. We're still using these same APC units at our new office location - they still work like a charm! We're impressed with the ruggedness, reliability, and product support offered by APC."

Trial by Fire

Brian Krause, Network Manager for Goodyear Airship Operations, knows how critical APC protection can be." The night of the All-star game a tornado came through our blimp hanger and took out our roof. Our airships demand absolute communication so I protect our local and remote servers with the most reliable protection I can find: APC. APC's PowerChute software shut our server down in an orderly way... closed out all files nice and neatly. When we reconnected, everything came back up perfectly, without a hitch."

Trial by Air

Doug Welch learns his reliability lessons well: "While still a Computer Science student, I was at home preparing a large spreadsheet for a final project when Anchorage experienced an all too common 5+ Richter earthquake. If not for my Back-UPS 400 it would have been back to square one! I'm now the Network Systems Manager at Charter College, in charge of three networks. I learned my UPS lesson well back in my student days. I've never been disappointed with APC and the product has had quite a work out."

Trial by Earth

Faced with a water main break, Mark Conley, Regional Manager of Novell's remote sales office in Detroit was amazed at APC's reliability. "The APC unit was sitting in an inch and a half of water, working just fine, as though nothing was unusual and we lost no data to this disaster. We've used APC here now for at least four years - more than a dozen units are all around the office, and we're well satisfied, so we were even more impressed to learn that the units are amphibious!"

Trial by Water

Back-UPS Award Winning FEATURES

- Unmatched surge/lightning protection for maximum hardware safety
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- User replaceable, hot swappable batteries insure uptime safe disposal. Batteries will last 3-5 years under normal use.
- $25,000 lifetime Equipment Protection
- 10 minute runtime with specified applications. For longer runtimes choose next largest unit.

Model	Application	Sugg.List
200 **NEW**	"Green" PCs	$119
280 **NEW**	LAN Nodes	$139
400	Desktop 486/386 systems	$199
450	Tower 486/386 systems	$254
600	CAD/CAM workstations	$359
900	Longer runtime	$529
1250	Multiple systems	$689

keyboard lockups, data loss, and crashes. With an APC UPS, you get six times the protection of a high-end surge protector for little more than twice the price. And $119 is much less expensive than false peace of mind. APC UPSs carry up to a $25,000 lifetime guarantee against surge damage to your properly connected equipment, and are available to suit any application, from network servers and PCs, to fax and satellite systems.

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It's been said that there are two types of computer users: those who have lost data, and those who are about to. Prevent the single largest cause of computer problems and join a fast-growing third category: those who protect their PC's with the most reliable protection they can buy: APC UPSes. So ask for APC at your favorite reseller. At just $119 an APC UPS is serious protection no serious computer user should be without.

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BEST OF COMDEX

Network and Windows 95 Take Top BYTE Awards

The next version of Windows and a high-speed network took top honors as BYTE editors at spring Comdex recognized innovative products that will impact the industry. This was the first Comdex at which Windows 95 was in full display on the show floor, and many vendors demonstrated preliminary versions of Windows 95 hardware and software. For this reason, BYTE's editors awarded Windows 95 Best Operating System and Best of Show.

MCI (Washington, DC) and the National Science Foundation (Washington, DC) won Best Technology for their high-speed vBNS (Backbone Network Service). The vBNS will serve as an experimental platform for developing new national networking applications and will link supercomputing sites. The vBNS will initially operate at 155 Mbps. Operations over 600 Mbps are planned for 1996.

AnchorPage for Windows ($895), from Iconovex (Bloomington, MN, (800) 943-0292) won Best Development Software. AnchorPage inserts hypertext tags into information on WWW (World Wide Web) document databases and also creates conceptual analyses and abstracts of text documents.

Matrox (Dorval, Quebec, (800) 361-1408 or (514) 969-6320; fax, (514) 969-6363) won Best Peripheral for its 64-bit Millenium, a 3-D accelerator and video playback card. Best Multimedia Software went to AudioActive from the Blue Ribbon SoundWorks (Atlanta, GA, (404) 315-0212; fax, (404) 315-0213). AudioActive is an intelligent music engine and Windows API for multimedia developers. The developer tells the software what kind of theme or atmosphere is needed and the engine generates copyright-free music to suit that scene. Best Multimedia Hardware went to Sigma Designs (Fremont, CA, (800) 845-8086 or (510) 770-0100; fax, (510) 770-2640), which combines video capture, compression, and editing in its RealMagic Producer board ($3995).

Kyocera (Somerset, NJ, (800) 232-6797 or (908) 560-3400; fax, (908) 560-8380) won Best Printer for the FS-3600A printer (about $3500), the newest ceramic-drum Ecosys laser printer, which has true resolution of 600 dpi. Multi-Tech Systems (Mounds View, MN, (800) 328-9717 or (612) 785-3500; fax, (612) 785-9874) won Best Connectivity Hardware honors for its MMV-Series MultiMux ($1499 each) that extends PBX capabilities to a remote site. It concentrates voice, data, and fax traffic onto a single phone line.

Best Connectivity Software went to CompuServe (Columbus, OH, (800) 848-8199 or (614) 457-8600; fax, (614) 457-0348) for its NetLauncher for Windows program that gives users access to WWW sites and other Internet services. Best Portable went to AT&T Global Information Solutions (Dayton, OH, (800) 447-1124 or (512) 445-5000) for its 75-MHz Pentium-based 250P.

The UniFlex 5/300 RISC PC from Deskstation (Lenexa, KS, (800) 793-3375 or (913) 599-1900; fax, (913) 599-4024) won Best System. The system BYTE saw houses a 300-MHz 21164 Alpha microprocessor. Symantec's (Cupertino, CA, (800) 441-7234 or (503) 334-6054) Norton Utilities for Windows 95 took the Best Application award. The package continuously monitors system resources, diagnoses and fixes file system problems, optimizes your drive, and provides system recovery tools for Windows 95 users.

BEST OF COMDEX FINALISTS

Systems: The TDZ-60 graphics workstation from Intergraph Computer Systems (Huntsville, AL, (800) 345-4856 or (205) 730-2000; fax, (205) 730-8300) can support up to six 100-MHz Pentiums and a selection of high-end 3-D accelerators. The RISCserver 2200 (starts at $11,400) from NEC (Boxborough, MA, (800) 709-3434 or (508) 264-8000; fax, (508) 264-8673) is based on two 200-MHz Mips R4400 processors running Windows NT.

Portables: The Austin Vista Notebook from IPC Technologies (Austin, TX, (800) 752-1577 or (512) 339-3500; fax, (512) 454-1357) is a DX4-75 or -100-based portable with an 11.3-inch screen. The Tadpole P1000 combines 100-MHz Pentium with a rugged magnesium alloy case (Austin, TX, (800) 232-6656 or (512) 219-2200; fax, (512) 219-2222).

Peripherals: Casio's (Dover, NJ, (800) 962-2746 or (201) 361-5400; fax, (201) 361-3819) QV-10 still-video camera lets you view the pictures you've taken without having to load them onto a Mac or Windows computer, and you can store up to 96 images in its 2-MB flash memory. Hewlett Packard's (Santa Clara, CA, (800) 722-6538; fax, (800) 333-1917) ScanJet 3c color scanner combines 600-dpi resolution with a host of bundled software for the same price (about $1100) as the older, 400-dpi ScanJet IIcx.

Printers: Epson America's (Torrance, CA, (800) 289-3776 or (310) 782-0770; fax, (310) 782-4455) Stylus Pro XL offers better color printing than the previous Stylus ink-jet printer and can handle 11- by 17-inch images. Kodak's (Rochester, NY, (800) 235-6325 or (716) 724-4000; fax, (716) 724-0663) $7495 XLS 8400 PS replaces the ColorEase dye sublimation printer with faster printing (full-color page in about 75 seconds) and 8.4- by 12-inch coverage.

Hardware Connectivity: The Konexx Konnector, from Unlimited Systems (San Diego, CA, (800) 275-6354 or (619) 622-1400; fax, (619) 550-7330) lets 28.8-Kbps modem users dial out through a digital PBX by plugging into the phone's handset connection. The M208 Workgroup Print Server with Intelligent Hub from Microplex Systems (Burnaby, BC, (800) 665-7798 or (604) 444-4232; fax, (604) 444-4239) is an eight-port Ethernet hub and print server that provides remote LAN access.

Connectivity Software: MobileWare 2.0, from MobileWare (Richardson, TX, (214) 690-6181, ext. 25; fax, (214) 690-6185) provides a remote access program for Windows NT that lets users exchange E-mail, send files, access data, and perform other functions remotely over wired or wireless networks. Elan Software's (Pacific Palisades, CA, (800) 654-3526 or 3(10) 454-6800; fax, (310) 454-4848) Goldsync Remote Synchronization Gateway lets users at remote sites replicate and synchronize the GoldMine PIM databases.

Multimedia Hardware: Movie Machine II from Fast Electronic (Foster City, CA, (415) 345-3400; fax, (415) 345-3447) is a video production system that lets you do A/B roll editing, Motion JPEG encoding, MPEG playback, and special effects for $1200. Radio Rock-It RDS (less than $250) from Advanced Digital Systems (Cerritos, CA, (310) 926-1928; fax, (310) 926-0518) lets you receive FM-stereo signals as well as text information like weather updates and news through the Radio Broadcast Data System.

Multimedia Software: OpenInfoManager for Windows from Horizons Technology (San Diego, CA, (619) 292-8860; fax, (619) 292-9439) lets you author multimedia presentations and training materials without having to learn a scripting language. Delrina's (Toronto, Canada, (416) 441-3676; fax, (416) 441-0333) Echo Lake (Windows version this spring, Mac version this fall) lets you easily assemble multimedia family albums and personal archives.

Applications Software: DesignCAD 3-D for Windows from American Small Business Computers (Pryor, OK, (918) 825-7555; fax, (918) 825-6359) provides highly capable 3-D CAD for under $500. Maptitude from Caliper (Newton, MA, (617) 527-4700; fax, (617) 527-5113) delivers GIS and mapping with census data, street maps, demographic data, state and county maps, and more for only $395.

Development Software: Calendar Widgets from Sheridan Software Systems (Melville, NY, (516) 753-0985; fax, (516) 753-3661) is an OLE Control for Visual Basic, Visual C++, and other development tools. WinHelp Office from Blue Sky Software (La Jolla, CA, (800) 677-4946 or (619) 459-6365; fax, (619) 459-6366) packages several tools (which will also be available separately) to help you create Windows help systems that can include hypertext documents, video, and sound.

Operating Systems: Windows NT 3.51, from Microsoft (Redmond, WA, (206) 882-8080) will run on the PowerPC and offers improved support for PCMCIA and the Windows 95 user interface. IBM's Warp Connect (Austin, TX, (800) 342-6672; fax, (800) 426-4329, ext. 99) combines OS/2 Warp with network connectivity, including a peer network OS.

Best Technology: The Real3-D technology embodied in the R3D/100 chipset from Lockheed-Martin (Orlando, FL, (800) 393-7730; real3d@mmc.com) brings excellent workstation-quality 3-D graphics—including the ability to process 750,000 polygons per second and 33 million textured pixels per second—to the desktop. The IIT3304 Multimedia Encode Chip from Integrated Information Technology (Santa Clara, CA, (800) 832-0770 or (408) 727-1885; fax, (408) 980-0432) is a programmable DSP-based processor that supports both MPEG encoding and decoding on the same chip.

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"Appropriate for documents of all lengths, VENTURA offers templates to get started quickly, better text formatting, and prepress capabilities."

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NETWORK MANAGEMENT

One Step Back for Integration

The inability of major network management platform vendors to agree on a common API and database schema has dealt a setback to the Management Information Consortium's efforts to resolve network management integration and incompatibility issues. The MIC (see December 1994 BYTE, page 114) sought to address the thorny issue of consolidating network management information that's stored in different DBMSes into a common repository, but four major backers, Digital Equipment, Hewlett-Packard, IBM, and SunSoft have withdrawn from the consortium, citing a number of reasons. "The end result is bad news for users," says David Passmore, president of the consulting firm Decisis (Herndon, VA). "Gathering management information will continue to be more difficult than it should be."

Companies that supply network equipment (hubs, routers, and adapter cards) are the driving force behind the MIC. In the early 1990s, equipment vendors such as Bay Networks, Cisco Systems, Chipcom, and others began developing network management applications that ran on network management frameworks like IBM's NetView, Sun's SunNet Manager, and HP's OpenView. The services (i.e., standard APIs) that each of these frameworks (aka platforms) provided reduced the effort required of network equipment suppliers to write their network management applications.

However, the platform approach has flaws. Applications running on a platform often store management information in different DBMSes, and network managers need a common way to access that information. Another problem was that third parties still had to spend a lot of money porting their software from one platform to a second or third. The MIC was trying to overcome these problems by developing an interface capable of pulling data from disparate DBMSes. Having all platforms conform to the interface would have also made the porting issue simpler.

Initially, the four companies all joined the MIC and pledged to support its work. But an official at HP cited a number of issues that quickly arose, including concerns over needless duplication with data integration efforts of other standards organizations and the MIC's slow progress. Decisis's Passmore says a more likely explanation for the break is that network management platform vendors want to differentiate their wares rather than have them conform to standards.

James Corrigan, MIC chairman and president of Ki Networks (Columbia, MD), says the MIC will forge ahead with its standards and work at the same time to avoid duplicating the efforts of other groups, such as the Internet Engineering Task Force. Corrigan expects MIC-compliant products to ship this year. However, the standards will have little impact if platform vendors do not support them. Right now, they do not have any plans to do so.

—Paul Korzeniowski

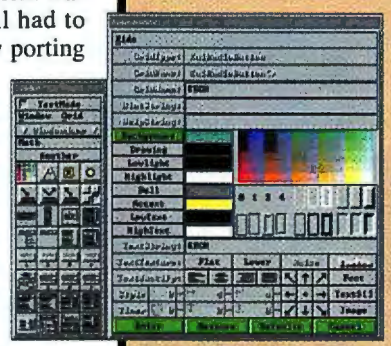
CODE TALK

RICK GREHAN

64 Bits of BASIC

Years ago, as the C programming language gained momentum on microcomputers, I'd have sworn that BASIC would be swept aside. I have never been more wrong; the success of Visual Basic has seen to that. Now comes XBasic, from Basmark (Cleveland, OH (216) 871-8855; fax, (216) 871-9011).

XBasic is a cross-platform compiler with a full-blown graphical integrated development environment (editor, debugger, and GUI-builder) that boasts—among other things—of being a 32/64-bit implementation of BASIC. It claims "64-bit-ness" thanks to its GIANT and XLONG data types. The former is a true 64-bit integer. The latter is a "machine-dependent" 64-bit integer (e.g., XLONGs are 32 bits on 32-bit machines, and 64 bits on 64-bit machines). Currently, XBasic runs on Intel CPUs only. Basmark claims future releases for PowerPC, RS6000, SPARC, and Alpha versions, where 64-bit data types can be handled natively will be released later in 1995.



Basmark's XBasic support for 64-bit integers and potential portability to CPUs other than x86-compatible processors is intriguing, but the Windows version needs fine tuning.

XBasic's platform independence is obvious, even with a casual glance. I experimented with XBasic on Windows for Workgroups 3.11 (Basmark has versions for Window 95, Window NT, OS/2 Warp, and 386 Unix), and none of the buttons, scroll bars, and fonts looked like Windows components. Still, I had no trouble navigating the development environment.

XBasic's GUI Designer is as good as any visual development tool I've seen. Click on a toolbar and up pops an empty window. With a few clicks and drags, you populate the window with buttons and scroll bars; then click another toolbar button, and XBasic pours into your program the source code template for initializing and drawing your window. This code amounts to a callback function, and it includes empty CASE statements corresponding to the window's widgets, including buttons, scroll bars, and others. Flesh out the CASE statements with code, and you can have a working program up and running in a matter of minutes.

Though XBasic is a compiler, the system's rapid compile cycles and integrated debugger give you all the benefits of an interpreted environment. You can build stand-alone executables, and as proof of this the engineers at Basmark told me that XBasic is—get this—written in itself.

I won't kid you: XBasic still has some rattles that need tightening. The latest release notes admit that there are "memory leaks" in the Windows version of the package. (Basmark says a version that fixes the memory leak should be available by mid-1995.) If you keep XBasic open too long, you have to shut down Windows and restart to get the memory back. XBasic doesn't currently support OLE controls or 16-bit VBXes. However, company officials say the ability to host OLE controls may be added later this year.

Still, XBasic brims over with potential. The Professional Edition (which I tested) is $249 for one user. If working with the GUI Designer is any indication of XBasic's capabilities, this should make for a powerful programming package.

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The P1000 was built for sheer speed, but it was designed to handle the ROAD comfortably too. Its Lexmark KEYBOARD with integral pointer and three mouse buttons is a nice touch. With 1MB of video RAM, large 10.4" active-matrix TFT **TRUE COLOR** screen and 16-bit CD-quality sound, every presentation is a **BIG PRODUCTION**. And to make a case for durability, we made a lightweight, rock-hard magnesium shell to protect the P1000 from life's hard knocks. Best of all, the processor module is factory-upgradable, and the SCSI-2 removable hard drive and memory are user-upgradable. This is the **LAST** notebook you'll ever need to buy.

Although the side effects of using the P1000 may be slightly disconcerting at first, just think of the corporate advantages of having your eyes in the back of your head.

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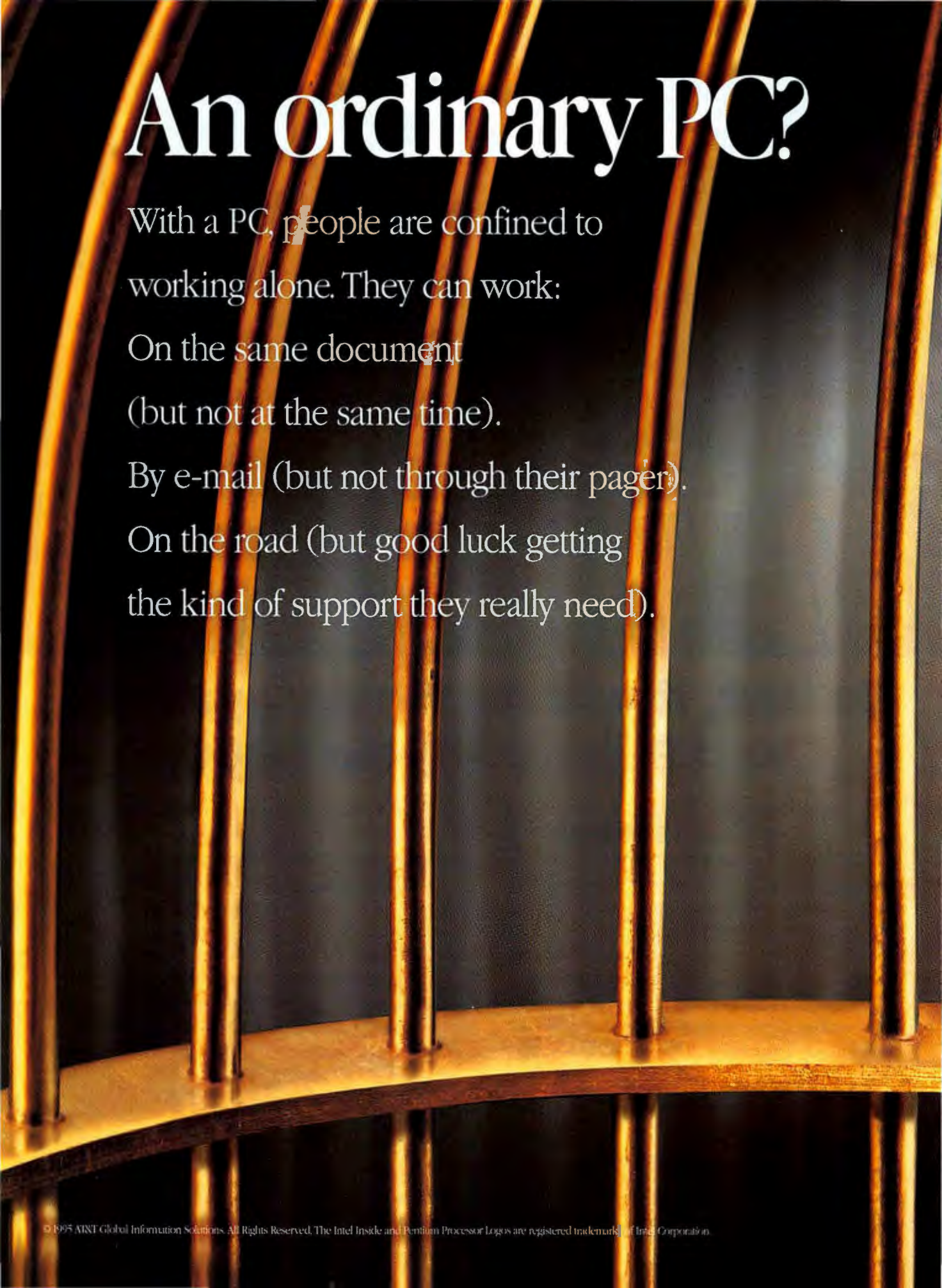

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SIX-SPEED CD-ROM DRIVES

6X Yields Better Software MPEG and Networking

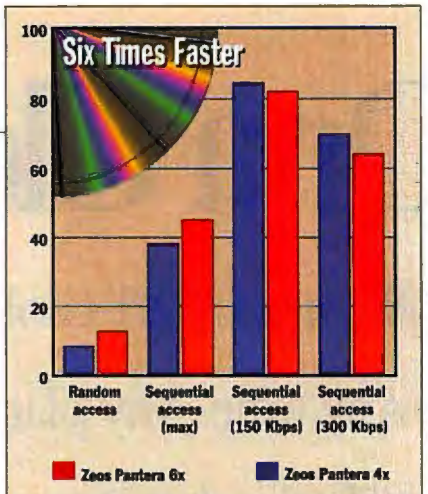
Quad-speed CD-ROM drives are the industry standard, but a new crop of six-speed CD-ROM drives with 900-Kbps data transfer rates should appeal to multimedia aficionados and network managers who want improved performance from their CD-ROM jukebox towers. Plextor's 6PleX drive should be followed by other six-speed CD-ROM drive offerings this year from such vendors as TEAC, NEC Technologies, and Wearnes.

Hard-core multimedia users will pay the steep premium ($600 for a bare six-speed drive versus about $200 for a quad-speed model) for a performance boost. "People still say 'I just want [six-speed drives] for games,'" says Felix Nemirovsky, engineering manager at Plextor (Santa Clara, CA). Nemirovsky notes, however, that a six-speed drive running on anything less than a Pentium system will show only marginal gains. Sophisticated animation and video sequences are the most demanding data types to play off a CD-ROM, and so their performance will see the greatest boost with a six-speed drive (see the benchmark table "Six Times Faster").

Perhaps even more significant, six-speed drives will make software-only MPEG compression and decompression much more viable. Acceptable playback of MPEG video generally requires a hardware codec. The two key bottlenecks that had held back software MPEG, according to Sorin Papuk, software development manager at MPEG codec vendor CompCore Multimedia (Sunnyvale, CA), were slow graphics acceleration under Windows and slow CD-ROM access rates. The latest PCI-based graphics boards and six-speed drives change that. "One year ago, software MPEG was a 'teasing' technology," says Papuk. "[It is] not yet fully equal to hardware MPEG, but it is closing the gap fast."

Networked CD-ROMs present a different kind of performance issue. On a network, you might have 50 people trying to access, say, a seven-drive tower at the same time. The faster those drives locate and read the data, the faster the tower can process all 50 requests. The tower must queue and register I/O for all requests; therefore, a few milliseconds' difference in the access time can improve overall throughput.

As prices drop, six-speed drives will replace quad-speed models. It took about 14 months for quad-speed drive prices to reach mainstream levels, says Julie Schwerin, president of research firm InfoTech (Woodstock, VT). "By this time next year," Schwerin says, "six-speed drives could be standard items."—**Michael Nadeau**



The National Software Testing Labs' InterMark benchmarks (in transactions per second) show the difference between a Mitsumi quad-speed drive and a Plextor six-speed drive running on the same 90-MHz Pentium system. The Random Access results indicate typical performance. Sequential access suggests the type of performance you will see reading large files, such as video. The last two tests measure performance when a drive slows itself down to read poorly recorded or damaged discs. Higher numbers are better.

DOCUMENT MANAGEMENT

DMA Promotes Information Anywhere

Two groups that sought to separately define industry specifications for version control, security, and other document services have joined to create the DMA (Document Management Alliance) and expect to release their first specifications this month. The goal: to make the information in documents available to anyone on a network, regardless of the application or interface.

DMS (document management systems) can help a company manage its memos, reports, and contracts, but incompatibilities among different systems result in isolated islands of information. The frustration that results from these incompatibilities is compounded as companies move to global networks.

The DMA formed in April 1995 when companies behind the DEN (Document Enabled Networking) effort, including Novell and Xerox, joined with the IBM- and Sarosled Shamrock Document Management Coalition. The DMA task force is organized under AIIM (Association for Information and Image Management) International in Silver Spring, MD. Frank Dawson, a senior programmer for IBM Software Solutions (Roanoke, TX) and cochairman of DMA, says the DMA wanted to coalesce around a common API while the industry was still young and relatively unstructured. First working demonstrations of product interoperability could occur later this year. The DMA, says Roger Sullivan, vice president of marketing at document management and work flow software vendor KeyFile (Nashua, NH), could eliminate the "myriad of formats" document managers and developers face today.

Most vendors and analysts are encouraged by the DMA, which will define three core elements (see the text box). Others worry the DMA will freeze innovation. "Standards work best when they evolve around something that happens de facto, not de jour," says Herb Edelstein, principal at Euclid Associates (Potomac, MD). "When you have lots of vendors, the tendency is to use the lowest common denominator."

—**Gordon E.J. Hoke**

DMA GOALS

- **A common interface for integration of the access and search methods of individual library services.**
- **A uniform API for accessing and searching across diverse document-management services.**
- **An object-based data model for standardizing access to enterprise library services. The model will allow for modular integration of library services where vendors could support either specific components or implement the complete model.**

The "P6" Processor

A GIANT STEP FOR PROCESSOR TECHNOLOGY

Intel Technology Briefing

WHERE NO PROCESSOR HAS GONE BEFORE.

Have you ever thought about what tomorrow's software will be like? Consider all you'll be able to do with the new applications like 3-D imaging, voice recognition and personal video conferencing. Ironically, as software enables these new, more user-friendly technologies, it means more work for your PC. These software programs will be larger and will require increased performance from your microprocessor. Intel engineers kept these thoughts in mind when they designed our new processor family, code-named "P6." The result is a processor that will handle tomorrow's software with ease.

Left: The companion 256KB L2 Cache.
Right: The "P6" Processor with 5.5 Million Transistors.

AVOIDING SOFTWARE BOTTLENECKS.

There are tens of thousands of PC software applications today, and new ones are being written everyday. Yet how a program is written can influence the processor's performance. For example, the program's instruction sequence can actually slow performance down when it forces a processor to stop what it is doing to "jump" or "branch" elsewhere in the program. Delays can also occur when an instruction must wait because it is dependent on the results of another which isn't finished being processed.

In other words, software design itself may cause delays in processing. To remedy this, a processor must not only be faster, but smarter. The "P6" processor is both.

The "P6" processor is actually a family of products. All members, the first of which will be introduced at a swift 133 MHz, will process instructions faster. But even more important than clock speed, the unique design of the "P6" processor makes it smarter—allowing it to process instructions more efficiently, no matter how the PC software is written.

A NEW WAY FOR PROCESSORS TO THINK.

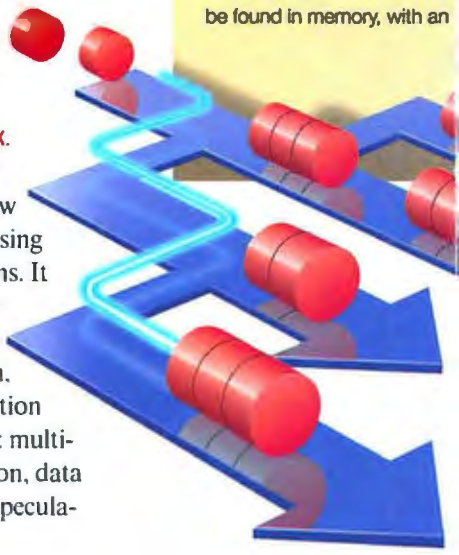
The "P6" processor takes an entirely new approach to processing software instructions. It uses a unique innovation called Dynamic Execution, which is a combination of three techniques: multiple branch prediction, data flow analysis, and speculative execution.

Multiple branch prediction allows the "P6" processor to look ahead and anticipate instructions that would slow down other processors, like multiple jumps and branches. Next it analyzes which instructions are dependent on each other's results to create an optimized schedule. Then, this schedule is executed.

All of this results in better software performance. Any idle time is held to an absolute minimum. And it works well no matter how individual software applications are written.

Multiple Branch Pred

The "P6" processor uses a multiple branch prediction alg rithm to anticipate jumps in th instruction flow. It predicts where the next instructions ca be found in memory, with an

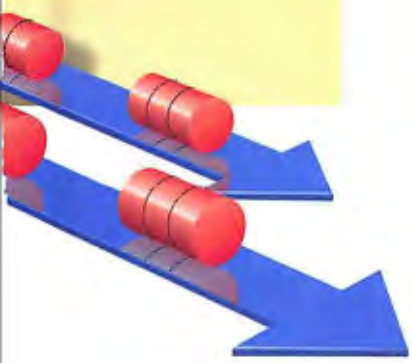


DYNAMIC EXECUTION

THIS CHART ILLUSTRATES HOW THE "P6" PROCESSOR UTILIZES DYNAMIC EXECUTION TO EFFICIENTLY MANIPULATE DATA RATHER THAN SIMPLY PROCESS A LIST OF INSTRUCTIONS. THE RED DISKS REPRESENT SOFTWARE INSTRUCTIONS.

iction

amazing 90% or greater accuracy. This is possible because as the "P6" processor is fetching instructions, it's also looking ahead at instructions further in the program.

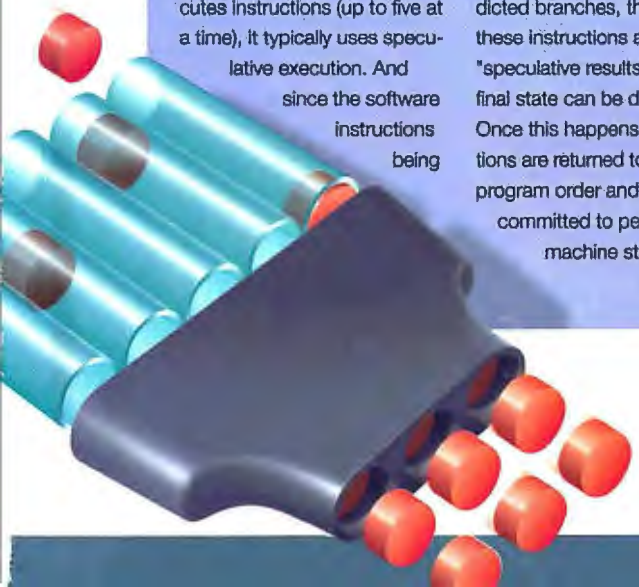


Data Flow Analysis

Using data flow analysis, the "P6" processor looks at decoded software instructions and determines if they are available for processing or dependent on other instructions. The "P6" processor then determines the optimal sequence for processing and begins executing them.

Speculative Execution

When the "P6" processor executes instructions (up to five at a time), it typically uses speculative execution. And since the software instructions being processed were based on predicted branches, the results of these instructions are stored as "speculative results" until their final state can be determined. Once this happens, the instructions are returned to their proper program order and their results committed to permanent machine state.



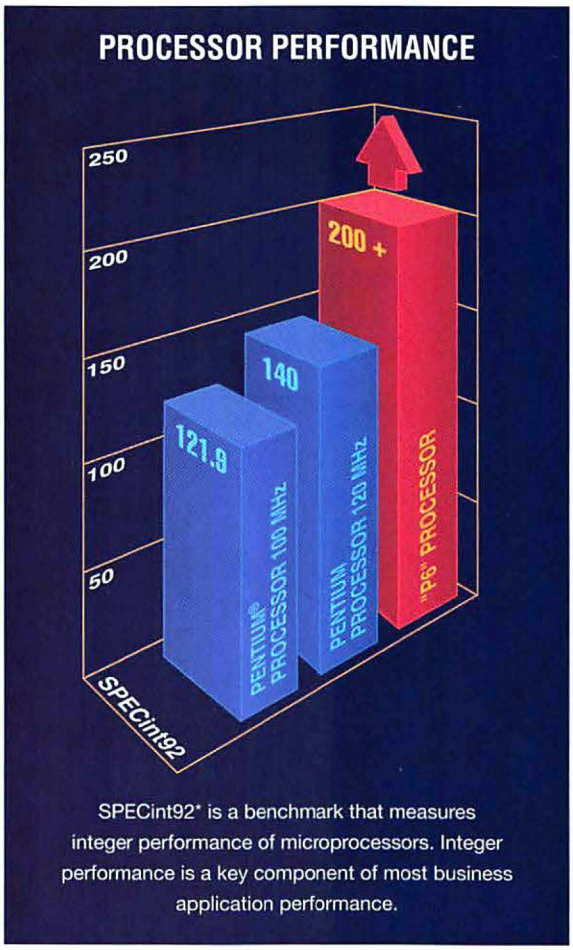
THE "P6" PROCESSOR IS ON THE HORIZON.

NEW APPLICATIONS NEED "P6" PROCESSOR POWER.

The "P6" processor delivers optimal performance for 32-bit software titles, including applications written for the Windows '95* operating system. But it also runs your 16-bit software, so that PC software compatibility, an Intel hallmark, is maintained. There are numerous existing and emerging applications that will benefit from the higher performance of the "P6" processor. They include:

ON DESKTOP SYSTEMS:

- 3-D image processing and rendering
- Real-time speech recognition
- Smooth-motion, software-only video conferencing
- Advanced multimedia digital sound capability



SPECint92* is a benchmark that measures integer performance of microprocessors. Integer performance is a key component of most business application performance.

ON SERVERS:

- Sophisticated financial modeling
- Intensive transaction processing
- Extensive, multidimensional databases

"P6" PROCESSOR SYSTEMS ARE COMING YOUR WAY.

Systems optimized for the "P6" processor are now being developed. Designed as "P6" computers from the ground up, they will take advantage of "P6" processor features to produce highly reliable, scalable systems. These new designs, combined with the "P6" processor's ability to reduce software bottlenecks, will result in better system-level performance. In addition, current PC subsystem technologies will be incorporated into these new computers, allowing the "P6" processor technology to dovetail easily with today's corporate and computer industry standards.

Want more information?

To get a tour of the "P6" microarchitecture, go to Intel's web site at: http://www.intel.com/procs/p6/; go to CompuServe,* GO INTELPROC; or dial Intel's FaxBack* documentation service at 1-800-525-3019 and ask for document #3012.

See Intel's briefings online.

To view this or other Intel Technology Briefings, go to Intel's web site at http://www.intel.com/ or go to CompuServe, GO INTELPROC.

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242554-001

Blasts from the Past

DENNIS BARKER

"The era of the personal laser printer is upon us." Low-cost lasers was the cover story. The lab tested a bunch of them, all compatible with the HP LaserJet II, and many priced in the $2000 neighborhood. Favorite picks were the LaserJet III, the TI microLaser, and the Mannesmann Tally MT 906.

Microbytes reported Microsoft's new spin on OS/2. VP Steve Ballmer told us the new nickname for OS/2 is Windows Plus. The alternative reality was thinking of Windows as OS/2 Minus.

We explored a range of input, control, and navigation devices, including stereoscopic displays for 3-D virtual environments, speech recognition, and gestures. As great as they sounded, note that most of us are still tapping on a mechanism developed more than a hundred years ago.

Buzz box There was a lot of talk about the Airis VH-286, a 6.5-pound notebook that the company first showed us under heavy secrecy. This $1895 "innovative new machine" had a 12.5-MHz 286, 2½-inch 20-MB hard drive, 11-inch black-on-white LCD, and 2400-bps modem on the motherboard, but no built-in floppy drive. It was a nice unit, but before the Chicago start-up could sell any, it met an untimely demise.

Notable reviews:

The Silicon Graphics Personal Iris Turbo workstation: "places real graphics in the hands of the people who need it most."

Lotus Notes 1.0: "a strange beast... [and] an interesting distributed-database network."

Zortech's C++ 2.0: "fully suited to professional code development."

Computers and space Some fun stuff for the Mercury-Gemini-Apollo generation: astronomical applications of microcomputers, calculating the locations of asteroids and comets, a program to determine the positions of satellites, ways to automate a telescope, and how NASA used a network of PCs to acquire and analyze data.

We reviewed two spaceflight simulators: Rendezvous, where you tried to hook up with a space station in Earth orbit, and Saturn Navigator, where you tried to reach a station near the ringed planet. Neither included a malevolent but mannerly computer that said, "I'm sorry, Dave, I can't do that."

The Texas Instruments Pro-Lite was a 10-pound portable that could take enough options to be nearly as functional as its desktop sibling, the TI Professional. It was one of the first PCs to have 3½-inch floppy drives. Our benchmarks showed it could load a WordStar document in 6.6 seconds, compared to 9.9 seconds on an IBM PC.

NCR's Personal Computer Model 4 *looked* like a portable, especially with those two built-in vertical disk drives. But it tilted the scales at a hefty 50 pounds. The keyboard alone weighed 4.5 pounds.

According to Webster In his inaugural column, "semiretired software engineer" Bruce Webster covered what's new: the Fat Mac (512 KB, two floppy drives), 10-MB hard drives for the Mac, a "mind-reading" program called Mind Prober, Steve Jasik's MacNosy disassembler, and IOmega's Bernoulli Box.

Computers in education Discussion and debate on PCs and learning. "Computer-aided instruction has many advantages and disadvantages that tend to offset or cancel one another," one contributor wrote.

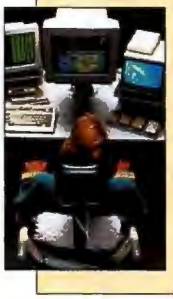
Forecast: "By the year 1984, there will be millions of general-purpose microcomputers in schools, colleges, and universities, with an even greater number available for educational use in the home."

J. C. Johnston, a graduate student at Cleveland State, wrote of his adventure building his own PC on a student's budget. Here's what he had to shell out:

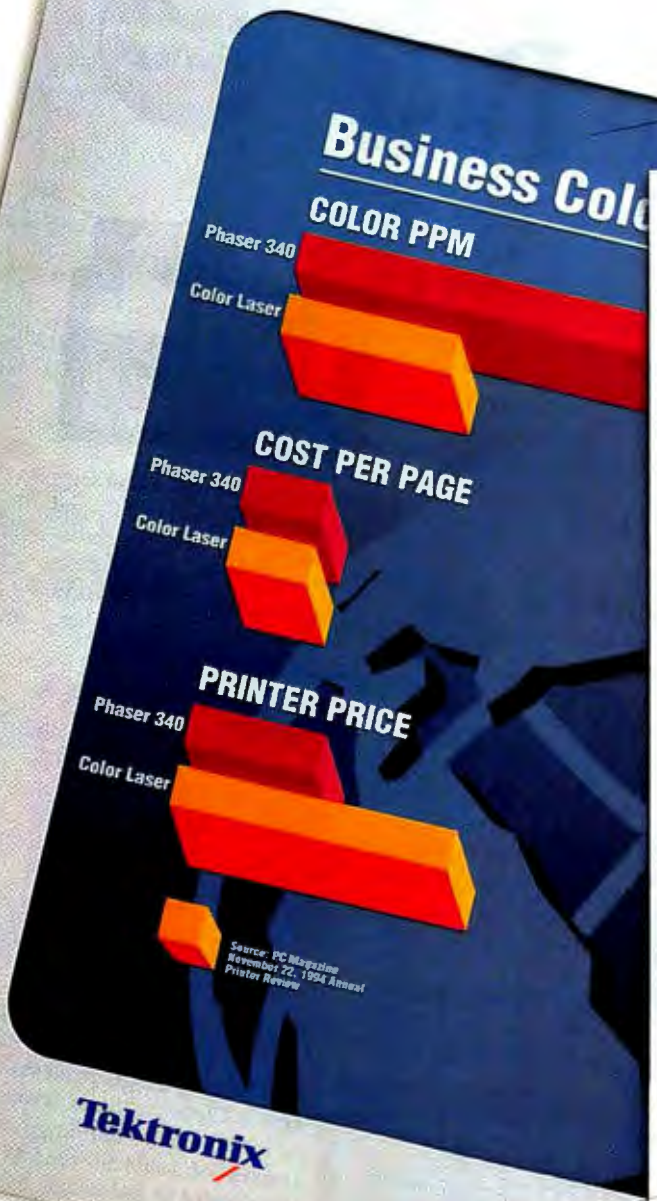
Z80 processor board	$120
4-KB memory board	$90
I/O board	$60
motherboard	$45
power supply	$25
enclosure	$40
power-supply extension	$12
video terminal	$200
total	$592

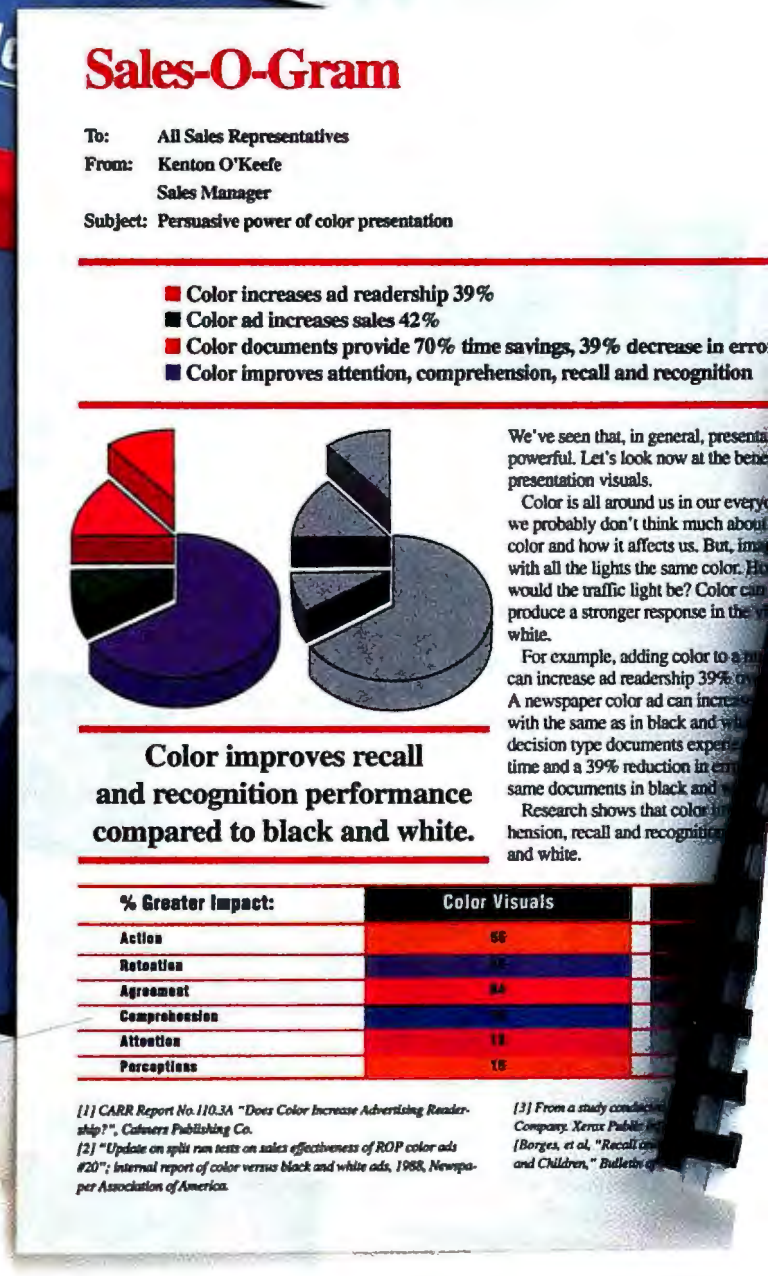
Dawn of Chaos Jerry Pournelle's first BYTE column appeared in this issue. "This will be a column by and for computer users, and with rare exceptions I won't discuss anything I haven't installed and implemented here in Chaos Manor."

Computing without keyboards was the State of the Art focus. To test our theory that you could do real work without punching keys, we strapped this subject to a special chair, put restraints on his wrists, and made him use an eye-tracking device to control the cursor. (At least he wasn't too close to the monitor and didn't risk repetitive-stress injury to his wrists from too much typing. However, eyestrain might be a danger.)



World-class overheads at astonishing speed and an equally amazing price.





Sales-O-Gram

To: All Sales Representatives
From: Kenton O'Keefe
Sales Manager
Subject: Persuasive power of color presentation

- Color increases ad readership 39%
- Color ad increases sales 42%
- Color documents provide 70% time savings, 39% decrease in erro
- Color improves attention, comprehension, recall and recognition

Color improves recall and recognition performance compared to black and white.

We've seen that, in general, presenta
powerful. Let's look now at the bene
presentation visuals.

Color is all around us in our everyc
we probably don't think much about
color and how it affects us. But, ima
with all the lights the same color. Ho
would the traffic light be? Color can
produce a stronger response in the v
white.

For example, adding color to a n
can increase ad readership 39% ov
A newspaper color ad can increas
with the same as in black and wh
decision type documents experi
time and a 39% reduction in er
same documents in black and w

Research shows that color i
hension, recall and recognitio
and white.

% Greater Impact:	Color Visuals
Action	55
Retention	42
Agreement	34
Comprehension	26
Attention	19
Perceptions	16

[1] CARR Report No.110.3A "Does Color Increase Advertising Readership?", Cahners Publishing Co.
[2] "Update on split run tests on sales effectiveness of ROP color ads #20"; internal report of color versus black and white ads, 1988, Newspaper Association of America.
*[3] From a study conducte
Company. Xerox Public
[Borges, et al, "Recall
and Children," Bulletin*

Text and spreadsheets can be printed from PCs, Macs and workstations. Or connect directly to virtually any network.

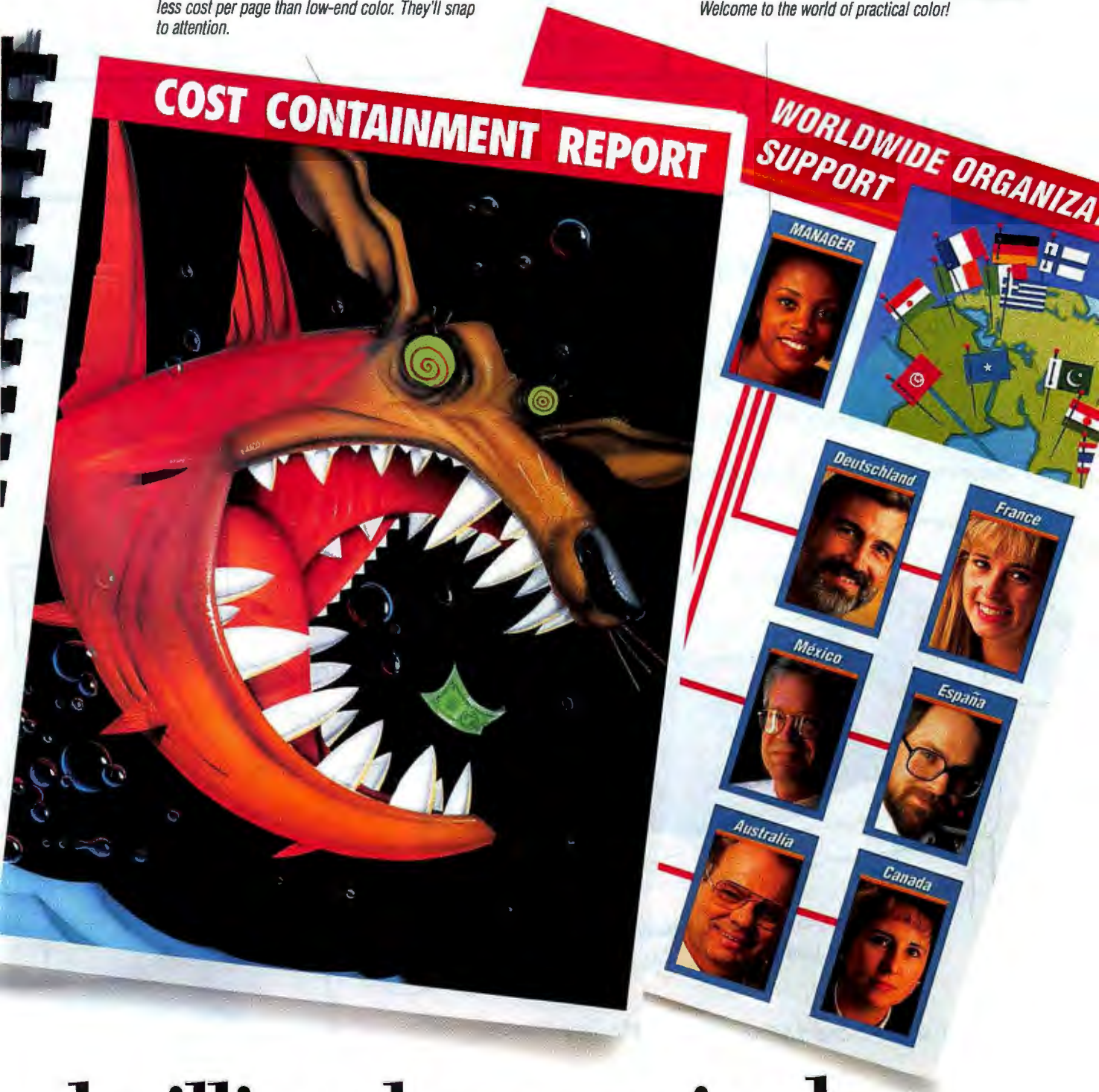
Color is color, unless it's

It's the business printer you've been waiting for. Office color that's so easy to use, reliable, and inexpensive, it's a practical office tool. It's the new Tektronix Phaser™340 color printer.

Speed? It's the world's fastest color printer at 4 color pages per minute. Cost? Full text pages on plain paper at 3¢ each. Color pages for 12¢ on your office paper. Simplicity? If you can load a stapler, you've mastered

Print vibrant, high-end color on office papers for less cost per page than low-end color. They'll snap to attention.

Connect faces and places with photorealistic quality. Welcome to the world of practical color!



brilliantly practical.

this machine. Reliability? Add 750 sheets of paper and let it run overnight. Now, that's robust. Cost? At $4,995 there's nothing in its performance range that even comes close. Best of all, it's from Tektronix, a Fortune 500 leader, that's been making world-class color printers for 13 years. **The Phaser 340 Color Printer. So practical, it's brilliant.**

Tektronix

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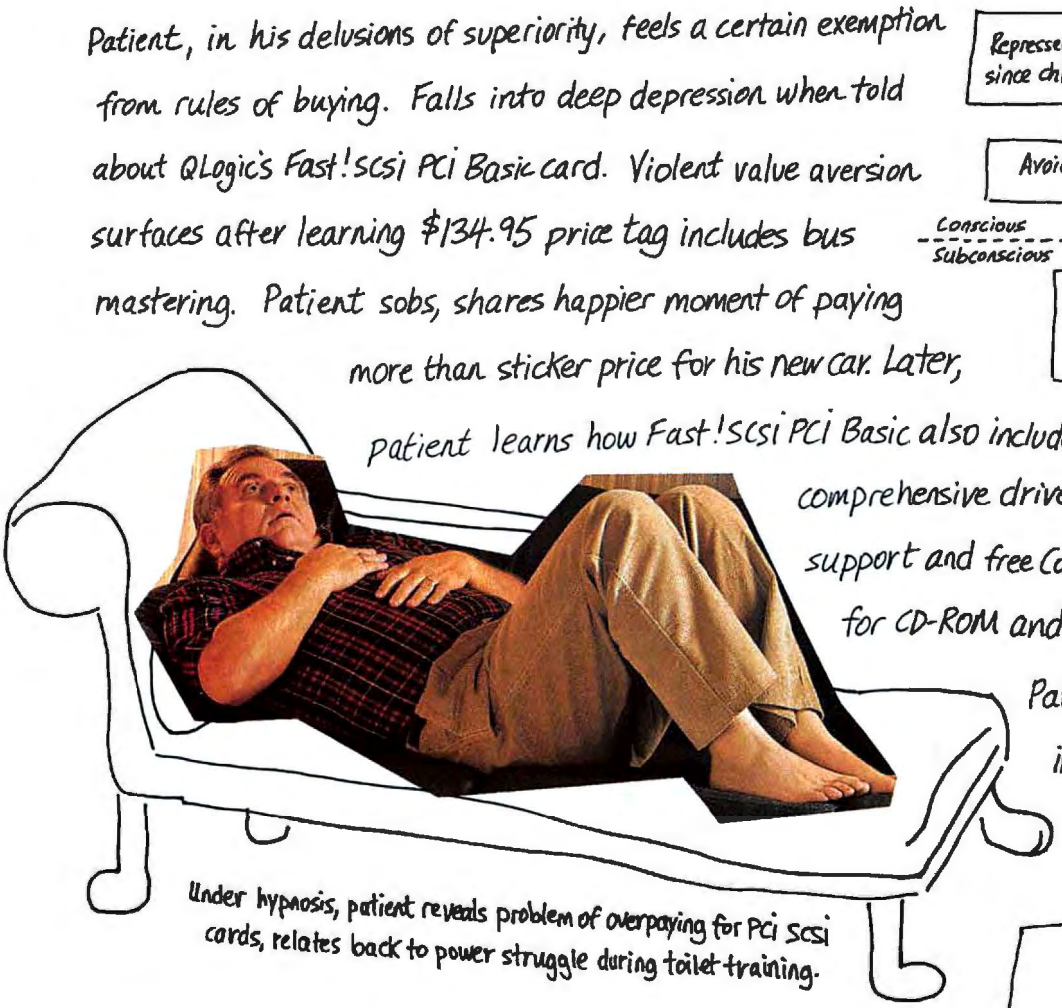
http://www.tek.com/CPad?1203

Circle 98 on Inquiry Card.

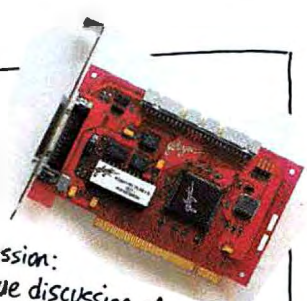
PATIENT	OCCUPATION	CONDITION
NEWHOUSE, JEFF	Corp. Buyer	Value Avoidance Syndrome

TOPIC	SYMPTOMS
PCi SCSi	Displays insatiable desire to pay excessive amounts for goods and services

Patient, in his delusions of superiority, feels a certain exemption from rules of buying. Falls into deep depression when told about QLogic's Fast!scsi PCi Basic card. Violent valve aversion surfaces after learning $134.95 price tag includes bus mastering. Patient sobs, shares happier moment of paying more than sticker price for his new car. Later, patient learns how Fast!scsi PCi Basic also includes comprehensive driver support and free CorelScsi for CD-ROM and hard disk drives. Patient develops twitch in left eye when he hears about toll-free technical support and five year warranty. Try reasoning with patient, explain that QLogic has over 20 million scsi solutions in marketplace. And only QLogic offers so much for hardly any money. Suggest patient call 1-800-TOP-Scsi (867-7274) for further analysis. Patient again grabs tissue box. (Note: Go to ValueWorld for more tissues.)



Under hypnosis, patient reveals problem of overpaying for PCi scsi cards, relates back to power struggle during toilet-training.



Next session: Continue discussion of QLogic's new Fast!scsi PCi Basic with bus mastering - priced $134.95 MSRP

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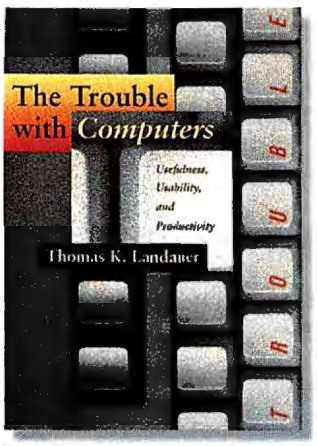
Impossible-to-Use Software



EDMUND X. DEJESUS

The entire computer industry—including this publication—is predicated on the proposition that computers are useful: They do things people cannot do, or they help people do things better. In *The Trouble with Computers: Usefulness, Usability, and Productivity*, Thomas K. Landauer convincingly calls that proposition into question.

Landauer explains why computers have not increased business productivity significantly. He then addresses the main reasons for this and offers some solutions. He presents an impressive statistical analysis demonstrating only negligible productivity gains—and actual productivity losses in many instances. In the sections expounding statistics, the going gets pretty dry, and I'm glad. I would far rather see a complete and thoughtful analysis of the statistical inferences, contextual caveats, and procedural minutiae than a one-page "Stats Lite" summary. The subject is too important to be treated cursorily. No one can dismiss this book as superficial or lacking depth of detail.

Happily, the text is leavened throughout with anecdotes of Landauer's encounters and misadventures involving computers. One of my favorites involves a point-of-sale system in an upscale store, with an "intuitive" icon-and-touchscreen interface. No one could figure out how to ring up a sale for candles. In this system's menu structure, "candles" were under "vases" under "platters" under "mixers" under "chairs."

In Landauer's analysis, phase one used computers for tasks that people cannot do (e.g., CAT scans, MRIs, and telephone switching equipment), or replaced people with computers for very simple or repetitive tasks (e.g., automatic lathes and milling machines) or dangerous tasks (e.g., controllers for chemical processes). Understandably, phase one of computerization showed tremendous gains in productivity.

Under phase two, we use computers as tools to augment our activities: writing, drawing, communicating, organizing, administering, and so on. Phase two has shown little evidence of gains in productivity. In fact, according to Landauer, "investments in computer technology have yielded significantly lower returns than investments in bonds." He writes that the gains from such an investment in computers ($4 trillion since 1960; now over $300 billion annually) should be obvious, but they are not.

Naturally, the step from analyzing symptoms to hypothesizing causes is a difficult one, and it's vulnerable to criticism. Landauer unhesitatingly lays major blame on software, in particular the problems of usability and usefulness. He believes that software developers are—mirabile dictu—computer experts, people not likely to know, understand, or appreciate the difficulties faced by the mere mortals who must actually use their software. "Programmers and software designers are too smart," he writes.

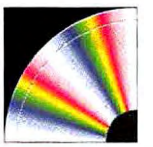
User testing and user input are nearly nonexistent in the industry. "Many designers seem to be genuinely uninterested in testing." When companies want to beta-test their products, they turn to computer managers and support personnel who are—mirabile dictu—computer experts, not ordinary users. Managers bemoan the high cost of training users. However, the corollary is that software must be too hard to use if it requires such effort and training to perform the simplest tasks.

Landauer sees the solution to these problems in user-centered engineering. He has the "embarrassingly simple" notion that if we want users to achieve more, they should be considered from day one in the design, development, and deployment of software. He marshals considerable evidence to show that in the studied cases where this is done (and there aren't many, according to Landauer), the results are impressive. *continued*

THE TROUBLE WITH COMPUTERS: USEFULNESS, USABILITY, AND PRODUCTIVITY

Thomas K. Landauer
MIT Press
ISBN 0-262-12186-7

$25



FOR GOLF NUTS ONLY

THE MASTERS: AN INTERACTIVE JOURNEY THROUGH ITS SIXTY-YEAR HISTORY **Creative Multimedia, 513 Northwest 13th Ave., Suite 400, Portland, OR 97209, (503) 241-1530, $39.99**

You have to breathe golf 24 hours a day and adore trivia about the Masters tournament to appreciate this CD-ROM (which requires Windows 3.1 or higher). If you don't fall into this category, you can stop reading.

Question: What is the longest putt in Masters' history? (A 100-foot birdie putt by Nick Faldo in 1989 at the second hole in the third round.)

Question: Which player missed a 1-inch putt? (Tommy Armour at the tenth hole in 1937.)

Question: What was the weather like for last year's Masters? (Good weather prevailed throughout the fifty-eighth Masters, with cool mornings and warm, sunny afternoons. Variable winds were at times erratic, which helped make scoring moderately high.)

And so it goes. If you want to relive, ad nauseam, Curtis Strange's 1988 hole in one on the twelfth hole via a small video window, it's there. We also learn that "the 12th has been the pivotal point in many a Masters, 1993 average score was 3.42, by far the highest number over par for any hole." Wind, we're told, was the primary culprit. In addition, there are aerial video views and 3-D computer-generated contour animations of each green showing the pin placements used throughout the years.

From the 1930s through the 1990s, there's a list of every player who made the cut, including his score, and for the winners, there's an elaborate scorecard of how they played each of the 72 holes. Even Bobby Jones, who was the creator of the Augusta National course, makes a cameo appearance. And for only $9.95, direct from Creative Multimedia, you can append this year's results to the overflowing Masters' trivia war chest you already own.

—Rich Friedman

Landauer has written the manifesto and planted a stake in the sand. We can keep dumping computer resources into a bottomless pit of unusabilty, or we can support and demand the effort to turn things around. Everyone in the computer industry now has to make a choice.

Edmund X. DeJesus is a senior technical editor located in BYTE's Lexington, Massachusetts, office. You can contact him on the Internet or BIX at edejesus@bix.com.

A FUN UNIX BOOK, NO KIDDING

THE UNDERGROUND GUIDE TO UNIX by John Montgomery
Addison-Wesley, ISBN 0-201-40653-5, $24.95

Although many books cover advanced Unix topics, *The Underground Guide to UNIX* by John Montgomery, who recently joined the BYTE staff, is one of the best I have come across in quite some time. Adhering to the *Underground Guide* format, Montgomery provides an insightful discussion of both common and obscure operational aspects of Unix.

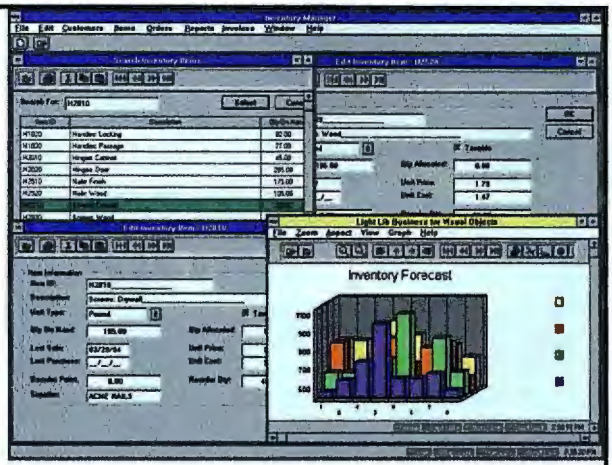
In the introductory sections, Montgomery covers Unix basics with tables containing lists and descriptions of the 10 most frequently used commands and keystrokes. The beginning chapters contain particularly useful information on command history and how to customize the system prompt. The fun starts when he tackles more advanced Unix material, such as rare shells like `tsch`, `jsh`, and `bash`. Other topics include use of the `.paths`, `.Xdefaults`, and `.mwmrc` files, as well as remote commands and useful command-editing tricks.

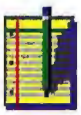
Later chapters contain worthwhile discussions of Unix file nomenclature, security and permissions, and the advantages and disadvantages of links. The book is full of interesting Unix nuances describing, for example, how using the `mv` command retains file ownership while using the `copy` command changes ownership. Montgomery lends a unique perspective to several Unix capabilities, including file searching with `grep` and `egrep`, file sorting and differentiation, and using `tar` with devices. Coverage of editors is minimal, focusing only on the Unix `spell` command, `vi`, and `emacs`.

The book contains only a short discussion of `mail` and `mailx`, including the `.signature` and `.mailrc` files. This section is just long enough to maintain continuity but short enough to keep the interest of experienced Unix users. Montgomery makes his impressions of `mail` versus `mailx` perfectly clear, opening one section with the following statement: "The mail program is one of the greatest examples of why people who created the System V UNIX system shouldn't be allowed out in public. Just kidding. Kind of."

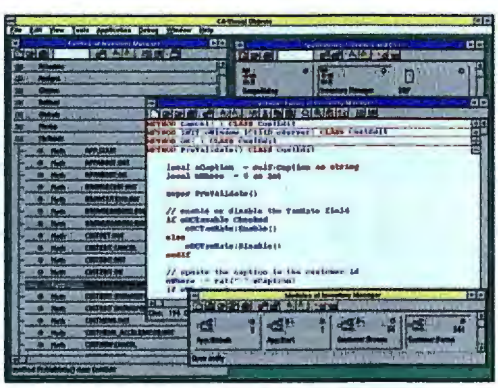
I can't recall when I have enjoyed reading a Unix book as much as this one. ■ *—Doug Tamasanis*

Highly informative business applications can also be great-looking.





Developers: Bet You Haven't Seen Xbase Like This Before.



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Fully Scalable
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WITH A

100MHz

processor.

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Take, for example, the Gateway 2000® Liberty™ DX4-100 Best Buy portable PC. Boy, does that 4.2-pound lightweight ever have an ego. And why not? With 100MHz processing power, 720MB hard drive, 24MB RAM, 256K L2 cache, and accelerated local bus video, the Liberty dictates Pentium® processor-like performance. Fire up this little soldier, and all your spreadsheets, graphics and word processing documents will run faster with its DX4 processor.

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The Liberty's footprint is a petite 10 by 8 by 1.6 inches. But it's no pipsqueak. It's a portable PC of greatness and substance, with more standard RAM than any other small notebook in the world. (All that RAM increases battery life in a big way!) And it's so powerful, the Liberty outperforms many PCs twice its weight. No wonder it sports a major attitude.

A little power hungry yourself? Call Gateway 2000 today.

The Liberty DX4-100 Best Buy boasts a 10.4" color display, 720MB hard drive, 24MB RAM, 256K L2 cache, TelePath™ 14.4 XJACK® fax/modem, extra battery, leather carrying case, desktop IR receptor, external floppy drive and MS Office Professional 4.3. **$4499**

intel inside

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#1

CorelDRAW
NUMBER ONE in ILLUSTRATION

Company	Units	Sales
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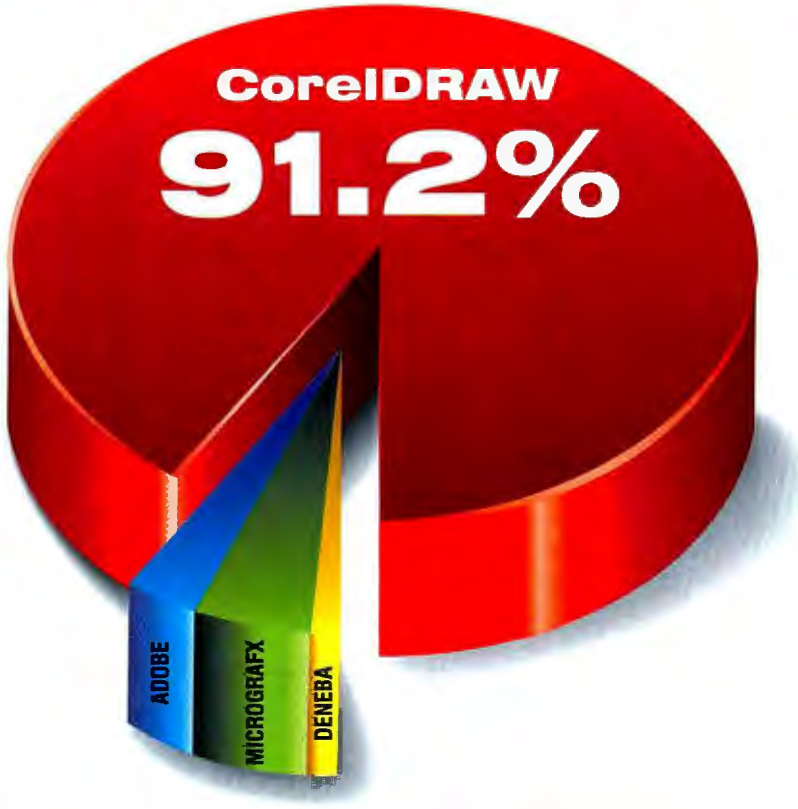
Adobe	257	73,968.64
Micrografx	380	36,696.38
Deneba	98	15,899.24
Totals	8,344	1,713,083.90

Market Share Windows Illustration Software
PC Data, December Sales, 1994



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Product	S.L.P. (US$)	Score
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QuarkXPress	$895	6.7
Aldus PageMaker	$895	6.2

3.5" disk version

INFOWORLD
Report Card Rating,
Desktop Publishing Software
March 20, 1995

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Adobe PhotoShop 3.0	$895	39
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PC World,
Best Buy Award,
April, 1995

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How Best to Migrate to Windows 95

DAVID S. LINTHICUM

CHRIS SPOLLEN © 1995

For the existing mass of 60 million Windows users—and the new users who join this club each day—there seems to be little doubt that Windows 95 will be their next-generation OS. Windows 95 promises productivity gains and better performance. However, when adopting any new OS, users and their organizations need to create an upgrade plan to avoid any potential pitfalls.

Without a doubt, there will be new hurdles to overcome. Technical problems are inevitable when you move from one OS to another. First and foremost, Windows 95 users need to work out hardware- and software-compatibility issues. Your personal combination of applications, drivers, fonts, and hardware could be unique, and thus untested in the Windows 95 environment. Microsoft expects compatibility and porting problems to be a fact of life when Windows 95 ships, which is now scheduled for late August.

Microsoft says that most existing 16-bit device drivers will work with Windows 95. The key word here is *most*. A few drivers won't work, at least until all device vendors get around to fixing the inevitable Windows 95 compatibility problems. The same goes for applications. Most are fully compatible with Windows 95, but some, especially those that don't use the Windows API, won't work until the applications vendors either make all their applications Windows 95–ready or provide upgrades to the Win32 API.

Be sure to rigorously test for compatibility conflicts, and then test some more

Other things for you to consider include upgrading to the 32-bit world. For example, your existing 16-bit TCP/IP protocol stack may work with Windows 95. However, Windows 95 provides a 32-bit TCP/IP protocol "stack in the box" that will perform better and with less memory. But will it work with your Internet applications? Moreover, you may have to port your current suite of 16-bit in-house applications to the new Windows 95/Windows NT Win32 API to take advantage of the new 32-bit features of the OS.

The Compatibility Shuffle

Microsoft's mixture of 16- and 32-bit architectures solves some compatibility problems but creates others. Microsoft provides a mix of 16- and 32-bit subsystems to ensure that Windows 95 can run existing 16-bit Windows software, as well as the new Win32-compatible applications. The use of 16-bit subsystems allows Windows 95 to run applications as fast as, or faster than, Windows 3.1 can—and, Microsoft claims, with minimum hardware requirements (a 386SX processor and 4 MB of RAM).

Within Windows 95, 16-bit subsystems are used where such code is needed to maintain compatibility or where 32-bit code would require additional memory without an equivalent increase in performance. The 32-bit code exists where Microsoft thought it would enhance performance without sacrificing compatibility.

continued

Windows 95 Migration Planning Kit

REX BALDAZO

To help IS professionals plan their move to Windows 95, Microsoft is offering a CD-ROM called Microsoft Windows 95 Migration Planning Kit. There is quite a bit of useful information to be found here, but there's also a fair amount of propaganda. And, despite coming from a company that has turned out some excellent CD-ROM references, the search engine for this CD-ROM has a cluttered and counterintuitive interface (see the screen at right).

In addition, you must have Excel, Word, and PowerPoint installed before you can use the search engine. We also experienced some glitches with the CD-ROM, such as a Windows 95 help file that, oddly enough, wouldn't open in Windows 95.

Rather than digging your way through the search engine, it's much easier to browse the CD-ROM directly. It's organized into directories containing information such as introductory and technical material, as well as information specifically aimed at IS managers.

The IS directory includes an Excel spreadsheet model that lets you input variables, such as how much training you expect to give your support staff, and it then calculates the payback you can expect from moving to Windows 95. Not surprisingly, it's fairly difficult to get the model to show a negative payback. And a disclaimer says that the model does not factor in the cost of the staff-hours you've entered. We found the model to be a great demonstration of some of Excel 5.0's features but an incomplete business-analysis tool.

The jewel in the crown of this collection is the Windows 95 Resource Kit, originally released as a 1400-page book but included here as a set of Microsoft Word files. This is one of the times that we missed Interleaf, which has a much better multifile book capability than Word. But the book is nonetheless a valuable, and searchable, resource for Windows 95 material.

Rex Baldazo is a BYTE technical editor. You can contact him on the Internet or BIX at rbaldazo @bix. com.

The Microsoft Presentation Builder is too busy and confusing to be usable. Viewing documents requires more mouse-clicks than simply using File Manager directly.

All the low-level services in the OS, for example, exist as 32-bit code. All I/O subsystems, including the file system, the network, and memory management, use 32-bit code. The remaining 16-bit code exists in Windows 95 as Intel-dependent assembly code that can provide the most performance per processor cycle. For instance, all Windows management code remains as 16-bit code for the sake of providing both compatibility and performance.

Windows 95 provides a much better device-driver architecture with 32-bit VxDs (virtual device drivers). These drivers work like conventional real-mode device drivers, but they use protected mode wherever possible. Thus, they use almost no conventional memory and should be more reliable. However, a better architecture does not mean compatibility. Beta testers have reported device-driver compatibility problems with the final beta version.

But Microsoft claims that most Windows 3.1 applications will work with Windows 95. That is, applications will work if they adhere to the rules of the API in the previous release of Windows (Windows 3.1 and Windows for Workgroups 3.11) or make use of the Win32 API (i.e., they are Windows NT applications).

Product Information

Windows 95...$99
Microsoft Corp.
Redmond, WA
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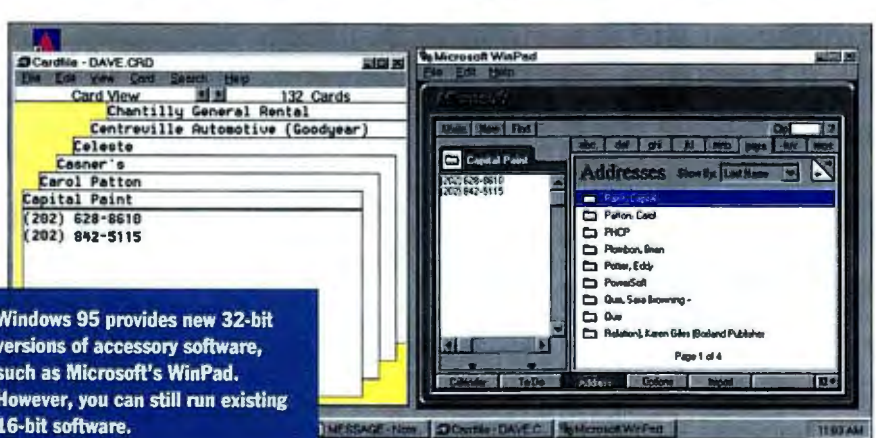
(206) 882-8080
fax: (206) 936-7329

Unfortunately, some software vendors have made their applications Windows 3.1 dependent. For example, an application may go directly to the graphics subsystem and bypass the API altogether. This may provide better performance for games and other graphics-intensive software, but Windows 95 won't like it. Windows 95, unlike Windows NT, supports only portions of the Win32 API. Therefore, some NT applications that use Win32 API calls that are unsupported under Windows 95 won't work. Win32 applications developers are certainly aware of the upcoming Windows 95 release, and they have avoided using API calls that are not shared by both Windows 95 and Windows NT.

How, then, do you know if your software will be compatible with Windows 95? The only reliable way is to actually run it on Windows 95. Even if your application works with the beta version, you could still run into compatibility problems with the shrink-wrap release. Microsoft will constantly change Windows 95 until the company freezes the code for production.



Windows 95 provides new 32-bit versions of accessory software, such as Microsoft's WinPad. However, you can still run existing 16-bit software.

Performance: Myth and Reality

Users who migrate from Windows 3.1 to Windows 95 will notice better performance for most 16-bit Windows applications, according to Microsoft. Windows 95 can

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You can use your existing TCP/IP transport protocol or the Windows 95 protected-mode version of TCP/IP for Internet access.

spend more time in protected mode, which provides a stable OS and enhanced performance. In addition, Windows 95 can avoid switching from real mode to protected mode, an operation that slows things down. Disk reads and writes don't require real mode in Windows 95. Also, applications that use a lot of disk I/O should run faster.

But if you want to take full advantage of Windows 95 performance, you'll have to upgrade to 32-bit applications. Most software vendors will create Win32 versions of their products shortly after Windows 95 hits the streets.

Windows 95 also supports multithreaded applications, which are applications that can split themselves into threads for parallel execution. Most multithreaded applications run faster than applications that don't take advantage of threading. In fact, Windows 95 tracks resources for each application by placing each one in a separate thread. Thus, Windows 95 protects applications from other ill-behaved applications, which stops an application crash from taking down the entire OS.

But there could be a downside to threading. During beta testing, some Windows 95 testers noticed that the use of multithreaded applications, such as Microsoft's own MSN (The Microsoft Network), cut the amount of available memory to such an extent that it caused an OS crash. Microsoft says it is fixing this problem for the final release.

Network Considerations

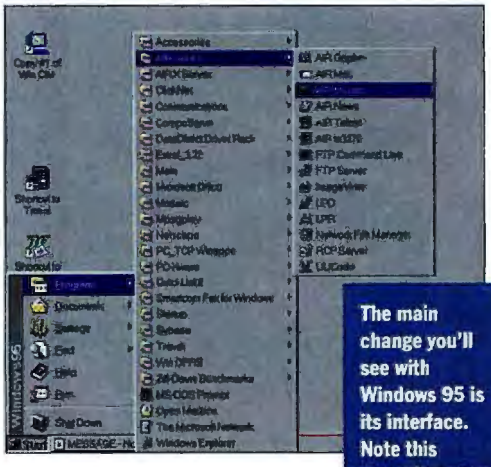
Windows 95 supports networks with its out-of-the-box client support for IPX/SPX, NetBEUI, and TCP/IP. Will it support your networking applications? Windows 95 employs a MAC (media access control) device-driver model. The MAC layer is the lowest point in a networking subsystem and communicates directly with your network adapter of choice (e.g., Ethernet and Token Ring).

A MAC driver uses the NDIS (Network Driver Interface Specification) 3.0 standard. MAC clients (i.e., transport protocols) bind to the MAC driver functions using the NDIS interface. If that's confusing, just remember that NDIS allows multiple transport protocols to communicate with multiple network adapters, and most network adapters come with NDIS drivers.

But initially, network vendors won't provide protected-mode Windows 95–ready NDIS drivers for Windows 95, and that's where the trouble will start as network users begin the migration to Windows 95. In addition, different network vendors have different ways of doing things. Novell's ODI (Open Data-Link Interface), for example, looks a lot like NDIS in that it provides a protocol-independent device interface, and there are a lot of ODI drivers available on the market. Therefore, Windows 95 supports ODI as well as NDIS, and if your application supports one of these standards, chances are that it will work with Windows 95.

To solve the problem of using non-NDIS protected-mode drivers (e.g., NDIS 2.0 and ODI), Windows 95 provides a series of low-level services known as *helper modules*. These modules bind the various interfaces to make them work together. For example, the Windows 95 protected-mode TCP/IP protocol for Internet access can run alongside a real-mode IPX/SPX driver for NetWare.

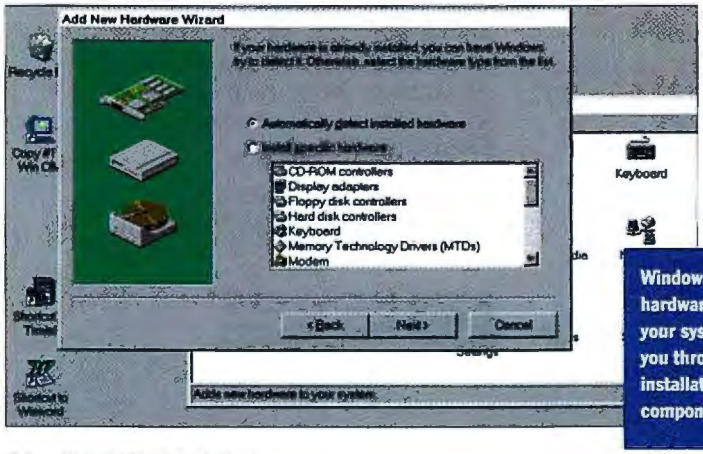
If you're running third-party network-protocol stacks and drivers, Windows 95 will probably work with them in 16-bit mode. For example, FTP's TCP/IP protocol stack and tools work with Windows 95 without any additional modification. Chances are that your current network configuration (i.e., the protocols and the drivers) will work with Win-dows 95.



The main change you'll see with Windows 95 is its interface. Note this cascading menu.

However, only testing will prove for certain whether or not that's true. If possible, you should use protected-mode protocols and drivers. They perform much better than their real-mode counterparts, and they require almost no memory.

There is no law that states you must upgrade to Windows 95. If your current environment works, don't rush to change it. However, if your organization will upgrade to Windows 95 the moment it becomes available, now's the time to do your homework and testing. ■



Windows 95 detects what hardware is already on your system and guides you through the installation of new components.

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Optimize Database Queries

JOHN L. CUADRADO

DANIEL PELAVIN © 1995

Complex queries on distributed databases can consume massive resources. Here's one strategy for making them more efficient.

Where's my data? I need it now!" That's the plaintive cry—or maybe the angry demand—of managers everywhere, who need more and more data to keep their organizations running. More sophisticated about data than ever, these managers are asking questions that have become more complicated and involve more factors. This is particularly true in areas such as decision support and deductively augmented database systems, and answering these queries often requires a large number of joins.

But performing those complex queries on large databases can be very time-consuming. Distribute those databases among multiple machines, and the problems multiply—but so do the possibilities. Multiple machines give us the ability to execute many operations in parallel. And we're now beginning to encounter multiprocessor computers that do parallel processing themselves, as well as new microprocessors that employ on-chip parallel pipelines.

More Efficient Joins

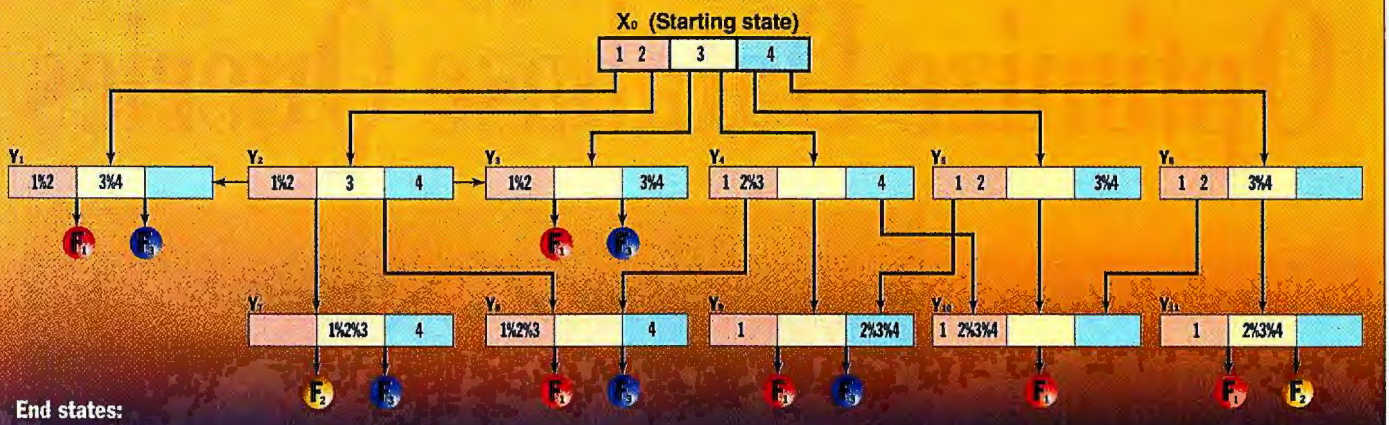
To take full advantage of this new multiprocessing capability, however, we have to arrange joins and other operations efficiently. Software that takes advantage of parallel processing is hard to find at the moment, but it's beginning to appear. We can expect the major database vendors to offer parallel versions of their database engines in the near future. The goal is always to achieve a radical speed increase in query response. This quick tour of some of the problems in the area of parallel queries will show some of the strategies you can use to determine the most efficient way to execute your queries.

Much of this discussion will be in the realm of abstract mathematical notation. To make it a bit more concrete, we'll first consider a real-world example, a scenario in which large amounts of data are gathered and several complex queries must be run on a regular basis.

Let's assume you're a database administrator at a large commercial weather organization. At its headquarters, your company collects data every half hour on the local conditions from 10,000 weather stations worldwide. For this example, we'll simplify the data and just consider the temperature, barometric pressure, and humidity components. But even this limited view means that every day you receive 480,000 data transmissions, and for each one you need to record the time, the sending station, and the relevant weather parameters.

Due to the kinds of queries that your analysts ask of this database and the kinds of computing hardware available, you have decided to organize the data as four separate tables (location, temperature, pressure, and humidity), as shown in the table

Transition System for a Three-Processor, Four-Relation Multijoin



Here's a complete graphical representation of all the ways in which we can move from a given initial state X_0, where the data is in four relations that are physically stored in three different systems, to one of three possible end states (F_1, F_2, F_3) in which all the relations have been joined into a single relation residing in one processor. Along the way, there are 11 possible intermediate states. We move from one state to another by performing one of three possible actions: joining two relations already in a single processor, moving a relation to another processor and joining it with a relation already there, or doing any two of these in parallel. For simplicity's sake, this diagram uses 1 to represent the relation r_1, and so on. While some paths from X_0 to the end states are clearly shorter than others, we can find the most efficient path (and thereby the most efficient end state) only by calculating the costs of the operations involved for each state change. For example, in joining a small relation with a large one, where each resides on a different machine, it's obviously more efficient to move the small one than to move the large one.

"Weather-Station Database." The actual physical distribution of these relations among a set of processors—in other words, where you actually store the data—is a different matter that we'll discuss later.

With this data, you might make such requests as the following.

- Find all stations reporting temperatures below 10°C and report on their relevant weather parameters.
- Find all stations between the latitudes of 30 degrees north and 50 degrees north that show temperature fluctuations of 10° or more during the hours of 5:00 a.m. and 7:00 a.m. over the past three months.

But you can also imagine far more complex queries that look for more subtle patterns: For example, you might need to find clusters of weather stations that have comparable readings over a given period. Queries like these can be extraordinarily expensive in terms of time and resources. This is where the ability to do queries in parallel can provide a distinct advantage. But how do we structure these queries so that they can be done in parallel? This is a central problem.

Notation for Joins

Here's an introduction of some notational conventions we can use to sort out the operations and relationships involved. *A*, *B*, and *C* are attributes (e.g., temperature or longitude in our example). We denote relations between attributes as $r(A,B)$ and $s(B,C)$. Next, we define the natural join of r and s, denoted $r \%_B s$, to be a relation on A,B,C that contains all the tuples (or rows) that result from concatenating tuples in r with those tuples in s that have identical values for the attribute. For example, in the weather-station database, we might be interested in taking a look at StationID = 123566789 and asking for Location $\%_{\text{StationID}}$ Temperature.

Now, a query generally involves creating a new relation using a join; we can represent it in the form $q = r \%_B s$. Three basic strategies have been developed over the past 20 years to compute the new relation: the nested-loops join, the sort-merge join, and the hash-based join. (These are called *uniprocessor join* strategies, since they assume that a single computer is

WEATHER-STATION DATABASE

10,000 stations collected data every half hour. Results are listed below.

LOCATION

STATIONID	NAME	LATITUDE	LONGITUDE	ELEVATION
123566789	NOAH, Evergreen 12	30 N	78 W	200
456334456	SPRITE, Cabo Verde	70 S	80 W	1000

TEMPERATURE

STATIONID	DATE	TIME	TEMPERATURE (C)
123566789	10/30/94	2100	10.6
456334456	10/16/94	1500	–20.7

PRESSURE

STATIONID	DATE	TIME	PRESSURE
123566789	10/30/94	2100	31.78
456334456	10/16/94	1500	29.04

HUMIDITY

STATIONID	DATE	TIME	HUMIDITY
123566789	10/30/94	2100	60.7
456334456	10/16/94	1500	80.9

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It may seem as though a lot of setup and computation goes into producing a strategy for one of these multijoin queries. This is definitely true.

performing the operations.) Many variations on these basic strategies have been developed that take into account page sizes and caching schemes of varying orders of sophistication. Here, we'll consider only the following basic algorithms:

- The *nested-loops join algorithm* is based on the definition of the join and is computed using two nested loops that sweep through the two relations.
- The *sort-merge join algorithm* first sorts the two relations to be joined and then merges the results using the matching tuples as the selection criteria.
- Finally, the *hash-based join algorithm* consists of partitioning the r relation into n buckets, using hashing on the attribute, and doing the same for the s relation. We then make passes over each bucket.

(For a thorough analysis of these join algorithms, see reference 1.) From this point on, we'll simplify the notation and omit the attributes over which we're computing the join. That is, for two relations $r_1(A,B)$ and $r_2(B,C)$, instead of $r_1(A,B)\ \%_B\ r_2(B,C)$, we'll simply write $r_1\ \%\ r_2$.

