

16 BEST PRODUCTS FROM COMDEX!

JANUARY 1996

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Development Extra**
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**Intergraph's Multiprocessor
Pentium Pro Powerhouse**

**Out of the Shadows:
Sun's Ultrafast UltraSparc**

Wired on the Web: Java

BYTE

THE MAGAZINE OF TECHNOLOGY INTEGRATION

#1 WORLD'S FASTEST COMPUTERS

- ✓ **Raw Speed: The 5** quickest computers you can buy
- ✓ **How to use supercomputers in your business**
- ✓ **Intel builds a supercomputer**

PLUS

Technical Analysis: The AMD/NexGen K6



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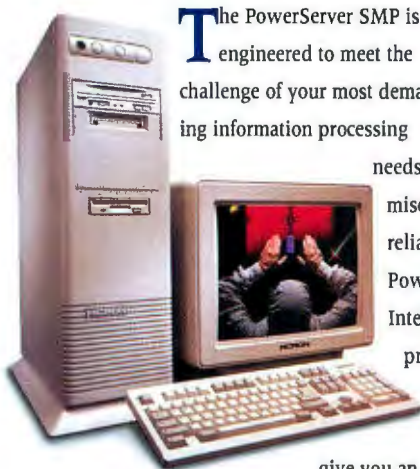
JANUARY 1996

BYTE

SUPERCOMPUTERS • BEST OF COMDEX • COMPONENTWARE

Volume 21, Number 1

QUALITY, RELIABILITY, SERVICE



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- Microsoft Windows® 95 CD



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- PCI 64-bit video, MPEG, 2MB EDO
- Full-size tower with 10 drive bays
- Microsoft Mouse, 104-key keyboard
- Microsoft Windows NT Workstation 3.51 CD



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- Microsoft Mouse, 104-key keyboard
- Microsoft Windows 95 CD
- Microsoft Works 95 CD
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- SoundBlaster 16 stereo sound & speakers
- 14.4 fax/modem, speakerphone, voice mail
- PCI 64-bit video, MPEG, 2MB EDO
- 17" Micron 17FGx, 1280NI, .26mm monitor
- Tool-free mini-tower or desktop
- Microsoft Mouse, 104-key keyboard
- Microsoft Windows 95 CD
- Microsoft Office Pro 95 & Bookshelf 95 CDs
- Microsoft Scenes: Sports Extremes; Microsoft Bob™ CD; Microsoft Encarta™ 95 CD; Quicken® Deluxe Edition CD; Microsoft Dangerous Creatures CD; Microsoft Golf Multimedia CD; Trial subscriptions for CompuServe™, Prodigy™ and America On-Line™.

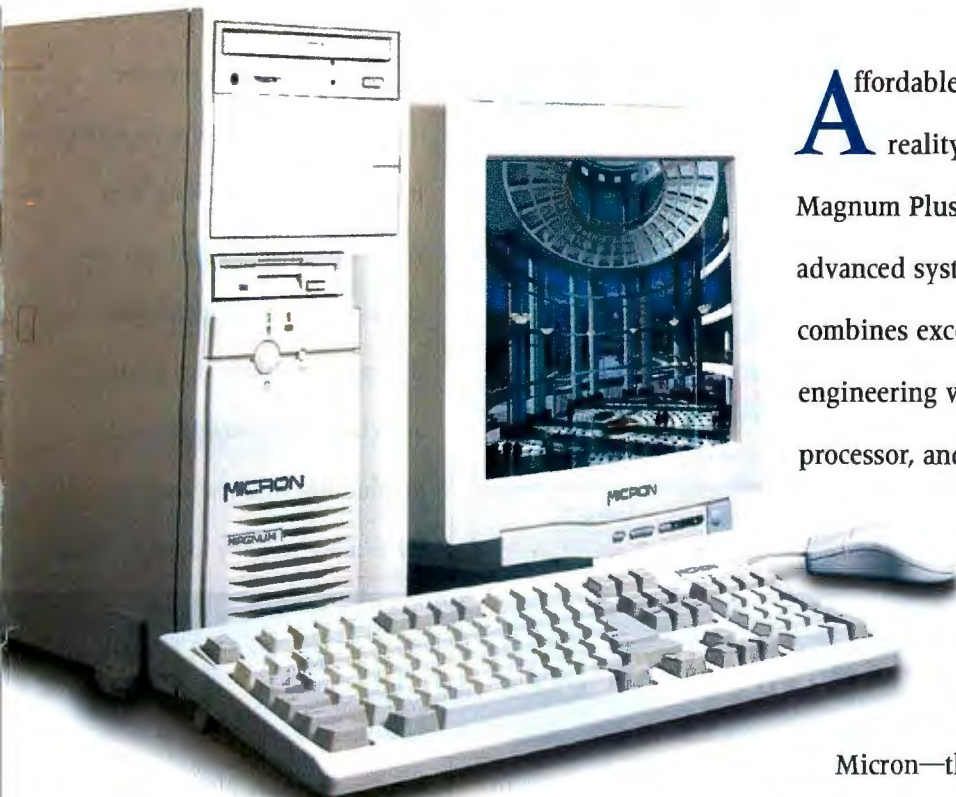
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A person wearing a grey cleanroom suit, a white hairnet, and orange nitrile gloves is holding a blue silicon wafer in front of a red server rack. The server rack has the text "MICRON. THE BEST THAT MONEY CAN BUY." printed on it. The background is dark with a colorful, circular light fixture visible in the upper right corner.