Defining Our Model

For this example, we make the basic assumption that the parallel system consists of a set of homogeneous processors P_1, P_2, ..., P_m communicating over a high-speed, fully connected data network. No further assumptions about the processors or the network are made. It may surprise some that we are using this simple distributed model using off-the-shelf processors. However, one of the lessons we've learned in the past 20 years is that we don't gain much from special-purpose database machines. On the contrary, the current trend is toward the so-called share-nothing architectures. (For a detailed review, see reference 2.)

We begin with a database R, which has a number of relations $r_1, r_2, \ldots, r_n$ that are distributed among the processors P_i such that each relation is fully contained in one of the processors. A given processor may contain more than one relation. A typical configuration is shown in the figure "Distribution of Relations" below.

We have four relations that are stored in three processors. For example, the relations r could be Location, Temperature, Pressure, and Humidity in our weather-station database. For the time being, we'll assume that to compute the join of any of two relations in the system, both must reside in the same processor. Thus, to compute the join of r_1 and r_2, we can just go ahead and use one of the uniprocessor join techniques described above, since both relations are already stored in the same processor.

However, if we want to compute the join of r_3 and r_4, then we have to move one of the relations to a different processor. Either we move r_3 to P_3 or we move r_4 to P_2. Which move should we make? This can make a significant difference in the amount of work required to perform the computation. If relation r_3, for example, is much larger than relation r_4, then it'll be far more cost-effective to move r_4.

This is the nub of the general problem here—the order of computing multiway joins. To keep this presentation simple, we'll continue to work with the example in the figure "Transition System for a Three-Processor, Four-Relation Multijoin on page 58. Our goal is to compute the join of the four relations $r_1\ \%\ r_2\ \%\ r_3\ \%\ r_4$. Since the join operation is associative, there are many different ways to compute the multiway join operation. So, even in this simple case, we could proceed in different ways. For example, we could compute $r_1\ \%\ r_2$, join the result with r_3, and finally join this result with r_4. Another strategy would be to compute the join of r_3 and r_4 on one machine, in parallel compute the join of r_1 and r_2 on another machine, and finally join their results. For more information, look up Catalan numbers in a good book about algorithms.

Parallel Join Strategies

To determine the best course of action, we need to model what it means for one solution to be better than another. We need to assign a cost to each solution, which means we need a method to compute the costs of intermediate steps in a given computation. One way to do this is to set up a transition system, where each state of the system corresponds to an intermediate state, and a prescription that tells us how to go from one state to another.

With this aim in mind, let's go back to our query $q(X_0) = r_1\ \%\ r_2\ \%\ r_3\ \%\ r_4$. This $q(X_0)$ notation will become clearer in a moment. Each state in our transition system is represented by an assignment of relations to processors. For example, the state represented in the figure "Distribution of Relations" is $X_0 = \langle r_1\ r_2 \mid r_3 \mid r_4 \rangle$. That is, relations r_1 and r_2 reside in processor P_1, relation r_3 is in processor P_2, and relation r_4 is in processor P_3. This represents the initial state in our transition system.

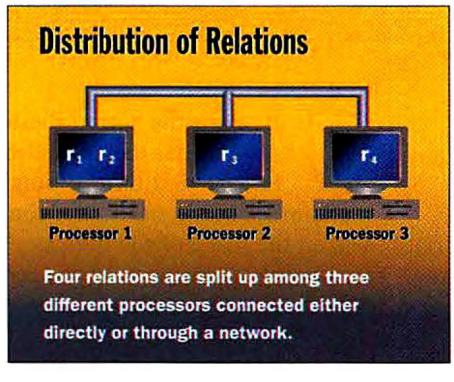
Now, where can we go from this state? One possible move would be to the state $\langle r_1\ r_2 \mid - \mid r_3\ \%\ r_4 \rangle$. Here we have moved relation r_3 to processor P_3 and performed the join with relation r_4. The figure "Transition Space" on page 62 represents a small section of the transition space we are describing here.

We also need to associate a cost with each transition. From our current state X, there are a finite number of states we can move to. Let's call the next state we want Y. Now we need to describe the cost of going from state X to state Y, which we'll call (X,Y). In general, the cost depends on the sizes of the relations to be joined and on the costs of one or more relations to the appropriate processors. The transition model we are discussing can take into account the parallelism that is potentially available. In the above example, for example, we can perform the joins $r_1\ \%\ r_2$ and $r_3\ \%\ r_4$ in parallel.

So, now we have a transition system associated with our query $q(X_0) = r_1\ \%\ r_2\ \%\ r_3\ \%\ r_4$. Furthermore, each transition has an associated cost. A final state in the transition system consists of a state that has the join relation $r_1\ \%\ r_2\ \%\ r_3\ \%\ r_4$ residing in one of the processors. For the current query, we have three final states; that is, the answer can be in processor P_1, P_2, or P_3. Our goal is to find a path that takes us from the initial state X_0 to one of the three final states containing the answer—and that does so at minimum cost.

Finding a Minimum-Cost Solution

First, let's consider the entire three-level transition system, as shown in the figure "Transition System for a Three-Processor, Four-Relation Multijoin." There is one



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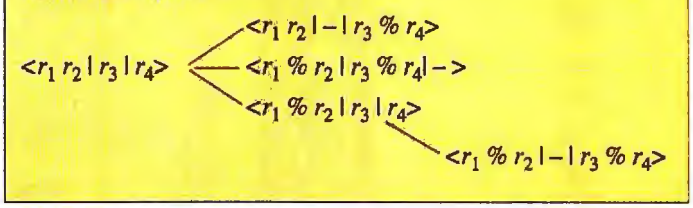
Transition Space



This shows how we can move from one state to another by moving one relation and/or joining it with another.

initial state, 11 intermediate states, and three final states. We'll present a cost model for transitions and establish criteria for determining a minimum-cost path through the system.

A realistic cost model for each transition has to take into account both the cost of performing a local join and the cost of the transmission of data among the different processors. In general, we will allow only transitions that accomplish some processing that gets us closer to one of the final states. That is, in going from a state X to a state Y, we must either perform some local joins or move some relations from one processor to another or perhaps do a combination of both actions. To make the example more concrete, assume that the cardinalities (i.e., the number of tuples) of each of the relations are as shown in the table "Size of Relations" below.

Let's illustrate how the cost computation proceeds here. We'll use the convention that the initial state of the system is labeled X_0, the three final states are labeled F_1, F_2, or F_3 (depending on where the final join relation r_1 % r_2 % r_3 % r_4 winds up—in processor P_1, P_2, or P_3), and the intermediate states are labeled Y_1 through Y_{11}. We will assume that, associated with each join r % s, is a cost $\alpha |r| \times |s|$, where α is a constant that measures the selectivity of the join. Also, the costs associated with moving relation r from one processor to another will be $\beta |r|$, where β is a constant that measures the cost of transmission in the network. With these notations understood, we can compute the following costs:

$$C(X_0,Y_2) = \alpha |r_1| \times |r_2| = 600{,}000\alpha$$

In going from state X_0 to state Y_2, we only incur the cost of performing the join between r_1 and r_2 located at processor P_1.

In going from state X_0 to state Y_1, we do the join of r_1 and r_2 at processor P_1 and, in parallel, move relation r_4 from processor P_3 to P_2 and do the join of r_3 and r_4 to obtain

$$C(X_0,Y_1) = \alpha |r_1| \times |r_2| + \alpha |r_3| \times |r_4| + \beta |r_4| = 600{,}000\alpha + 500{,}000\alpha + 500\alpha.$$

As a final example, in going from Y_4 to Y_9, we move r_2 % r_3 from processor P_3 to P_4 and do the join r_2 % r_3 % r_4, so the cost becomes

$$C(Y_4,Y_9) = \alpha |r_2 \,\%\, r_3| \times |r_4| + \beta |r_2 \,\%\, r_3| = 125{,}000\alpha + 250\beta.$$

Having computed all the one-step transitions, we can now use any of a variety of algorithms to find a minimum path. This problem has been studied for many years, and books on algorithms provide detailed descriptions of the techniques.

Next Steps

One possible approach is to use the technique of dynamic programming, where we find optimal solutions for subproblems by finding optimal solutions to sub-subproblems, and so on. At some point, we get down to one-step transitions, and we just look up their costs in a table.

Learning the details of the dynamic programming approach is worthwhile, since this is a very general approach that finds application in many areas of computer science and operations research. There is a stochastic version of the material we've discussed in this article, and here, too, the dynamic programming approach has been used to solve this class of problems.

It may seem as though a lot of setup and computation goes into producing a strategy for one of these multijoin queries. This is definitely true. And it's important to remember that, in queries that require the joins of many relations (over 10, say), the brute-force approach of simply enumerating all the possible options and then choosing the minimum-cost strategy is basically impossible. Also, the job we do in selecting a good

SIZE OF RELATIONS
The cardinalities of each of the relations.

RELATION	CARDINALITY (NO. OF TUPLES)
r_1	1000
r_2	600
r_3	1000
r_4	500
r_1 % r_2	300
r_2 % r_3	250
r_3 % r_4	400
r_1 % r_2 % r_3	200
r_2 % r_3 % r_4	150

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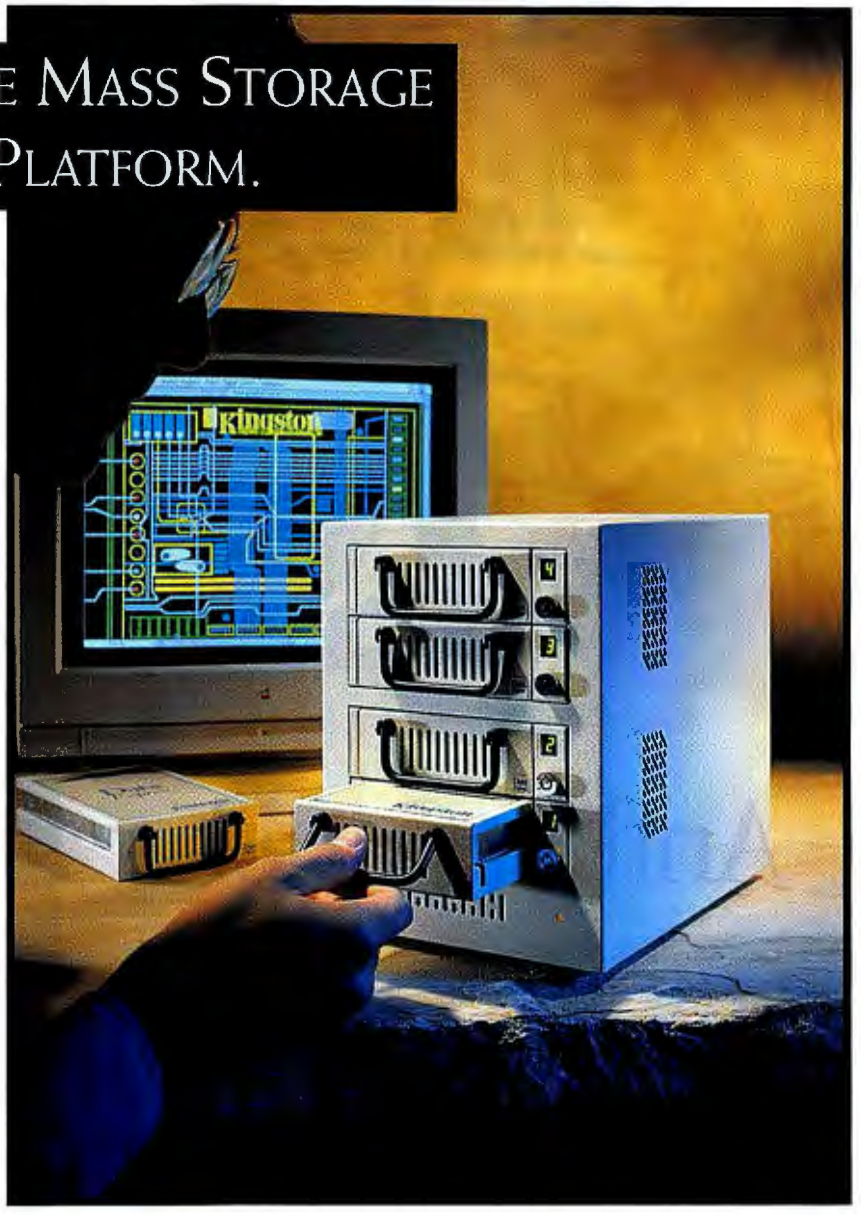

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strategy can make the difference as to whether we get any answer back at all. In many large systems, it is relatively easy to generate queries that take days to complete. Therefore, it's important to plan multijoin queries intelligently.

More Work Ahead

The example given here was intended to provide a flavor for the issues that are involved in creating an efficient set of parallel query mechanisms. At the present time, there is a relatively large amount of literature dealing with many of the topics discussed in setting up our simple three-processor/four-relation example. (For a review of some of the products that are currently available in this market, see reference 3.) Techniques similar to those in the dynamic programming approach that we used to compute an optimal query strategy are applicable in the area of distributed object-oriented databases.

In an ODBMS (object-oriented database management system) we have objects that are often stored across several processors. For example, we might have a large image database that contains not only the raw images but also semantic information associated with each image. A typical query might ask for all images that satisfy certain semantic criteria. Such a query could be handled most efficiently using techniques similar to those discussed in our simple example.

Although considerable work remains to be done in this area of query optimization, many companies and academic centers are working on the problem, and funding in this area appears to be quite good. ■

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3. Ferguson, M. "Parallel Database: The Shape of Things to Come," *Database Programming and Design*, October 1994: 32–44.

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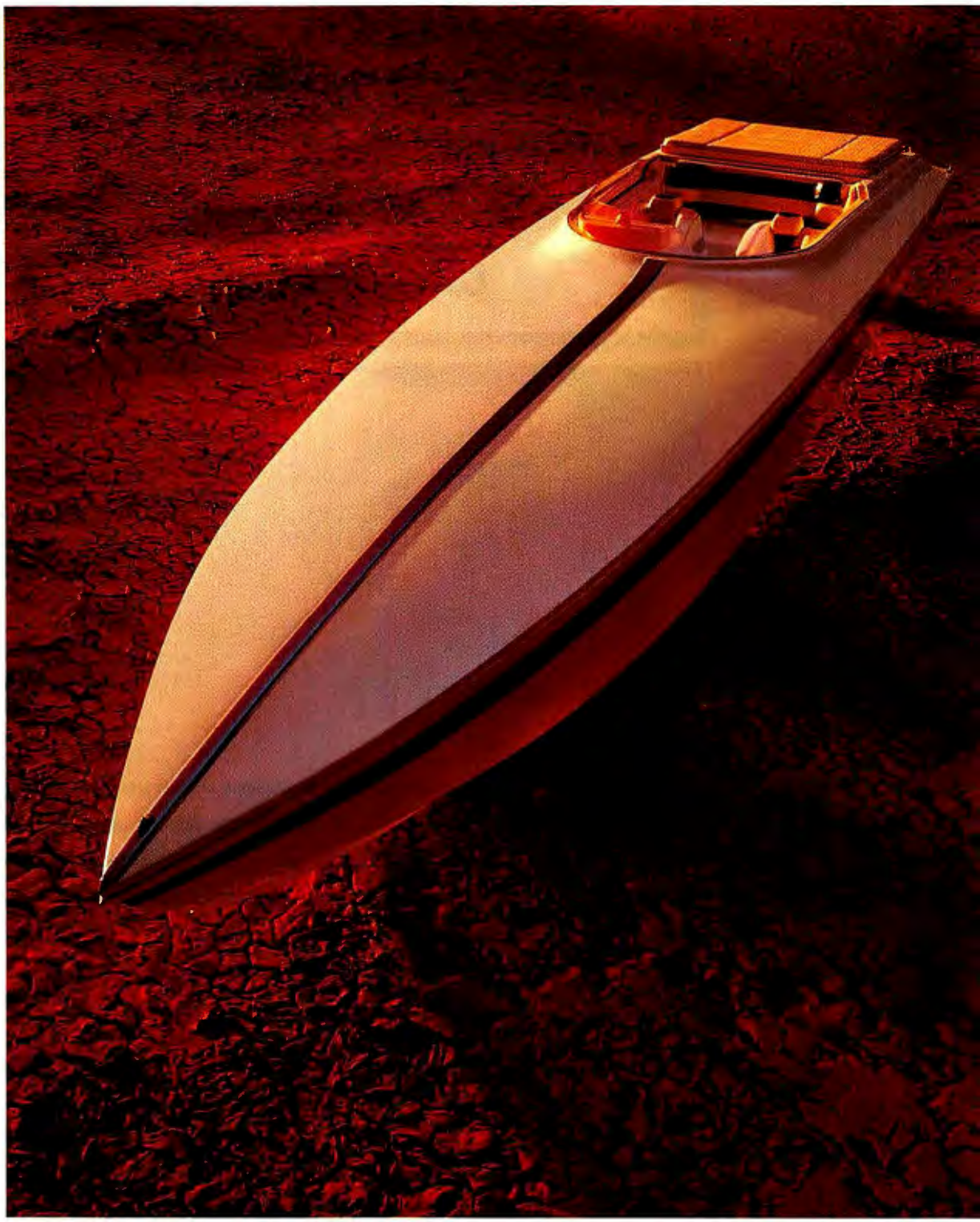

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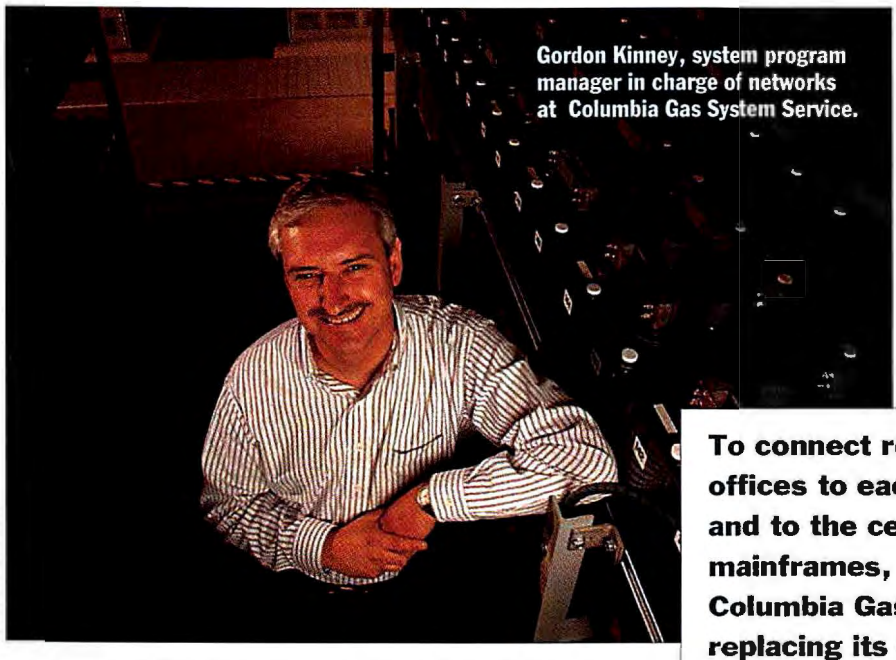
That was the situation Columbia Gas System Service (Columbus, Ohio) faced with respect to its network. For many years, the corporate network had provided users in remote sites, as well as the folks at headquarters, access to company applications and data. But times have changed. Today's users want access to different types of data and new applications. Columbia Gas's network was starting to seem like that old pair of boots.



Gordon Kinney, system program manager in charge of networks at Columbia Gas System Service.

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To connect remote offices to each other and to the central mainframes, Ohio's Columbia Gas is replacing its entire SNA backbone

About two years ago, Columbia Gas recognized the need for access routers in its remote offices. The company saw that an increased amount of traffic would be coming in from the remote sites, which would swamp the 19.2-Kbps analog links, and that traffic was increasingly of a multiprotocol nature due to the deployment of LANs in those offices. So, Gordon Kinney, system program manager in charge of networks servicing certain Columbia Gas subsidiaries, decided to replace the company's existing SNA (Systems Network Architecture) network of dumb terminals with a router-based, collapsed-backbone network that could handle all the SNA traffic and, for the first time, tie together all the LANs located at the company's remote sites.

Running on Empty

Most of the applications used at Columbia Gas's subsidiaries run on mainframes in the company's data center in Columbus. These applications include a customer-service information database, billing programs, payroll systems, programs to handle accounts payable and receivable, and some engineering applications. For many years, users accessed all these services over a traditional IBM SNA network that included some 6000 dumb terminals at remote sites, as well as many interconnected bridges in the central site.

The people at the remote sites also ran typical office applications (e.g., word processors, spreadsheets, and E-mail programs) on LANs. Increasingly, they wanted to share the work that they'd done using these office applications with people in other sites, but that posed a problem.

Sending files, spreadsheets, and other LAN traffic over the existing SNA links was impractical. Typically, remote sites were connected to the data center via low-speed (i.e., 9.6 or 19.2 Kbps) analog links. And even if the traffic could get to the central site, the existing bridged network might not have been able to handle the volume or mix of traffic. On top of that, the existing E-mail system, IBM's OfficeVision running on a mainframe, did not support the exchange of files from LAN-based applications.

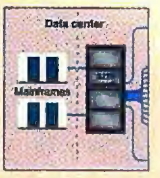
The bottom line was that a new networking architecture was needed to handle the increased LAN traffic from the remote sites. Two major changes to the network were needed. First, Columbia Gas had to find an economical way to bring LAN traffic in from remote sites while still transporting the SNA session traffic. Second, the bridged backbone network, which was steadily being overwhelmed, had to be modified to handle the increased volume of mixed-protocol traffic.

Combined or Separate Networks?

Columbia Gas faced a classic choice. One option was to have two independent and parallel networks—the existing SNA network for

COLUMBIA GAS'S NETWORKING MAKE-OVER

The Problems



- The bridged network had outgrown itself.
- Remote sites were increasingly using LAN-based applications that couldn't easily integrate with or access data on mainframes.

The Solution

- Migrate to a collapsed-backbone, router-based network.
- Use access routers at remote sites to handle both PC-based LAN traffic and SNA (Systems Network Architecture) traffic on a single link.

The Benefits

- Consolidation of equipment in a central site.
- All data connections are integrated into one SNMP-manageable network.

accessing mainframe data, plus a new IP network to support PC-to-PC or LAN-to-LAN communications. But the company chose a different approach, one that some in the industry consider risky: It opted to bring in both types of traffic over a single network using access routers.

The reason why this decision isn't a universal one is that there can be problems associated with maintaining SNA sessions in a routed internetwork when SNA and LAN traffic are combined. SNA networks are deterministic by nature, while multiprotocol routed networks are not.

Routers work fine with LAN traffic because there are no strict time limits for getting data across an internetwork. But SNA sessions operate by different rules. When a user accesses mainframe data, the sessions break off unless "keep-alive" acknowledgments are exchanged within a certain period of time, which is typically 10 seconds.

Many large internetworks can meet this 10-second time limit—most of the time. However, if a user sends a huge file when the network is highly stressed, the SNA-session traffic might end up waiting in a router's queue. If this happens, the SNA user gets logged off the system and must then reconnect and start that session over again. Another problem is that, if a link fails, the routers may take longer than 10 seconds to dynamically recalculate new paths and redirect traffic.

Because of these problems, many companies have deployed parallel networks: one for SNA and one for LAN traffic, even though this costs much more than putting both forms of traffic on a single network. After all, the parallel-network solution requires two sets of access lines to each remote site and two sets of termination equipment.

All-in-One Makes Sense

Columbia Gas chose IP as the protocol for its backbone network. That permitted two primary options for bringing in SNA traffic—encapsulating the SNA traffic (SDLC [synchronous data-link control] frames) in IP packets or converting the SDLC frames locally at each remote site before transporting them over the wide-area connection.

The first alternative, while practical in some situations, was deemed unsuitable for Columbia Gas. To keep SNA sessions alive requires the exchange of many acknowledgment packets in both directions over each wide-area connection, which would eat up bandwidth.

Instead, Columbia Gas chose to convert the SDLC frames to LLC-2 (logical link control-2) token-ring frames—and to do it locally, at each remote site (see the text box "How Conversion Works" on page 64NA 10). There are several advantages to converting SNA traffic at remote sites. First, once SDLC frames are converted to token-ring frames, they can be bridged or routed over an internetwork like any other LAN packet. Second, all acknowledgments are kept within the local network, significantly reducing the amount of keep-alive traffic that must be sent over a wide-area connection. That was a key consideration for Columbia Gas, because its small sites were connected with relatively low-speed links, running at no more than 56 Kbps.

Choosing a Router

Kinney needed a router for the remote sites that could convert the SDLC traffic and also handle the LAN traffic. It had to be economical and work with a variety of telecommunications services. And it had to be easy to use, because most sites—typically, a local gas-company office with five or six employees—have no technical staff. Kinney also wanted to manage the remote devices from the central office. "We need to be able to perform diagnostics and management from headquarters," he says.

Columbia chose an access router that uses DLSw (Data Link Switching) for the conversion. Putting such an access router in each remote site simplifies the company's connectivity requirements (see the figure "Columbia Gas's Network Connectivity" on page 64NA 8).

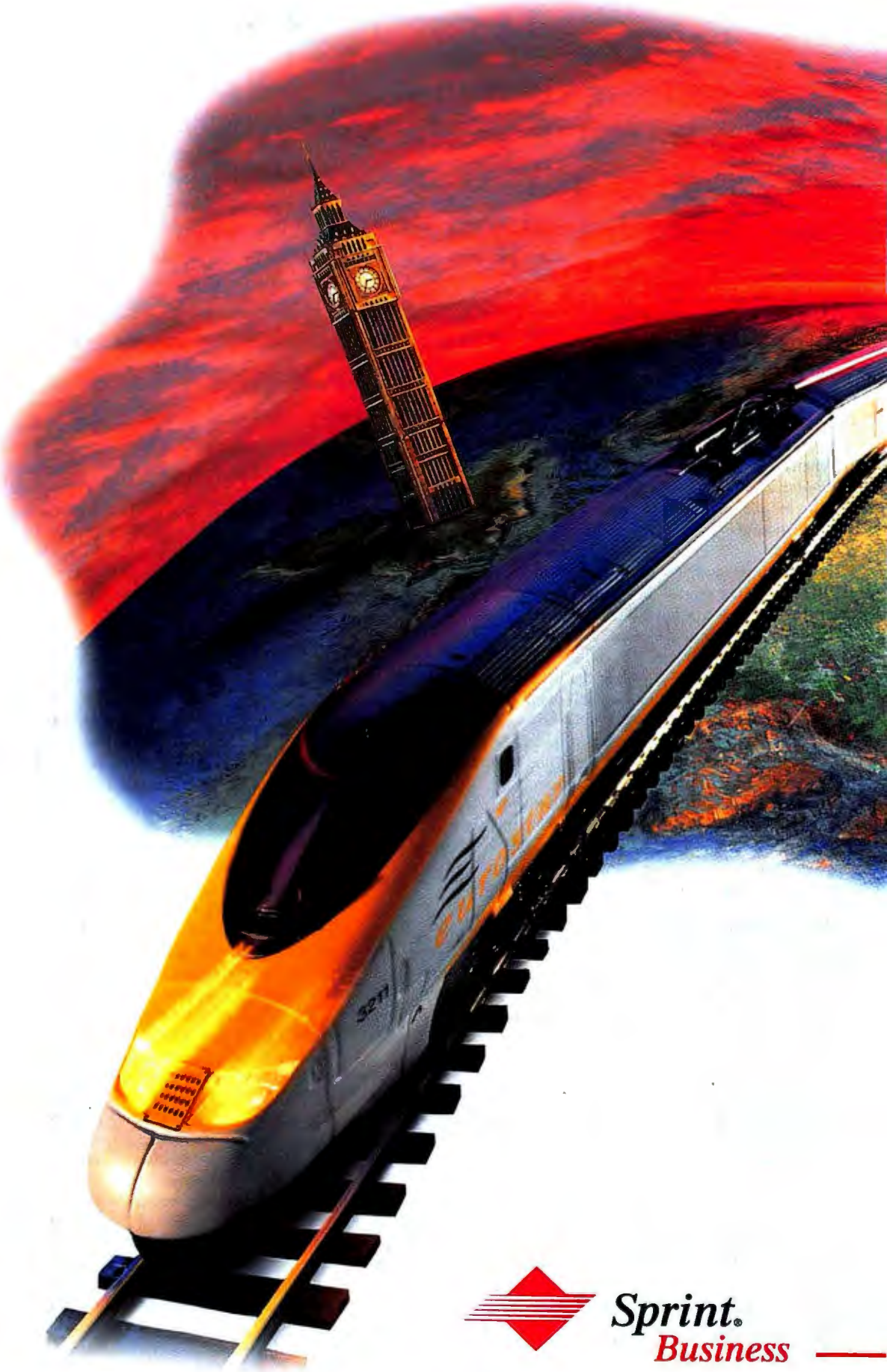
Prior to using access routers, each remote site had a 3174 cluster controller to which 3270 terminals (or PCs with Irma boards running 3270 terminal-emulation software) were attached. Each 3174 controller was connected over a low-speed analog link to a dedicated 3725 controller in the central data center. This gave people in the remote offices access to the mainframe applications and data. All told, there were 250 point-to-point analog lines, which supported about 6000 3270 terminals at the remote locations. If a remote site happened to have a LAN, it wasn't connected to any other site.

After Columbia Gas installed an access router in a remote site, the situation changed. For those sites that wanted to retain the installed 3174 controllers and 3270 terminals, the 3174 could be attached to one of the router's synchronous communications ports. And if the site had a token-ring network, the ring could be attached to the LAN port on the same router.

To reduce telecommunications costs and improve the overall data-carrying capability, Columbia Gas chose a frame-relay-based network. Compared to the previous point-to-point analog links, each new link is higher-speed—56 Kbps versus 19.2 Kbps—and each is local. The connections from all the remote sites are multiplexed by the carrier (using AT&T's Interspan frame-relay service) onto a single-access line into the data center. Therefore, no one has to take care of 250 incoming lines and their associated termination equipment.

The single incoming line feeds into a high-end router instead of the previously used 3725 controller rack, which Columbia Gas is phasing out. This will represent a noticeable cost savings because, although the company has used the 3725 controller modules for over 10 years and they are paid for, they require expensive annual maintenance contracts.

The 3174 controllers in the remote sites can also be retired gradually as each site migrates to token-ring LANs and gets its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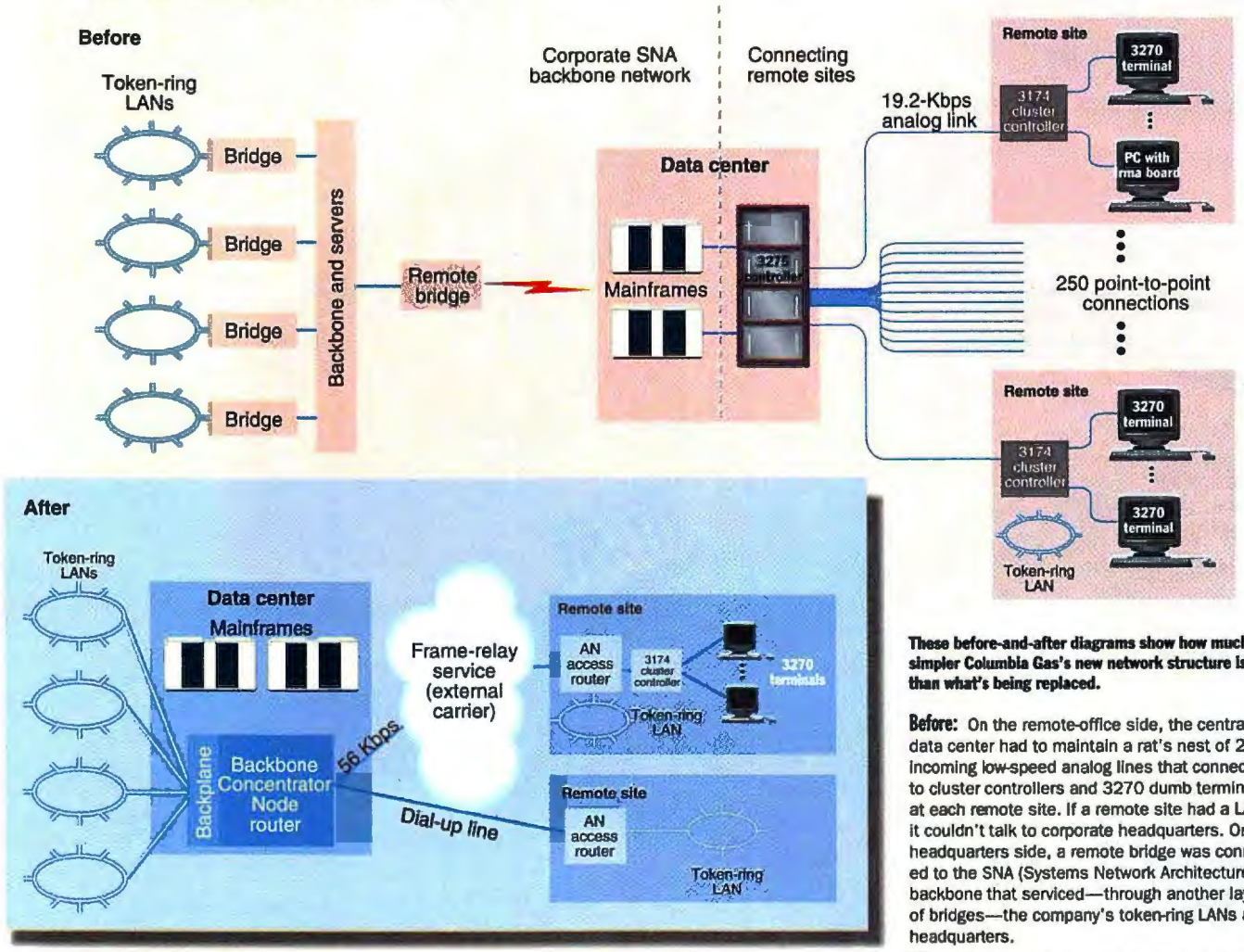


These before-and-after diagrams show how much simpler Columbia Gas's new network structure is than what's being replaced.

Before: On the remote-office side, the central data center had to maintain a rat's nest of 250 incoming low-speed analog lines that connected to cluster controllers and 3270 dumb terminals at each remote site. If a remote site had a LAN, it couldn't talk to corporate headquarters. On the headquarters side, a remote bridge was connected to the SNA (Systems Network Architecture) backbone that serviced—through another layer of bridges—the company's token-ring LANs at headquarters.

After: With the switch to Bay Networks' BCN (Backbone Concentrator Node) connecting via a frame-relay service to AN (Access Node) access routers at each remote office, Columbia Gas now has to deal only with a single incoming line—and a higher-speed digital line at that. On the headquarters side, all the LANs now connect directly to the BCN.

mainframe access through PCs instead of terminals. When a site moves completely to LAN access, the synchronous communications port previously used by the controller can be used for dial-out backup in the event that the dedicated frame-relay link fails. This port can also be used as a dial-in management port by network management staff in the central site (again, in the event of a primary-link failure).

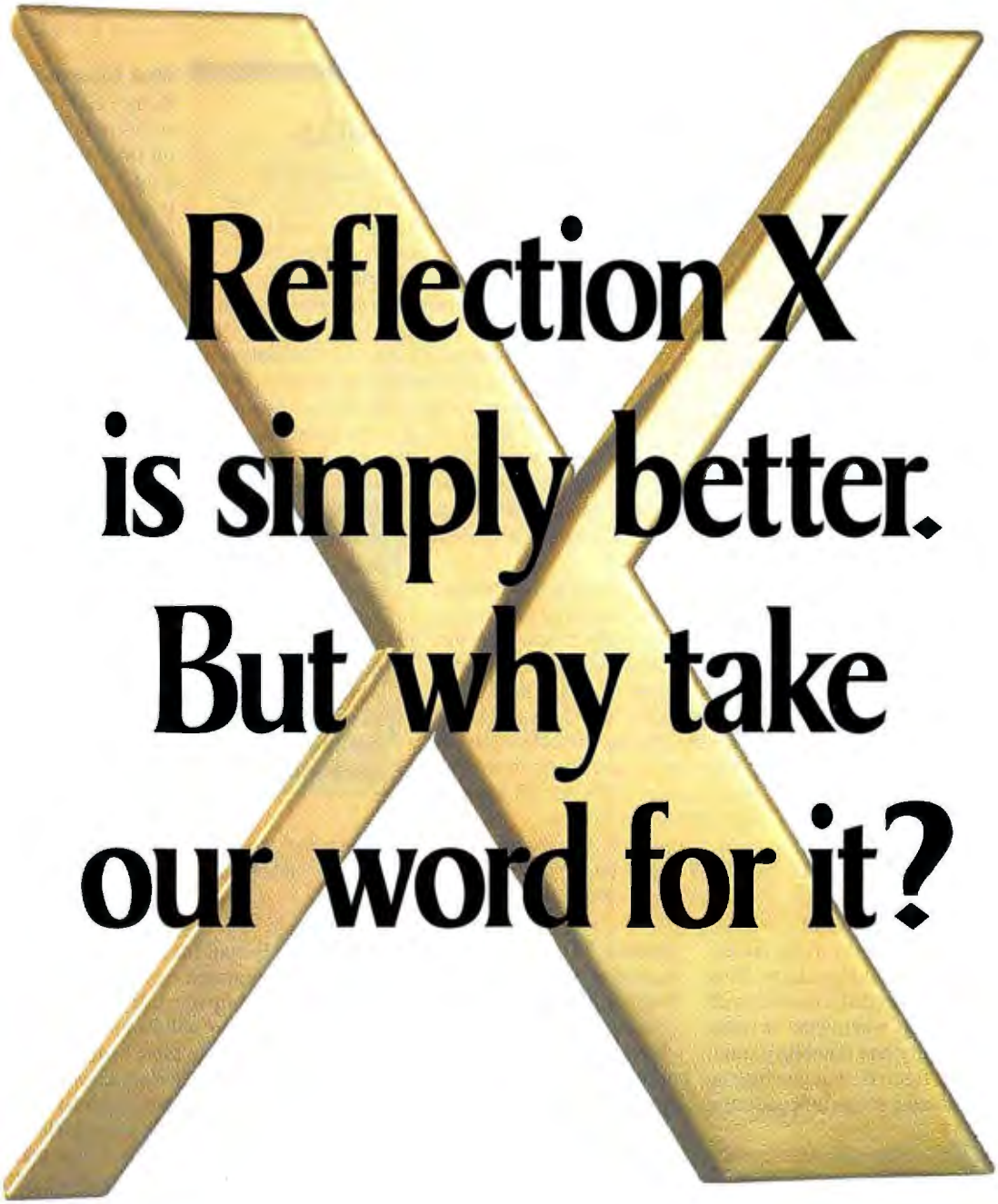
Routers Beat Out Bridges

Columbia Gas had another reason for selecting a router-based solution. Some employees were concerned that the company was outgrowing its corporate backbone network, which consisted of multiple bridged token rings. Unfortunately, large bridged networks can suffer from traffic glut if they're flooded with packets. Such networks are particularly prone to performance problems if so-called chatty protocols, such as NetBIOS, run over them. And, indeed, Columbia Gas's network used NetBIOS a great deal. As more LAN applications were added to the network, performance problems would inevitably occur somewhere down the line.

An even greater potential problem was the threat of broadcast storms. This happens when packets flood the network, choke off the useful bandwidth, and bring the network down. Columbia Gas can't afford to have its network crash, and it had already experienced disruptions due to broadcast storms.

Moving to a routed network would help this situation in several ways. The influence of chatty protocols could be confined to certain portions of the network. And the threat of network disaster from broadcast storms could be greatly reduced by virtue of a router's filtering capability. "We wanted layer-three control [the Open Systems Interconnection layer at which routers function] over the network," says Kinney. He also wanted to have dynamic control over such events, which a router-based network would provide. If he had opted for a bridged network, on the other hand, static filters would have to be set, requiring lots of manual configuration.

So, Kinney started looking for a router to serve as the functional heart of his network. He narrowed the field down to a handful of possibilities that had the performance and SNA-handling capabilities that Columbia Gas's network required. The final selection was narrowed down to three vendors: Bay Networks (the company formed when Wellfleet and Synoptics merged), Cisco, and IBM. This is a fairly typical list for a company migrating from



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a large SNA network to an IP network. Other vendors with similarly capable products include Ascom Timeplex, CrossComm, and 3Com.

Sometimes quirks of fate play a role in helping the selection process. Bay Networks lent a router unit to Columbia Gas for evaluation, but it arrived with one corner smashed in. The device had been strapped on top of a shipping pallet, but the pallet had evidently been loaded onto a dolly upside down, with the router on the bottom. To make matters worse, the router fell off the shipping dock and apparently landed on one of its corners.

The people at Bay Networks told Kinney that they would get him a replacement and that, in the meantime, he could try powering up the damaged router and playing with its configuration and management functions. Kinney did just that, and the router worked properly. "We ran the network off of it for a while," he notes.

This incident was significant because Columbia Gas had been planning to use a more powerful version of this type of router as the centerpiece of its new collapsed backbone. That meant the company needed a product with high reliability. And what better demonstration of reliability and durability could you get, Kinney figured, than having the router work even after it was dropped from a loading dock?

Columbia Gas's plan with regard to the backbone routers was to convert the hierarchical bridged networks located in the larger sites to collapsed-backbone routed networks. In this case, token-ring LANs would be connected to a single Bay Networks BCN (Backbone Concentrator Node) router. The local traffic on each LAN would be confined to that LAN, and any traffic that needed to reach another LAN or the IBM host would be routed over the BCN's backplane.

After the decision was made to use Bay Networks' routers for the network's core, the choice of access routers for the remote sites was still open. And although access routers from many different vendors could theoretically interoperate with the Bay Networks router, Columbia Gas believed that a single-vendor solution would keep things simpler. "There are different implementations of DLSw that all offer the same features but require learning multiple sets of things," Kinney says. So, Columbia Gas chose Bay Networks' AN (Access Node) access router, which uses DLSw for the conversion.

Another benefit is that Bay's network management program, Opticity, lets Kinney control many of the remote-access routers' functions from a central site management console. Besides offering SNMP management of remote devices, Bay's AN routers can capture a trace of LAN traffic and send it back to Kinney for analysis. This packet-capture feature saves the trace in DRAM on the router, which can then be sent via FTP back to the central site. "That means a manager can get the trace in minutes instead of days," says Kinney.

To put this into perspective, consider the usual alternative. "Typically companies have to [ship via] Federal Express a protocol analyzer to the site, or even send a technician out there with it, to get a similar amount of information to diagnose a problem," says Kevin O'Brien, a systems engineer at Bay Networks.

Where to Find

Bay Networks, Inc.
Santa Clara, CA
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(408) 988-2400
fax: (408) 988-5525

How Conversion Works

SNA-session (Systems Network Architecture) traffic between a terminal and an IBM mainframe cannot be routed over an internetwork. Specifically, the SDLC (synchronous data-link control) frames that make up the common SNA data stream don't have the network-layer-addressing information that multiprotocol routers look for when making decisions on what network path over which to send packets.

One way to make SDLC frames easier to handle in an internetwork comprised of bridges and routers is to convert them to something that a traditional internetworking device knows how to handle. There are several possible approaches to take. One is simply to encapsulate the SDLC frames in IP packets. However, this approach does not work well when the packets have to travel over low-bandwidth, wide-area links, because lots of acknowledgments must be exchanged.

For many companies, the preferred method of handling SDLC from remote sites is to convert the frames before they leave the remote site and terminate the acknowledgments locally. In this way, the converted SDLC traffic can be bridged or routed to the host computer in the central data center, and the "keep-alive" acknowledgment traffic doesn't flood the low-speed wide-area links.

By converting SDLC frames to common token-ring frames, known as LLC-2 (logical link control-2) frames, the packets are transported over the network as any other LAN packet would be.

Columbia Gas uses DLSw (Data Link Switching) algorithms running on Bay Networks' AN (Access Node) routers to convert the SDLC frames. DLSw was originally developed by IBM, which made the specifications publicly available. In the past two years, DLSw has become a de facto standard for handling SNA traffic on internetworks.

What About Costs?

Kinney and Columbia Gas look at this project in terms of return on investment—that is, how long it will take the conversion to pay for itself. Here is how they see it working.

The company's telecommunications charges will go down by virtue of replacing 250 point-to-point, low-speed (most are 19.2 Kbps) analog links with 56-Kbps, local-access, frame-relay-service connections. Kinney figures that the telecommunications savings will offset the routers' purchase price (which is approximately $500,000) in three years. At the same time, the enterprise network can handle multiprotocol traffic with improved performance due to the higher-speed digital connections.

Making Progress

The network-conversion and migration process is currently in full swing at Columbia Gas. E-mail for the LAN-based users is being migrated from OfficeVision to Novell's GroupWise. By the time you read this, routers will be up and running in 20 sites. In two to three years, about 200 sites will be connected via access routers. According to Kinney, there's no set number per month that will be deployed. He's working with each site to select a time that's convenient. For now, the conversion of the backbone network is under way, and the migration process is ongoing.

Kinney says he's learned that it's important to have two main things—simplicity in the products and open standards. And he's found that users at remote sites are eager to convert to LAN-based applications.

But the conversion has added a whole new set of problems for him and his staff. "With SNA, we insulated the users from the network," Kinney says. "Now they have to be smarter about how their applications will run on the network." And that means the networks group has to work more closely with developers. ■

Salvatore Salamone is a BYTE news editor based in New York. You can reach him on the Internet or BIX at ssalamone@bix.com.

BYTE Special Report

THE BYTE NETWORK PROJECT

Hello, World

Is your Web server working hard enough? Jon Udell shows you how to bring out its best in BYTE's newest column.

PAGE 87

INTERNET & BEYOND

10 Reasons Why the Net Will Continue to Be a High-Wire Act

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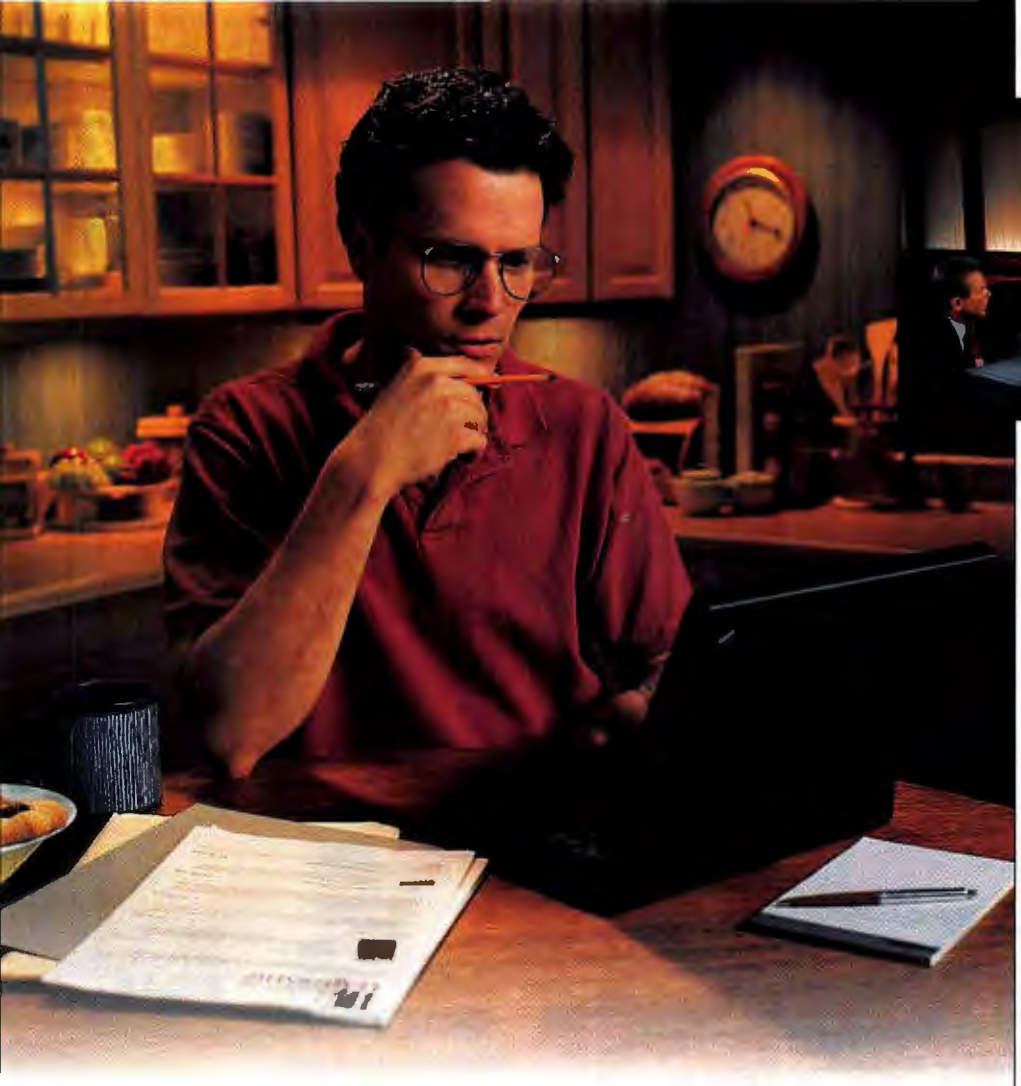

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The Greatest Show on Earth

Nicholas Baran

Working without a net is the trapeze artist's ultimate display of bravery. The ultimate in bravery—or carelessness—for a business today is working without the electronic Net, if you believe the barkers who have created a circus atmosphere around the Internet.

But many Net-aware businesses find the confusion and uncertainty that surrounds the Internet overshadow financial rewards. Customers surf the Net in droves, yet most resist making on-line purchases because of security concerns. The University of Michigan Business School recently found that four to five times more people use the WWW (World Wide Web) to find information about products and services than those who actually buy something through the Net.

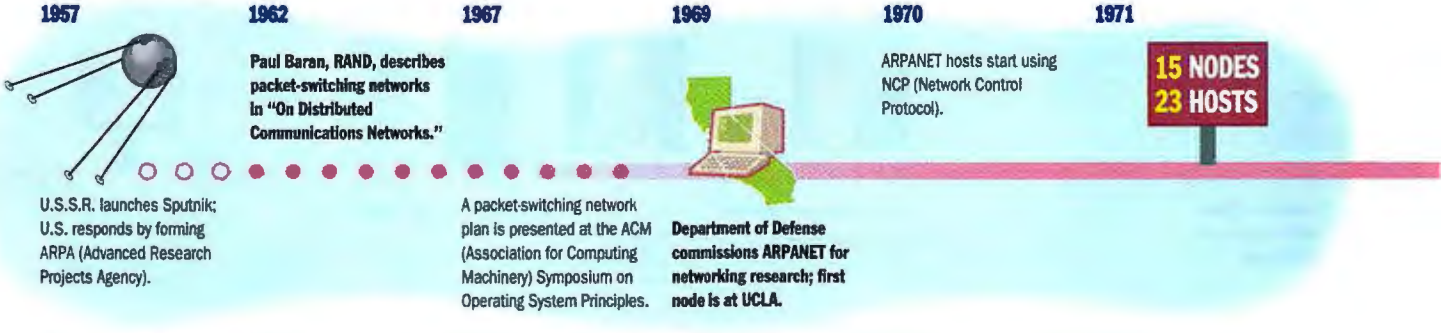
10 reasons why the Net will continue to be a high-wire act

To make matters worse, service quality and reliability vary among Internet connection providers. And the Internet itself is in a critical transition from being largely government funded to becoming a commercial enterprise funded by the private sector.

All this may already have created a backlash. Net veteran Clifford Stoll, in *Silicon Snake Oil*, raises a cybernetic red flag about what he calls "the gross disparity between the ballyhooed electronic utopia and the mundane reality of today's networked community." He equates the slow speed of accessing data over interconnected networks to hanging "bananalike, in lime-flavored Jell-O."

Only time will tell if the Internet successfully evolves as a commercial marketplace. Until then, you'll need to develop an Internet strategy or risk taking a fall without a safety net. Step right up, here are 10 reasons to begin developing that strategy today.

Birth of an Electronic Nation



Source: Robert Hobbes' Zakon (hobbes@hobbes.mitre.org)

Special Report

UNCLE SAM LOGS OFF

1

The Internet's traditional benefactor is withdrawing funding.

On April 30, the federal government essentially pulled the funding plug on the Internet when the Net's traditional benefactor, the NSF (National Science Foundation), shifted the bulk of its funding to a new experimental network called the vBNS (Very-High-Speed Backbone Network Service). The vBNS will exist primarily for research rather than commercial operations and may be the venue to "discover some pretty wild notions," says Vinton Cerf, an Internet founder, a designer of TCP/IP, and now an MCI senior vice president of data architecture and head of the company's Internet initiative. "It will lead us to applications not considered possible because of bandwidth [limitations]," he predicts.

Research on vBNS will focus on broadband, internetworked technologies and services. The core of the project will be to improve the speed and scaling of the Internet and its underlying technologies, according to Jane Caviness, interim director of NSF's Networking Division. The vBNS will initially provide a 155-Mbps-service (OC-3) test-bed for new network applications, and in time, the test-bed will accommodate speeds of 622 Mbps (OC-12). The NSF anticipates that the vBNS will upgrade to 2.5 Gbps (OC-48) in 1998, although the actual dates depend in part on the availability of some commercial products, including routing and switching technology. By contrast, the Internet backbone operates at 45 Mbps using T3 circuits (until 1991, the Internet used a 1.5-Mbps T1 circuit).

MCI owns the $50 million, five-year cooperative agreement to operate the vBNS, which will be physically separate from the Internet. The latter will continue life under the auspices of commercial network-service providers.

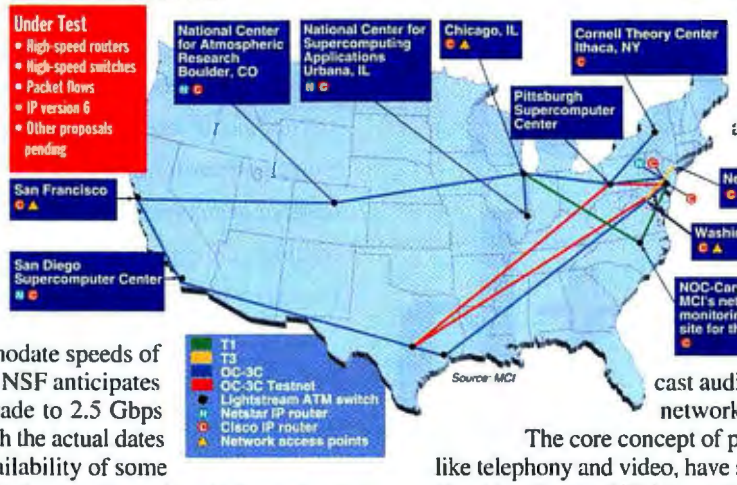
The vBNS will have network-access points like those in current backbones (see the figure "The MCI vBNS Network") and will connect five supercomputer centers across the country. For day-to-day operations, however, these supercomputer centers will continue to use the Internet, and for the first time, they'll have to purchase Internet access from commercial service providers.

The vBNS will test high-speed router and switching technologies, such as ATM (asynchronous transfer mode) and frame relay (see "All-Terrain Networking," August 1993 BYTE). ATM is the current access method for the carrier-based, high-speed SONET (Synchronous Optical Network) infrastructure and is also the way to gain high-speed data transfers in WANs.

Other technologies expected to be tested include packet flows, a technique that allows packets of data to be sent from one source to multiple destinations. (Traditional packet-switched networks are designed for two connection points, a sender and a receiver.) Packet-flows technology may be critical for so-called "multicasting" of multimedia data across networks. Like a TV station broadcasting a program to millions of homes, multicasting may broadcast audio/video presentations to multiple networked computers.

The core concept of packet flows is that some services, like telephony and video, have special transmission requirements. One idea that the NSF is considering is to do the work at layer 2 using something like ATM's CBR (constant bit rate) or VBR (variable bit rate) service. Another proposal being discussed is to build new functionality into the Internet work layer. IP version 6, which we'll discuss in a moment, has a special field, the FlowID, that may help implement this function. Internet routers would also need to perform some degree of traffic isolation among services (i.e., ftp and video) so that large ftps would not impact the delivery of video streams.

The MCI vBNS Network



1971

Ray Tomlinson of BBN invents E-mail program for a distributed network.

1973

ARPANET establishes connections to England and Norway.

1974

Robert Metcalfe's Harvard Ph.D. thesis outlines Ethernet.

Vinton Cerf and Bob Kahn detail TCP (Transmission Control Protocol) in "A Protocol for Packet Network Intercommunications."

BBN opens Telenet, a commercial version of ARPANET.

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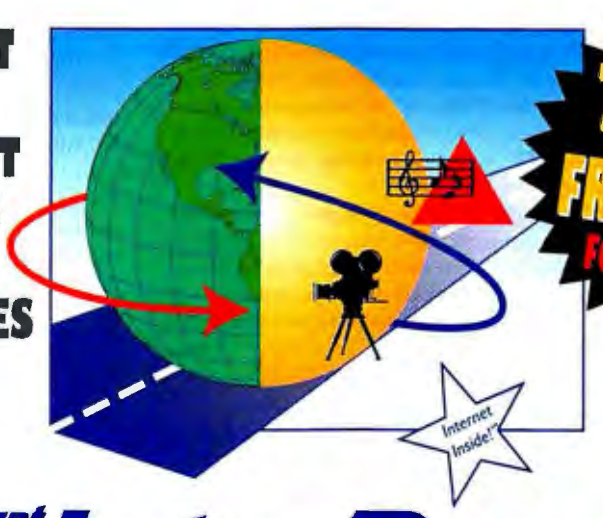

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Prior to the multicast, you'll be able to use packet-flows technology to allocate network resources based on the packet size and packets-per-second speed required by your multimedia content. An early version of this technology operates on the government-sponsored MBone, or multicast backbone, which distributes video and audio presentations to some Internet sites (see "Smile When You Say That" on page 74). Space-shuttle launches are broadcast on the MBone, for example. However, the MBone operates at relatively low bandwidth, ranging from 56 Kbps to 1.5 Mbps. According to Rick Wilder, MCI's senior manager for Internet technology, vBNS video applications will require speeds in "the tens of megabits per second."

The vBNS will also be the test-bed for IPng (next generation), or IP version 6, the updated internetworking protocol. IP 6 will offer expanded addressing and simplified packet routing and message handling (see "Create More IP Addresses," April BYTE). The IP 6 draft won't be implemented until 1996, and it may not have a commercial impact on the Internet until 1997 at the earliest. In the meantime, the vBNS will work out IP 6's design mandates to expand routing and addressing capabilities, offer simple packet headers, and be deployed incrementally when making the transition from the current IP version.

PREDICTIONS FROM THE ORIGINAL NET SURFER

This is "an amazing period of jockeying and adjusting" of the Internet, says to Vinton Cerf, one of the Internet's founders and an MCI senior vice president and head of the company's Internet initiative. By the year 2000, Cerf expects that financial instruments will be well established on the Internet. "We will probably have picked a few if not one method for moving money around the network. There is a strong desire for a single common protocol for transaction processing." As far as bandwidth is concerned, Cerf expects cable access to the Internet to be prevalent "but not necessarily from whom you'd expect. The power companies may be the distributors." He also expects backbone transmission speeds to reach 80 Gbps using multiple light frequencies. "Basic transmission capacity will be readily available—switching capacity [router technology] may be more of a problem."

Cerf said he was surprised how rapidly the Internet has penetrated the business community. The turning point came in 1990 with for-profit enterprises, such as Lexis/Nexis and MCI Mail. His only regret is that he and his colleagues "never had a chance to try it a second time." They had originally planned to do a "complete reimplementation based on lessons we had learned." But the Internet turned out to be so useful that "no one wanted to let go of it."

—N.B.

GET A PIECE OF THE NET

2

Commercial networking companies are jockeying for control.

Now that the federal government has backed off, who will maintain the Internet? The main Internet backbone (NSFNET) had been operated by ANS (Advanced Network & Services), a research-oriented nonprofit company set up by Merit Network, IBM, and MCI in 1990 under a cooperative agreement between the NSF and Merit. That contract ended in April. In February, ANS sold its backbone infrastructure to America Online. Backbone maintenance responsibilities previously borne by the NSF are being taken over by ANS/AOL and other network service providers, like MCI and Sprint.

WHO CONTROLS THE INFRASTRUCTURE?

Yesterday	Today
• National Science Foundation	• MCI • Sprint • ANS/AOL

The cost of operating the Internet was divided among the NSF and public and commercial users. Since 1993, the NSF has been shifting backbone funding to the commercial sector. As a result, the April 30th decommissioning was largely a nonevent.

In recent years, the NSF has spent about $11 million annually on backbone funding. It will continue to subsidize NAP connections for the regional networks on a decreasing scale but plans to reduce funding to zero by 1998.

The IETF (Internet Engineering Task Force) still largely governs the Internet on an ad hoc basis. The traditional IETF membership represented the federal government and academia, but it now may be driven by commercial forces. "The Internet will go where private money sends it, [to] companies like Microsoft," says Howard Mirowitz, vice president and deputy general manager of Mitsubishi Electronics America's North American Multimedia Business Center. He worries that lessened government involvement may have a downside. "How do we agree on what digital money is or on encryption standards? Without a government role, there will be a lot of uncertainty," Mirowitz warns. Optimists say that as usage increases, a more-commercial Internet may bring down costs for Internet access, transmissions, and for switches and other hardware.

1976

UUCP developed at AT&T Bell Labs.

Tom Truscott and Steve Bellovin establish Usenet using UUCP between Duke and UNC.

1982

TCP/IP becomes the protocol suite for ARPANET. This leads to one of the first references to an "internet" of connected networks.

EUnet (European Unix Network) begins.

235 HOSTS

1983

University of Wisconsin develops name servers.

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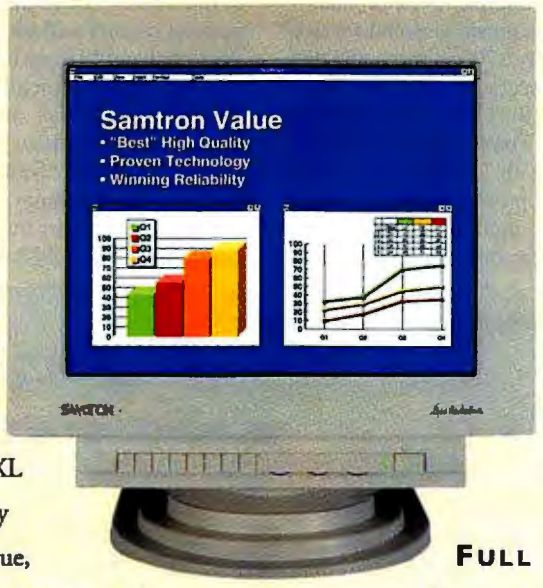
JANUARY 1995 BYTE BEST HIGH-QUALITY 17-INCH COLOR MONITOR

WINDOWS



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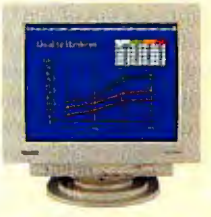

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SMILE WHEN YOU SAY THAT

3

Internet videoconferencing struggles between possible and practical.

Videoconferencing over the Internet is not for the fainthearted, but one effort could eventually make it practical for business. The MBone (multicast backbone) establishes a means to send multicast packets over parts of the existing physical Internet. It already carries live meetings of the IETF, and some scientists use it to collaborate in real time. The MBone has even broadcast part of a Rolling Stones concert. Over a dozen regional service providers support the MBone for roughly 1700 subnets, and this number is doubling every six months, according to Steve Deering, a computer scientist at Xerox's PARC (Palo Alto Research Center) and a key MBone developer. "The Internet is doubling every year, so [the MBone] is catching up," he says.

Fully implemented, the MBone could provide modestly priced videoconferencing capabilities to any individual or business with Internet access. For now, bandwidth constraints and limited availability keep the MBone out of prime time.

Multicast packets differ from "normal" unicast packets in that they go to many destinations rather than just one. The source data travels to just one "group" address over the MBone, but any MBone-configured system can pick up the signals by using that address, like a radio tuning in to a specific station.

Not everyone on the Internet can receive these broadcasts, however. Your system must support IP multicasting, which is something that most Unix workstations do out of the box or with a software upgrade. FTP Software's PC/TCP OnNet software, Windows for Workgroups, and the upcoming Windows 95 provide IP multicasting to DOS/Windows systems. Apple's Open Transport, in beta at press time, will include IP Multicast. Your service provider must also use a multicast router to send videoconferencing signals to MBone-capable endpoints by creating "tunnels" (see the figure). These tunnels use the "mrouted" multicast-routing daemon to channel through nonmulticast routers to the intended endpoints.

Because conventional network routers can't cope with multicast packets, broadcasters encapsulate the packets using a conventional IP header so that the routers see the packets as normal. Once on the other side of the router, the header is stripped off, and the packets return to multicast form. In the future, some commercial routers will incorporate both conventional and MBone capabilities.

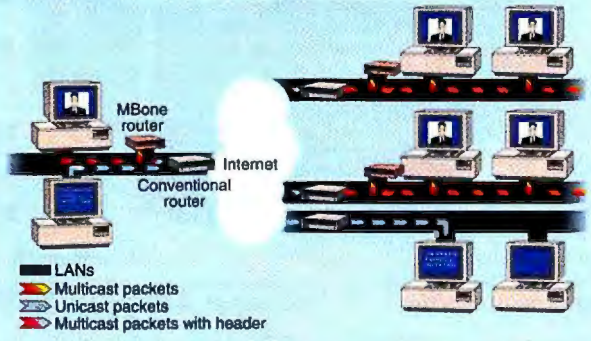
A T1 line is typically used to connect MBone-capable sites, but even at 1.5 Mbps, T1 can effectively carry only two or three videoconferences at a time. For this reason, broadcasters schedule MBone videoconferencing transmissions for specific times to avoid overburdening the system. Due to overhead of other traffic on the T1 line, the maximum bandwidth available to MBone users at any given time is about 500 Kbps. Video streams require 128 Kbps (at about 4 frames per second), and audio consumes 64 Kbps. That doesn't include header overhead. That lack of bandwidth is the key limiting factor to widespread MBone use. "[Videoconferencing] applications require a lot of bandwidth, and it's just not there," Deering observes. He's optimistic that capacity will become available as Internet service providers upgrade their hardware.

The MBone is not the only means of conducting videoconferencing over the Internet. Future Communications Systems' VideoVu is a $479 package of hardware and software that lets you send and receive audio and video signals over the Internet via a regular modem connection and a standard digital camera. The company claims display rates of up to 15 fps. But VideoVu only sends unicast signals. Martin Fox, Future's president, hopes to make use of the MBone in the future, but "right now, most people don't have the MBone."

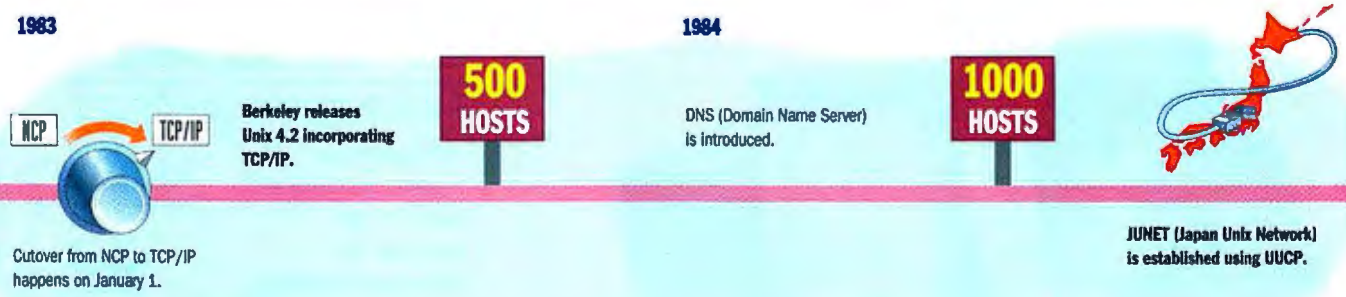
For more information about the MBone, see the MBone FAQ at http://www.eit.com/techinfo/mbone/mbone.html.

—Michael Nadeau

Components of the MBone



The MBone is a virtual multicast network overlaying the existing Internet. It "tunnels" through that infrastructure by making multicast packets appear unicast to conventional routers. The packet's header contains the unicast address of the receiving conventional router and code identifying the packet contents as IP addresses. Once through the receiving router, the head is stripped off and the multicast packets are sent to their intended destinations.



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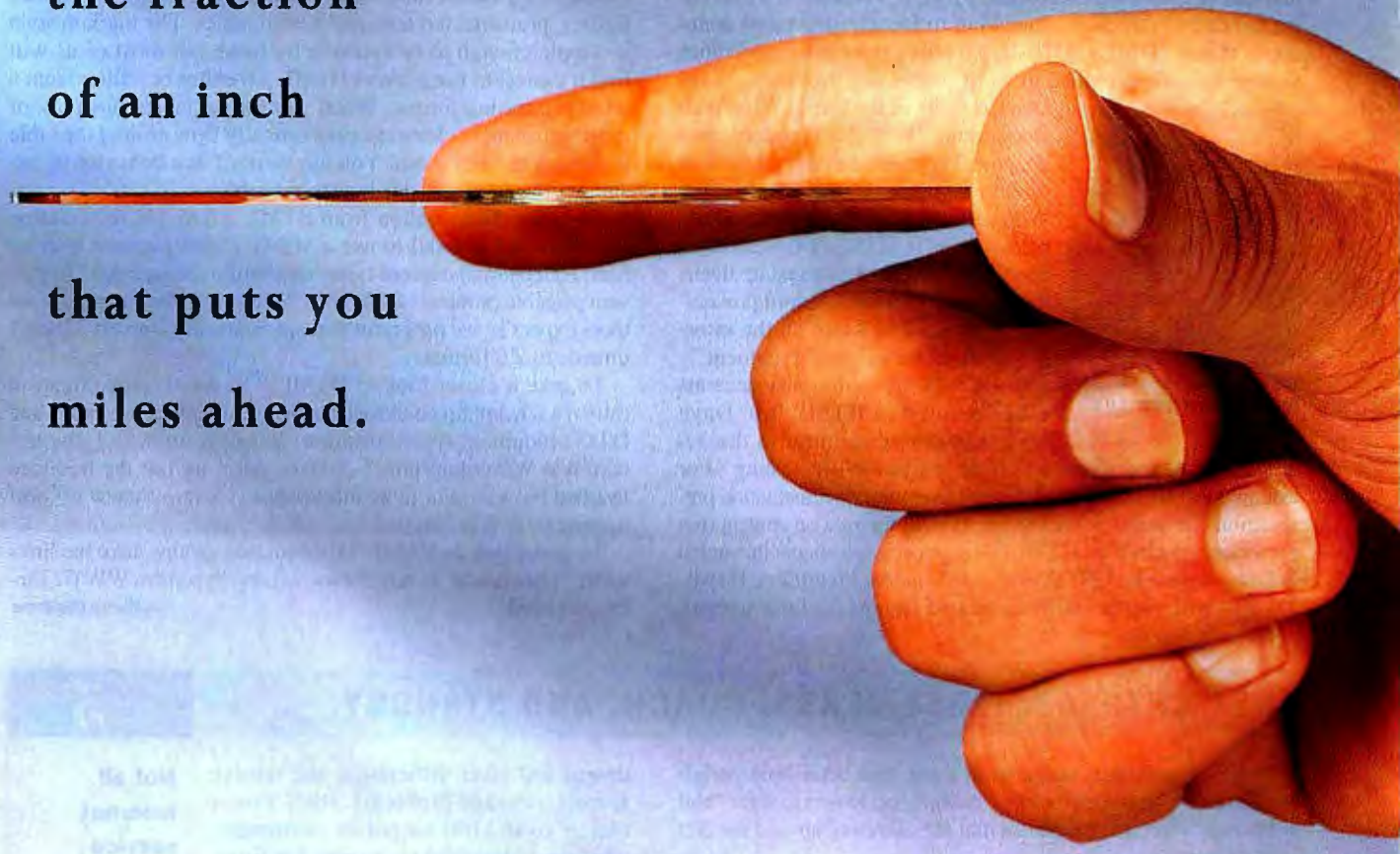

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CAN YOU SAY LINGUA FRANCA?

4

HTML will undergo a major revision.

Since 1990, HTML, the WWW's (World Wide Web's) standard markup system for hypertext documents, has undergone two major revisions: HTML 2.0, an upgrading of the formal standard, and HTML+, an informal set of extensions that became widely used on the WWW. By the end of this summer, many Web browsers are expected to support a new version, HTML 3.0.

The latest iteration will provide features introduced by HTML+ and will be backward-compatible with 2.0. Version 3.0 is also expected to be more accommodating to loosely structured documents than is HTML+. "HTML 3.0 offers expressive capabilities similar to those provided in word processing programs," says Dan Connolly of the World Wide Web Consortium. "With 2.0, if your original document contained a table, there was no way to describe that information. With 3.0, there is. This increased expressiveness in HTML 3.0 means that people will be able to translate documents from commercial word processing programs and retain all the information from the original document."

The ability to wrap text around figures is one of HTML 3.0's enhancements.

The WWW drives the enhancements to be included in HTML 3.0. Dave Raggett, a key contributor to the 3.0 draft, calls the specification "a huge exercise in user testing." For example, information providers want to control documentation presentation. To do this while keeping HTML focused on content (not presentation) markup, HTML 3.0 supports stylesheets through a link to a stylesheet URI (Universal Resource Identifier). HTML 3.0 also will handle text flow around figures (see the screen), math equations, customized lists, and the ability to include tables in a document.

The table feature is among the most interesting additions to HTML 3.0. The new version will avoid the complexity of the CALS (Continuous Acquisition and Life-Cycle Support) table model and uses a markup style that works on a wide range of output devices, including braille and speech synthesizers. Tables can contain headers, lists, paragraphs, forms, figures, preformatted text, and nested tables. The markup style is simple enough to be typed in by hand, but most of us will find it easiest to use a direct HTML 3.0 editor or a filter from a word processing format. When you format tables flush left or right, subsequent elements automatically flow around the table if there is enough room. You can turn off that behavior by assigning the "noflow" attribute to the table.

To make the transition from HTML 2.0 to 3.0, information providers are advised to use a MIME (Multipurpose Internet Mail Extensions) content type "text/html; version=3.0" to prevent possible problems for HTML 2.0 users. In the future, 3.0 authors expect to see programs that automatically convert 3.0 documents to 2.0 format.

To take a closer look at HTML 3.0, see the specification (http://www.hpl.hp.co.uk/people/dsr/html/CoverPage.html) and DTD (document type definition) (http://www.w3/org/hypertext/WWW/markup/html3-dtd.txt). Also, try out the freeware test-bed browser. For more information, see http://www.w3.org/hypertext/WWW/Arena/.

To participate in HTML 3.0 discussion groups, take the links under "Discussion" in http://www.w3.org/hypertext/WWW/TheProject.html.

—Karen Muldrow

NET ENTRÉES: FIRST-CLASS, COACH, AND STANDBY

5

Not all Internet service providers are created equally.

Service providers range from those that offer "industrial-strength" Internet for large businesses, to services for "roll your own" Internet companies that are climbing aboard the Net on a shoestring.

Industrial-strength users hire a service, such as BBN Planet, internetMCI, or IBM Global Network, to take care of all aspects of Internet usage. For example, BBN Planet will set up WWW pages for your business, give you an IP address, provide firewalls, do 24-hour monitoring of the network for slowdowns and other difficulties, and resolve E-mail message problems. BBN Planet claims over 1100 corporate customers, which include publishing houses, law firms, printing companies, and power utilities.

Providers like BBN also offer remote access to its servers, which lowers security risks and makes the providers responsible for maintaining adequate bandwidth. As

1986

NSFNET is created, with a backbone speed of 56 Kbps.

The NSF (National Science Foundation) establishes five supercomputing centers; an explosion of connections follows.

NNTP (Network News Transfer Protocol) enhances Usenet news performance over TCP/IP.

Mail Exchanger (MX) by Craig Partridge gives non-IP hosts domain addresses.

Hosts number 2000 in February, 5000 by November.

1987

Merit Network manages the NSFNET backbone; Merit, IBM, and MCI later found ANS (Advanced Network & Services).

HOW DO SAVVY COMPANIES USE ADOBE ACROBAT TO PRESERVE THEIR IMAGE ON-LINE?

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experienced Internet users know, networks become overloaded or break down, regardless of the bandwidth. Large service providers promise adequate bandwidth to avoid major performance problems. But bandwidth isn't cheap. For example, BBN Planet offers 56-Kbps service ranging from $500 to $1000 per month, and T1 service (1.5 Mbps) ranges from $1800 to $2500 per month. Note that bandwidth is not dynamically allocated but instead is based on usage forecasts. Acquiring additional bandwidth is a matter of adding more T1 or T3 lines to the network to react to additional customer demands.

At the other end of the spectrum are the "grassroots" Internet access companies, which are typically local service providers that lease dedicated lines to their T1 lines. Business customers purchase Internet access via these dedicated lines and rent space on the service provider's WWW server to set up a home page (for more details about setting up Web servers and defining content, see "Hello, World" on page 87 and "Build Your Own WWW Server," April BYTE).

Renting is economical, especially for fledgling Internet companies. For example, Hooked (San Francisco, CA) rents 2 MB on its WWW server for $35 a month, which includes 20 hours of access, as well as $3 per additional hour. There is also a $100 fee for establishing a domain name. The charge for setting up a Web page is $70 per hour. Dedicated lines are considerably more expensive. A 56-Kbps ISDN line in San Francisco costs $250 per month and requires a router that ranges in price from $800 to $1500 (see "How to Implement IDSN," April BYTE).

For Homer H. Hillis Jr., the president of HHH Enterprises (Abilene, TX), gaining Internet access was simple. After using Prodigy for a year, Hillis decided to advertise his company's jewelry supplies on the Internet. He turned to OnRamp Technologies, a Dallas Internet service provider. The company gave Hillis an account number and outfitted his PC with Chameleon communications software from NetManage (Cupertino, CA). "Access is easy as long as you are willing to get your feet wet and read up on the technology," Hillis says.

The downside to small-scale service providers, however, is that some of them oversell capacity, according to Thom Stark, principal of Stark Realities (El Cerrito, CA). If two dozen businesses rent access to a WWW server on a local network with a limited number of T1 lines, the whole network can slow to a crawl if one of those businesses becomes hot and starts to get thousands of hits per day. "It's hard to plan for something like the *Playboy* Web pages getting a quarter million hits per day," points out Stark. Greg Lesko, director of sales of Hooked acknowledges that bandwidth overload can be a problem "especially if there's a lot of graphics on the page."

Dan Adachi, a product manager at Software Professionals in San Mateo, California, is a customer of Hooked and of a competing Internet service provider. He says that Hooked has stayed on top of performance problems, but the other service "can be horrendous on some days when the whole company is using the Web."

Steve Heflin, president of New Age Micro Systems (Milpitas, CA), encountered other problems. "Getting [access] products to conform to underlying network protocols was so frustrating that I had to either start laughing or go crazy," the computer-industry consultant says. "Every time I called the company, a technician would tell me the software was not compatible with my access provider," Heflin explains. "I kept changing providers but nothing helped."

Eventually, Heflin successfully installed SuperHighway Access from Frontier Technologies (Mequon, WI). He began using the Internet to send E-mail and has branched out to multimedia presentations. However, Heflin warns others about potential pratfalls: "There are few standard rules and protocols, [so] the user often has to determine which items work together, and that process can be difficult and time consuming."

As in any new market, there is bound to be a shakeout of smaller companies. There are signs that this shakeout has already begun. For example, CompuServe (Columbus, OH) recently acquired Spry, a Internet service provider and publisher of Internet In A Box. National Internet provider Performance Systems International (PSI, Reston, VA) recently bought Pipeline (New York, NY), a smaller provider and developer of Internet access software.

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What You'll Pay

- 56-Kbps service: $500 to $1000 per month
- T1 (1.5 Mbps) service: $1800 to $2500 per month

WHAT REGIONAL ACCESS PROVIDERS GIVE YOU

- Leased access to T1 lines
- Home-page rental space on a WWW server
- Adequate or inadequate bandwidth, depending on the provider

What You'll Pay

- WWW server space: $35 per month for a set number of access hours
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- Home page setup: $70 per hour

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SECURITY TRUCE?

6

Security standards remain in flux.

Inadequate security is the biggest challenge to making the Internet a commercial marketplace. Because incidents of security breaches on the Internet are legion, many businesses and consumers are understandably uneasy about performing financial or other confidential transactions on-line.

Today, there are two basic approaches to secure electronic commerce. The first one focuses on protecting resources by securing individual servers and network sites. This access security is generally addressed by firewalls or other means of "perimeter security" (see "Barricading the Net," April BYTE and "Cash on the Wirehead," June BYTE).

The second approach focuses on transaction security. Transaction security addresses unauthorized listening in or eavesdropping on buyer/seller communications; authentication, so both parties are confident they know who they're talking to; message integrity, so the message contents can't be changed or tampered with; and a nonrepudiable record of the transaction in the form of a receipt or signature.

One way to achieve these security properties is *channel-based security*, which secures the channel along which the transaction is taking place. Users assume that any data passing through this channel is secure. *Document-based security* focuses on securing the documents that make up the transaction. Two emerging standards address channel-based and document-based security. The SSL (Secure Sockets Layer) system from Netscape Communications (formerly Mosaic Communications) is the leading channel-based technology. The key document-based approach is the SHTTP (Secure Hypertext Transport Protocol) system from Enterprise Integration Technologies, which is the lead sponsor of CommerceNet, a nonprofit consortium. Its members include Apple, Bank of America, and Hewlett-Packard. CommerceNet has created many pilot electronic-commerce projects and is a key proponent of SHTTP.

SSL, which includes some features of document security (e.g., digital signatures), is further along than SHTTP, which remains in its pilot stage. Some observers are skeptical that SHTTP will ever come to market. "As of today, SHTTP doesn't exist. It's almost becoming a joke," says Andrew Singleton of Money.com (Cambridge, MA). "Everybody's using Netscape's SSL system." Others disagree about SHTTP's potential. "There is a strong contingent for SHTTP," says MCI's Cerf. "We can't make a determination [about its fate] at this point." Proponents of SHTTP say that its document security model is inherently more reliable than channel security and that some financial institutions will settle for nothing less.

In the meantime, businesses on the Internet are preparing to support both security protocols. "We'll go with what customers want," says Bill Rollinson, cofounder and vice president of marketing of the Internet Shopping Network. "Sixty to 70 percent of our customers are using Netscape browsers [which support SSL], but we will probably have to support various solutions." Despite his skepticism about SHTTP, Money.com's Singleton is pursuing a similar strategy. "We'll support both [SSL and SHTTP] by having two servers; we'll have a header that will direct the transaction to the appropriate server."

At press time, a start-up company announced plans to merge the two standards. Terisa Systems (Menlo Park, CA) is owned jointly by RSA Data Security, one of the leading developers of cryptographic systems, and EIT. Among Terisa's investors are America Online, CompuServe, Prodigy/IBM, and Netscape. What's intriguing is the teaming of Netscape and EIT (SSL and SHTTP proponents, respectively). This may indicate a security-protocol truce, which improves the prospect for a single security standard. "I am confident that we will end up with a common, secure, interoperable environment," says Chini Krishnan, senior marketing engineer with EIT. "The market needs it, and therefore it will happen."

Rosanne Siino, director of communications at Netscape, confirms Terisa's goal to integrate SSL and SHTTP. "They're not incompatible since they operate on different levels," she notes. Siino says that Netscape will help Terisa develop a toolkit that will make the integration possible.

Commercial products based on Terisa technology aren't expected until fall, although the toolkit that merges SSL and SHTTP may be available this summer.

TOWARD A COMMON STANDARD

A single protocol for secure financial transactions will probably combine elements from today's two leading camps.

SSL (Secure Sockets Layer)
Secures the transaction channel. Proponents include Netscape Communications. Used currently by commercial businesses on the Internet.

SHTTP (Secure Hypertext Transport Protocol)
Secures documents that comprise the transaction. Proponents include Enterprise Integration Technologies and CommerceNet. Not widely implemented but potentially more secure than SSL.

1990

Mitch Kapor founds the Electronic Frontier Foundation.

1991

CIX (Commercial Internet eXchange) association is founded.

Thinking Machines releases WAIS (Wide Area Information Service).

University of Minnesota introduces Gopher.

U.S. establishes the NREN (National Research and Education Network).

617,000 HOSTS

Hosts number 376,000 in January, 617,000 in October.

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WINDOW SHOPPING IN CYBERSPACE

7

Surfers far outnumber buyers on the WWW.

Secure WWW servers are today's fastest way to jump-start commerce on the Internet. Such servers almost exclusively use Netscape's SSL system and require the customer to have a Netscape browser, which also supports SSL.

Some companies use WWW servers to initiate transactions. For example, businesses can post more-detailed information about their products and services than is possible in a printed catalog. Says Money.com's Singleton, "The real value of the World Wide Web is as a database front end. It gives customers access to data."

Garnering attention because of the company's financial resources is marketplaceMCI, an "electronic mall" that is open to anyone with access to the WWW. MCI has signed up a variety of merchants to sell their products and services on marketplaceMCI, including Sara Lee, Amtrak, and Timberland.

However, it's difficult to measure commercial success on the Internet. Some business people, such as Bill Rollinson of the Internet Shopping Network, boast about getting "300,000 hits per day." But hit rates say nothing about how many purchases are made or even how many actual E-mail requests for more information are received. A hit simply means someone looked at your Web page.

The WWW as a commercial marketplace has performance limitations. At typical modem speeds (9.6 to 28.8 Kbps), the WWW's performance is relatively slow. Matt Kursh, CEO of eShop, a company that designs user interfaces for electronic commerce, complains that even the most sophisticated commercial WWW servers "aren't what I'd call compelling, even at T1 speeds."

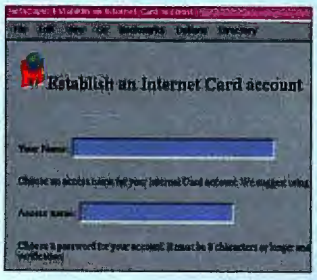
For these reasons, many businesses establish a WWW presence more for image-building reasons than for financial reward, according to ActivMedia (Peterborough, NH), a market researcher that specializes in the Internet. In a recent survey of Internet marketers, 72 percent said that the purpose of their on-line presence was to enhance their company's image, and 74 percent use the Internet to distribute pricing and product information. Only 22 percent said the Internet was "financially rewarding," and 40 percent didn't expect financial rewards for another 12 to 24 months. These companies still rely heavily on telephones and fax machines to exchange credit-card information. Encrypted credit-card information, or "E-cash," are insignificant payment means used by less than 6 percent of Internet companies, according to the survey.

WEB TOOLS AND SERVICES

A number of products provide diversified Web page and site development services. For example, **Global Commerce Link,** from the company of the same name, is part of a suite of Internet business communications services. They include packaged services, custom design, systems integration, and consulting services focused on specific business applications.

GCL packaged services use a Mosaic interface and home page. End users and customers can use the services with Mosaic, as well as with other client applications, including E-mail and FTP. Depending on the service level, a customer may have private accounts to update, upload, or download.

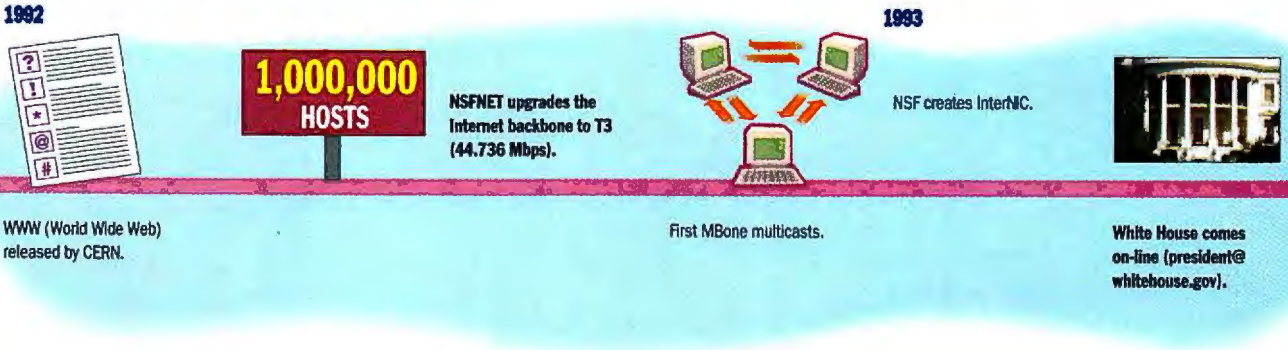
Customer information typically resides on GCL Web site servers via a GCL Product & Services menu (see the screen). Global Commerce Link uses multiple servers and network connections via SprintLink for such systems services as data redundancy, automatic backup, and service redirection. The package lets you display graphical information about your business using Mosaic. For example, Hays Photography, a sole proprietorship in Denver, Colorado, uses GCL's Mosaic capabilities to display its limited-edition black-and-white photographs for gallery owners and customers. **GCL packaged services start at under $500 and step up to around $24,000. Large sites with custom design and integration services may spend $500,000 or more.**



Open Market (Cambridge, MA) sells Commerce Connection, a module that provides Web companies with credit-card authorization, buyer authentication, and customer service and dispute-resolution facilities. **Pricing is $1495 for the WebServer, $4995 for a secure WebServer; and $2495 for Commerce Connection.**

Internet Video Services (Sunnyvale, CA) offers a range of services to digitize, compress, format, and optimize video, audio, and graphical data for Internet access (see the screen). Internet-based video catalogs let companies distribute information to customers that can access the information at the source location, saving distribution and replication costs. Internet video distribution also reduces administration and tracking. **The cost of these services range from $5000 to $20,000 per quarter.**

—Nicholas Baran and John R. Vacca



Discover The New World Of Content-Driven Navigation

BEST OF BYTE COMDEX/Spring '95 Winner

AnchorPage Fully Automates Concept Extraction And Hypertext Anchoring Of HTML Documents.

AnchorPage uses semantic and syntactical analysis to "read" HTML documents and extract the significant concepts from them. AnchorPage then builds four *Synopsis Views* of the document and links each view's entries with the corresponding passages in the original document.

This provides your end users with four different methods of referencing the content of each document, so they can quickly determine if it has the information they're looking for *before* they invest the time in downloading it.

The *Table Of Contents View* presents the overall document headings and subheadings in outline form. This allows users to see the overall shape and content of the document at a glance.

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The *Concept View* presents these same concepts arranged alphabetically on the basis of the key words they contain. This allows users to search for an important term or phrase (e.g., taxes, social security) and immediately see the context in which the term is discussed.

The *Phrase View* presents an alphabetical list of all the key terms and phrases of the document, whether or not they happen to appear within the discussion of a significant concept. This view is both briefer and more all-inclusive than all others, and allows users to quickly skim for key terms that may point to the information they are looking for.

Website administrators can offer as many of these options as they choose, along with any combination of hypertext jumps linking them to one another and to the original document.

This results in fully referenced, fully linked document content that makes your information quickly and easily accessible to your user.

Internet Demonstrations. To try AnchorPage for yourself, visit the ICONOVEX home page on the World Wide Web (http://www.iconovex.com). Or call ICONOVEX for more information, **1-800-943-0292** or **1-612-896-5100.** Or write: ICONOVEX Corporation, 7900 Xerxes Avenue South, Suite 550, Bloomington, MN 55431.

ICONOVEX

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AnchorPage Benefits For Website Administrators:

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•Fully customizable, both in the amount of detail in the Synopsis Views you choose to present and in the appearance of the final pages.

•Files can be stored anywhere on your system.

•Documents are segmented for faster download times.

•No modification to existing website pages is necessary. AnchorPage won't affect the structure or organization of servers.

•High speed. AnchorPage analyzes single or multiple documents at very high speed without human intervention.

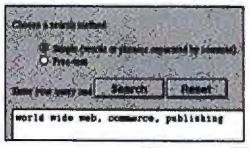
•Satisfied users make for a popular website. Helping them find information quickly, easily, and reliably assures repeated visits.

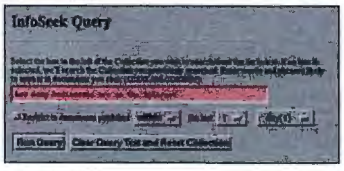
DO YOU KNOW WHERE YOUR DATA IS?

8

Data-search tools aren't mature.

Surfing the Internet is becoming a common business term, like "FedExing" packages or "faxing" a letter. Unfortunately, many businesses find that locating strategic business data is almost as difficult and frustrating as putting together a child's swing set.





Clockwise from top: Topic WebSearcher, InfoSeek, and Surfboard.

The problem lies in the Net's complexity and the fact that its standard data search tools require knowledge and a touch of luck to quickly find useful information.

Traditional browsers include Gopher, which is character-based. Auxiliary packages like Archie and Veronica sift through various servers. The most popular GUI-based browser is Mosaic, originally shareware developed by the University of Illinois' NCSA (National Center for Supercomputing Applications).

Netscape Communications and Spyglass now sell their own versions of Mosaic browsers. These products make it simpler for users to sift through information, but they are not panaceas for wading through oceans of information. "If a user has to go through 10 or more hypertext links, he may not remember how he arrived at a specific server," notes Charles Baugh, the director of knowledge products at Cisco Systems, a communications supplier in Menlo Park, California. "Once he logs off, he may never be able to get back to it."

Several vendors address these problems by tailoring search tools specifically for the Internet. Verity offers Topic, a search tool for users sifting through corporate files. Recently, the company introduced Topic WebSearcher.

InfoSeek provides WWW access and search-and-retrieve capabilities articles from more than 80 computer publications, as well as medical journals, major wire services, Internet news groups, and WWW pages. The service supports Netscape and Mosaic browsers. The standard monthly fee is $9.95, which includes 100 free transactions and 10 cents for each transaction past the free limit or 20 cents per transaction with no monthly fee.

Fulcrum Technologies uses its existing text-retrieval engine in Surfboard, a new search-and-retrieval system marketed for Internet users. Once you locate a document of interest, you can instruct the engine to find more documents like the example, according to the company. Surfboard supports HTTP-compatible browers, as well as WAIS (Wide Area Information Service) and Gopher. OS support includes Windows NT, SunOS, and HP/UX. Server pricing starts at $15,000. **—Paul Korzeniowski**

PUBLIC VS. PRIVATE PERSONAS

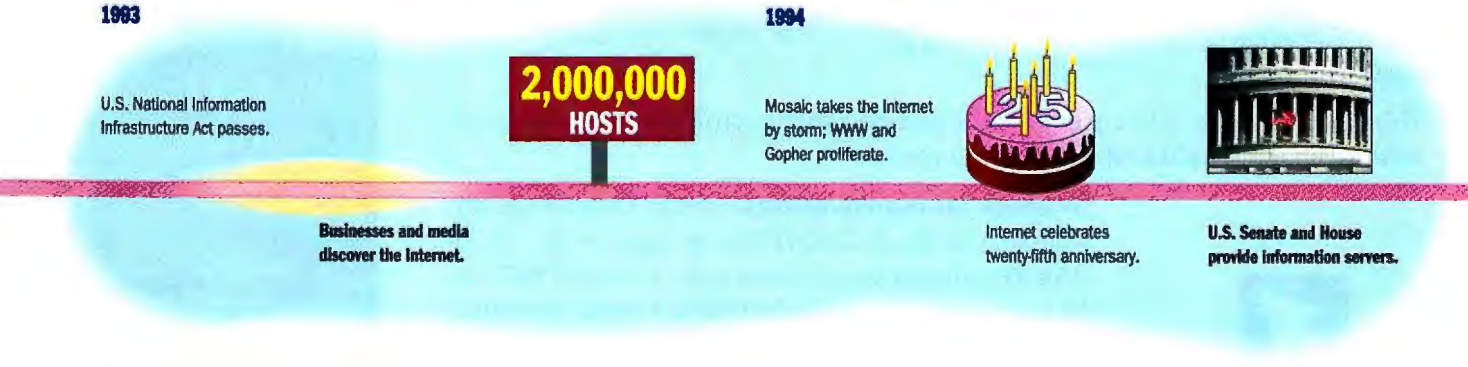
9

Private networks are working to make the Net passé.

Pioneering commercial networks, such as AT&T's PersonaLink and EasyLink networks, are not saddled with the technical limitations of the Internet (see "The Network with Smarts," October 1994 BYTE). It's easier for the private networks to try new things. PersonaLink and EasyLink networks support General Magic's Telescript protocol and Magic Cap interface, a graphics-based operating environment that was designed from the ground up for telecommunications. Developers can write applications designed for this commercial on-line system rather than kludging together applications in an arcane Unix environment. eShop has designed a user interface for on-line shopping that runs on Magic Cap, as well as on Windows. Users can customize their "storefronts" using popular business presentation or graphics design software.

eShop's on-line shopping GUI.

However, some analysts think the Internet can still compete with private networks. "Private networks are expensive and the spontaneity isn't there," says Cathy Medich, the executive director of the CommerceNet consortium. "You're limited to specific trading partners, while the Internet is a low-cost way for a lot of customers to participate."



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"HI, I'M YOUR SERVER, BILL"

10

Microsoft's on-line offerings may debut this year.

Microsoft plans to enter the on-line marketplace with MSN (The Microsoft Network), scheduled to roll out later this year in conjunction with Windows 95. Initially, MSN will operate like CompuServe or other commercial on-line services, with Internet connectivity to let users exchange E-mail across the Internet and to access newsgroups. It eventually may offer technical support for Microsoft software, upgrades, and on-line sales of non-Microsoft software.

At a later time (optimistically scheduled for the end of this year), MSN will have full Internet access through a TCP/IP network to be supplied and operated by UUNET under contract to Microsoft. MSN users will then have full access to the Internet, including the WWW. Microsoft has licensed Web browser software and other Internet tools from Spyglass. MSN will basically be a firewalled private network.

Anthony Bay, director of Internet & Business Services, says Microsoft will make available APIs for developers to produce applications specifically for MSN and subsequently for Internet access.

With its huge resources and its enormous software developer and user communities, MSN could reshape the Internet. It could also be a flash in the pan, mired in delays and buggy applications. Only time will tell. ■

THE MICROSOFT NETWORK

FIRST RELEASE FEATURES

- Ships within Windows 95
- Provides Internet connectivity
- Access to Internet E-mail and news groups
- Hooks to Microsoft for technical support and upgrades

FUTURE VERSIONS

- Internet access via a TCP/IP network
- WWW (World Wide Web) access

Contributors

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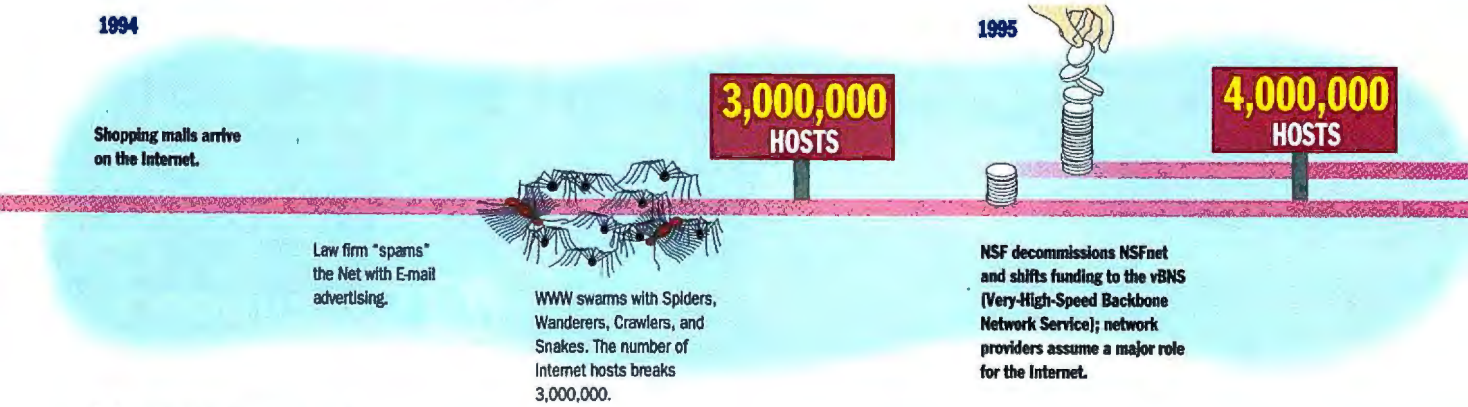
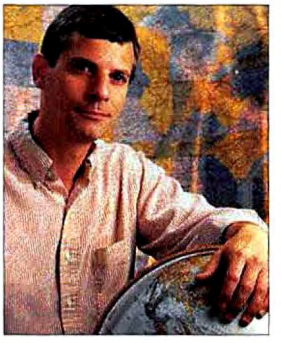


JON UDELL

HELLO, WORLD



You've felt the electric thrill of connecting to your very own Web server. Now what? As I find the answers each month, I'll pass them along.

One day this spring, an HTTP request popped out the back of my old Swan 386/25, rattled through our LAN, jumped across an X.25 link to BIX, negotiated its way through three major carriers and a dozen hosts, and made a final hop over a PPP link to its rendezvous with BYTE's newborn Web server, an Alpha AXP 150 located just 2 feet from the Swan.

Thus began the project on which this column will report monthly. Its mission: To engage BYTE in direct electronic communication with the world, retool our content for digital deployment, and showcase emerging products, technologies, and ideas vital to these tasks. We don't have all the answers yet—far from it. But we're starting to learn how a company can provide and use Internet services in a safe, effective, maintainable, and profitable way.

Cheap Thrills

The first contact with your own WWW (World Wide Web) server is an electric thrill. Experiencing that thrill gets easier every day (see "The Virtual Storefront," January BYTE, and "Build Your Own WWW Server," April BYTE).

In our case, the ingredients for our first prototype included an Alpha workstation, a U.S. Robotics Sportster 28.8 modem, Windows NT 3.5, the EMWAC (European Microsoft Windows NT Academic Consortium) Web server, and a dedicated 28.8-Kbps dial-up link to our Internet service provider, MV Communications (Manchester, NH, (603) 429-7428, info@mv.com). Here's how easy it can be:

❶ You `ftp` the server software from its home in Edinburgh, Scotland (http://emwac.ed.ac.uk), or from one of the mirror sites that archie or a Web searcher can find for you. How? I used BIX (see the text box "Don't Dis the Host" on page 92), but any client-side access kit will do. Spry's Internet In A Box and IBM's Internet Access Kit for OS/2 Warp are two good ones I've used.

❷ Configure NT's Remote Access Service to call the service provider and establish a PPP session, using the TCP/IP settings (i.e., IP address and subnet mask, primary and secondary DNS [Domain Naming System] servers) supplied by the provider. NT wouldn't talk to our Sportster modem at first, but a new modem initialization file from U.S. Robotics' BBS solved that. Now the Alpha had a full-time link to the Internet.

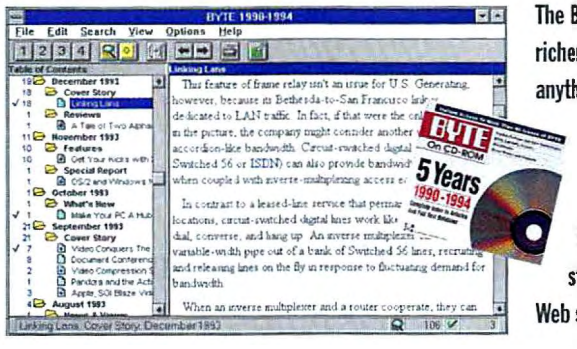
❸ Fire up the Web server and point it at the root of a document collection. If you're itching for that "Hello, world" moment, a single file containing those two words will suffice. Now find a second connection to the Internet, point a browser at your site, and observe it as visitors will.

That's all there is to it. Well, not quite. Now that you can say hello to the world, what do you want to tell it? How will you get its attention? What if you get too much attention? How will you ensure the quality and consistency of the information you publish? How do you turn documents into applications that serve business goals? How do you prepare your LAN to meet the demands and mine the opportunities of business-to-business networking? Should you place bets elsewhere than the Internet—on AT&T/Novell NetWare Connect Services or AT&T/Lotus Network Notes? Beats me, but as I find answers, I'll pass them along.

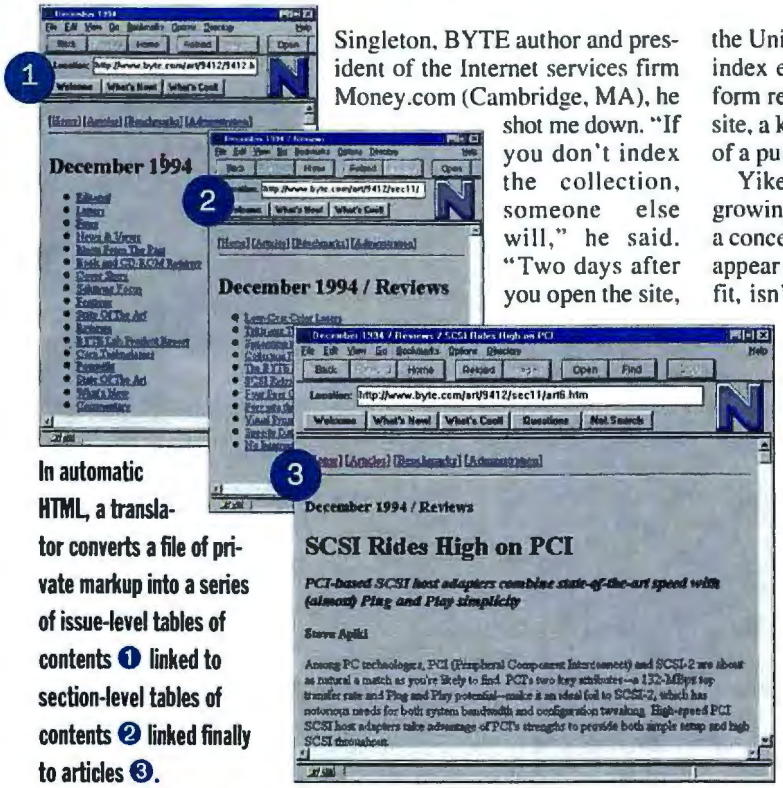
Worm Bait

Fielding well-structured content on the Web is shockingly easy to do nowadays, and publishers are scrambling to figure out how to exploit this opportunity without sandbagging print and CD-ROM revenues. It's tricky, because the Internet is evolving with breathtaking speed. My original plan for the BYTE Web server, for example, was to offer navigational but not search access to the five-year, 8000-article text collection that is also navigable (and searchable) on the BYTE CD-ROM.

I figured we could add searching to the Web site in a leisurely way, after working through the security, billing, and pricing issues. But when I mentioned this to Andy



The BYTE CD-ROM interface is richer and more dynamic than anything the Web can offer today. But we're hedging our bets. BYTE's CD-ROM, which includes graphics, builds from the same HTML stream that feeds the BYTE Web server.



In automatic HTML, a translator converts a file of private markup into a series of issue-level tables of contents ❶ linked to section-level tables of contents ❷ linked finally to articles ❸.

Singleton, BYTE author and president of the Internet services firm Money.com (Cambridge, MA), he shot me down. "If you don't index the collection, someone else will," he said. "Two days after you open the site, the University of Washington WebCrawler will get in there and index everything it can find." He advises caching URLs (uniform resource locators) into a single file at the entrance to your site, a kind of worm bait to spare your server some of the effects of a punishing deep scan.

Yikes! Our 8000 articles form a mere drop in the vast and growing ocean of documents indexed by the Web searchers. At a concentration of a few parts per million, BYTE articles would appear only sparsely in hit lists. And that's a promotional benefit, isn't it? Sure, but if we plan to serve up content with real commercial value—and it won't be interesting unless we do—we'll likely have to regulate access in some way. That will require user-level security, some applications development, and perhaps even a secure server. For now, we'll offer just the 1994 issues.

Text Wrangling

The text stream that feeds both the Web server and the BYTE CD-ROM is plain ASCII, with simple tags marking such elements as headlines, tables, and author biographies. There are converters all over the Internet that can transform nroff, RTF (Rich Text Format), WordPerfect, TeX, and other structured formats into HTML (Hypertext Markup Language). Good lists of these are at www.yahoo.com, and www.stars.com/vlib.

But in real life, archival documents often use proprietary markup, or they must be carved into Web-efficient

Network utilities—vital, but set aside 100K

DOS 6 utilities—handy, but about 120K

Multimedia—fun, but can you spare 50-80K?

Internet utilities—where will you get 120K?

If you don't have QEMM 7.5, what else have you sacrificed?

Sooner or later, as you push the limits of your PC's capabilities, you will run into a wall. Memory limits. Drivers that won't load. Crashes. "Out of Memory" messages. And you'll run into this wall whether you have one megabyte in your PC or 16.

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MemMaker, the memory utility that comes with DOS 6, does an OK job of delivering additional memory, but it just hasn't kept up with demanding users.

Say you wanted to run a mouse, sound card, SmartDrive, your DOS 6 and Novell utilities, and your Microsoft Bookshelf '94 CD ROM. You couldn't with MemMaker. Not unless you were willing to manually 'tune' it. And then you might end up with 490K or so to use. But QEMM 7.5 routinely returns 634K of conventional memory. And when you consider as little as one 'K' of memory makes the difference between a program loading or not, you can see where an additional 140K or so could be vital.

Hot new features

- 100% Windows installable
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Registered U.S. users of earlier versions of QEMM may purchase upgrades from dealers or direct from Quarterdeck for $29.95 plus $5 shipping & handling. Call (800) 354-4757.

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TOOLWATCH

PartitionMagic for OS/2, $129.95 from PowerQuest Corp., (801) 226-8977; fax (801) 226-8941

Finally, a partition editor for the 1990s. OS/2 users will love the ability to convert a FAT (file allocation table) volume to HPFS (High Performance File System) in place. But the real magic is that you can grow and move partitions, whether you're running DOS, OS/2, Windows 95, NT, or all of these at once. In the age of gigabyte IDE drives, almost everyone needs a better FDISK.

chunks. Thus, if your Web project involves piles of documents, you'll likely have to write some text filters.

The tool of choice for this job is the language in which most HTML converters are written—Perl (for Practical Extraction and Reporting Language). Larry Wall's language (see "Developing Applications in Perl," April 1994 BYTE) wields the powers of Unix text-processing tools—including `sed`, `awk`, and `sh`—in an interpreted environment that has galvanized the Unix programming community, as Visual Basic fired up Windows development. Good news spreads fast, and Perl is available on many platforms (see the University of Florida Perl archives at ftp://ftp.cis.ufl.edu).

Unfortunately, I'm not (yet) a Perl programmer, and I was in a hurry. So I reached for my favorite text-processing tool, Lugaru Software's EEL (Epsilon Extension Language), the C-oriented language embedded in Epsilon, an EMACS-like text editor for DOS, OS/2, and Unix.

The formatter I wrote in EEL transforms a file of private markup into a three-tiered HTML collection. The issue-level table of contents lists hypertext links to a series of section-level tables of contents, which in turn link to articles (see the screens on page 88). It's vital to display navigational cues in a collection of electronic documents.

The style I've adopted uses a row of standard links at the top of each page, but it varies document titles as you go up and down the tree. How do you write or modify thousands of links and titles while ensuring their integrity? You don't. This kind of HTML is like object code. Your job is to invent or adapt a compiler that can generate it.

BOOKNOTE

HTML Sourcebook by Ian S. Graham, John Wiley and Sons, ISBN 0-471-11849-4, $29.95

This is the best of the HTML (Hypertext Markup Language) cookbooks I've seen so far. It includes sound advice; authoritative coverage of HTML 2.0; extensive lists of servers, browsers, and tools on all major platforms; and case studies of real-world Web development.

Barrels of Browsers

Web browsers are a dime a dozen. It's a good idea to keep a variety of them on hand because each renders HTML in a slightly different way. Netscape, for example, makes the document title the window title, and Mosaic derivatives show it in a reserved field.

More important, browsers vary in how strictly they interpret HTML. When I first pointed lynx at my auto-formatted 1994

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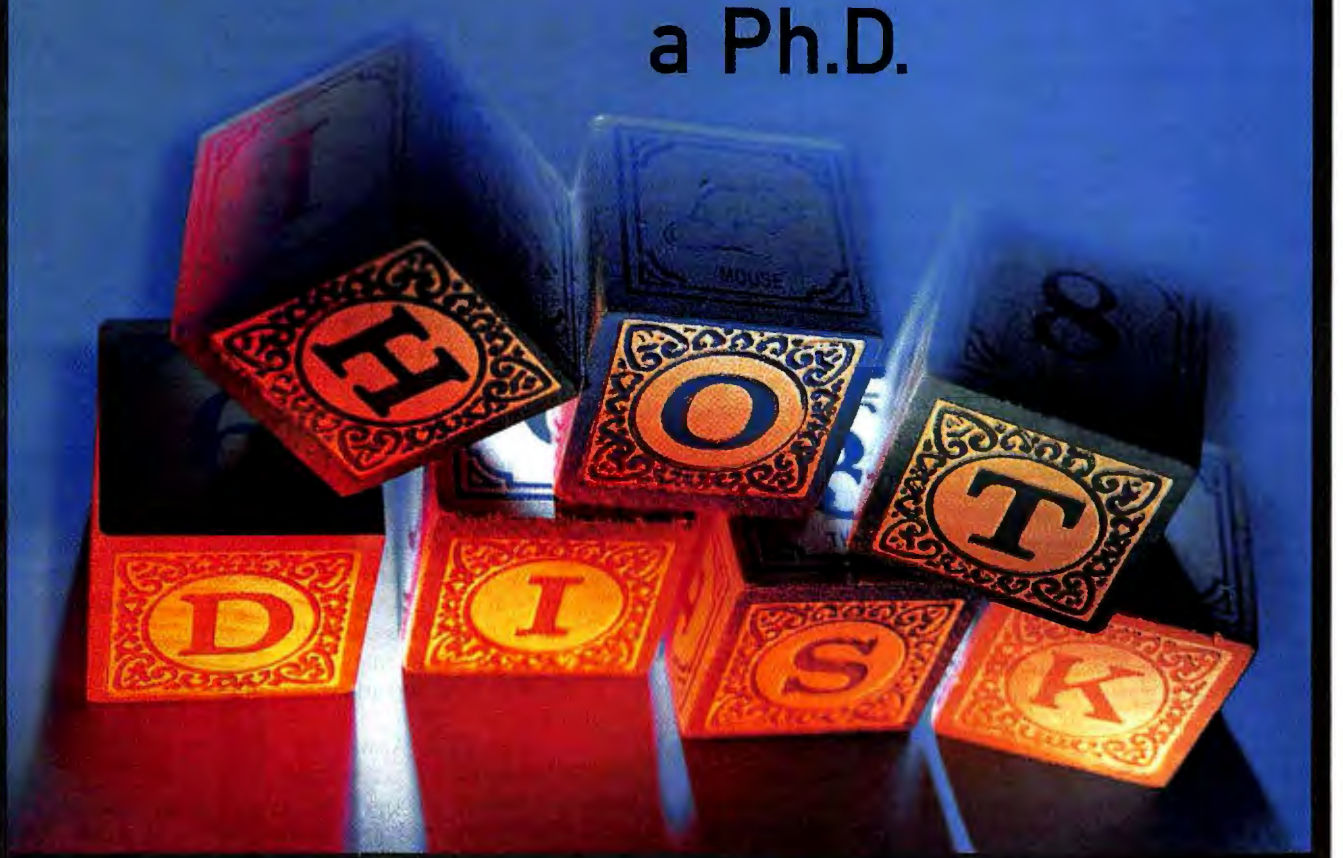

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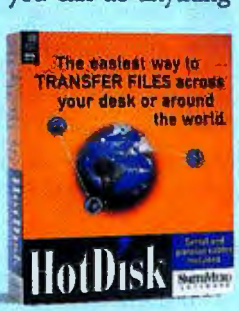

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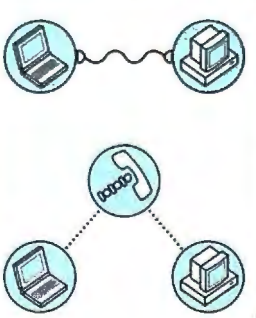

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DON'T DIS THE HOST

If you get to the Internet through a host, are you a second-class citizen? In some ways yes, but look at the benefits. Security and maintenance are the host's problem, not yours. With BIX, BYTE's primary link to the Internet, we can access its Internet services (plus public and private BIX conferencing) from the LAN or any Tymnet node, and we can use them effectively even on the humblest DOS laptop over the worst-case hotel-room dial-up link. As the PC LAN culture collides with the scary realities of wide-area directory synchronization and data replication, host-based systems can look pretty attractive.

You doubt that central computing is back in style? Consider that Microsoft Exchange product managers are now pitching "terminal-mode" access to mail servers (i.e., the ability to read a message store without altering its state) as a key innovation. Or think about how Lotus is cranking up the number of connections that Notes will handle in version 4, so you won't have to spread data across servers just to boost capacity, and you can reserve data distribution for the problem that really justifies it—geographical separation (see "Your Next Mainframe," May BYTE).

The Unix-based, TTY-oriented host called BIX is reliable, secure, and convenient. And thanks to Jean van Waterschoot's brilliant navigator and off-line reader, called Galahad, it's lately become downright gorgeous. BIX's mail and conferencing services are a vital part of BYTE's infrastructure, and I hope to remain judell@bix.com for a long time to come.

Of course, we can't field a Web server on BIX. And while I prefer its news reader, nn, to any of the GUI alternatives now available, I admit I'm a knuckle-scraping Neanderthal in this regard. None of my colleagues use nn. They all want direct, graphical access to the Internet, not terminal mode, and they should have it. So we're experimenting with direct dial-up and leased-line connections to the Internet. (ISDN isn't an option yet in New Hampshire, sadly. Nynex, please get with the program!) An open pipe to the world, however, can be a scary thing. Client-side Internet access that's mediated by a host—BIX, CompuServe, America Online, Prodigy, the Microsoft Network—can be the ticket for individuals and even some businesses.

collection, the authors WERE ALL SHOUTING LIKE THIS. Why? The code that wrote the level-two headings had incorrectly paired the begin tag—<h2>—with the end tag—</h3>. Thus, the all-caps style that lynx uses for level-two heads carried on through the article.

Netscape forgives this error, but that's not necessarily a good thing if you end up creating documents that look silly in other browsers. HTML lint utilities and parsers are common on the Internet, and they're probably useful, but your first line of defense should be a good selection of browsers. NCSA (National Center for Supercomputing Applications) Mosaic derivatives, such as Spyglass's Enhanced Mosaic, interpret HTML rather strictly. By testing your collection against a range of browsers, you'll catch errors, and, just as important, you'll adapt your presentation style to the widest possible audience.

Literate Programming

Predating the WWW by a decade was Donald Knuth's own WEB. This was a toolkit that joined his typesetting language called TeX with the programming language Pascal, in the service of what Knuth called "literate programming." A literate programmer, he said, simultaneously considers the behavior of a program and the aesthetic rendering of its text and documentation. Years later, Interleaf added a Lisp engine to its publishing system and began talking about active documents that are both texts and applications (or interfaces to applications).

Today's WWW consummates the marriage of documents and programs, and it radically democratizes client/server software development. For the first time, lots of people have ready access to tools that can generate useful *and inherently network-aware* applications. And because browsers will reveal source code if asked, there are no secrets—HTML is an open book. You can go a long way in building a Web collection using nothing fancier than a browser. If you write links to local content in relative form (e.g., ../../bmark/bmark.htm rather than http://www.byte.com/bmark/bmark.htm), you can seamlessly intermix file-oriented access to your own site with server-based access to remote sites.

To make the documents into applications—that is, to exploit the CGI (Common Gateway Interface) through which Web documents call programs that search indexes, take credit-card numbers, and do anything else you can think of—is trickier, but this is clearly the next frontier for today's GUI application builders. I'll bet that by the time you read this in late June, components for Visual Basic, Tcl/Tk, and other RAD (rapid application development) environments will already have begun to tame the CGI for the masses.

In the Pipeline

I'm working with two Web servers. Purveyor ($1995), from Process Software, is the commercial version of the EMWAC server. It's available for Intel- and Alpha-based machines; I'm running it on the Alpha machine. It adds security features that the downloadable EMWAC server lacks. It can also run as a proxy server, connecting Web clients on BYTE's (currently unregistered) internal IP network to Web servers on the Internet.

O'Reilly & Associates' WebSite ($495) is the commercial version of another freely available server, Bob Denny's elegant WinHTTPD, a port of the NCSA server. WebSite is a Win32 program that runs on Windows 95 and NT. It sets a new standard for GUI-based Web-server administration.

By next month, www.byte.com should be open for business, so you can see how these servers perform in real life. OS/2 and Unix servers will take their turn, too, but right now I'm in a hurry to get up and running. For me, NT is the quickest way. I'll also decide which of two modes of client-side Internet access—IPX via Instant Internet (see "Short-Order Internet Access" on page 139) or IP with proxy servers—gives the best balance of reliability, security, convenience, and performance.

Stick around, this is going to be fun. ■

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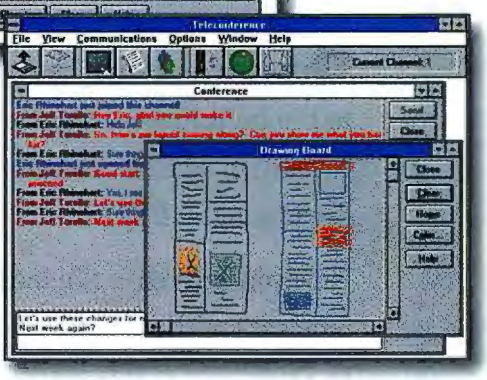

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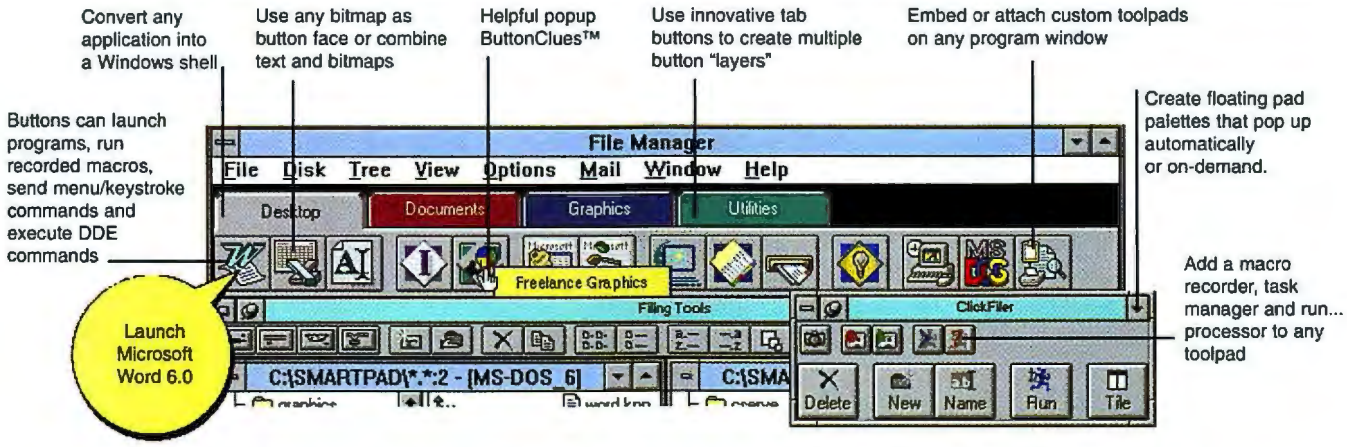

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More powerful and sophisticated ways to create and display 3-D computer graphics are appearing right before your eyes

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Displaying 3-D objects on a 2-D screen has always been a special challenge. We want computers to be a window on the worlds of reality and imagination, and we judge few things so impressive as well-done 3-D graphics.

As interest in remarkable 3-D graphics in applications and entertainment continues to grow, so does interest in the standards programmers use to create these 3-D wonders. These new and emerging standards include OpenGL, QuickDraw 3D, and others. In "3-D Steps Forward," John Foust examines the characteristics of standard APIs, file formats, and languages. Considerations include platform support and capabilities, 3-D standards in OSes, and hardware manifestations. As president of Syndesis, whose Interchange software translates between over 30 3-D graphics file formats, Foust brings considerable 3-D graphics expertise and experience to this overview of emerging standards.

Those standards can help bring inanimate data to life on-screen. Financial data visualization software helps stock analysts and other financial experts keep track of a blizzard of numbers and statistics, acquired in real time from a variety of sources, and represent them in ways that are immediately understandable. In "Assets in Wonderland," David Baum looks at new software products out on the rim of virtual reality that can display this information in new and more useful forms. The 3-D color animated images change as the data does. Trends may manifest themselves as differences in size, color, or motion. Baum has written about scientists using such visualization software before. Now the technology is becoming more mainstream and more applicable to the kinds of data-handling problems we all face.

To some, more serious even than money is entertainment. Surprisingly, most of the 3-D graphics for television and films is born on computers not so different from what you have on your desk, with off-the-shelf software. Grant Boucher's "Desktop Hollywood FX" shows how studios create astonishing effects with fairly modest machines. He works on challenging computer animation for TV shows, including "Star Trek: Voyager" and "Seaquest DSV" for Steven Spielberg's Amblin Imaging effects company.

With the synergy of hardware, software, and human imagination, 3-D computer graphics technology is becoming more mature, more real, and so easily accessible you might find yourself trying out some 3-D projects on your own. ■

—Edmund X. DeJesus, Senior Editor

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DESKTOP HOLLYWOOD F/X

Amazing special effects require modest hardware and software, but you'll need an extraordinary imagination

GRANT S. BOUCHER

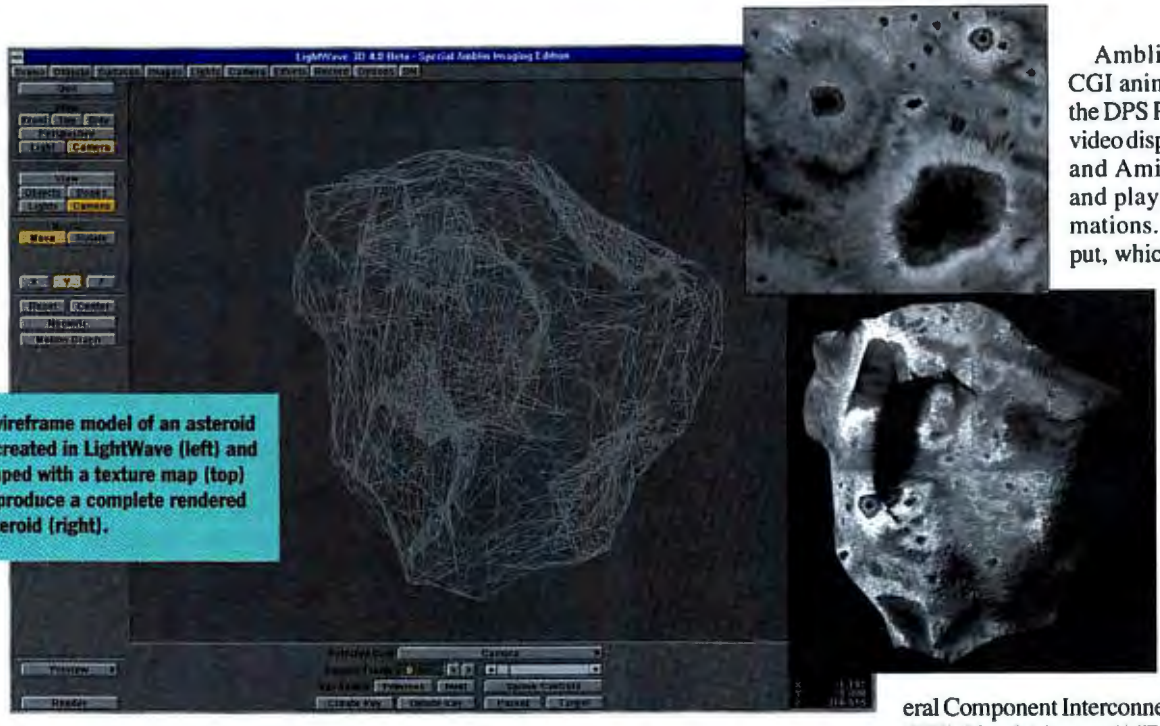
JOHN BLECK © 1995

In the pilot episode of United Paramount Network's flagship show *Star Trek: Voyager*, the sleek state-of-the-art starship pursues a Maquis vessel into the deadly plasma storm–ridden Badlands. Navigating through this space hazard, the U.S.S. Voyager's crew suddenly encounters a large, fast-moving energy wave of unknown origin. Terrifyingly, the Voyager is swallowed completely, its hull searing in a sea of white-hot fiery energy, and swept to the other side of the galaxy, never to return home.

It may surprise you that this scene was not created at a cost of $20 million, using hundreds of Silicon Graphics computers running expensive software costing more than a house. Instead, Amblin Imaging, Steven Spielberg's CGI (computer-generated imaging) special-effects facility, used desktop computers running off-the-shelf software to create the swirling Badlands, the cyclone-like plasma storms, the galactic wave, and even the Voyager itself as it was swallowed by a digitally created sea of fire.

Amblin Imaging's current platform of choice is NewTek's LightWave 3D ($995 for IBM, Mips, and Silicon Graphics computers) running on 275-MHz Digital Equipment Alpha–based Carrera Computers PCs running Windows NT 3.5. Previously, Amblin also used LightWave 3D running on a Commodore Amiga 2000/040 ($2500) equipped with NewTek's Video Toaster ($2395) desktop video hardware and software (which includes LightWave 3D).

By the time you read this, NewTek will be shipping LightWave 3D 4.0 for IBM PCs, all Silicon Graphics computers (including the popular Indy and Indigo lines), and, of course, all Amigas. In short, any machine that has a Digital, Intel, Mips, or Motorola CPU or that can run NT can now create the kinds of effects shown on TV series such as *Star Trek: Voyager*, *SeaQuest DSV*, *Sliders*, *The X-Files*, *Babylon 5*, *VR.5*, and virtually every other science fiction–



A wireframe model of an asteroid is created in LightWave (left) and draped with a texture map (top) to produce a complete rendered asteroid (right).

related TV show. Somewhere, somehow, LightWave 3D is involved.

Planet Construction 101

For one *Star Trek* episode, Amblin Imaging created a Saturn-like planet with rings composed of planetoid-size asteroids (see the images above). Below is a list of the steps Amblin uses to create realistic 3-D planets.

- Create surface textures for the planet. Use as a source commercial CD-ROM texture and image libraries, books (check copyrights), or the backyard. Amblin digitally scanned a photo of terrain using an Epson 800C color scanner at 600 dpi, using the Scantastics (Adept Solutions/Second Glance) software driver in Adobe Photoshop on an Apple Mac Quadra 900.
- Using Photoshop, adjust the contrast, color, and gamma (i.e., the ratio of lights to darks) until the desired planet is obtained.
- Save the image (called the "texture map") in Targa format from Photoshop.
- Load a planet (i.e., any default sphere object) in LightWave 3D.
- Load the saved texture map.
- Use a spherical map to paint the planet with the texture. In addition, superimpose another sphere with a transparent cloud texture on the planet-surface sphere, creating realistic atmosphere.
- Position the planet in the frame. (You can even make the planet rotate slowly during the sequence by selecting a beginning and ending rotation angle; the computer calculates all positions in between.)
- Light the planet. A light to the upper left of the planet simulates the sun shining down.
- "Render" one test frame. Complex mathematical formulas determine how lights interact with objects and create a digital photograph of the virtual scene. Depending on the complexity of the scene and the speed of the computer, a single frame can take seconds or hours to render. Adjust any incorrect features and render another test frame until the planet looks perfect.
- Render the entire animation or sequence of individual frames.
- Compile all the rendered frames on a DPS PAR (Digital Processing Systems Personal Animation Recorder). Use specialized hardware and software to record them frame by frame to an expensive VCR, or compile them into a QuickTime or Flick animation for easy viewing.

Amblin previews all CGI animation by using the DPS PAR, a real-time video display card for PCs and Amigas that stores and plays rendered animations. Its superb output, which is suitable for TV or VCR, can even be used for final output or for on-air broadcast. At a recent NAB show, DPS announced a successor to the DPS PAR, Perception Video, which has even better image quality, runs on a PCI (Peripheral Component Interconnect) bus, and uses SCSI-2 hard drives and NT-compatible software, all for the same price as its predecessor ($1995 without a SCSI-2 drive).

One problem with the PAR is that the JPEG algorithm used to compress rendered images onto the PAR's dedicated display drive makes stars appear too large and bright—a bad thing when showing tests to *Star Trek*'s producers. This inherent JPEG artifact, caused by the mathematics used to reduce the size of the image, has nothing to do with DPS's superb product.

Virtual Starship

For shots that are impossible to achieve using the actual 5-foot Voyager model, Amblin Imaging created the 3-D, CAD-like "virtual Voyager" for the pilot, using the construction blueprints, photographs, and much hands-on study (see the image below). Every part of virtual Voyager's surface was textured using high-resolution digital-image texture maps from 4- by 5-inch negatives of the actual Voyager model, scanned by a service bureau. No expensive 3-D digitizing (wherein a laser records the shape of a physical object as data) was required. When it was completed, the virtual Voyager

A side view of the wireframe model of the Voyager starship, as seen in LightWave 3D.

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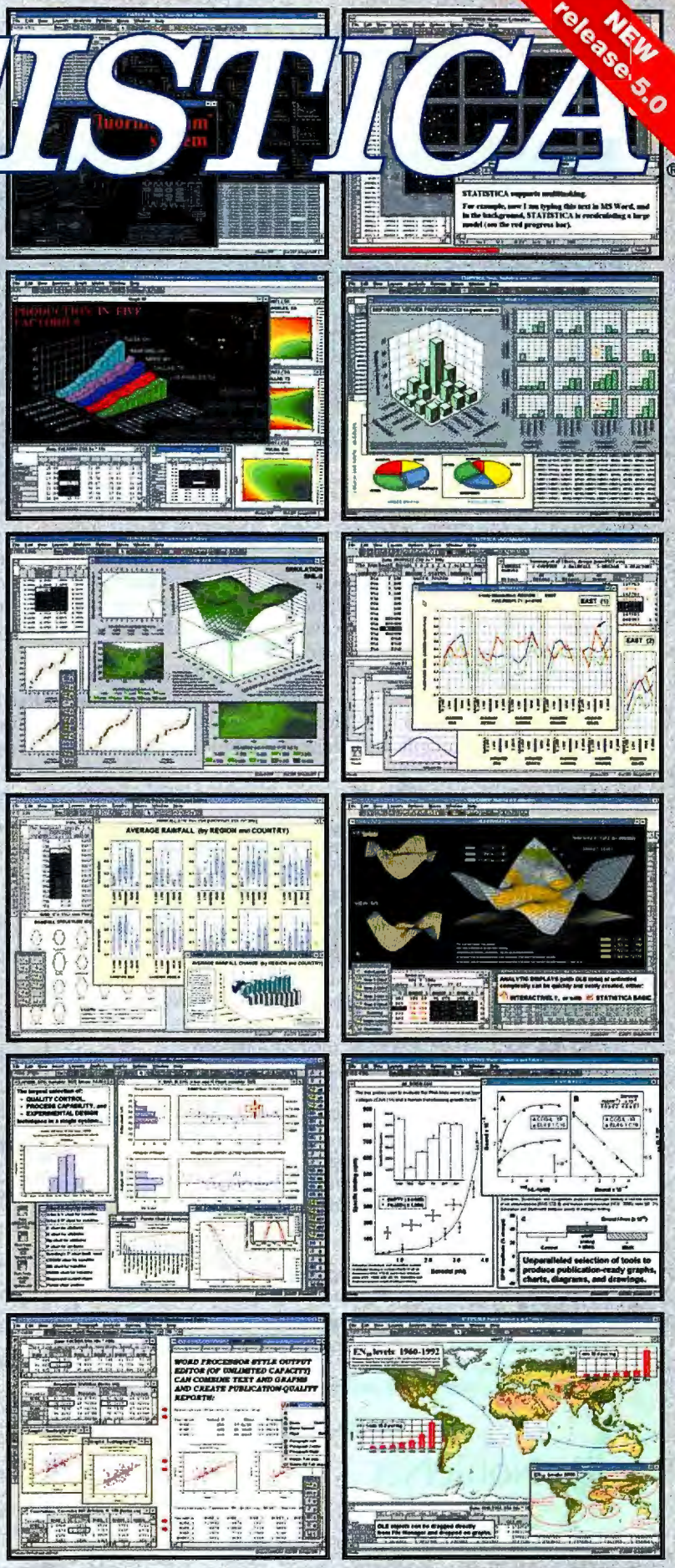

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had no limitations on the distance it could travel, its rotation or camera angles, or its moving parts. It's also possible to burn, blow up, or duplicate this Voyager without damaging the original: Just make a copy, and then modify only the copy. In one episode, virtual reflective mirrors inside a cave all around the Amblin Voyager reflected the ship realistically, but the LightWave "camera" was invisible. With the real Voyager model, real mirrors would have shown the lights, camera, and crew: most undesirable.

Also, because this Voyager is actually 1000 feet long (inside the computer, that is), close-ups of the hull and the passing of cameras through the windows are now possible—a feature the producers of *Star Trek: Voyager* hope to take advantage of in the future.

Past, Present, and Future

Microsoft's purchase of RenderMorphics and Apple's announced QuickDraw 3-D standard mean that both vendors might include 3-D extensions right in their OSes. Word processors will be able to display 3-D animations as part of a document, for example. The ambitious idea is to make 3-D operations as simple and as universal as icons and cut-and-paste operations are now.

Making movies with new animated graphics standards, including MPEG, QuickTime, Video for Windows, and VTASC (from NewTek), will keep getting faster, easier, and less expensive. Graphics accelerator cards that support these standards and the new Silicon Graphics–sponsored OpenGL format are already arriving for the desktop computer. Of course, not everyone needs to create 3-D computer-generated special effects every day, but with the increasing power of desktop hardware and software, the capability exists to do just that. ■

Grant S. Boucher is supervising animator at Amblin Imaging in Los Angeles. You can contact him at 74237.1146@compuserve.com in this quadrant of the galaxy.

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ASSETS IN WONDERLAND

Virtual-reality interfaces and 3-D software are changing the way financial traders perceive the market

DAVID BAUM

JOHN BLECK © 1995

It's just another sunny day at the beach: sea gulls, sunbathers, a surfer or two. But wait—who's that guy with the virtual-reality goggles talking to the sky?

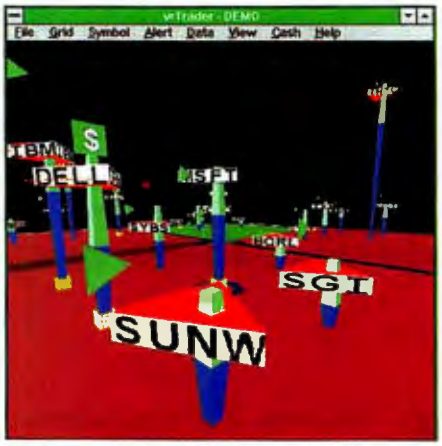
That's Mas Dinero, lead securities analyst at Market InSight, keeping an eye on utility-stock fluctuations during lunchtime. And that's not the sky he's talking to, it's a microphone concealed in his goggles. He just sold a million shares of Con Ed.

Farfetched? Not according to Peter Rothman, managing partner at Dive Laboratories, a virtual-reality company. Dive has produced a financial-trading application called vrTrader, which lets PC users chart market movements by interacting with audio and visual cues in an animated 3-D scene. Market data on stocks, indexes, futures, and options is displayed as 3-D objects, real-time graphs, and text. Users are immersed in a world of color, motion, and sound; it's like walking around in a life-size bar chart. Individual investments, up to 100 at a time, are the bars, or rather poles, that can spin around, change color, flash, or give off sounds in response to changes in the market (see the screen on page 112).

Market information travels to vrTrader via a live data feed from Data Broadcasting, a financial news service in San Mateo, California, that transmits real-time stock-market data by cable TV, FM radio, or satellite. A decoder box, which is leased from Data Broadcasting, captures the data and feeds it to the PC in binary format through a serial port. The vrTrader software processes the data in real time, mapping current values for particular stocks and stock groups to their 3-D representations on the screen (see the figure "Live 3-D Data" on page 115).

"So long as you have the FM radio data feed," Rothman says, "you could run vrTrader on a laptop computer at the beach."

You can experience vrTrader's 3-D world on a well-equipped Windows PC,



Dive Laboratories' vrTrader shows financial data, such as the stock prices shown here, as animated color 3-D objects.

preferably a Pentium, with 16 MB of RAM and a 256-color display. Optional LCD-based shutter glasses (see the photo on page 113) add binocular depth to the 3-D scene, or, for total immersion, vrTrader Pro supports a complete virtual-reality headmount with voice recognition and spatial sound capability.

Each 3-D icon can display a dozen pieces of information simultaneously. If you want to sell your stock when it hits $30 per share, you could enter an alert related to the price, such as a red flash. When the price goes above $30, the visual alert (plus whatever sound you associate with it) will trigger. Other visual cues can represent how an entire industry group is trading as a whole.

"Once you are used to the visual metaphors, it is very easy to apprehend a lot of information at once," says Maurice Doucet, who is a vice president at Dive. Currently, vrTrader can read only live data, Doucet adds, but an upcoming version will show historical data from a relational database as well.

Donning headgear to watch stock ticks might seem a bit, well, extreme. But just look at it from Mas Dinero's perspective. If a picture is worth a thousand words, a 3-D picture must be worth a million, right? The better you can perceive the market's subtle gyrations, the better you can reap its rewards. And the bigger the rewards, the more time you can spend soaking up sun on pearl-white beaches.

Through the Looking Glass

Several technologies have converged to bring 3-D visualization and virtual-reality interfaces into mainstream commercial use: faster PCs, improved digital-compression techniques, better video-capture boards, high-resolution bit-mapped displays, and live data feeds of financial information, to name a few. There are even software development tools for building virtual-reality applications, such as WorldToolKit from Sense8, the development environment from which vrTrader was built.

"Virtual reality is the next logical step," says Tom Coull, who is the president of Sense8. "Multimedia typically implies prerecorded sound and images; the scene is not computed frame by frame on the fly. Virtual reality, on the other hand, means real-time graphics. It's interactive. You can do anything you want to the objects, and they will respond."

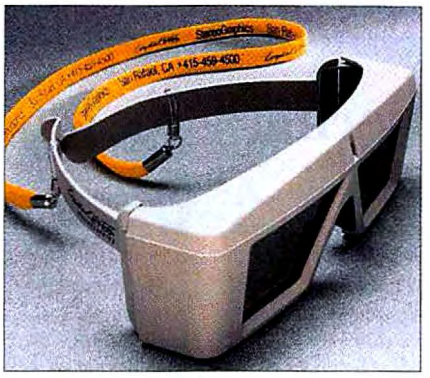
But where virtual-reality applications once required specialized platforms and programming skills, WorldToolKit now brings the technology to Windows PCs and other platforms. It's a C toolkit of

about 650 functions that developers can use to control real-time simulations, mapping data onto a 3-D display using an object-oriented paradigm.

Most of the development work involves the graphical description of the 3-D world—the database, in virtual-reality parlance—and writing the behavior for the objects. The former involves manipulating prebuilt objects from libraries of common visual displays—buildings, fish, birds, airplanes, cars, what have you—or adding your own graphical items from CD clips or a graphical modeling tool. The latter means hand-coding in C or C++.

WorldToolKit uses the OpenGL API and graphics language, developed by Silicon Graphics but which is fast becoming a de facto standard on many platforms, including Windows. Developers use the API to give the virtual objects tasks to perform, such as dynamically resizing screen icons to reflect changes in a stock's value.

"The metaphor that you use to represent your data is part of the art of building these applications," Coull says. "That's where the developer's own experience and creativity come into play."



StereoGraphics' CrystalEyes visors have LCD lens shutters that alternate views of the monitor for a 3-D stereoscopic view.

Getting your arms around these new technologies is like chasing a white rabbit, so Coull uses another WorldToolKit application as an example. Quantal International, a start-up firm, developed a visual portfolio management tool. Quantal uses a "flying" metaphor for its virtual universe. Portfolio managers use two mouse buttons to move in three dimensions through a cityscape that represents selected stocks and securities.

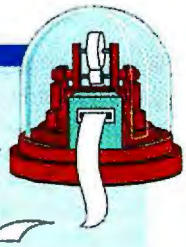
Quantal's software is designed to simplify international portfolio management. It can analyze changes in up to 10,000 stocks in different currencies, with an eye toward recommending investment strategies whenever investment managers wish to evaluate and update their holdings, typically once a month.

"There is no good way to represent this with a standard 2-D spreadsheet interface," says Terry Marsh, a professor of finance at the University of California at Berkeley and one of Quantal's three founders. "So we use virtual reality to present an ever-changing surface that you can fly above and walk around on."

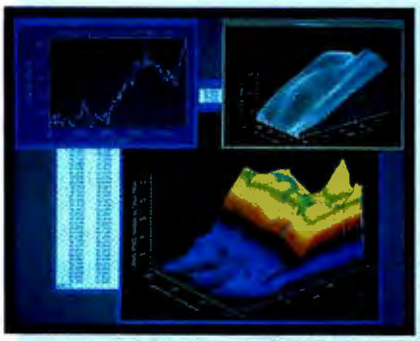
Down the Rabbit Hole

Diving from the aerial view of the cityscape into the streets and back alleys of Quantal's virtual world is how users home in on a particular industry or group of securities (see the screens on page 116). For example, a group of utility stocks might appear from a distance as a skyscraper. Once you fly closer, the building comes into focus as a group of individual data elements, representing the data objects themselves. Alighting on that building allows

Financial Engineering



"Technical trading is all about searching for patterns and trends," says Brandon Davies, head of Financial Information Technology at Barclays Bank Global Treasury Division in London. Davies heads an elite group of mathematical analysts, programmers, and product developers known as the Financial Engineering group. His team provides Barclays' dealers with trading support programs to analyze where the market has been and predict where it is going.



PV-Wave can display financial data as a contour map, exposing patterns difficult to visualize otherwise.

Barclays watches more than 50 foreign-exchange rates change in real time up to 18,000 times a day. Barclays uses PV-Wave to handle this expanse of data.

One custom PV-Wave application allows the bank's foreign-exchange traders to compare international currency performance using multilayered color graphs. Barclays traders use the application to request data about various currencies, specifying the time period they wish to examine, from the last 30 minutes to the last 30 years.

The exchange data comes over the wire and into a relational database on a Unix server. Subsets of this data can be selected, analyzed by PV-Wave on a variety of high-end Unix workstations, and then displayed as color contour plots, or "heat maps," as Davies calls them, which show performance at designated intervals (see the photo at the left).

Color, shading, and intensity denote areas of high and low interest, Davies continues. A new rate, for example, will appear in a brighter hue than an older one, so a trader can discern at a glance the timeliness of the information. Other financial-modeling algorithms (e.g., relative strength analysis and moving and weighted averages) can be superimposed on these graphs in another set of colors. Thus, a change from blue to light blue to white might represent the decline of a foreign-currency rate.

"Color is one of the most vital elements in the data-interpretation process," Davies says. "It allows the human brain to keep up with the computer processing speed. Most of the time, the traders will be uninterested in 90 percent of the information, but until they start digging, they don't know which 90 percent."

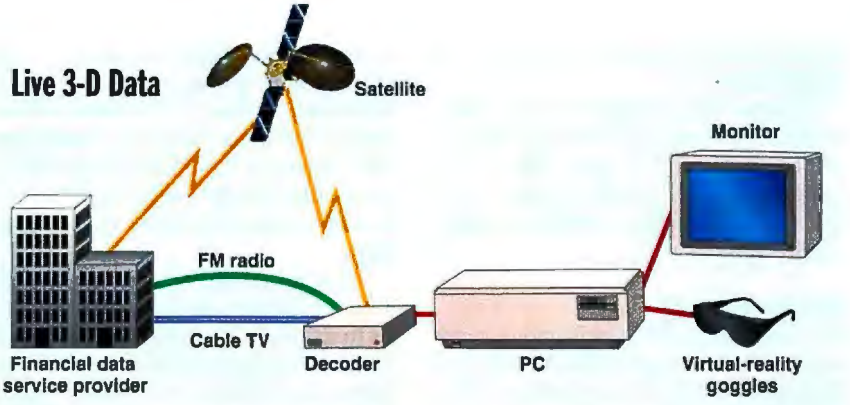
you to drill down to reveal its contents.

Users can analyze investment options by selecting specific countries, industries, and stocks of interest. For example, they might look at financial securities in Singapore or the auto industry in France. The portfolio management software performs off-line computations and modeling to recommend specific holdings in those areas.

The portfolio management software doesn't perform real-time data visualization from a stock feed, although it could potentially, Marsh says. Rather, it draws from a Microsoft SQL Server relational database of information loaded daily from Reuters.

"For the most part, real-time data feeds that are applied to real-time graphics are disappointing," Coull believes. "The information doesn't change that quickly, and thus it doesn't affect the virtual environment very dramatically." Obviously, this depends on the application.

The Quantal portfolio manager runs in Windows NT (on 90-MHz Pentiums and up) and interacts with SQL Server through any ODBC-compliant (Open Database Connectivity) query-and-analysis tool. Programmers, led by Indro Fedrigo, a founding member of Olivetti-Sixcom, devised risk-analysis programs in Visual C++ and used WorldToolKit to present the data in three dimensions with a virtual-reality interface.



Financial data originates with services such as Data Broadcasting. Data is transmitted via cable TV, FM radio, or satellite. When received, it's decoded with the decoder box. It enters the PC through the serial port. The vrTrader software processes the data, and 3-D images appear on-screen.

"Computing the optimal holdings for 10,000 securities is no easy feat," says Marsh. "Our competitive edge is a new way of doing that, and a new way to visualize the results. With our portfolio manager, computations of this scope can be performed in a minute or two on a standard 90-MHz Intel Pentium. The biggest limitation is the speed of the video card. As those get faster, the graphics get more impressive."

However, users must be careful not to fly too high, lest their wings get burned. There is an important distinction to be

made between visualizing data and giving financial advice.

"We can help you interact with the financial data or envision the value of a certain composite of securities," Marsh says. "But we don't tell you when to buy or sell. What you do with that information is up to you."

Analyzing the Data

The Quantal and Dive applications are examples of the potential of data visualization and virtual reality. WorldToolKit helped automate their unique visual worlds, but programmers had to drop into C to create business logic and perform data-analysis functions.

A step up in complexity leads to VDA (visual data analysis) software. VDA technologies include the high-speed 3-D graphics that visualization and virtual-reality tools provide and a host of analytical capabilities as well. Some of these are mathematics and statistics, signal processing, data sorting and subsetting, plotting, color-table manipulation, animation, data-point differentiation, and interpolation routines. There are also tools for building menuing systems, GUIs, and hooks to other programs. This gives business developers an enormous bag of tricks for building complex trading applications.

To cope with this huge volume of data, firms such as Barclays Bank (see the text box "Financial Engineering") are using a VDA package called PV-Wave from Visual Numerics. Most trading houses already have applications in place that monitor data feeds and report ticks to hundreds of thousands of securities, rates, and currencies. From these existing applications, data structures that monitor market data can be created and loaded into the VDA package, where they can be treated as variables.

Once the variables have been defined, it's a simple matter to apply the data-analysis functions (e.g., correlation and regression analysis) and use built-in plotting and animation functions to visualize the results. Plotting the data points from a large array labeled Z, for example, is accomplished with the simple command:

```
PLOT, Z
```

where `Z` is a variable that represents the entire data set. Such high-level operators make the application code much more compact and efficient than FORTRAN and other low-level languages.

Within PV-Wave applications, traders can click on a button or pull down a menu to select calculation and analysis functions. They can then visualize the results.

Advice from a Caterpillar

Dan Clark, who is director of marketing at Visual Numerics, uses an example to explain what makes VDA software tick. To compare fluctuations in the exchange rates of the mark and the pound against the dollar, the changing values of each currency could be stored as data points within ASCII files, a database, or directly within the VDA package as they come in over the live data feed, he says.

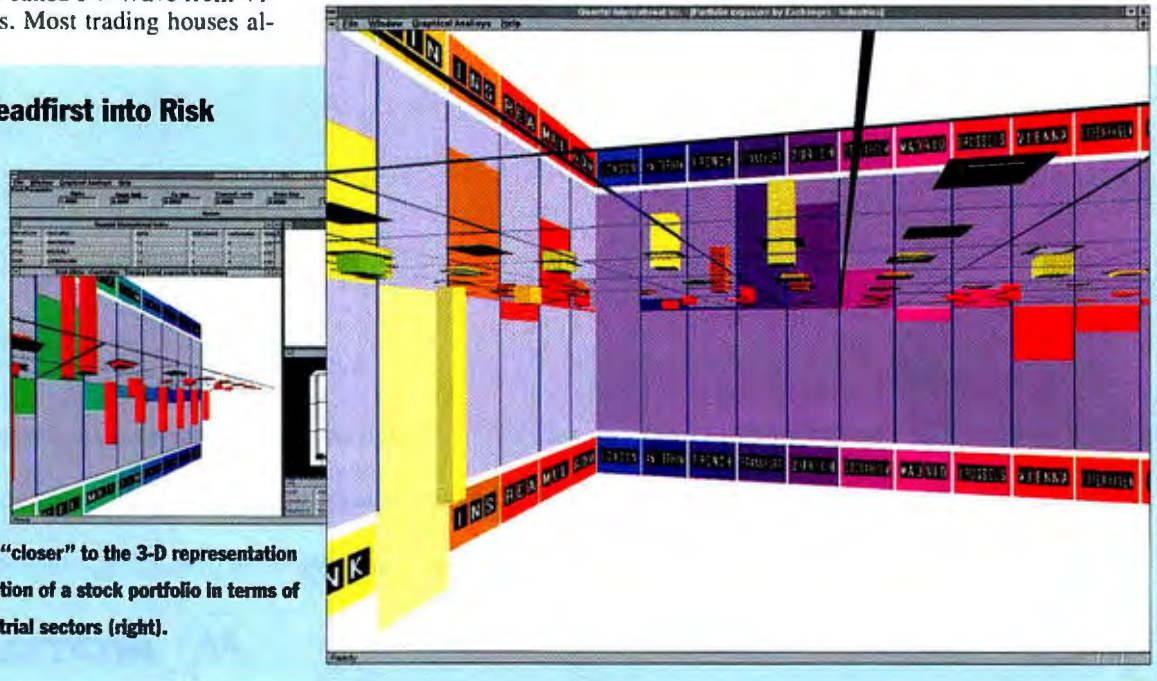
Data for the different currencies from a specific time period comes into the VDA software. That data is then combined to form an array, and 3-D plots are constructed to show the value of the dollar against the other two currencies.

The result is a 3-D surface, with peaks and valleys representing the highs and lows of the three currencies over the time period. Traders could use this to quickly spot trends, such as a line of peaks indicating how the value of the dollar is maximized whenever a certain combination of the pound and the mark occurs.

Traders could then represent a fourth currency, such as the yen, with color, as Barclays is doing. "The fourth variable could be draped over the 3-D surface contour of the other three," explains Clark. "This would allow analysts to easily see if there is a correlation or decorrelation between the surface plots of the first three currencies and the color intensities of the fourth. Peaks and valleys reveal the changing values of the first three variables, and 'hot' and 'cold' colors designate the values of the fourth."

The plots can be stored as images and then played back frame by frame. Thus, once the VDA software has plotted the

Diving Headfirst into Risk



Quantal's portfolio management software displays the risk exposure of a stock portfolio by market, as 3-D objects (left). Getting "closer" to the 3-D representation of the distribution of a stock portfolio in terms of country/industrial sectors (right).

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currencies for several time intervals, it can create the illusion of animation by flipping the 3-D images by in rapid succession.

"A similar operation in FORTRAN might involve hundreds of lines of code for error analysis, boundary checking, and so forth, in addition to the algorithm itself," Clark says. "But VDA tools handle such functions as signal processing, matrix manipulation, data I/O, and animation with little or no coding."

Barclays has completed a price tracking and hedging system using PV-Wave, and it is developing a series of applications for pricing and risk management of second-generation foreign-exchange options. (These options offer features such as the ability to hedge exposure to an average rate or to create an option on an option. Tricky stuff.)

The data-visualization programs developed by Barclays Financial Engineering Group have a response time of less than one-tenth of a second, according to Brandon Davies. Line plots can update almost instantaneously, and most 3-D plots can update multiple times per second. Intensive math processing might slow the response rate down a second or two, but developers can handle this by batching the data. Moving 250,000 floating-point data values from disk to display in under 3 seconds is typical.

Vanishing Smile

Obtaining a competitive edge as a financial trader is a lot like looking for a Cheshire cat: Just when you think you've got a clear picture, it vanishes. That's why many analysts and traders are looking to 3-D visualization technologies to help them gain a more intuitive grasp of the reams of data they must deal with every day. Market data, after all, is just numbers, an ever-changing canvas of digits and decimals piped in from worldwide data feeds.

It's easy to miss an important number as it moves across a trader's Telerate screen, but a real-time 3-D graph that changes color in response to a dramatic fluctuation in a stock's price is likely to catch the eye. Looking a few years down the road, Coull envisions room-size virtual-reality chambers, with wall-mounted screens, surround sound, and motion detectors that respond to hand and body movements without imposing gloves, goggles, or even a mouse.

You think it sounds impressive? No. As Mas Dinero says, it's just another way to make a buck. ■

David Baum is a freelance business and technology writer in Santa Barbara, California. You can reach him on the Internet at 5542167@mcimail.com or on BIX c/o "editors."

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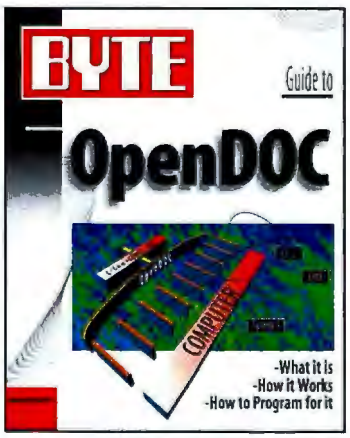

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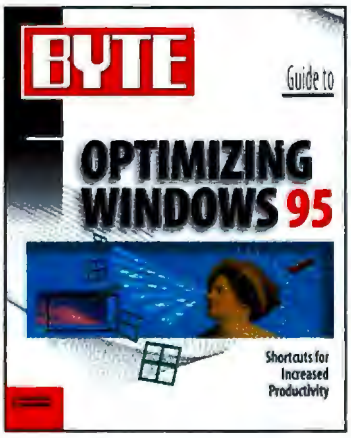

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3-D STEPS FORWARD

Emerging standards, from a variety of sources, promise to simplify 3-D graphics development

JOHN FOUST

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"Standards are great, that's why everyone has one," goes the old joke. The history of computer graphics is littered with now-unused standards and out-dated acronyms from yesterday's technology.

Today, emerging standards for 3-D graphics hardware and software are leaving the relatively obscure realms of scientific visualization, engineering, and computer animation, and appearing in ordinary operating systems and applications. 3-D graphics standards include APIs that define standard sets of graphics functions for programmers to use and specialized hardware to accelerate those functions, as well as file formats to help pass data from one program to another.

What's different about the latest standards? These technologies certainly affect the users of 3-D programs, but they're also working their way into everyday applications like spreadsheets, presentation graphics, and even your next operating system. (The World Wide Web is also becoming three-dimensional: see the textbox "VRML and the 3-D Web" on page 124.) The flow of technology is unusual, too. We've come to expect that new high-priced, high-power technology will eventually drop in price and become commonplace. While true for 3-D graphics, there's also an interesting flow from so-called "low-end" computer game technology up into common personal computers.

OpenGL

OpenGL is a graphics programming standard that began as a proprietary API but then evolved to become a cross-platform success. It started on Silicon Graphics workstations but is now part of OSes like Windows NT and OS/2. It is most popular in mechanical and architectural CAD, animation, and simulation because of its growing use on various workstations, and the extra speed that specialized hardware delivers.

VRML and the 3-D Web

IRIS GL became OpenGL, which begat Open Inventor, which fostered VRML (Virtual Reality Markup Language), a standard for 3-D graphics for the World Wide Web. By defining a new file format to represent 3-D scenes, and by creating stand-alone viewing programs for that file format, today's browsers could handle 3-D scenes. Silicon Graphics was eager to promote Open Inventor, which has an ASCII file format representing a scene. Inventor seemed to fit well with the objectives for a 3-D extension to the Web.

WebSpace is an add-on for Web browsers to view 3-D VRML Web pages.

VRML represents 3-D geometry, motions, and Web links. VRML files are a subset of Inventor scene files, with the minor addition of cube, cone, and cylinder primitives, plus ways to define links to other Web locations and 3-D files. With a VRML viewing tool, Web pages can now include animated 3-D graphics. The VRML viewing tool reads the almost-Inventor file and renders it to your screen using local processor power.

Silicon Graphics' release of C++ parsing code for Inventor files spurred the development of the first VRML viewers. In March, Silicon Graphics and Template Graphics Software introduced the first VRML viewer called WebSpace, an add-on module for existing Web browsers (see the screen above). Other companies soon followed: Intervista Software announced WorldView, a VRML browser for Microsoft Windows and Macintosh computers.

OpenGL includes more than 120 functions to draw 2-D and 3-D data to the screen. It supports polygon shading, texture mapping (coloring polygons with bit-map images), lighting, animation, atmospheric effects, depth cueing (dimming objects farther from the viewer), and fast rasterization (calculating the pixels that fill a polygon on the screen). Higher-level operations, such as CAD-like parts and predefined subobjects, are left to the application developer.

OpenGL uses an underlying client-server model for interpreting commands. This makes it possible (but not necessary) for client and server to be on different networked machines: For example, to use your hardware efficiently, the intense floating-point operations of a 3-D renderer could run on a more powerful computer, while the display appears on a lower-cost workstation. For greatest speed, eliminating any bottlenecks between client and server, all operations can run on a single computer.

OpenGL doesn't have functions related to windowing, so it is not tied to other standards like X Windows or Microsoft Windows. Instead, vendors develop extension libraries for OpenGL for each user interface standard. For example, there is an OpenGL extension called GLX for X Window applications, and another for Tk, a popular user interface toolkit for X Window development. For Windows NT, Microsoft added a layer called wgl that connects OpenGL to the window programming interface of Windows NT. Like other windowing extension libraries, wgl helps connect OpenGL's drawing abilities to the usual programming interface for Windows NT.

OpenGL began in the early 80s as IRIS GL, which was a proprietary graphics programming interface for Silicon Graphics workstations. Years of graphics programmers working with some of the most advanced graphics hardware and software refined the character of IRIS (a type of Silicon Graphics computer) GL (graphics language). As IRIS GL became more popular and customers wanted to port their GL programs to other platforms, Silicon Graphics opened the GL standard to other parties, giving rise to OpenGL.

Due to its open licensing, OpenGL is available for environments including Windows NT Workstation 3.5 and Win32s, OS/2, Sun Solaris, Apple MacOS for Power Macintosh, Digital Equipment OSF/1 AXP, and many others. There is even a freely distributable "clone," called Mesa, that offers some of OpenGL's functionality. OpenGL has been licensed to more than thirty vendors, including Microsoft, IBM, Digital, Sony, and Evans & Sutherland. Addison-Wesley publishes the most popular guides to OpenGL, the *OpenGL Reference Manual* and the *OpenGL Programming Guide*, also known as the "blue book" and the "red book," respectively.

OpenGL Hardware Acceleration

On workstations, OpenGL benefits from special-purpose hardware acceleration, without which it would be impossible to manipulate hundreds of thousands of lines and polygons. This hardware ranges in power, of course, but also in price, from tens of thousands to millions of dollars. Now hardware graphics-acceleration technology is available in video cards for a few hundred dollars.

Hardware acceleration of simple graphics functions like line drawing and bit-map copying have been present in hardware cards for a few years, but now more sophisticated OpenGL functions are appearing in hardware, too, in cards from S3, STB, Creative Labs, and Intergraph.

For example, under Windows NT, there are three levels of support for OpenGL. The simplest is software emulation: all OpenGL functions are implemented in

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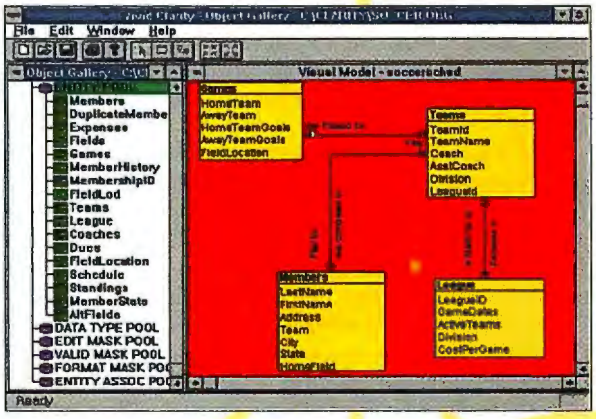

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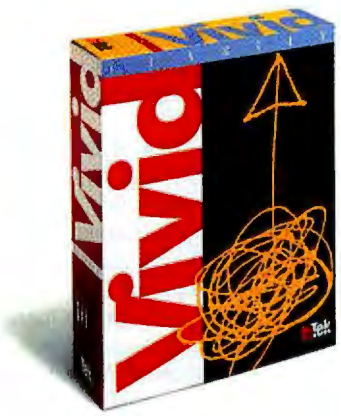

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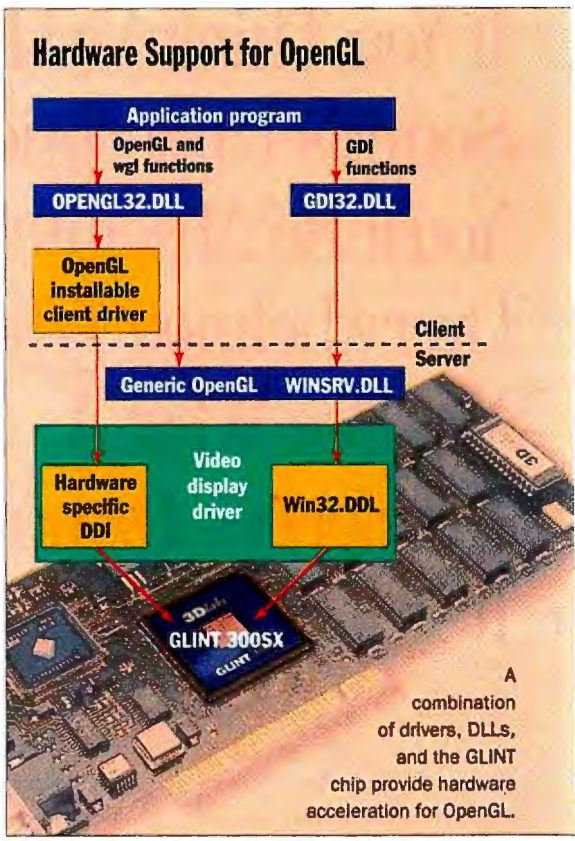
software (in a new DLL, like many other extensions to Windows NT), so any Windows NT computer can run OpenGL programs. Software emulation is slow, however. The second level of support is called hardware assist, in which an accelerated video driver makes an optimized connection to the software OpenGL functions. This technique is faster than pure software emulation, but not by very much. The speed increase in this level of support is similar to the gains that any accelerated video card delivers. The final level is native mode, where one or more OpenGL functions correspond directly to hardware support.

The 3Dlabs GLINT chip is special-purpose hardware for accelerating OpenGL. (Other similar OpenGL-accelerating chips are available from Accel Graphics, ATI, Oki, and S-MOS.) The GLINT chip is unusual because it was designed with OpenGL in mind. Its hardware accelerates OpenGL's rasterization layer. It also includes antialiasing, texture mapping, smooth shading of polygonal regions, and clipping pixels against stencil masks. Simply stated, it answers such questions as "Which pixels are in this polygon?" "What color are they?" and "Are they visible on screen?"

A native mode driver in Windows NT supports the GLINT chip. OpenGL calls are routed directly to the GLINT chip. Normal GDI (Graphical Device Interface) graphics calls pass through GDI32.DLL and into the GLINT device driver interface. See the figure, "Hardware Support for OpenGL."

Other companies are using GLINT to improve performance in their PC applications. 3Dlabs and Creative Labs are allied to develop a very low-cost version of the GLINT chip for multimedia cards. Intergraph Software Solutions created optimized software that links its MicroStation CAD product to OpenGL and GLINT chip hardware optimization. They claim a 3000 percent speed increase in some 3-D operations, and an overall 40 percent improvement in the time it takes to display average CAD drawings on a two-processor system.

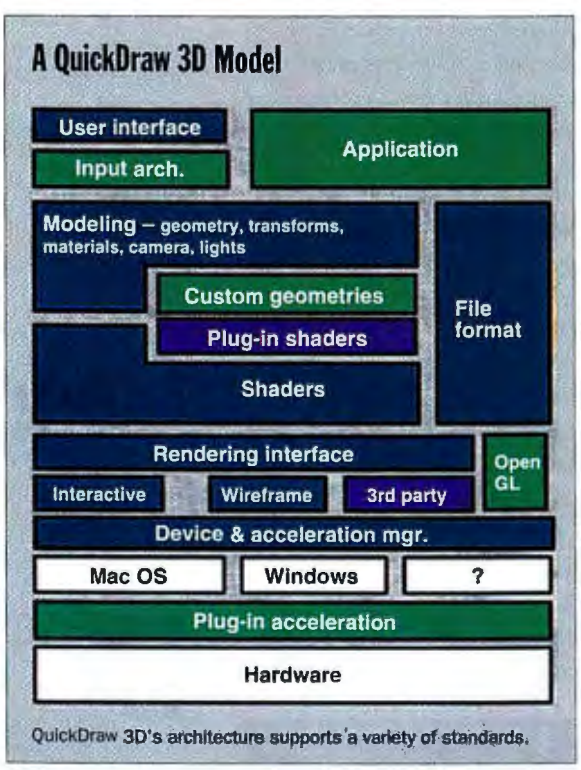


Open Inventor

Silicon Graphics' Open Inventor is an object-oriented 3-D toolkit that rests upon OpenGL. A library of C++ objects and methods that provide higher-level abstractions beyond the simple drawing functions of OpenGL, Open Inventor makes it even easier to write 3-D applications and provides a higher-level interface above OpenGL, incorporating geometry and motion. Open Inventor's objects include geometric primitives with attributes such as surface coloring and motions, manipulators for expressing methods (such as trackballs for moving objects), and premade components such as lighting and material editors.

The Inventor Component Library links to Xt Intrinics for Motif-style X Window programming. With this, a simple demo containing a shaded cone, light source and trackball manipulator takes less than thirty lines of C++ code (see the demo program "3-D in 30 Lines" on page 128). Open Inventor programs can even make direct calls to OpenGL rendering functions, through subclassing of Open Inventor objects.

Like OpenGL, Open Inventor has been licensed to other companies, including Template Graphics Software and Portable Graphics. These companies have ported Open Inventor to such platforms as the Sun SparcStation, the IBM RS/6000, and the Power Mac.



QuickDraw 3D's architecture supports a variety of standards.

QuickDraw 3D

Early in 1995, Apple Computer introduced QuickDraw 3D, a 3-D graphics extension to the Mac OS. QuickDraw 3D is an API for developers, but it also defines a new file format standard. QuickDraw 3D will become part of the PowerPC-based Mac OS in late 1995. Apple promises cross-platform support, too, and intends to have a version for Microsoft Windows within six months.

Like OpenGL, QuickDraw 3D includes standard functions for 2-D and 3-D primitives. QuickDraw 3D goes far beyond OpenGL, though. It stores higher-level geometry, from 3-D points to polygons to NURBS (nonuniform rational B-spline) spline-based geometry, similar to Open Inventor. Plus, it is an extension of the Mac environment into three dimensions.

One primary goal is ease of use: 3-D programs are notorious for complex user

3-D in 30 Lines

This is a simple demo program illustrating how a complete, illuminated 3-D scene with a trackball manipulator can be implemented in less than 30 lines of C++ using Open Inventor.

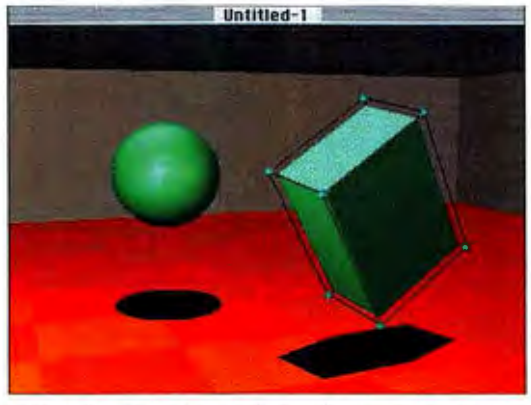
```
main( int, char **argv )
{
    // Init Inventor and Xt
    Widget myWindow = SoXt::init(argv[0]);
    if (myWindow = NULL) exit(1);

    // Make a scene containing a red cone
    SoSeparator *root = new SoSeparator;
    root->ref();
    SoPerspectiveCamera *myCamera = new SoPerspectiveCamera;
    root->addChild(myCamera);
    root->addChild(new SoDirectionalLight);
    root->addChild(new SoTrackballManip);
    SoMaterial *myMaterial = new SoMaterial;
    myMaterial->diffuseColor.setValue(1.0, 0.0, 0.0); // red
    root->addChild(myMaterial);
    root->addChild(new SoCone);

    // Add a render area to the window
    SoXtRenderArea *myRenderArea = new SoXtRenderArea(myWindow);

    // View everything in scene
    myCamera->viewAll( root, myRenderArea->getViewportRegion() );

    // Put scene to render area, set title
    myRenderArea->setSceneGraph(root);
    myRenderArea->setTitle("Hello Cone");
    myRenderArea->show();
    SoXt::show(myWindow);
    SoXt::mainLoop();
}
```

interfaces often radically different from each other. Apple plans standards for 3-D user interfaces, such as bounding boxes that surround objects and methods of selecting and scaling objects, so that the same keystrokes and mouse movements will produce the same results even in different programs.

For example, the screen at right shows a sphere and a cube floating above a checkered floor. Both objects have shadows to help show position and height above the floor. Without these visual clues, it might be difficult to determine which object was closer to the viewer. The cube is selected, highlighted by a bounding box, and rotated slightly: its shadow changes shape, too. This 3-D view is generated by QuickDraw 3D's interactive renderer, so developers no longer need to spend time writing fast rendering code.

Because the makers of Macintosh-based 3-D programs have found it quite easy to integrate QuickDraw 3D, expect to see some aspect in all 3-D programs. Apple claims QuickDraw 3D support was added to one popular 3-D program in less than two hours.

QuickDraw 3D also defines a new file format, known as the QuickDraw 3D metafile. For the user, the metafile means easy clipboard cut-and-paste of 3-D graphics between applications, and a new standard for exchanging models between 3-D programs, eliminating the need for cumbersome and inaccurate conversions involving DXF or IGES files.



Editing a QuickDraw 3D scene in Apple's interactive renderer.

QuickDraw 3D is a very open architecture. Almost every API component is extensible. Once installed, all QuickDraw 3D–aware applications can use the new extensions. Similarly, QuickDraw 3D fits into future developments such as OpenDoc, Apple's plan for a compound document architecture. Clicking on a 3-D graphic might invoke a 3-D modeler in the form of an OpenDoc part editor.

QuickDraw 3D does not exclude the use of OpenGL as a graphics API (see the figure "A QuickDraw 3D Model" on page 126). Since QuickDraw 3D encompasses far more technology than simple cross-platform drawing commands, it is easy to subsume the functions of OpenGL.

For example, Template Graphics makes an OpenGL library for the Apple Power Macintosh with special extensions. They created AGL (Apple graphics library), an extension that links the OpenGL graphics calls to the Mac's windowing system, similar to the wgl library in Microsoft's implementation of OpenGL. AGL makes it easier for an OpenGL application to read and write the QuickDraw 3D metafile, or to write cooperative applications that exploit both OpenGL and QuickDraw 3D.

Hardware companies also plan accelerators for QuickDraw 3D. YARC Systems Corp. has announced a board called Screamer that couples a RISC processor with a 3Dlabs GLINT chip. Through the proper device drivers, any hardware graphics accelerator (like GLINT) can provide its services to both QuickDraw 3D and OpenGL.

Rapid Renderers

In the past two years, three products delivered rapid rendering technology suitable for personal computers. These products are RenderMorphics' Reality Lab, Canon Criterion's RenderWare, and Argonaut Technologies' BRender. With the greater power of today's 486 and Pentium computers, it became possible to render animated 3-D models composed of thousands of polygons at nearly real-time speeds, as fast as 30 frames per second (see the screen of RenderWare's animated knights on page 130).

Surprisingly, the popularity of rapid rendering technology is moving from the alleged "low end" of the computer market, where it was used for game technology, into the mainstream where

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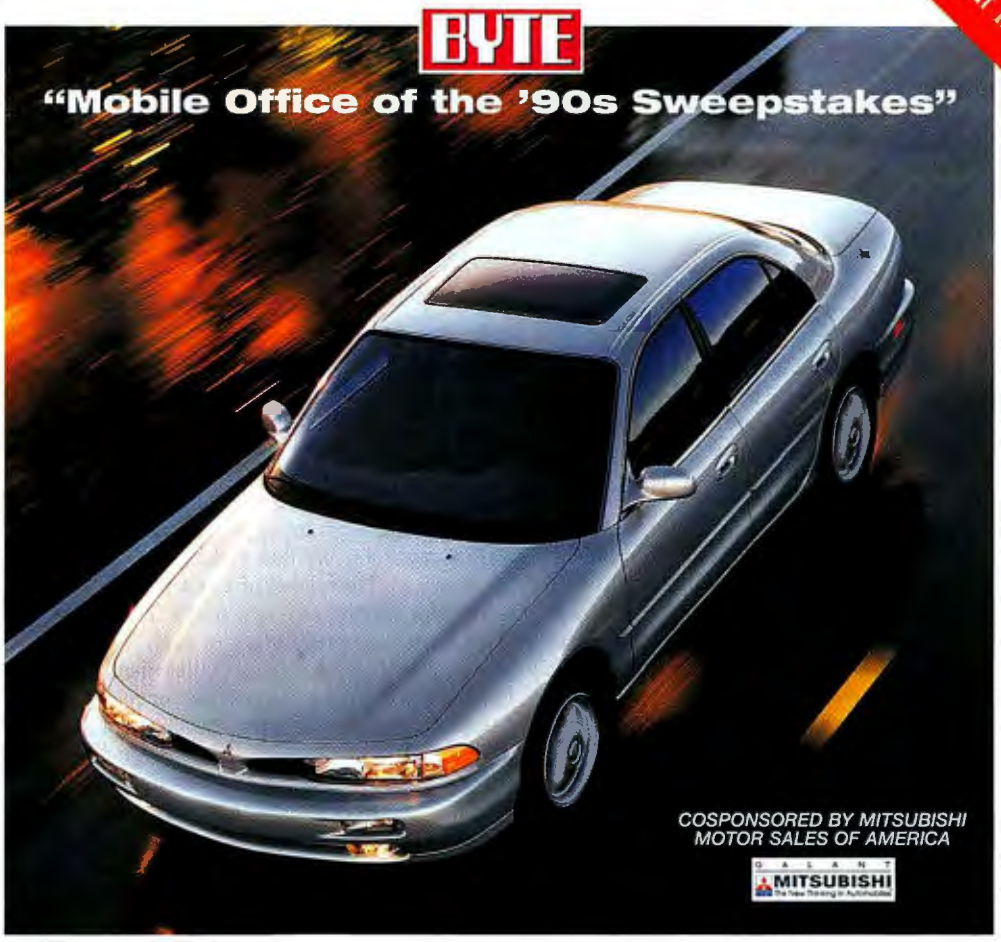

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Entries must be received by mail or fax on or before November 15, 1995, or submitted in person at BYTE's Booth at Comdex/Fall, Las Vegas, from November 13 to November 15. The finalist will be determined in a random drawing to take place at BYTE's Comdex Booth #2654 at 3:00 PM on November 16, 1995. The winner will be contacted by telephone following the drawing and announced in the January 1996 issue of BYTE. Personal contact with the individual specified on the entry card must be made for the finalist to be declared the winner. If the winner cannot be contacted within 15 days of the drawing, then the unclaimed prize will be awarded to an alternate winner selected at random.

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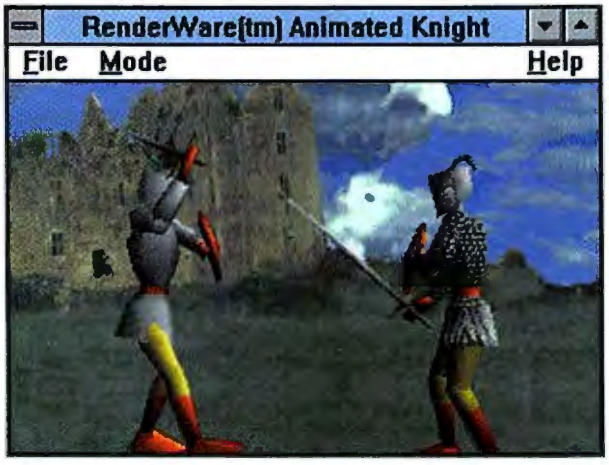

This demonstration program shows two animated knights rendered with smoothing and texture maps, in a scene complete with castle and cloudy sky, rendered in real-time using Canon Criterion's RenderWare.

it becomes part of the basic operating system. This market took a step forward when Microsoft purchased RenderMorphics in early 1995 and announced plans to fold its renderer into new versions of Microsoft Windows. It is positioned to complement the high-precision rendering of OpenGL in Windows NT. The RenderMorphics API is being promoted as a standard for programming games as well as more mundane applications. But not all users of rapid rendering technology are making games. The advance of multimedia means a programmer is more likely to need rapid rendering of 3-D charts and graphs in a spreadsheet or presentation graphics program.

How do these packages achieve their speed? According to Argonaut's managing director Jez San, "BRender is significantly faster than OpenGL because it is an immediate-mode renderer. BRender's math and rendering routines operate on polygons in bulk using tight loops, avoiding the context-switching and thrashing of the cache you might see in OpenGL because of one-by-one polygon processing." Also, BRender uses either fixed-point math or floating-point math, depending on which is the fastest method for the processor. On Intel processors, fixed-point has the advantage, while the PowerPC version benefits from floating-point math.

Plug-In

Another extensible technology is bringing dramatic changes to photo-realistic 3-D rendering packages such as Autodesk 3D Studio, NewTek LightWave 3D, Strata Studio and the Electric Image Animation System. Each of these 3-D programs has defined a "plug-in" standard. Plug-ins are a way for third-party programmers to extend and customize the interface and abilities of the 3-D program. For example, 3D Studio plug-ins create geometry like fractal plants, add the effect of a lens flare or fireworks to an animation, alter the texture of objects, and calculate kinetic effects like accurately bouncing balls and collision detection.

Plug-ins give a marketing advantage, too. Although 18 months may pass between major releases of a 3-D program, plug-ins can be released at any time. Outside developers can make plug-in tools as well as the company that makes the 3-D program can. The release of a new plug-in teaches an old program new tricks. These "standards" are proprietary to each 3-D program, but many companies utilize them. In this case, there's a good excuse for each company creating its own standard for plug-ins.

Speed is the essence of this concept. 3-D rendering programs must be very fast, and any extensions to the rendering process must be very fast, too. Plug-ins therefore require a tight coupling between the main program and the plug-in. Program execution may jump from the main 3-D program into the plug-in many thousands of times per rendering. For example, a plug-in might provide an algorithmically generated "orange peel" texture. For each pixel assigned the orange peel texture, the main 3-D application will shift program control to the plug-in to let it calculate the exact pixel color to maintain the orange peel appearance.

Wise Ending

In theory, standards exist to make life easier for everyone who uses a computer: hardware developers, programmers, and users. The changing nature of computer applications—including beveled and shaded buttons, increasingly complex multimedia displays, virtual reality interfaces, and other three-dimensional features—requires the firm foundation of fast and capable graphics standards. These standards must not only support existing uses, but anticipate new possibilities to come in the next few years: a tall order to fill for any technology, but especially for one we look at every day. Standards can be frustrating when they hinder rather than help. The future is bright: OpenGL, VRML, QuickDraw 3D and 3-D plug-ins will certainly enhance the applications you use today, as well as those you'll use tomorrow. ■

John Foust is president of Syndesis Corp. (Jefferson, WI), makers of InterChange, a program that translates between more than 30 3-D file formats. You can reach him on the Internet or BIX c/o editors@bix.com.

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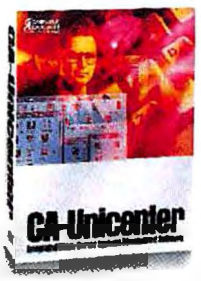

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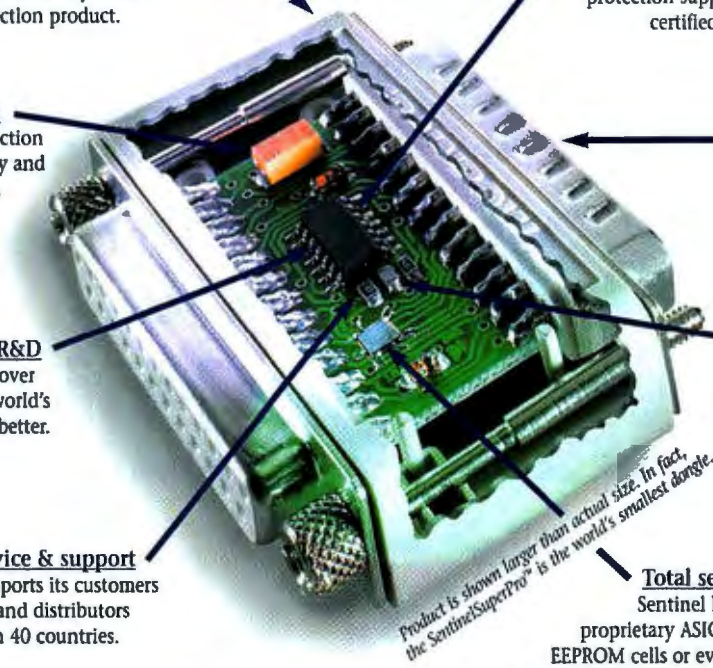

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page 132DM 15

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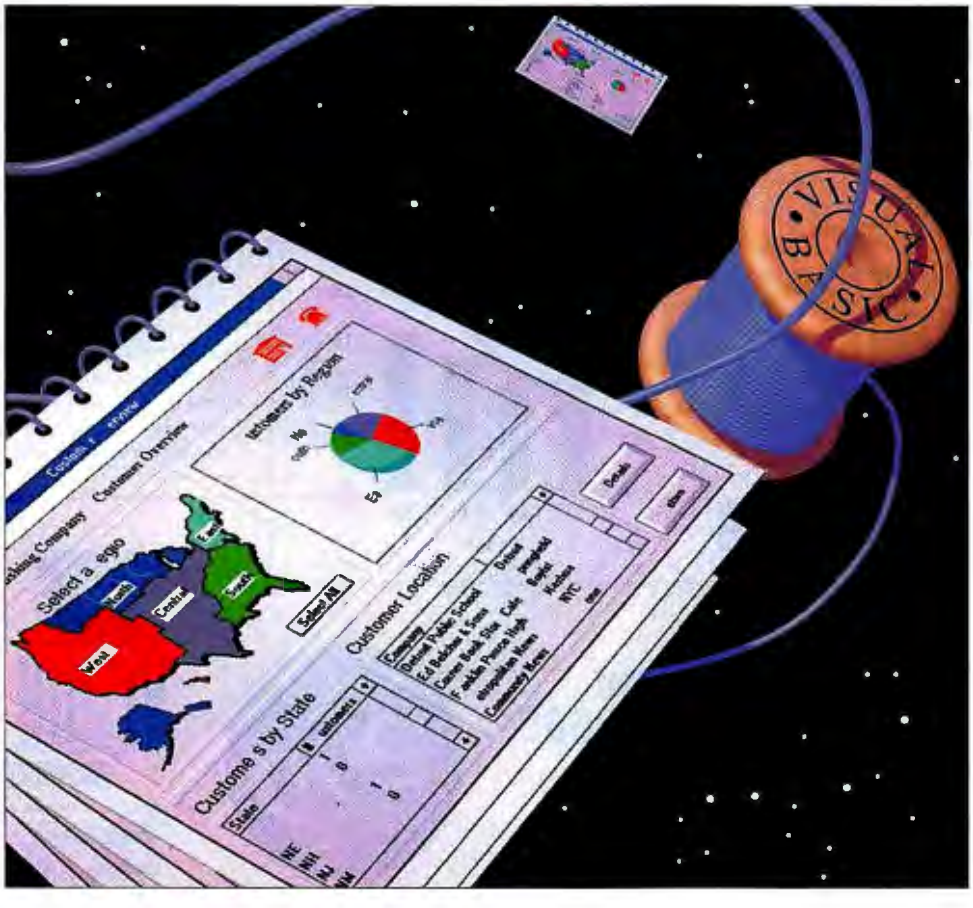
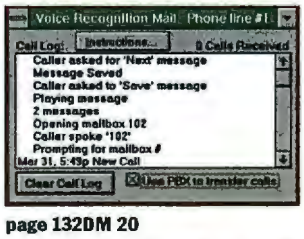


◀ Prototyping with Visual Basic

Visual Basic has made possible a unique kind of rapid application development: prototyping. To the clever Windows programmer, a new application is simply a job of gluing together pieces of old applications with a little Visual Basic cement.

page 132DM 5

Visual Voice adds voice-recognition capabilities.



page 132DM 20

Symantec's C++ 7.0 distributes compilation across your network.

page 132DM 3

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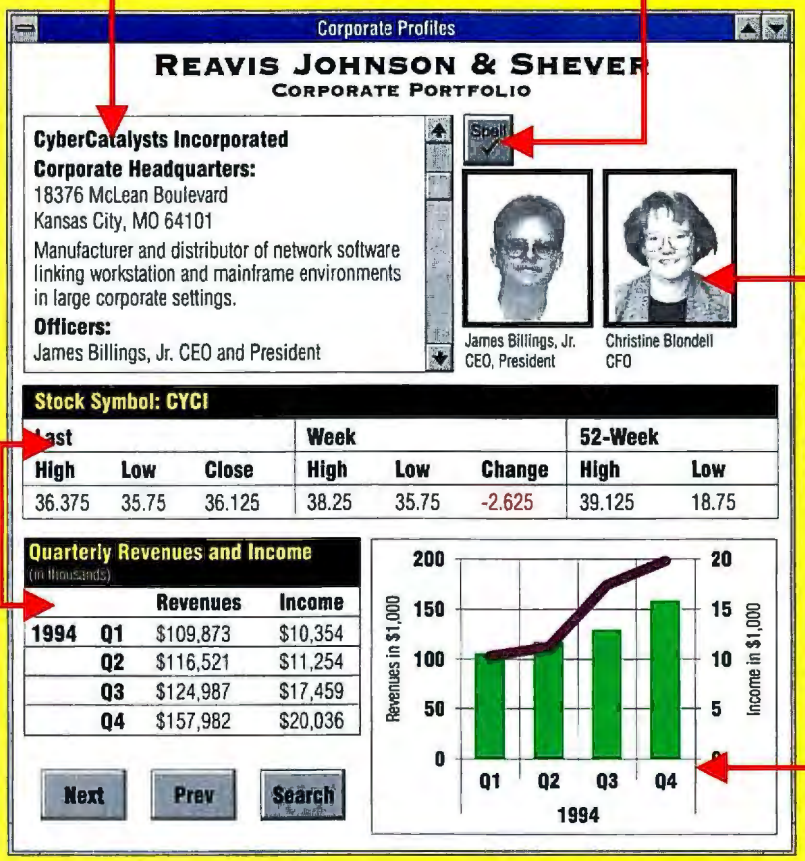

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The Jump to Windows 95

For programmers eyeing Windows 95, here's the good news: If you've already moved your application from Windows 3.x to Windows NT, you've done the hard part. The jump from the 16-bit world to the 32-bit world was far harder than dealing with any newness inherent in Windows 95.

So, at least, says Chris Shipley of NorthCoast Software. He was involved in the port of NorthCoast's flagship product, Photomorph, from Windows NT to Windows 95. "We ported Photomorph to Windows 95 in a couple of hours. The only troubles were one or two DOS calls that were no longer supported," Shipley said.

Shipley is pleased so far with the performance. He estimates that overall, Photomorph ran 60 percent to 70 percent faster under Windows 95 than under Windows, largely due to the move to 32-bit code.

The key to a smooth port is sticking to Microsoft's guidelines. "If you write your code by the rules—keeping in mind that at some point in the future you may have to move to a different version of Windows—then everything happens automatically."

Jim Hurd, the designer of NSTL's InterMark benchmark suite, agrees that the port to Windows 95 is simple, if you are coming from NT. But NSTL's InterMark benchmarks dig deeper into the OS than a typical business application does, so Hurd has encountered problems others may never see. "The Win16 InterMark runs fine under 95," says Hurd. "The Win32 version runs most things but not the disk test." (The disk test requires direct access.)

Hurd was still investigating Windows 95's direct disk access API. He had also found what he referred to as "irregular behavior" with Windows 95's timers, which InterMark must manage on the fly. He hopes Microsoft's next beta release will provide the cure for both problems. Still, Hurd remains enthusiastic: "It's a programmer's nirvana if they've already made the jump to NT."

PORTING TO 95

- **It's easy if you've already ported to NT.**
- **The key is to program to Microsoft guidelines; for example, use Microsoft-supplied "message crackers"; don't create your own.**
- **New visual components of Windows 95 not in NT 3.5 are being made available in NT 3.51.**

DEVELOPMENT TOOLS

Symantec C++ 7.0

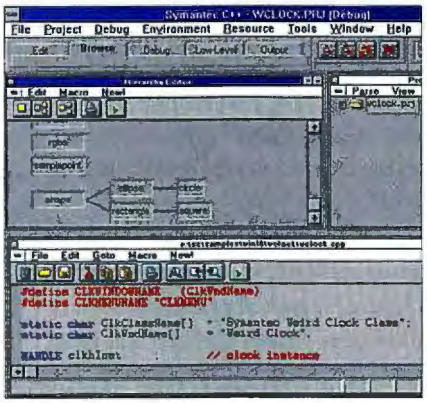
Symantec C++ 7.0 is the latest in that company's series of integrated C++ development environments for the DOS/Windows world. In this release, Symantec has extended the output of the compiler to include not only 16-bit and extended-DOS executables, Windows 3.x, and Windows NT, but also a Windows 95 executable. Choosing a target platform is as simple as clicking on a radio button.

Much of the environment is multithreaded. We noticed this immediately: When we loaded a new project, the system continued parsing even as we worked in the editor.

The browser is one of our favorite components of Symantec C++. It's a classic three-pane browser, similar to those found in most Smalltalk environments. Ordinarily, a C++ browser is read-only. But Symantec's browser has full editing capabilities. This means you no longer need to think of a C++ project as a collection of source files; you can begin working with your programs as a collection of objects.

Even C programmers can make use of the browser. A C project is treated as having one class (indicated by :: in the class pane), but the members pane does a good job of grouping components. Click on the Functions heading, and you can scan through the list of functions. Click on a member, and the function's source opens in the lower pane, ready for editing.

A technically interesting innovation to Symantec C++ 7.0 is netbuild, which lets you distribute a project build across a network. You set up a server machine as the netbuild administrator and load netbuild server processes on other participating machines. The next time you build a project, the system distributes the application's source files to all available netbuild servers.



Symantec C++ 7.0's integrated environment includes a parser that operates as a separate thread. You can be editing in one window while the parser is busy building a class hierarchy in another.

We loaded up the source for the BYTEmark benchmarks and compiled them optimized for a Pentium. We built an extended-DOS executable and ran the result on our baseline Dell XPS 90. For two of the integer benchmarks, the Symantec compiler turned in times that were equal to and even better than the baseline (the baseline compiler is Watcom 10.0); but for overall results, Symantec scored 0.81 on the integer tests and 0.55 for the floating-point tests.

We haven't even covered other important portions of C++ 7.0, such as the AppExpress, ClassExpress, and ProjectExpress—Symantec's versions of "wizards" for eliminating programmatic drudge work. The system also includes the integrated Multiscope debugger as well as a resource studio for creation and incorporation of icons, bit maps, cursors, and such. Symantec C++ may not take the blue ribbon for raw speed of the resulting executable, but the designers deserve high praise for real innovations—not mere additional features—in C++ 7.0. Other purveyors of C++ systems for Windows would do well to watch Symantec carefully.

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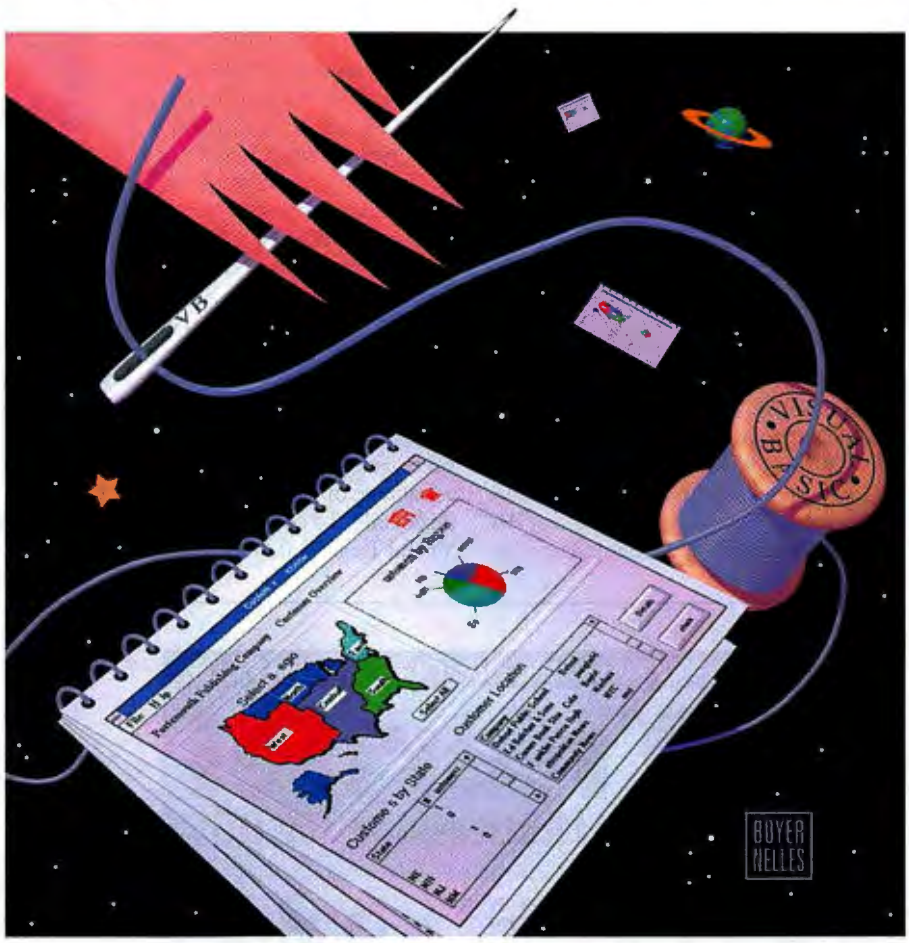
Prototyping with Visual Basic

STEVE GILLMOR



LYN BOYER-NELLES © 1995

Visual Basic has emerged as the de facto standard in Windows application prototyping. The ability to draw buttons, edit boxes, and scroll list boxes and other Windows interface elements on your screen and then add English-like commands to make things happen has been entrancing programmers ever since Apple's HyperCard first pioneered the technology. And Microsoft's decision to encourage third-party development of VBXes (Visual Basic custom controls) gave programmers off-the-shelf modules that extended Visual Basic's toolkit.

With the addition of data access tools, Visual Basic 3.0 graduated to the big leagues in corporate application development. As VBA (Visual Basic for Applications) migrates across the Microsoft Office suite, developers at all levels of expertise will soon leverage a common language and event-based programming model.

The forthcoming release of Windows 95 intensifies the pressure to create and link new applications that support the 32-bit environment's capabilities. Visual Basic's prowess as a quick and efficient prototyping engine will prove crucial in this transition.

The Visual Basic family has become the thread that sews Windows applications together

Visual Basic Everywhere

Competing products, such as PowerSoft's PowerBuilder, Gupta's SQLWindows, Borland's Delphi, and even Microsoft's own C++ development tool, Visual C++, use VBXes. Scripting languages from Lotus (LotusScript) and Novell are both dubbed BASIC-compatible. When Microsoft introduced VBA in the current versions of Excel and Project, the message was clear: Look for VBA across the Microsoft Office suite and perhaps beyond. VBA lacks the interface tools of its older brother, concentrating instead on optimizing language structures for the coming OLE Automation environment. Tools for manipulating the host application round out VBA's command set: You can control cells, ranges, worksheets, graphs, and charts in Excel, while Project's VBA commands manipulate tasks, durations, and resources.

Microsoft has announced that the next version of Access will include VBA support. Access 2.0 took a large step toward synchronizing its Access Basic language with Visual Basic 3.0, offering what Microsoft estimates as 80 percent compatibility. Access 2.0 is more robust in its security and query generation tools, but you remain tied to the Access run-time engine at the cost of speed and memory usage. Many developers prototype a database application in Access, using the QBE graphical interface to assemble and test queries and filters. They then copy the generated code from the SQL View window into a Visual Basic code module and construct a smaller, faster executable version of their project.

Microsoft Word has yet another flavor of Basic; Word Basic has less in common with its Visual Basic or Access Basic cousins

but shares a powerful macro recorder/code generator capability with Excel.

Macro Programming

Indeed, the macro recorder is a favorite tool for learning the VBA language. Excel developers can type data into a cell, make the type bold, launch a bar chart, and so on, all while creating code for reuse in future applications. This technique works, although the macro-generated code is often filled with extraneous material. For example, the listing "Excel Macro" shows the macro text generated by typing "This is a test" in a cell, selecting the text, clicking the button for bold, changing the font size to 14 from the drop-down list, pressing Enter, and turning off the recorder.

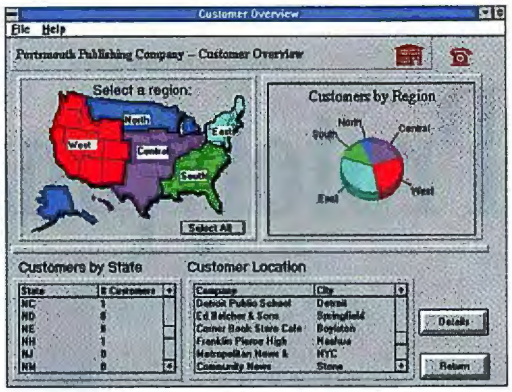
Most of the lines in this macro state the obvious: that little has changed. You can remove the extraneous code and create the listing "Abridged Excel Macro," which produces the identical effect when the macro is rerun.

You can move recorder code out of Excel's VBA window and transplant it in a Visual Basic application, but you have to make adjustments. The features that make VBA work efficiently with OLE automation objects are not yet supported in Visual Basic. The `With...End With` construct in these two listings is one such feature.

Visual Basic Meets OLE

OLE automation is one of several elements of Microsoft's OLE 2 technology. OLE 2 is a more powerful blend of the best of DDE and the original OLE. OLE 2–enabled applications support OLE automation by defining and "exposing" some or all of the application's objects. For example, Excel exposes 77 objects—everything from top-level structures you explore to reveal the application's object hierarchy to worksheet, charting, drawing, and user-interface objects.

Since VBA is resident within Excel, it is automatically aware of these objects and can speak directly to them without explicitly defining the surrounding Application object. The `With...End With` construct saves valuable execution time by taking advantage of its implied location to minimize code. To convert the code for use in Visual Basic 3.0, you use `Dim` and `Set` statements to create object variables to refer to the Excel Application and other frequently used objects. You replace the `With...End With` statements with explicit references, include the application's constant .BAS file in the Visual Basic project, and repair other language variances between VBA and Visual Basic.



HiTest Tools' Portsmouth Publishing sample application combines multiple Notes views and databases with Visual Basic's graphical interface design tools.

Visual Basic's Entourage

Although Visual Basic does not offer automatic macro recorder code generation, it does provide plenty of code examples. Sample code covers printing, file I/O, graphics, MAPI mail, DDE, OLE 2, the data control tools, a terminal communications program, and a nifty icon editor. For advanced programmers, there's a CALLDLLS directory, which shows you how to call functions from Windows DLLs.

One of Visual Basic's most important attributes is its ability to let you continue to prototype and modify your applications as they evolve. The event-based programming model is more receptive to incremental development. Programming with a more traditional procedural language can be much more difficult to pull apart and rework, whereas the modular Visual Basic environment lends itself to tinkering, testing, and quick response to user feedback. Although Visual Basic remains an interpreted language that cannot match compiled language speed, many applications prove acceptable in their prototyped form.

As OLE 2 spreads across application suites, robust systems can be cobbled together with minimal Visual Basic programming; so-called switchboard forms serve as little more than point-and-click traffic cops between familiar word processors, spreadsheets, and presentation programs. The Visual Basic developer has to be careful to manage limited resources, closing each application object before

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opening the next and keeping the number of controls to a minimum. Custom controls fill the gap between interapplication systems and self-contained Visual Basic efforts; many of these VBXes started life as Visual Basic modules, only to be recoded in C or C++ to be compiled for speed and compactness.

Specialized applications are easier to build, thanks to the variety of custom controls available. VBXes range from 3-D data-aware controls to image-manipulation tools to the latest and greatest in Internet browsing and telephony modules. The 3-D look of many VBXes foreshadows the look and feel of Windows 95. This augurs well for Visual Basic's future, because much of the overhead associated with multiple graphics-rich controls will be eliminated by calls to internal code in the new OS. Microsoft anticipates a smooth and comprehensive transition from the proprietary VBX specification to the more open OLE 2–aware OCXes (OLE custom controls), currently supported by Microsoft only in Access 2.0.

HiTest

Lotus is one of Microsoft's major competitors, but the company has clearly committed itself to OLE 2 and OCX as a vehicle for supporting Windows 95 programmability in the near future. For now, Lotus has shipped Notes HiTest Tools release 2, a unique set of VBXes that give Visual Basic developers access to the Lotus Notes groupware environment. An inexpensive desktop "run-time" version has encouraged the spread of Notes technology beyond Fortune 500 companies to smaller businesses and even individuals via on-line networks.

The HiTest Tools include 12 custom controls and a BASIC language API for Lotus Notes. The visual controls both retrieve and allow access to Notes servers, databases, documents, views, and related objects via familiar combo, check, and edit boxes (see the screen). The controls work hand in hand: The server selector combo box produces a server name that you can pass to the database selector control, which lists that server's available databases. You continue down the hierarchy, making these connections in one of several ways—setting the properties of the destination controls during the build process or at runtime, or taking advantage of HiTest's intuitive piped properties technology.

HiTest controls have built-in intelligence about each other. Hence, you can make piped properties connections without a single line of code by simply right-clicking on the destination control (e.g.,

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Excel Macro

A macro recorded in Excel by entering text, changing it to bold, and setting the font size to 14.

```
Sub Macro1()
 ActiveCell.FormulaR1C1 = "This is a test"
 With ActiveCell.Characters(Start:=1,
 Length:=14).Font
  .Name = "Arial"
  .FontStyle = "Bold"
  .Size = 14
  .Strikethrough = False
  .Superscript = False
  .Subscript = False
  .OutlineFont = False
  .Shadow = False
  .Underline = xlNone
  .ColorIndex =
xlAutomatic
 End With
 Range("A2").Select
End Sub
```

Abridged Excel Macro

The same code from "Excel Macro," with extraneous lines removed.

```
Sub Macro1()
 ActiveCell.FormulaR1C1 = "This is a test"
 With ActiveCell.Characters(Start:=1,
Length:=14).Font
  .Name = "Arial"
  .FontStyle = "Bold"
  .Size = 14
 End With
 Range("A2").Select
End Sub
```

the database selector that receives the information) and then dragging and releasing the button on the source control (e.g., the server selector that passes the information). When you click on the destination control, the pointer turns into a disconnected plug and socket icon; when you release on the source control, the plug connects. You can confirm the connection in Visual Basic's properties window. In short, you can set up a typical Visual Basic Notes application, such as a data browser, in a few mouse clicks.

HiTest's Visual Controls manual walks you through the construction of four short applications that cover the use of all 12 controls. Once you're comfortable with the ease of use and code-free programming capabilities of the piped properties interface, the manual leads you through more examples that extend the controls' power with HiTest Basic API functions.

Lotus has emulated Visual Basic 3.0's integration of the data control with the more robust data access layer. The data control offers a way to create an interactive view of data from a query or table; the programmatic layer lets you create powerful applications for use in any setting.

Similarly, the HiTest API functions can work with the custom controls or by themselves. If you want to give a user a choice of databases, the database selector control's drop-down list will do the job nicely. If you already know the database you want, you can hard-code it with the `HTDatabaseOpen` function.

Inside Notes

The HiTest Basic API delivers inside access to the Notes environment; it lets the Visual Basic developer accomplish tasks that are not easily done (if at all) within the Notes interface. For example, moving a hierarchy of response documents from one database to another is a nontrivial, but common, task performed when refining or restructuring workflow databases. HiTest Tools functions accomplish most of this work, as shown in the listing "HiTest Hierarchy Copy." Of course, you need to declare appropriate variables and house the server, database, and view selectors on a form with a command button that fires off the Move Document script. Add error checking, and you have a nifty house-cleaning utility.

HiTest Hierarchy Copy

A simple program fragment for Lotus HiTest that copies the hierarchy of one response database to another.

```
'Copy the hierarchy from the source
' database to the destination database
Status =
HTIndexCopyHierarchy(HVViewDocSel1(0).ioIndex,
HVDBAccess1(1).ioDatabase, DestDocID, DocCount)
'Then delete the original hierarchy
Status =
HTIndexDeleteHierarchy(HVViewDocSel1(0).ioIndex,
HTDOCDELETEF_FORCE_COMMIT, DocCount)
```

The API's abstraction of what Lotus calls "Notes metadata" provides single-function access to and creation of form, view, and agent information. You can avoid the details of the internal Notes BLOB file structure and concentrate on the code to get your business rules and workflow established. Programmers familiar with the standard Notes API will find relief from dealing with callback functions, ID tables, collections, memory blocks, and composite data.

At the user programmer level, the combination of the HiTest Visual Controls and the Basic API gives quick access to a number of useful executive information tools. For example, you could integrate a Notes ToDo database with a small Visual Basic executable that scans your medium, high, and hot priority categories and then lists them in editable fields. Load the Visual Basic application in your start-up group, and you have a quick start on your day with low resource overhead.

Notes ships with a powerful customer service application template, which includes a series of interlocking databases for call tracking, product suggestions, and problem reporting. With Visual Basic and HiTest, you can simultaneously view multiple databases on a single screen, so that you could check whether the same client who called to report a problem might also have recommended a solution. In Notes, you could get some of this functionality with the "tile" command but with none of the programmability.

The HiTest API functions can be called via VBA from other elements of your office suite applications. The Tools let users of the Microsoft Office and Novell Perfect Office suites come close to and, in some cases, surpass the integration Lotus has provided with its NotesSuite bundle via Notes/FX.

Visual Basic Forever

As VBA and similar languages continue their evolution across the Windows landscape, the opportunities for migrating existing applications can only increase. The transition from Visual Basic to OLE custom controls will give Visual Basic and VBA developers more powerful and flexible tools for integrating multiple applications.

The distinction between a prototype and its completed application form will continue to blur. As new OSes and CPUs absorb more multimedia technologies, the Visual Basic/Access/VBA developer will venture into emerging technologies such as telephony, 3-D virtual reality, digital video, and imaging.

The ongoing pressure to leverage the leap in computing horsepower should propel these innovators forward but always with the need for an identifiable return on investment. The old adage "If it works, don't fix it" should keep the power of prototyping firmly in the driver's seat. ■

Steve Gillmor is a vice president of Barkley Communications Co. and director of Southern Digital, Inc., both based in Charleston, South Carolina. He can be reached on the Internet at sgillmor@aol.com or on BIX c/o "editors."

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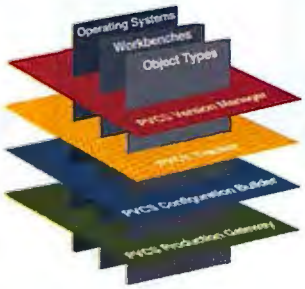

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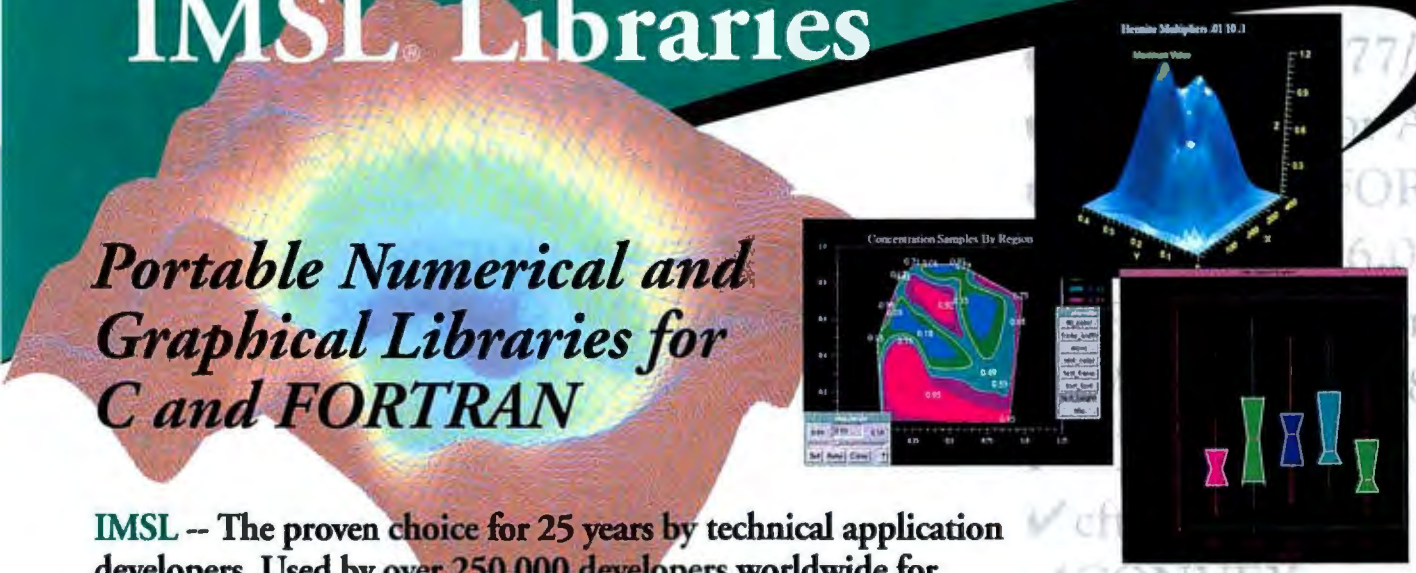

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AD95110

Embedded Development

HOWARD EGLOWSTEIN

LYN BOYER-NELLES © 1995

Embedded programming places the software closer to the hardware. Here's what's involved.

Although you may not know it, embedded processors are everywhere. The keyboard attached to your computer has one that scans through the keys to figure out what you pressed. Your computer's system board is likely to have several more. And they're not just hiding in what we think of as technology products; your microwave oven has one, and so does your telephone, your children's toys, and your car.

The classic definition of an embedded processor—or any processor—suggests that it be programmable. However, an embedded processor is typically programmed in a specific nature to perform a dedicated task. Some people would add that embedded processors don't include tools to change their programming but, rather, require that you run a preset program stored in ROM. This fact, and others that will emerge, suggests that programming for an embedded environment requires an entirely different mindset than programming a desktop computer running System 7, Windows, OS/2, Unix, or some other general computing environment.

Case in Point

Recently, my colleagues and I have been working on a device to help teach handwriting to children. The specification dictated that it have some sort of pen input and associated processing power to interpret the pen motions. Most important, it had to be inexpensive.

When we started our design, we broke the problem down into hardware and software and determined the minimum hardware configuration that would be needed to do the job. Back then, in 1993, several small hand-held computers had been developed using integrated chip sets from Chips & Technologies, Vadem, and others. We investigated two designs, both based on 8086 processor cores.

We immediately ran into a snag. Companies that design 8086-based embedded processors expect that you will be incorporating them into DOS machines. Our design, however, had no keyboard, conventional communication ports, or any of the standard PC resources. When the companies thought we were building their PC-compatible chips into DOS machines, they were thrilled. When we explained that we wanted to use their hardware in a design without a BIOS or DOS, they realized that they couldn't help us. AMD's and Vadem's support engineers had no experience outside of the BIOS/DOS environment. Vadem revealed that not only had their BIOS been written by a contractor, but they had no source code and didn't know the chip well enough to tell us how to initialize it without their BIOS.

We selected AMD's Elan, a highly integrated 386-based processor. It contained just about everything we needed to design a hand-held PC. Essentially, it's an entire PC on a chip. The main

core is an AMD 386-compatible processor with several levels of power conservation. It includes the standard 8254 timer, dual interrupt controllers, parallel and serial ports, DMA, LCD, and PCMCIA controllers. Our product wasn't going to use the keyboard and CGA LCD controller, but having the rest of the resources combined into a single 208-pin package was compelling.

By the Bootstraps

Although an integrated chip set can have huge advantages, the drawbacks can be just as severe. If you're planning to use a PC-compatible chip set in a non-BIOS/DOS environment, as we were, the PC compatibility is no advantage.

Take the screen support, for example. If you have a design with a separate CPU and video controller, you can probe the interface between the two and see if the CPU is driving the controller properly. The Elan's built-in video requires that you write the code and run it. If you get video out, that's great. If not, you have to guess what the problem is, fix it, and try again.

Also, if the chip is a new design—as the Elan was when we began our project—information on how to get the most out of it is often hard to come by. Application notes may not have been written, and the preliminary documentation that comes with a prerelease chip is often wrong. If you use a standard environment like a PC BIOS, you will want to know if it has been ported to the chip. If the chip does not have enough market share to attract a BIOS vendor, you may have to get BIOS source code and write your own support.

To bring up our Elan-based system the first time, we customized a copy of the Annabooks BIOSMaker to run on the Elan. We had to remove the screen, keyboard, and disk support, but at least we had something to run preliminary tests. We never planned to use a PC-compatible BIOS in the final design, but considering that the Elan is fully PC-compatible, a commercial BIOS seemed like an excellent way to get some test code up and running.

BIOSMaker

If you've worked with IBM-compatibles before, you know that the BIOS first tests and initializes all the standard PC peripherals. Devices like the timers, DMA controller, keyboard, and display adapter all require some setup. The Annabooks BIOS starts by testing the system memory and verifies that enough RAM is working to set up a system stack. It then switches from handwritten assembly language code to a series of C modules to test and set up each of the main PC subsections. When it reaches out to a device that doesn't respond, the Annabooks code usually reports a graceful failure. In other cases, such as an unresponsive keyboard, it crashes.

Not only did our design fail to have a keyboard connected, but it used the Elan's keyboard logic to drive other hardware. The Annabooks code looked for a keyboard, saw our hardware instead, and died. Happily, the Annabooks product is entirely in source code, giving us the option of removing the keyboard and disk code

INTEGRATED CHIP SETS

PROS

- Reduced hardware design time; peripherals are already there
- Less board real-estate required
- All-in-one solution; guaranteed interoperability of peripherals and CPU

CONS

- Reduced flexibility in hardware design; difficult to customize peripherals
- Limited options for adding debug testpoints
- Impossible to "watch" communications between CPU and integrated peripherals to pin down bugs

Embedded Debugging Alternatives

Embedded systems use highly integrated chip sets and have little room for connecting test equipment; remember that fact as you design your system. Debugging an embedded system is easily the most difficult part of the entire design process. Here's a suggestion: Put in an extra serial port for a debugging terminal, or run some critical signals out to a connector.

If you're lucky enough to be using a processor with ICE (in-circuit emulator) support, you can simply install a socket instead of the processor and plug in the ICE. The ICE is usually run by a desktop computer. A processor in the ICE executes the same instructions that your target processor runs, but it lets you step through them one at a time and examine the processor registers. If you can design your system to allow for an ICE, do it; the debugging time you save is worth it.

If your system has an external EPROM socket, try an EPROM emulator. This looks like a block of RAM to your host or development machine and like an EPROM to your target. Instead of having to repeatedly program an EPROM, you simply download the binary EPROM image into the emulator. It saves time, trouble, and wear and tear on the EPROMS and sockets. Also, EPROM emulators often contain debugging gadgets.

For example, some versions of the ROMEM (B&C Microsystems) EPROM emulator let you prestore a specific address in memory. When the target processor accesses that address in the emulator, the emulator turns on an LED and sends a TTL signal out to a test clip. You can use that signal to trigger an oscilloscope or other test equipment or as part of a debugging kernel to set breakpoints. Another emulator, PromICE (Grammar Engines) lets your target software send data back through the emulator socket by accessing specific memory locations in a predefined manner.

Depending on the processor core you've selected, there may be a debugging kernel available. A debugging kernel is a small program that you load into the processor and that takes advantage of any special features in your processor (like single stepping) that facilitate debugging your program. If the kernel knows you have a serial port, it may support a terminal through it for interactive debugging.

Finally, there's the low-budget, cross-your-fingers-and-pray debugging method. You write your code (often using a cross assembler or cross compiler on a desktop machine), stick the code image into an EPROM, turn on your target board, and then hope that it runs. If it doesn't, you have to examine the clues and figure out what happened.

This is where a well-designed system board is invaluable. If you have a logic analyzer available, you can use it to spy on the processor address/data bus. You can't watch the register contents with the logic analyzer, but you can see what code is running and see what effect the code has on your hardware. If you don't have a logic analyzer, use a simple LED that you can blink on and off under software control. Simply have your code run to some known point and then turn on the LED. If it doesn't light up, you know that the code died somewhere earlier.

from the BIOS image. To Annabooks' credit, the kit is well documented, or it would have been impossible to get it running.

We used the Annabooks BIOS as a kind of "proof of principle." It was an invaluable diagnostic tool that let us shake the bugs out of much of the hardware. The next step was to build the real code.

Multitasking Without Disks

Our product had several important tasks to perform at once. Part of the reason we chose a 386-family processor was to facilitate using a commercial multitasking kernel. Microware's OS-9000 seemed like a good fit for our application and should have run well on the AMD processor. Unfortunately, it turned out that our environment was a little limiting.

Microware's OS-9000 is a scalable multitasking environment that grew out of OS-9 (an OS for the 6809 processor) and is now available for the 386 and 68000 families. OS-9000 starts with a multitasking core, and you add command processors and file system support as needed. In development, you load the OS onto a 386-based PC and add the PC peripheral drivers, file system support, compilers, and other tools. After you develop your applications, you port the OS to your target and remove the OS components your target doesn't need. On paper, it looks perfect.

In our case, Microware hadn't had any experience porting OS-9000 to the Elan. (At that point, the Elan was still just a promise on paper.) Another serious problem was that without any storage device except 128 KB of ROM, our device was a severely restricted environment for a system as complex as OS-9000. Microware was extremely accommodating and worked out a solution for us. We loaded the OS onto an old, creaky 16-MHz 386DX and had quite a time learning how OS-9000 works. It's an efficient environment, but the development tools seemed primitive. Additionally, the documentation was incomplete, lacking examples, and sometimes wrong. Microware has since fixed these problems.

Eventually, we decided that we could write our own preemptive kernel with less trouble than adapting OS-9000. Our application is specific; it has requirements that OS-9000 had to stretch to meet, and it used up more resources than our low-end product could offer. OS-9000 would have taken up 256 KB of ROM/RAM; to do the same job for our application, our kernel would have taken up less than 10 KB.

Back to Square 1

Once we decided to write our own environment from scratch, the next problem was to find tools. All the assemblers we normally use on the PC generate DOS executables. That won't do for an embedded design—you need specifically located code that runs in precise locations in ROM. You also need a way to generate the image so that an EPROM programmer understands where in the ROM it belongs.

For most 8-bit work, we use Cross-32, a universal cross assembler from Universal Cross-Assemblers. Cross-32 is a table-driven assembler that supports just about all 4-, 8-, and 16-bit processors. Cross-32 came with only limited support for the 386 in real mode. After calling around to all the manufacturers of cross-assembler products, the only solution we found that specifically generates ROM code for the 386 was a VMS-based product. Apparently, the 386 addressing modes are too complex for a general-purpose cross assembler. We were forced to select either Microsoft's MASM or Borland's TASM, conjuring a new problem: how to use MASM or TASM to generate ROM images.

The answer was a locating linker. Unlike standard DOS linkers (which generate relocatable code), a locating linker will take a Microsoft OBJ file and write out an absolute memory image for a specific location in the memory map. You need this if you want a 386 to start out of a ROM because you need to have a starting `JMP` instruction at the right spot in the boot ROM.

LESSONS LEARNED

- Design debugging access into the hardware
- Consider software development tools during hardware design, not after
- Look for an in-house software solution that may be superior to a commercial kernel or OS; the latter can force you to include hardware resources to support features you don't need

The problem is that there's relatively little demand for these linkers. We found only two—one from Pharlap and another from Systems & Software, Inc. SSI's product comes in regular ($595, real mode only) and deluxe ($895, all processor modes) versions. Pharlap's product, LINKLOC, sells for $895 as well. It came down to a coin toss, but we decided on Pharlap's LINKLOC, and it's worked out fine.

The only other software problem remaining was that once we had a ROM image properly located with the target address, we wanted to generate the output file with the proper offsets to move it into the correct part of the ROM. In our case, we had a 128-KB ROM socket (`00000-20000h`) that represented `E0000-FFFFF` in the 386 address space. A piece of code written to run at `F0000` (the standard PC boot ROM location) needed to be located at `10000` in the ROM. It seems simple, but we discovered that even a $900 linker can't do that.

We crafted the solution using possibly the most ubiquitous and flexible of all programming tools: BASIC. Using QuickBASIC, in one afternoon we built our own set of tools to read and relocate Intel extended hex files. We could download these directly to ROM.

No Bugs Allowed

Embedded processors often perform critical jobs, so you don't want them to crash. Imagine how annoying it would be if the processors running the elevator in your office building shut down as often as the fancy windowing environment machine on your desk.

The ability to write well-structured, bug-free code is especially critical for an embedded processor product. Your customer won't be able to simply replace the software with an update, and the results of a software failure could be life-threatening. If you're planning an embedded project, choose the tools—software as well as hardware—carefully. The right tools can make the difference between a design delight and a debugging nightmare. ■

Howard Eglowstein is a developer for Penmanship, Inc., of Incline Village, Nevada, and a BYTE consulting editor who works with handwriting software for education. He can be reached on the Internet or on BIX as heglowstein@bix.com.

Where to Find

Chips and Technologies, Inc.
San Jose, CA
(408) 434-0600

Vadem
San Jose, CA
(408) 943-9301

Advanced Micro Devices (AMD)
Sunnyvale, CA
(408) 732-2400

Annabooks
San Diego, CA
(800) 462-1042
(619) 673-0870

Microware Systems Corp.
Des Moines, IA
(800) 475-9000
(515) 224-1929

Universal Cross-Assemblers
Quispamsis, New Brunswick
Canada
(506) 849-8952

Systems & Software, Inc.
Irvine, CA
(714) 833-1700

Pharlap Software
Cambridge, MA
(617) 661-1510

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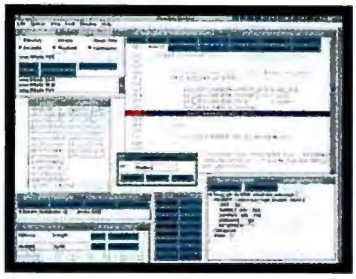
What's New

68000 C CROSS-COMPILER TOOLKIT

Intermetrics has reduced the price of its InterTools C Cross-Compiler PC Toolkit ($1500) for



the Motorola 68000 processor family. The toolkit includes an ANSI C compiler, an assembler, a linker, run-time libraries (with source code), and utilities. It runs under DOS or Windows on IBM PC-compatible computers. It can also interface to the PassKey debugger, available in ROM monitor and CPU32 background modes as well as popular in-circuit emulators. The toolkit with PassKey is $3000. After May, the toolkit is $1750. The total package is $3250.

Contact: Intermetrics, Inc., Cambridge, MA, (617) 576-3266.

Circle 1381 on Inquiry Card.

OBJECT SERVER FOR SMALLTALK

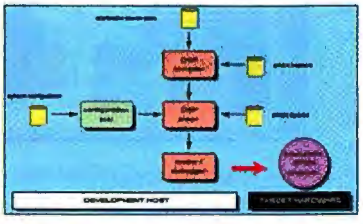
Servio is now offering a version of the GemStone 4.0 object server and database for Digitalk's Visual Smalltalk 3.0. More than an object-oriented database, Gemstone ($6000 per application developer; $1200 per user) includes a server-based Smalltalk execution engine that lets application developers transparently partition applications between client and server. The pricing is reduced as you add users.

Contact: Servio Corp., Beaverton, OR, (503) 629-8383; info@slc.com.

Circle 1386 on Inquiry Card.

SPOX PORT TO TI DSP

Spectron's real-time, multitasking SPOX OS ($12,000) has been ported to the Texas Instruments'



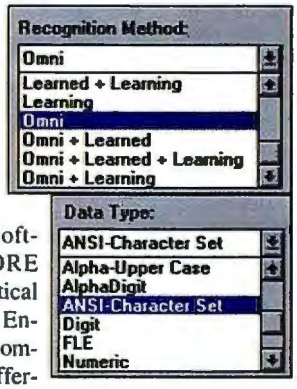
TMS320C80 DSP. The port includes the SPOX kernel, with Spectron's suite of signal-processing software development tools. In the near future, Spectron will move its full SPOX environment, which will include a SPOX-aware front end to TI's TMS320C80 debugger, libraries, and development-host communications.

Contact: Spectron Microsystems, Inc., Santa Barbara, CA, (805) 968-5100; sales@spectron.com.

Circle 1382 on Inquiry Card.

OCR DEVELOPMENT KIT

Maxsoft-Ocron has released Recore 4.0 ($2495), an OCR software development kit written in C for Windows. The kit includes Maxsoft-Ocron's MORE (Multiple Optical Recognition Engine), which combines four different OCR engines. Incorporated into MORE is a voting manager that coordinates the results from the different engines for making final decisions. The kit also includes a neural network, automatic de-skew functions, and other features that permit recognition speeds of up to 250 cps. An optional bar code–reading library is available for $995.



Contact: Maxsoft-Ocron, Inc., Fremont, CA, (510) 252-0200; info@maxsoft-ocron.com.

Circle 1384 on Inquiry Card.

NUMERICAL C LIBRARY FOR WINDOWS

The Numerical Algorithms Group now provides its C library of numerical routines as a DLL for PCs running Windows 3.1. These routines let software developers easily integrate numerical routines into their Windows applications. The library ($495) includes over 250 rigorously tested routines covering areas such as minimization, ordinary differential equations, Fourier transforms, quadrature, linear algebra, curve and surface fitting, and statistical functions. Academic discounts and site licenses are available.

Contact: Numerical Algorithms Group, Inc., Downers Grove, IL, (708) 971-2337; naginfo@nag.com.

Circle 1389 on Inquiry Card.

IMAGE-PROCESSING LIBRARY

Sinectonalysis has released EyeLib ($5000), a software library for image-processing applications for the Texas Instruments TMS320C40 DSP. EyeLib includes over 400 functions useful for such tasks as fast edge detection, 2-D FFTs (fast Fourier transforms), convolutions, and filtering. This version is optimized at both the algorithm and machine code (for the TMS320C40) level, and the routines are callable from C, C++, assembler, and ADA.

Contact: Sinectonalysis, Inc., West Newton, MA, (617) 894-8296; sinecto@clark.net.

Circle 1380 on Inquiry Card.

NEW DSP MICROKERNEL

VoCAL Technologies has released a DSP microkernel for DSP Group's PineDSPCore and OakDSPCore products. VTMK-400 ($6000) is a microkernel with background/foreground scheduling ideal for audio, telephony, imaging, and communications equipment. The VTMK-400 interrupt-driven foreground mode is suitable for deterministic, real-time activities; its background mode is useful for running non-real-time tasks.

Contact: VoCAL Technologies, Ltd., Buffalo, NY, (716) 688-4675; info@vocal.com.

Circle 1383 on Inquiry Card.

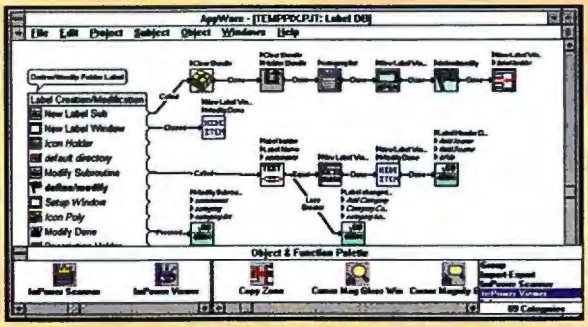
EMBEDDED UNIXWARE

VenturCom's Venix Embedded Development System ($14,000) is now available on Novell's UnixWare. This offers application builders Posix-compliant Unix with embedded and real-time features while letting them incorporate any third-party UnixWare tools and maintain compatibility. At the heart of EDS is the EOX (Embedded Operation Extension), which adds embedded features to the UnixWare core. The price includes training and support.

Contact: VenturCom, Inc., Cambridge, MA, (617) 661-1230; info@vci.com.

Circle 1387 on Inquiry Card.

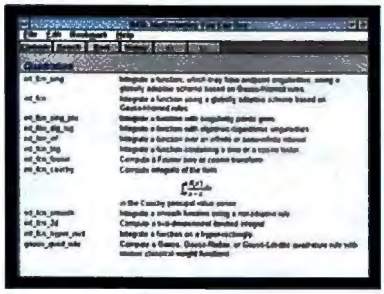
IMAGING TOOLS



Alta Technology has announced the availability of its Alta ImPowerTools (starting at $7500), an imaging toolkit for Novell LANs and Windows-based PCs. Built on Novell's AppWare (included with the package), ImPowerTools lets application developers draw on ALM (AppWare loadable modules) software components, including a scanner, a viewer, ICR, OCR, and routines to index, store, retrieve, and print images.

Contact: Alta Technology Corp., Sandy, UT, (801) 562-1010; sales@altatech.com.

Circle 1391 on Inquiry Card.



NUMERICAL LIBRARIES FOR THE MAC ▲

Visual Numerics has made available the IMSL C Numerical Libraries for the Apple Macintosh ($695). The libraries support 680x0-based and PowerPC-based Macintoshes and are compatible with the Metrowerks Code Warrior compiler CW4. The C version of the IMSL libraries, originally released into the Unix world in 1992, include more than 200 functions that can be used to solve numerical analysis problems.

Contact: Visual Numerics, Inc., Houston, TX, (713) 784-3131; marketing@houston.vni.com.

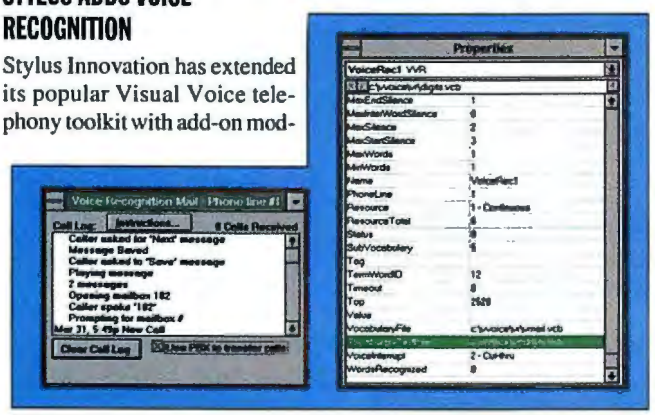
Circle 1385 on Inquiry Card.

STYLUS ADDS VOICE RECOGNITION

Stylus Innovation has extended its popular Visual Voice telephony toolkit with add-on modules that include text-to-speech and voice-recognition capabilities. Both add-on modules are available in software-only or hardware-assisted versions. The voice-recognition control ($495, software- or hardware-assisted version; the latter requires a Dialogic VR/40 board) is speaker-independent and supports continuous and discrete speech recognition. The hardware-assisted version includes advanced features such as changing vocabularies on demand. The software-only version provides discrete recognition for a limited vocabulary of words and digits. The text-to-speech control ($495, software- or hardware-assisted version; the latter requires BST firmware and a standard voice board or a dedicated TTS board) uses Berkeley Speech Technologies' BeST-speech software to speak any text over a phone line. Run-time licenses start at $195.

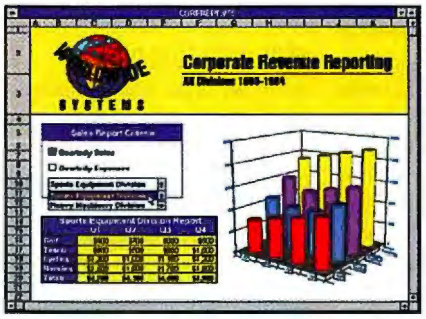
Contact: Stylus Innovation, Inc., Cambridge, MA, (617) 621-9545; info@stylus.com.

Circle 1393 on Inquiry Card.



VISUAL DEVELOPERS SUITE DEAL ON CD

VisualTools has released its Visual Developers Suite Deal ($399) on CD. The suite is comprised of software components that include a Microsoft Excel–compatible spreadsheet component, a graphics file conversion component, a 3-D charting component, an RTF-compatible text-processing and editing component, and a spelling-checker component. The components can be used with major Windows-based development environments, including Microsoft Visual Basic, Visual C++, Borland C/C++, and Delphi. Originally, the suite was available on 3½-inch disks. Owners of the disk version can upgrade to the CD for $25.



Contact: VisualTools, Inc., Lenexa, KS, (913) 599-6500; CompuServe 74774,443.

Circle 1390 on Inquiry Card.

NEST SDK AVAILABLE

Novell is now shipping a software developer's kit for the Novell Embedded Systems Technology. The NEST SDK ($50,000) includes OS- and CPU-independent source code for SPX, IPX, and LSL drivers, as well as MLIDs (Multiple Link Interface Drivers). It also includes embedded drivers for print servers and remote printers as well as separate tools for testing SPX and IPX protocols. NEST devices can make use of NetWare services, security, and management facilities. Also, NEST devices can access NDS (NetWare's Directory Services). Two days' worth of training in NEST for up to two engineers is included with the package.

Novell, Inc., Provo, UT, (801) 429-7000.

Circle 1392 on Inquiry Card.

MORE OBJECTS FOR XVT

XVT Software has released version 3.2 of its complete object-oriented Development System for C++. This system ($2325 for PCs; $7500 for workstations) combines XVT-Power++, XVT-Architect, and the Rogue Wave Tools.h++ library of data structures. XVT-Power++ is a development framework that includes portable images, native font access, and a hypertext help system. XVT-Architect is a graphical application builder that replaces code handwriting with point-and-click interaction with the XVT-Power++ object hierarchy.

Contact: XVT Software, Inc., Boulder, CO, (303) 443-4223.

Circle 1394 on Inquiry Card.

VISUALAGE C++

IBM announced its VisualAge C++ object-oriented application builder running under OS/2. Originally a Smalltalk platform, VisualAge C++ (price as yet undetermined) is built atop IBM's C Set++ product. VisualAge C++ includes the BIM Open Class Library and a set of C++ building blocks, as well as a variety of C++ tools and a complete code-generation environment. In beta testing at press time, VisualAge C++ should be available for release in June 1995.

Contact: IBM, Somers, NY, (800) 426-3333.

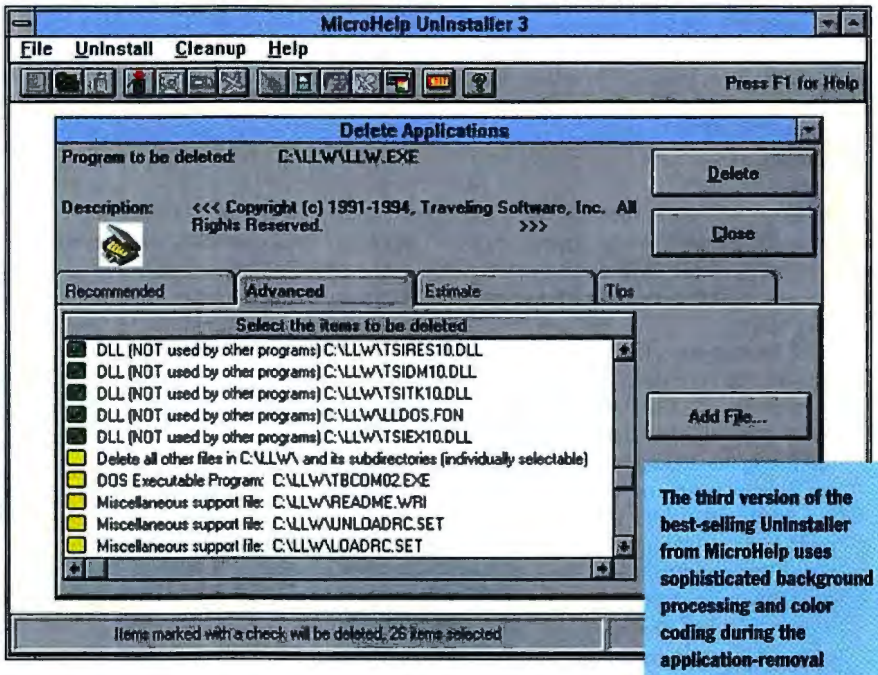
Circle 1395 on Inquiry Card.

Weeding Windows

The latest uninstallers employ new technology and clever tricks to track the installation habits of even the worst-behaved programs

STAN MIASTKOWSKI

Removing Windows applications from your hard drive can be like weeding your garden: Every time you think the job is done, a new weed pops up. Complex Windows applications litter files all over the place without worrying about how to clean up the mess later on. Easy, reliable uninstalling is tricky because there's no such thing as a "typical" Windows application; the way each handles its installation and file structure varies widely. An increasingly popular category of software—Windows uninstallers—helps clean up the mess by yanking applications out at the roots.



The third version of the best-selling Uninstaller from MicroHelp uses sophisticated background processing and color coding during the application-removal process. Its advanced option (shown above) lets you choose the program files to be deleted.

Nooks and Crannies

Most Windows applications rely on DLLs, and how they're handled is one of the thorny problems of removing Windows applications. Most applications have their own DLLs. Sometimes the DLLs are put in a dedicated subdirectory, but usually they're tossed into the \WINDOWS\SYSTEM subdirectory with everything else. Some applications use "standard" Windows DLLs, such as the bloated VBRUN300.DLL (Microsoft's Visual Basic run time). Multiple applications from the same manufacturer often share common DLLs, a widespread practice in applications suites like Lotus SmartSuite. If you wipe out an application and its associated DLLs, you may find that other Windows applications will not run. And if you tend to add or delete Windows applications frequently, you'll have numerous space-eating (and unused) DLLs that can slow down your system or cause intermittent problems.

And on it goes. Windows applications create their own INI (initialization) files; they also mess around with the standard Windows WIN.INI and sometimes the critical and fussy SYSTEM.INI files. Many installations also modify your DOS CONFIG.SYS and AUTOEXEC.BAT files. Some applications will even futz with your software drivers.

Developers can simplify removal by following simple guidelines, such as putting all their files in a dedicated subdirectory and placing REM statements in INI files. The most conscientious developers even include an uninstall option that does the removal for you. Unfortunately, such fine touches are rare.

The Contenders and the Offenders

We looked at six uninstallers. To test them, we configured a Windows installation with standard and nonstandard applications and then restored the applications from tape backups after using each uninstaller.

We concentrated on removing two packages: Microsoft Office 4.2, with its huge disk requirements and many shared files, and Traveling Software's LapLink for Windows 1.0. LapLink is one of the most complex Windows applications around; its remote-control and remote-access features require many changes to INI files, including changing the communications and video drivers in Windows' SYSTEM.INI file. Removing LapLink was a good challenge for the uninstallers. Thankfully, LapLink has its own Remove icon that wipes out all traces of the program and changes the Windows settings back to where they were.

All the uninstallers were able to remove the various components of Microsoft Office with few problems, although the space reclaimed varied from package to package. On the other hand, none of them were able to remove all the components of LapLink for Windows.

The differences among the packages can be boiled down to how aggressive or conservative they are. Aggressive uninstallers open up more space, but with some risk of creating problems. Conservative uninstallers are more careful, but they leave more files around when they're done. Some balance aggressive versus conservative approaches, and some give you a choice. Despite the claims of companies, we don't see application speed as an important issue. Although times for each of the utilities tested varied widely, none of them are slugs. The utilities that use newer analysis technologies take longer because they do more—an acceptable trade-off. We've concentrated on the unique features of each program. For a summary of all products, see the table "Comparing Uninstaller Features" on page 136.

continued

The Windows 95 Question

The impending shipment of Microsoft's Windows 95 and its different ways of handling applications create some interesting questions and implications for the future of uninstall utilities. Windows 95 will come with a registry, a centralized database of application requirements and file locations. This eliminates the need for WIN.INI, SYSTEM.INI, and separate application-specific INI files, but only for Windows 95 native applications. In addition, to be able to use the Windows 95 logo, software developers must provide each application with its own uninstall option.

At first glance, these Windows 95 realities would appear to spell the end of separate utilities that remove Windows applications. But the picture is more complicated than that. For one, not everyone will move from Windows 3.1 to Windows 95 immediately. More important, because widespread availability of Windows 95 applications will take a while, most Windows 95 converts will run a combination of Windows 3.1 and Windows 95 applications under Windows 95. And for backward compatibility, all Windows 3.1 applications still require the usual array of Windows 3.1 INI files.

Although the Windows 95 registry will eliminate many removal problems with native Windows 95 applications, the registry still doesn't track complex interdependencies among application files. And unless the required Windows 95 application-uninstall option is carefully designed, it could be inefficient or possibly delete files that are required by other applications (e.g., DLLs). The bottom line? Windows 95 is likely to make uninstallers as important, if not even more so, in the long run. That fact has been tacitly underlined by Microsoft: The Windows 95 registry contains an entry that lets you specify an application to use for uninstalling Windows 95 applications, such as the uninstallers covered here.

Windows 95's registry corrals application parameters in a central database.

● CleanSweep

Quarterdeck Office Systems, best known for its Desqview (DOS multitasking) and QEMM (memory management) packages, recently entered the uninstaller market with CleanSweep. Besides removing Windows applications, CleanSweep does an excellent job of finding unused Windows system components (e.g., unused video drivers or installed fonts). It also sniffs out unused or obsolete files, as well as duplicate files across drives. Those are common features across many of the packages.

CleanSweep uses two technologies new to the latest generation of uninstallers (and shared by several of the tested packages). Although they go by various names, in CleanSweep they're called Helper and SuperLinks. *Helper* is a database of popular Windows applications and their installation processes, making the uninstall process more of a sure thing. The Helper database does need to be regularly updated. You can do that via Quarterdeck's BBS, CompuServe, or the Internet.

SuperLinks is a technology that continually tracks all DLLs installed on your system and the programs that use them. This is important for managing DLLs that are used by multiple applications. CleanSweep does this automatically in the background, using a TSR in the `load=` section of WIN.INI. This tracking technology, new (and common) in many uninstallers, means that the longer you have the package installed, the more it "knows" about your Windows installation and the more accurate it becomes.

CleanSweep is one of the fastest packages, although speed isn't the most important issue when choosing an uninstaller. More important are the crucial safeguards that CleanSweep offers. There's a Trial Run option that figures out what must be removed and tells you how much space you'll recover. And for the truly cautious, there's a useful Create Backup option that puts deleted files in a compressed backup. If you later need the application back (or part of it), you can restore files from the backup. Creating a backup doesn't leave as much disk space free, but it is an important feature.

● Remove-It

Vertisoft's Remove-It is unique in several ways. For one, its basic interface is easy to use. Remove-It offers all the usual uninstaller options, along with a few extras. For example, it stands alone in offering an Emergency Recovery Disk option. This creates a floppy disk that will get you back up and running if you accidentally delete crucial system files. (That's not likely, though, because Remove-It gives you many warnings before you do that.)

During installation, Remove-It gives you the option of loading two add-in utilities. Watch-It, a 1.3-KB TSR loaded in your AUTOEXEC.BAT, is another unique feature. It continually monitors your application and file usage and suggests unused files that you can safely delete. Log-It, placed in the `load=` line of WIN.INI, continually tracks DLL relationships as well as applications installed after you install Remove-It. This is similar to CleanSweep's SuperLinks.

Another singular feature of Remove-It is a choice of Express and Custom removal options. Express is conservative and fast. It decides what to remove and does the job without further user intervention. Most important, it automatically makes a compressed backup that lets you restore what you deleted if you need to. As the name implies, Custom goes much further. It's more aggressive at finding the parts and pieces of applications, but it also gives you much more control.

● UnInstaller

MicroHelp was the first company to ship a Windows application remover. It had the field to itself for several years, and it's recently been a regular on software best-seller lists. The latest incarnation of UnInstaller, version 3.0, underlines MicroHelp's substantial experience in this field.

continued

The 1995 Chili for Children Cook-Off is missing a key ingredient: YOU!

Thanks again to all our 1994 Chili for Children Cook-Off sponsors. It was the hottest cook-off yet, as your support helped raise over $500,000 for missing children. This year's event promises to be another great time for all, and while the Cook-Off is the largest event of Fall Comdex, it's sure to sell out. Reserve your sponsorship now and help make the 1995 Chili for Children Cook-Off the best ever. Call Kate Potts at Micrografx, (214) 994-6413, for details.

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UnInstaller 3.0 is one of the slowest uninstallers. But that's not much of a criticism, because the program is also the most careful of the group. At the same time, it takes an aggressive approach to removing applications. It uses an integrated (and updatable) database of common Windows applications. UnInstaller's centerpiece is SmartLinks, a program that works continually in the background to build a "rules file" of DLL and applications relationships. It has similarities to features in CleanSweep and Remove-It, but it seems to go further in its analysis function. SmartLinks uses FILOG, a 2.4-KB TSR that's installed in your CONFIG.SYS file.

During UnInstaller installation, you can also add PM Sentry, which adds Install Application and Uninstall Application to the Windows Program Manager pull-down File menu. Even if you don't opt for PM Sentry, you can (and should) use Setup Monitor. When you install a new Windows application, using the Setup Monitor instead of the more familiar File/Run option makes UnInstaller an integral part of any application installation as it tracks all the parts of an installation. This makes uninstalling virtually a sure thing.

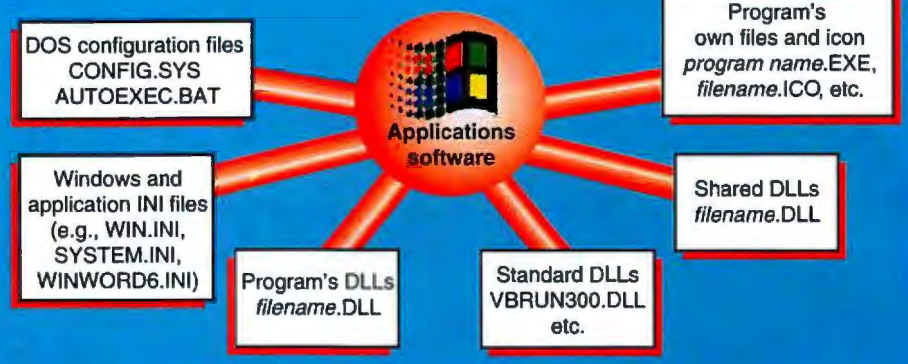
UnInstaller also has a Move option that lets you map an entire Windows application to a different drive on your PC. It sounds simple, but this is difficult to do manually. This option is handy if you add a second hard drive or a removable hard drive.

The features that set UnInstaller apart from its competitors are its Archive and Transport functions. Archive is similar to the backup options found in other uninstallers, but with a crucial difference (UnInstaller also has its own standard backup option). Archive creates a compressed backup of all the parts of an application, which you can store on any drive in your system. What makes it unique is that a dummy application icon (with bars over it) remains on your Windows desktop. If you ever need the application, just double-click, and it's automatically uncompressed and started. But when you're not using it, the application takes less space.

Transport lets you move an entire Windows application to a different computer. This is perfect when you have a portable computer and want to easily transport your most-used applications. Transport creates compressed floppy disks that you use on another PC. (You'll need UnInstaller 3.0 on the other system as well.) Transport is effective for applications that rely on your own data. For example, we transported cc:Mail Remote from a desktop to a portable computer, complete with custom mailing lists and a large database of messages. (One caveat: To make it legal, you'll need to purchase additional licenses for most applications used on more than one PC.)

Finally, one thought-

Cutting an Application's Tentacles

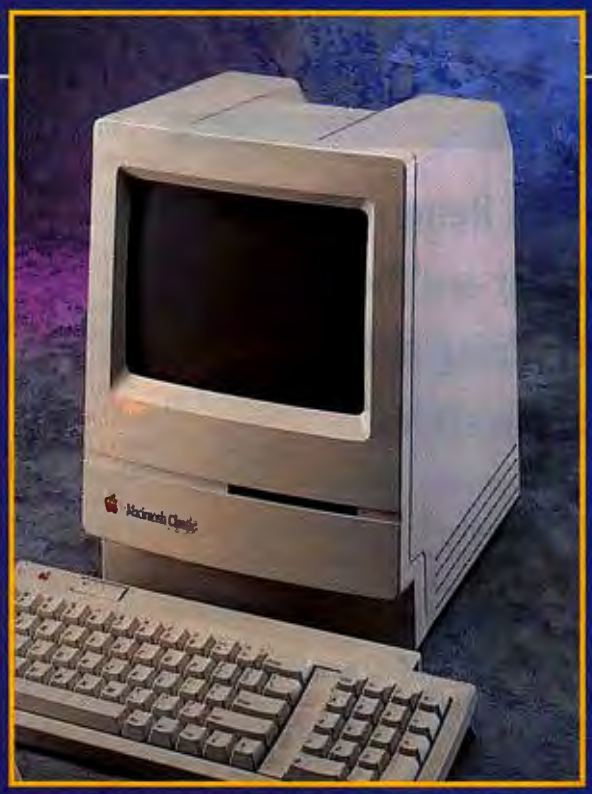


Ill-behaved Windows applications litter files all over the place and change existing files. A good uninstall program must find modifications and restore your Windows environment. Removing shared DLLs and failing to restore Windows initialization files are common mishaps. Uninstall programs prompt you before deleting or modifying such files.

COMPARING UNINSTALLER FEATURES

	CLEANSWEEP	REMOVE-IT	UNINSTALLER	UNINSTALL-IT	WINDELETE	WINFORMANT
Performs trial runs	●	○	●	○	○	○
Estimates recovered space	●	○	●	●	¹	○
Deletes INI files	●	●	●	●	●	●
Removes unused fonts, drivers, and system files	●	●	●	○	○	○
Archives applications	●	●	●	●	○	○
Restores deleted files	●	●	●	●	○	○
Finds duplicate files	●	●	●	●	○	○
Allows moving applications	○	○	●	●	○	○
Allows transporting of applications to another PC	○	○	●	○	○	○
Generates reports	●	●	●	●	○	○
Offers integrated application database	●	○	●	○	○	○
Watches subsequent installs	●	●	●	○	●	○
Provides integrated installation utility	○	○	●	○	●	○
Creates emergency boot disk	○	●	○	○	○	○
Uninstalls over network	●	○	●	○	○	○
Uninstalls itself	●	●	●	●	●	○
Offers password access	○	○	●	○	○	○

¹ Provides estimates only for individual files.
● = yes; ○ = no



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ful feature that none of the other products offer is optional password access. If your PC is used by novice users, placing a password on UnInstaller can eliminate all sorts of trouble.

● Uninstall-it

Landmark's Uninstall-it is one of the simplest uninstallers. It takes a conservative approach and doesn't use any TSRs or special INI settings to track subsequent installations of Windows applications.

The fact that it's simple doesn't mean it lacks features. Uninstall-it lets you back up and move applications to other drives and predicts how much space you'll save. It also finds duplicate and unused ("stray") applications. The user interface is simple and uncluttered. If you want an easy-to-use and painless installer, Uninstall-it is a good choice.

● WinDelete

IMSI's WinDelete is another uninstaller that takes a simple, direct, and conservative approach to removing Windows applications. Like Uninstall-it, it doesn't use TSRs or special INI settings. Its user interface is one of the simplest of the lot, with just a handful of icons and few choices to make. Testing showed it to be the most conservative of the group. Unless you tell it otherwise with multiple mouse-clicks, it removes only the files that it's sure of.

WinDelete is best used as an "after the fact" uninstaller. One of its icons is an Install Applications choice. Like the feature found in several of the other packages, WinDelete creates its own detailed database of the details of an application's installation, as long as you install it through WinDelete.

CleanSweep, Remove-It, and UnInstaller are the most effective at wiping out all traces of applications.

WinDelete lacks most of the advanced features of its competitors. Many of them aren't crucial, but one serious drawback is the lack of trial run, backup, and reinstall options. Once you remove an application with WinDelete, it's gone for good. The only way to get it back is by alternative methods (e.g., a tape backup).

● Winformant Professional

In many ways, Neocom's Winformant Professional holds a unique position among the packages reviewed here. It takes the middle ground between the conservative and aggressive approaches. However, it lacks backup and archive options, doesn't use TSRs or special INI settings, and doesn't create its own database of details as you install new Windows applications. Winformant is actually a minisuite of utilities, including a sophisticated file-search utility. Also included is a Windows swap file checker/editor, a sophisticated INI file editor, and a handy little utility named Eject. Clicking the icon (which looks like the ejection-seat handle on a jet fighter) immediately exits Windows without further prompts.

Winformant is obviously designed for experienced Windows users, because most of its utilities will be of little use to novices. That fact is underlined by its middle-of-the-road approach to uninstalling applications, along with the lack of backup capabilities.

The package does, however, suffer from a couple of idiosyncrasies. It's the only one of the uninstallers covered here that can't uninstall itself. To remove it from our test PC, we had to use one of the other uninstallers. In addition, there's a warning buried in its readme file that cautions you to turn off write-behind caching if you're using MS-DOS SmartDrive disk caching. This is worrisome and unacceptable, because failing to disable write-behind caching could cause data loss when you're using the package.

Making Choices

The state of Windows uninstallers proves that competition ultimately benefits us all. The heavy competition among makers has generated capable packages with cutting-edge technology. And the price has fallen, too. Even though list prices of the packages vary from $50 to $80, they're available on the street for $40 to $50. That's an unbeatable deal for an essential utility that belongs on every PC.

Packages that use cutting-edge technology are generally the most aggressive. CleanSweep, Remove-It, and UnInstaller are sophisticated, and they're the most effective at wiping out all traces of applications. But they're still not perfect. More conservative packages—such as Uninstall-it, WinDelete, and Winformant—don't free as much space, and they lack the bells and whistles of the other packages. But they're still good choices if you want simple yet effective utilities.

We believe MicroHelp has the best overall solution. With its SmartLinks, Setup Monitor, Move option, Archive and Transport features, and password protection, we give UnInstaller a green thumbs up. ■

Stan Miastkowski is a BYTE consulting editor who's been writing about computer technology for 17 years. He's coauthor of the Windows for Workgroups Bible *(Addison-Wesley, 1993). You can contact him on the Internet or BIX at stanm@bix.com.*

Product Information

CleanSweep 1.0...$59.95
Quarterdeck Office Systems, Inc.
Santa Monica, CA
(800) 354-4757
(310) 392-9851
fax: (310) 314-4217
Circle 977 on Inquiry Card.

Remove-It 1.0...$69.95
Vertisoft Systems, Inc.
(800) 466-5875
(415) 956-5999
fax: (415) 956-5355
Circle 978 on Inquiry Card.

Uninstaller 3.0...$79.95
MicroHelp, Inc.
Marietta, GA
(800) 775-8645
(404) 516-0899
fax: (404) 516-1099
Circle 979 on Inquiry Card.

Uninstall-It 1.03...$69.95
Landmark Research International Corp.
Clearwater, FL
(800) 683-6696
(813) 443-1331
fax: (813) 443-6603
Circle 980 on Inquiry Card.

WinDelete 1.0a...$49.95
IMSI
San Rafael, CA
(800) 833-8082
(415) 257-3000
fax: (415) 257-3565
Circle 981 on Inquiry Card.

Winformant Professional 1.0...$49.95
Neocom Microspecialists, Inc.
Martinsville, VA
(703) 666-9533
fax: (703) 666-9534
Circle 982 on Inquiry Card.

Short-Order Internet Access

Netra and Instant Internet connect LANs to the Internet

BEN SMITH

It's a simple problem: You want Internet access for your LAN. The solution, too, can be straightforward. Drop a turnkey box on your LAN and plug in to the world. But when vendors with divergent viewpoints start marketing Internet products, you can end up with very different solutions to the same problem. Performance Technology's Instant Internet and Sun Microsystems' Netra Internet Server, for example, are both dedicated systems that connect your LAN to the Internet. The two products even look similar—pizza boxes with communications ports and no keyboard or monitor—but that's where the similarity ends.

Netra Internet Server (Netra i for short) is a SparcStation running Solaris (Sun's Unix); Instant Internet is a 486SX-based system running a proprietary NOS (network operating system). Netra i delivers Internet access to any LAN workstation with a TCP/IP stack; Instant Internet works only for PCs running IPX/SPX protocol and Microsoft Windows. These basic differences mirror the two companies' interpretations of both how Internet services should be provided and what constitutes a typical LAN.

Sun doesn't expect you to configure and maintain your Netra. You buy Netra through a qualified Sun reseller, who delivers the necessary support and additional software that your installation may require, such as firewall software for Netra, TCP/IP stacks for LAN clients, and Internet browsing software.

This is just as well, given the difficulty and complexity involved in installing Netra, particularly on something like the PPP-, modem-based Internet connection that we required at BYTE. The reseller shields you from Netra's complexity, creating the impression of instant installation. Of course, the price of a Netra installation increases to reflect what the reseller adds to the product.

By contrast, you buy Instant Internet directly from a dealer and install it yourself. Although it supports only Windows systems, it does provide some security, a few Internet tools, and easy installation—almost plug-and-go.

Sun's Netra Internet Server (bottom) and Performance Technology's Instant Internet are single-box solutions for LAN Internet access.

AL KAREVY © 1995

What's Your LAN?

To Sun, a LAN is a network of workstations that use the TCP/IP protocol. After all, Sun systems are the most common TCP/IP network clients and servers in the world, and the Internet is primarily a network of TCP/IP subnetworks and servers.

As for Internet clients that don't run Unix, Apple Macintosh computers can use TCP/IP, although they traditionally use AppleTalk and EtherTalk. Windows- and DOS-based PCs can use TCP/IP, although they more commonly use Novell NetWare's IPX. Even Digital Equipment's VMS systems and IBM mainframes can speak TCP/IP in addition to their proprietary network protocols. The Internet client programs—gopher, FTP, Telnet, and WWW (World Wide Web) browsers—are all thought of as TCP/IP programs (although, in fact, they only require sockets services, a higher layer in the protocol stack). Therefore, it would seem that Sun's assumption that all LANs can use TCP/IP is a safe one.

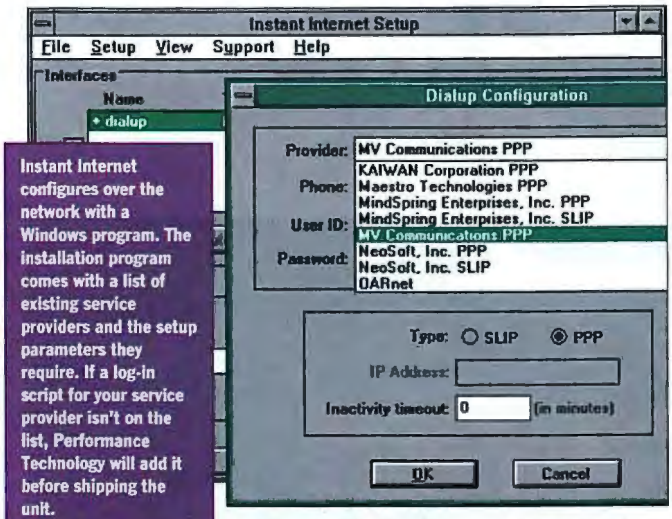
In reality, the most common LAN consists of Microsoft-based PCs connected through NetWare and speaking IPX. For these client workstations, TCP/IP is a second protocol stack that you must install and manage. Installation might be fairly trivial, but management can be a burden, especially in a large organization.

This is the view that Performance Technology takes. Its Instant Internet uses IPX to provide TCP/IP services to the LAN. Instant Internet is a Windows-only provider of Internet services. Macs and VMS-based systems gain nothing from it. Also, pure DOS-based PCs can't use it, because the client applications require WinSock services. Nonetheless, Instant Internet provides an easy solution for most Internet clients.

Performance Technology is not alone in providing low maintenance TCP/IP services to IPX LANs. FireFox and Novell also ship TCP/IP, but through NLMs (NetWare loadable modules) that run on a NetWare server. The Instant Internet box is its own server and runs independently of NetWare servers.

Access Servers

Instant Internet and Netra are not Internet servers in the expected sense, because they don't provide services to the world Internet. Instead, they provide Internet access



Instant Internet configures over the network with a Windows program. The installation program comes with a list of existing service providers and the setup parameters they require. If a log-in script for your service provider isn't on the list, Performance Technology will add it before shipping the unit.

services to the LAN, acting as bridges between a LAN and the Internet.

Instant Internet provides nothing more than TCP/IP to an IPX LAN (and also to Performance Technology's own PowerLAN peer-to-peer network). It connects to the IPX network through its internal Ethernet transceiver (which is built into its 33-MHz 486SX motherboard) and out to the Internet through either a router on the LAN or a SLIP/PPP connection using its internal U.S. Robotics V.34 modem. Instant Internet doesn't run any other network services, such as E-mail queuing, Internet Usenet news transfers and services, or other Internet server demon processes.

Sun's Netra i does not provide TCP/IP-to-IPX gateway services, but it does include programs for Internet E-mail and Usenet news. E-mail runs on even the simplest Netra configuration, but Usenet news requires much more disk space than the low-end version of Netra provides (535 MB). We tested a Netra i configuration with an 85-MHz MicroSparc II processor, 32 MB of RAM, and a 1.05-GB hard drive—basically a SparcStation 5 without a keyboard or monitor. All Netra i models come with floppy and CD-ROM drives but no modem. Netra can run other Internet services, such as gopher and WWW server demons, but as value-added options that your Unix system administrator or the Sun reseller installs.

Instant Installation

We installed Instant Internet as a PPP-TCP/IP server for BYTE's PC LAN. We plugged a 10Base-T wire into the unit's Ethernet port, a phone line into the internal modem, and the power cable into a wall outlet. Instant Internet has no keyboard or screen, and it boots from an internal (and inaccessible) floppy drive. Four LEDs provide status information. We configured it running the bundled Windows software from a NetWare workstation.

Installation and configuration (including putting the client software in a shared NetWare directory) took about 10 minutes. You don't need knowledge of TCP/IP, Unix, or IPX. You just install a Windows application and copy files onto a NetWare server. Performance Technology had already requested log-in script information from us and from our Internet service provider (MV Communications, Litchfield, NH), created and tested the log-in script, and included it on the configuration floppy disk, along with the scripts for over 100 other service providers.

Each workstation must run an installation program to set up the special WinSock that makes Instant Internet work. Although existing WinSock applications can immediately use the WinSock, Performance

Cyberspace Proxies

When you connect your company to the Internet, you may well be extending your corporate LAN—and all its confidential information—to an electronic world full of hackers, spies, and saboteurs. Before plugging in, make sure you're protected (see "Barricading the Net," April BYTE).

One effective approach lies in not letting the Internet see your network. One method of achieving this—and still maintaining Internet access for your users—is a *proxy server*, a system or process that hides the location of the real client applications by handling Internet communications in place of the clients. Acting as an intermediary, it is both a server to the real client and a client to the real application server. An example will help illustrate a proxy's role.

A popular Internet-based client/server application is WWW (World Wide Web) browsing. The client is the WWW browser residing on your workstation. The server is some unknown process somewhere out in cyberspace. All that is known about the WWW server is that it has a valid URL (uniform resource locator), such as `http://happy.hacker.org`, for example, and that it can carry on the protocol responsibilities of HTTP.

If you connect directly to the Internet through a router, the server immediately knows your IP address, and it may be able to gain greater control over it. But if an intermediate process (the proxy) on a secure system is acting as the client, the server will see only the proxy server. Typically, the proxy server is the only address the Internet can see. The protected LAN hides behind that one address, usually in a separate network domain.

Unfortunately, ordinary client software won't work in such a scheme. You need versions that can talk through a proxy rather than directly to the server. The Netscape WWW browser is a good example. It can talk directly to a server, but it also has options for talking to various proxy agents.

Sun's Netra can run proxy services, although this is one of the elements the VAR must add. Because Instant Internet acts as an TCP/IP-to-IPX gateway, it is by nature a proxy server for the TCP/IP sessions of its clients. The outside world sees only the Instant Internet unit; all transactions with the outside world are connected to its single IP address. The NetWare PC clients don't need IP addresses because they can carry on a sockets connection to the outside world through the guise of Instant Internet.

Proxy servers are only one wall of protection. Firewalls (e.g., CheckPoint Software Technologies' FireWall-1, optional for Netra) are another. If you are really concerned about security, your Internet access plan might include both an Instant Internet, for the convenient Internet access it allows IPX clients, and a Netra running a firewall and proxy agent processes for maximum security.

Compare: Simple vs. Flexible

Instant Internet	Netra Internet Server
• User-installable	• VAR installs
• IPX/SPX clients running Windows only	• Any TCP/IP client
• No client TCP/IP required	• Requires TCP/IP on client
• $3495	• $6149 (plus substantial VAR costs)
• Moderately secure through isolation	• FireWall-1 optional, but secure
• Client browsing software	• Internet E-mail and Usenet news software

Instant Internet is simpler to install and less costly for smaller installations but works only with NetWare Windows clients. Since it has more flexibility, Netra is a better foundation for larger installations that don't have Unix expertise.

Technology includes an FTP and Telnet client, Gopher, NewsReader, and mail client, as well as a WWW browser.

Within 30 minutes of taking Instant Internet out of the shipping box, we had happy PC users surfing the Internet. Since that time, the only necessary administration has been to change the PPP activity time-out to zero so that the PPP link on BYTE's dedicated dial-up connection remains up continuously. Offices that have time-metered Internet access would do better with a time-out setting of several minutes.

Netra Experience

There is no "instant Internet" for Sun's Netra without the setup, software services, and support provided by a VAR. There are good reasons for this. One is that Netra configuration requires experience with Unix system administration, and more important, with Netra's cryptic configuration software. Another is that Netra Internet Server, as supplied by Sun, doesn't include much more than E-mail and Usenet news capabilities.

We spent a good deal of time and effort attempting to install Netra ourselves, without help from Sun and without the benefit of the training and experience a Netra reseller would have. The reseller would normally handle most of the difficulties we encountered, thus probably saving the customer from grief. We eventually resorted to several visits from Sun technical people, who demonstrated the normal reseller installation procedure and provided several critical bug patches.

Our test Netra worked but wouldn't hold a permanent PPP connection, despite the administrative hack of periodically forcing activity across the PPP connection. Nor would it reestablish connection after it disconnected from the service provider. This is a problem that Sun and the reseller would work out for the customer, but we ran out of time. So, we finally installed Netra to work through a router; that's a much easier configuration process.

When you receive Netra from the Sun reseller, it comes with a tailor-made configuration floppy disk. As with Instant Internet, you only need to plug it in to your network, connect a modem, insert the disk, and turn it on. There is no need for an external workstation, keyboard, or screen, since voice clips played through the internal speaker inform you of the success of the Netra's boot sequence. (However, the voice clips don't give diagnostics if Netra isn't properly configured.)

Different Needs

For plugging a NetWare LAN of Windows-based PCs into the Internet, Instant Internet is a good fit. It requires only a single IP address routed through the Internet service provider. Because it achieves its TCP/IP through a proprietary protocol carried by IPX communications, Instant Internet offers a natural barrier to intruders. You can maintain other IP domains on the same Ethernet; if you don't route these other IP subnetworks out to the Internet, there is little need for a firewall to protect them. At the same time, IPX-connected PCs have full access to the outside world.

Instant Internet provides Internet connectivity for most, but not all, systems at BYTE, as it would for many other businesses. It is far simpler and less expensive than providing individual dial-up IP accounts and high-speed modems for each workstation. Instant Internet with a single-LAN license sells for $3495.

Sun's Netra, because it is completely TCP/IP based, can meet all the needs of an entire heterogeneous LAN. However, one could argue that Netra, as it is supplied to the VAR, doesn't provide any value beyond that available from any other Unix server: Unix E-mail and Usenet news. What Netra does provide is a foundation on which a VAR can build the Internet access and security services your organization requires, and the price will rise accordingly.

As a result, a Netra installation will easily cost you upwards of $10,000 because you are paying for a Sun workstation plus what the reseller adds. You should budget for software (OS and application) support from the reseller as well. If you already have Unix systems administration expertise, you might consider the less expensive alternative of buying a PC and installing BSDI Unix. Or, if all you need is PPP connectivity for your LAN, consider something such as a Telebit Netblazer.

The differences between Sun's Netra and Performance Technology's Instant Internet boil down to your network environment. If all you need is an inexpensive shared connection to the Internet for Windows PCs on a NetWare LAN, Instant Internet is a simple, effective solution. If, on the other hand, you want a Unix-based Internet server for your TCP/IP network, but you don't want to hire Unix experts to manage it, then invest in a Netra with custom installation and a maintenance contract from a Sun VAR. ■

Product Information

Instant Internet.....$3495
(single LAN license)
Performance Technology
San Antonio, TX 78230
(800) 784-4638
(210) 979-2000
fax: (210) 979-2002
info@instant.net
Circle 1062 on Inquiry Card.

Netra Internet Server
70-MHz MicroSparc II, 16 MB RAM, 535-MB hard drive.....$6149
85-MHz MicroSparc II, 32 MB RAM, 1.05-GB hard drive.....$8499
60-MHz SuperSparc, 32 MB RAM, 1.05-GB hard drive.....$13,199
(VAR prices, before services added)
Sun Microsystems
Mountain View, CA 94043
(800) 821-4643
(415) 960-1300
fax: (415) 969-9131
Circle 1063 on Inquiry Card.

Ben Smith is an Internet consultant, a former BYTE testing editor, and the author of Unix Step-by-Step *(Hayden Books, 1990). You can reach him on BIX as "bensmith" or on the Internet at ben@ronin.com.*

Windows to the Internet

They may be friendlier than Unix shell accounts, but these five front ends have some rough edges and problems handling quirky connections

SCOTT HIGGS

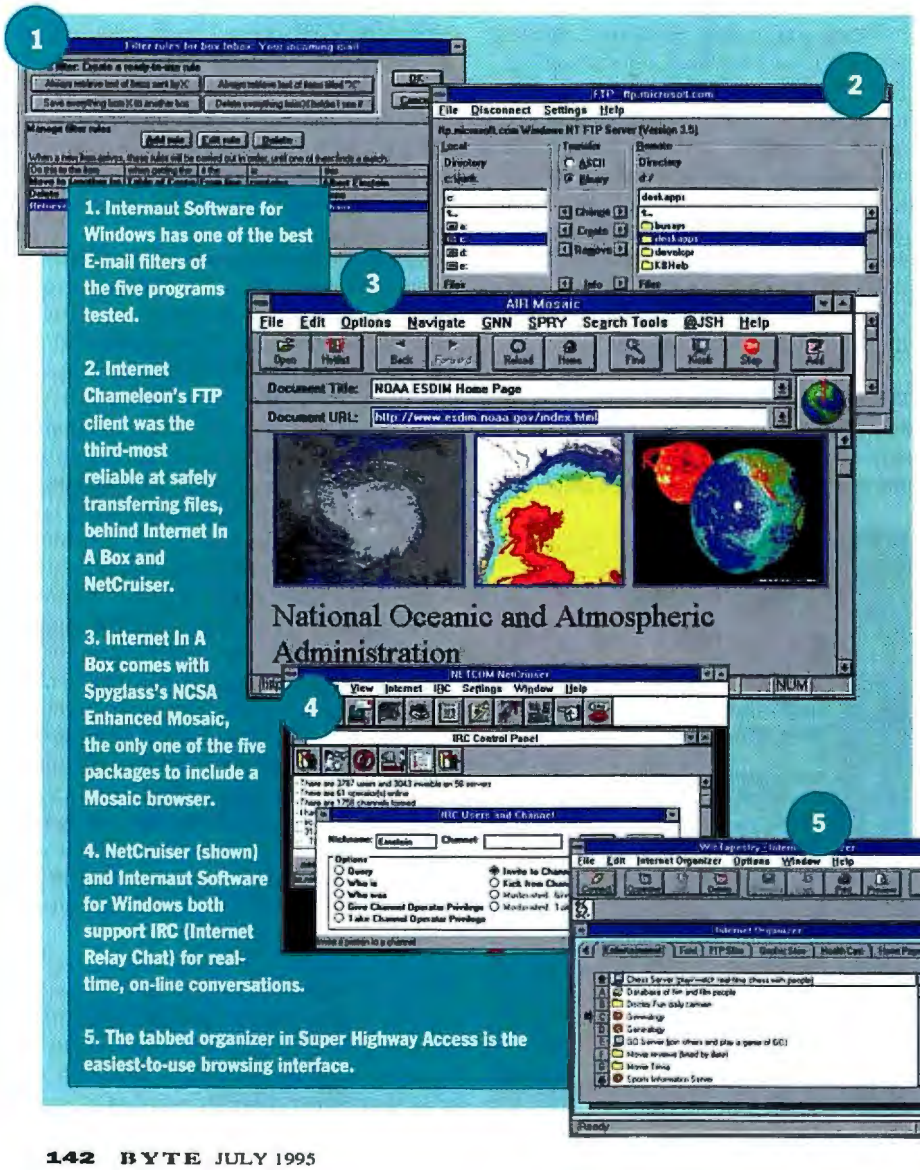
Why, when some of the most popular Internet access programs are free, would anyone want to pay for one? The answer lies in the generally superior integration offered by the five commercial programs included in this month's roundup.

Each program follows one of two completely different interface strategies. Spry's Internet In A Box, Net Manage's Internet Chameleon, and Frontier Technologies' Super Highway Access are really collections of applications that must be run individually to perform routine Internet procedures. This modular approach reflects the Unix heritage of Internet use.

Netcom's NetCruiser and PSINet/Pipeline's Internaut Software for Windows, by comparison, present integrated interfaces, with all program functions accessible from the main menu. Modular programs demand awkward maneuvering; it's a bit like running a word processor that requires separate modules for block editing and printing. The integrated interfaces, however, limit you to specific service providers: PSINet/Pipeline for Internaut Software for Windows and Netcom for NetCruiser.

NSTL selected packages that include a full set of tools for all standard Internet functions, including dialers and scripts for establishing connections. All the programs run under Microsoft Windows and include support for Web browsing (with and without graphics), E-mail (with full-screen editing), newsreaders, and FTP, Gopher, and Telnet connections.

With the explosion of interest in Internet access, many vendors market products that provide some, but not all, of the functions in the reviewed packages. You are likely to have heard about Netscape, Mosaic, the Internet Membership Kit, and several others, as well as Web access through Prodigy. In most cases, these products offer a significant subset of the tools needed for dial-up Internet access, but they leave gaps.



1. Internaut Software for Windows has one of the best E-mail filters of the five programs tested.

2. Internet Chameleon's FTP client was the third-most reliable at safely transferring files, behind Internet In A Box and NetCruiser.

3. Internet In A Box comes with Spyglass's NCSA Enhanced Mosaic, the only one of the five packages to include a Mosaic browser.

4. NetCruiser (shown) and Internaut Software for Windows both support IRC (Internet Relay Chat) for real-time, on-line conversations.

5. The tabbed organizer in Super Highway Access is the easiest-to-use browsing interface.

Look, Ma, No Hands

If you're one of the few people who still read manuals, you might be disappointed in these products. Internaut Software for Windows offers no manual, and the "free" version of NetCruiser ($25 start-up fee, plus $19.95 per month for connect time) comes without documentation (a $49.95 retail version comes with two books). Even for the modular programs, most manuals offer help primarily with installation and configuration, not with general program procedures.

We had trouble learning some procedures but generally made good headway through trial and error. NetCruiser and Internet In A Box were the easiest to learn overall. The help screens in Internet Chameleon and Internaut Software for Windows were—well—unhelpful. Super Highway Access offers the best help of the five programs, but you'll need more help to learn it—a trade-off of sorts.

Cruising Speed

The helpful features that make programs easy to learn sometimes bog down experienced Internet surfers. NetCruiser, while easy to use overall, offers an awkward metaphor

Highlights

	Strengths	Limitations
Internaut Software for Windows	Filters news articles by subject or sender Includes Finger utility Program elements integrated in a single interface	Cannot save Web page to disk Slow performance Allows accidental file overwriting with FTP
Internet Chameleon	Built-in uuencode/decode utility ISDN support Fastest program overall	No text searching in Web pages or article headers Cannot search mail headers by sender or subject Program elements scattered in subapplications
Internet In A Box	Text searching in pages and headers Built-in uuencode/decode utility Custom keyboard remapping and macros	No Finger utility Program elements scattered in subapplications
NetCruiser	Text searching in Web pages Program elements integrated in a single interface Top-rated for usability	No text searching in headers Must be on-line to read or compose mail Minimal connection diagnostics
Super Highway Access	Supports MIME mail attachments Can limit distribution scope when posting to newsgroups Can search mail headers by sender or subject	Limited news searching and sorting Allows accidental file overwriting with FTP Program elements scattered in subapplications

for Gopher and FTP access. Once you mark files for downloading, NetCruiser assumes that the primary factor in choosing a server is its geographic location and presents a map for selecting a site. Although such an approach encourages considerate use of Internet bandwidth, it isn't convenient for routine use.

Internaut Software for Windows, the other integrated program, creates a new window for each step you take, quickly cluttering your desktop with inactive windows. The clutter is distracting and inefficient, and it gets worse. You can't even resize the windows, making it that much harder to organize your work space.

Among the modular programs, fewer idiosyncrasies appear, although all would be more usable if they had integrated interfaces. Super Highway Access suffers from a mild variation of the problem Internaut Software for Windows has: In many circumstances, windows are inappropriately sized, obscuring key information. We also weren't thrilled by the lack of information provided by Internet Chameleon during Web downloads. Internet In A Box merits guarded praise: It succeeds better than the other modular programs in providing useful shortcuts and keeping relevant functions at your fingertips.

Overall, despite faults in FTP and Gopher, we recommend NetCruiser as the best choice to get up and running quickly and easily. Among the more capable modular programs, Internet In A Box stands out for its combination of clean interface and logical structure. We regard it as the easiest full-featured program to work with on a daily basis.

Web Browsing

Although the programs share most basic features, they vary considerably in the breadth and depth of individual modules. Some mail modules include extensive sorting and filtering capabilities, and others include utilities for handling binary file attachments. Some newsreaders include a full array of saving, posting, and updating options; others offer only the most basic choices.

Excitement about the WWW (World Wide Web) has been a major factor in public interest in the Internet. All these programs support Web navigation aids, graphics viewing options, and automatic caching to speed access. Every program also allows some customization of Web page displays and adapts to handle Gopher and FTP servers.

Internet In A Box and NetCruiser can search a page for text and provide useful status information during downloading. Along with Super Highway Access, these programs feature built-in support for more graphics formats than are supported by Internaut Software for Windows and Internet Chameleon.

Only Internet In A Box and Internet Chameleon let you print a Web page, although Internaut Software for Windows has a crude print-screen option. All the programs except Internaut Software for Windows let you save a page to disk for later importing into other applications.

continued

OVERVIEW

NSTL RATING		VERSION	PERFORMANCE	VERSATILITY	EASE OF USE	EASE OF LEARNING	ERROR HANDLING	PRICE
★★★★	Internet In A Box	1.0	▲	▲	▲	▲	▲	$99*
★★★	Internet Chameleon	4.1	▲	▲	▲	▲	▲	$199
★★★	NetCruiser	1.5	▲	▲	■	▲	▲	$44.95*
★★★	Super Highway Access	4.0	▲	■	■	▲	▲	$125*
★★	Internaut Software for Windows	2.0.7	▼	■	▲	▲	▲	$15–35**

KEY

★★★★★ Outstanding
★★★★ Excellent
★★★ Average
★★ Below average
★ Poor

▲ Good
■ Fair
▼ Unacceptable

*Includes first monthly service fee of $19.95. **Free with subscription to PSINet; monthly plan ranges from $15 to $35.

BROWSING AND MAIL FEATURES

	INTERNAUT	INTERNET CHAMELEON	INTERNET IN A BOX	NETCRUISER	SUPER HIGHWAY ACCESS
WEB BROWSER					
Shows history and go-to selection	●	●	●	●	●
Saves addresses of favorite sites	●	●	●	●	●
Toggles graphics on and off	●	●	●	●	●
Saves Web page to disk	○	●	●	●	●
Refreshes from network	●	●	●	●	○
Searches page for text	○	○	●	●	○
Establishes FTP link within browser	●	●	●	●	●
Establishes Gopher link within browser	●	●	●	●	●
Establishes Telnet link within browser	●	●	●	[1]	●
Saves multiple custom style schemes	[1]	●	○	○	○
Graphics viewer supports GIF	●	●	●	●	●
Graphics viewer supports JPEG	[1]	○	●	●	●
Graphics viewer supports MPEG	○	○	○	○	○
Prints Web page	●	●	●	○	○
MAIL					
Supports SMTP	●	●	●	●	●
Supports POP2 and POP3 standards	[2]	●	●	[2]	●
Supports MIME	[1]	●	[1]	○	●
Notifies user when mail arrives	●	●	●	○	●
Reads and composes mail off-line	●	●	●	○	●
Attaches signature automatically	●	●	●	●	●
Sorts by sender, date, or subject	●	●	●	○	●
Searches for sender or subject text	●	○	●	○	●
Saves message as user-defined file	●	●	●	○	●
Saves messages as a single text file	●	●	●	○	○
Creates address book	●	●	●	●	●
Allows mailing lists with aliases	●	●	●	○	●
Has built-in uuencoder	●	●	●	○	○
Has built-in uudecoder	●	●	●	○	○
File, forward, or delete based on source	●	●	○	○	●
File, forward, or delete based on subject	●	●	○	○	●
NEWSGROUP SUPPORT					
Provides newsgroup browser	●	●	●	●	●
Allows subscribe/unsubscribe	●	●	●	●	●
Allows multiple groups of newsgroups	●	○	●	○	●
Sorts articles by subject, sender, or date	●	●	●	●	○
Searches article headers for text	●	○	●	○	○
Marks groups of messages as read	●	●	○	○	●
Flags read messages to retain	●	●	○	○	●
Saves message to user-specified file	●	●	●	○	●
Selects a group of messages to save	●	●	●	○	●
Saves multiple messages to a single file	●	●	●	○	●
Posting automatically adds header	●	●	●	●	●
Can limit distribution during posting	○	○	●	○	●
Has built-in uuencoder	[1]	●	●	○	○
Has built-in uudecoder	[1]	●	●	○	○
SEARCH TOOLS					
Graphical Archie	●	●	●	●	●
Direct FTP support from Archie	●	●	●	○	○
Graphical Veronica	●	●	●	●	●
Graphical WAIS	●	●	●	●	●
Finger	●	●	○	●	[1]
WHOIS	●	●	○	●	[1]

● = yes; ○ = no
[1] Vendor plans to add feature by mid-1995.
[2] Supports only POP3 (Post Office Protocol 3).

Uneven E-Mail

Of the key program elements, E-mail receives the most uneven support. All the programs provide full-screen editing, create reply headers, and can attach a signature automatically to messages. Handling of incoming mail, attached files, and address books varies considerably.

Internet Chameleon, Internaut Software for Windows, and Super Highway Access have the best features for handling this flow, letting you establish rules for forwarding, deleting, and filing messages based on predetermined criteria. All the programs except NetCruiser at least permit easy sorting of headers. Only Internet In A Box, Internaut Software for Windows, and Super Highway Access let you search for specified text.

Support for file attachments also varies widely. Only Internet Chameleon and Super Highway Access support MIME (Multipurpose Internet Mail Extensions) for attaching binary files (e.g., executable files, spreadsheets, and graphics) to messages, although other vendors plan to add such support soon.

In the meantime, the classic workaround for this challenge has been to convert binary files into ASCII text. The resulting data looks like gibberish, but it can be sent as a text message and then translated into its original form by the message recipient. Internet Chameleon, Internet In A Box, and Internaut Software for Windows offer built-in encoding and decoding of binary files. NetCruiser provides neither MIME nor encoding functions. It further compounds mediocre handling of incoming mail with a lack of support for attachments as well as weak addressing.

Newsreaders

With any of these programs, you can access Usenet newsgroups when connected to an appropriate server. Internaut Software for Windows provides the most impressive help with managing newsgroups. Its newsreader module can automatically download, refile, or delete articles based on date, subject, sender, or length before you even look at the list of titles.

The other programs would do well to imitate this feature. On an ad hoc basis, both Internet In A Box and Internaut Software for Windows let you search for text in article headers to identify messages of interest. The remaining programs offer limited functions for managing the volume of articles, although all (with the exception of Super Highway Access) let you sort titles by subject, sender, or date. *continued*

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CONNECTION PROTOCOLS AND UTILITIES

	INTERNAUT	INTERNET CHAMELEON	INTERNET IN A BOX	NETCRUISER	SUPER HIGHWAY ACCESS
FTP					
Saves addresses and log-in profiles	● [1]	●	●	○	●
Shows file dates, sizes on remote host	● [2]	●	●	●	●
Views remote file	●	●	●	●	●
Marks group of files to download	●	●	●	●	●
Allows multiple simultaneous FTP sessions	●	○	●	●	●
Aborts FTP transfer, keeps connection	●	●	●	○	●
GOPHER					
Saves addresses of favorite sites	●	●	●	●	●
Retries access at specified intervals	○	○	●	○	○
Automatically caches menu pages	○	●	○	●	●
Saves page to disk	○	●	●	●	○
TELNET					
Saves Telnet addresses and log-in profiles	● [1]	●	●	○	● [1]
Provides scroll-back buffer	●	●	●	●	●
Provides custom keyboard remapping	○	●	●	○	○
Provides custom keyboard macros	○	●	●	○	○
PROTOCOLS AND CONFIGURATION					
Offers Winsock compatibility	●	●	●	●	●
Supports SLIP	●	●	●	○	●
Supports CSLIP	●	●	●	●	●
Supports PPP	●	●	●	○	●
Supports ISDN	○	●	○	○	○
Handles dynamic IP addressing	○	●	●	●	●
Supports BOOTP address protocol	○	●	●	○	●
Supports MHS mail services	○	○	○	○	○
Complies with MAPI mail standards	○	○	○	○	○
Allows user-set time-outs	●	○	●	○	●
Allows log-in scripting	●	●	●	●	●
Allows saving of multiple profiles	○	●	●	○	●
UTILITIES					
Tallies on-line time	●	○	●	●	●
Estimates time required for download	○	○	○	○	○
Provides Ping utility (to test connection)	●	●	○	○	●
Allows user-specified Ping settings	○	●	○	○	●
Supports IRC for real-time conversations	●	○	○	●	○
Offers troubleshooting log of "raw" messages	○	●	●	○	●
Offers connection diagnostics and statistics	●	●	●	○	●

● = yes; ○ = no
[1] Saves Internet address only.
[2] Displays size only.

NetCruiser's newsreader is by far the weakest of the group. As with the program's E-mail module, there's no option to name files saved to disk, so you must hunt for the saved text after exiting the program. And NetCruiser won't let you remove previously read articles from the title list.

Because of the wide range of system types used to store and read newsgroups, almost all binary file attachments to news articles are encoded into ASCII form. Internet In A Box and Internet Chameleon are the only programs that include the necessary utility programs to encode and decode such attachments.

FTP Functions

FTP functions let you transfer files from any corner of the world to a local computer in a remarkably short time. The magical Unix FTP commands can be baffling, but most of the reviewed programs design FTP functions along the lines of the Windows File Manager—with hierarchical listings of files and directories and point-and-click directory changes.

The file transfer process does not entail much interaction. Reaching the remote host and locating desired files can be more challenging, and it sometimes works better when a few basic file-manipulation capabilities are built into the process.

With varying degrees of difficulty, you can use any of these products to search Archie listings to locate desired files. Once the site has been located and the connection made, Internet In A Box, Internet Chameleon, and Super Highway Access let you save the address, log-in, and profile information for future use, which can save time in future sessions. Internaut Software for Windows saves only the address of the remote host.

Assorted Tools

All the programs handle Gopher and Telnet sessions with relatively little variation in their capabilities. Internet Chameleon and Internet In A Box provide custom keyboard remapping and macros to save time for users who run frequent Telnet sessions. Internet Chameleon also offers more terminal emulations than the other programs to accommodate different types of Telnet hosts.

Three handy capabilities offered by some programs make it easier to connect with other Internet users. Internet Chameleon, NetCruiser, and Internaut Software for Windows offer the Finger program, which identifies users on other systems. Internaut Software for Windows and NetCruiser provide easy access to IRC (Internet Relay Chat), a utility that lets users "talk" with each other across the Internet. To determine whether a connection to another Internet site is "live," Super Highway Access, Internaut Software for Windows, and Internet Chameleon include the Ping utility, which sends a standard signal across the Internet that is echoed by the remote site if the connection is good. Such utilities can be invaluable when troubleshooting connection problems.

Sorting Out Features

The feature tables on pages 144 and 146 provide a detailed breakdown of the relative strengths and weaknesses of each program. Overall, Internet Chameleon is unmatched for sheer depth of features, although many of these (e.g., extensive terminal emulations and protocol support) won't matter to most users.

Internet In A Box provides the richest functionality in modules that see regular use: Web browser, newsreader, and FTP. Internaut falls short of average in its Web browser and FTP functions. Super Highway Access has a weak newsreader. With the exception of its strong Web browser and Gopher elements, NetCruiser offers only the most basic Internet functions. In

particular, its newsreader and its support for E-mail are significantly weaker than those of the other programs.

Performance Matters

If you log in to the Internet via a dial-up connection, be prepared for slow performance. Despite variables such as network traffic and modem speeds, our tests indicate that some programs and service providers consistently complete tasks faster than others. We tested the three modular programs using a local service provider. We tested the two integrated programs, Internaut Software for Windows and NetCruiser, using local access numbers to connect to their proprietary services.

For browsing Web sites, Internet Chameleon and Internet In A Box load pages slightly faster than Super Highway Access and 10 percent to 250 percent faster than the integrated programs, depending on the specific test. The minor differences among the modular programs indicate slight variations in the way they handle downloads. The big performance gap between these programs and the integrated packages suggests that the service provider can create major bottlenecks.

NetCruiser's Web browser, with graphics toggled off, runs almost as fast as those of the modular programs. With graphics switched on, NetCruiser is much slower. It's the only program that doesn't support text streaming: displaying Web text while graphics download in the background. In practice, NetCruiser requires a wait of over 20 seconds before presenting information that most of the other programs display in less than 5 seconds. Even without text streaming, downloading the full page with graphics takes 30 percent less time in the modular programs.

Internaut Software for Windows implements text streaming but seems to run all processes in slow motion. Direct connection to Web sites with no graphics takes twice as long as with the next-slowest program. With graphics enabled, Internaut Software for Windows still takes twice as long to display text as any of the other text-streaming programs.

Results for FTP and newsreader performance follow the same general trends. The three modular programs run fastest, with Internet Chameleon completing tasks slightly ahead of the others.

Error Handling

Dealing with problems is part of everyday life on the Internet. A remote host may go off-line, a server may be overloaded, or an entry error may transpose an address digit. How the Internet client programs handle such pitfalls is a measure of their maturity. Unfortunately, our tests produced many situations with misleading prompts, loss of data, and unrecoverable program lockups.

If a phone line is connected improperly or offers no dial tone, the three modular programs alert users with a warning message. NetCruiser and Internaut Software for Windows simply dial and attempt vainly (for minutes at a stretch) to connect, offering no useful information or troubleshooting suggestions.

If a telephone line loses its connection while the program is on-line, Internaut Software for Windows and Internet In A Box simply identify the problem and suggest redialing. Super Highway Access and Internet Chameleon give no indication that anything is wrong, behaving as if the link were still active and giving misleading error messages. Internet Chameleon provides a help option that turns out to be inactive. NetCruiser accurately identifies the connection loss and tries to exit but fails. An hourglass sits on-screen, and no menu commands or keystrokes can break through the jam.

Incorrect addressing can cause additional

Product Information

Internaut Software for Windows 2.0.7.....$15–$35
(monthly PSINet subscription)
PSINet/Pipeline
New York, NY
(212) 267-3636
Circle 1375 on Inquiry Card.

Internet Chameleon 4.1.....$199
Net Manage, Inc.
Cupertino, CA
(408) 973-7171
Circle 1376 on Inquiry Card.

Internet In A Box 1.0.....$99
Spry, Inc.
Seattle, WA
(800) 557-9614
Circle 1377 on Inquiry Card.

NetCruiser 1.5.....$44.95
(includes first $19.95 monthly service fee)
Netcom On-Line Communications Services, Inc.
San Jose, CA
(800) 353-6600
Circle 1378 on Inquiry Card.

Super Highway Access 4.0.....$125
Frontier Technologies Corp.
Mequon, WI 53092
(800) 929-3054
Circle 1379 on Inquiry Card.

problems. Super Highway Access offers the most informative error messages, and Internet Chameleon and NetCruiser are better than average. Internaut Software for Windows offers little of use, but at least it handles capitalization errors gracefully. Internet In A Box gives almost no prompts that could help in recovering from addressing problems.

File management can be a problem while you're trying to recover from transmission problems. Only Internet In A Box, NetCruiser, and Internet Chameleon give clear warnings to prevent accidental overwriting of files.

The Net Effect

Weeks of testing left us lukewarm about most of the programs. With occasional exceptions, they are quirky to set up, intolerant of user or network errors, and uneven in the depth of their support for Internet activities. On the bright side, any of them can provide a successful Internet connection, and all represent a huge step forward in usability from Unix shell accounts.

These products are the first generation of all-in-one Internet connection packages. It will take time for standards to evolve and for rough edges to wear off.

That said, our top recommendations go to Internet In A Box and NetCruiser. Internet In A Box stands apart from the field. Although it ranks first only in error handling, it finishes second in every other area, exhibiting consistent strength across almost all applications.

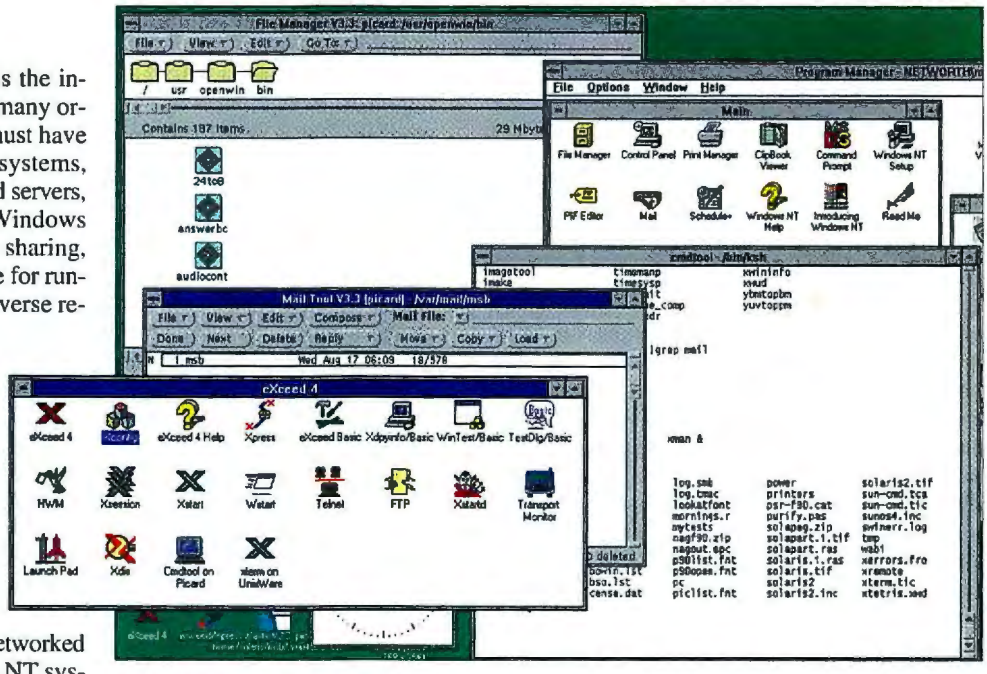
NetCruiser's strength lies in its interface: We loved the program's integrated approach, finding it easy to learn and use. Furthermore, its low price ($44.95) makes it our second recommended program, even though its evaluation total was slightly lower than that of the $199 Internet Chameleon. However, below-average speed and limited functionality (it's by far the least feature-rich package of the group) make NetCruiser less appealing than Internet In A Box. ■

This report contains the partial results of a recent issue of Software Digest, *a monthly publication of NSTL, Inc. To purchase a complete copy of the 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 McGraw-Hill, Inc.*

The Power of X for Windows NT

Hummingbird's eXceed combines the look and feel of Windows NT with the networking muscle of X Window System

STEVEN BAKER



Windows NT running alongside X Window System applications using eXceed's multiple-window mode. X clients shown include File Manager, Mailtool, and CmdTool from Solaris OpenWindows Deskset (above). Hummingbird's Xconfig tool makes it easy to configure and modify the X server (left).

Like it or not, Windows is the interface of choice across many organizations. But if you must have remote connectivity with other systems, particularly Unix workstations and servers, Windows is no solution. While Windows NT delivers basic file and printer sharing, it lacks a networked user interface for running graphical applications on diverse remote systems. eXceed for NT gives you the best of both worlds: the look and feel of NT and the functionality of a robust X Window System. And as a bonus, you can easily pass data across the divide.

Developed a decade ago at MIT as part of Project Athena (with support from Digital Equipment and IBM), X has become the de facto standard for a networked GUI in the Unix realm. Using an NT system as a PC X server to handle input and display results, a local desktop can execute programs remotely on systems as varied as Sun SparcStations and the fastest Cray supercomputers. The X technology is limited only by the extent and speed of the network connection.

The X Connection

Hummingbird was the first vendor to release native X server software for NT. eXceed ships on 16-bit Windows, DOS, and OS/2. NT support was the next logical step for handling native Win32 and other 32-bit applications. Although the 16-bit version worked on NT, its performance slogged when it was pitted against demanding network and graphical tasks. eXceed now supports X Window System 11 release 6, the latest version of the X system.

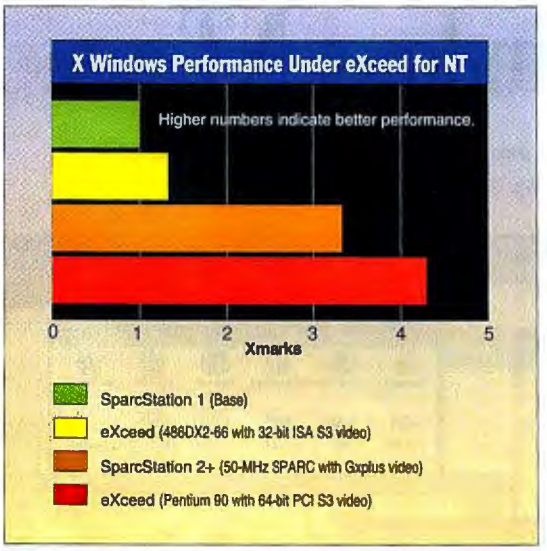
eXceed allows you to deploy NT as your window manager, with X applications launched in separate multiple NT-style windows. You can also establish a window manager (e.g., Open Look or Motif) on the remote Unix client that handles one large, single X root window. Either way, you can cut and paste between NT and X applications. If the remote client is running at a lower display resolution than the server application, the local display pans to support windows larger than the physical screen. eXceed also ships with Hummingbird's own `hwm` local window manager for use in single-window mode. In most cases, you'll prefer the multiple-window mode that allows treatment of X applications as local NT applications.

The standard package, eXceed 4 for Windows NT, includes both the network version and the Xpress serial version. Hummingbird's eXceed 4 comes with several stand-alone TCP/IP tools, including `telnet` and `ftp` clients for starting up remote X applications and troubleshooting. The Hummingbird `ftp` client is far superior to the standard text-based `ftp` client that ships with NT, because it emulates the file manager GUI, supporting drag-and-drop file transfers.

Also included in the standard package is eXceed Basic, a BASIC language interpreter and compiler (i.e., tokenizer) for writing NT applications and local X client programs. In addition to the normal BASIC language commands, eXceed Basic supports an extensive set of API commands that can use Hummingbird's X library (Xlib), along with its `ftp` and `telnet` libraries. eXceed Basic's powerful scripting and debugging options can automate complex tasks, such as connecting to a networked host computer and starting up X client applications.

eXceed/Xpress is a serial-only version that uses Tektronix's Serial Xpress protocol to compress the X packets for transmission over serial links. Xpress requires communication with a terminal server that supports the Tektronix protocol or installation of the Xpress/Host software (which must be purchased separately) on the target Unix host machines. Xpress uses a proprietary protocol rather than the familiar SLIP or the PPP protocols of TCP/IP.

eXceed 4-XDK for Windows NT is a superset of eXceed 4, adding a software development kit and libraries for NT. With the XDK, you can port X Window applications based on Xlib and Motif from Unix to NT. The resulting applications run as local X clients on NT, using the eXceed server or a Unix machine as the X server for input and display. You can distribute



Xmarks reduce performance data to a single number that rates performance relative to a Sun SparcStation 1.

these local X clients with DLLs so that they will run on other machines with just the basic X server software. The XDK includes X header files, libraries, and sample source code for several local X clients. You'll need the 32-bit Microsoft C/C++ development tools to build local X clients with the XDK.

A Control Panel for X Windows

Xconfig, a utility similar to the Windows Control Panel, lets you quickly view or change system settings, such as start-up method, key mapping, security, protocol (i.e., which extensions to support), fonts (i.e., font database and aliasing), transports (TCP/IP and DECnet), and performance parameters. Using Xconfig, you can select the fastest method to complete graphics operations based on the video card and the NT video device driver. For troubleshooting, eXceed can trace X protocol requests and log them to a file.

The newest version of eXceed adds password protection to the Xconfig utility and, for more fine-grained control, issues passwords for configuring individual categories. At large sites, this can simplify management by supporting standardized setups and letting users modify only a limited number of personal settings.

Another administration utility, `Sconfig`, lets you customize and simplify the eXceed setup program for deployment. Usually you would use `Sconfig` to build template files for classes of target systems or to customize installation for specific applications.

Once you install the X server, you can manage the configuration remotely with `Rconfig`. This utility supports transferring files, viewing and changing Xconfig settings, managing fonts, modifying .INI files, and installing Program Manager icons on remote machines. Scripts can automate the process of remote configuration and management on any number of target systems. Extensions to the X protocol handle remote communications, so `Rconfig` can manage other eXceed systems only when the remote X server is running.

Hummingbird wrote `Sconfig` and `Rconfig` with the scripting language of eXceed Basic, which illustrates the language's impressive scripting power. Using the eXceed Basic workbench as a text editor, you can also write scripts for the `ftp` and `telnet` programs to automate common tasks.

Not Quite Point-and-Click

For new X users, setting up and starting remote Unix clients is a tricky process because of the variety of start-up methods supported by X clients and the variations across Unix platforms. You can start applications from NT on demand (using `telnet` or executing scripts), or XDMCP can automatically start X clients based on files configured on the Unix hosts. You can also create a local Xsession file in NT that will automatically start a large number of X clients. This Xsession file (.SES) can contain a list of other script files and applications to start when you double-click on the Xsession.

Launch Pad emulates features common on Unix systems with X managers, such as Motif and Open Look. Launch Pad displays a pop-up menu for starting applications. A customized launchpad can trigger any local NT application or X application (remote applications via one of the X start-up methods). This is the same concept used by the Explorer interface in Windows 95. The Launch Pad utility comes preconfigured with menu items for standard NT applications, eXceed programs, a DOS box, window management, and a placeholder for X applications.

Launch Pad also offers a virtual desktop window manager similar to the OLVWM (Open Look Virtual Window Manager). This eXceed desktop provides a virtual screen that's much larger than the physical screen. With a small virtual screen pop-up utility, you can move windows off the physical screen onto the virtual screen to reduce clutter and make it easier to work with several applications.

X to the Test

We tested eXceed 4 for Windows NT in two environments. First, we used a 90-MHz Pentium with 32 MB of RAM, a Diamond Stealth 64 VRAM PCI (Peripheral Component Interconnect) card, and an SMC PCI Ethernet network card running NT Server 3.5. Second, we used a 486DX2-66 system with 16 MB of RAM, an Orchid Fahrenheit ISA card, and an SMC Elite16 network card running NT Workstation 3.5. In both cases, we configured NT with the video card in 1024-by 768-pixel by 256-color noninterlaced mode.

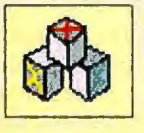
For testing, we used the eXceed X server to run client applications on a variety of Unix systems, including Sun SPARC machines running SunOS 4.x and Solaris 2.x, IBM workstations running AIX, Digital Alpha boxes running OSF/1, and UnixWare and Solaris x86 on Intel. We found only a few compatibility problems (which are noted below) and no instability issues.

Running on the Pentium 90, eXeed's X performance was excellent. To quantify its X server performance, we ran both the

What's New

General features
Scripting language (eXceed Basic)
Enhanced X server performance
Integrated dial-up remote X
Programmable toolbars
Drag-and-drop `ftp` client

X11R6 compliance
XTEST extensions
SYNC extensions
SHAPE extensions
Tools for transforming fonts



System administration
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Password protection for configuration components
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Core executables	9400 KB
eXceed/Xpress	359 KB
eXceed Basic tools	3099 KB
Fonts (default)	8230 KB
Fonts (100 dpi)	544 KB
System administration	740 KB

older Xbench tests and X11perf, using the newer Xmark benchmark.

X11perf takes a number of hours to run and generates test times for several hundred drawing and text primitives. Xmarks massage this performance data into a single magical number that rates performance relative to a Sun SparcStation 1 (see the figure "X Windows Performance Under eXceed for NT" on page 150). Based on Xmarks and Xbench, eXceed running on a Pentium delivered faster X performance than an older SparcStation 2+ (50-MHz) machine with a Gxplus graphics accelerator running Solaris 2.4.

We hit a few minor compatibility problems when running some common Unix clients. The font alias for the default font used by SunOS and Solaris Deskset applications (e.g., cmdtool and textedit) and the equivalent UnixWare desktop programs displayed the single quote character (') for the backward quote character (`). The backward quote character (or grave) is commonly used in many Unix shell scripts. This problem was mostly a mild annoyance once we realized that it was only a font-aliasing problem. We also encountered some font-aliasing problems resulting from font metrics (e.g., character spacing) using a few X applications.

Using the NT PVIEW (Process Viewer) tool from the Resource Kit or the Win32 SDK, we occasionally found some dummy local X clients (i.e., eXceed Basic run times) left running after using `Sconfig` and `Rconfig`. A user would not notice these zombie tasks because they weren't associated with windows.

Overall, Hummingbird has delivered a fast and full-featured X server in eXceed 4 for Windows NT. The system-administration features make this product especially attractive to large sites that are deploying X technology. ■

Steven Baker works for the Oregon Department of Energy. He is the Networking columnist for Unix Review *and former editor of* Programmer's Journal. *He can be reached on the Internet at msbaker@cs.uoregon.edu or on BIX at editors@bix.com.*

Product Information

eXceed 4 Windows NT
(Intel, Mips, or Alpha)
eXceed/Xpress for Windows NT $249
eXceed 4 for Windows NT $545
eXceed 4-XDK for Windows NT. $745
Xpress/Host with eXtend (Unix). $125

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(905) 470-1203
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sales@hcl.com
Circle 976 on Inquiry Card.

Color and a Pentium To Go

Quirky design mars the well-equipped Toshiba 4900CT

REX BALDAZO

Toshiba has long produced impressive laptop computers, and the T4900CT continues the family tradition. This 6.9-pound portable features a low-voltage Pentium processor, a 10.4-inch SVGA active-matrix color screen, separate Type II and Type III PCMCIA slots, and an unusually roomy 772-MB hard disk. But while we found it a powerful traveling companion, problems with the AccuPoint mouse substitute gave us second thoughts.

Solid Pentium Performance

With its speedy 75-MHz Pentium CPU, the T4900CT was about 80 percent as fast as our 90-MHz Pentium baseline in the BYTE Benchmarks test. The 3.3-V Pentium also helped stretch battery life on the Thumper 2 word processing test to 4 hours and 15 minutes.

A small, nonbacklit LCD strip located above the keyboard displays the charge remaining in the main battery, as well as other status information. Known as the QuickRead icon bar, this LCD can show remaining battery life as either a percentage of the maximum charge or in hours and minutes.

When the laptop is idling in resume mode, the QuickRead bar displays an icon of a book with a bookmark. In this mode, a backup battery supplies power to main memory even when you shut off the computer. The main battery continuously charges the backup battery, so simply turning the T4900CT back on returns you to where you left off. But don't depend on this feature if you plan to leave the computer unplugged for an extended period—the backup battery will eventually drain the main battery, and you'll lose everything that you had stored in RAM.

Resume mode also allows you to swap out the main battery without losing the memory contents. However, this feature requires Toshiba's tailored version of DOS, which is included with the T4900CT. When we installed MS-DOS 6.22 and swapped out the main battery, the computer rebooted instead of resuming, and we lost everthing in RAM.

The other icons on the QuickRead bar are fairly intuitive, though sometimes text would be better than a picture. For example, we'd prefer a simple Num Lock label to the tiny keypad icon.

Many laptops have a single Type III PCMCIA slot that also accepts a pair of Type II cards, but the T4900CT has separate Type II and Type III slots. You can install one of each type of card simultaneously, or two Type II cards. Both slots are on the right side of the computer, and they have separate access doors. Oddly, the Type II slot has a hinged door, while the Type III slot has a pop-off door.

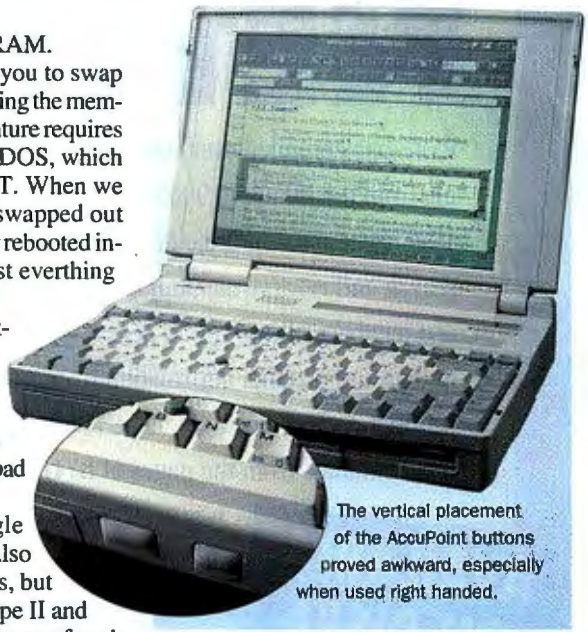
For multimedia presentations, the T4900CT has a built-in sound system. But there's only one speaker, so if you want stereo sound, you'll still have to carry a pair of external speakers.

AccuPoint Agony

We like the T4900CT's mix of features for power users, but we think the Achilles' heel of this machine is its AccuPoint pointing device. It handles pointing quite well, but is awkward for the clicking half of point-and-click operations.

The AccuPoint is a small green knob sticking out of the keyboard between the G and H keys. It works at least as well as similar devices, allowing confident control over the pointer. But for some reason, Toshiba decided to place the mouse buttons vertically along the front edge of the computer (see photo).

This peculiar placement makes it nearly impossible to use a wrist rest and the buttons at the same time. While writing this review on a T4900CT, the buttons became a real sore point, both literally and figuratively.



The vertical placement of the AccuPoint buttons proved awkward, especially when used right handed.

We also found that manipulating the AccuPoint with our right hand required a very nonergonomic twist of the wrist to reach the right button. In fact, we found the AccuPoint easier to use left-handed. Perhaps that was the intent, but it seems unusual in the face of competing designs that work equally well for right-handers or southpaws.

Flip of the Coin

Our problems with the AccuPoint might seem like a minor complaint, but modern Windows applications increasingly rely on point-and-click operations, and it's those very applications that would make you consider a Pentium-powered portable in the first place. For that reason, we recommend that you try using a T4900CT for a while before buying; if the AccuPoint buttons don't bother you, the T4900CT is definitely a worthy machine. Its combination of a huge hard disk, built-in sound, and Pentium power is very appealing. Just leave room in your luggage for an external pointing device. ■

Product Information

Toshiba T4900CT (8 MB of RAM)
772 MB HD $6499
Toshiba America
Irvine, CA
(800) 334-3445
(714) 583-3000
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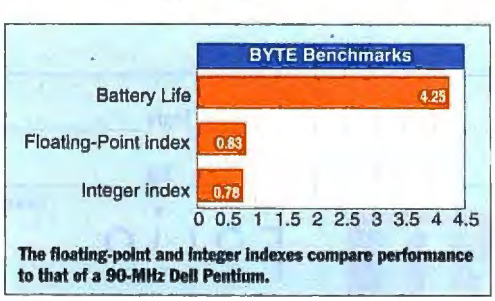

The floating-point and integer indexes compare performance to that of a 90-MHz Dell Pentium.

Rex Baldazo is a BYTE technical editor. You can reach him on BIX or on the Internet at rbaldazo@bix.com.

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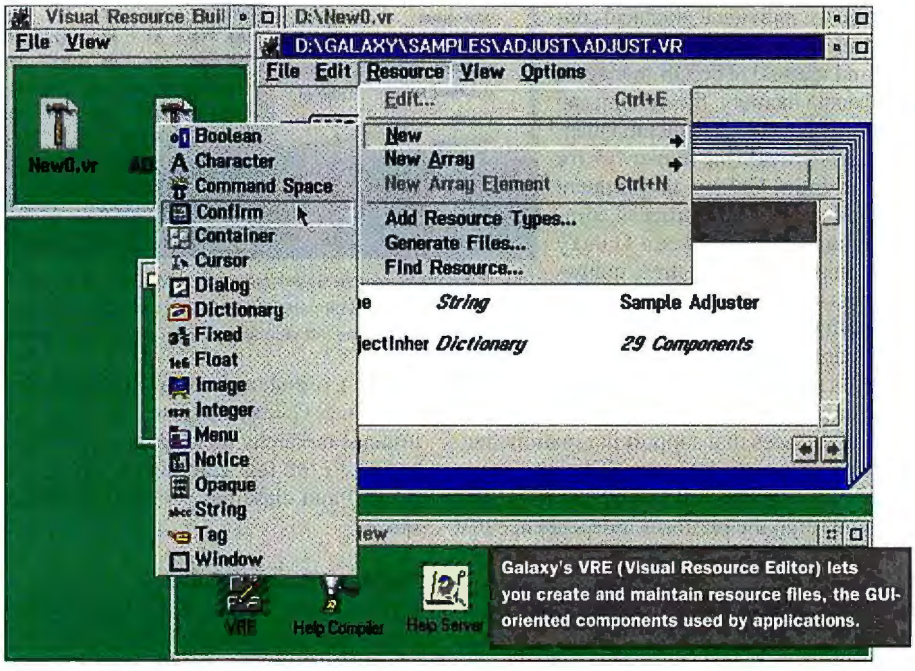
A Whole Other Galaxy

It's big, expensive, and learning-intensive, but Visix's development environment is cross-platform and object-oriented without compromises

BARRY NANCE



Developing object-oriented applications to run natively on many hardware platforms requires a lot of code—and a lot of compromises. Visix Software dispenses with the compromises in Galaxy, a complex, high-end development environment.

Galaxy consists of several thousand object-oriented API functions. The APIs are embodied in link libraries, a visual screen-design tool, a help compiler, and a run-time service broker that supplies distributed services on a LAN. You use C or C++ compilers to produce the code you link with the Galaxy libraries.

Intended for vertical-market data processing in a distributed, LAN-based setting, Galaxy avoids the lowest-common-denominator approach to cross-platform development. For platforms that don't offer a particular feature (e.g., CUA [Common User Access] controls on the Macintosh), Galaxy supplies the behavior itself. Galaxy's consistent interfaces present high-level abstraction to the programmer while it tightly couples itself to or replaces the services of the native platform.

A Galaxy of Options

Cross-platform development has come a long way since Borland International's $49 Turbo Pascal compiler that came in DOS and CP/M versions. The current state of the art lets you produce computer programs that run equally well on Macintosh System 7, Windows 3.x, Windows 95, Windows NT, OpenVMS, Unix, and OS/2. Although most cross-platform environments concentrate almost completely on the management of the GUI screen, Galaxy goes a step further and offers file and directory management, memory management, and RPC (remote procedure call)-like distributed-processing services. Visix says a future edition of Galaxy—in beta test at this writing—will add relational database access through a standardized SQL delivery system.

We evaluated Galaxy 2.5 on a PowerMac 6100 running System 7.5, a Twinhead 486/33 notebook running OS/2 Warp, and an IBM PS/ValuePoint running Windows 3.11. Before we could begin the evaluation, we had to go to school: Visix insists that its customers go through a 4½-day training program before using Galaxy. The product's price includes the training (but not the travel and lodging). The training seminars are friendly, relaxed, comprehensive, and conducive to learning the complexities of Galaxy. Visix also supplies a wealth of sample programs. The samples are the same for all platforms. Only the make file varies for the different operating environments.

C Is the Word

You can develop Galaxy-based software using a variety of 32-bit compilers, including Borland's C/C++ 4.5, Symantec's Think C 6.0, Watcom's C/C++ 10.0, and IBM's C Set++ 2.0. Visix supports only C and C++, but we had some success linking MicroFocus COBOL programs with the Galaxy libraries in an experiment we performed. Visix should consider supporting other computer languages in the future: C and C++ aren't always the best tools for developing business software.

Visix implements Galaxy as a set of class libraries. The naming convention for the API functions is v<*prefix*><*verb*><*noun*>. *Prefix* identifies the Galaxy manager module for that API. *Verb* is typically set, get, load, init, destroy, open, or close. And *noun* indicates the target on which the function operates. vdialogOpen() is an example of a Galaxy function (one that doesn't need a noun, because the noun is the same as the prefix). vbuttonSetBackground() is another.

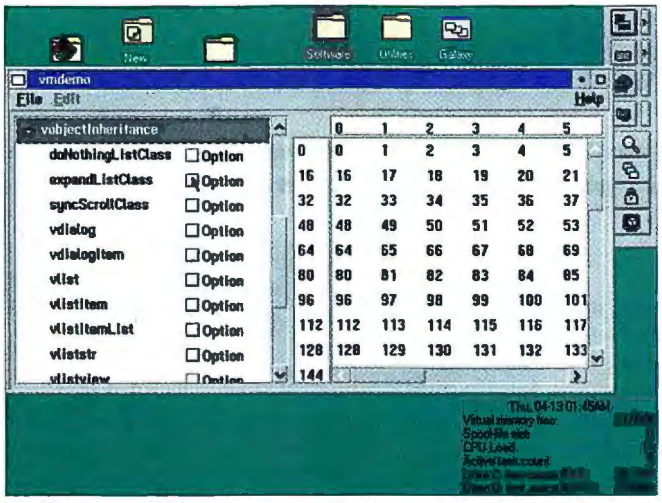
The Galaxy class libraries give C programmers an object-oriented perspective on software development through class hierarchies and functions the programmer can use to dynamically modify the Galaxy environment. Through Galaxy "meta-functions" (our term), you can customize a number of Galaxy functions to add new behavior. The effect is similar to using C++ inheritance to customize the methods of an existing class. The result is superb parallelism and consistency between APIs, which brings Galaxy's complexity down to a manageable level.

Managers, Managers Everywhere

Galaxy's architecture consists of more than 50 managers, with each manager handling some functional classification (see the table "Selected Function Class Managers" on page 156). These include abstractions for

distributed computing, the GUI, OS services, structural matters, and the windowing system.

The distributed-computing services let you target some of the logic of your application to run on different computers. The GUI abstractions build and manage the individual graphical controls (e.g., buttons, list boxes, and menus). The OS managers handle memory, file-system, and timer issues. The structural managers provide the framework for the entire Galaxy environment and supply interprocess communications between Galaxy components. And the windowing-system managers abstract such window services as the clipboard, cursor shape, font selection, image rendering, printing (PostScript), and drag and drop. Also included are services that support internationalization. If you wish to use native services in your program, you can do so. However, you forgo the platform-independence that Galaxy offers.



One of the many sample Galaxy programs, VMDEMO, demonstrates the List Manager while illustrating parts of the Galaxy hierarchy. The right side is the spreadsheet object. The left side shows a small section of the class hierarchy.

The Galaxy API itself consists of about 3500 functions (you *will* need the training), but the consistent naming and design of the functions within each manager group make it possible for you to learn and use Galaxy without constantly referring to the extensive printed documentation.

Visix designed a sophisticated relationship manager in Galaxy, called the Command Manager, that separates operating-environment events (e.g., a mouse-click) from the code that you want to execute when the event happens. With the Command Manager, you give each event a name and specify which chunk of code Galaxy should run for that name. You can thus perform some program maintenance on the graphical behavior of your program simply by changing the design of a dialog box or window in the resource file and modifying the name table to indicate which existing program-logic modules should handle the changed window objects. At run time, Galaxy quickly finds, in a context dictionary, the name and the associated code that should execute for that named event.

For example, suppose a push button labeled CANCEL has a tag (a Galaxy internal name you specify) of QUIT. When someone clicks the push button, Galaxy issues a "notify" for the button as well as a command bound to the tag that the Command Manager will dispatch. If you haven't registered a command for the QUIT tag, Galaxy traverses the class and instance hierarchy looking for a command bound to the tag. Each object (i.e., instance) and class has its own command space.

The Visual Resource Editor

Galaxy resource files don't typically become part of executable program files. The resource file is a platform-independent binary representation of the specifics of the Galaxy components that your program uses. Each resource file is a hierarchically linked collection of Galaxy objects—a nested dictionary of resources akin to Macintosh `res` and Next `nib` files. Different members of a LAN-based development team can share a common resource file; you don't have to maintain a separate copy for each programmer. Visix supplies utilities that convert resource files to and from ASCII files, but you'll almost always use VRE (Visual Resource Editor) to manage and update the resource file. VRE itself is a Galaxy application.

To distribute a Galaxy application, you bundle your executable file, the VRE-generated resource file (which has a .VR extension), and the global Galaxy resource file VGALAXY.VR. You can optionally configure your program to use Galaxy DLLs (on those platforms that support DLLs). Visix does not impose run-time fees for Galaxy-based applications.

VRE doesn't write Galaxy programs for you and is not a CASE tool. Rather, VRE lets you visually create and maintain the GUI aspects of your program. The screen on page 155 shows the list of objects that you can add to your screens via VRE. Visix doesn't include a class browser with Galaxy, but you'll find Galaxy works with the class browsers available in most C/C++ development environments. Through VRE, you can configure how your Galaxy-based application should react to resizing on your target platforms. You can also specify that Galaxy automatically resize dialog-box items to suit target platforms.

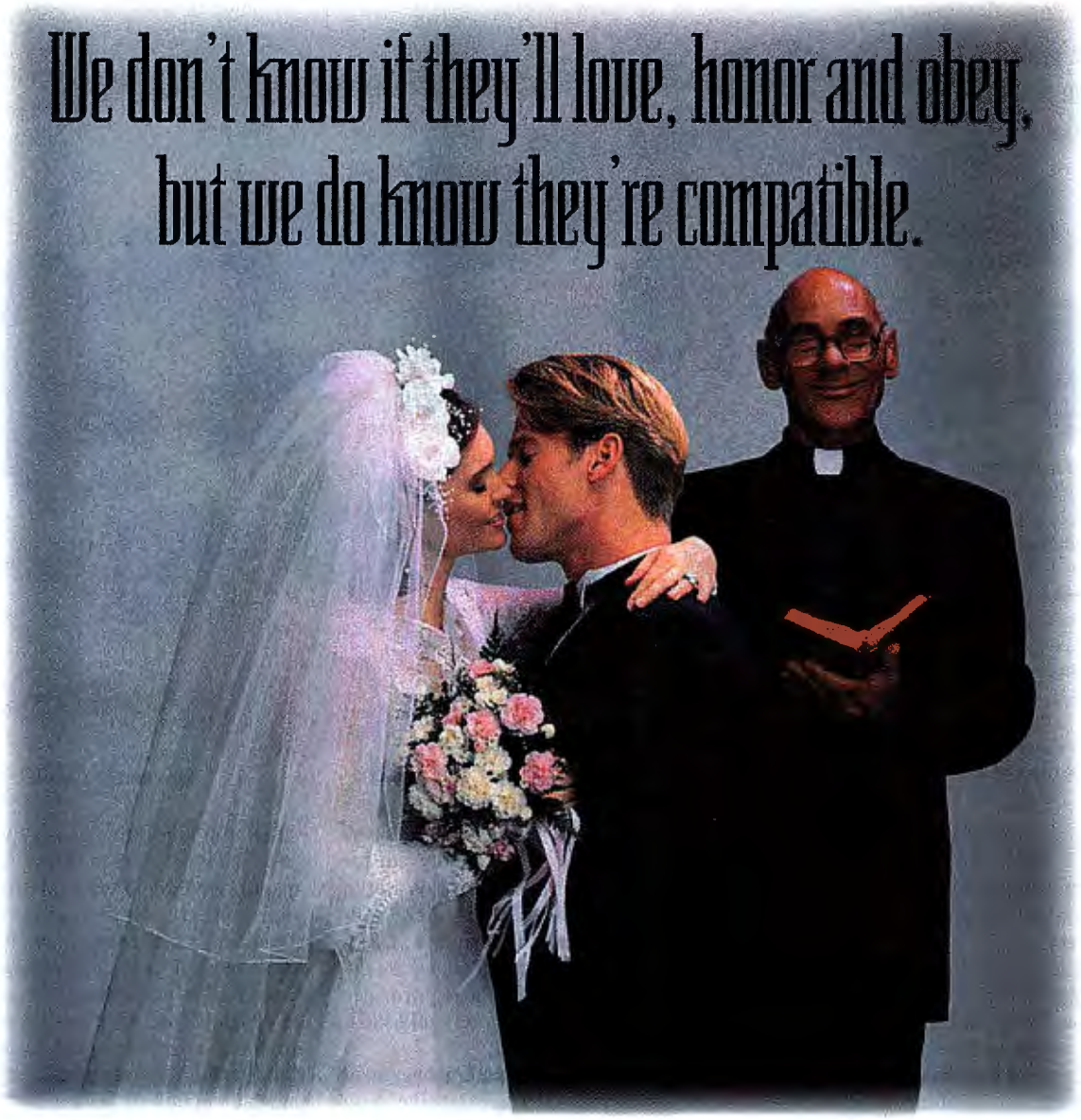
The distributed-services component of Galaxy works on TCP/IP, DECnet, and AppleTalk transports. Visix says it could

SELECTED FUNCTION CLASS MANAGERS

Functionally, Galaxy can be broken down into 48 class-oriented managers, each a relatively self-contained group of functions and data types. Following are 11 of the most important ones.

Application Manager	Manages multiple instances of Galaxy clients, stores application-wide attributes, and manipulates global state information
B-Tree Manager	A key-oriented file access method
Class Manager	Gives C programmers an object-oriented view of Galaxy through subclassing, overloading, inheritance, polymorphism, and class identification
Clipboard Manager	APIs that access native clipboard mechanisms
Command Manager	Allows access to GUI events and OS features via name relationships established by programmer
Communication Manager	A transport-oriented message-sending mechanism
Datatag Manager	A platform-independent representation of data items provided via object-oriented attributes
File System Manager	File services (open, create, read, write, and record locking) and directory services (creation, deletion, and lookup)
Look-and-Feel Manager	The heart of Galaxy's GUI screen management
Memory Manager	APIs for allocating and freeing memory
Session Manager	APIs that applications can use to become consumers or providers of distributed services on a LAN

We don't know if they'll love, honor and obey, but we do know they're compatible.



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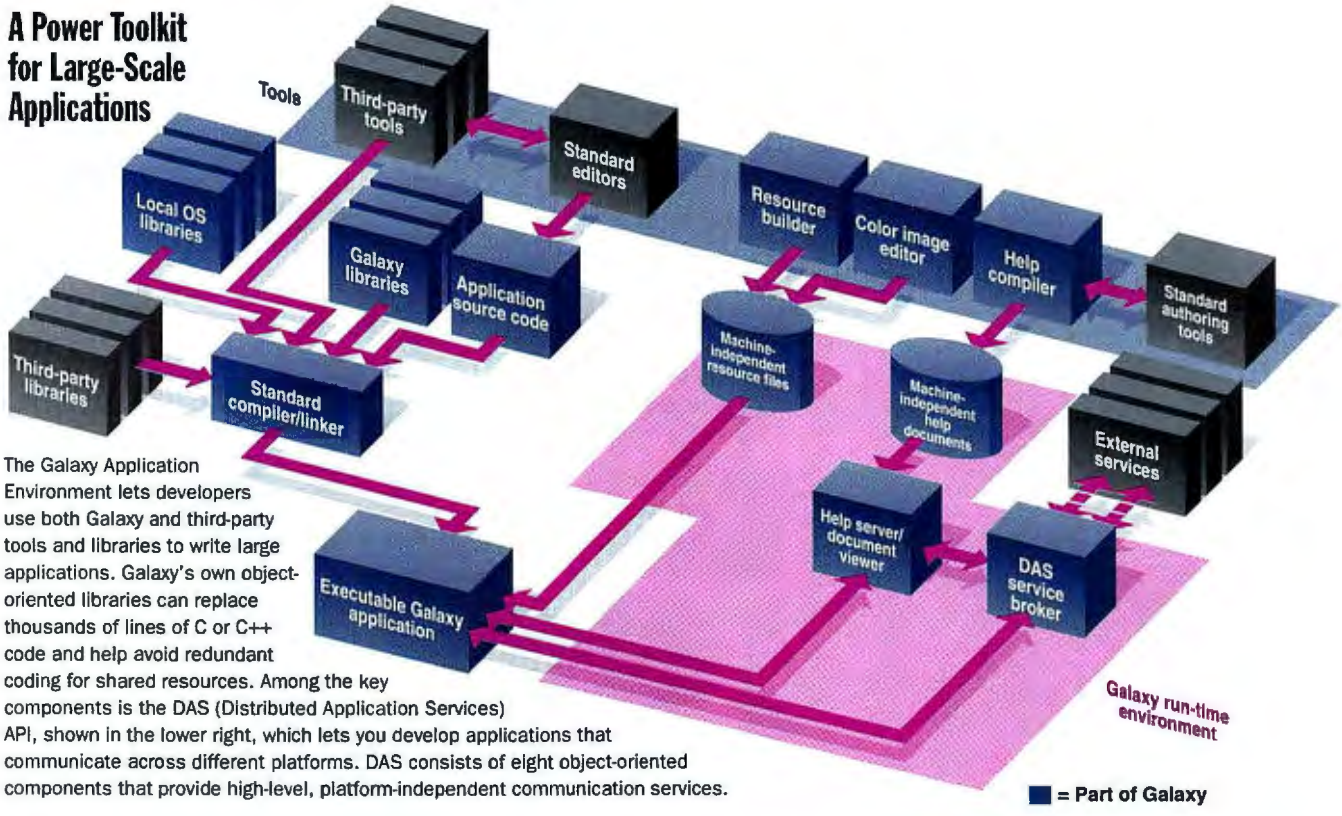


The Galaxy Application Environment lets developers use both Galaxy and third-party tools and libraries to write large applications. Galaxy's own object-oriented libraries can replace thousands of lines of C or C++ code and help avoid redundant coding for shared resources. Among the key components is the DAS (Distributed Application Services) API, shown in the lower right, which lets you develop applications that communicate across different platforms. DAS consists of eight object-oriented components that provide high-level, platform-independent communication services.

easily expand this list to include NetBEUI (NetBIOS), IPX, or LU 6.2 if customers want them. We think it would be better if support for those protocols came standard with Galaxy.

In addition to telephone, BBS, and fax-based support, Visix maintains a site on the Internet for its customers. You can ask questions and get answers from other Visix customers as well as from Visix support staff, and you can download sample code and bug fixes via FTP.

Galaxy at Work

To exercise Galaxy, we developed a personal stocks-and-funds investment-tracking application for use on Windows, OS/2, or Macintosh systems. We easily modified the standard File menu and File Open dialog box (Visix calls it the File Chooser) to use the term *Portfolio* in place of *File*. Our application used DB2/2, IBM's OS/2-based relational database manager, to store stocks, quotes, and transactions.

Because Galaxy doesn't yet provide a standard, consistent interface to relational databases, we coded the SQL delivery mechanism to run as a background task on OS/2 and used Galaxy's distributed-services feature, over TCP/IP, to route database requests to and from the database server. (At this writing, Galaxy was working on an upgrade that would add access to such relational database managers as Oracle and Sybase but probably not for other important products like Watcom SQL or Ingres, which several other development tools support.) Macintosh, OS/2, and Windows clients could all access the database with equal ease. The performance of the resulting software is certainly satisfactory.

Galaxy's control over and management of the underlying GUI is extensive. You probably wouldn't do this in a real multiplatform environment because you'd confuse users, but you can even set a look-and-feel flag within Galaxy to make Galaxy use something other than the native windowing system. On a Macintosh, for instance, you can make your application appear to be running on X Windows or Presentation Manager. (For legal reasons, you can't make the Macintosh look-and-feel appear on other platforms.)

Client/Server Solution

Galaxy isn't for building shrink-wrapped software, such as games or word processors, but it is an excellent cross-platform development environment for large-scale, client/server-based business automation. Galaxy supplies a wealth of functionality. Our only serious complaint is with Galaxy's limited database access and network-transport compatibility.

The most impressive thing about Galaxy is that its developers managed to achieve object-oriented and cross-platform operation without compromising either. It would have been easy to cut corners if a mouse control in the class hierarchy, for example, didn't layer itself correctly across the Windows and Mac platforms. The result could have been some decidedly un-Mac-like GUI conventions creeping into the Mac version of Galaxy applications. But Visix went the extra mile to write the code that avoids such a compromise. The result is impressive. ■

Barry Nance is a BYTE contributing editor and has been a programmer for 20 years. He is the author of Using OS/2 Warp *(Que, 1994),* Introduction to Networking *(Que, 1994), and* Client/Server LAN Programming *(Que, 1994). You can reach him on the Internet or BIX at barryn@bix.com.*

Product Information

Galaxy 2.5
C version . . . . . $9600 per seat
C++ version . . . . . $12,100 per seat

Visix Software, Inc.
Reston, VA
(800) 832-8668
(703) 758-8230
fax: (703) 758-0233
galaxy@visix.com
Circle 1144 on Inquiry Card.

A Less Wobbly Wabi

Unix gets Windows-friendly: Wabi 2.0 is faster, runs more Windows applications, and now supports OLE 2

DOUG TAMASANIS

The initial Wabi (Windows Application Binary Interface) release stirred up lots of excitement as the long-awaited panacea for running Windows applications under Unix, but poor performance and spotty application support spoiled the promise and left many of us cynical about the whole idea. SunSoft's Wabi 2.0 has risen from those ashes as a much more successful attempt to bridge the two OSes.

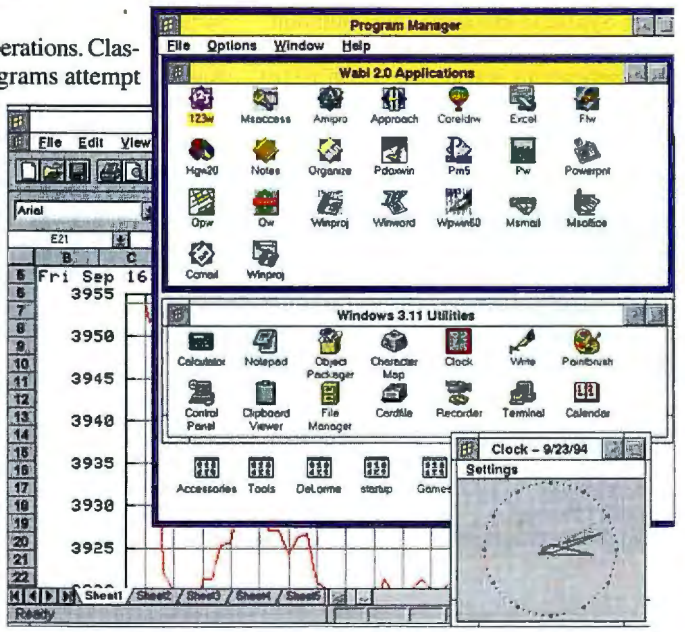
SunSoft had good reason to forge ahead with its much-maligned product: namely, an installed user base of approximately 150,000. The 2.0 release of Wabi addresses many of the first Wabi's shortcomings and delivers a larger set of Windows applications to the Unix desktop. Wabi now supports OLE, OLE 2.0, and DDE; runs in 386 enhanced mode; uses less memory; and is available in several Unix flavors. On the down side, Wabi requires an optional program to connect to NetWare and lacks support for sound, video devices, and Win32 APIs. Despite these shortcomings, Wabi 2.0 is a significant improvement over previous versions.

The 80 Percent Rule

SunSoft has addressed the major problems with Wabi—lack of application support and slow execution speed—by encouraging you to install Windows 3.1 (instead of contending that you don't need a Windows license). Windows 3.1 is now one of the 24 applications certified to run with Wabi 2.0.

According to SunSoft, the 24 certified applications make up over 80 percent of the commercial Windows applications market. New applications supported include Approach 2.1, cc:Mail 2.0, Lotus Notes 3.0 and the Microsoft Office 4.3 applications suite. SunSoft claims that beta testers have found at least 50 more not-yet-certified applications that will run under Wabi 2.0. Among these are such products as DeLorme Mapping's Street Atlas and Micrografx's Picture Publisher.

Instead of relying on emulation, Wabi principally uses API translation, occasionally resorting to an enhanced CPU instruction translation scheme to increase the speed of CPU-intensive operations. Classical emulation programs attempt to create the whole PC right inside the system by interpreting individual Intel operation codes into RISC operation codes. For each Intel instruction, it takes some eight RISC instructions. This inefficiency results in a significant performance hit.



Wabi 2.0 on a SparcStation 10 running the Windows 3.1 Program Manager and Microsoft Excel. Note the console and X Window icons.

Translation takes advantage of the X GUI by mapping Windows GUI commands to X GUI commands. For example, when creating a window, Wabi maps the Windows `create windows` API command to the X `create window` API. Because of this direct mapping, you get native performance during your interaction with the Windows API (where most Windows applications spend about 80 percent of their time).

Wabi always translates when running on an Intel box. So, if there is a CPU-intensive call, Wabi takes advantage of the presence of the Intel processor, never needing to map the Intel operation codes to the RISC operation codes. On RISC systems, emulation is necessary for certain applications that directly call the CPU. In this case Wabi does a CPU translation (essentially an emulation). To enhance performance, Wabi maps and caches each Intel operation code. If the call is outside the Windows API, then Wabi must perform the CPU translation.

Wabi Still Wobbles But Doesn't Fall Down

Wabi requires each user to load a copy of Windows—a limitation that consumes a lot of disk space on a multiuser system. On loading, all standard Windows applications and utilities are available and appear just as they do on a PC, except that there is no DOS emulator included. The DOS shell requires a separate DOS emulation program. Otherwise, all interaction with the system mimics that of a PC including drive labels and filenames.

Although not blazingly fast, Wabi 2.0's performance is acceptable. Based on hand timing of various application tasks, Wabi loaded on a SparcStation 10 with 64 MB of RAM runs at roughly the speed of a 50-MHz 486 PC. On occasion, an application would hang for several seconds but, in general, applications ran smoothly.

In addition to better performance, Wabi 2.0 greatly improves application integration. Each Windows application has its own launchable icon. Once open, applications run in individual scaleable windows right on the Solaris desktop. You can cut-and-paste and drag-and-drop between Windows and Unix applications. Wabi's support of Winsock networking enables file sharing and lets you access network printers from within Windows applications.

Wabi now lets you embed Microsoft Word objects into your Unix mail tool and send them. The receiver can then simply double-click on the icon to launch Wabi and Word and load the file. Depending on the configuration of your gateway, users of Word on a PC may not be able to read

Word embedded messages.

Another caveat on connectivity: If you need to connect to a NetWare network, you'll have to purchase an additional add-on product like Netcom to provide an IPX/SPX stack. SunSoft said they are licensing server and client IPX/SPX stacks from Syntac to eliminate this limitation.

We couldn't resist the temptation of loading applications not on Sun's certified list. Harvard Graphics for Windows 3.0 was one of several that we tested. Using Harvard Graphics, we created a presentation containing several complex charts and printed it from our workstation without a problem. We also copied the presentation onto a floppy that we then manipulated and printed on a PC.

Other programs we loaded didn't fare as well. Mathematica 2.0, for example, loaded a notebook but crashed when loading the kernel. There was a DOS conflict error box displayed, but the problem didn't crash the system. We simply closed Mathematica and continued using other applications. Essentially, if the application makes any reference to DOS, the program won't run under Wabi.

The 24 Wabi-Certified Windows Applications

- Microsoft Access 2.0
- Lotus AmiPro 3.01
- Lotus Approach 2.1
- Lotus cc:Mail 2.0
- CorelDraw 4.0
- Microsoft Excel 5.0
- Lotus Freelance 2.01
- SPC Harvard Graphics 2.0
- Microsoft Mail 3.2
- Lotus Notes 3.0c
- Microsoft Office 4.3
- Lotus 1-2-3 for Windows 4.0
- Lotus Organizer 1.1
- Aldus PageMaker 5.0
- Borland Paradox for Windows 4.5
- Microsoft PowerPoint 4.0
- ProComm Plus 1.02
- Microsoft Project 3.0
- Borland Quattro Pro for Windows 5.0
- Intuit Quicken 3.0
- Microsoft Word for Windows 6.0
- WordPerfect for Windows 6.0a
- Lotus SmartSuite 2.0
- Microsoft Windows 3.1

Beyond Solaris

Wabi is available for Solaris 2.3 and comes bundled with 2.4. Additionally, SunSoft ships Wabi 2.0 to OEMs such as IBM, Hewlett-Packard, Novell, and The Santa Cruz Operation. These OEMs will release versions of Wabi either bundled or as options with their operating systems.

With Wabi 2.0 SunSoft has improved both the speed and integration of its Windows translator program as well as the number of compatible applications. It does lack support for Microsoft's Win32 APIs, sound and video devices, TCP/IP, and NetWare. It's no panacea, but it is a solution for running certified Windows applications on Unix platforms. If you want to use Word, Excel, and cc:Mail on Unix, Wabi gets you there. ■

Product Information

Wabi 2.0 $225 (upgrade, $80)
SunSoft
Chelmsford, MA
(508) 442-0430
fax: (508) 250-5517
Circle 1060 on the Inquiry Card.

Doug Tamasanis is a BYTE senior technical editor. He holds an M.S. in physics and systems engineering. Doug is also a senior member of the IEEE. You can reach him on The Internet or BIX at dtam@bix.com.

Win a Notebook Computer!

BYTE's research department would like to know what your computer notebook requirements are. Please take a few minutes to fill in this form by July 31 and you will automatically be entered in the sweepstakes. The prize is this WinBook XP, a DX4-100MHz notebook.

Portable: a notebook or subnotebook computer weighing 8.5 lbs. or less.

1 Do you plan to purchase a portable computer within the next 12 months? *(Choose one.)*

Definitely yes ..... ____1.
Maybe *(continue survey as if you plan to buy)*.... ____2.
No *(continue survey as if you plan to buy)* ..... ____3.
☐ Check here if you have purchased in the last six months

1A (If yes or maybe) Will this unit be paid for by yourself or by your employer?

Self (please go on to Question 2) ..... ____1.
Employer (please go to Question 1B)..... ____2.

1B (If paid by employer) Approximately how many are employed by your company: *(Choose one.)*

1000 or more employees..... ____1
500-999 employees..... ____2.
100-499 employees..... ____3.
50-99 employees..... ____4.
Fewer than 50 employees ..... ____5.
Uncertain..... ____6.

2 Will you require CD-ROM with your next portable computer? *(Choose one.)*

Yes, internal CD-ROM, built into notebook ____1.
Yes, external CD-ROM, connected to port or docking station..... ____2.
No ..... ____3.
Uncertain..... ____4.

3 For the unit selected above in question 2, what weight would you be willing to accept? *(Choose one.)*

4.5 lbs. ..... ____1.
5.0 lbs. ..... ____2.
5.5 lbs. ..... ____3.
6.0 lbs ..... ____4.
6.5 lbs ..... ____5.
7.0 lbs. ..... ____6.
8 lbs. or more ..... ____7.

4 What type of processor will you require? *(Choose one.)*

Intel 486 SX/33 MHz..... ____1
Intel 486 DX2/50 MHz..... ____2
Cyrix DX2/50 MHz..... ____3.
Cyrix DX2/66 MHz..... ____4.
Cyrix DX2//80 MHz..... ____5.
Intel 486 DX4/75MHz..... ____6.
Intel 486 DX4/100 MHz..... ____7
486, unsure which version ..... ____8
Intel Pentium 60 MHz..... ____9.
Intel Pentium 75 MHz..... ____10.
Intel Pentium 90 MHz..... ____11
Intel Pentium 100 MHz..... ____12
Intel Pentium 120 MHz..... ____13.
Intel Pentium 150 MHz..... ____14
Intel Pentium, unsure which version..... ____15
AMD K5 ..... ____16.
Cyrix M1 ..... ____17.
Other..... ____18
Don't know..... ____19.

4A What type of bus will you require?

PCI only..... ____1
ISA only..... ____2.
Both PCI and ISA ..... ____3.
No preference..... ____4.

5 Which screen will you require for your portable computer?

Screen type *(Choose one.)*
Monochrome..... ____1.
Dual-scan color ..... ____2.
Active-matrix color ..... ____3.

Screen size *(Choose one.)*
8.4 diagonal..... ____4.
9.4 inch diagonal..... ____5.
10.4 inch diagonal..... ____6.
11.4 inch diagonal..... ____7.
12.4 inch diagonal..... ____8.
Larger than 12.4 inch diagonal ..... ____9.

6 (If you require a color screen) What resolution will you require? *(Choose one.)*

640 x 480 x 256 colors ..... ____1.
800 x 600 x 256 colors ..... ____2.
1024 x 768 x 256 colors ..... ____3.
1280 x 1024 x 256 colors ..... ____4.
1024 x 768 true color ..... ____5.
Uncertain..... ____6.

7 Will you require the following in your portable, docking station or both?

	Portable	Docking Station	Both	Neither
Speakers	1.	2.	3.	4.
Available CD-ROM	5.	6.	7.	8.
Available floppy drive	9	10.	11.	12.
Parallel port	13.	14.	15.	16.
Serial port	17.	18.	19.	20.
Ethernet port	21.	22	23.	24.
Infrared port	25	26	27.	28.
SCSI port	29.	30.	31.	32.
Tape back-up	33	34.	35.	36.

8 (If paid by employer in 1A) Would your organization agree to purchase terms of net 45 days with 3% late fee stipulated? *(Choose one.)*

Yes ..... ____1.
No ..... ____2.
Uncertain..... ____3.

9 What is the most important feature you look for in a notebook computer?

_____
_____
_____
_____
_____
_____
_____

BYTE

Contest Rules

The contest is open to all U.S. residents 18 years of age or older. No purchase necessary. An individual may enter regardless of whether or not he or she chooses to participate in the survey. Entrants should fill out their daytime telephone number where indicated. Limit: one entry per person.

Entries must be received by July 31, 1995 to be eligible for the drawing. The finalist will be determined in a random drawing to take place at BYTE. The winner will be contacted by telephone on August 1, 1995. Personal contact with the individual specified on the entry card must be made for the finalist to be declared the winner. If the winner cannot be contacted within 15 days of the drawing, then the unclaimed prize will be awarded to an alternate winner selected at random. The winner shall be required to sign an affidavit releasing McGraw-Hill, Inc., from liability in connection with use of the prize.

The odds of winning depend on the total number of entries received by the cutoff date of July 31. Employees of McGraw-Hill, Inc., Winbook, their agencies, subsidiaries, employees and families are not eligible to participate in the contest. McGraw-Hill, Inc., is not responsible for lost, late, or misdirected mail or ineligible entries. All federal, state, and/or local rules and regulations apply. Void where prohibited by law. One prize will be awarded. Total value of prize is $3800. The prize is not redeemable for cash, nor is substitution of the prize by the winner allowed. The winner is responsible for any and all taxes associated with the acceptance of the prize. BYTE reserves the right to substitute a prize upon unavailability. For the name of the winner, send a self-addressed, stamped envelope after August 1 to Winbook Sweepstakes, Marketing Department, BYTE Magazine, One Phoenix Mill Lane, Peterborough, NH 03458.

Name: _____

Title: _____

Company: _____

Address: _____

City: _____ **State:** _____ **Zip:** _____

Phone: _____ **Fax:** _____

Fax your responses to (603) 924-2535, or mail them to BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

29 SWITCHING HUBS

Because they're more efficient, more convenient, and increasingly less expensive, Ethernet switching hubs are replacing router-repeater setups in LANs

TADESSE W. GIORGIS

Ten years ago, LAN wire speeds didn't come close to approaching bottleneck status. But these days, bandwidth is a jealously guarded resource, and the actual throughput on a crowded 10-Mbps Ethernet network or a 16-Mbps token-ring network is often slower than what you get from even a 28.8-Kbps modem. Anxiety-ridden network administrators are calling for more bandwidth at reasonable prices—and they're buying Ethernet switching hubs.

Without a switching hub, one fast workstation can choke a 10-Mbps Ethernet bandwidth in no time and take the network down with it. Ten-Mbps Ethernet switches don't sacrifice installed bases of network hardware and software. Until the newer, faster standards fall into place (which could take years), they present a solid interim solution.

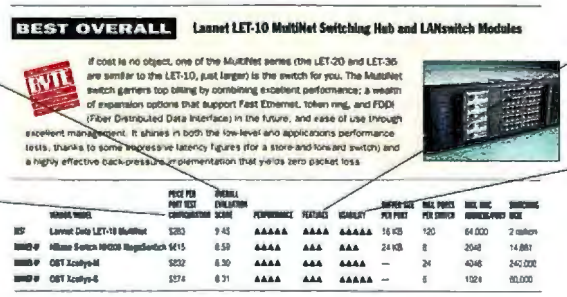
Ten-Mbps Ethernet switching hubs alleviate traffic jams by making virtual connections between transmitting and receiving nodes and sending data only to each packet's Ethernet destination address (i.e., a type of private connection) rather than broadcasting data to everyone. This improves every node's network performance, and it offers a security benefit as well. Many LANs rely on routers and repeaters to distribute network data, but repeaters aren't capable of port-specific transmission, and routers don't conserve bandwidth. Although the cost per port of switching hubs is currently greater than that of router/repeater combinations, prices are falling, due largely to the increased use of ASICs.

Most of the switching logic and management capability of the 29 hubs we tested is hard-coded into ASICs that manage specific ports. Developing the ASICs is expensive. But once vendors have the design, ASICs cost much less than the commonly used general-purpose RISC-based Intel 960 processors. Most 960 designs in switches use dual processors, with one CPU for switching and one for management. Port-specific flow requires two CPUs at each port and is expensive.

How to use this guide

We combine our low- and high-level performance test results with usability and features ratings to choose winners in categories by technology (i.e., cut-through and store-and-forward) and then by configuration or expandability (i.e., stackable and rack-mountable). Some are hybrids. You can configure Kalpana's cut-through EtherSwitch EPS-2115M to perform a few store-and-forward functions.

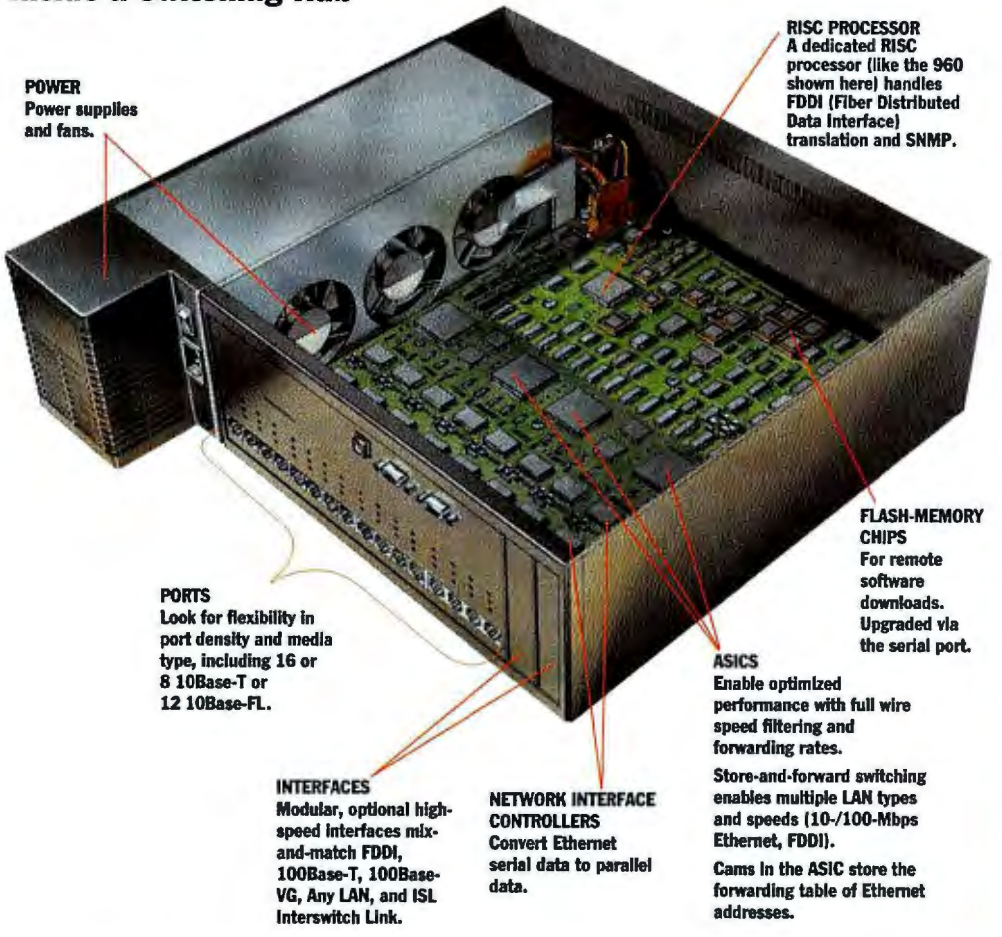
Using charts like the one shown here, we summarize test details about the winners and runners-up in each of these categories.



BEST

SAVE THE BANDWIDTH

Inside a Switching Hub



STORE-AND-FORWARD SWITCHES

BEST OVERALL
Lannet LET-10 MultiNet Switching Hub and LANswitch Modules
The LET-10 combines excellent performance, expandability, and robust management tools. **PAGE 165**

BEST STACKABLE
Nbase NH208 MegaSwitch
The competitively priced eight-port NH208 MegaSwitch is fast and simple. Lacking expansion options and multiple LAN support, it's suited for a small workgroup. **PAGE 165**

BEST RACK-MOUNTABLE
Lannet LET-10/20/36 MultiNet
The Lannet MultiNet switching hubs provide unmatched modular expandability. A single hub can support up to 120 Ethernet ports, and its 1.28-Gbps internal bus can handle intense bandwidth demands. **PAGE 165**

CUT-THROUGH SWITCHES

BEST OVERALL
NetWiz TurboSwitch-2000
The TurboSwitch-2000 excels in our benchmark tests, has the best features score, and offers the most expandability of the cut-through switches. **PAGE 167**

BEST STACKABLE
Ornet LANbooster 2000
The LANbooster 2000's back-pressure technique simply does not lose packets. Designed for reliability, it also offers a swappable switch module. **PAGE 167**

BEST RACK-MOUNTABLE
NetWiz TurboSwitch-2000
Highly expandable and flexible, the TurboSwitch-2000 supports several protocols simultaneously and has excellent network management tools. **PAGE 167**

Switching hubs come in both Ethernet and token-ring varieties. We tested only the Ethernet type. Store-and-forward switches receive each packet into a memory buffer and examine them for errors and undesirable fragments before transmission. Cut-through switches examine only the header segment of a frame to obtain its destination address (and source address for virtual LAN support) before they begin transmitting partially received packets. As a result, cut-through switches exhibit shorter latency (i.e., forwarding delays) than do store-and-forward switches. But store-and-forward switches provide protocol-based filtering and more sophisticated virtual LAN grouping based on membership rules.

In contrast to cut-through switches, store-and-forward switches can switch packets between standard Ethernet and Fast Ethernet or between standard Ethernet and FDDI (Fiber Distributed Data Interface) networks, when configured with both the standard and fast switch types. Cut-through switches cannot handle speed conversions unless they include some form of frame buffering. A fast network called vBNS (very high speed Backbone Network Service) was recently announced by MCI and the National Science Foundation. It combines ATM (asynchronous transfer mode) and SONET (Synchronous Optical Network) technologies and should achieve speeds of 600 Mbps by 1996. Advances such as this will make speed-switching devices essential.

We chose standard 10-Mbps Ethernet switches because they represent a large installed base. For in-house workgroup needs, 10 Mbps is usually sufficient.

TRADING SPEED FOR EFFICIENCY

STORE-AND-FORWARDS

Unlike a cut-through switch, which starts to transmit a frame before it has completely received it, a store-and-forward switch waits until it has received a whole packet into its buffer before forwarding it. By waiting to read the entire frame, a store-and-forward switch not only makes more involved routing decisions but can also filter out bad packets and shield destination LANs from corrupted or truncated frames. But there is a penalty for waiting to examine whole frames: long latency.

The store-and-forward switches tested have different configurations and expandability options. Thirteen of them are stackable, and the other 10 are chassis-based. Most stackable switches work with additional modules for switching between faster and slower wire speeds. OST's Xcellys-S is the only store-and-forward switch that offers a pluggable switch module. This design would save your investment in the housing and power supply if your switch module fails.

The stackable switches range in expandability from Xedia's six-port MAD-switch 10, which has one high-speed expansion slot, to 16-port switches based on the PlainTree WaveSwitch 100 (including the Fibronics FX8616 Switching Ethernet Hub, Proteon Series 80 p8900, and Xyplex SX-6601), with two high-speed expansion slots. The Alantec 12-port PowerHub Model 3500 featured two FDDI (Fiber Distributed Data Interface) expansion slots.

Even some chassis-based switches provide expansion options that can satisfy many midrange and some high-end network installations. These range from Cabletron's ESX-MIM, with 12 ports in its maximum configuration, to the Optical Data Systems 12-slot chassis version of the 1094-16EF, supporting up to 176 ports (we tested the seven-slot model). The Lannet LET-36 MultiNet, a larger-chassis version of the LET-10 that we tested, provides up to 120 ports and 64,000 address tables per switch port. The LET-10 also provides an intelligent, high-performance management application and the most complete virtual LAN support of all the switches we tested.

Variations in the performance of store-

PUTTING THE BRAKES ON RUNAWAY FRAMES

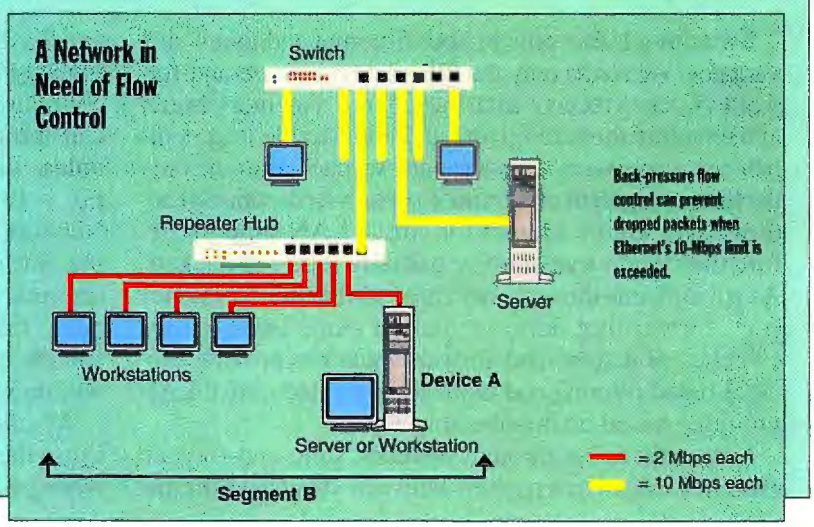
In a standard Ethernet installation, where several nodes transmit to a common destination, such as a file server, the total traffic on the destination port can exceed Ethernet's standard 10-Mbps wire speed. When this happens, overloaded ports are bound to drop packets. In addition to outfitting each port with hefty buffers, switch vendors are using back pressure and/or software flow control to prevent traffic jams. These techniques force the source addresses to slow down or hold a steady pace until the overloaded destination ports catch up with the forwarding.

Back pressure generates collision-detection signals in the CSMA/CD MAC-layer (media access control) protocol of Ethernet when a port is overloaded. These collision-detection packets from the congested port would "fake" the sending port into thinking that the collision is about to occur and therefore back off. This in turn forces a throttling back of the LAN segments that are experiencing congestion. When the sending ports try to transmit after the standard Ethernet delay time, the congested port may again send another collision-detection packet or accept the incoming frames if ready.

The figure illustrates the advantages and drawbacks of back pressure. (These scenarios are hypothetical, because they don't factor in normal collisions that delay throughput.) For the first scenario, let's assume that device A is a workstation and that each of the five workstations attached to the repeater hub transmits at 2 Mbps, for an aggregate transfer rate of 10 Mbps going into the switch port. If just the five workstations are transmitting to the file server, the aggregate at the switch port connecting the file server is within the legal Ethernet limit of 10 Mbps.

But if the two workstations directly attached to the switch each send data to the file server at 10 Mbps, this will create an aggregate rate of 30 Mbps at the switch port. This exceeds the Ethernet legal limit of a 10-Mbps wire rate. Without flow control, the file-server port would be forced to drop 67 percent ((30–10)/30*100) of the packets. In this case, back-pressure flow control would help, especially if it can be applied on a port-by-port basis.

But in the second scenario, assume that only two of the five systems on segment B send data through the repeater hub to the switch, and the two workstations connected directly to the switch are both sending data at 10 Mbps. Applying back pressure would slow down all five systems in segment B, because a repeater cannot transmit to selective ports.



and-forward switches are due in part to differing file I/O activities. In our high-level applications tests running under NetWare's standard IPX mode and under burst-mode IPX, average scores for the store-and-forward switches were slightly slower (within 15percent) than the performance of cut-through switches in our Excel for Windows 5.0 and Word for Windows 6.0 tests. However, store-and-forward switches were faster in the FoxPro for Windows 2.5 tests. Surprisingly, performance under FoxPro improves as latency increases, until a point of diminishing returns when latency becomes a hindrance.

This turnabout could have something to do with the timing characteristics or setup of FoxPro under NetWare, or maybe the lock-unlock requests that FoxPro makes to the file server have time-sensitive windows that simply appear to exhibit a bad showing under the 50-microsecond delay window. It could also occur if FoxPro bypasses the SPX of IPX/SPX. SPX performs checksums at the transport layer of the OSI (Open Systems Interconnection) model, and if errors aren't detected there, switches (on the lower network and data link levels) find the errors and retransmit packets over a longer connection.

Flow control (see the text box "Putting the Brakes on Runaway Frames" on page 164) also improves performance. If hubs can't keep up with demand, they waste time dropping and retransmitting packets.

Hardware-based back-pressure flow control is another high-performance feature, as exhibited by two cut-through switches (the NetWiz Turbo-Switch-2000 and Ornet's LAN-booster 2000) and also by two store-and-forward switches (Lannet's LET-10 and Nbase's NH208 MegaSwitch). Interestingly, the Xedia MAD-switch 10, with software-controlled back pressure, posted one of the highest latency scores.

If your network has a complex infrastructure with high demand for management support, expanded virtual LAN support, sophisticated filtering, and increased expansion options, you should be looking for a store-and-forward switching hub. But if performance happens to be your major concern, a cut-through switch with flow-control features is the way to go.

BYTE BEST — STORE-AND-FORWARDS

It does it all and does it well

BEST OVERALL — Lannet LET-10 MultiNet Switching Hub and LANswitch Modules

If cost is no object, one of the MultiNet series (the LET-20 and LET-36 are similar to the LET-10, just larger) is the switch for you. The MultiNet switch gamers top billing by combining excellent performance; a wealth of expansion options that support Fast Ethernet, token ring, and FDDI (Fiber Distributed Data Interface) in the future; and ease of use through excellent management. It shines in both the low-level and applications performance tests, thanks to some impressive latency figures (for a store-and-forward switch) and a highly effective back-pressure implementation that yields zero packet loss.

	VENDOR/MODEL	PRICE PER PORT TEST CONFIGURATION	OVERALL EVALUATION SCORE	PERFORMANCE	FEATURES	USABILITY	BUFFER SIZE PER PORT	MAX. PORTS PER SWITCH	MAX. MAC ADDRESS/PORT	SWITCHING RATE
BEST	Lannet Data LET-10 MultiNet	$283	9.45	▲▲▲▲▲	▲▲▲▲	▲▲▲▲▲	16 KB	120	64,000	2 million
RUNNER-UP	NBase Switch NH208 MegaSwitch	$615	8.59	▲▲▲▲	▲▲▲	▲▲▲	24 KB	8	2048	14,881
RUNNER-UP	OST Xcellys-M	$832	8.30	▲▲▲▲	▲▲▲	▲▲▲▲	—[1]	24	4048	240,000
RUNNER-UP	OST Xcellys-S	$574	8.31	▲▲▲▲	▲▲▲	▲▲▲▲▲	—[1]	6	1024	60,000

For small, stable workgroups

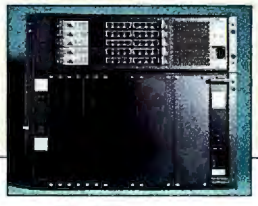
BEST STACKABLE — Nbase NH208 MegaSwitch

The competitively priced NH208 MegaSwitch targets small workgroups that don't need expansion options and multiprotocol LAN support. The eight-port switch doesn't excel in the frills department, but it has the performance network administrators need to break through bandwidth barriers.

	VENDOR/MODEL	PRICE PER PORT TEST CONFIGURATION	OVERALL EVALUATION SCORE	PERFORMANCE	FEATURES	USABILITY	BUFFER SIZE PER PORT	MAX. PORTS PER SWITCH	MAX. MAC ADDRESS/PORT	SWITCHING RATE
BEST	NBase Switch NH208 MegaSwitch	$615	8.59	▲▲▲▲	▲▲▲	▲▲▲	24 KB	8	2048	14,881
RUNNER-UP	OST Xcellys-S	$574	8.31	▲▲▲▲	▲▲▲	▲▲▲▲▲	—[1]	6	1024	60,000
RUNNER-UP	3Com SuperStack LinkSwitch	$1165	8.21	▲▲▲▲	▲▲	▲▲▲	128 KB	6	169	89,280

For large LANs that keep growing

BEST RACKMOUNTABLE — Lannet LET-10/20/36 MultiNet



In addition to excellent performance, the Lannet MultiNet switching hubs provide unmatched modular network expansion. A single hub can house up to 18 full-height or 36 half-height modules and support up to 120 Ethernet ports. A 1.28-Gbps internal bus can handle bandwidth-intensive transmissions, such as voice and video.

	VENDOR/MODEL	PRICE PER PORT TEST CONFIGURATION	OVERALL EVALUATION SCORE	PERFORMANCE	FEATURES	USABILITY	BUFFER SIZE PER PORT	MAX. PORTS PER SWITCH	MAX. MAC ADDRESS/PORT	SWITCHING RATE
BEST	Lannet Data LET-10 MultiNet	$283	9.45	▲▲▲▲▲	▲▲▲▲	▲▲▲▲▲	16 KB	120	64,000	2 million
RUNNER-UP	OST Xcellys-M	$832	8.30	▲▲▲▲	▲▲▲	▲▲▲▲	—[1]	24	4048	240,000
RUNNER-UP	Xyplex SX-6001	$600	8.21	▲▲▲▲	▲▲▲▲	▲▲▲▲	256 KB	16	1000	238,000

[1] Shared-RAM architecture.

KEY

Ratings from 1 to 5: ▲ is the lowest; ▲▲▲▲▲ is the highest.

SWITCHING ON THE FLY

CUT-THROUGHS

Categorically, cut-through switches begin forwarding frames before they entirely receive them—on the fly. In our tests, the six cut-through switching hubs exhibited slightly shorter latency than the 23 store-and-forward switches. Latency varies according to many factors, including how well a switch "slices" or "cuts" a frame before transmitting it and whether it reads just the first 6 bytes for a destination address, the first 12 bytes for the entire MAC (media access control) address (including the source address), or the entire frame for a CRC (cyclic redundancy check). In the last case, the switch is using store-and-forward techniques. Forwarding delays also increase when incoming traffic is hampered by outgoing traffic.

Of the cut-through switches, only the NetWiz TurboSwitch-2000 lets you preselect a latency value. Most of the others opt for the middle ground and read the entire MAC address (necessary for virtual LAN support) before transmission.

Although a cut-through switch can achieve lower forwarding delays than a store-and-forward switch, it may suffer from errors received during its travels. This is likely because switches can detect errors only by reading the end of each frame. Error propagation is a particular concern with Ethernet, because the Ethernet protocol specifies the generation of corrupted and truncated frames for flow control. The TurboSwitch-2000 has a clever workaround for this problem. Although it doesn't block bad frames, it does calculate CRCs for each frame and reports statistics back to the management station for monitoring and possibly for an error-correction decision at a higher protocol layer.

Three of the six cut-through switches we tested are stackable, and three are rack-mountable. Of the stackable models, only Ornet's LANbooster 2000 provides a pluggable switch module. This design lets you swap a defective switch with a standby unit to allow continued network operation while the defective switch module undergoes repair. The other two stackable cut-through switches—Hewlett-Packard's EtherTwist LAN Switch and the IBM 8271 EtherStreamer Switch Model 1—are not expandable. The only way to expand them is by stacking more switch units.

The three rack-mountable cut-through switches allow for expansion. Kalpana's three-slot EtherSwitch EPS-2115M can be expanded to 15 ports, the Fibronics GigaHub supports 72

XNET SERIES 1800 PARALLELSWITCH

If you want to improve NetWare network performance without the expense of a stand-alone switch, you might consider a server-based Ethernet switch, such as the XNET Series 1800 ParallelSwitch from XNET Technology (Milpitas, CA). Unlike the external switches in our test-bed, the Series 1800 is an internal card that provides a direct link into a file server via an ISA, EISA, or PCI (Peripheral Component Interconnect) bus slot. We tested an EISA version.

The Series 1800 needs the file server for loading the necessary NLM (NetWare loadable module) to initialize the switch and for running its NLM-based management program. It does not need the server for its basic switching functions, although, generally, this is not a useful configuration. We tested the switch in a Compaq ProSignia 486/33 running NetWare 3.12. The Series 1800 delivered slightly better-than-average performance results in both the low-level and applications tests.

The Series 1800 has six full-bandwidth Ethernet ports and the one bus interface. It is a store-and-forward switch with a RISC processor and an address capacity of 8000. (The ISA version supports only 4000 addressees.) The $3288 switch (as configured for testing with a BNC connector) costs less than the external switches, but when you consider the $499-per-port cost, it's no great shakes. The 1-MB ISA version costs $1988, and the 2-MB EISA and PCI versions with UTP (unshielded twisted-pair) connectors cost $2988.

The server-based XNET Series 1800 ParallelSwitch is a store-and-forward switch with a RISC processor, six full-bandwidth Ethernet ports, and an address capacity of 8000.

XNET's Series 1800 provides a dedicated 10-Mbps bandwidth to each of its six ports, or you can use it as an integrated switch with a high-speed server interface. This integrated approach to switching allows communication between devices from six Ethernet segments and the file server, achieving the maximum bandwidth of 60 Mbps. The switch has multiple management capabilities, including an NLM-based management console, SwitchCON, an SNMP agent, and both in-band management and an optional RS-232 terminal console for out-of-band management.

ports, and the NetWiz TurboSwitch-2000's Maxi Chassis (which is a big brother of the 18-port Mini Chassi unit) supports 120 ports per chassis. The maximum number of supported MAC addresses on each port varies from 1700 (for the Kalpana EtherSwitch EPS-2115M, HP's EtherTwist LAN Switch, IBM's 8271 EtherStreamer Switch Model 1, and Fibronics' GigaHub) up to 131,000 addresses for Ornet's LANbooster 2000.

Cut-through switches perform slightly better than store-and-forward switches in standard NetWare IPX protocol tests. On average, the cut-through switches show an appreciable performance advantage over their store-and-forward counterparts in the Excel and Word for Windows tests, but the results are reversed in the FoxPro for Windows tests. Under burst-mode IPX, the performance gap remains essentially the same for Excel, it's slightly narrowed for Word, and it reverses for FoxPro in favor of the store-and-forward switches. We expected the Word test results, because Word file I/O activity is basically similar to a file transfer activity. Simple read/write requests should closely correlate with latency characteristics, and Excel's file I/O characteristics are similar.

There is a huge performance gap between the best and the worst cut-through switches. This reflects how the various switch designs, architectures, and methods of handling latency affect performance. The TurboSwitch-2000 and LANbooster 2000 are considerably faster than the other four.

KEY

Ratings from 1 to 5: ▲ is the lowest; ▲▲▲▲▲ is the highest.

A highly expandable switching meister

BEST OVERALL — NetWiz TurboSwitch-2000

The TurboSwitch-2000 edges out Ornet's LANbooster 2000 for the best performance in our benchmark tests; the two totally outdistance the other four products. With its combination of back-pressure flow control and high frame rates (up to 10 million frames per second in its maximum configuration), the TurboSwitch-2000 performs superbly in both the low-level and applications benchmarks. The NetWiz switch also has the best features score and offers the most expandability of all the cut-through switching hubs.

	VENDOR/MODEL	PRICE PER PORT TEST CONFIGURATION	OVERALL EVALUATION SCORE	PERFORMANCE	FEATURES	USABILITY	BUFFER SIZE PER PORT	MAX. PORTS PER SWITCH	MAX. MAC ADDRESS/PORT	SWITCHING RATE
BEST	NetWiz TurboSwitch-2000	$570	9.45	▲▲▲▲▲	▲▲▲▲	▲▲▲▲	256 KB	120	64,000	10 million
RUNNER-UP	Ornet Data LANbooster 2000	$795	8.75	▲▲▲▲▲	▲▲	▲▲▲	256 KB	12	131,000	176,400
RUNNER-UP	Fibronics GigaHub	$739	8.54	▲▲▲▲	▲▲▲	▲▲▲▲	256 KB	72	1700	44,640
RUNNER-UP	Kalpana EtherSwitch EPS-2115M	$650	8.05	▲▲▲	▲▲▲	▲▲▲▲▲	512 KB	15	1700	223,200

A pick-me-up for tired LANs

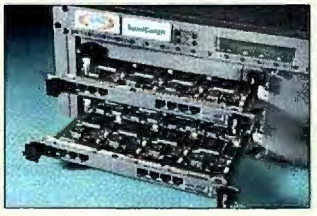
BEST STACKABLE — Ornet LANbooster 2000

If you work with a small workgroup that doesn't require expansion options or multiple LAN support capabilities, Ornet's LANbooster 2000 is the perfect choice. Performance-wise, it finished right on the heels of the NetWiz TurboSwitch-2000. Its zero-packet-loss back-pressure technique accounts for much of this sterling performance. And in the case of a switch module failure, you can swap the 12-port switch module to minimize downtime.

	VENDOR/MODEL	PRICE PER PORT TEST CONFIGURATION	OVERALL EVALUATION SCORE	PERFORMANCE	FEATURES	USABILITY	BUFFER SIZE PER PORT	MAX. PORTS PER SWITCH	MAX. MAC ADDRESS/PORT	SWITCHING RATE
BEST	Ornet Data LANbooster 2000	$795	8.75	▲▲▲▲▲	▲▲	▲▲▲	256 KB	12	131,000	176,400
RUNNER-UP	HP EtherTwist LAN Switch	$570	7.89	▲▲▲▲	▲▲▲	▲▲▲	128 KB	6	1700	14,880

It's expandable, fast, and flexible

BEST RACKMOUNTABLE — NetWiz TurboSwitch-2000



Highly modular, with plenty of room for expansion, the TurboSwitch-2000 series (which includes the four-slot Mini Chassis and the 20-slot Maxi Chassis) supports from eight to 120 LAN ports. It accommodates Ethernet, token-ring, and FDDI (Fiber Distributed Data Interface) support in the same chassis, and it also provides a flexible management capability you can access via an RS-232 connection directly on the CPU module, an external terminal connection, or the vendor's SNMP-compliant management application.

	VENDOR/MODEL	PRICE PER PORT TEST CONFIGURATION	OVERALL EVALUATION SCORE	PERFORMANCE	FEATURES	USABILITY	BUFFER SIZE PER PORT	MAX. PORTS PER SWITCH	MAX. MAC ADDRESS/PORT	SWITCHING RATE
BEST	NetWiz TurboSwitch-2000	$570	9.45	▲▲▲▲▲	▲▲▲▲	▲▲▲▲	256 KB	120	64,000	10 million
RUNNER-UP	Fibronics GigaHub	$739	8.54	▲▲▲▲	▲▲▲	▲▲▲▲	256 KB	72	1700	44,640

How We Tested

Our test suite evaluates the 29 10-Mbps Ethernet switches' performance by passing them through two rounds of benchmark tests. For each benchmark, we tested the switching hubs that arrived with fewer than eight ports in a six-port configuration, and those with eight or more ports in an eight-port configuration. The overall scores combine low- and high-level performance scores (75 percent), features (15 percent), and usability (10 percent).

CONFIGURATIONS

The low-level benchmark test setup consists of three dual-analyzer DA-30s (see the text box "The Analyzers") connected to the switches with six ports and four DA-30s connected to those with more than six ports. Each of the two analyzers from each DA-30 attaches to one switch port through its AUI (attachment unit interface) connector. We configure one DA-30 as a master, and the remaining analyzers in the group of DA-30s serve as slaves. (In the latency test with multicast traffic, the traffic-generating DA-30s have their own master and slave stations separate from the DA-30 that measures latency.) The master initiates each test and collects results by using an out-of-band trigger line hooked to a BNC connector.

We used 10 75-MHz Dell Dimension XPS P75 Pentium systems with IDE drives for the applications tests. We configured one as a file server with a 525-MB Quantum 525AT hard drive and 16 MB of RAM. The other nine systems have 300-MB hard drives and 8 MB of RAM; four serve as traffic generators, and five run the applications tests. The server runs NetWare 3.12, and the workstations run MS-DOS 6.22 and Windows 3.1. While undergoing testing, the switching hubs dedicate ports to the server and to each of the four traffic stations. The five workstations running applications macros share a single switch port via a 16-port Kingston repeater hub.

PERFORMANCE

The performance score of each switching hub is a weighted average of the low-level benchmark scores and the high-level applications test results. The low-level benchmarks provide highly repeatable and consistent performance numbers. But low-level throughput tests rarely represent real-world network activity. Different applications create frames of varying sizes and use irregular timing constraints; our applications tests perpetrate these undesirable performance effects that are inherent in actual use. The applications' setup, environment, and hub configuration also contribute to the high-level performance scores.

LOW-LEVEL BENCHMARKS

Our *latency tests* measure the duration between when a packet arrives at a port and when it is sent out through another port. We involve only two ports in this benchmark and use a FIFO (first-in/first-out) approach—instead of last-out/first-in, which may give misleading results—to measure a sampling of thousands of frame transmissions.

The latency figure is an

THE ANALYZERS

We're using 10 Wandel & Goltermann Technologies' DA-30 protocol analyzers to test the low-level performance of the Ethernet switches in our test-bed. You can configure the DA-30s to be single or dual analyzers for single network tests or for simultaneous operation on networks with different topologies. DA-30s monitor network traffic by capturing it in memory and then writing to disk for further analysis. They also can generate their own traffic for simultaneously testing other network nodes or components. For this article, we use the DA-30 as a traffic generator in its dual-analyzer configuration.

The DA-30's architecture divides network analysis into three sections: network interfacing, protocol analysis, and the user interface. Each section has its own processor working in parallel with the other tasks.

Based on an Inmos transputer, the network-interface processor handles the setup and implementation of up to 256 hardware address filters, time stamping, and communication with other processors. As many as four different interfaces (e.g., Ethernet, token ring, V.24, and LED displays) can be installed in a standard DA-30.

The DA-30 protocol analyzer captures and generates network traffic.

Another transputer serves as a protocol analyzer to capture frames at network speeds. The transputer executes multiple parallel processes, one for each layer of the OSI (Open Systems Interconnection) protocol stack and one for central control and interaction with the other processors.

The DA-30's third processor, an Intel 386SX, manages the user interface similar to how a 386 manages a typical 386 PC. It incorporates all the standard PC I/O interfaces. The AT bus serves as a communications link between the user-interface module and the two analyzer modules.

average travel time for 64-byte frames (the smallest legal Ethernet frame size), with and without traffic, and for 1518-byte frames (the largest legal Ethernet frame size), with and without traffic. To determine the traffic-handling ability of the switches' backbone, we multicast 64-byte packets among four ports uninvolved in the latency measurement, using five MAC (media access control) addresses and 25 percent of each transmitting unit's bandwidth.

We also run a *port overload test*. Per switching hub, one port receives and the others transmit 64-byte packets. Each port sends from five MAC addresses. We run this test at a 2000-frame-per-second transmission rate and again at 3000- and 4000-fps rates. The port overload score is a ratio of the total packet count the overloaded port acknowledges to the sum of all the packets transmitted to it.

During our *throughput (packet loss) test*, each analyzer unit on a DA-30 is set up with five MAC addresses and transmits 64-, 128-, and 1518-byte frames to every other analyzer unit on the switch. In other words, on a six-port switch, one port sends to five other ports and receives from five other ports, in crisscross traffic. We test this at 50 percent and 100 percent utilization, once with broadcast traffic and once without. We also test the 64-byte packets with 1 percent and 10 percent broadcast traffic at 50 percent and 100 percent network-utilization levels.

The *behavior test* rates how well the switching hubs handle illegal frames, FCS (frame check sequence) errors, runt frames (shorter than 64 bytes), and run-on frames (longer than 1518 bytes). For each behavior test, we configure each DA-30 to generate 64-byte frames (and 1518-byte frames for the FCS test) at a 10 percent error rate with 10 percent overall network use and one destination MAC address.

APPLICATIONS BENCHMARKS

In the high-level applications benchmarks, four workstations running traffic, each on a dedicated switch port, engage in two paired "conversations." A sends an IPX packet to B, B sends to A, C sends to D, and D sends to C. In each paired conversation, one station transmits longer frames (1024-byte IPX packets) while the other sends 229-byte IPX packets, for a combined network-utilization level of 100 percent.

This test indicates how the switches operate with no bandwidth to spare. Five workstations running applications tests share a single 10-Mbps port via a repeater hub and communicate with a NetWare 3.12 file server on a dedicated 10-Mbps switch port. The workstations run Excel 5.0, Word for Windows 6.0, and FoxPro for Windows 2.5 macros under the control of a "master" workstation, each for 5 minutes. The benchmarks measure the speed of network file I/O activity when loading and saving files, and under FoxPro, for record lock and unlock actions.

We automate the applications tests through a Windows application manager. Each workstation reads from and writes to a network disk in all the applications tests. We run this suite once in standard-mode IPX and once in burst-mode IPX for each switching hub. Benchmark results for each application constitute the average transaction time in milliseconds for a specific I/O transaction (e.g., file open and file save), compiled from the five workstations' scores.

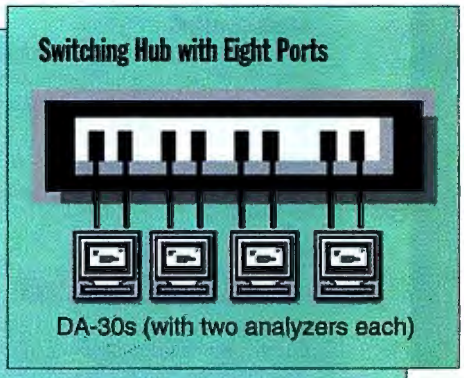
EASE OF USE AND FEATURES

To evaluate ease of use, we examine documentation for organization, comprehensiveness, clarity, diagrams, and examples. We also rate how well the LED indicators communicate link status, traffic, collisions, error conditions, and fault isolation. We rate the ease of setup and device management. Basically, the documentation for the majority of these switches applies to operation and the management interface. However, we didn't deem documentation worthy unless it also included a description of and key for LED indicators, including the colors and various sequences that signify fault conditions.

We looked into such features as pluggable switch modules, hot-swappable and redundant power supplies, expansion options, and support for high-speed backbones and virtual LANs to arrive at a features score. We weight individual features based on our judgment of each one's importance.

SWITCH TEST BENCH

To monitor a switch, you must define an application to measure it. Our low-level benchmark tests are based on Wandel & Goltermann's Switch Test Bench test suite. The Switch Test Bench applications test Ethernet switches under high-stress, real-world conditions. The application generates random patterns of multidirectional traffic on the ports being tested and then tests the switch for characteristics such as packet loss, throughput, latency, error handling, and overload conditions.



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Hub Glossary

ACTIVE PORT
A switch or a repeater hub port through which communication is taking place.

ADDRESS AGING
A spanning-tree parameter that controls how long a switch or bridge/router must keep learned addresses in its address table before they are discarded and replaced by new ones.

ADDRESS TABLE FILTER
A mechanism by which devices such as a switch or bridge/router selectively forward or discard (filters) data by using address table information.

AGENT
The software component that is embedded onto an internetworking device, such as a switch,

via firmware, or downloaded into the device's memory via software, to provide SNMP-compliant (or some other management standard) information about the device's status. In an SNMP-compliant device, the agent performs information preparation and exchange with the NMS (network management station) via such management primitives as SET, GET, and GETNEXT, and generates traps.

ASICS
Computer chips developed for such functions as implementing a switching matrix on a network switching hub device.

ATM
A connection-oriented network technology that uses small, fixed-size cells at the lower data-communications protocol layer. ATM (asynchronous transfer mode) promises to provide high-speed network services for voice, video, and data traffic with a single underlying technology.

BACKBONE
A high-speed network medium to which multiple LANs are connected using switches and/or bridges/routers and over which internetwork traffic is channeled.

BANDWIDTH
A measure of the amount of network traffic the transmission medium can handle at one time. In a LAN, bandwidth describes the amount of data that can be transmitted over the line in bits per second.

BRIDGE
A store-and-forward device that operates at the data link layer to connect similar and sometimes dissimilar LANs.

BROADCAST
A packet-delivery system; copied packets are passed to all participating stations attached to the network.

CRC
A value computed from a sequence of octets (i.e., bytes) to detect errors that occur during data transmission. Typically, packet-switching network hardware computes a CRC (cyclic redundancy check) and appends it to a packet when transmitting. On a standard Ethernet LAN, this is known as the FCS (frame check sequence). Upon reception, the hardware verifies the contents of the packet by recomputing the CRC and comparing it to the CRC attached to the data it receives.

CSMA/CD
A network medium access method in which each participating station waits for a clear channel before starting to transmit a packet. As part of the communications protocol, each participating station is able to detect collisions and retransmit.

DESTINATION ADDRESS
The first 6 bytes in a standard Ethernet frame, which contains the address of the station to which a frame is being sent.

DYNAMIC ADDRESS
An address learned by an intelligent network interconnection device, such as a bridge or a switch (by reading it from the data packets it processes), as opposed to addresses that are manually entered into the device's address table.

ETHERNET
A LAN communications system using 10- and now 100-Mbps baseband transmission, CSMA/CD access, logical-bus topology, and 10Base-5 (thick-wire Ethernet), 10Base-2 (coaxial), or 10Base-T (UTP or STP) cable.

ETHERNET STATION
An addressable device or node on an Ethernet network capable of transmitting, repeating, and/or receiving data.

FCS ERROR PACKET
A data packet that was received with an integral number of octets in length but does not pass the FCS check.

FRAME
A group of digits transmitted as a unit, over which a coding procedure is applied for synchronization (synonym: packet).

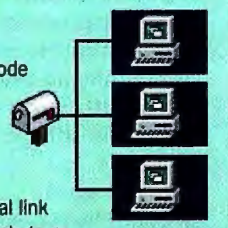
HARDWARE ADDRESS
The low-level address used by physical networks. Each type of network hardware has its own addressing scheme.

IN-BAND MANAGEMENT
The process of managing a device over a network using such protocols as TFTP (i.e., Telnet).

LATENCY
On a network switch, this indicates the time between when a packet arrives at a port to the time when it is retransmitted via a destination port. It also refers to the time between when a network station seeks access to a transmission channel and when access is granted or received.

MAC
The sublayer within the data link layer of the IEEE-802 model for data communications over Ethernet that's responsible for scheduling, transmitting, and receiving data on a shared-medium LAN. MAC (media access control) addresses are unique, 48-bit, binary numbers (usually represented as a 12-digit hexadecimal number) encoded in a device's circuitry to identify it to a LAN.

MULTICAST
A type of network addressing that enables a node to send messages or data packets to an address that represents a group of stations rather than a single station.



OUT-OF-BAND MANAGEMENT
The managing of a device over an RS-232 serial link using such protocols as SLIP to transmit IP packets or using a standard terminal emulation (e.g., VT100).

PACKET
The unit of data sent across a packet-switching network (synonym: frame).

ROUTER
An intelligent interconnection device that decides which of several paths network traffic will follow. Routers use a routing protocol to gain information about the network topology and algorithms to choose the best route based on several criteria known as routing metrics. As internetworking devices, they open a virtual network to connect a sending station with a receiving station.

SNMP
A standard protocol used to monitor hosts, routers, and the networks to which they attach.

Sources for glossary: *HUBwatch for Windows User Manual*, Digital Equipment Corp., and *Internetworking with TCP/IP, Volume I: Principles, Protocols, and Architecture* by Douglas E. Comer, Prentice-Hall, 1995.

Scaling Up with One MAC Address

What if you prefer a dedicated 10-Mbps port for each network device rather than having them share a 10-Mbps switching port? The FastSwitch 10/100 AG Workgroup Switch from Grand Junction Networks (Fremont, CA) uses one MAC (media access control) address per port. It is a true workgroup switch, combining 24 dedicated 10-Mbps ports per workstation using only one MAC address per port, as well as a dedicated or shared 100-Mbps Fast Ethernet port. The FastSwitch lets you build networks of 10 to 200 users and eight servers across a 100-Mbps backbone.

The FastSwitch 10/100 AG Workgroup Switch.

The FastSwitch boasts an impressive low latency of only 29 microseconds and no packet loss at up to 100 percent network usage for any frame size within the legal Ethernet network transmission rate, even with short frame lengths and broadcast traffic. Its performance results in the applications tests were also impressive. We would have compared it to the other switches but excluded it because it has only one MAC address per port (the 48-bit number unique to each LAN card). Unfortunately for the FastSwitch, most of our throughput tests use five MAC addresses per port for crisscross traffic.

The FastSwitch has 30 ports, including:

- 24 10-Mbps Switched Personal Ethernet ports that each connect to a single workstation via an RJ-45 connector
- a 100-Mbps Switched Fast Ethernet port that connects to a single server, workstation, another FastSwitch, or other 100Base-X compatible devices via an RJ-45 connector
- four 100-Mbps Shared Fast Ethernet ports that connect to servers, workstations, another FastSwitch, or other 100Base-X compatible devices via RJ-45 connectors (as a shared switch, it can be split into four 2.5-Mbps segments)
- a 10-Mbps Switched General Ethernet port that can be used for uplinking to another FastSwitch 10/100 AG; connect to a multiaddress device or network via an RJ-45, AUI (attachment unit interface), or BNC connector, or to a twenty-fifth workstation for use as a Personal Ethernet port

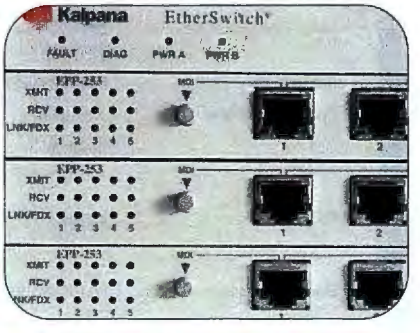
The FastSwitch's front panel has a vast array of status LEDs. Each Shared Fast Ethernet port has three status LEDs: link integrity, receive, and disabled. There are also two group-related LEDs for collision and activity. At $8950, the FastSwitch's price works out to a comfortable $298 per port, extremely competitive with the price of any switch we tested.

HONORABLE MENTIONS

NetWiz's TurboSwitch-2000, Fibronics' GigaHub, and Xedia's MADswitch 10 all provided MIB (Management Information Base) access via the front-panel LCD console. They also let you operate the hub and receive log data, statistics, and diagnostics via the LCD console.

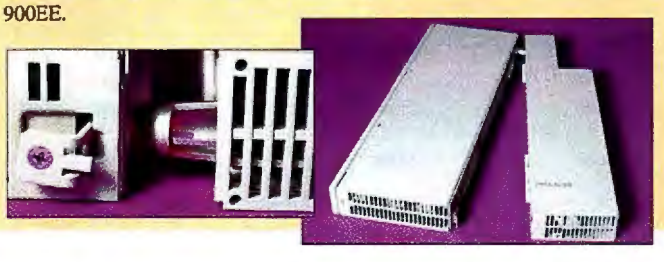
Having to access software via the RS-232 terminal consoles for advanced management tasks is a necessary undertaking (you need access to the device's firmware-based MIB to assign IP addresses to a port on a TCP/IP network) if your switch doesn't have a configurable panel interface. Finding the right cable with the right connectors to fit the switch and the PC—to say nothing of the trouble you might have due to different port pin-outs—can be a challenge.

Configurable port connections: Fibronics, Cabletron, and Kalpana support ways to use both straight-through and cross-connect cables. Typically, straight-through cables (or end-node connections) are used to connect workstations or servers to a hub; cross-connect cables are used to connect hubs to one another. Fibronics' GigaHub has two ports for cross-connect cables, and the last port on Cabletron's ESX-MIM, which is a snap-on port module, allows straight-through or cross-connect port configuration via a slide switch. Also, the first port on Kalpana's EtherSwitch EPS-2115M switch toggles via a push button (easily the most convenient method).



DUBIOUS ACHIEVEMENTS

Both Digital Equipment's PEswitch 900TX and DECswitch 900EE can work with a snap-on DEChub One "power and out-of-band terminal connection" module that occasionally fails to make proper contact and crashes the switch. A locking L-bracket on the DEChub One presses on a delicate electrical hot-swap switch on the network module; we had to physically adjust the contact bar to get power on the DECswitch 900EE.



CUT-THROUGH

STORE-AND-FORWARD

ROLL CALL OF ETHERNET

VENDOR	MODEL	PRICE AS TESTED	PRICE PER PORT	OVERALL SCORES	PERFORMANCE SCORES	FEATURES SCORES	USABILITY SCORES	MAXIMUM PORTS SUPPORTED	SWITCH MFR.	SWITCHING TECHNIQUE
Fibronics International, Inc.	GigaHub	$5700	$739	8.54	8.61	7.97	8.85	72	Kalpana	Frame (packet) switching
Hewlett-Packard Co.	EtherTwist LAN Switch	$3399	$570	7.89	8.01	7.26	7.96	6	Kalpana	Frame (packet) switching
IBM Corp.	IBM 8271 EtherStreamer Switch Model 1	$4800	$600	7.88	8.07	7.00	7.78	8	Kalpana	Frame (packet) switching
Kalpana, Inc.	EtherSwitch EPS-2115M	$9750	$650	8.05	7.86	7.94	9.62	15	Kalpana	Frame (packet) switching
NetWiz, Ltd.	**TurboSwitch-2000**	**$14,880**	**$570**	**9.45**	**9.65**	**8.89**	**9.80**	**120**	**NetWiz**	**Frame (packet) switching**
Ornet Data Communications Technologies, Ltd.	**LANbooster 2000**	**$9540**	**$795**	**8.75**	**9.33**	**6.93**	**7.08**	**12**	**Ornet**	**Cell switching**
Alantec Corp.	PowerHub Model 3500	$19,800	$1650	7.58	7.29	8.59	8.25	12	Alantec	Frame (packet) switching
Bytex Corp.	Enterprise LAN Switch	$18,150	$786	7.49	7.19	8.59	8.11	64	Xylan	Frame (packet) switching
Cabletron Systems, Inc.	ESX-MIM	$8995	$1499	7.75	7.54	8.79	7.78	7	Cabletron	Frame (packet) switching
Digital Equipment Corp.	DECswitch 900EE	$6345	$1057	8.10	7.99	8.37	8.50	6	DEC	Frame (packet) switching
Digital Equipment Corp.	PEswitch 900TX	$4345	$724	8.09	7.95	8.56	8.50	6	DEC	Frame (packet) switching
Fibronics International, Inc.	FX8616 Switching Ethernet Hub	$10,450	$653	7.97	7.95	7.64	8.60	16	PlainTree	Frame (packet) switching
Lancast Technologies, Inc.	Ethernet Switch Model 5608	$4149	$500	8.21	8.53	7.69	6.57	8	NetVantage	Frame (packet) switching
Lannet Data Communications, Ltd.	**LET-10 MultiNet Switching Hub and LANswitch Modules**	**$28,670**	**$283**	**9.45**	**9.62**	**8.48**	**9.60**	**120**	**Lannet**	**Cell switching**
Nbase Switch Communications, Inc.	**NH208 MegaSwitch**	**$3995**	**$615**	**8.59**	**8.87**	**7.66**	**7.91**	**8**	**NBase**	**Frame (packet) switching**
Network Peripherals, Inc.	EIFO Client/Server Switching Hub	$7495	$576	8.18	8.47	7.37	7.23	12	NPI	Frame (packet) switching
NetWorth, Inc.	PowerPipes Ethernet/FDDI Hub	$8995	$643	7.85	8.07	6.89	7.64	12	NPI	Frame (packet) switching
Optical Data Systems, Inc.	1094-16EF	$11,400	$712	7.95	7.88	7.67	8.94	176	PlainTree	Frame (packet) switching
OST, Inc.	Xcellys-M	$9995	$832	8.30	8.47	7.67	8.00	24	OST	Cell switching
OST, Inc.	Xcellys-S	$3445	$574	8.31	8.37	7.54	9.03	6	OST	Cell switching
PlainTree Systems, Inc.	WaveSwitch 100	$9500	$595	7.97	7.94	7.50	8.93	16	PlainTree	Frame (packet) switching
Proteon, Inc.	Series 80 p8900	$7995	$499	7.86	7.92	6.96	8.82	16	PlainTree	Port switching
Standard Microsystems Corp.	EliteSwitch ES/1	$33,000	$1650	7.46	7.00	8.56	9.23	20	SMC	Frame (packet) switching
Standard Microsystems Corp.	TigerSwitch XE	$9450	$394	6.98	6.63	8.12	7.89	20	SMC	Frame (packet) switching
3Com Corp. 1200	SuperStack LinkSwitch	$6995	$1165	8.21	8.59	6.73	7.64	6	3Com	Frame (packet) switching
UB Networks, Inc.	DragonSwitch	$13,200	$825	7.29	7.27	7.58	7.01	80	UB	Frame (packet) switching
Xedia Corp.	MADswitch 10	$2995	$499	8.10	8.37	7.63	6.86	6	Xedia	Cell switching
Xylan Corp.	OmniSwitch	$18,150	$850	7.64	7.45	8.31	8.11	64	Xylan	Frame (packet) switching
Xyplex, Inc.	SX 6601	$9995	$600	8.21	8.14	8.16	8.77	10Base-T, 16; 10Base-FL, 12	PlainTree	Frame (packet) switching

= BYTE Best.

N/A = not applicable.

SWITCHING HUBS TESTED

CONFIGURATION	SWITCHING RATE (PPS)	BUFFER SIZE PER PORT	MAX. MAC ADDRESSES PER PORT/ PER CHASSIS	INTERNAL ARCHITECTURE	VIRTUAL LANS SUPPORTED/ PER SWITCH	UPGRADABLE TO ISDN/ATM	TOLL-FREE PHONE	PHONE	ON-LINE ADDRESS	INQUIRY NUMBER
Chassis-based	44,640	256 KB	1700/6000	ASIC on cross-point matrix	No/N/A	No/Yes	(800) 327-9526	(508) 671-9440	http://www.fibronics.co.il	1396
Stackable	14,880	128 KB	1700/6000	Cross-point switching matrix	No/N/A	No/No	(800) 533-1333	Contact local Hewlett-Packard dealer.	http://www/hp.com	1397
Stackable	14,880	500 KB	1700/6000	VLSI	Yes/4	No/No	(800) 426-2255	Contact local IBM dealer.	http://www.raleigh.ibm.com/nethard.html	1398
Chassis-based	223,200	512 KB	1700/10,000	Cross-point switching matrix VLSI and distributed memory	Yes/7	No/No	(800) 525-7262	(408) 749-1600	http://www.kalpana.com	1399
Chassis-based	10 million	256 KB	64,000/64,000	Central matrix with distributed	Yes/128	No/Yes	N/A	+972 4 376656	netwiz@actcom.co.il	1400
Stackable	176,400	Shared-RAM architecture	131,000/131,000	ASIC-based nonblocking switching core	Yes/256	Yes/Yes	N/A	+972 4 9961314	support@ornet.co.il	1401
Chassis-based	80,000	96 KB	8192/8192	Dual RISC with shared memory	Yes/256	No/Yes	(800) 252-6832	(408) 955-9000	powerhub@alantec.com	1402
Chassis-based	200,000	256 KB	2000/16,000	Distributed RISC and distributed memory	Yes/32	No/Yes	(800) 227-1145	(508) 366-8000	http://www.network.com	1403
Chassis-based	14,777	Shared-RAM architecture	8000/8000	Dual RISC with shared memory	Yes/Unlimited	Yes/Yes	N/A	(603) 332-9400	http://www.ctron.com	1404
Stackable	62,500	500 KB-1.5 MB	64 distributed across six Ethernet ports, 7936 FDDI ports/ 8000 per switch	Multiple Motorola processors with distributed VLSI	No/N/A	No/No	(800) 344-4825	Contact local DEC dealer.	http://www.digital.com	1405
Stackable	62,500	500 KB-1.5 MB	1333/8000 per switch	Multiple Motorola processors with distributed VLSI	No/N/A	No/No	(800) 344-4825	Contact local DEC dealer.	http://www.digital.com	1406
Stackable	14,880	32 KB-128 KB	1024/1024	ASIC design	No/N/A	No/No	(800) 327-9526	(508) 671-9440	http://www.fibronics.co.il	1407
Stackable	14,800	Variable up to 2 MB	16,384/16,384	Central RISC with shared memory	Yes/4	No/No	(800) 952-6227	(603) 880-1833	N/A	1408
Chassis-based	2 million	16 KB	64,000/ 1,024,000	VLSI-per-port with high-speed backplane	Yes/256	No/Yes	(800) 552-6638	(714) 752-6638	N/A	1409
Stackable	14,881	24 KB	2048/2048	Distributed VLSI	No/N/A	No/Yes	(800) 858-7815	(818) 773-0900	jamesc@nbase.com	1410
Stackable	157,000	128 KB	1016/1016	ASIC-based with distributed buffer memory	No/N/A	No/No	(800) 674-8855	(408) 321-7300	info@nplx.com	1411
Stackable	12,000	64 KB	1016/1016	Distributed ASICs	No/N/A	No/No	(800) 544-5255	(214) 929-1700	http://www.networth.com	1412
Chassis-based	14,880	32 KB	1024/11,264	ASIC-based	No/N/A	No/No	N/A	(214) 234-6400	http://www.ods.com	1413
Chassis-based	240,000	Shared-RAM architecture	4048/4048	Distributed RISC around a high-speed matrix switch	Yes/16	No/Yes	(800) 678-9678	(703) 817-0400	N/A	1414
Stackable	60,000	Shared-RAM architecture	1024/1024	Central RISC with shared memory	Yes/16	No/No	(800) 678-9678	(703) 817-0400	N/A	1415
Stackable	14,880	32 KB	1024/1024	Dual ASIC design and a 100-Mbps switched fabric	No/N/A	Yes/Yes	(800) 370-2724	(617) 290-5800	http://www.plaintree.com/plaintree	1416
Stackable	150,000	128 KB	1024/1024	Distributed ASICs	No/N/A	No/Yes	(800) 545-7464	(508) 898-2800	http://www.proteon.com	1417
Chassis-based	130,000	Shared-RAM architecture	8192 per box; no limit per port/ 8192	Dual RISC	Yes/100–200	No/Yes	(800) 762-4968	(516) 435-6255	http://www.smc.com	1418
Stackable	178,560	Shared-RAM architecture	8192 per box; no limit per port/ 8192	Dual RISC with distributed hardware switching per port	Yes/100–200	No/Yes	(800) 762-4968	(516) 435-6255	http://www.smc.com	1419
Stackable	89,280	128 KB	169/1016	Distributed VLSI	No/N/A	No/No	(800) 638-3266	(408) 764-5000	http://www.3com.com	1420
Chassis-based	115,000	90 KB-100 KB	8000/8000	Central RISC with shared memory/shared high-speed bandwidth for connection between modules	Yes/65,000	No/Yes	(800) 777-4526	(408) 496-0111	http://www.ub.com	1421
Stackable	14,880	64 KB	1024/4096	Distributed RISC cell-based time division multiplex bus	N/A/3 (planned)	No/Yes	(800) 989-3342	(508) 658-7200	info@xedia.com	1422
Chassis-based	200,000	256 KB	2000/16,000	Distributed RISC/distributed memory	Yes/32	No/Yes	N/A	(818) 880-3500	N/A	1423
Chassis-based	238,000–538,000	32 KB	1000+/1024	RISC with shared memory	No/N/A	No/Yes	(800) 338-5316	(508) 952-4700	http://www.xyplex.com	1424

● = yes; ○ = no.

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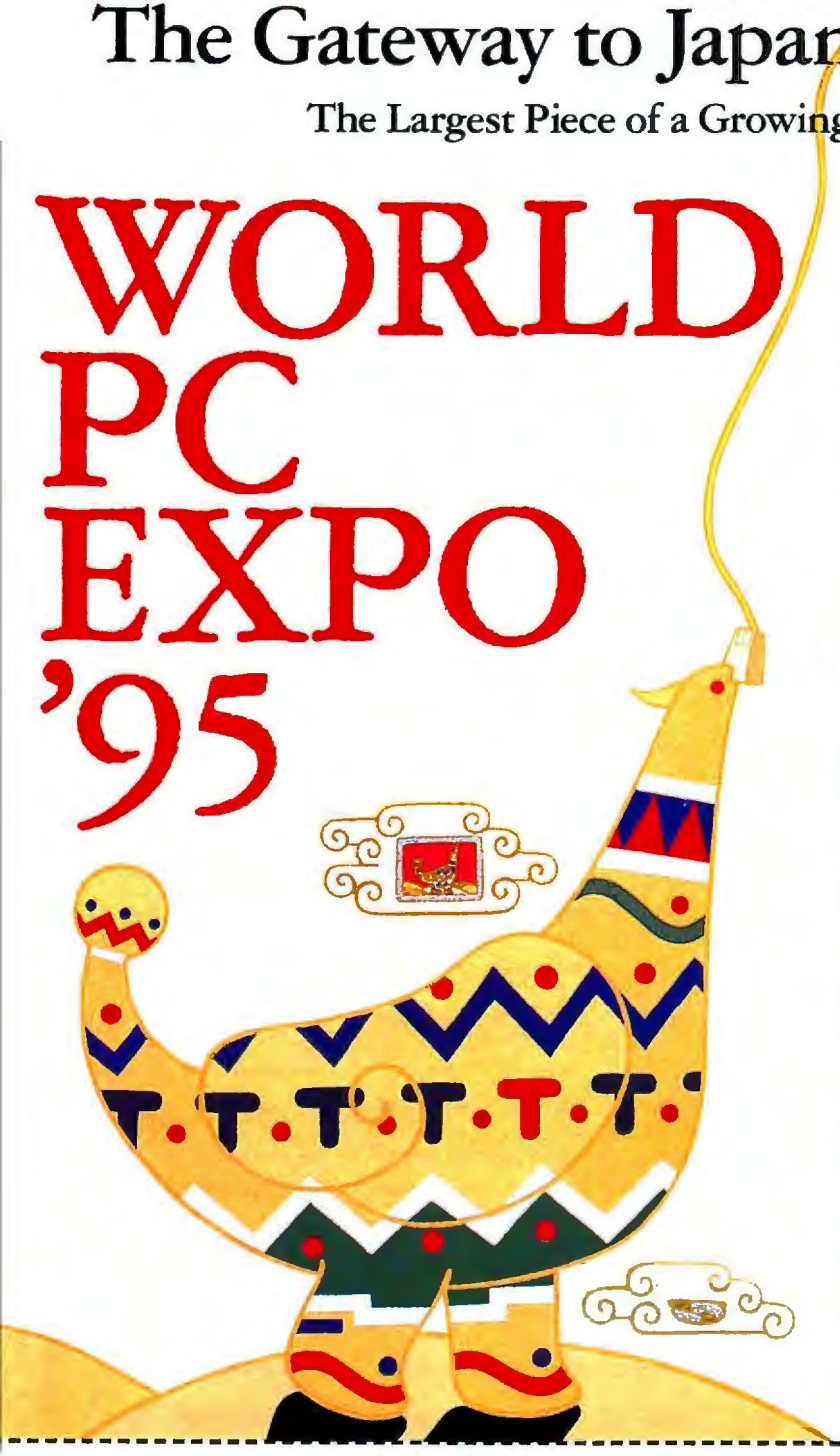

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HP's Speedy RISC

Numerous function units and smart load/store processing make the PA-8000 the fastest RISC processor

DICK POUNTAIN

Less than a year after its PA-7200 announcement, Hewlett-Packard again claims to have the world's fastest RISC architecture in its new PA-8000. Once again, the claim looks plausible. The PA-8000 design aims for "sustainable superscalar" operation by employing multiple function units and a radical out-of-order execution strategy that executes four instructions simultaneously most of the time. It's intended to handle clock speeds of up to 200 MHz, which, if achieved, suggests a throughput of 360 SPECint92 and 550 SPECfp92, ahead of both the PowerPC 620 and the Mips R10000. At the time of this writing, the PA-8000 has just been taped out for HP's 0.5-micron, 3.3-volt CMOS process, but there's no silicon yet.

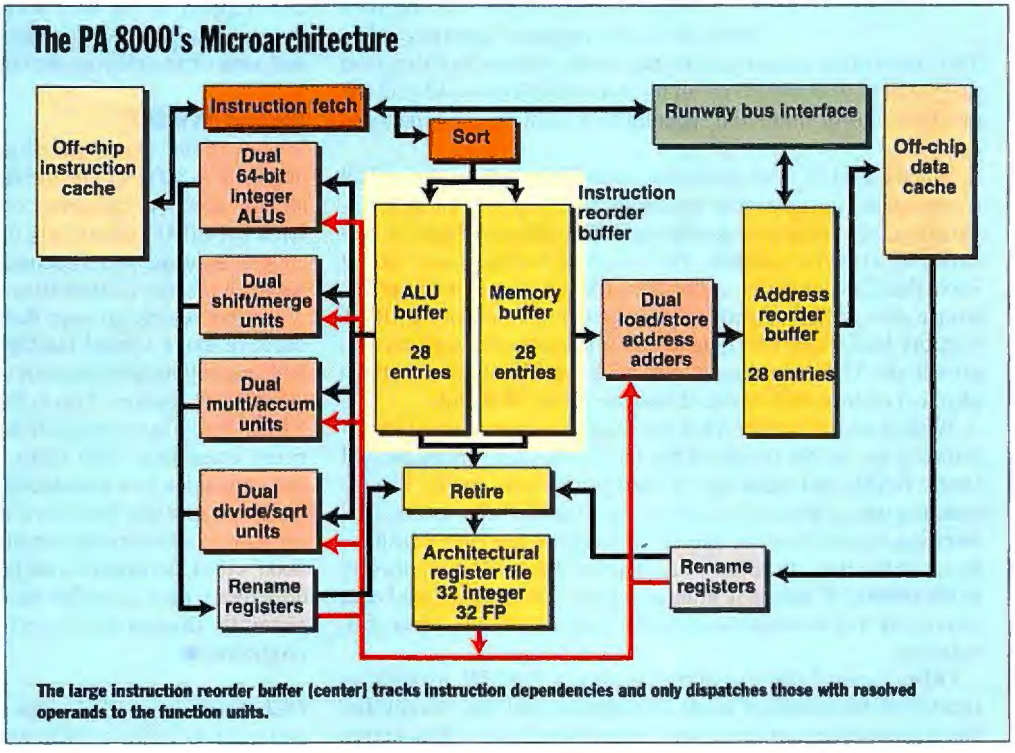
The PA-8000's microarchitecture is wholly new, borrowing almost nothing from the PA-7200 implementation, except the blindingly fast (960 Mbps) 64-bit Runway processor bus and the strategy of keeping the instruction and data caches off-chip. The new chip is 64-bit throughout, with 64-bit flat addressing, plus 64-bit floating-point and integer arithmetic. Nevertheless, for compatibility it executes all old 32-bit PA RISC code.

Out-of-Order Execution

The first step towards sustaining the execution rate of four instructions per cycle is to provide ample hardware resources. To this end, the PA-8000 supplies 10 function units: Two integer ALUs, two IUs (integer shift/merge units), two floating-point MAC (multiply accumulate) units, two floating-point divide/square-root units, and two load/store units. See the figure "The PA 8000's Microarchitecture" for details. The MAC units have a three-cycle latency and are fully pipelined to deliver up to four FLOPs per cycle. The divide units have 17-cycle latency and are not pipelined, but they run concurrently with the MACs.

The real trick is to keep most of these units busy, and it's here that the PA-8000 gets radical. It employs hardware scheduling to extract the maximum parallelism from the instruction stream. Previous two-way superscalar HP designs like the 7200 left scheduling issues to the compiler, but with a four-way superscalar design, this solution is no longer sufficient. That's because four sequential instructions are likely to contain data dependencies that can't be resolved at compile time. Accordingly, the PA-8000 has a deep IRB (instruction reorder buffer), which examines the 56 most current instructions to find four that can execute simultaneously.

The PA-8000's instruction-fetch unit fetches blocks of four quadword-aligned instructions per cycle (exactly matching the maximum execution rate) from the external I-cache. The fetch unit passes them to a sort unit that in turn feeds them into the IRB. The IRB consists of two 28-slot buffers: an ALU buffer that holds instructions destined for the integer units and FPUs, and a memory buffer that holds load/store instructions. Certain instruction types, such as load-and-modifies and branch

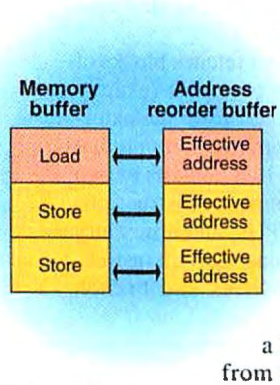


The large instruction reorder buffer (center) tracks instruction dependencies and only dispatches those with resolved operands to the function units.

instructions, go into both buffers.

Once an instruction arrives in an IRB slot, the hardware monitors the instruction stream to the execution units to see whether any of them supplies operands for the stored instruction. This instruction can request to be dispatched only after the last instruction for which it has dependencies has been dispatched. Each of the IRB buffers dispatches two instructions per cycle, and the paired function units are coupled to odd- and even-numbered slots (for example, all even slots use ALU0, and the odd slots use ALU1). In all cases, it's the oldest instruction in the buffer that gets dispatched. When an instruction has been successfully executed—or its trap status becomes known—it's retired from the IRB in program order. Up to four instructions per cycle can be retired.

The PA-8000 employs register renaming via 56 rename registers (one for each IRB slot) and 64 architectural registers (32 integer and 32 floating-point). This enables the PA-8000 to execute (but not retire) many instructions speculatively, without corrupting the processor state if the speculation proves false and all of them have to be scrapped. This is used to hide branch delays and other latencies (see "The PA-8000's Microarchitecture"). Exception traps also get signaled at retire time, which means that the PA-8000 can maintain a precise exception model despite its out-of-order execution.



Loads and Stores

The PA-8000 tries hard to eliminate the performance penalties that load-store dependencies cause. The commercial data processing applications that HP targets with its PA chips use large data sets and require correspondingly large data caches (up to 4 MB on the PA-8000) to achieve good throughput. With such a large external cache, loading data from the cache requires several cycles. This means that an instruction that needs the result of that load may have to wait, which on an in-order machine would stall the pipeline. Out-of-order and speculative execution can hide these delays.

When a load or store instruction in an IRB slot has received all its operands, it requests to be dispatched, just like an ALU instruction, but the destination is one of the address adders, to calculate its effective address. The calculated address gets stored into a third 28-slot buffer, called the ARB (address reorder buffer), whose slots are associated one-to-one with the slots of the IRB's memory buffer (see the figure above). The effective address also goes to the TLB (translation look-aside buffer), which returns a physical address that's placed into the same ARB slot.

With its address in the ARB, the load/store instruction starts arbitrating for access to one of the banks of synchronous SRAM (static RAM) that make up the dual-ported data cache. The instruction tries again each successive cycle until it wins access. (Arbitration is based on the age of the original load/store instruction, not the time its address has been in the ARB, with priority to the oldest.) If access is granted on the first attempt, load data arrives on chip three cycles after the dispatch of the address calculation.

Other operand-dependent instructions in the IRB are kept informed of the status of loads in progress, and they won't dispatch themselves until their load wins cache access. This leaves the function units free to run any younger instructions whose operands are ready, and so the load delay can usually be concealed.

The ARB hardware also checks for store-to-load dependencies. Whenever a store instruction has its effective address calculated, it's compared to the addresses of any younger load instructions that have completed their cache accesses (by executing out-of-order). If it's the same address, then that load and all younger instructions are flushed from the IRB and reexecuted. Similarly, whenever a load instruction calculates its address, the addresses of all older stores in the IRB are compared. In the event of a match, the load waits until the store data becomes available. These mechanisms ensure that out-of-order execution can't cause stale data to be read.

When a store instruction retires, its value gets copied from a register into the Store Queue, a FIFO (first in/first out) write buffer with room for 11 doublewords for each cache bank. This queue's contents get written out to the data cache during idle cycles or when other stores are performing tag lookups. Using these otherwise wasted cycles reduces the likelihood that a load will be held up due to cache contention with a store.

Predictions and Speculations

Like most of the current generation processor architectures, including Intel's P6, the PA-8000 uses target address caching, branch prediction, and speculative execution to minimize the pipeline breaks caused by changes of control flow, implemented via both static and dynamic branch prediction schemes.

The PA-8000 indulges in several forms of speculative execution. It executes instructions from the predicted arm of every conditional branch but doesn't retire them until the branch condition is resolved. It executes younger instructions before it knows the exception status of older ones. And it executes younger load instructions while an older store is still pending. In the event of failure (i.e., the branch was predicted wrongly, the older instruction trapped, or the store was to the load address), all younger instructions in the IRB must be discarded. These cases are rare, and most often "playing the hunch" pays off in time savings.

The Last PA RISC?

In view of the new partnership between HP and Intel, it's likely that the PA-8000 will be the last PA architecture from HP. There already seems to be some convergence between Intel's P6 and HP's PA-8000, particularly in the area of the out-of-order execution hardware, and it becomes less difficult to imagine a hybrid between the two architectures.

It's interesting to note that both Intel and HP have made a decisive move toward intelligent hardware scheduling and that both are relying less on smart compiler technology than are many other RISC vendors. This is the exact reverse of the trend toward VLIW (very long instruction word)—which relies heavily on smart compilers—that many market watchers predicted when the companies first announced their partnership. This is probably due to the fact that both firms have large installed bases of legacy software, and hardware scheduling, as implemented by the PA-8000's IRB, boosts old code performance more simply and more effectively than compiler-based tricks can, as witnessed by the generally disappointing performance of recompiled Pentium programs. ■

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Copland: The Abstract Mac OS

Apple rewrites the Mac OS to help support clone systems

TOM THOMPSON

Late last year, Microsoft announced that the release of its latest revision of Windows, now known as Windows 95, was going to be delayed until August of this year. Microsoft wanted to fine-tune Windows 95 to operate on the widest possible range of PCs. With a remarkable knack for timing, Apple also happened to announce that the next revision of its Mac OS, code-named Copland, was going to be delayed until early 1996 (see "Apple's New Operating System," June BYTE). Apple needed the extra time to structure its new OS around a HAL (Hardware Abstraction Layer). The irony is that these delays came about because both companies were grappling with the same basic problem: how to support the hardware diversity present in desktop computers.

Apple had originally planned to add the HAL in a Mac OS revision due out after Copland. However, the woes Microsoft experienced attempting to support today's numerous hardware configurations had major implications for anyone trying to sustain a nascent Mac clone market. Because Copland is a complete revamp of the Mac OS architecture, it made sense to incorporate hardware abstraction while the system software was still under construction. This decision delayed Copland's release date, but hopefully the future payoff is that Apple has minimum support headaches when the droves of Mac clones and PowerPC-based CHRP (Common Hardware Reference Platform) systems appear.

Fundamental Changes

In previous Mac OSes, the system code relied on the numerous custom ASICs that are the hallmark of the Mac hardware. With Copland, the HAL hides the hardware from the system software so that it can be written without any explicit or implicit dependencies on a particular hardware configuration.

It should be noted that efforts to decouple the Mac OS from the hardware were under way with the release of the first Power Macs: The PowerPC version of System 7.1 was built around a nanokernel. This nanokernel operated in the supervisor mode and provided low-level interfaces for interrupts, exception handling, and MMU (memory management unit) operations. Only System 7 and debuggers had access to these interfaces.

Also, the basic building blocks of any PowerPC Mac program, called code fragments, use a pointer-based, processor-neutral access mechanism. The access mechanism is the basis of the dynamically loaded shared libraries that Copland uses to reduce its footprint in memory.

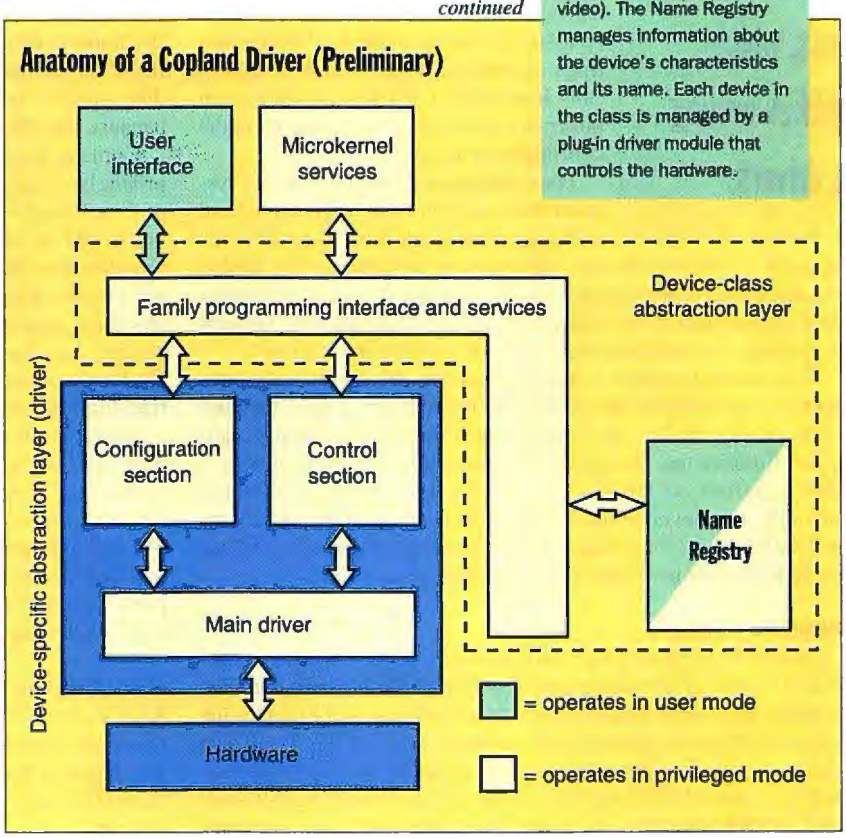
One consequence of this redesign is that Copland is no longer a ROM-centric OS, but a disk-based one. Put another way, Copland doesn't need the massive 4-MB ROMs that house the OS code in existing Macs. Instead, a bootstrap ROM uses the Open Firmware (IEEE standard P1275) boot process to configure expansion boards and locate a start-up hard drive. When the system finds the boot drive, it reads files containing the code fragments that make up the Copland OS into memory. Once this is done, execution jumps to the microkernel, and Copland takes control.

New Driver Design

Hardware abstraction required a major change in how the Copland device drivers were written.

continued

An FPI (Family Programming Interface) hides details about a class of device (e.g., video). The Name Registry manages information about the device's characteristics and its name. Each device in the class is managed by a plug-in driver module that controls the hardware.



Formerly, devices were operated through the Mac API. First you obtained device-specific information through calls to managers such as the Slot Manager for NuBus boards and the SCSI Manager for SCSI peripherals. Then you controlled these devices using Device Manager calls.

The preliminary Copland driver design bifurcates between a device-specific code module and OS interface modules that use the API calls. This division resolves certain compatibility problems. Specifically, device-specific code must be reentrant to support the preemptive scheduling exploited by the new concurrent Device Manager, and some Mac API code isn't reentrant.

The split design also enables the driver to operate in privileged mode, within a separate memory space. This provides memory protection while allowing the main driver to exercise fine control over system services, such as interrupt handling or memory paging. That wasn't possible when all calls went through the Mac API.

Applications make the usual calls to these APIs, such as to the File Manager for file I/O and the Sound Manager for sound I/O. These managers in turn call a device-specific interface, the FPI (Family Programming Interface), which is designed for the needs of that device category (e.g., sampling rates for sound playback). The FPI accesses a specific device via its driver. The FPI abstracts the class of device, while the driver abstracts a specific device in the class (see the figure "Anatomy of a Copland Driver").

The Name Registry enables a consistent set of rules for device access, which simplifies writing Mac drivers.

Consequently, a Copland device driver is a plug-in module that consists of three parts: the main driver, a configuration section, and a control section. The main driver operates in privileged mode and uses device-level programming interfaces to operate the hardware. The main driver makes no assumptions about the hardware's settings or configuration. It makes no API calls. Instead, the main driver obtains setup information through data sent to it via the configuration section.

The configuration section obtains system information for the main driver and manages other high-level functions for it, such as reading device settings from a resource file. It also manages a user interface that lets users adjust the device's settings and lets the main driver notify users of certain conditions (perhaps displaying a dialog box that warns of an invalid baud rate).

The control section is that part of the driver that mediates transactions between the OS and the main driver. It uses standard services exported by the family to accomplish this. Astute readers will notice that this driver design parallels Open Firmware's device definition, which consists of a device interface (which manages low-level device initialization and control), a client interface (which communicates with the driver), and a user interface (which handles user interaction with the device settings).

What's in a Name?

A Name Registry helps provide a certain level of hardware abstraction and driver-design consistency while providing device control. The Name Registry is an object database that manages the creation of device entries (either at boot time or on the fly). It also stores information about the various devices in the system. For example, a second SCSI port on a clone system would register itself and its characteristics with the Name Registry, which makes Copland aware of its existence. Applications or the File Manager can readily access a peripheral on this port by using its name and associated information from the Registry.

The Name Registry enables a consistent set of rules for device access, which simplifies the writing of Mac drivers. Formerly, you had to use different driver designs to access devices on NuBus boards, PCMCIA cards, or the main logic board. Because device entries are created dynamically, the Registry supports driver loading and unloading. This lets Copland manage hot-swappable devices, such as PCMCIA cards, or identify the peripherals in a docking station when a notebook computer gets plugged into it. The Registry also provides the means to update expansion boards: It can be instructed to load an updated driver from a disk file rather than from the board's firmware.

Opaque Data

Copland also conceals other dependencies. Currently, both the OS and applications access certain information (e.g., the height of the menu bar, the reference number for the boot drive, and the graphics device handling the main screen) stored in global variables located in low memory. Under Copland, you should no longer directly access these variables, but instead use accessor functions to obtain this information. Accessor functions were first implemented in System 7.1, but anyone cruising through the SDK header files could see these function calls were simply macros that touched the low-memory globals. This won't be the case with future OS releases, so if you need to use low-memory globals, start using the accessor functions.

Speaking of header files, all those system-data structures in them that you know and love disappear. As with the global variables, you'll use accessor functions that reference them. Concealing the data this way, often called *data hiding* or *data opacity*, provides needed flexibility in the OS design. This allows data structures to be revised without impact to the application software. It also lets them be placed elsewhere in memory, even separate address spaces, in the future. Data hiding under Copland is limited because the OS must support existing application binaries.

Copland handles text as an abstract object called—not surprisingly—text objects. Text objects don't suffer the limitations of C or Pascal strings. They also extend string data by allowing you to add annotations to the text. Such annotations might provide pronunciation hints for the PlainTalk text-to-speech engine. Text objects are opaque; you needn't worry about their contents. This lets them manage multibyte text encodings, such as kanji and Arabic, and they will provide a smooth migration to Unicode. Under Copland, a Unicode converter transparently manages translations from one text encoding to another.

All these mechanisms help free Copland from the bonds of a particular set of hardware. Thus, Mac-clone vendors can differentiate their systems by adding unique devices. The new driver design enables vendors to quickly write drivers for new peripherals. The Name Registry allows Copland to both understand and exploit features in a particular peripheral, such as a SCSI drive that supports Fast SCSI transfers. Finally, through data opacity, Copland readies the Mac OS for future enhancements. ■

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Casting Arrays

Inside the mechanics of array access in C, with a side trip to deciphering cast operations

RICK GREHAN

I shall begin this tale at its end. This will be about a particular programming problem in C, one that you've likely encountered if you've ever dealt with dynamically allocated arrays.

Here's the situation: You've just allocated a pointer to a linear or one-dimensional array of integers. It's something like `ptr=(int *)malloc(ARRAYSIZE)`. Later in the program, a function will treat this array as a 2-D array with dimensions of 100 by 200. The function is declared as `void func1(int array[][200])`.

How do you pass the pointer you got from `malloc()` to the function and keep all C compilers happy? Certainly, this will require a cast operation, but how do you construct it?

As promised, here's the answer:

```
func1((int(*)[200])foo);
```

I will happily admit that when the above solution was presented to me I found it to be less than obvious. Not only was I confused by the nested elements in the cast operation, I was further thrown by the explanation that was given by the solution's provider: The above cast will work because `func1()` is expecting a pointer to an array of 200 integers.

On the surface, that seems wrong. The routine `func1` is expecting a pointer to a 2-D array of integers, not a 1-D array of 200 integers—or so I thought. The solution required an investigation into how C treats arrays, as well as how to interpret cast operations.

The First Wrong Answer

This problem arose when I was working with the BYTEmark program (see "BYTE's New Benchmarks," March BYTE). Many of the routines in the BYTEmark program worked with *varying numbers* of arrays. In other words, although a particular routine—say, `func1()`—would operate on a single 100 by 200 array of integers, the caller of `func1()` would have allocated space for three or four such arrays.

The allocation would, of course, have taken place via `malloc()`. It would be up to the caller of `func1()` to determine the offset into the buffer to the start of each 2-D array and pass the properly adjusted pointer to `func1()`. Hence the problem: Coercing a pointer to an integer (a sequential buffer of integers, to be precise) into something I could pass to a function expecting a 2-D array of integers.

The first wrong answer was to simply do it. After all, you can pass a pointer in place of a reference to a 1-D array. For example, I could easily pass `ptr` (as defined earlier) into a function defined as follows:

```
void func1(int array[]);
```

However, for the original case—`func1()` expecting a 2-D array—simply calling `func1()` with `ptr` as the argument worked for only some compilers. For example, Watcom C/C++ had no problem with it. But the Metrowerks Code Warrior compiler for the Mac refused it. Several discussions with the engineers at Metrowerks left me with the feeling that it wasn't Metrowerks' problem. I would have to come up with a workaround.

The Unused Answer

There is a related problem, one whose solution leads to the solution to the original problem. The related problem is this: How do you write a routine that manipulates a 2-D array of indeterminate size? That is, at compile time, we don't know how many rows and columns will be in the array—the algorithms handling the array are such that the dimensions are determined at run time. (We're keeping things down to only 2-D arrays; astute readers will be able to extend this to multidimensional arrays.)

A not-so-right answer to a problem can work and ultimately provide the last right answer.

Consider how a C compiler "sees" a 2-D array. At one level, the array is just a contiguous set of memory locations. But at a higher level, the compiler has to understand that members of the array are accessed via two indexes. So, to reference an element of the array, the compiler needs to know the array's dimensions.

That turns out to be only partly true. To allocate space for the array, the compiler does need to know both dimensions (as well as the data type). But to reference an item in the array, the compiler need know only how many columns are in the array.

For example, consider a byte array with dimensions of [2][3]. The offset to element [i][j] can be calculated by i*3+j. The compiler doesn't need the size of the first subscript.

Thus, you *can* manipulate 2-D arrays of indeterminate size. Where you would have written `array[i][j]`, you

simply write `*(&array[0][0]+i*COLS+j)`. (`COLS` represents the number of columns.) The expression `&array[0][0]` returns the address of the first element of the array; the rest of the expression calculates the proper offset.

The catch is, this is not generally efficient. Consider the case where either `i` or `COLS` in the above equation is a power of two. In that case, you'd want to turn the multiplication into a shift operation. Also, if you had access to the machine's registers, you might want to keep `COLS` inside a register to reduce a load-multiply operation to simply a multiply operation. This is what a compiler would do as part of its optimization process. The upshot: A compiler is better at optimizing array access than you're ever likely to be.

In any case, this technique solves the original problem. Once you've allocated enough space for 100 by 200 integers using `malloc()`, you pass that to `func1()`, which is now defined as `void func1(int *array)`. Of course, inside `func1()`, you'll have to handle all array subscripting manually. But, as described above, it's likely to produce slower code.

The Wrong Answer That Worked

After all, what was `func1()` *really* working with but a pointer. In terms of size, a pointer to a 1-D array was as large as a pointer to a 2-D, 3-D, 4-D, or whatever-dimensional array. I knew that, but I just couldn't get C to believe me.

The first answer that worked was to make use of the `union` declaration. I handled it through a `typedef`:

```
typedef struct {
  union {
    int *ptr;
    int (*aptr)[ROWS][COLS];
  } p;
} tp;
```

This got the job done, and compilers happily accept it. In use, though, it's bulky, as the following call shows:

```
tp locptr;
...
locptr.p.ptr=(int *)malloc(ARRAYSIZE);
...
func1(*(locptr.p.aptr));
...
```

It's also—in one sense, at least—wrong. The expression `(*aptr)[ROWS][COLS]` defines a pointer to a 2-D array. As it turns out, this is what you would pass to a function that expects a 3-D array.

If you find that confusing, don't be alarmed—I did, as well. Given an array defined as `int matrix[2][3]`, I originally thought that the expression `matrix` (with no subscripts) was understood by the C compiler to be a pointer to an integer—in this case, the first integer in the array. The compiler simply used the subscripts to calculate proper offsets from that pointer. Not so; `matrix` is treated as a pointer to two elements, each element being an array of three integers. Thus, `matrix` is a pointer to an array of integers (that array being the first row). Another way of saying the same thing—`matrix` is a pointer to a pointer to an integer.

As a result, the expression `matrix[0]` (specifying only the first index) is valid: It returns a pointer that references the first element of the first row of `matrix`. So, `*matrix[0]` will retrieve the same value as would `matrix[0][0]`. Similarly, `matrix[1]` will return a pointer to the first element of the second row of the array, and so on.

Now that we know how C "sees" arrays, we can derive a more correct way of using the `union` declaration to solve the problem:

```
typedef struct {
  union {
    int *ptr;
    int (*aptr)[COLS];
  } p;
} tp;
```

This lets you call the function without the extra level of indirection:

```
tp locptr;
...
locptr.p.ptr=(int *)malloc(ARRAYSIZE);
...
func1(locptr.p.aptr);
...
```

In some ways, using the `union` declaration to coerce a pointer to a buffer to a 2-D array reference is quite flexible. You can load up the `union` structure with multiple pointers to arrays of different dimensions, if you wish. This would let you reference a single array as a 1-D, 2-D, or 3-D array (although offhand I can't think of an algorithm that would need that capability). However, this is not very elegant, and it betrays a lack of understanding of how to use the C cast operator.

The Last Right Answer

Knowing what we now know, we need to cast `ptr`—declared as a pointer to an `int`—into a pointer to an array of `int`. We already know what the answer is (reread the beginning of the article if you've forgotten), and because deciphering a complex cast can be difficult, we'll reverse-engineer what we already know works. The cast expression is `(int(*)[200])matrix`.

To understand a complex cast operation, you use the right-left rule: Start with the identifier, look right, and then look left. Continue this recursively to "work your way out" of the expression. As you work your way out, evaluate `()` (identifies a function) and `[]` (identifies an array) at a higher preference than `*` (identifies a pointer).

So, for the cast given above, because there is no identifier, start with the innermost `(*)`—it's a pointer—look right—it's a pointer to an array—look left—it's a pointer to an array of integers—and you're done.

I'm embarrassed to say that the last right answer was not the one that made its way into the first version of the BYTEmark benchmarks. The current release of the benchmarks uses the `union` trick instead. Still, it's often the case that a not-so-right answer to a problem can work, lead to a deeper understanding of what is actually going on, and ultimately provide the last right answer. ■

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ACKNOWLEDGMENT

I wish to thank James Janney, who gave me the last right answer.

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ISDN and Analog Access in One Package

Users moving to ISDN often still require access to analog links

SALVATORE SALAMONE

With ISDN services becoming more available, users who crave higher-speed access are quickly making the move to such services. But most people soon discover there are still many situations where they need to connect to traditional analog modems.

One way to get both forms of access is to have two access lines—an ISDN link and an analog phone line—each with the appropriate termination equipment (an ISDN terminal adapter and a modem, respectively). But from a financial perspective, that hardly makes sense, especially when you consider that you can use an ISDN link for both voice and data connections.

For those users who truly need both types of access, a new solution is starting to emerge: hybrid devices that connect to an ISDN line and also support analog modem communications. Such products are essentially enhanced ISDN terminal adapters, but a more apt name for them would be ISDN/analog modems. Products in this category include the Courier I-modem with ISDN/V.34 from U.S. Robotics, the Elite Series ISDN modems from ZyXel, the Hybrid Modem TA 200 (also known as the HMTA 200) from Motorola, the ISDN System Adapter from Hayes, and the WaveRunner from IBM.

These devices typically cost more than modems that incorporate V.35 technology, and they're usually just a bit more pricey than standard ISDN terminal adapters. However, they sell for less than what a combination ISDN terminal adapter/high-performance modem would cost. For instance, the ZyXel Elite Series ISDN modems start at just $549.

These hybrid products allow you to take advantage of an ISDN link's higher bandwidth when ISDN is available at the other end of the line. For example, they enable you to connect to an Internet service that offers ISDN connections. And if the endpoint on the connection doesn't support ISDN, these devices can also support a link to a traditional modem (see the figure "Simplifying Digital Access" below).

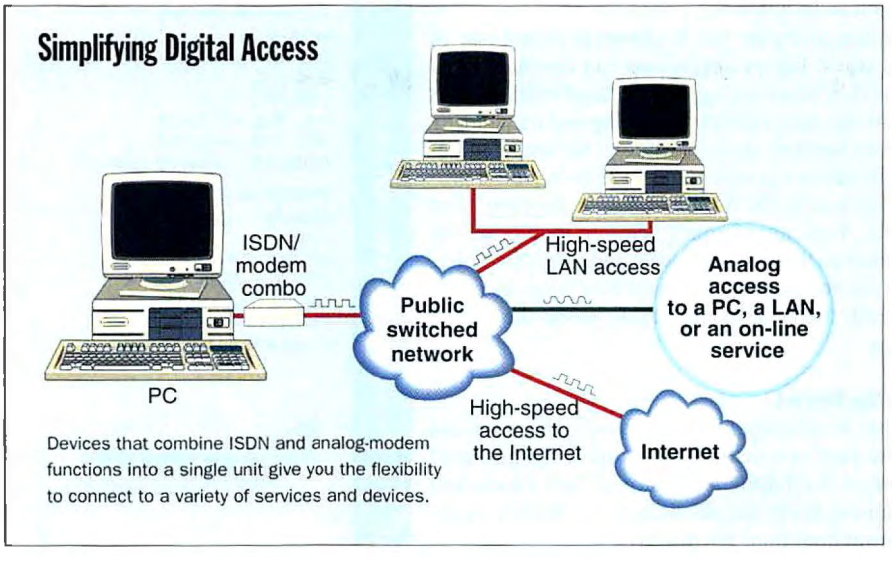
These new devices can be regarded as modem replacements. However, they should not be confused with higher-end products, such as access routers that can combine ISDN and analog access into one device through separate ports.

The new ISDN/analog modem-like products are just that: modem-like. For example, for analog access they use the same communications software programs as a regular analog modem. Also, many use standard AT commands (with slight modifications) for ISDN connections.

The biggest difference between ISDN/analog devices and regular modems is that the former are more difficult to configure. This is because of the complexity involved in making an ISDN connection. If you don't have your equipment configured correctly for your local exchange carrier's central-office equipment, an ISDN/analog hybrid modem will not work. This is an ISDN-specific problem common to all ISDN modems, not just the hybrid products.

That's in contrast to the case of two regular modems attempting to establish a connection. If the two devices are configured differently—say, to operate at different data rates—they are capable of negotiating at the start of the call and settling on a default transmission rate that both can handle.

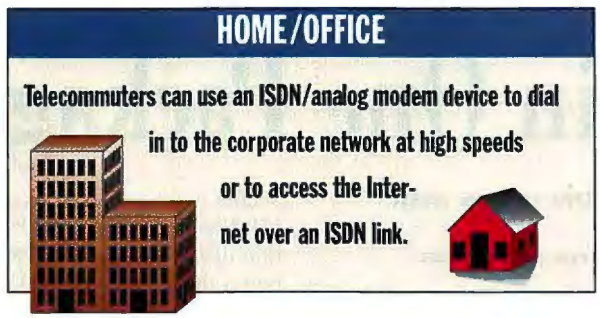
continued



Devices that combine ISDN and analog-modem functions into a single unit give you the flexibility to connect to a variety of services and devices.

When you use an ISDN/analog modem, however, you are typically required to enter information about the type of switch that the central office is using, the SPIDs (service provider identifications) associated with the channels over which the connection is being made, and the telephone numbers of the SPIDs. All this information varies, depending on the local exchange carrier whose equipment you are connecting with.

There are other parameters that sometimes require setting when you are establishing an ISDN connection. But the switch type, SPIDs, and telephone numbers are the basic ones you need to get an ISDN/analog modem up and running. To help, manufacturers of these hybrid devices include configuration tools to make the setup process easier. For example, U.S. Robotics offers an easy-to-use configuration menu and includes a test routine that checks to see if you can establish a connection. Motorola includes a Windows-based configurations manager with the HMTA 200.



All these products support connections with the major ISDN switches you are likely to find in a local exchange carrier's central office. These switches include AT&T's 5ESS, Northern Telecom's DMS-100, and those that are compatible with the National ISDN-1 specifications.

Varying Uses

ISDN/analog modems can have many uses. One place where they are likely to be installed is in homes that have ISDN services. For instance, a telecommuter might use one to dial in to the corporate network at high speeds or to access the Internet over an ISDN link. Using the same device, that person can also make a connection to CompuServe or another corporate site where analog modems are used to accept incoming calls.

The first step you must take to use an ISDN/analog modem is to obtain ISDN services. Most telecommuters are likely to get BRI (Basic Rate Interface) service, the basic ISDN residential offering of most carriers. BRI service provides two B (i.e., bearer) channels, each of which offers 64-Kbps rates, and one D (i.e., data) channel that carries signaling information at 16 Kbps.

You can configure the B channels in any one of several ways. For example, you can combine them to achieve a resulting aggregate bandwidth of 128 Kbps. At this rate, videoconferencing and transferring large files become realistic options for the telecommuter. In addition, connections to high-overhead protocols, such as the X Window System, become more tolerable. You can, of course, choose to allocate the B channels so that one is for data and one is for voice. This gives you between two and four times as much bandwidth than you could obtain using the fastest modems.

Driving the Market

ISDN has been around for many years. However, not until the past two or three years have a significant number of the RBOCs (Regional Bell Operating Companies) made the services more widely available throughout their territories.

Fueling the growing demand for ISDN services are applications such as remote LAN access, personal videoconferencing, and collaborative work-sharing programs. Before ISDN, of course, most users simply relied on analog-modem connections to the LAN. But the main reason people are now buying the new ISDN/analog modem devices is to obtain Internet access, according to the vendors. Anyone who regularly surfs the Internet can probably understand why this is so. It all has to do with WWW-site (World Wide Web) access. Such access involves receiving many data types (e.g., graphics, audio, and movie clips) that are difficult to compress. This makes it painfully slow to access them using even a high-end analog modem.

Many Internet service providers are now offering ISDN links to their service. And in April, another on-line service, Prodigy, announced that it, too, would offer its users ISDN access, primarily to improve Internet and WWW-site access.

But Internet access aside, many users are now moving to ISDN because it has become much more affordable than it was in the past. Some RBOCs, for example, are pricing ISDN services attractively to entice home users. For instance, Pacific Bell, which has been one of the most aggressive carriers in terms of rolling out ISDN services to its customers, is offering residential ISDN services for about $25 per month, plus per-minute charges of 3 cents for the first minute of a local call and 1 cent for each additional minute. Even better, these per-minute residential charges apply only during prime times—there's no charge during the weekends or at night.

Basically, everything seems to be coming together for ISDN access. The telecommunications charges for ISDN services are getting reasonable, and user demand for higher-speed access to LANs—and the Internet—is growing. ■

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Product Information

Courier I-modem with ISDN/V.34...from $595
U.S. Robotics, Inc.
Skokie, IL
(708) 982-5010
fax: (708) 933-5800
BBS: (708) 982-5092
Circle 997 on Inquiry Card.

Elite Series ISDN modems.....$549–$749
ZyXel
Anaheim, CA
(714) 693-0808
fax: (714) 693-8811
BBS: (714) 693-0762
Circle 998 on Inquiry Card.

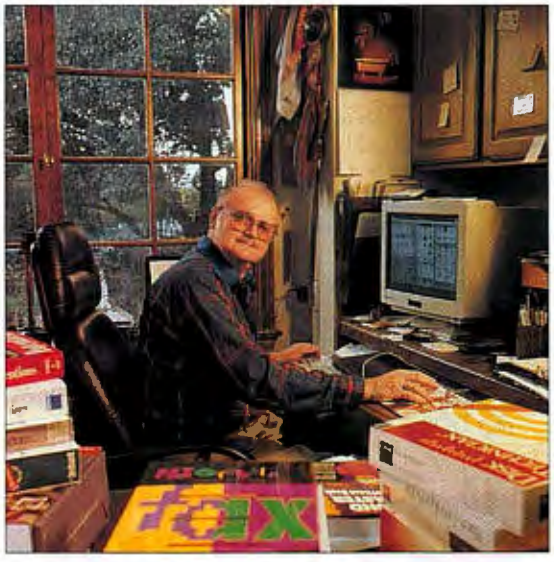
Hybrid Modem TA 200....$895
Motorola, Inc.
Transmission Products Division
Huntsville, AL
(800) 451-2369
(205) 430-8000
fax: (205) 430-8926
Circle 999 on Inquiry Card.

ISDN System Adapter....$999
Hayes Microcomputer Products, Inc.
Norcross, GA
(800) 964-2937
(404) 840-9200
fax: (404) 441-1213
Circle 1000 on Inquiry Card.

WaveRunner.....$545
IBM
Armonk, NY
(800) 426-3333
(914) 765-1900
Circle 1001 on Inquiry Card.

JERRY POURNELLE

Windows 95 Arrives



AMY ETRA © 1995

Jerry is both successful and unsuccessful at installing Windows 95 on the Chaos Manor machines

Last month I went to Washington, where I participated in hearings about the future of NASA. What I said, along with contributions from many others, including Edward Teller and Hans Mark, should now be available from the House Committee on Science. Write your congressperson for a printed copy of the March hearings on space policy.

There were many different views presented. I'll summarize mine by saying NASA ought to develop far-out high-risk technology (i.e., X programs) and leave production vehicle design and operations to private space lines or the military services. You can find out more by looking at my papers on the Internet, at SCIENCE@hr.house.gov, or in the listings section of the tojerry conference on BIX.

It was an exhausting trip, but I was able to get a lot of work done using the Gateway 2000 Liberty 100-MHz 486DX color notebook. When I got back to Chaos Manor, I was faced with the usual flood of software, including the non-final "final-beta" version of Windows 95.

Let me start by saying that I had no problems installing Windows 95 on Pentafluge, our big PCI-bus (Peripheral Component Interconnect) Pentium system, and it runs just fine there; more about that later. Having said that, I want to talk about problems we had with Windows 95 and Big Cheetah, our 66-MHz 486DX2, because what I learned was all interesting and mostly useful.

Windows 95—I'll call it W95 from here on—comes on one CD-ROM or 12 3½-inch floppy disks. Unfortunately for me, the CD-ROM was labeled "Windows 95 SDK Kit," and I rather stupidly thought it held only development tools rather than W95 itself, so I used the floppy disks. That was tedious, but eventually it stopped asking for disks, told me to clear the disks from the drives, and rebooted. I got messages such as "Preparing to run Windows 95 for the first time," what looked like an attempt to run with my old CONFIG.SYS and AUTOEXEC.BAT files—and then a total lockup of the system.

Rebooting produced a screen announcing that W95 hadn't installed properly and offered several choices, the default being safe boot. Alas, that produced another lockup. The installation process had generated a floppy disk to be labeled "Windows 95 Start-up." That wouldn't boot either.

Of course, I had thoroughly backed up the machine before I started, so it was no great trick to boot up with my "panic" DOS 5 floppy disk. Windows wouldn't load, so I used Norton Commander to investigate what W95 had done to my system. It was a *lot*. There were new files in the WINDOWS\ and DOS\ directories, a new WINDOWS\COMMAND\ subdirectory full of stuff, and a lot of new hidden system files in the root directory. Worse, almost everything I tried got me the message "Incorrect DOS Version." Worst of all, there's no uninstall program; getting rid of W95 is a tedious manual job.

I had two backups. The quickest would have been the Maxoptix T3-1300 optical drive, but that's on the network, and until Windows for Workgroups is running, I have no way to get at the network from this machine. However, I had everything stored on DAT (digital audiotape)

ILLUSTRATIONS: STEPHEN BURDICK © 1995

with Palindrome's Network Archivist. Tape is slow, but it beats reloading five years' worth of stuff. I brought up the machine from the "panic" floppy disk and told it to SYS the C drive. That worked just fine, and now I could boot up from the hard drive.

About half the items in the CONFIG.SYS and AUTOEXEC.BAT files weren't working properly. I had a moment of panic when Network Archivist wouldn't work, but that was because W95 had removed my Files statement, and it was fixed by adding FILES = 30 to CONFIG.SYS. I told Network Archivist to restore the DOS subdirectory; that was when I discovered that the W95 installation had put a lot of new files in there. I erased the whole directory before letting Network Archivist do its thing.

Then I tried CHKDSK and got "Incorrect DOS Version," unless I logged on to the C:\DOS subdirectory. This led me to look at my PATH statement in AUTOEXEC.BAT. WINDOWS\COMMAND\ was now the first item in the PATH, meaning that it would be the first place DOS would look for a file not in the currently logged subdirectory; and sure enough, there were new versions of CHKDSK and other DOS tools in WINDOWS\COMMAND\. At this point, I did what I should have done in the first place: I used BOOTCON to restore my CONFIG.SYS and AUTOEXEC.BAT files to what they had been before I started working with W95, and rebooted yet one more time.

Windows loaded so fast it scared me. Provided you have a good backup system, I can recommend that you reinstall Windows every few years; it speeds things up and gets rid of a lot of garbage.

This time DOS worked, but I still couldn't get into Windows.

I installed W4WG a long time ago, and over the years a *lot* of gubbage had accumulated in my WINDOWS and WINDOWS\SYSTEM directories. In addition to a few hundred fonts, there were tag ends and pieces of programs I've deleted. I had no way of knowing which of those fonts and stubs were needed.

In addition, W95 had changed some things and added others. This looked like a perfect opportunity to reinstall Windows from scratch. Windows could decide which fonts and INI files it needed, and if an application needed something, I could always find it on tape. I copied my PIFS and ICONS subdirectories and all my GRP files to a safe place, and used Norton Commander to delete the entire Windows directory with all its subdirectories. Then I got out the floppy disks and had at it.

That all went well, and Windows loaded so fast it scared me. Having over a hundred fonts installed really slows things down. It was easy enough to get my desktop back, because it's no trick at all to restore a group. Just tell Program Manager the name of its GRP file. I had to run the ATI Technologies and Creative Labs Sound Blaster installation programs again. It took a bit of mucking about to get things the way I wanted them, but none of this was a real problem. Provided you have a good backup system, I can recommend that you reinstall Windows every few

URGENT—YOUR INPUT NEEDED

On: Data Acquisition

Dear Reader:

To improve BYTE's coverage of technology in the State of the Art section, we'd like to get your feedback about what topics, areas, and products we should be considering, and in what ways.

Later this year, we're planning to take a look at data acquisition in manufacturing—the latest developments in process control systems, integration of CAD/CAM operations, inventory control, and other manufacturing-related applications. But we'd like to hear what *you're* interested in—what you'd like to see us report on and analyze. Are you interested in design integration, ruggedized systems, shop-floor control and input systems? We want to hear your ideas, to find out about concerns that we may not fully appreciate, and to learn about just what aspect of manufacturing data acquisition you're interested in. Also, we'd like your help in identifying the people we should be talking to—users, vendors, researchers—you tell us.

To let us know what you think, please use the following as a template to send us, via E-mail, an ASCII text file with your comments. Please be sure to include the <FIELDNAMES> with their angle brackets, followed by your information and comments. And thanks very much for your help.

Please E-mail the completed form to: **surveys@bix.com**

```
<TOPIC>
Data Acquisition in Manufacturing

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<COMMENTS>
This is where your comments go. Be as brief or as long as you
want. Tell us what you think, what you need, what you want to
know more about. Tell us what you're doing. Tell us who we should
be talking to.
```
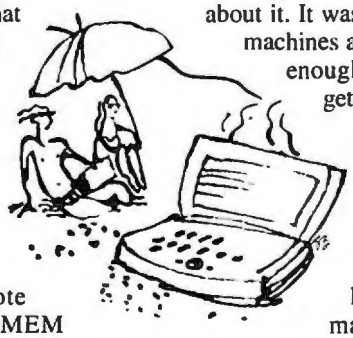

years; it speeds things up and gets rid of a lot of garbage.

Now I was back where I started, and it was time to figure out why W95 wouldn't run. I got out my logbook. When the W95 installation program reboots the machine, you first see what looks like your old CONFIG.SYS and AUTOEXEC.BAT files being executed; then W95 takes over. Perhaps, I thought, the problem is that I've been using DOS 5 and Quarterdeck's QEMM 6.03. This is partly sloth, but it's mostly the theory of not fixing what ain't broke. Maybe it's time to update to MS-DOS 6.22 and QEMM 7.5, and then see if W95 will install.

If I'd thought about it a little longer, I'd have realized that was silly. Why should a new OS care what DOS and memory management I'd been using before installing it? I realized this as I was about halfway through the upgrade, but by then it was easier to continue. I got MS-DOS 6.22 installed and rewrote CONFIG.SYS to use HIMEM.SYS. Once again I was thankful for Norton Commander, which makes it a snap to view, copy, and edit files such as CONFIG.SYS.



I got the DOS start-up message. HIMEM.SYS began its memory tests—and I got a message that the A20 line handler wasn't working. There would be only the base 640 KB of memory; it couldn't find the other 15+ MB. I rebooted a couple of times and got the same message.

The A20 line controls the way in which high memory is addressed. When the IBM AT was designed, IBM gave the A20 line-handling job to the keyboard encoder chip. This is why you sometimes get spurious memory-error messages if you've spilled coffee or popcorn into your keyboard. It can also generate spurious keystrokes in some versions of WordPerfect.

Not all computers use the keyboard processor to handle the A20 gate. HIMEM.SYS is supposed to figure that out for itself, but it sometimes can't. Thus, HIMEM.SYS can be invoked with command-line switches (`/M:`*n*, where *n* is a number between 1 and 20). This is explained in great detail in New Riders Publishing's *Inside MS-DOS 6.22*, and in adequate detail in Que Development Group's *Using MS-DOS 6.21*. If you ever have an A20 handler message, I suggest you get one of those books and read up on it.

I tried a couple of the HIMEM.SYS switches, and I was able to get HIMEM to believe I had an A20 handler; but it gave other and even stranger errors, including memory errors. I tried other `M:` switches. Some locked the machine up; none worked well. I thought about this for a bit and had a sudden flash of insight.

The Cheetah 486/33 was designed in the 1980s, before there were any DX2 chips. When I replaced the CPU with the new Intel 486DX2/66 chip, I thought there might be a problem. There was: about once every six or eight times I'd reboot the machine, it would start up DOS, give the QEMM sign-on—and hang. Turning it off and back on again would fix the problem. Once the machine came up all the way, everything was fine, so I never worried about it. It was still one of the fastest machines around, more than good enough. I just figured it was getting old and cranky. Perhaps one of the "glue" chips was going bad.

HIMEM's problems with the A20 handler made me think again. Why should a hardware problem let the machine start to boot up and then die when QEMM 6.03 began to install itself? Moreover, once before when I tried to upgrade to QEMM 7, I never got it past that opening QEMM message, which is why I went back to QEMM 6.03. All of that sounds more like a software problem, not a failing chip.

The Cheetah was designed by Ron Sartore. Cheetah International is, alas, no more. The company was brought down by money, not technical, problems. Ron lives in Southern California, where he is the chief architect of PCI products for Applied Micro Circuits. I called him, and when I described the situation, he knew at once what the problem was.

The Cheetah's BIOS was written before there were any DX2 chips. "The CPU is telling the keyboard chip to close the A20 gate, and then it impatiently doesn't wait long enough for it to do it."

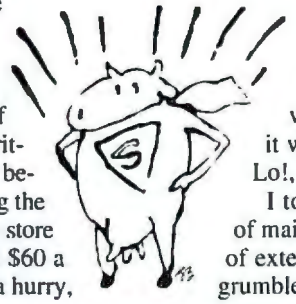
That sounded serious. "So we need new BIOS ROMs?," I asked. "Or a faster keyboard encoder?"

"Well, it would help if you had a DX2 keyboard encoder, but maybe there's a simpler way. You can jumper the Cheetah motherboard to speed up the keyboard encoder, and that might be good enough. I'll look up just where those jumpers are and fax you."

At this point, it was time to go down to the beach house to do some fiction writing. I

was still curious about W95. Therefore, in addition to the laptops, which would have been more than enough for the work I'd assigned myself, I lugged along SuperCow, the desktop Gateway 2000 486DX2/66. I also brought the W95 installation disks.

SuperCow came with 8 MB of memory. Microsoft swears W95 will run in 8 MB, but I have 16 MB on the OS/2 machine. I decided to put another 8 MB in SuperCow before trying to install W95. I took the precaution of examining the SIMMs and writing down all relevant numbers before I went looking, but finding the right memory at a nearby chain store was no problem. It cost about $60 a megabyte; if I hadn't been in a hurry, I could have found it for less.



I tested the new memory by putting it in banks 0 and 1, where the original memory had been. SuperCow came up fine. I added the other 8 MB. SuperCow couldn't find that memory at all. Worse, I couldn't figure out how to get into setup mode. Needless to say, I'd left the manuals back in Los Angeles; and try as I might, I could not get SuperCow to believe there was more than 8 MB of memory installed.

When you're a long way from your manuals, it's time to use the network. I logged on to BIX and described my problem. Within hours I got my first answer: the way to access SuperCow's setup is to wait until it boots and then do Ctrl-Alt-Esc. Unfortunately, that didn't work, and I said so online. A couple of minutes later a user sent me E-mail: QEMM interferes with the Setup program. Try it without QEMM. I did, and Lo!, there I was.

I told Setup we had 640 KB of main memory and 15,744 KB of extended memory. SuperCow grumbled that my CMOS settings were wrong and reset the number to 7552 KB; it still couldn't see the memory I'd installed. Back to the network. Next day, two people told me: there's a switch block on the motherboard. The first four switches need to be set off-off-on-on. With that done, everything was simple, and SuperCow had 16 MB of memory. It was also Sunday evening, and I no longer had time to install W95 before I went back to Los Angeles.

Note: most new machines find the memory automatically, but it's always a good idea to keep your PC's manual handy. If it's small enough, put it *inside* the computer—you won't lose it there.

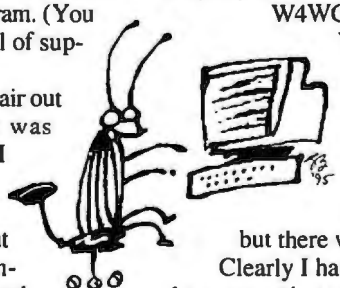
When I got back home, Ron's instructions were waiting on my fax machine. Two jumpers control keyboard-controller chip-access speed for the Cheetah. They should both be set on. He included a diagram showing where those jumpers are, because the manuals and paperwork for the Cheetah long ago sank in the Chaos Manor paper storm.

It took about a minute to open up Big Cheetah and change the jumpers. When I turned him on, I got an error message: "Missing keyboard." But then that message went away, and boot-up proceeded without interruption. I shut down and began again. Same thing. A message complaining about a missing keyboard; then a smooth and fast boot-up. HIMEM.SYS didn't complain a bit, so I tried it with QEMM. Still no problem. The upshot is that I rebooted the system about 20 times,

and I never got a glitch beyond the easily ignored "Missing keyboard" message. Clearly I'd had a software timing problem, and that was now fixed; neither HIMEM nor QEMM had a problem with the A20 line handler.

It seemed likely that the A20 line-handler problem was what had crashed W95, so I tried that installation again. Microsoft's W95 product manager, Brent Ethington, was coming to Chaos Manor the next morning, and I thought it would be neat to have W95 working on Big Cheetah when he got here. Alas, after 12 disks, the installation program got to the same place as before and hung up.

Enter Brent Ethington, who'd come down to show me things about W95. First thing was to try a reinstallation on Big Cheetah, this time using the CD-ROM; the program is indeed on there. The installation went a *lot* faster, but unfortunately with the same result. Brent got hold of some people in Redmond. They talked a while and then connected Big Cheetah up to Redmond via modem and a debug program. (You probably won't get this level of support.)



While he was tearing his hair out trying to determine what was wrong with Big Cheetah, I took the CD-ROM, put it into Pentafluge, and ran the W95 Setup program. In about 10 minutes, I had W95 running. There was only one real problem. A thing called Watch-it, which seems to have come in along with a program called Remove-it, kept popping up on start-up no matter how hard Brent and I tried to eliminate it.

With Watch-it running, you can reliably crash W95 by running Procomm Plus, the DOS communications program, and trying to get into the Procomm setup menu. The machine locks to hardware reset. Removing Watch-it cured this problem. It's not easy to remove. Not only is it in WIN .INI, but it loads in AUTOEXEC.BAT.

I also found I had to reset the Sound Blaster 16 board. I had Windows set so that when it came up, an announcer would tell you to "stay tuned while Beavis and Butt-head burn things and blow stuff up." W95 retained that. XCOM: UFO Defense ran properly with sound under W95. I brought over Master of Orion (MOO for short), discovered it was configured wrong, and had problems changing the configurations; and, of course, the Sound Blaster configuration program wants you to reboot when you're done changing settings.

You don't just turn W95 off. Like OS/2, you invoke a shutdown program, which gives you several options. One is to reboot in DOS, so I tried that. It worked just fine. Once in DOS, if you do VER to get the version number, you are told that it's W95; but it's a perfectly good DOS, similar to MS-DOS 6.22. If you reset while in W95's "DOS," the machine automatically comes back up in W95.

The great thing is that once Sound Blaster is set properly, W95 will not only play games like XCOM and MOO—it will even keep both of them open and let you switch from one to the other, and there's sound in both games. I can't do that with OS/2, which will play either of those games, but not both at once. Windows won't even play them, at least not well enough that you'd want to.

I spent another hour fooling around with W95. I loaded up Norton Commander and Q&A Write. I loaded up Microsoft Word. I loaded up Doom. I connected a modem to the system and looked out on the Internet. I made sure the local network was working properly and that I could access not only W4WG machines, but the OS/2 Warp machines running OS/2 LAN Server. All that worked. It wasn't always easy to make things happen—W95 does things a bit differently from Windows—but there was no real problem.

Clearly I haven't worked with W95 long enough to warrant a real opinion, but so far I like what I've seen. I'm particularly impressed with the Help Wizards, which tell you how to make things happen. It's easier to set up than either Windows or OS/2. W95 is certainly a better DOS than Windows, it may be a better DOS than DOS, and if you like Windows, you'll love W95.

Stay tuned, though. There are mysteries. Some, such as my constantly losing programs from the groups I put them in, are due to my ignorance of the system. Others, such as an intermittent inability in Microsoft Word to turn off the "show nonprinting characters 'feature,'" are both mysterious and annoying.

Overall, assuming that it works and I can overcome the initial annoyances, I like W95 better than Windows; but we'll see what happens.

Now back to Brent and Big Cheetah. After using the debug program through a modem, the technicians in Redmond concluded that the problem is the Perceptive Solutions SCSI hard drive controller that's running in block mode. For some reason,

W95 expects some information it's not getting.

There are several possible remedies. One is to change the mode of the controller from block mode to Western Digital mode. Of course, that betrays the age of the controller. What we called Western Digital mode five years ago is now known as IDE, and what I would be doing is slowing the SCSI controller down to IDE speeds.

I could also change controllers. Meanwhile, all this is a good indication of the problems Microsoft faces in getting W95 to work with the hardware out there. My Cheetah with the Perceptive Solutions controller was an advance in the state of the art of its time—indeed, the Cheetah, with its 35-nanosecond zero-wait-state memory, is in some ways more advanced than a number of more "modern" systems. Now imagine what will happen when everyone updates their 486s with DX4 chips with Pentium features! We do live in interesting times.

Big Cheetah is my main writing machine, and since he wasn't going to run under W95, I had to get him going with DOS and Windows again. Now that I'd moved the keyboard jumpers, I didn't have to stay with DOS 5 and QEMM 6.03, so I booted with an MS-DOS 6.22 floppy disk, did the SYS command, and copied version 6.22 into the DOS subdirectory. Then I erased the Windows directory and let Network Archivist restore that from tape.

I was using HIMEM.SYS and EMM386.EXE for memory management. If I turned off XMS memory, I had DOS windows of 615 KB, but DOS games like MOO wouldn't work in Windows because they need expanded memory. I exited Windows and added "AUTO" to the EMM-386.EXE device line; that got me XMS memory, but my DOS windows were only 501 KB, too small for many of my DOS programs, including MOO.

Meanwhile, all this is a good indication of the problems Microsoft faces in getting Windows 95 to work with the hardware out there. Imagine what will happen when everyone updates their 486s with DX4 chips with Pentium features! We do live in interesting times.

My next step was to try the Microsoft memory-optimizer program called Memmaker. That brought my DOS windows up to 538 KB. *Inside MS-DOS 6.22* has a whole chapter on tricks you can use to increase your usable memory, and I suppose I should have tried some of them. However, I was running out of time, and there's an even better remedy. Installing QEMM 7.5 took about 10 minutes, with another 5 minutes to run its Optimizer program. That's all I did, and I now have 624-KB DOS windows, plenty good enough.

W95 has its own memory management (it automatically allocates XMS memory), but as long as you stay with DOS and Windows, you really need QEMM. One warning: QEMM by default turns on Quarterdeck Fast Boot, and while that really speeds up rebooting when it works, it reliably hangs about half the machines I've tried it with, including Big Cheetah. If Fast Boot hangs your machine, the hard-won remedy is to put "BE:N" on

the QEMM386.SYS device line.

With that caution, QEMM 7.5 is highly recommended.

One last point. One of the alterations W95 made to my AUTOEXEC.BAT file was to remove the "Last drive" command. When I restored DOS and W4WG, I couldn't make network connections. "Error 15," it told me. I couldn't find that in any W4WG reference work I have. Eventually I went back out to DOS and tried to start up the network; I got the same message, but this time there was a reference to "Last drive." When I replaced the Lastdrive = Z in the AUTOEXEC.BAT file, Error 15 went away.

We went to NetWorld+Interop in Las Vegas last week. It was an impressive show. Smaller than Comdex, but at least as interesting. One of the most amazing things is that the *entire show* is connected to itself: there's a network connecting every booth that wants to participate. I learned a lot about routers, networks, network tools, and the Internet in general; but for me, the big hit of the show was OS/2 Warp Connect.

I don't normally review products I don't have and haven't used. In this case, IBM had OS/2 Warp Connect set up on 50 interconnected workstations and let us play with it awhile. So, I do have a little experience with it; but keep in mind that I don't own a copy of it yet.

OS/2 Warp Connect, which should be available about the time you read this, is everything OS/2 Warp and W4WG ought to have been; indeed, if OS/2 Warp Connect had come out last year, I believe it would have put a serious hole in W4WG sales. It's a peer-to-peer LAN, but it's also a lot more. It contains Lotus Notes Express (a light version of Lotus Notes); that in itself makes OS/2 Warp Connect valuable, because Lotus Notes Express has RSA (Rivest-Shamir-Adleman) public-key encryption.

OS/2 Warp Connect is more secure than W4WG. It's got all kinds of little features I wished I had more time to play with. More on OS/2 Warp Connect when I have it, but I was impressed by what I saw.

One of the neat gadgets that I saw at Interop was Garrett Communications' Magnum H80-B Personal Hub. This is a box about the size of a small book. You plug one end into an Ethernet coaxial T connector, and you've got eight 10Base-T slots. Unlike the Ethernet concentrators we've had in the past, this one is small enough to sit on a table or attach to a wall, and it has its own power supply. You can carry it around and use it where it's needed. Connecting it up is simple, and there's no software to install.

We have thin-net coaxial cable running all over the place here—Roberta opines that networks are not decorator-friendly—but often enough we need to connect in a system that's got a 10Base-T connector; for instance, an Ethernet adapter on a PCMCIA card.

You can daisy chain the Magnum H80-B Personal Hubs, up to the Ethernet limit of five hops. Ethernet works at 10 Mbps, independent of the wire, so you don't lose anything by using a mix of network types. The hubs are small, and it's hard to connect one up wrong. We're going to get a lot of use out of this.

Until recently, I have connected Big Cheetah through the parallel port to a Hewlett-Packard LaserJet III (one of the first ever made, and still working like a champ). Actually, it wasn't a direct connection: I had a 20-foot parallel cable from Big Cheetah to a box full of memory. The box is called a Printer Optimizer, and I've used it for years; but it's dying. Its latest trick is to print Q&A Write files just fine, but print garbage when I send a Word for Windows file.

The obvious remedy would be to remove the box and connect the printer directly to the computer; but, alas, that requires an additional 3 feet of cable, and when I did that, the computer couldn't find the printer. When they tell you 20 feet is the maximum distance for a parallel connection to a printer, believe them.

Valiant, which is an IBM ValuePoint Pentium machine that runs OS/2 Warp and OS/2 LAN Server 4.0, is only about 10 feet from the printer. In the past, when I had a really big print job—the last one was printing *Beowulf's Children*—I would send the file over to Valiant, connect him to the printer, and print from there, because printing from Windows takes ages. Why not, I thought, connect Valiant up permanently to the printer and use OS/2 LAN Server to make that printer available to all the other machines?

It took about an hour. Telling OS/2 LAN Server to share a printer is fairly easy, provided you remember that you use a template by dragging it out to the work surface, not by double-clicking on it.

Networking is a mysterious thing. I now have all my machines connected up so they print through Valiant, and I can't think why I didn't do it before. Printing over a network is lightning fast compared to letting Windows do it with Print Manager. W95 is said to have solved that problem,

but I haven't had enough experience with it to know.

As of today, Pentafluge sends print jobs onto the network just like the other machines. One of these days I'll connect a printer directly to it to see if W95 has sped things up.

Anyway, I can print through the OS/2 machine to the LaserJet III, and it's all exceedingly fast—and doesn't tie up the OS/2 machine at all.

That's when things are working.

A few minutes ago, I tried to connect a portable to the network using Xircom's Performance Series CreditCard Ethernet Adapter IIps. I didn't manage to do it; but whatever I did crashed two machines on the network. The OS/2 system didn't have any problems, and neither did Big Cheetah, but Little Cheetah and SuperCow were locked up to hardware reset. I have no idea why, because I didn't touch either machine. The notion that you can use the network to crash machines at a distance is a bit frightening.

Later, another bit of mucking about with the Ethernet connections convinced Little Cheetah that he wasn't on the network any longer. The machine worked fine, but the network couldn't find him, and vice versa. We had to exit Windows, reset, and bring Windows up again. That worked fine. Who knows why?

What I have found is that OS/2 LAN Server works nicely with W4WG and W95, although, again, there are mysteries. W4WG saw the network printer by browsing. That was fortunate, because although I had told OS/2 LAN Server that I wanted the printer there to be called VAL, it named it hplaserj. I've no idea why, but I don't care, because I was able to connect Big Cheetah to it, and it prints 10 times as fast as I could print by directly attaching the same printer to Big Cheetah's parallel port.

W95 didn't find the network printer by browsing. On the other hand, W95 has a very nice wizard to walk you through the installation process, and because I knew what the printer's name was, I could type in `\\valiant\hplaserj`. Everything connected fine, and I can print like crazy.

Provided, of course, that the network doesn't crash.

My network problems were caused by my doing something weird with the cable connections, not by the Xircom adapter. It is a painless way to add a laptop to your network. Most laptops come with W4WG 3.11 installed, so all you have to do is install the network card and turn the networking features on.

That works fine on the Liberty. Alas, we haven't yet managed to get the Zenith Z-Noteflex to use it; Zenith's PCMCIA card-handling software seems to clash with the Xircom drivers. We know we have the latest Xircom drivers, because we downloaded both drivers and a flash-RAM update for the card just a few minutes ago from their BBS. [Editor's note: *Jerry did not have time to test them for this column, but he plans to report on them in a future column.*]

You can always connect your portable to your network through LapLink, but Ethernet is much faster; and the Xircom Performance Series CreditCard Ethernet Adapter IIps works. Recommended.

I've had a Citizen PN-60 printer for months now, and somehow I never have room in this column to do it justice. This printer is the size of a typewriter roller. It has a rechargeable battery. It's slow, but it will do letter-quality printing, a sheet at a time, and you can fit it into your briefcase. I don't see how anyone can make a smaller

printer. Or would want to.

The CD-ROM of the month is Return to the Moon from Lunar Eclipse Software. Pictures, games, atlas, moon-flight simulator, and LunaCorp. rovers; if you have any interest in the moon, this is for you.

The gadget of the month, and maybe the year, is the Timex Data Link. This is a perfectly good digital alarm watch that will also store appointments, phone numbers, to-do lists, and suchlike. The interesting part is that you put in the data on your PC and then hold the watch up to the screen; a tiny electric eye in the watch downloads everything. Richard, our son who's a congressional staffer, snaffled off our copy, and he won't let go. He says it's one of the most useful things he's had. I suppose I'll have to get one for myself.

The computer book of the month is by Joshua Quittner and Michelle Slatalla: *Masters of Deception*. I have the British edition (Vintage, 1994), given to me by Dr. Alan Solomon of antivirus fame; the U.S. edition is published by HarperCollins. This is the story of the network war between two hacker gangs, the Masters of Deception and the Legion of Doom, and it's fascinating. Read it along with Steven Levy's *Hackers: Heroes of the Computer Revolution* (Dell, 1985) and you'll have a lot of insight into where the computer revolution is going.

The book of the month is Donald Kagan's *On the Origins of War and The Preservation of Peace* (Doubleday, 1995). This is one of those rare books I call important. By comparing the outbreak of war in ancient and modern times, Kagan gives you some insight into why wars happen and what you might do about them.

Dr. Solomon visited Chaos Manor this week; next month, that story, more on Windows 95, and a catch-up column about a lot of neat stuff that's piling up. I sure do like little computers. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on the Internet or BIX at jerryp@bix.com.

For More Information

The **Citizen PN-60 printer** ($399) will do letter-quality printing, a sheet at a time, and you can fit it into your briefcase. Contact **Citizen America Corp.,** Santa Monica, CA, (310) 453-0614. **Circle 1233 on Inquiry Card.**

The **Magnum H80-B Personal Hub** ($349) was one of the neat gadgets at Interop. Contact **Garrett Communications, Inc.,** Fremont, CA, (510) 438-9071; garrett@mediacity.com. **Circle 1234.**

Xircom's **Performance Series CreditCard Ethernet Adapter IIps** (for 10Base-T, $199; for 10Base-T/10Base-2, $259) is a painless way to add a laptop to your network. Contact **Xircom, Inc.,** Thousand Oaks, CA, (800) 438-4526 or (805) 376-9300; http://www.xircom.com. **Circle 1235.**

If you have any interest in the moon, you need the **Return to the Moon** ($39.95) CD-ROM. Contact **LunaCorp./Lunar Eclipse Software,** Arlington, VA, (800) 467-7223 or (703) 841-9500; 71147.3603 @compuserve.com. **Circle 1236.**

The **Timex Data Link** ($130) is the gadget of the month, and maybe the year. Contact **Timex Corp.,** Middlebury, CT, (800) 367-8463 or (203) 573-5000; data.link@timex.com. **Circle 1237.**

What's New Hardware

PREVIEW PC NOTEBOOKS

SVGA and Full-Screen Doom to Go

AST Research's Ascentia 950N notebook provides 75-MHz Pentium performance in a package that lacks some features found in more expensive notebooks, such as an integrated CD-ROM drive. However, it offers solid performance and interesting full-motion video and graphics capabilities.

The Ascentia 950N's 10.4-inch active-matrix screen is outstanding, especially when running Windows at a resolution of 800 by 600 pixels. If you want to run a DOS application that's not recommended to run from within Windows (e.g., Doom), the 950N's SVGA controller lets you do so in full-screen mode.

Ascentia 950N
(75-MHz Pentium, 8 MB of RAM)
With 510-MB hard drive and 10.4-inch dual-scan passive-matrix screen, about $3499;
with 1.2-GB hard drive and 10.4-inch active-matrix screen, about $5499.
AST Research
Irvine, CA
(800) 876-4278
(714) 727-4141
go astforum@compuserve.com
Circle 1039 on Inquiry Card.

When you switch from a resolution of 800 by 600 to 640 by 480, some SVGA-capable notebooks shrink the screen image by about an inch on each side. The 950N's Cirrus Logic 7543 SVGA controller can selectively replicate lines in a DOS application's 640 by 480 image so that the program uses the entire SVGA screen, which is a benefit. In addition, the controller's YUV-to-RGB-conversion capabilities provide full-motion video-playback assistance.

Other notable features include a Creative Labs' Vibra16 Sound Blaster chip set; a 36-mm speaker, which provides bigger sound than some built-in notebook stereo speakers we've heard; and lithium-ion batteries that should provide about 4 hours of battery life. (The preproduction unit that BYTE tested didn't have a final BIOS, so we couldn't test battery life.)

Performance	
Integer index	.829
Floating-Point index	.939
(A 90-MHz Dell Pentium = 1)	

AST plans to release a docking station with a CD-ROM in June. The Ascentia 950N is a solid mainstream entry in the high-end PC notebook market. —**Dave Andrews**

AFFORDABLE TELEPHONY

The VM100 Telesound Voice Mail for PC System ($59) and the Reveal VM500 Decathlon XL card ($249) provide PCs with telecommunications capabilities, including a speakerphone and voice mail. The VM100 system combines a serial-port adapter, a microphone, and software. The adapter serves as the communications hub for the system, connecting your phone line with your PC's serial port and sound card to create a phone system that includes voice-mail and speakerphone capabilities. The VM500 card provides voice-mail and speakerphone functionality plus a 14.4-Kbps fax modem, a 16-bit sound card with SRS surround sound, and a CD-ROM controller. The card provides up to 999 fax or voice-mail boxes.

Contact: Reveal Computer Products, Woodland Hills, CA, (800) 738-3251 or (818) 704-6300; goreveal@compuserve.com.

Circle 1040 on Inquiry Card.

PORTABLE DATA ACQUISITION SYSTEMS

DASport (from $695) features 16SE/8DIFF analog inputs, eight digital inputs and outputs, two crystal-controlled rate generators, and a 16-bit counter. The system provides 100-kHz streaming to PC RAM or disk, transient capture, and waveform generation. Options include analog triggering and outputs ($100) and an internal battery ($200).

Designed for use with notebook PCs, I/Ocard connects to a PCMCIA Type II slot and features eight differential analog inputs, 30-kHz throughput, and external triggering. Gains and input ranges are software selectable; both unipolar and bipolar input ranges are available. I/Ocard ($595) also features four digital inputs and outputs at TTL-compatible levels, cold-junction compensation, and a voltage-reference output.

Contact: Intelligent Instrumentation, Tucson, AZ, (800) 685-9911 or (602) 573-0887.

Circle 1041 on Inquiry Card.

PORTABLE LCD PROJECTION PANELS

Mobile professionals who deliver electronic presentations on the go may be interested in the PanelBook 500e Series of LCD projection panels (from $4299). The devices offer a resolution of 800 by 600 pixels, a palette of 16.7 million colors, and the In Focus PC-Remote. You simply place the LCD panel on an overhead projector and connect the panel to a PC or a Mac. You can also plug VCRs, CD-ROM drives, and laserdiscs directly into the PanelBook.

Contact: In Focus Systems, Wilsonville, OR, (800) 294-6400 or (503) 685-8888.

Circle 1042 on Inquiry Card.

MULTICHANNEL FAX AND VOICE BOARDS

The GammaFax CP-6/SC six-channel ($3995) and CP-12/SC 12-channel ($7495) boards help you develop PC-based fax broadcast, fax-on-demand, T1 fax connections, and integrated voice-response systems. Each channel has a microprocessor-based fax modem with a CPU, a custom ASIC, 512 KB of RAM, and 32-Kb PROM. The boards offer 14.4-Kbps transmission/reception, Rockwell modem chips, Modified Read and Modified Modified Read data compression, ITU error-correction mode, and ITU T.434 binary file transfer. You can configure multiple boards to support up to 30 fax channels per fax-server chassis.

Contact: GammaLink, Sunnyvale, CA, (800) 755-4444 or (408) 744-1400; sales@dialogic.com.

Circle 1043 on Inquiry Card.

REMOVABLE PLUG-AND-PLAY HARD DRIVE ▲

KanguruDisk is available in both internal and external versions. The internal kit ($64) includes a KanguruDock, which you install in a PC bay, and one KanguruDisk. The external kit ($229) includes the KanguruBay external box, one KanguruDisk, and a cable that you plug into your PC's parallel port. The KanguruDisks are available in 420-MB ($299), 540-MB ($349), 850-MB ($439), and 1.3-GB ($649) versions.

Contact: Interactive Media, Holliston, MA, (508) 429-9070.

Circle 1044 on Inquiry Card.

120-MHZ PROLIANT SERVER

Compaq's ProLiant 1500 5/120 server has an Intel 120-MHz Pentium processor and includes such features as ECC memory, server-recovery software, hot-pluggable drives and disk arrays, and the TriFlex/PCI system architecture. Available in both tower and rack-mount configurations, a system with 16 MB of RAM, a SCSI array controller, and 4 GB of disk storage costs about $12,749.

Contact: Compaq Computer, Houston, TX, (800) 345-1518 or call local Compaq dealer; http://www.compaq.com.

Circle 1045 on Inquiry Card.

CD-ROM FOR THE ROAD

With the CD940, your notebook PC's battery powers the CD-ROM drive. The double-speed drive offers a data capacity of 635 MB, an access time of 350 ms, a data transfer rate of 320.7 KBps, and a memory buffer of 64 KB. The CD940 package ($449) includes the CD-ROM drive with motorized front-tray loading, a headphone jack, volume control, and audio CD support; a PCMCIA interface card; and an interface cable.

Contact: EXP Memory, Irvine, CA, (800) 397-6922 or (714) 453-1020.

Circle 983 on Inquiry Card.

OPTICAL MASS-STORAGE DRIVES

The Infinity 6000 family includes the LD6100 single-disk 12-GB drive ($31,000), the LF6600 72-GB six-disk RapidChanger drive ($38,000), and the LF6602 144-GB 12-disk dual-drive RapidChanger drive ($69,000). All models come with a fast SCSI connector and dual-head simultaneous transfer capabilities, which provide immediate on-line access to 12 GB of data per drive.

Contact: Philips Laser Magnetic Storage, Colorado Springs, CO, (800) 777-5674 or (719) 593-7900.

Circle 984 on Inquiry Card.

PENTIUM SYSTEMS

The Austin PowerPlus Energy Star–compliant desktop PCs ($1799 to $4299) include 75-, 90-, 100-, and 120-MHz Pentium processors; 8 to 128 MB of RAM; 420-MB to 1.8-GB hard drives; 32- or 64-bit PCI Windows accelerator boards with DRAM or video memory; and 256-KB pipeline burst L2 cache and FP memory, 256-KB asynchronous L2 cache and FP memory, standard 256-KB cache and FP memory, or EDO RAM.

Upgrade options include the MediaMagic Telemetry-32 Communications Manager (consisting of a 19.2-Kbps fax modem, voice mail with caller ID, and 16-bit wavetable sound); 14.4- and 28.8-Kbps fax modems; a 3½-inch Infrared Data Exchange Module; a voice-enabled PC add-on; and quad-speed multimedia upgrade kits.

Contact: IPC Technologies, Austin, TX, (800) 849-8681 or (512) 339-3500; russell.carlisle@ipctechinc.com.

Circle 985 on Inquiry Card.

REMOTELY CONTROL SURGE PROTECTION

With a Touch-Tone telephone, you can remotely power up or power down as many as seven different components and reboot your system from anywhere in the world, 24 hours a day. Phone Director ($119.95) protects your system against power disturbances that can cause system crashes, corrupted data files, disk drive damage, and computer lockup and enables you to access your files, send data via either fax or modem, and retrieve your E-mail.

Contact: Newpoint, San Diego, CA, (800) 639-7646 or (619) 677-5700.

Circle 986 on Inquiry Card.

V.34 PCMCIA CELLULAR MODEM ▲

A 28.8-Kbps cellular data/fax modem, the Mobile Plus V.34 Cellular lets you send and receive information from a mobile computer without wires. The credit-card-size modem supports more than 30 cellular phones and features direct-connect capability. When you plug in a dedicated cellular-phone cable, the card automatically changes from land-line mode to cellular mode. In addition, the Mobile Plus ($449) can store several cellular-phone configurations, eliminating the challenges associated with using more than one phone model.

Contact: Apex Data, Pleasanton, CA, (800) 841-2739 or (510) 416-5656.

Circle 987 on Inquiry Card.

COLOR MONITORS WITH BUILT-IN SPEAKERS

The ViewSonic 15GA ($595) and 17GA ($995) monitors offer high-fidelity dome speakers that are integrated into the bezel and aim stereo sound directly at you. The monitors also include front-mounted volume and mute controls; a built-in microphone, a headphone jack, and an external microphone port; a Super Contrast screen; an ARAG antireflective/antiglare coating; an Invar Shadow mask; a 0.27-mm dot pitch; up to 1280- by 1024-pixel resolution; refresh rates as high as 160 Hz; and Plug and Play+ (DDC1 and DDC2B) compatibility to support Windows 95.

Contact: ViewSonic, Walnut, CA, (800) 888-8583 or (909) 869-7976; 73374,514@compuserve.com.

Circle 988 on Inquiry Card.

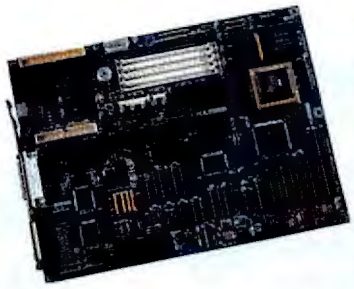
VIDEOCONFERENCING PORTABLE

Dolch Computer Systems can configure the TelePac portable videoconferencing system with a 386, 486, or Pentium processor; primary RAM; secondary RAM cache; DRAM; 270-MB to 1.1-GB hard drives; ISA, EISA, VESA, and PCI slots; and a video camera, all in a ruggedized chassis. The TelePac (monochrome models, from $5000; color models, from $6300) provides room for teleconferencing codecs, an Indeo video board, and ISDN and network interfaces. Dolch's flat-panel video-interface technology provides 16.7 million colors and a rating of more than 100 WinMarks.

Contact: Dolch Computer Systems, Fremont, CA, (800) 995-6599 or (510) 661-2220.

Circle 989 on Inquiry Card.

What's New Hardware



RUN WINDOWS ON YOUR PS/2 ▲

The Genesis\PC Replacement Motherboards allow the IBM PS/2 Models 25, 25 286, and 30 286 to run Windows, OS/2 Warp, NetWare, and other software. The motherboards ($295 each) provide a Texas Instruments 40-MHz 486DLC CPU; CMOS technology; sockets for 128 KB of second-level cache and a math coprocessor; two 16550-compatible serial ports; an Enhanced Parallel Port; a game port; PS/2 mouse, keyboard, and headphone connectors; the ability to accommodate an additional 32 MB of memory; and SVGA graphics. Two 16-bit ISA expansion slots are provided with the PS/2 Model 25 and 25 286 motherboards. Three with the Model 30 286 motherboards.

Contact: PC Enterprises, Wall, NJ, (800) 922-7257 or (908) 280-0025.

Circle 990 on Inquiry Card.

NUBUS-BASED ISDN FILE TRANSFER BOARD

4-Sight Quatro can transmit files across as many as eight ISDN channels to attain data rates of up to 3.54 MB per minute. You can install up to four boards ($3495 each; bundled with 4-Sight's iSDN Graphics Superhighway Broadcast software, $5795 each) simultaneously, which provides 16 lines and 32 channels for data transmission. Diagnostic utilities automatically check the configuration to—as well as handshake with—ISDN lines and switches.

Contact: 4-Sight, West Des Moines, IA, (800) 243-0516 or (515) 221-3000; foursight @aol.com.

Circle 991 on Inquiry Card.

REMOTE NETWORK ACCESS

ConnectPlus LT, a multiprotocol, two-port, remote-access server, provides client-to-LAN access for remote users running TCP/IP, NetWare, and AppleTalk. Self-configuration features include automatic modem recognition, automatic protocol detection, and dynamic network addressing. Virtual-Port technology allows eight PCs to be simultaneously remote-control-ready and selectable on the LAN. In addition, ConnectPlus LT ($899) provides telecommuters and remote users with dial-in access to the Internet.

Contact: Emulex, Costa Mesa, CA, (800) 854-7112 or (714) 662-5600; literature@ emulex.com.

Circle 992 on Inquiry Card.

MULTIPROCESSOR SUPERSERVER

Capable of handling up to four 90- or 100-MHz Pentium processors, the Star Q SMP superserver (from $7500) can accommodate 13 dual hot-swappable drive bays and three VESA and 10 32-bit EISA expansion slots. An LVL-Bus video card has 1 MB of video RAM, upgradable to 2 MB. The system's 64-bit multiprocessor bus has a throughput of 267 MBps. Each CPU board includes, in addition to the processor, a cache controller and 256 KB of two-way set-associative write-back cache RAM. The Star Q SMP comes with a BusLogic EISA SCSI controller or, for a RAID configuration, a Mylex multichannel controller.

Contact: Star Technologies, Laguna Hills, CA, (714) 768-6460; leigh@startech.com.

Circle 993 on Inquiry Card.

ETHERNET SWITCHES ▼

Winswitch and Openswitch are fully expandable via 100-Mbps Fast Ethernet, an integrated 1.44-Gbps Netbus link, 10-Mbps ports, or an ATM port. Both products provide eight 10-Mbps ports with auto-detecting half- or full-duplex capability. For use with small- to medium-size peer-to-peer networks, Winswitch ($2400) supports 512 Ethernet user addresses; Openswitch ($3500), intended for medium- to large-size client/server networks, supports 4096 Ethernet user addresses and provides transparent connectivity among network operating systems. Expandability features in both devices support stacks of up to eight switches for a total of 64 dedicated 10-Mbps ports or segments.

Contact: NetCorp, Brossard, Quebec, Canada, (514) 923-4040; info@netcorp.qc.ca.

Circle 994 on Inquiry Card.

14.4 PCMCIA FAX MODEM

A V.32bis PCMCIA fax modem, the Zoltrix PCM144 can send and receive faxes and transmit data at 14.4 Kbps. V.42bis error correction and data compression enable a throughput of up to 57.6 Kbps. The Zoltrix PCM144 ($155) comes with PCMCIA configuration software as well as BitWare fax and data software.

Contact: Zoltrix, Fremont, CA, (510) 657-1188.

Circle 995 on Inquiry Card.

INTERNET-READY PCS

The Innova Media Series of PCs offer PCI, plug-and-play capability, and bundled software for instant cruising on the Internet. The systems (from $1699) come with 14.4- or 28.8-Kbps full-duplex fax modems and preloaded software for easy Internet access. The series includes five models: the MT4900 (100-MHz 486DX), MT7010 (75-MHz 586 Pentium), MT9010 (100-MHz 586 Pentium), MT7000 (75-MHz 586 Pentium), and MT9100 (100-MHz 586 Pentium). The PCs also come with 8 or 16 MB of RAM (expandable to 128 MB), quad-speed CD-ROM drives, amplified speakers, and a 16-bit sound card and provide enhanced video, hard drive, and peripheral performance.

Contact: Canon Computer Systems, Costa Mesa, CA, (800) 848-4123 or (714) 438-3000; gocanon@compuserve.com.

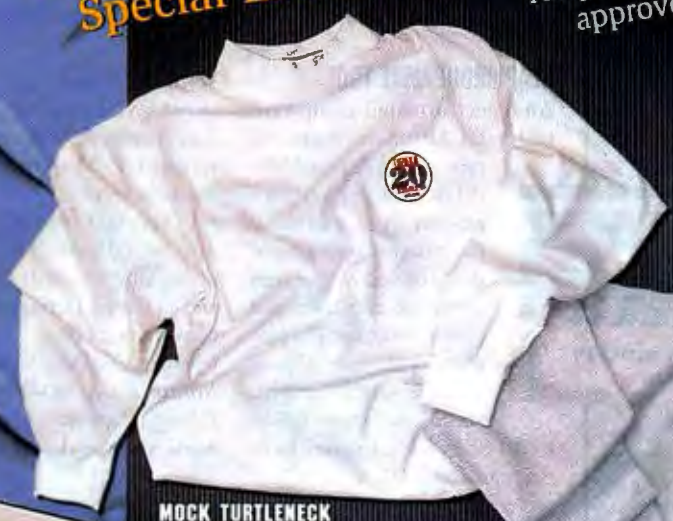
Circle 996 on Inquiry Card.

BYTE WEARHOUSE

Celebrate BYTE's 20th Anniversary with Special Limited Edition Merchandise

All products are officially approved by BYTE.

BYTE 20 Years 1975-1995



MOCK TURTLENECK
Outer Banks 100% cotton mock turtleneck. White. Sizes M(BYT 4), L(BYT 5), XL(BYT 6). **$26.00**

INSIGNIA PEN
Parker Insignia ball point pen. Lacquer black. (BYT 9) **$34.50**

BASEBALL CAP
Soft brushed cotton free-form cap with adjustable Velcro closure back. Black. (BYT 11) **$10.00**

MUG
11oz. ceramic mug with logo on both sides. (BYT 8) **$4.50**

COMPUTER TOOL KIT
Deluxe computer device tool kit in black vinyl zipper case features: 2 nut drivers, 3-prong parts retriever, torx driver, IC extractor, 1 phillips and two slotted screwdrivers. (BYT 12) **$20.00**

SWEATSHIRT
11 oz. cross grain Lee sweatshirt features generous athletic cut and side gussets. 95% cotton, 5% polyester. Ash. Sizes M(BYT 1), L(BYT 2), XL(BYT 3). **$31.00**

MOUSE PAD
Hard top mouse pad. 7.5"x 8.5". (BYT 7) **$5.25**

VECTOR PEN
Parker Vector Sport roller ball pen. Black. (BYT 10) **$6.25**

T-SHIRT
100% cotton Oneita Power-T. White. Sizes L(BYT 13), XL(BYT 14). **$8.00**

Call 1-800-676-4256

or 1-708-647-4906 in Illinois, 8:30 a.m.-5:00 p.m. Central Time.
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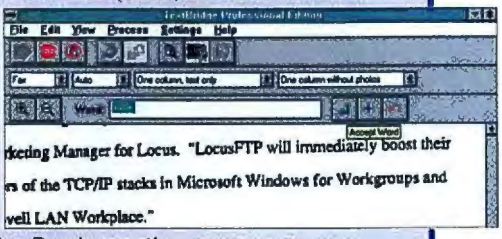
What's New Software

PREVIEW **DOCUMENT SYSTEMS**

Xerox's Solid Paperless-Office Bridge

OCR software continues to improve. When BYTE reviewed OCR software three years ago, the character-recognition accuracy of some packages was as low as 60 percent. Now these programs can typically recognize 96 percent—or higher—of a scanned document correctly while integrating with your word processing applications and preserving such format information as multicolumn document layouts; font attributes, such as boldface and italics; headers and footers; and tables.

The latest example of this trend is the Windows version of TextBridge Professional Edition 3.0 ($349; a Power Mac version is slated for release in June). The preproduction version BYTE previewed installs itself into Windows word processors, including Microsoft Word, WordPerfect, and Lotus Development's forthcoming WordPro (formerly known as Ami Pro), so you can recognize and proof documents within your word processor. If your word processor supports multicolumn layouts, you can take advantage of TextBridge's ability to preserve multicolumn layouts to obtain further time savings. TextBridge is also intelligent; it can recognize a header or footer in a scanned document and maintain that designation when it converts the document to a word processor that supports headers and footers.



Xerox Desktop Document Systems Division
Peabody, MA
(800) 248-6550 ext. 3
fax: (508) 977-2435
Textbridge_sales@xis.xerox.com
Circle 1002 on Inquiry Card.

The accuracy you see depends on such variables as the quality of the faxes or documents you scan and the point size of the fonts used. For instance, when I asked TextBridge to recognize a faxed press release containing 12-point skewed text (see the screen), its character-recognition accuracy was 99.4 percent. The program also has an interactive training component that lets you teach TextBridge to recognize unusual words, such as product names, to further increase accuracy. This heightened accuracy, together with the program's integration with other applications, indicates that TextBridge Professional Edition 3.0 for Windows will prove to be a worthy companion for your word processor.

—Dave Andrews

SYSTEM 7 UTILITIES

Aladdin Desktop Tools 1.0 ($89.95) gives you a better way to organize and manage your everyday desktop functions and chores. The package's tools include Desktop SpeedBoost, which eliminates long waits during the copying, duplicating, and trashing of items; Desktop Shortcut, which lets you instantly find, open, and view the contents of files; and Desktop Viewer, which lets you view the contents of files without having to open (or even own) the application that created them. In addition, the Desktop Printer tool allows you to instantly switch printers, Desktop Makeover adds features to the Finder, Desktop Magic Tools adds tools to the Finder, and Desktop Secure Delete erases sensitive files, rendering them unrecoverable from file-recovery utilities.

Contact: Aladdin Systems, Watsonville, CA, (800) 732-8881 or (408) 761-6200; aladdin@well.com.

Circle 1018 on Inquiry Card.

OLAP GROUPWARE TOOL

An object-oriented groupware tool for OLAP (on-line analytical processing), ExpressView ($1295) enables you to access, analyze, and share the business intelligence that's buried within your corporate databases and data warehouses. The program's data-smart objects include live tables, graphs, and data selections linked to IRI Software's Express multidimensional OLAP server. The software allows you to investigate such dimensions of your organization as products, time periods, markets, financial accounts, and organizational hierarchy.

Contact: IRI Software, Waltham, MA, (800) 765-7227 or (617) 890-1100; iri.software@infores.com.

Circle 1008 on Inquiry Card.

DRAG-AND-DROP TECHNICAL GRAPHICS

The Axum 4.0 for Windows graphics and data-analysis package ($595) lets you create publication-quality technical graphs. The program provides Windows 95 features while running under Windows 3.1. These features include OLE 2.0, drag and drop, multithreading, object orientation, tabbed dialog boxes, outline views, and shortcut menus. You can drag and drop data from an OLE 2.0 spreadsheet directly into an Axum graph and embed Axum graphs in word processing documents.

Contact: TriMetrix, Seattle, WA, (800) 548-5653 or (206) 527-1801.

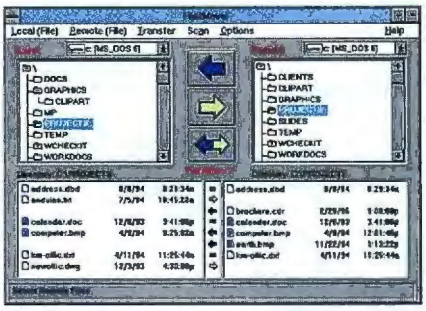
Circle 1025 on Inquiry Card.

WINDOWS DATA-TRANSLATION ENGINE

With the DataExport Engine ($795), you can easily export data from your Windows applications into 37 spreadsheet and database formats, including Excel, Access, Lotus 1-2-3, Paradox, and dBase. The product uses a simple ASCII source file and an Export Definition File for conversion of data.

Contact: Spalding Software, Norcross, GA, (404) 449-1634; DE-info@spaldingsoft.com.

Circle 1006 on Inquiry Card.

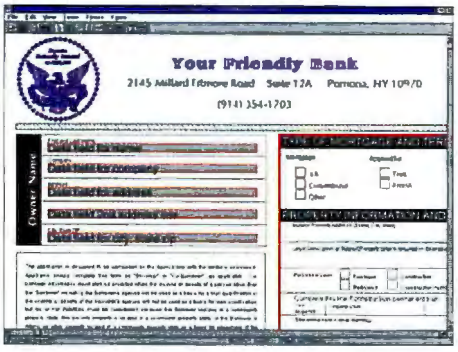


EASY FILE TRANSFERS ▲

With FastMove (about $50), you can keep your files up to date across multiple PCs. The program shows you which files need updating and lets you select the ones you want and preview the exchange of files before it occurs. A virus remover scans each file as it's transferred, keeping your PCs safe from contamination. You can also choose the circumstances under which a file is overwritten during a transfer—always, by date, or never without confirmation.

Contact: TouchStone Software, Huntington Beach, CA, (800) 531-0450 or (714) 969-7746; go touchstone@compuserve.com.

Circle 1020 on Inquiry Card.



DESIGN AND INTEGRATE FORMS ▲

Visual Forms ($249) lets you print forms and data together on laser printers without having to hard-code escape codes or modify software designed for end users. The program generates a PCL file containing the escape codes for a laser printer, so you can easily create complex forms to be integrated into Windows and DOS applications.

Contact: Bytech Business Systems, Pomona, NY, (914) 354-8666; 74577,1032@compuserve.com.

Circle 1026 on Inquiry Card.

MULTIUSER PROJECT PLANNING

With a multicolumn outliner, full-featured calendars, and a to-do-list manager, In Control for Workgroups enables teams to use their network to plan projects, delegate tasks, coordinate schedules, send and receive status updates, and track progress from their desktop Macintoshes or PowerBooks. You can take project files with you, and In Control for Workgroups ($149.95; 10-user pack, $949.95) automatically reconciles any file changes when you reconnect the documents, via either the network or AppleTalk Remote Access.

Contact: Attain, Somerville, MA, (800) 925-5615 or (617) 776-1110; sales@attain.com.

Circle 1009 on Inquiry Card.

DOUBLE THE MEMORY ON WINDOWS PCS

Now you can boost your system's memory by two or more times the amount of its installed physical RAM. MagnaRAM allows you to multitask more software applications, allows applications running under Windows to execute faster, and lets you run more features of complex applications. Not a memory manager, MagnaRAM ($69) runs as a Windows VxD that intercepts Windows' Memory Manager calls to the pager. The program then compresses data onto your hard disk or stores data in physical memory.

Contact: Landmark Research International, Clearwater, FL, (800) 683-6696 or (813) 443-1331.

Circle 1011 on Inquiry Card.

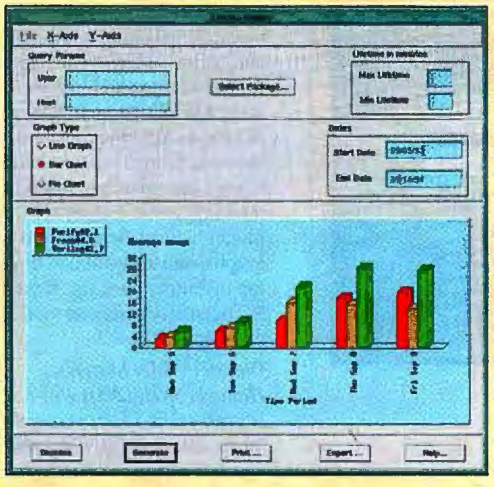
MULTIMEDIA TOOLS

Sentfactor Multimedia Tools ($149.99) lets you incorporate videos, pictures, sounds, and text for each record in a database. You can read text files into your database, read DBF files from other databases, integrate WAV and MIDI audio into the database, capture video pictures in your application, play AVI videos on command, scan and display images, and create your own search strings. Sentfactor Multimedia Tools Runtime ($59.99) lets you create an executable runtime version of the database you create in Sentfactor Multimedia Tools.

Contact: Sentfactor, Lakeland, FL, (813) 647-3220; 100045.2312@compuserve.com.

Circle 1013 on Inquiry Card.

TRACK APPLICATION-USAGE TRENDS



An automated management tool for capturing application usage in heterogeneous computing environments, LicenseTrack (PC servers, from $1000; Unix systems, from $5000) lets you quickly determine software-usage trends and licensing information. The program also reports on upcoming maintenance-renewal dates and carries vendor contacts and phone numbers for each application on the network. In addition, LicenseTrack captures historical data, can report on license-usage trends, and lets you export data to spreadsheets and database applications.

Contact: Central Design Systems, San Jose, CA, (800) 366-2374 or (408) 383-9399; info@cdsi.com.

Circle 1004 on Inquiry Card.

Software Update

Saros Document Manager 1.5 includes mobile computing, expanded enterprise collaboration through wider platform coverage, an enhanced user interface, and an expanded suite of integrated applications, such as work flow and imaging. $495 per workstation.

Contact: Saros, Bellevue, WA, (800) 827-2767 or (206) 646-1066.

Circle 1027 on Inquiry Card.

The **DeltaGraph Pro 3.5** charting application for Windows adds 18 charts, a new Chart Gallery, smart page layouts, enhanced color capabilities, more design options, 63 distinct charts, multiple document support, an outliner, and a PictoGraphic Library. $195.

Contact: DeltaPoint, Monterey, CA, (800) 446-6955 or (408) 648-4000.

Circle 1028 on Inquiry Card.

Prepare 2.0, disaster-recovery-planning software, includes sample network- and business-recovery plans, an online tutorial for new planners, customization options for experienced planners, seamless integration with popular business applications, and flexible report and documentation options. $995.

Contact: Palindrome, Naperville, IL, (800) 288-4912 or (708) 505-3300; go palindrome@compuserve.com.

Circle 1029 on Inquiry Card.

KopyKat 1.1 incorporates faster file transfer capabilities, TCP/IP support, expanded modem support, and increased performance to help OS/2 users remotely control other OS/2-based PCs, workstations, and networks. Two-user pack (host and remote), $199.

Contact: Hilgraeve, Monroe, MI, (800) 826-2760 or (313) 243-0576; custsupt@hilgraeve.com.

Circle 1030 on Inquiry Card.

What's New Software

REUSABLE COMPONENTS FOR DATE AND TIME ▲

You can visually display date- and time-related information in Windows-based applications with Calendar Widgets ($139). The program includes four controls—DayView, MonthView, YearView, and DateCombo—and provides 16-bit Visual Basic custom-control and 16- and 32-bit OLE Control versions.

Contact: Sheridan Software Systems, Melville, NY, (800) 823-4732 or (516) 753-0985; go sheridan@compuserve.com.

Circle 1014 on Inquiry Card.

COMPUTER-AIDED R&D

With CARD ($495), you can define experiment goals, variables, and constraints; create, evaluate, and select design options for each application and goal; create correctly structured, analysis-ready data matrices; and organize efficient testing procedures. A Design Navigator guides you to the right experiment design for each situation, and built-in error trapping virtually eliminates operating mistakes.

Contact: Westing Software, Corte Madera, CA, (800) 325-1862 or (415) 945-3870; westing@aol.com.

Circle 1012 on Inquiry Card.

ACCELERATE TRANSFERS AND NETWORK OPERATIONS

TurboTalk (call for prices), a Macintosh System Extension, accelerates file transfers and network file operations. The application-independent program supports System 7 File Sharing and AppleShare 3.x/4.x servers; improves performance over LocalTalk, Ethernet, FDDI, and 100Base-T; works with uShare Unix-based servers; and runs in native PowerPC mode.

If you're looking for better AppleShare server performance and more usable network bandwidth, LessTalk may be for you. Also a System Extension, LessTalk (call for prices) comes with a simple configuration application to tune the polling interval for optimum bandwidth availability and improved server performance. For instances where security is important, the network administrator can configure individual volumes with a fixed interval that client Macs cannot modify.

Contact: Information Presentation Technologies, San Luis Obispo, CA, (805) 541-3000; info@iptech.com.

Circle 1022 on Inquiry Card.

ELIMINATE WORKSHEET ERRORS

PentaFix ($49) forces Excel and Lotus 1-2-3 to recalculate worksheets that may have been incorrectly calculated on PCs with flawed Pentium chips. You can specify that PentaFix search for and fix individual worksheet files or sets of files or automatically scan for and fix the worksheets on an entire drive.

Contact: Circle Systems, Seattle, WA, (800) 366-3794 or (206) 682-3783; pentafix@circlesys.com.

Circle 1015 on Inquiry Card.

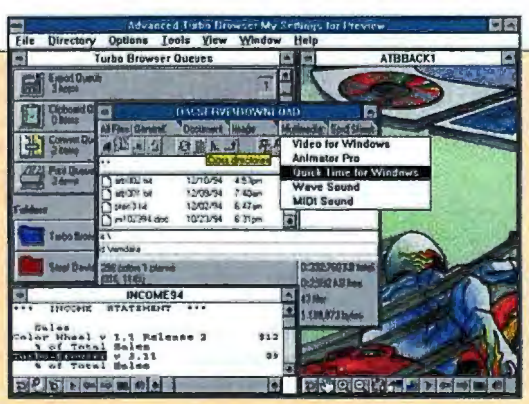
AMERICAN YELLOW PAGES ON CD-ROM

A reference directory of 10 million U.S. businesses, the American Yellow Pages CD-ROM ($149) lets you search by type of business using Yellow Page headings or SIC (standard industrial classification) codes for any city, state, county, or ZIP code. You can also search by company name.

Contact: American Business Information, Omaha, NE, (402) 593-4565.

Circle 1016 on Inquiry Card.

FIND YOUR DATA



To help cut through the maze of working with programs and data in Windows, Advanced Turbo Browser 4.0 ($89.95) provides multilevel cross-directory and fuzzy search (i.e., best match) features for finding files on hard disks, CD-ROMs, or LAN servers. The program's file-viewing capabilities let you visually identify files by their contents. You can launch files directly into applications and delete files with on-screen audio and visual verification. The program also lets you convert document and spreadsheet files into ASCII format.

Contact: Pacific Gold Coast, Glen Cove, NY, (800) 732-3002 or (516) 759-3011; gobrowser@aol.com.

Circle 1010 on Inquiry Card.

Software Update

Remote-control and remote-access software, **NetRemote 6.0** provides bidirectional drive mapping; true-color support for 16- and 24-bit colors; drag-and-drop file transfers; enhanced security options, such as dial-back connections, file transfer restrictions linked to individual users and directories, screen blanking, keyboard locking, and log-in restrictions; network support for IPX/SPX and NetBIOS; simultaneous multiprotocol remote connections; remote mouse and keyboard support; and remote printing. $65.

Contact: McAfee, Santa Clara, CA, (408) 988-3832; support @mcafee.com.

Circle 1031 on Inquiry Card.

A program for fitting model equations to experimental data, **Scientist 2.0 for Windows** adds equation-editing capabilities, improved graphics interaction via tabbed dialog boxes for specifying or modifying plot options, a more powerful text editor for new report-generation capabilities, and refined model parsing, error trapping, and numerical routines. $395.

Contact: MicroMath Scientific Software, Salt Lake City, UT, (800) 942-6284 or (801) 943-0290; MicroMath@Delphi.com.

Circle 1032 on Inquiry Card.

CentaMeter 2.0, a package for monitoring license compliance and optimizing software usage for networked and locally installed Windows and DOS applications, provides customized suite metering; two-way suite-license optimization; inactivity tracking; enhanced security, application identification, and graphs; and a NetCensus desktop inventory package. Cost per PC license depends on total number of PCs.

Contact: Tally Systems, Hanover, NH, (800) 262-3877 or (603) 643-1300; product .information@TallySys.com.

Circle 1033 on Inquiry Card.

ACCESS AND NAVIGATE THE INTERNET

A Windows-based tool, Mariner provides a unified user interface to Internet services and protocols. The program ($99) enables you to simultaneously record and explore multiple WWW sites, send and receive E-mail, and read Net News. You can also create a map of your travels through Internet services, store it on your hard disk, and then go back later to retrace your steps and get updated information.

Contact: Network Computing Devices, Mountain View, CA, (800) 416-1956 or (415) 694-0650; mariner@ncd.com.

Circle 1003 on Inquiry Card.

MANAGE START-UP FILES AND CONFLICTS

For Mac start-up-file conflicts and management, the Conflict Catcher 3 ($99.95) gives a description of your start-up files and a note on each file's purpose. You can sort and view start-up files by seven criteria and customize file management. An intuition feature enables you to guess which start-up files might be causing problems and tests them first. You can also color-code start-up files for easier and quicker viewing.

Contact: Casady & Greene, Salinas, CA, (800) 359-4920 or (408) 484-9228; C&G@casadyg.com.

Circle 1007 on Inquiry Card.

NETWORK MANAGEMENT ▼

Now you can easily map, monitor, diagnose, and manage network resources with the Sectra Management System for Windows ($895). The product includes SNMP management, a report-oriented interface, critical event and alarm logging, and compatibility with other network management packages. Through PING management, Sectra can monitor IP- or IPX-compatible devices. The program lets you create reports that you can store and reuse against different target devices on the network. An event log stores recent events, and an alarm log contains only events that generate alarms.

Contact: Thomas-Conrad, Austin, TX, (800) 332-8683 or (512) 836-1935; go tccforum@compuserve.com.

Circle 1019 on Inquiry Card.

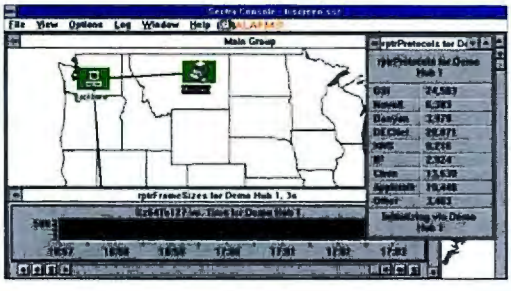


IMAGE EDITING

Fauve xRes for Windows ($499) enables you to manipulate files as large as 500 MB in real time. Included with the program are photo-retouching and painting tools, editable color-lookup tables, an advanced masking brush, and masking technology that compensates for antialiasing at the edge of the mask. Fauve xRes for Windows supports standard channel operations, selection operations, and filters; in addition, it provides support for multiple floating objects, channels, plug-ins, curves, filters, and multiple undos.

Contact: Fauve Software, San Francisco, CA, (800) 898-2787 or (415) 543-7178; fauvesoft@aol.com.

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WINDOWS NT ANTIVIRUS SOFTWARE

Protecting against boot, file, stealth, multipartite, and polymorphic viruses, InocuLAN for Windows NT (50 clients, $595; 250 clients, $2295) includes a National Computer Security Association–certified virus-scanning engine; domain implementation; DOS-, Windows-, and Mac-client support; and flexible licensing. An automated alert system notifies you of virus incidents via Microsoft E-mail, the print queue, SNMP managers, or an alphanumeric pager. A Get-BBS feature allows you to designate file servers to automatically download the latest virus signature files from Cheyenne's BBS and automatically distributes new files during log-in.

Contact: Cheyenne Software, Roslyn Heights, NY, (800) 243-9462 or (516) 484-5110; cheyenne@chey.com.

Circle 1005 on Inquiry Card.

Software Update

A help-authoring tool, **Help Magician Pro 3.0** features integrated support for Microsoft WinHelp, network-project management support, a Microsoft Visual Basic Source Code Scanner, the ability to use a variety of word processors to build help files, manual-to-help-file and help-to-manual-file conversion, a Topic Outliner/Navigator, multimedia support, 256-color bit-map support, and support for most graphics file formats. Single-user license, $249.

Contact: Software Interphase, Foster, RI, (800) 542-2742 or (401) 397-2340.

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IDL 4.0, a computing environment for R&D engineers and scientists, includes easily accessible graphics, plotting, image processing, and numerics; 50 new statistics functions; fully indexed on-line manuals with hypertext links; cross-platform interface controls; improved debugging support; support for the current versions of HDF, CDF, and netCDF; application connectivity that lets you call outside programs or embed IDL as a graphics engine; and scientific improvements that sharpen research insights. Windows, NT, Mac, and native Power Mac versions, $1500; Unix and VMS workstation versions, from $3000.

Contact: Research Systems, Boulder, CO, (303) 786-9900; info@rsinc.com.

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Software for statistics, graphics, and data management for scientists, **Systat 6.0 for DOS** adds object-oriented graphics, more statistical capabilities, improved data handling, and extended memory support. $995.

Contact: SPSS, Chicago, IL, (800) 543-2185 or (312) 329-2400; sales@spss.com.

Circle 1037 on Inquiry Card.

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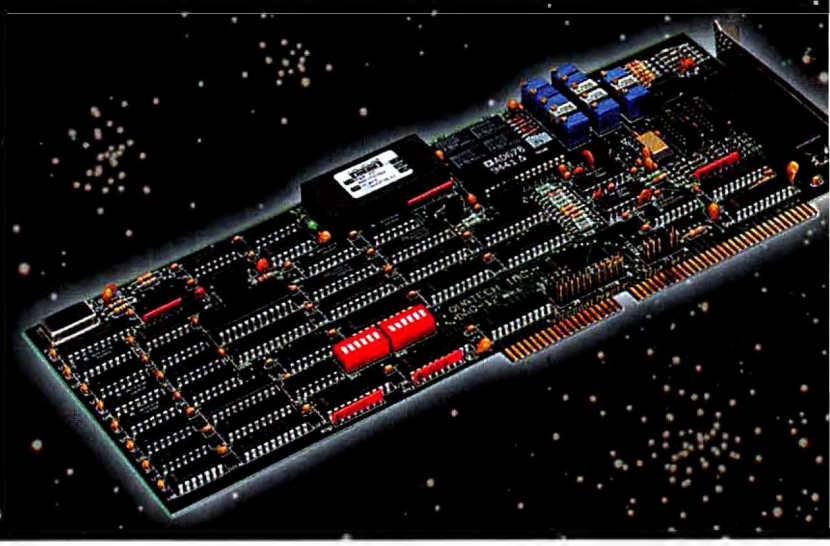

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Versa M DX4/100 540MB hi-res clr	4249.89
Versa M DX4/100 540MB true clr	4156.52
Versa M DX4/100 810MB hi-res clr	4619.75
Versa P 5/75 340MB act clr	4297.22
Versa P 5/75 540MB act clr	4638.81
Versa P 5/75 810MB act clr	5018.78
Versa P 5/75 540MB hi-res clr	5018.78
Versa P 5/75 810MB hi-res clr	5428.33

TEXAS INSTRUMENTS

TM4000M SX2/50 200MB dual color	1999.00
TM4000M DX2/50 340MB dual clr	2098.00
TM4000M DX2/50 455MB act clr	2248.31
TM4000M DX4/75 344MB act color	2689.25
TM4000M DX4/75 455MB dual color	2438.33
TM4000M DX4/75 455MB act color	2838.43
TM4000M DX4/100 524MB act color	3049.89
TM5000 5/75 524MB dual clr	4099.35
TM5000 5/75 810MB active clr	5579.78

DOT MATRIX & LASER PRINTERS

OKIDATA

184 Turbo	219.14	ML591	579.12
ML320	299.98	Pacemark 3410	1213.86
ML321	427.46	OL400E	304.98
ML380	512.43	OL410E	539.89
ML395	666.87	OL410E/PS	799.86
ML395C	1030.74	OL810	804.98
ML520	365.77	OL830 Plus	1078.51
ML521	466.27	OL850	1169.69
ML590	427.71		

Canon

BJ10SX	244.89	BJ100	209.89
BJ30 mono	359.88	BJ200ex	229.86
BJ70 color	395.85	BJ230	391.85
BJC600e color			471.89
BJC4000 720dpi + color			348.78

EPSON

AP2250	86.64	DFX5000 Plus	1384.01
AP3250	146.45	DFX8000	2322.45
AP3260	187.82	Stylus 300	163.16
LX300	165.85	Stylus 800+	211.14
FX870	298.45	Stylus 1000	436.15
FX1170	374.86	Stylus Color	509.53
AP5000+	229.71	ActionLaser 1100	383.62
LQ1070+	375.26	ActionLaser 1400	582.40
LQ870	454.44	ActionLaser 1500	488.82
LQ1170	523.51	ActionLaser 1600	765.79
LQ2550	665.09		

LEXMARK LASER PRINTERS

WinWriter 400 laser	755.03
WinWriter 600 laser	899.00
ValueWriter 300 (4037 5E 5PPM)	644.87
ValueWriter 600 laser	815.87
Optra R 600dpi laser	1426.80
ExecJet IIc	283.76

Panasonic

1150	133.49
2023	162.27
2130	204.40
2135 Color	247.43
3123	249.09
4400 Laser	464.90
5400 Laser	409.49
KX-SP100 printer/fax/copier	756.46

TEXAS INSTRUMENTS

microWriter PS23	630.45
microLaser 600	865.10
microLaser Pro 600 PS23	1197.02
microLaser Pro E	1309.48
microLaser Power Pro 600 PS65	1629.80

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OfficeJet inkjet fax/copier/printer	699.56
DeskJet 540	389.75
DeskJet 660C	485.78
DeskJet 1200C	994.40
DeskJet 1200C PS	1599.40
LaserJet 5P	999.77
LaserJet 4 plus	1449.96
LaserJet 4Si	2098.96
LaserJet 4V	1967.30
LaserJet Color	5828.62

COSTAR

LabelWriter XL WIN	139.89
LabelWriter XL Plus Win	224.89

HARD DRIVES & CONTROLLERS

Maxtor

270MB Fast-ATA	199.85
345MB SCSI-2	174.50
425MB Fast-ATA	161.17
540MB Fast-ATA	199.52

MICROPOLIS

3221 2.1GB SCSI-2	1068.46
3243 4.3GB SCSI-2	1699.79
1936 3GB SCSI-2	1275.17

CONNER

425MB IDE	206.89
540MB IDE	227.93
850MB Fast-ATA	367.26
1.27GB Fast-ATA	488.31

All Conner drives listed include complete installation hardware and software.

Seagate

426MB Fast-ATA	183.51
545MB Fast-ATA	192.88
722MB Fast-ATA2	263.40
1GB Fast-ATA2	372.14
1.0GB SCSI-2	565.24

WESTERN DIGITAL

Caviar 540MB EIDE	229.94
Caviar 730MB EIDE	268.25
Caviar 1GB EIDE	368.61
Caviar 1.2GB EIDE	379.42

CONTROLLERS

Acculogic SIDE-3+ w/on-board BIOS	48.90
Acculogic SIDE-4+ w/par, 2ser, game	56.96
Acculogic SIDE-4VL EIDE, 16550 serial	89.78
Acculogic ISApport SCSI-2	89.48
Adaptec AVA1505 SCSI-2 CD Kit	94.95
Adaptec AHA1542CF SCSI-2	265.45
Adaptec AVA2825 VLB SCSI-2/EIDE	166.87
Adaptec 2842 VLB SCSI-2	249.83
Promise 2300+ EIDE VLB	59.87

MODEMS & COMMUNICATIONS

US Robotics

SPORTSTER MODEMS

V.34 28.8K internal w/fax	224.89
V.34 28.8K external w/fax	242.86
14.4K internal w/fax	94.81
14.4K external w/fax	111.80

COURIER MODEMS

V.34 internal w/fax	387.69
V.34 external w/fax	402.52

Hayes

ACCURA 144 internal w/fax	91.87
ACCURA 144 external w/fax	111.18
ACCURA 288 V.34 internal w/fax	183.78
ACCURA 288 V.34 external w/fax	218.88
OPTIMA 144 external w/fax	374.30
OPTIMA 144 pocket w/fax	296.93
OPTIMA 288 V.34 internal w/fax	365.14
OPTIMA 288 V.34 external w/fax	406.55

PRACTICAL PERIPHERALS

14.4 internal w/fax	86.74
14.4 Mini Tower w/fax	168.62
V.34 28.8 internal w/fax	186.59
V.34 28.8 Mini Tower w/fax	268.64
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BOCA

Online Express 14.4 internal w/fax	64.25
Online Express 14.4 external w/fax	79.75
V.34 28.8 internal w/fax	184.44
V.34 28.8 external w/fax	200.90

MICROCOM

Deskporte ES 14.4	146.39
Deskporte Fast ES V.34 28.8	178.94
Deskporte Fast EP V.34 28.8	241.49

BATTERY BACKUP AND UPS

American Power Conversion

BackUPS 280	99.53
BackUPS 400	144.29
BackUPS 450	175.81
BackUPS 600	243.00
BackUPS 900	345.79
BackUPS 1250	449.29
SmartUPS 400	299.89
SmartUPS 600	363.39
SmartUPS 900	514.61
SmartUPS 1250	644.24
SurgeArrest Network	33.28
SurgeArrest Pro	29.45
SurgeArrest Network + Phone	49.98
Line-R 600	119.99

Tripp Lite

BC250	94.97
BC400	136.91
BC500 LAN	177.51
BC PERS 500	173.89
BC PRO 675	231.43
BC PRO 850	288.60
BC PRO 1050	327.59
BC1250 LAN	426.19

SMART UPS SERIES NEW

SMART 250 LAN	218.30
SMART 450 LAN	273.94
SMART 500 LAN	298.77
SMART 600 LAN	313.69
SMART 750 LAN	399.68
SMART 1050 LAN	455.07
SMART 1400 LAN	569.41
Isobar 4 OUTLET	36.98
Isobar 8 OUTLET	46.38

PCMCIA CARDS

3Com Etherlink IIIB combo	213.80
Hayes EZJack 14.4 w/fax	179.48
Hayes EZJack V.34 w/fax	298.87
IBM Token Ring 16/4	399.97
Linksys Ethernet combo	168.74
Megahertz 14.4K data/fax	179.48
Megahertz XJack 14 4 data/fax	179.58
Megahertz XJack Gold 14 4 data/fax	198.88
Megahertz V.34 XJack data/fax	353.09
New Media Bus Toaster SCSI-2 host	199.94
New Media Wave Jammer sound card	229.48
New Media Multimedia Combo	439.80
Simple Tech 14.4K data/fax modem	145.51
Simple Tech 14.4K modem + voice	143.07
Simple Tech Ethernet 10BT adapter	136.64
Simple Tech SCSI adapter	153.68
Simple Tech 130MB hard drive	359.88
Simple Tech 170MB hard drive	404.80
Adaptec APA1460 SCSI-2	209.89
Turtle Beach Audio Advantage	119.98
USR Sportster 14.4K	178.90
USR Sportster V.34	348.78
Xircom Ethernet coax	79.00
Xircom Ethernet 10BT	158.69
Xircom Ethernet combo	208.15
Xircom Ethernet+modem 10BT	449.83
Xircom Ethernet+modem combo	487.57
Xircom Token Ring 16/4	399.97

INTEL OVERDRIVE

Intel OverDrive DX2/50	125.88
Intel OverDrive DX2/66	169.67
Intel OverDrive DX4/75	175.96
Intel OverDrive DX4/100	259.77
Intel OverDrive Pentium 63MHz	395.45

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	Adaptec	•Different drivers for the 1740, 2740 and 2940. (VERY CONFUSING!)

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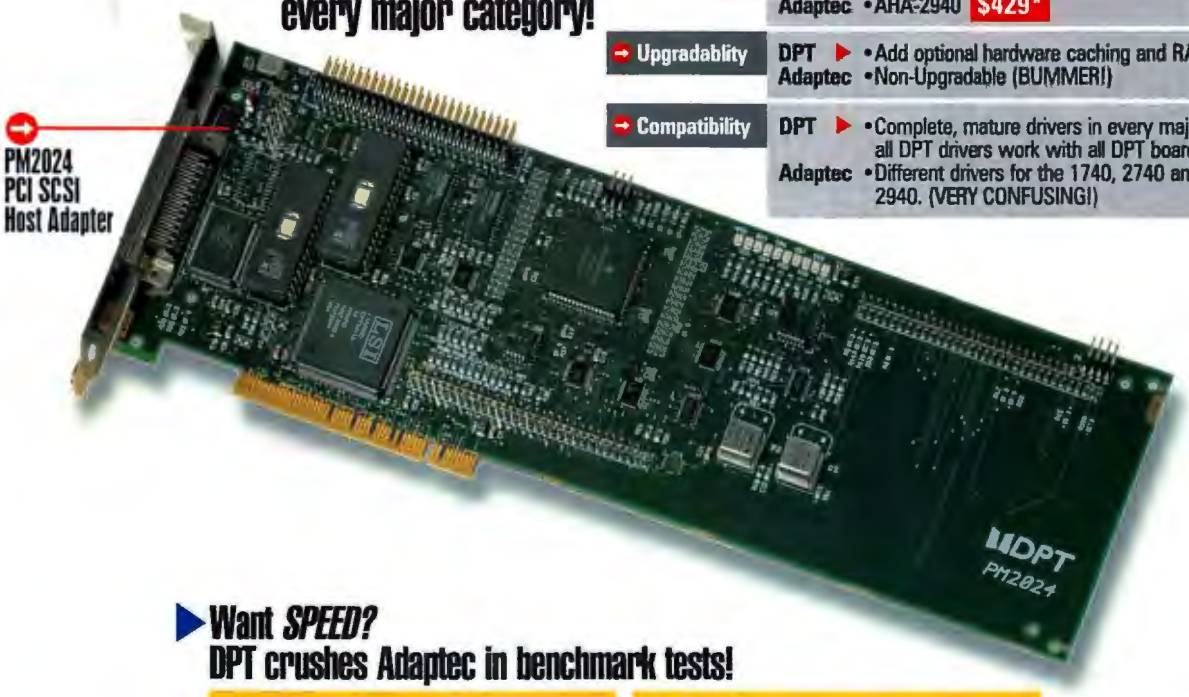

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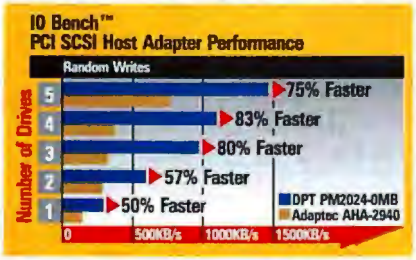

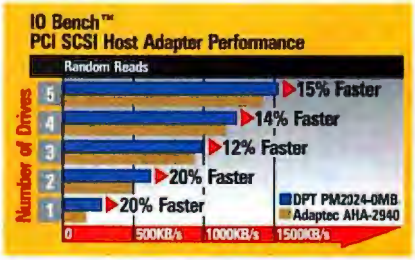

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T2100

- Integrated Accupoint - small, accurate & easy to use
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- 10.4" Dual Scan display

Processor	Screen	HD	Price
486DX2/50	9.5" Mono	250MB	$1419
486DX2/50	10.4" Dual Scan	330MB	2199
486DX2/50	8.4" Active	330MB	2699

T2150

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- 10.4" Active & Dual Scan
- Built-in AC adapter - small, sleek design & reduced weight
- Integrated Accupoint - small, accurate & easy to use

Processor	Screen	HD	Price
486DX4/75	10.4" Dual Scan	500MB	$3099
486DX4/75	10.4" Active	500MB	3699

75MHz Pentium

T4900 as low as $5499

T4800 as low as $3099

T4900CT

- 75MHz Pentium - for blazing performance
- 10.4" Active Matrix display
- Built-in 16-bit sound, microphone, speaker & MIDI

Processor	Screen	HD	Price
Pentium 75	10.4" Active	772MB	$5499

Other Notebooks from Toshiba

Processor	Screen	HD	Price
T4800CT			
486DX4/75	9.5" Active	500MB	$3099
T4850CT			
486DX4/75	10.4" Active	500MB	$3199
486DX4/75	10.4" Active	772MB	3349
T3600			
486DX2/50	8.4" Active	500MB	$3239

NEC

Versa M

- High Res. displays available - 800x600 res. on notebook
- True color displays available - 16.7 million colors on notebook
- Removable/Reversible display
- Replace floppy w/ 2nd battery for 6-10 hrs. battery life
- Replace floppy w/ Versa Bay - Add extra PCMCIA
- Built-in 16-bit sound, microphone & speaker
- Upgradable hard drive - easily add more storage

Processor	Screen	HD	Price
486DX4/75	9.5" Dual Scan	250MB	$2649
486DX4/75	9.5" Dual Scan	340MB	2739
486DX4/75	9.5" Active	340MB	3169
486DX4/75	9.5" Active	540MB	3449
486DX4/75	9.5" True Color	340MB	3449
486DX4/75	9.5" High Res.	540MB	3829
486DX4/100	9.5" Active	340MB	3639
486DX4/100	9.5" True Color	540MB	4199
486DX4/100	9.5" Active	810MB	4299
486DX4/100	9.5" High Res.	540MB	4299
486DX4/100	9.5" High Res.	810MB	4679

Versa P

Versa P

- 75MHz Pentium - for blazing performance
- High Res. displays available - 800x600 res. on notebook (10.4" on selected models)
- Removable/Reversible display
- Replace floppy w/ 2nd battery for 6-10 hrs. battery life
- Replace floppy w/ Versa Bay - Add extra PCMCIA
- Built-in 16-bit sound, microphone & speaker
- Upgradable hard drive - easily add more storage

Processor	Screen	HD	Price
Pentium 75	9.5" Active	340MB	$4349
Pentium 75	9.5" Active	540MB	4629
Pentium 75	9.5" Active	810MB	4999
Pentium 75	9.5" High Res.	540MB	4999
Pentium 75	9.5" High Res.	810MB	5389
Pentium 75	10.4" Active	540MB	4999
Pentium 75	10.4" Active	810MB	5389
Pentium 75	10.4" High Res.	810MB	5769

TEXAS INSTRUMENTS

75MHz Pentium with PCI BUS

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TravelMate 5000

TravelMate 4000M

- Brilliant color display
- 16-bit sound card
- Integrated pointing device
- 2 Type II or 1 Type III PCMCIA slot

Processor	Screen	HD	Price
486DX2/50	9.5" Dual Scan	340MB	$2119
486DX2/50	8.4" Active	455MB	2379
486DX4/75	9.5" Dual Scan	455MB	2459
486DX4/75	8.4" Active	340MB	2729
486DX4/75	8.4" Active	455MB	2979
486DX4/100	9.5" Active	525MB	3939

TravelMate 5000

- 75MHz Pentium with PCI Bus to optimize Pentium processor performance
- 10.4" Active Matrix display with 2MB Video RAM
- 10.5" Dual Scan display with 2MB Video RAM
- 65K colors on notebook display
- 16-bit Sound Card, Speaker, Microphone & MIDI
- Upgradable hard drive - easily add more storage
- Built-In Dual Lithium Ion Batteries
- Built-in infrared for no hassle printer connections

Processor	Screen	HD	Price
Pentium 75	10.4" Dual Scan	500MB	$4999
Pentium 75	10.4" Active	772MB	5599

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Processor	Screen	HD	Price
Ascentia 950N New!			
Pentium 75	10.4" Dual Scan	500MB	$3439
Pentium 75	10.4" Dual Scan	800MB	3739
Pentium 75	10.4" Dual Scan	1.2GB	4229
Pentium 75	10.4" Active	800MB	4899
Pentium 75	10.4" Active	1.2GB	5399
Ascentia 810N			
486DX2/66	10.4" Dual Scan	250MB	$1969
486DX2/66	10.4" Dual Scan	340MB	2119
486DX2/66	10.4" Dual Scan	510MB	2259
Advantage Adventure Multimedia (4X CD-ROM)			
All-N-One (4000)	486DX2/66	540MB	$1699
Desktop (6000)	486DX2/66	540MB	1299
Desktop (6000)	486DX2/66	540MB	1599
Desktop (6000)	Pentium 75	540MB	1999
Minitower (8000)	Pentium 75	1GB	2299
Minitower (8000)	Pentium 90	1GB	2599
Minitower (8000)	Pentium 100	1GB	2799

Monitors priced separately

Ascentia 910N

- 10.4" Active & 10.3" Dual Scan
- Lithium Ion battery technology
- Intelligent power management to maximize performance
- Integrated Smartpoint - small, accurate & easy to use

Processor	Screen	HD	Price
486DX2/50	10.3" Dual Scan	340MB	$2559
486DX4/75	10.3" Dual Scan	510MB	2749
486DX/75	10.3" Dual Scan	700MB	3049
486DX4/75	10.4" Active	510MB	3829
486DX4/75	10.4" Active	700MB	4129

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- Built-in infrared

Processor	Screen	HD	Price
486DX4/100	10.4" Dual Scan	340MB	$4099
486DX4/100	10.4" Dual Scan	540MB	4449
486DX4/100	10.4" Dual Scan	810MB	4899
486DX4/100	10.4" Active	340MB	4999
486DX4/100	10.4" Active	540MB	5349
486DX4/100	10.4" Active	810MB	5799
486DX4/100	10.4" Active	540MB	6349*
486DX4/100	10.4" Active	810MB	6799*
Pentium 75	10.4" Active	540MB	6549
Pentium 75	10.4" Active	810MB	6999

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More IBM® Notebooks

Processor	Screen	HD	Price
IBM ThinkPad® 360 & 360E			
486SL/33	8.4" Active	340MB	$1999
486DX2/50	8.4" Active	340MB	3099
486DX2/50	8.4" Active	540MB	3449

Processor	Screen	HD	Price
IBM ThinkPad® 701			
486DX2/50	10.4" Active	360MB	$4799
486DX2/50	10.4" Active	540MB	5149
486DX4/75	10.4" Dual Scan	360MB	4399
486DX4/75	10.4" Dual Scan	540MB	4749
486DX4/75	10.4" Active	360MB	5299
486DX4/75	10.4" Active	540MB	5649

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Contura 410

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- Compaq, 3-year worldwide warranty

Processor	Screen	HD	Price
486DX2/50	9.5" Dual Scan	350MB	$2369
486DX2/50	8.4" Active	350MB	2839

LTE Elite

- 10.4" Active Matrix display
- Fast 486DX4/75 processor
- Built-in AC adapter - small, sleek design & reduced weight
- Upgradable hard drive - easily add more storage

Processor	Screen	HD	Price
486DX4/75	9.5" Dual Scan	340MB	$3129
486DX4/75	9.5" Dual Scan	510MB	3499
486DX4/75	10.4" Active	510MB	5029
486DX4/75	10.4" Active	810MB	5389

Byte 7/95

HEWLETT® PACKARD

More Hewlett-Packard Products

Processor	Screen	HD	Price
HP OmniBook 600 Notebook PC			
486DX2/50	8.5" Dual Scan	170MB	$2419
486DX2/50	8.5" Dual Scan	260MB	2549
486DX4/75	8.5" Dual Scan	170MB	2869
486DX4/75	8.5" Dual Scan	260MB	3049

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HP LaserJet 5P printer (IBM, 600dpi)	$879.99
HP LaserJet 5MP printer (IBM&MAC, 600dpi)	1039.99
HP LaserJet 4L (IBM, 300dpi) printer	$499.99

HP InkJet Printers

HP DeskJet 320 printer (portable)	$299.99
HP DeskJet 540 printer	289.99
HP DeskJet 660C printer	479.99
HP DeskJet 1200C printer	979.99
HP OfficeJet	689.99

HP OmniBook 4000

- 10.4" Active & 10.3" Dual Scan
- Built-in 16-bit sound, microphone & speaker
- Replace floppy w/ 2nd battery for 5-7 hrs. battery life
- Built-in infrared for no hassle printer connections

Processor	Screen	HD	Price
486DX4/75	10.4" Active	340MB	$3639
486DX4/75	10.4" Active	520MB	3879
486DX4/75	10.4" Active	810MB	4219
486DX4/100	10.3" Dual Scan	340MB	3259
486DX4/100	10.3" Dual Scan	520MB	3549
486DX4/100	10.3" Dual Scan	810MB	3889
486DX4/100	10.4" Active	340MB	3819
486DX4/100	10.4" Active	520MB	4099
486DX4/100	10.4" Active	810MB	4439
486DX4/100	10.4" Active	810MB	5099*

* 16MB RAM standard

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—Jerry Pournelle/BYTE Magazine User' Choice Award/May 1994

"[POST-PROBE] is the only card that will function in every system on the market. The documentation is extensive, and not only covers the expected POST Codes for different BIOS versions, but also includes a detailed reference to the bus signals monitored by the card."
—Scott Mueller, from "Upgrading & Repairing PCs," Second Edition

"[The Universal Diagnostics Toolkit] provides the most sophisticated diagnosis and repair of any PC. Ideal for technicians and support staff—in fact anyone who maintains or repairs PCs must have it. This product is a technician's (or serious enthusiast's) dream tool kit."
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"...If you're responsible for technical support of hardware, there's no other tool I'd recommend sooner than MICRO-SCOPE. The product's power, coupled with excellent, prompt and knowledgeable technical support, makes it a sure winner."
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"My favorite diagnostic program is MICRO-SCOPE from Micro 2000, Inc. It will test everything you can think of, and a few things that would never occur to you. The list of features is quite long. Every purchaser gets a telephone walkthrough during which an experienced technician shows you the features of the product. My technician was quite knowledgeable and helpful."
—Drew Heywood/Inside NetWare 3.12, 4th Edition

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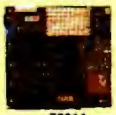
- IDE hard/floppy controller
- Five expansion slots
- Two serial & one parallel port

115705 286 12MHz bare-bones sys. **$169.95**

Jameco Motherboards



- Some motherboards also available without CPU! Call for details
- Diagnostic and operating system software available
- One-year warranty

79214

115941	80386SX 40MHz w/ CPU	**$79.95**
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116118	80486SLC 66MHz w/ CPU	**219.95**
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95169	80486DX 50MHz w/o CPU	**139.95**
95231	80486DX 50MHz w/ CPU	**449.95**

486DX2 66MHz Motherboard

- AMI BIOS
- Supports up to 32MB of RAM on-board
- Supports 256K x 9, 1MB x 9 and 4MB x 9 SIMMS
- 256KB Cache RAM
- Supports Windows, Unix, Xenix, Novell, OS/2 and most popular software
- Two 32-bit VESA slots, six 16-bit (four when using both Local bus slots) and two 8-bit slots
- Size: 10.0"L x 8.8"W • Weight: 3.0 lbs.

119731 486DX2 66MHz Motherboard **$329.95**

IDE Hard Drives

SPECIAL!

- For laptops and standard cases

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119095	ST9145AG 120MB 2.5" for laptops	**149.95**
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Hard Drive Mounting Kit

This kit converts a 2.5" IDE hard drive into a 3.5" IDE hard drive format.
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- Mounting screws
- 44-pin cable and power converter allows use of standard IDE data cable and power connector interface

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- Programs EPROM's, EEPROM's, and flash memories
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NEW

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- Has an upper and lower chambers for erasing
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- Timer turns the eraser off at the end of the selected time period.
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NEW

- PC/XT/AT and compatibles
- MM1201 & MicroSoft Mouse emulation
- Compact 5" x 5" active area
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- Easy Auto-Driver installation utility
- Includes WINTAB, ADI and MS Mouse Drivers
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120096 Graphics Tablet **$109.95**

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- PC/XT/AT and compatibles
- Precise self centering analog joystick
- 4 suction cups for desktop mount
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- X and Y axis trim centering adjustments for cursor control
- Trigger buttons for both single and rapid fire
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- Size: 5.5"L x 4.25"W x 7.5"H • Weight: 0.9 lbs.

120088 2-button joystick **$11.95**

3 Button Serial Mouse

- PC/XT/386/486 and compatible computers
- Microsoft® Mouse compatible
- One-year warranty
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104441 3 Button serial mouse **$9.95**

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117786

- DOS environment supports QIC-40, QIC-80 and PC-36
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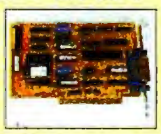
Multi-Function IEEE-488 Card



- PC/XT/AT and compatibles
- Implementing the IEEE-488 standard
- Allows re-direction of printer port to IEEE-488 device
- Built-in high speed DMA capability; uses IRQ2-7; software driver is in the on-board bios
- Cable not included
- Weight: 3.6 lbs. • One-year warranty

120184 IEEE-488 card **$299.95**

TEAC Quad 4X AT-CD-ROM

SALE

- Sound blaster compatible interface
- Access time: 195ms • 64KB data buffer
- Data transfer rate: 600KB/sec
- Multi-session photo ready, CDI, XA ready
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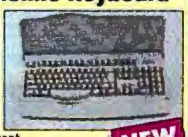
- Weight: 1.78 lbs. • One-year warranty

121144 TEAC 4X CD-ROM drive **$249.95**

Focus Ergonomic Keyboard



NEW

- AT/PS2 compatibles
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- Includes dust cover and detachable wrist rest
- Large space bar
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122999 Ergonomic keyboard **$69.95**

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NEW

- Allows printing from an IEEE-488 device to a parallel printer
- Uses a 9VDC, 200mA wall transformer (included)
- IEEE-488 24-pin female input connector
- Centronics 36-pin male output connector
- DIP switch configurable to 31 IEEE-488 addresses • Size: 4"L x 2.5"W x 1"T
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122964 IEEE-488 to Centronics convrtr ..**$69.95**

RS232 to RS485/422 Isolated Converter

NEW

- Controlled by RTS signal
- DCE & DTE selectable
- Point to point & Multidrop operations
- RS-485: Terminal block & RJ-11 connections
- RS-232: DB-25 female connector
- Data rate: 1MB/sec.
- 4-wire full duplex or 2-wire half duplex
- RS-485SI optical isolation: 2000V
- Cable length: 4000' max. • Size: 3"L x 2"W x 0.9"T
- Weight: 0.8 lbs. • One-year warranty

122956 RS232 to RS485/422 convrtr ..**$99.95**

External Modem

VALUE

- PC/XT/AT and compatible computers
- Quicklink II & Procomm Plus compatible
- 2400BPS (2400/1200/300)
- Hayes smartmodem compatible
- Bell 103/212A, CCITT V.22/V.22bis
- Auto-Dial and Auto Answer • Full/half duplex
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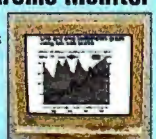
122884 2400 Baud external modem **$24.95**

AST Research 14" Paper White Monochrome Monitor



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- Resolution: Hercules 720 x 348
- Displays up to 132 characters by 44 rows
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32Kx8 (3.3V)	–	–	14.50	–
64Kx1	–	11.00	9.00	8.00
64Kx4	–	11.00	9.00	8.00
16Kx4	–	8.00	7.00	6.00
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MEMORY FOR IBM & APPLE

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1Megx4 (Zip Pk)	–	24.00	22.00	21.00	–
256x4 (Page Dip)	–	7.25	6.75	6.50	5.95
256 4 (Static Dip)	–	–	9.95	–	–
256x4 (Page Zip)	–	9.25	9.00	8.95	–
256x4 (Video Zip)	–	–	12.95	11.95	9.95
256x8 (SOJ)	–	29.00	24.00	–	–
256 x1	–	3.25	2.95	2.75	2.25
64x4	–	–	–	3.75	–
64x1	–	–	–	–	2.00
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4 x 32 16 mg	–	–	499.00	479.00	479.00	–
72 Bit & 64 Bit Simms	Call	Call	Call	Call	Call	Call
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	8Meg	500987-003	338.00
	16Meg	500987-004	479.00
	32Meg	500987-005	958.00
Premmia LX P/60, MX4/66d, 4/100T, P/60	8 Meg	500987-003	338.00
	16 Meg	501340-002	479.00
	32 Meg	500987-005	958.00
	64 Meg	501569-001	Call
Premmia 4133, 4133S, 4/50d, 4/60d	8 Meg	501159-002	338.00
Premmia SE 4/33, 4/66d, P/60	16 Meg	501159-003	658.00
Premmia MTE 4/33, 4/66d, P/60	32 Meg	501159-004	1149.00
Manhattan G, V Series Server	64 Meg	501159-005	2298.00
Power Premium 3/33, 4/33, 4/33S, 4/50d, 4/66d; Premium 486/25, 486/25E, 486/33, 486/33E; Premium 386/33TE, 486/25TE, 486/33TE; Prem. II 386/25, 386/33, 486/33, 486 SX/20 (72 pin)	8Meg	500780-001	378.00
Bravo 486/25, 486/33	2 Meg Kit	500780-005	118.00
Advantage 486/25, 486/33, 486/33P, 486 SX/20; Premium SE4/22; Premium SE 4/50, d, 66d, P/60; Prem. 386/33T, 386 SX16, Prem II 386SX 20, 386/25 (64 pin)	6Meg Kit	500780-001	378.00
	1 Meg	500780-003	59.00
	4Meg	500780-004	189.00
Premmia GX P/90, P/100	8Meg Kit/16MegKit	501565-001/501566-001	378/699
	32Meg Kit/64Meg Kit	501567-001/501568-001	958/2298
AST Cupid Board	0-32 Meg	500818-001	179.00

AMBRA

Ambra Pentium-60	4/8/16 Meg	175.00/389.00/599.00
Ambra NC 425SL	2/4/8 Meg	109.00/209.00/449.00
Ambra N Series	4/8/12/16 Meg	189.00/349.00/569.00/679.00
Ambra SN Series	4/16 Meg	189.00/699.00
Ambra Sprinta SLC II	2/8 Meg	89.00/319.00
Ambra N-75, N-100	4/8/16	189.00/369.00/659.00

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Z386/33, 25, 20, 33E, 486/25E	4Meg	ZA3800MK	180.00
Z386SX	2Meg	Z-605-1 modules	119.00

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30F5348 (512K)	50-286	37.00
30F5360 (2Meg)	50-286, 25-286, 50/MTHR BD.	104.00
6450375 (1Meg)	80-041	79.00
6450379 (2Meg)	80-111, 311-121, 321, 081, 181	84.00
6451060 (4Meg)	80-A21, A-61, 80-A31, 80-111, 80-311	189.00
6450604/92G7198 (2Meg)	70-081, E61, 121, 50Z, 55SX, 65SX, P-70, 55LS, 65LS, X-Station 120 & 130, 35SX, 35LS, 40SX	99.00
6450608 (2Meg)	70-A21, A-61, B-21, B-61, 35SX, 35LS, 40SX, Val Pt. 325T	90.00
78X8955 (128K)	25	35.00
34F2933 (4Meg)	35SX, 40SX, 55SX, 65SX, 55LS, 65LS	175.00
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1057035 (512K)	P/S1-286	49.00
92F9935 (2Meg)	P/S1 & P/S1/386SX-2121	109.00
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92G7545 (32Meg)	Aptiva 310, 330, 350, 510, 530, 710, 730	Call
73G3132/92G7203 (8Meg)	Value Point Performance, PC Server 4/66	339.00
60G1622/92G7204 (16Meg)	Value Point Performance, PC Server 4/66	609.00
92G7205 (32Meg)	Value Point Performance, PC Server 4/66	1239.00
6450902 (2Meg)	56, 57, 57SX, 90, 95, P-75, 57SLC, Value Point 77 486DX2, 486SX, SVR 85	90.00
6450128/92G7200 (4Meg)	57SX, 90, 95, P-75, 57SLC, 56, 56SLC, P/S1, 386SX, Mod-2123, 2133, 2155, Val Pt 77, 486SX2, 486SX, SVR85, Value Point 77 486DX2, 486SX, SVR 85	175.00
6450129/92G7428 (8Meg)	35SX, 40SX	339.00
6450130/92G7202 (8Meg)	56, 57, 57SX, 90, 95, P-75, 57SLC, Value Point 77 486DX2, 486SX, SVR 85	339.00
6451158/92G7208 (4Meg ecc)	486; 95XP; 95A (install in pairs)	199.00
6451159 (8Meg ecc)	486; 95XP; 95A (install in pairs)	399.00
92G7209/92G3720 (16Meg ecc)	9595 OPT	749.00

IBM NOTEBOOK & LAPTOP MEMORY

07G1415/07G1420 (4Meg)	Thinkpad 750, C, 730, C, 720, C, CL57SX	189.00
07G1416/07G1421 (8Meg)	Thinkpad 750, C, 730, C, 720, C, CL57SX	369.00
66G0095 (16Meg)	Thinkpad 750, C	669.00
66G0094 (4Meg)	Thinkpad 755, 360, 355, 340, 450	179.00
66G0094 (8Meg)	Thinkpad 755, 360, 355, 340, 450	349.00
66G0094 (16Meg)	Thinkpad 755, 360, 355, 340, 450	629.00
8189098 (4Meg)	Thinkpad 500, 510CS (3.3 volt)	209.00
8189099 (8Meg)	Thinkpad 500, 510CS (3.3 volt)	389.00
8189113 (16Meg)	Thinkpad 500, 510CS (3.3 volt)	799.00
79F0999 (2Meg)	LX40, N33SX, PS Note	103.00
79F1000 (4Meg)	LX40, N33SX, PS Note, Tkpd 350, 350c, PS Note 425	189.00
79F1001 (8Meg)	LX40, N33SX, PS Note	349.00
Hard Drive (524Meg, 710 Meg)	Thinkpad 750, 755, 360, 355	949.00/1149.00
(4Meg/16Meg)	Thinkpad 755 Dimm Modules	209.00/699.00
(4Meg/16 Meg w/Adap	Thinkpad 755	239.00/749.00
60G0378 (8Meg)	Thinkpad 350, 350c, PS Note 425	339.00
60G0379 (16Meg)	Thinkpad 350, 350c, PS Note 425	569.00
92F8804 (2Meg)	N45SL	109.00
92G7259 (4Meg)	Thinkpad 701C, CS, Butterfly	Call
92G7261 (8Meg)	Thinkpad 701C, CS, Butterfly	Call
92G7263 (16Meg)	Thinkpad 701C, CS, Butterfly	Call

COMPAQ MEMORY MODULES

MODEL	AMT. UPGRADED	CMPQ PART #	PRICE
DeskPro 386/33, 386/33L, 486/25, 486/33L, 486/50L, System Pro	2Meg Module	115144-001	109.00
	8Meg Module	116561-001	399.00
	32Meg Module	116568-001	1399.00
DeskPro 386/33L, 486/33L	(Exp Bd)	116569-001	279.00
DeskPro 386/25, 386/20	1Meg Module	113131-001	79.00
	4Meg Module	113132-001	199.00
DeskPro 386S-16MHz	1Meg Exp Bd	113633-001	149.00
	4Meg Exp Bd	113634-001	279.00
	1Meg Module	113646-001	79.00
	4Meg Module	112534-001	199.00
DeskPro 386/20E	1Meg Exp Bd	113644-001	149.00
DeskPro 386/25E	4Meg Exp Bd	113645-001	279.00
	1Meg Module	113131-001	79.00
	4Meg Module	113132-001	199.00
DeskPro 286N, 386N, 386SX20, all "M" series, sytem LT series, all "I" series	1Meg Module	118688-001	59.00
	2Meg Module	118689-001	89.00
	4Meg Module	118690-001	169.00
	8Meg Module	128877-001	339.00
M Series Exp Bd	0-64Meg	129160-001	189.00
DeskPro 386/16	1Meg Kit	108071-001	99.00
	4Meg Kit	108072-001	299.00
	1-2Meg Exp Bd	108069-001	239.00
	4-8Meg Exp Bd	108070-001	437.00
DeskPro 286 (ALL OF THESE MACHINES USE THESE MODULES)	512K Kit	113012-001	49.00
DeskPro 5/60, 5/66M, 5/66M	8Meg Kit	149911-001	389.00
Prosignia 5/60	16Meg Kit	149949-001	699.00
Proliant 100 5/60	32Meg Kit	149912-001	1358.00
Proliant 2000 4/30, 5/66	64Meg Kit	149913-001	2518.00
Proliant 4000 4/50, 5/66	128Meg Kit	149914-001	5799.00
Prolinea 386 3/25S, 3/25ZS	2Meg	141738-001	90.00
	8Meg	141742-001	316.00
Prolinea 486 4/25S, 4/33, 4/50, 4/66, CDS Enhanced Prolinea, Prosario series	2Meg	141683-001	95.00
	4Meg	141684-001	175.00
	8Meg	141685-001	339.00
Prosignia PC Server, 486/33, 486 DX2/66	8Meg	141685-001	339.00
	16Meg	149320-001	599.00
	32Meg	149147-001	1199.00

COMPAQ LAPTOPS & NOTEBOOKS

LTE/286	4Meg Bd	117081-003	179.00
LTE/386S/20	4Meg Module	121125-002	209.00
LTE LITE/20, 25, 25C	4Meg Module	129769-002	209.00
LTE LITE/20, 25, 25C	8Meg Module	129769-003	389.00
LTE LITE/20, 25, 25C	16Meg Module	129769-004	769.00
LTE LITE 425C/33C/25E/25L	4Meg Module	142337-002	189.00
LTE LITE 425C/33C/25E/25L	8Meg Module	142337-003	329.00
LTE LITE 425C/33C/25E/25L	16Meg Module	142337-004	639.00
SLT/286	4Meg Module	110237-001	199.00
SLT/386	2Meg Module	118304-001	109.00
SLT/386	4Meg Module	118305-001	219.00
Concerto, LTE Elite	4Meg	144790-001	189.00
	8Meg	144790-002	369.00
	16Meg	144790-003	699.00
Contura 320, 325	2Meg	139497-001	99.00
	4Meg	139498-001	189.00
	8Meg	139499-001	339.00
Contura 400, 410	4Meg/8Meg/16Meg		199/389/709
Contura 4/25, 4/25C, 4/25CX	4Meg	146520-001	189.00
	8Meg	146521-001	339.00
	16Meg	146531-001	699.00
Aero 4/25, 4/33L	4Meg	190532-001	184.00
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T2000SXE/2200SX/T1800 1850, C	4Meg	PC-PA2001U	189.00
T2000SXE/2200SX/T1800 1850, C	8Meg	PC-PA2002U	359.00
T2100, 2105, 2150	4Meg/8Meg		199/389
T2100, 2105, 2150	16Meg/24Meg		729/1249
T4400SX, SXC T6400, T6600	4Meg	PC-PA2004U	189.00
T4400SX, SXC T6400, T6600	8Meg	PC-PA2005U	359.00
T4400SX, SXC T6400, T6600	16Meg	PC-PA2010U	689.00
T4500, C T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	4Meg	PC-PA2012U	199.00
T4500, C T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	8Meg	PC-PA2013U	389.00
T4500, C T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	16Meg	PC-PA2014U	789.00
T4700, 4800, 4850 (Hard Drive)	524Meg/710Meg		949/1149
T3400CT, T2400, T3600	4Meg	PC-PA2019U	194.00
T3400CT, T2400, T3600	8Meg	PC-PA2020U	359.00
T3400CT, T2400, T3600	16Meg	PC-PA2021U	707.00
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T3200SX	2Meg	PC12-PA8307U	55.00
T3200SX	4Meg	PC12-PA8309	199.00
T5200/T8500	2Meg	PC10-PA8304U	114.00
T5200/T8500	8Meg	PC10-PA8313U	419.00

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ACER 730, 735C, 760, 78C	2Meg/4Meg/8Meg		109/209/399
ACER 750	4Meg/8Meg/16Meg		199/459/799
ALR Venture	4Meg	12407980	249.00
Altima Virage	4 Meg/ 16 Meg		199/679
Altima Virage II	4Meg/8Meg/16Meg		199/389/679
AST Ascentia 900N, 800N	4Meg/8Meg/16Meg		199/379/679
AST Bravo & Explorer	4Meg/16Meg	501255-001, -002	189/679
AST Notebook Prem Exec 386SX/20/25/25L	4Meg	500814-003	189.00
AST Power Exec 3/25C, 425EL, 425SL	4Meg/16Meg	501166-001, -003	199/699
AST Power Exec 4/33SL	4Meg/16Meg	501318-001,002	194/769
AT&T Globalyst 200	4Meg/8Meg/16Meg		199/389/679
AT&T Safari NSX/20	4Meg	PEC 37851	259.00
Austin DX4, DX2, SX2, SX Series	4Meg/16Meg		Call
Bondwell B310, Plus	1Meg	23050-09100	69.00
Bondwell B310V, SX	1Meg		109.00
Bondwell B310V, SX	4Meg		229.00
Canon Innova Book 150	4Meg/16Meg		199/769
Canon Innova Book 200LS	4Meg/8Meg/16Meg/24Meg		Call
Canon Innova 486	2Meg/4Meg/8Meg		109/209/449
Canon Innova 486-10	4Meg/16Meg		189/829
Canon Notejet 486	4Meg/ 8 Meg		199/389
Chaplet 486	4Meg/16Meg		199/579
Chicony NB5	4Meg/16Meg		199/679
Compuadd 425TX Notebook	4Meg/16Meg		Call
DEC HiNote	4Meg/8Meg/16Meg		199/379/669
Dell Latitude M, MC, MCX	4Meg/8Meg/16Meg		219/449/719
Dell Latitude XP, 475, 4100, 4100CX	4Meg/16Meg		199/549
Dell Latitude 486, 425, 433C, 433CX, 450, 450CX	4 Meg/16 Meg		199/679
DTK 4T100P Notebook	4Meg/8Meg/16Meg/32 Meg		Call
Epson ActionNote 650, 650c	4Meg/8Meg/16Meg		209/399/659
Epson ActionNote 700, 700c, 700cx	4Meg/16Meg		199/639
Epson ActionNote 4000 Notebook	8Meg		Call
Epson ActionNote 4LC/25, 4LC/33, 4SLC/2-50			Call
Everex Tempo LX, LX20, Carrier	2Meg	PCA 00053-0001	109.00
Gateway 2000 Colorbook 4/33	4Meg/16Meg		199/679
Gateway 2000 Nomad 425 DXL/SXL	4Meg/16Meg		199/1199
Gateway 2000 486 Handbook	4Meg/16Meg		199/679
Goldstar GS520 386SX/16	4Meg		249.00
HP Omnibook 300, 425, 425	2Meg/4Meg		129/269
HP Omnibook 530, 600	4Meg/8Meg/12Meg		229/439/789
HP Omnibook 4000	4Meg/8Meg/16Meg		199/379/649
Leading Edge Amrz	4Meg/16Meg		199/679
Lexmark SE10	4Meg/16Meg		209/399
Magnavox Metalis	1Meg/4Meg	286, 386SX	109/199
Midwest Micro Elite SX-25, SX33, DX2-50, DX2-66	4Meg/8Meg/16Meg		199/389/679
Midwest Micro Elite 486 SLC 33 Subnotebook	4Meg/8Meg/16Meg		109/199/299
Midwest Micro Elite Sndbk SX33, DX2-50, DX4 75, DX4 100	4Meg/8Meg/16Meg		199/389/679
Midwest Micro Elite Sndbk Plus D5-75, D5-90	4Meg/8Meg/16Meg		199/389/679
NCR Safari 3180	4Meg/ 8 Meg		239/449
NEC Prospeed 386	2Meg	PC31-21	119.00
NEC Prospeed 386	8Meg	PC31-22	399.00
NEC Prospeed 286, 386SX-16, 386SX-20	4Meg	PC21-22, PC43-22	199.00
NEC Ultralite Versa, E, V	4 Meg/8Meg/16Meg/20Meg	OP4104	183/359/739/919
NEC Versa Removable Hard Drive	340Meg/524Meg/710Meg		749/899/1049
NEC Versa S	4Meg/8Meg/16Meg		209/379/799
Packard Bell 386SX, 286	1Meg, 4Meg	286, 386SX	109/199
Packard Bell Statesman	2Meg/8Meg		119/369
Panasonic CF170, CF270, CF370	1Meg	CF-BA165	59.00
Panasonic CF380, CF480	2Meg/4Meg/8Meg		119/199/309
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Sanyo 17/18 NB	2Meg	MBC-MBMEM2	109.00
Sharp 6781, 6881, 6785, 6700, 6800, 6741	2Meg/4Meg		109/199
Sharp 8150, 8650, 8660, 7700, 7780	4Meg/16Meg		199/679
Sharp 8700 & 8900	4Meg/8Meg/16Meg		199/379/649
TI Travelmate 2000	1Meg	2568034-0001	79.00
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TI 4000, TI 4000E	4Meg/16Meg		199/659
TI 4000M	4Meg/16Meg		219/799
TI 5000	4Meg/16Meg		Call
Tandy 1510, 2810, 3810	1Meg		49.00
Tandy 2820, 3820, 3830	2Meg/4Meg/8 Meg		119/199/309
Twinhead, Altima, Compudyne, 486SX, DX, Tandy 4860	4Meg/16Meg		199/679
Twinhead Slimnote 5	4Meg/8Meg/16Meg		199, 379, 649
Ultra 486 TS38	4Meg/8Meg/16Meg		249/459/899
Zeos 386SX Notebook (not the + version)	2Meg		109.00
Zenith Master Sport 386SX	2Meg	ZA-300-1	114.00
Zenith Master Sport SL, SLE, 600, 620, 625NL	2Meg	ZA-4-4	119.00
Zenith Super Sport 286, 286E	1Meg	ZA-180-86	99.00
286E, SX	2Meg	ZA-180-84	149.00
SX Alpha/SX Beta	2Meg	ZA-180-86/ZA-180-87	149.00
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Zenith Z-Star 4/33	2/8Meg		119/369

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28.8/28.8 Data/Fax Modem	379	CD-Rom Drive w/SCSI Interface	299
14,400/14,400 Data/Fax Modem	189	Wavjammer™ (16 bit stereo sound card)	275
Readwriter Card (15A Slot)	149	Multimedia Combo, Sound/SCSI	499
Lan Ethernet Combo	Call	Type III 105 Mg Hard Drive	319
Lan Ethernet (10 Base T)	169	Type III 130 Mg Hard Drive	399
Lan Ethernet (Coax)	169	Type III 170 Mg Hard Drive	439

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Canon LBP 430	–	–	69	–	–	–	189	–	–	–	–	–
Canon LBP 860	–	–	–	99	–	–	179	–	–	349	669	1249
Canon LBP4, 4Lite, 4plus	–	–	159	219	–	–	–	–	–	–	–	–
Epson 6000, Action Laser	–	–	–	139	–	–	229	–	–	–	–	–
Epson Action Laser 1100, 1600	–	–	69	99	–	–	189	–	–	379	599	–
Epson Action Laser II	–	–	89	–	208	–	–	327	–	–	–	–
Epson 8000, 1800, 4000, 4100, 4300	–	–	89	–	208	–	–	327	–	Call	Call	Call
Epson 1000, 1500, 5000, 5200	–	–	–	119	–	–	239	–	Call	–	–	–
HP 2, 2D	–	–	–	109	–	–	189	–	–	–	–	–
HP 3, 3D, 3P, 2P, 2P+	–	–	–	99	–	–	169	–	–	–	–	–
HP 4, 4M, 4SI, 4SIMX, 4P, 4MP	–	–	–	89	–	–	169	–	–	349	–	–
HP 4L	–	–	59	–	–	–	–	–	–	–	–	–
HP 3SI	–	–	69	–	–	–	169	–	–	349	–	–
HP 4SI	–	–	–	89	–	–	175	–	–	349	–	–
HP Design Jet 600, 650, 200	–	–	–	89	–	–	175	–	–	349	–	–
HP Deskjet 500, 500C, 510, 550, 560	–	55	–	–	–	–	–	–	–	–	–	–
HP Deskjet 1200C, 1200C/P	–	–	–	89	–	–	175	–	–	349	–	–
HP Laserjet	–	–	–	–	–	–	179	–	–	379	679	–
HP Paintjet XL300	109	–	–	–	–	–	289	–	–	469	837	–
IBM Laser 4019, 4019E	–	–	–	–	–	169	–	–	–	–	–	–
IBM Laser 4029, 4037	–	–	–	–	–	–	169	–	–	–	–	–
IBM Laser 4039, 4079	–	–	–	99	–	–	169	–	–	350	–	–
Konica LP-3110	–	–	119	189	239	–	–	–	–	–	–	–
NEC 90, 290	–	–	–	139	–	–	–	–	–	–	–	–
NEC 95, 97	–	–	–	99	–	–	–	–	–	–	–	–
Oki 400	–	–	–	64	–	–	–	–	–	–	–	–
Oki 400E, 400EX, 410E, 410EX	–	–	135	189	–	–	–	–	–	–	–	–
Oki 830, 840	–	–	–	109	–	–	–	–	–	–	–	–
Packard Bell PB 9500	–	–	–	139	–	–	227	–	–	–	–	–
Packard Bell 9815	–	–	–	159	–	–	289	–	–	–	–	–
Panasonic 4420/4450i	–	–	–	129	–	–	229	–	–	–	–	–
Panasonic 4410/4430	–	–	–	126	–	–	185	–	–	–	–	–
Panasonic 4450	–	–	99	–	–	–	–	–	–	–	–	–
Panasonic 4400/5400	–	–	89	129	–	–	229	–	–	–	–	–
Panasonic 4440, 5410	–	–	109	179	–	–	Call	–	–	–	–	–
Sharp 9400, 9460, 9600, 9700E	–	–	89	149	–	–	249	–	–	–	–	–
Sharp 9500, E, H, 9700, H	–	–	109	–	–	–	279	–	–	–	–	–
TI XL/PS17/PS35	–	–	55	–	–	–	–	–	–	–	–	–
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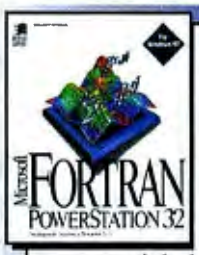

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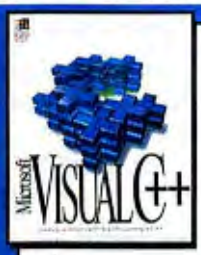

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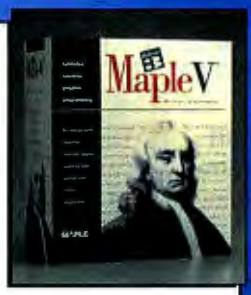

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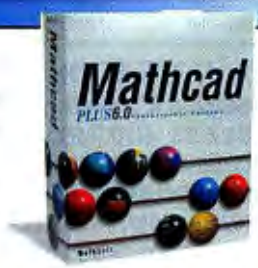

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SystemPro LT and M Series
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8MB 118877-001 ... $356
ProSignia PC Server 486/33, DX2/66
16MB 149330-001 ... $610
32MB 149147-001 ... $1,152
DeskPro 386-33, 486 33, SystemPro and SystemPro E series
2MB 115144-001 ... $109
8MB 116461-001 ... $378

Image 425, 433, 466
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Ready 425, 433
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PowerLite SX/20
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Canon LBP-4
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Canon LBP-8II, 8II, 8IT
2MB 56-1880 ... $119
Epson ActionLaser 1000, 1500
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Epson ActionLaser 1100
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Epson ActionLaser 1600
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HP LaserJet 4L
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HP LaserJet II, IID
2MB 33444B ... $95 — 4MB 33445B ... $169
HP LaserJet IISi, 4, 4Si, 4SiMX, 4SiSX, 5L 800, DeskJet 1200c
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4MB C2065A ... $174 — 8MB C2066A ... $339
HP LaserJet 4P, 4MP Color LaserJet
2MB C3113A ... $95 — 4MB C3112A ... $179
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256K 127078 ... $40
IBM/Lexmark Laser 4019 (all models)
2MB 1938675 ... $107 — 3.5MB 1099157 ... $167
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Panasonic LaserPartner 4400, 6400
2MB KX-PE311 ... $116 — 4MB KX-PE312 ... $204
Panasonic LaserPartner 4410, 4430
2MB KX-P444 ... $115 — 4MB n/a ... $196
Panasonic LaserPartner 4450i, 6420
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Texas Instruments MicroLaser XL
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UltraLite SL/20, SL/20P
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ProSpeed 286, 386SX/16
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Contura 400 models
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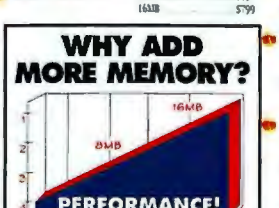

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	4mb	113132-001	189
Deskpro 386S	4mb Board	113634-001	254
	4mb Module	112534-001	186
Deskpro 386-20E; 25E	4mb	113645-001	238
Deskpro 386/33/33I; 486/25; 33L; 50L; Systempro	2mb	115144-001	108
	8mb	118561-001	378
	32mb	118598-001	1458
Systempro; Deskpro	66KT Exp Brd w/2mb	116599-001	268
Compaq "M"	2-64mb	129160-001	188
Deskpro 286M; 386N; 386SX/20; 20N, Portable 486c, Deskpro M, Systempro LT Series 129160-001,			
Pro Signia	1mb	118688-001	49
	2mb	118689-001	84
	4mb	118690-001	168
	8mb	128677-001	348
Prolina 3/25 & 25Z	2mb	141736-001	88
	8mb	141742-001	318
Prolina 4/25si, 4/33, 4/50zmb Module		141683-001	94
	4mb Module	141684-001	178
	8mb Module	141685-001	338
Compaq Pro Signia	16mb	149320-001	684
	32mb	149147-001	1524
DeskPro 5/60, 5/66M	8mb	149911-001	388
Prosignia PC Server, 486/33/66	8mb	141685-001	348
	16mb	149320-001	648
	32mb	149147-001	1468
Prosignia 5/60	16mb	149949-001	698
Proliant 100 5/60	32mb	149912-001	1398
Proliant 2000 4/30,5/66	64mb	149913-001	2898
Proliant 4000 4/50, 5/66	128mb	149914-001	5800

Compaq Laptop & Notebook Memory

Concerto 486	4mb	$188
	8mb	358
	16mb	698
Contura 320, 325, C	2mb	139497-001	98
	4mb	139498-001	174
	8mb	139499-001	318
Contura 4/25CX	4mb	146520-001	178
	8mb	146521-001	338
	16mb	146532-001	718
SLT/285	1mb	110235-001	75
	4mb	110237-001	218
SLT/386	1mb	118303-001	79
	2mb	116304-001	108
	4mb	118305-001	198
Lte 286	1mb	117081-001	79
	2mb	117081-001	98
	4mb	117081-004	178
Lte 386SX/20	1mb	121125-001	98
	4mb	121125-002	208
Lte Lite/20, 25, 25C	2mb	129769-001	138
	4mb	129769-002	208
	8mb	129769-003	388
	16mb	129769-004	808
Lte Lite 486/25C	4mb	143337-002	178
	8mb	142337-003	348
	16mb	142337-004	718
Aero 3.3volt	4mb	190532-001	188
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IBM MEMORY

Model	Memory	Part#	Price
AMERA Enterprise 386, Hurdia 386, Sprinta 386	2mb	n/a	$ 93
	8mb	n/a	328
AMERA Enterprise 486, Hurdia 486, Sprinta 486	4mb	n/a	198
PS/1 and 386SX (2121)	2mb	92F9935	88
	4mb	92F9694	198
	16mb	n/a	648
PS/2 30/286, 25/286; Adpt Brd 1497259	512K	30F5348	35
	2mb	30F5360	98
PS/2 35SX, LS, 40SX, 70-E51; 061; 121, Adpt Brd 6450809; 34F3011; 34F3077, 502, 55SX, 655SX, P70, 55LS, 65LS X Station 120 & 130	1mb	6450803	39
	2mb	6450804	94
PS2 50, 502, 55SX, 60, 65SX	2-8mb	1497259	198
	2-16mb	6450809	358
PS/1 Consultant, Essentials & Expert models x 43, x44 & PS/Valuepoint all models except Cox series	4mb	96F9290	198
	16mb	96F9291	598
PS/2 70-A21; A61; B21; B61; PS/1 Consultant, Essential & Expert models x11, x13 & x14, PS/Valuepoint Cox series	1mb	6450803	39
	2mb	6450808	89
PS/2 35SX; LS, 40SX, 55SX; LS, 65SX	4mb	34F2033	198
PS/2 90 XP, 95 XP, P75 (Pairs), 56, 57 (all), 76, 77, PS/1 Pro 2123	2mb	6450902	88
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32 Bit Boards	4-16mb	34F3011	318
PS/2 80-A21; A31; A61	4mb	6451060	188
PS/2 80-041	1mb	6450375	78
PS/2 80-111; 311; 121; 321; 061; 161	2mb	6450379	94
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4033	32mb		1598
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	8mb	33G9289	358
Thinkpad 350, 350C, 350, PS/Note	8mb	6060378	338
	16mb	6060379	647
Thinkpad 500, 510CS, 2618	4mb	81B9098	198
	8mb	81B9099	398
	16mb		648
DLS7SX	4mb	07G1420	208
Thinkpad 700, 700C, 720, 720C, 750C	8mb	07G1421	378
	16mb	9685109	898
Thinkpad 710T	4mb	n/a	188
	8mb	n/a	318
PS/Note N45SL	2mb	92F8804	106
PS/2, N51, SLC, SX	2mb	07G1826	98
	4mb	07G1827	188
	8mb	07G1828	418
Laptop N33SX, L40SX & PSNOTE 182	2mb	79F3999	98
	4mb	79F1000	184
L40SX, PSNOTE 182 only	8mb	79F1001	358

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Model	Memory	Part#	Price
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	8mb	501159-002	368
	16mb	501159-003	768
Advantage 386SX/20, 25, Pro SX/25 Bravo 3/33's	2mb	500962-001	88
	8mb	500962-002	348
Bravo MB/485	4mb		198
	16mb		798
Advantage Pro 486DX/33, SX/25, Bravo LC 4/25S; 33; 33S; 50D; 466D	2mb	500987-001	88
	4mb	500987-002	164
	16mb	500987-004	578
Premium 386/25; 33; 33T II 386SX/16; 20, 25	1mb	500780-003	48
	1mb	500780-002	48
Advantage 486/25, 33, 33P; SX20, Bravo 4/33; 485/25; Premium 425; 33TE, SE 4/33	2mb	500718-004	68
	2mb	500780-005	68
Advantage 486/25, 33; 33P, SX20, Power Premium 3/33, 4 33; 33S, 50D; 66D, Premium 386/33TE, 485/25; E, 25TE, 33, 33TE; Premium II 386/25, 33, 486/33, 486SX/20 Premium Server SE 4/33	4mb	500780-004	178
	8mb	500780-001	348

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Power Exec 4/25SL/33SL	4mb	178
	16mb	688
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	4mb	188
	16mb	668
Ascentia 900N, 800N, 4133-50-75	4mb	198

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Model	Memory	Part#	Price
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T1000 SE/LE/XE	2mb	PA3312U	73
T2000/T2000SX	2mb	PA3317U	73
T2000SX/T1000 LE	4mb	PA3314U	188
	8mb	PA3315U	358
T1200 XE	2mb	PA3309U	98
T1600	2mb	PA3302U	98
T2000 SXE/T2200SX/T1800, T1850, C	2mb	PA2000U	78
	4mb	PA2001U	198
	8mb	PA2002U	358
T2400, T2450, T3600 3.5v	4mb	PA2018U	218
	8mb	PA2020U	398
	16mb	PA2023U	798
T3100	2mb	PA7135E	138
T3100 E	2mb	PA834U	109
T3100 SX	2mb	PA8308U	108
	4mb	PA8310U	188
T3200 SX	2mb	PA8307U	118
	4mb	PA8309U	188
T3200 SXC	2mb	PA8318U	108
	4mb	PA8319U	198
T3200	3mb	PA7137U	184
T3300SL	2mb	PA2008U	118
	4mb	PA2057U	238
	8mb	PA2008U	258
	16mb	PA2005U	698
T3400CT	4mb	PA2019V	218
	8mb	PA2020V	369
	16mb	PA2021V	758
T4400 SX, SXC, T6400 SXC, DXC	2mb	PA2003U	125
	4mb	PA2004U	198
	8mb	PA2005U	358
	16mb	PA2016U	698
	32mb		1548
T4500, T4600, T1900C (3.3volts) T4700	4mb	PA2012U	198
	8mb	PA2013U	368
	16mb	PA2014U	658
T5100	2mb	PA8301U	94
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CFA1275	1.27 gb	10 ms	3.5" IDE	365

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ST3780A	730 mb	10 ms	3.5" IDE	239
ST31220A	1.08 gb	10 ms	3.5" IDE	349

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2850	850 mb	10 ms	3.5" IDE	249
31200	1.2 gb	10 ms	3.5" IDE	359

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ST11900N	1.7GB	9MS	SCSI-2	899
ST12400N	2.1GB	9MS	SCSI-2	849
ST32430N	2.1GB	10MS	SCSI-2	873
ST43400N	3.5GB	11MS	SCSI-2	1050
ST15230N	4.2GB	9MS	SCSI-2	1287
ST410800N	9.0GB	11MS	SCSI-2	2899
SCSI-BARRACUDA · 7200 RPM				
ST31250N	1.05GB	8MS	SCSI-2	669
ST32550N	2.1GB	8MS	SCSI-2	969
ST15150N	4.2GB	8MS	SCSI-2	1489

Maxtor
FACTORY NEW-2 YEAR WARRANTY

M7420AV	420MB	12MS	IDE	$174
M7540AV	540MB	12MS	IDE	183
M7850AV	853MB	12MS	IDE	231
M71260AV	1.2GB	12MS	IDE	343
M7345S	345MB	14MS	SCSI	235
MXT540A	540MB	8.5MS	SCSI	345
MXT540S	540MB	8.5MS	SCSI	345
DR3410	105MB	MBL MAX	PCMCIA	380
MobileMax131	131MB	19MS	PCMCIA	375
MobileMax171	171MB	19MS	PCMCIA	445

Fujitsu
FACTORY NEW-5 YEAR WARRANTY

M2684	530MB	13MS	IDE	$196
M2684S	530MB	13MS	SCSI	209
M1606S	1.1GB	9.5MS	SCSI	449
M2915S	2.1GB	9.5MS	SCSI	849

Conner
FACTORY NEW-1 YEAR WARRANTY

CFS425A	420MB	13MS	IDE	$179
CFA540A	540MB	12MS	IDE	188
CFA850A	850MB	10MS	IDE	247
CNR1275A	1.3GB	10MS	IDE	368
CFP1080S	1.06GB	9MS	SCSI-2	480
CFP2105S	2.1GB	9MS	SCSI-2	875
CFP2107S	2.1GB	9MS	SCSI-2	908
CFP4207S	4.2GB	9MS	SCSI-2	1479

Micropolis
FACTORY NEW-5 YEAR WARRANTY

MC2210A	1.05GB	10MS	IDE	$645
MC2217A	1.75GB	10MS	IDE	875
MC4110	1.05GB	9MS	SCSI-2	650
MC2217	1.75GB	10MS	SCSI-2	875
MC3221/4221	2.05GB	8.5MS	SCSI-2	999
MC1936	3.0GB	11MS	SCSI-2	1399
MC3243	4.3GB	8MS	SCSI-2	1309
MC1991	9.0GB	11MS	SCSI-2	2159
MC4221AV	2.05GB	8.5MS	SCSI-AV	1069
MC1936AV	3.0GB	11MS	SCSI-AV	1545
MC3243AV	4.3GB	8.5MS	SCSI-AV	1429
MC1991AV	9.1GB	10MS	SCSI-AV	2259

Western Digital
FACTORY NEW-3 YEAR WARRANTY

AC2420	425MB	12MS	IDE	$183
AC2540	540MB	11MS	IDE	207
AC2850	850MB	10MS	IDE	247
AC31000	1.1GB	10MS	IDE	350
AC31200	1.2GB	10MS	IDE	355

IBM PS/2
PS/2 50, 50Z, 60, 70, 80, P70, 855X

200MB	15MS	IDE	$349
420MB	13MS	IDE	399
540MB	12MS	IDE	499
540MB	12MS	SCSI	499
1.2GB	12MS	SCSI	799
MICROCHANNEL CONTROLLER			
IDE	169	SCSI-2	$179
IBM PS/2 INTERNAL DRIVE KITS 30-0005, 30-286, 25-0006, 25-286			
210MB		IDE	$299
420MB		IDE	399
540MB		IDE	449
1.0GB		IDE	699

IBM Standard

527MB	12MS	SCSI	$265
728MB	12MS	SCSI	350
1.0GB	10MS	SCSI	599
2.04GB	7.5MS	SCSI	1300
4.25GB	11MS	SCSI	2149
527MB	12MS	IDE	246
728MB	12MS	IDE	325
1.05GB	10MS	IDE	569

Hewlett Packard
FACTORY NEW-5 YEAR WARRANTY

C3323A	1.05GB	10MS	SCSI	$649
C2490	2.1GB	8.9MS	SCSI	1029

Digital
FACTORY NEW-5 YEAR WARRANTY

DSP3107	1GB	9.5MS	IDE	$694
DSP3210	2GB	9.5MS	IDE	1149
DSP5300	3GB	12MS	IDE	1299
DSP5400	4GB	12MS	IDE	2479

Quantum
FACTORY NEW-2 YEAR WARRANTY
5 YR WRNL ON P DRIVES/1 YR. WRNL. ON 2.5" UNITS

TR420A	420MB	12MS	IDE	$180
30420LPA	420MB	12MS	IDE	199
MV540A	540MB	11MS	IDE	203
LT540A	541MB	11MS	IDE	217
LT730A	731MB	11MS	IDE	239
LT365S	365MB	11MS	SCSI-2	186
MV540S	540MB	14MS	SCSI-2	219
LT541S	541MB	11MS	SCSI-2	243
LT730S	731MB	11MS	SCSI-2	289
XP31070	1.06GB	8MS	SCSI-2	709
MP1080S	1.08GB	8MS	SCSI-2	589
MP2160S	2.1GB	9.5MS	SCSI-2	880
XP32150	2.1GB	8MS	SCSI-2	909
GP4200S	4.2GB	8.6MS	SCSI-2	1499
TRAIL BLAZER SERIES				
30420TRA	420MB	12MS	IDE	199
30420TRS	420MB	12MS	SCSI-2	210
30850TRA	850MB	12MS	IDE	309
30850TRS	850MB	12MS	SCSI-2	319
FIREBALL SERIES				
30540FBA	540MB	12MS	IDE	229
30540FBS	540MB	12MS	SCSI-2	245
31080FBA	1.08GB	12MS	IDE	339
31080FBS	1.08GB	12MS	SCSI-2	345

WIDE SCSI HARD DRIVES

Conner

CFP1080W	1.08G	10MS	3.5	$749

Seagate

ST31200W	1.05GB	9MS	3.5"	$749
ST32550W	2.13GB	8MS	3.5"	1329
ST15150W	4.29GB	8MS	3.5"	2499

Micropolis

MC4221	2.05GB	8.5MS	LP3.5	$1229
MC3243	4.30GB	8.5MS	3.5	2169
MC1991	9.10GB	10MS	FH	3359

EXT. SCSI HARD DRIVE CASES

Half Ht for 5.25" or 3.5" Devices (1Bay)	$125
Half Ht for for CD-ROM's w/ Audio Jacks	125
JMR WIDE Chico 3.5" Drive Case w/Term Cable	299
5.25"Full Ht for (1) FH or (2) HH Devices (2 Bay)	169
5.25"Double Full Ht for (2) FH Devices (4 Bay)	299
5.25"3-Full Ht & HH or 7 HH Devices (7 Bay)	499

NOTEBOOK HARD DRIVES

Toshiba
NOTEBOOK DRIVES/1 YEAR WARRANTY ON 2.5"

MK2124FC	120MB	15MS	IDE	$199
MK1522FC	126MB	15MS	IDE	199
MK1724FC	260MB	15MS	IDE	295
MK2326FC	340MB	15MS	IDE	344
MK1824FC	360MB	15MS	IDE	344
MK2526FC	524MB	15MS	IDE	574
MK2528FC	700MB	15MS	IDE	530
MK2428FC	520MB	15MS	SCSI	528
MK2628FC	810	13MS	IDE	650

IBM

IBMHDN520	520MB	IDE	650

Seagate

ST9145AG	128MB	16MS	$275
ST9150AG	128MB	16MS	275
ST9235AG	210MB	16MS	276
ST9385AG	340MB	16MS	395
ST9550AG	455MB	16MS	429
ST9655AG	524MB	16MS	529

Quantum

GLS256AT	256MB	17MS	$295
GLS256S	256MB	17MS	295
GLS514S	514MB	17MS	518

Conner

CP2064	64MB	17MS	$149

Fujitsu

M2637T	240MB	17MS	$295

REMOVABLES/OPTICALS

SyQuest
REMOVABLE CARTRIDGE DRIVES

270MB INTERNAL/EXTERNAL FOR PC	$399/499
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Fujitsu
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230MB 3.5" OPTICAL EXT FOR MAC	699
230MB CARTRIDGE 1-PACK $29 5-PACK	129

FLOPPY DRIVES

TEAC

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DUAL FLOPPY 1.44 & 1.2	99

MULTIMEDIA

Creative Labs

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Sound Blaster Pro Value Edition	69
Sound Blaster 16 SCSI-2	179
Sound Blaster Multi CD	149
Sound Blaster AWE 32	299
Sound Blaster Discovery CD16	299

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Hewlett Packard BEST BUY! 1995

35470A	2.0GB TAPE INT/EXT	$789/899
35480A	4-8GB TAPE INT/EXT	899/999
C1533A	4-16GB TAPE INT/EXT	1099/1,199
4MM 90MT DAT CART (1/5 PK)		18/86
4MM 120MT DAT CART (1/5PAK)		25/120
3.5"-5.25" CONVERSION KIT		39

Colorado Memory Systems

Jumbo 250 Internal	$159
Jumbo 350 Internal	179
Jumbo 700 Internal	328
Jumbo 1400 Internal	399
Trakker 250 parallel port	299
Trakker 350 parallel port	330
Trakker 700 parallel port	499
Powertape 2.4GB SCSI Int/Ext	927/1127
Powertape 4GB SCSI Internal	1177
PowerDAT 4GB SCSI External	1388

Exabyte

4200	2GB TAPE INT/EXT	849/950
4200C	4GB TAPE INT/EXT	999/1,099
8205	2.5GB TAPE INT/EXT	1,325/1,549
8200	2.6GB TAPE INT/EXT	1,379/1,679
8505	5GB TAPE INT/EXT	2,029/2,399
8500	10GB TAPE INT/EXT	2,289/2,399
8505XL	14GB TAPE INT/EXT	2,200/2,499

WangDAT

3100	2-8GB TAPE TAPE INT/EXT	849/949
3200	4-8GB TAPE TAPE INT/EXT	899/999
3400DX	4-8GB TAPE TAPE INT/EXT	999/$1,099

MicroSolutions
BACKPACKS

DOUBLE SPEED PARALLEL PORT CD ROM DRIVE	$339
QUAD SPEED PARALLEL PORT CD ROM DRIVE	395
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DSKTTE DRV 1.2, 5.25	175
DSKTTE DRV 1.4, 3.5	175
HARD DRIVE 420	469
BKPACK 420MB PARLL PORT INTRFACE	469
800MB TAPE DRIVE	469
850MB HARD DRIVE	579

Iomega

Zip drive 100MB Parallel Interface	$199
Zip drive 100MB SCSI Interface	199
Zip drive 100MB 3pk	69
Ditto 420MB Tape Drive Internal	183
Ditto 850MB Tape Drive Internal	237
Tape250 Internal Basic	156
Tape510 Internal Basic	299
Bernoulli 90 MB DR	345
Bernoulli 150MB Internal SCSI	413
Bernoulli 150MB Internal IDE	389
Bernoulli 230MB Insider SCSI	474
Bernoulli 230MB Transportable	474
90MB/150MB/230MB Cartridge	99

Conner

TapeStor 250MB Internal	$151
TapeStor 250MB Ext. Par. A250ep	339
TapeStor 420MB Internal	187
TapeStor 420MB Parallel Port	337
TapeStor 850MB Internal	298
TapeStor 850MB Parallel Port	429
4320/50 Python 2GB up to 11MB mi/ext	749/1,039
4354XP Python 2GB Turbo 22MB/min ext	1099
4326NP Python 4-8GB 5MB/sec int	978
4356XP Python 4-8GB w/comp1MB Cahe	1209
4324T Python 4GB turbo int/ext	879/989

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1MB X 9-80NS 9 CHIP SIMM	44
1MB X 9-70NS 3 CHIP SIMM	42
1MB X 9-70NS 9 CHIP SIMM	47
1MB X 9-60NS 3 CHIP SIMM	45
1MB X 9-60NS 9 CHIP SIMM	48
16MB X 9-70NS SIMM	625
16MB X 9-60NS SIMM	650
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4MB X 8-80NS SIMM	145
4MB X 8-70NS SIMM	150
4MB X 8-60NS SIMM	160
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256K X 9-70NS SIPP	20
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256X36-1MB-70NS	55
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2X36-8MB-70NS/60NS	338/348
4X36-16MB-70NS/60NS	535/545
1X36-4MB-70NS/60NS EDO	180/190
2X36-8MB-70NS/60NS EDO	365/375
4X36-16MB-70NS/60NS EDO	620/640
8X36-32MB-70NS/60NS	1325/1375
16X36-64MB-70NS/60NS	2595/2645
72 PIN/32 BIT NON PARITY	
1X32-4MB-70NS/60NS	155/165
2X32-8MB-70NS/60NS	305/325
4X32-16MB-70NS/60NS	550/570
8X32-32MB-70NS/60NS	1195/1245
16X32-64MB-70NS/60NS	2495/2545

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PENTIUM-66		325	599
PENTIUM-75		325	649
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PENTIUM-100*		375	1199
PENTIUM-120*		CALL	CALL
486DX-33	256K CACHE/7-ISA /2-VLB/ AMI-BIOS/8-30 PIN OR 4-30 PIN & 2-72 PIN OR 4-72 PIN	145	239
486DX2-66		145	315
486DX-100		145	459

MICRONICS & INTEL MOTHERBOARDS

MICRONICS J230WB	MICRONICS M5PI	MICRONICS M54PI	Intel
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DX2-100 459		P5-100 1259	P5-100 1299

CD ROMS

NEC

NEC 2Vi	$179
NEC 2V Deluxe	298
NEC 3XP Plus/PlusKit	399/469
NEC 4Xi Plus/Plus Kit	399/469
NEC 4XE Plus/Plus Kit	499/569
NEC 4XE Pro	769

Plextor

PX-43CS	Internal 4-Speed, 256 Cache	$339
PX-45CS	External 4-Speed, 256 Cache	499
PX-43CS	Internal 4-Speed, 1MB Cache	399
PX-43CH	External 4-Speed, 1MB Cache	529
PX-63CS	Internal 6-Speed, 900 Cache	549

Pioneer

DRM602X 2X 6 disc	$389
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DRM1804X 4X 18 disc	1879
SINGLE DISC QUADRA SPEED	
DRU104X 240ms 614kb/sec 256K in/ext	329/429
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Toshiba

3501 SCSI 4X Internal/External	$345/445
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XM350MB Quad Speed Internal IDE	199

Chinon

CDS525 DS SCSI II Internal Drive Only	$199
CDS535 Double Speed SCSI II Internal	279
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Sony

CDU-55E 2X Internal	$149
CDU-55S SCSI 2X Internal	199

TEAC

CD-55A SuperQuad Int. 4X AT KIT w/Interface	$249
CD-55B SuperQuad 4X AT Bar Drive	229

Mitsumi

CRMC-FX400 Quad Speed IDE	$223

MODEMS

US Robotics

Sportster 28.8/28.8, V.34 Int	$239
Sportster 28.8/28.8, V.34 Ext	259
Sportster Pocket Modem	285
Sportster PCMCIA V.34	380
Sportster 14.4/14.4, Ext	119
Sportster 14.4/14.4, Int	99
Courier V.34 28.8/28.8 Ext	429
Courier V.34 28.8/28.8 Int	399

Hayes

Accura 14.4 int w/fax	$95
Accura 14.4 ext w/fax	111
Accura 28.8 V.34 int w/fax	186
Accura 28.8 V.34 ext w/fax	220
Optima 14.4 ext w/fax	174
Optima 28.8 V.34 int w/fax	Call
Optima 28.8 V.34 ext w/fax	449

Intel

SatisFAXtion 200 Int	$253
SatisFAXtion 400 Sup Fx Pk	348
SatisFAXtion 400 Ext	358

Supra

MBSUP141 14.4/14.4 Int	$109
MBSUP14LCE 14.4/14.4 Ext	129
MBSUP6014 14.4/14.4 PCMCIA	235
MBSUPV34E 28.8 V.34 Int	209
MBSUPV34I 28.8 V.34 Ext	230

Practical Peripherals

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14.4/14.4 Int. Series II	115
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28.8/14.4 Ext. Series II	256

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TMC1680	SVP 16-Bit Value Pack 7HD/4FD	139
SCSI 2 GO	PCMCIA Fast SCSI 2 Type2	279
TMC3260	32 Bit PCI Kit	149
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Adaptec

1505	CD ROM 16-Bit SCSI Card Kit	75
1515	16 Bit ISA SCSI 2 KIT	99
1522	16 Bit 7HD/2FD IO	139
1530PK	16 Bit ISA to FAST SCSI II Kit	189
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1640	MicroChannel for PS/2, 7HD	299
1570	ISA-SCSI AUDIO KIT	299
2940K	32-Bit PCI SCSI-2 Kit RISC Based I/O	284
2940WK	32-Bit PCI Wide Kit w/WIDE CABLE	369
2742	EISA KIT, 14HDs	369
2742W	FAST WIDE SCSI CARD	399
2825VL	Enhanced SCSI/IDE Kit	179
2842A	VLBus SCSI-II VESA	258
2842W	Kit VESA WIDE SCSI	349
APA-460	Slim SCSI PCMCIA SCSI Card	299
APA-2940W	PCI Fast-Wide SCSI Kit	399
3940	Dual Channel PCI Controller Kit	499
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Promise Technology, Inc.
IDE CACHING CONTROLLERS

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DC4030VL II	2FD/2HD 16MB/Sec [illegible]	119
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400	16550 2HD/2FD 2-16550 2s/1p/1g ISA	95
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Trantor

T160	16-Bit SCSI	$85
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Q-Logic

FastSCSI 16-Bit ISA for CD ROMs	$49
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FastSCSI 32-Bit ISA EISA/EISA-FL	199/209
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FastSCSI 32-Bit PCI Basic Entry Level	129
FastSCSI 32-Bit IO-PCI Wide SCSI-2	259
FastSCSI 32-Bit IO-PCI Model 10 Narrow	224

DTC

2278VL IDE/FDD 1P/1S/1G	$35
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2280 IDE/FD 1 P/2S/1 G	29
2290 EISA IDE 32-Bit	137
3270VL SCSI-2 VL-BUS FDD/HDD	119
3290AS SCSI-2/4 FDD	119
3290AS EISA SCSI-2/4 FDD	339
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Acculogic

s-CDI-116 8BIT XT Card w/Bios	$49
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VL Support 32bit VLB Kit w/Corel SCSI M/20	249
PCIpport Model 20 w/wide SCSI-3 Support	249
PCIpport Model 40 w/wide SCSI-3 w/Corel SCSI	299

BusLogic

KT445C	32-Bit VLB Fast SCSI-2 Kit	$199
KT545C	16-Bit ISA BusMaster Fast SCSI-2 Kit	209
KT742A	32-Bit EISA SCSI-2 Kit	289
KT747C	32-Bit EISA Fast SCSI-2 Kit	299
BT757S	32-Bit EISA Fast Wide SCSI Card	349
SW-190	Software Drivers for BT757S	49
KT946C	32-Bit PCI Fast SCSI-2 Kit	299
KT956C	32-Bit PCI Fast Wide SCSI-2 Kit	329
IDE CACHE CONTROLLERS		
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KT410A	VESA/IDE Cache Controller	139
KT910A	PCI/IDE Cache Controller	189

SCSI-IDE CABLES

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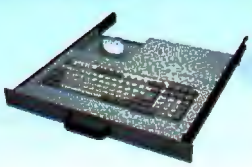

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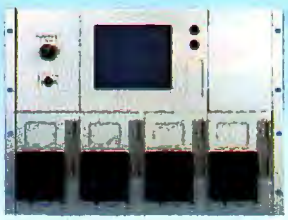

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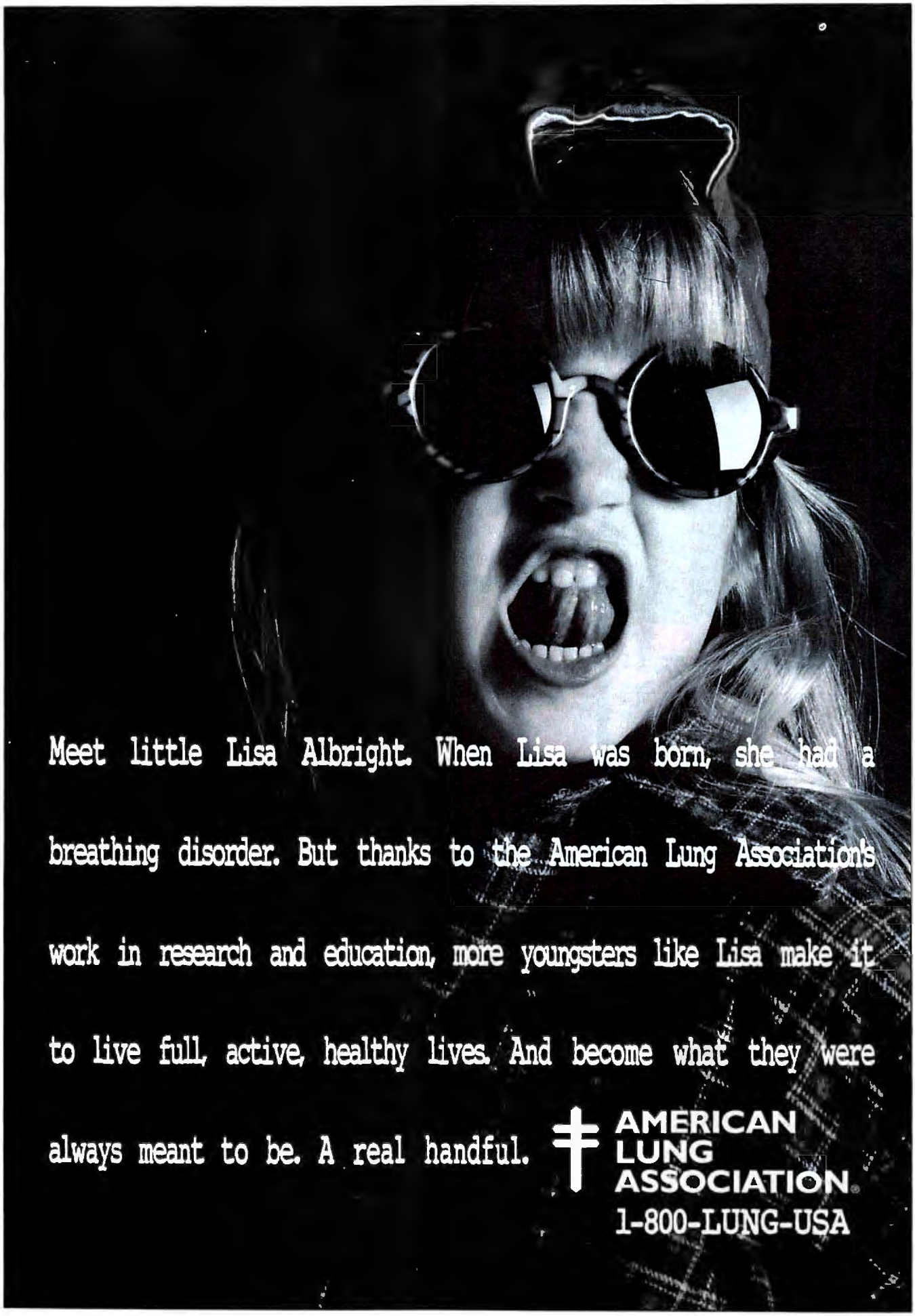
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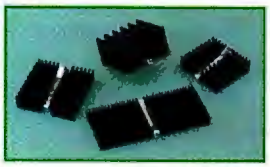

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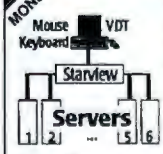

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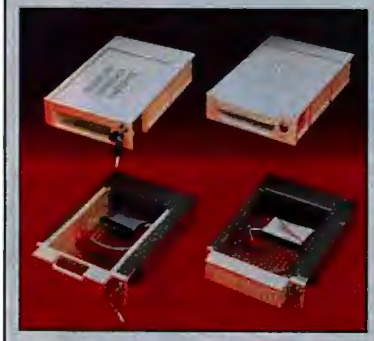

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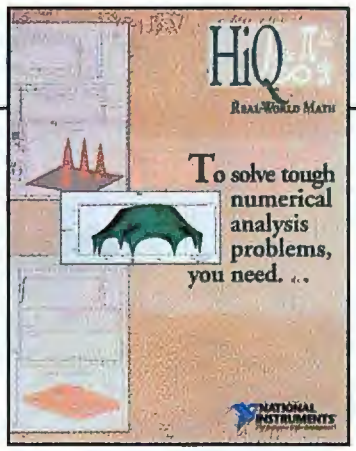

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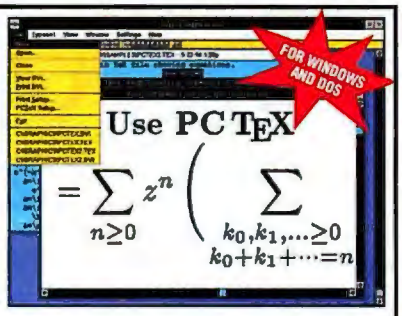

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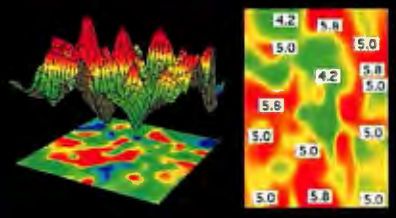

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AD FORMAT: Each ad will be designed and typeset by BYTE. Do NOT send logos or camera-ready artwork. Advertisers should furnish typewritten copy. 2"x1⅛" ads can include headline (23 characters maximum), descriptive text (300 characters is the maximum recommended) plus company name, address, telephone and fax number. 2"x2⅜" ad has more space for descriptive text (850 characters is the maximum recommended).

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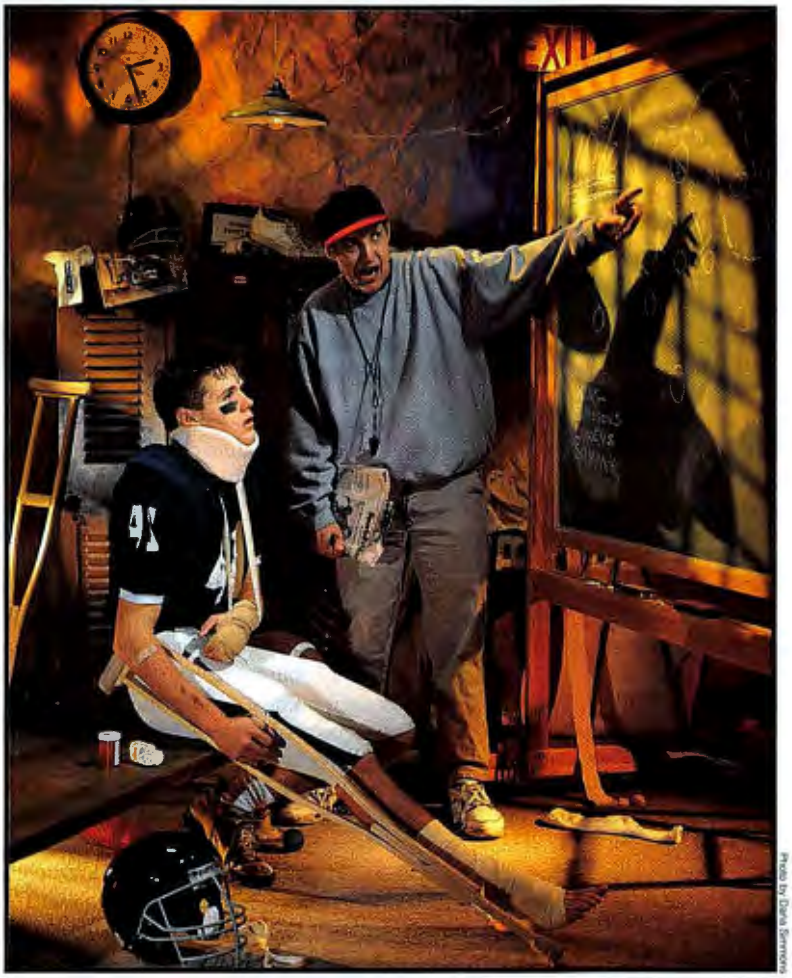

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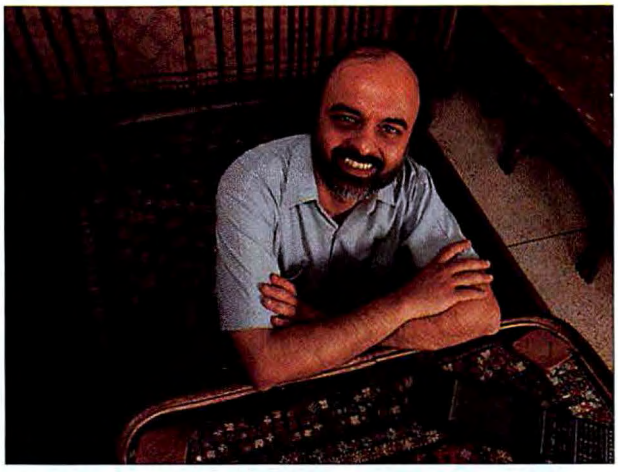

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The freedom of the Internet is under attack. Legislation such as U.S. Senator Jim Exon's proposed Communications Decency Act would potentially make employers, service providers, and carriers liable for transmitting material somehow deemed "offensive." But the Internet is incompatible with such censorship. Users are fiercely protective of their freedom and will sabotage any efforts at censorship. The only practical way to impose stringent control over what the Internet carries is to shut it down.

Commercialization of the Internet threatens one of its most dynamic channels: Usenet. (Although it's technically not a part of the Internet, Usenet is generally delivered via that route.) In the free-for-all discussion groups that constitute the Usenet, novices and experts mingle. You can tune in to a news group and find the best advice on everything from how to set up a modem, what photographic paper lasts longest, or where to find good Chinese food in Los Angeles.

However, participation can be expensive. While a student at a university, for instance, may have full access around the clock to all the wonderful goodies available, people in remote areas have to make long-distance calls to read and download messages. Even if they never post to a Usenet news group, just keeping up with the discussions can cost them a great deal. Usenet has a rather poor signal-to-noise ratio, and many people find it impractical to download a haystack to get at the few needles.

There is a way to attack these problems: Use unencrypted broadcasting to transmit Usenet and public mailing lists by satellite. Broadcasting is ideal for the Usenet because it is such a widely disseminated medium. Digital radio has already made available most of the hardware necessary to receive Usenet in this manner to millions in the U.S. The cost of broadcasting a message is largely independent of the number of people who receive it. It makes little difference whether the recipient lives in a remote corner of Arizona or in Manhattan.

There have also been experiments using the vertical interval of regular TV broadcasts for Usenet. This makes broadcast Usenet compatible with the existing hardware that cable operators use to provide their customers with TV and digital radio signals. The technology works—it only needs to be popularized so that the hardware becomes more widely affordable.

The disadvantage of this approach is that people need to find some other way of posting to Usenet. However, this is not a reason to reject the idea because most people receive a lot more information than they post.

Of course, most people will still have to dial in to send their messages or to receive private mail, but you have to be a prolific user to exceed a couple of minutes of transmission time a day. People who receive Usenet via their cable TV connection will feel as if they are eavesdropping on a party. They will be tempted to get an E-mail connection at least.

Broadcasting Usenet also makes the Internet uncensorable for all practical purposes. The entity responsible for the broadcasts can easily be located outside the legal reach of the recipient country. Even governments far more restrictive in their control of information than the U.S. are, in any case, reconciled to not being able to censor international radio transmissions.

In India, for instance, the government makes no attempt to censor unencrypted TV signals beamed in by CNN and Star TV, because anyone can receive them via standard equipment. However, because the encrypted Star-Movies channel requires decoding by the cable TV provider, the government insists that the movies receive prior clearance from the Censor Board.

Jerry Pournelle predicted at the start of the 1980s that the U.S.S.R. would not last out the decade because it would have to choose between having to forgo the benefits of PC technology and losing control over dissemination of information. Each PC with a printer was a potential samizdat printing press. PCs on the Internet are even more powerful. If stand-alone PCs pose a serious dilemma for authoritarian regimes, the Internet may easily be devastating.

Countries seeking to compete globally will be loath to lose the benefits of Internet access. Yet, bureaucrats find the anarchic Internet bewildering and threatening. They are uncomfortably aware that if they ever attempt a Tiananmen Square in cyberspace, the students will have the more powerful tanks. ■

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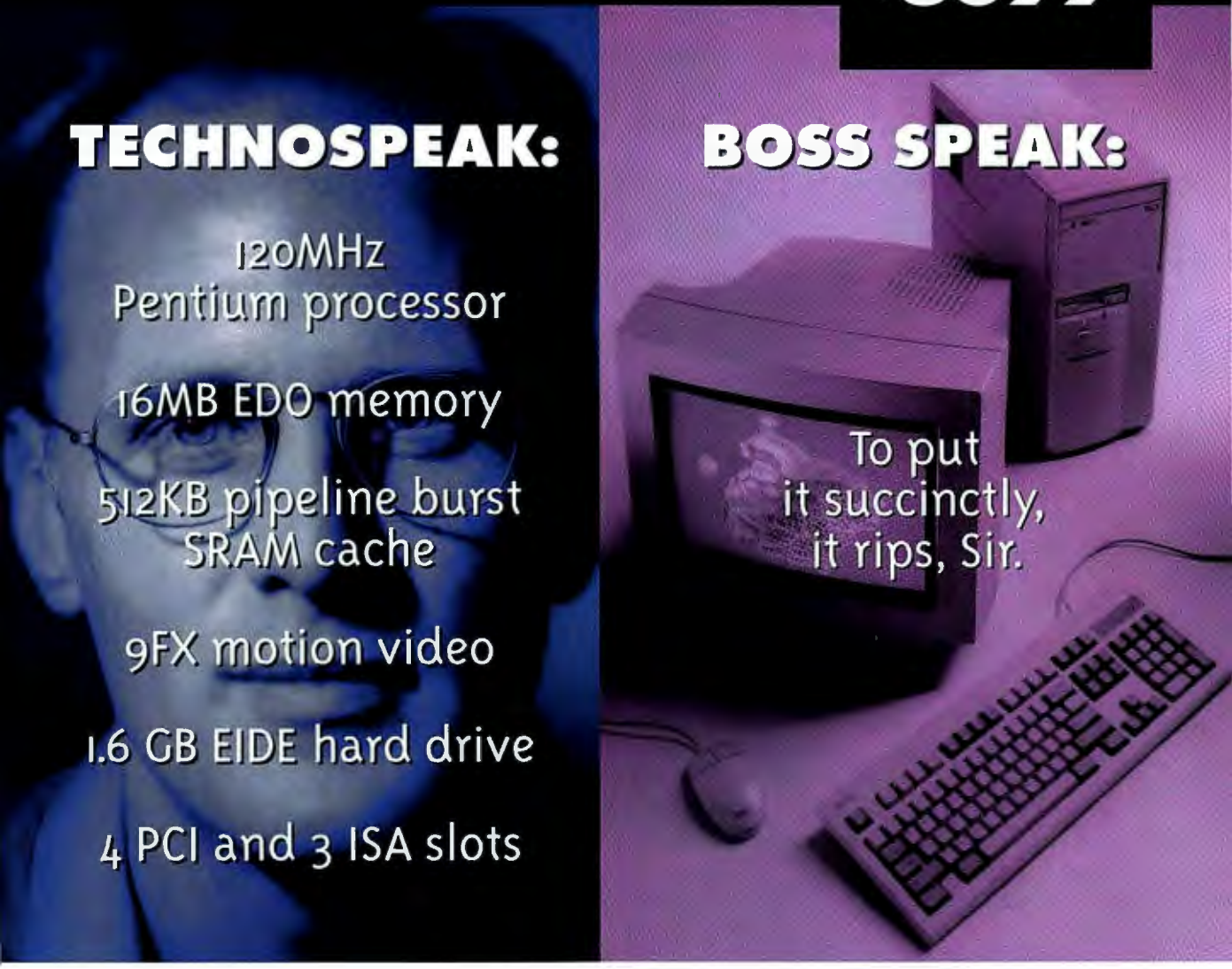

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