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- PCI 64-bit video, MPEG, 2MB EDO
- Tool-free mini-tower or desktop
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- Microsoft Windows NT Workstation 3.51 CD
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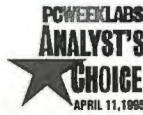
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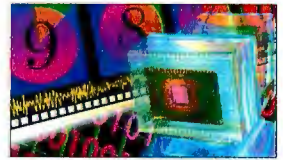
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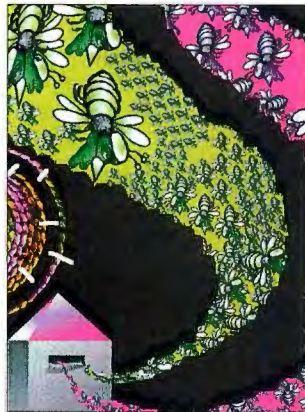
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When you just can't get enough...



Disk space, that is.

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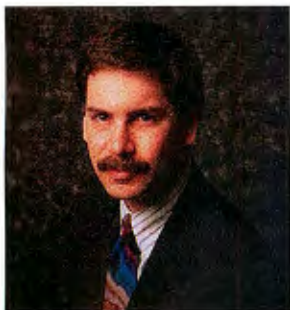


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Web Sites: Don't Blink



From your mind to the Web—it's frightfully easy to build an on-line business. The only dangers: Timidity. Planning. Meetings.

I am in my office at BYTE's headquarters talking to my boss, publisher Dave Egan. He is asking me about the Internet, about this site and that service, grilling me with rapid-fire questions that are making it obvious to me that even my best efforts to keep up with the state of the 'net are not enough. Question, answer, question, answer. Finally I get frustrated and say, "I don't know! I can't keep up!" I put my head down on my desk. And Dave says to me, "My boy," (Dave really talks like that when he thinks he knows something you don't), "My boy, *that* is the definition of opportunity."

I hate to say it (and I never will to Dave), but he is right. On the Internet, business can transcend the physical world. Building equipment and mailing reports gives way to simply posting bits on-line, and the basic rules of commerce change dramatically. Have an idea? From your mind to the 'net—it's that simple. No factories, no offices, no heavy start-up costs required. Take your idea, put it on-line, and see if it sticks.

Some Web business ideas are lousy, of course. In fact, like most small-business ventures, the majority of Web concepts will fail. But you don't know until you try. We recently discovered, however, that there is one way to guarantee the failure of an on-line venture: Wait on it.

True story: We had a great idea. It was unique; it was hot. So we had meetings, we drew up plans, we drafted proposals. Because we first wanted to plan it perfectly, we did not build it. But by the time we were ready to get moving, somebody else had come up with the same idea and implemented it. We lost.

We learned from that experience and have applied that knowledge to our current on-line venture, our Web presence. The BYTE Site (www.byte.com) changes daily. Sometimes the changes are subtle.

In 1 hour, I watched our Webmeister, Jon Udell, implement and refine a totally new interface on our search results page. He created a navigational tool for lists that, in its broadest sense, is similar to a tabbed dialog box—

you really have to see it yourself to understand how well it works.

Sometimes the changes are dramatic, as they are once a month when we post selected stories from the latest issue for all the world to see. And every now and then, we clean house completely, as we did in November, and totally revamp and redesign the site.

But the point is, we've learned. Jon doesn't seek endless planning meetings before he improves the site. He just does it. The only limit to our site's improvements is the speed at which we can think.

And here's what we've thought up: It's called the Virtual Press Room. Jon has been writing about this application for a few months in his monthly feature, the Network Project. Briefly, VPR is an application running on our Web server that lets people in the computer industry—the people who send us baskets of paper press releases every day—submit their releases to us electronically. The concept is simple: A vendor logs on to the VPR and pastes the press release into an on-line form.

Once that is done, a program running on our server full-text-indexes the release and puts it in the database. Any of our editors, including those on the road and in our satellite offices, can scan for releases by company, product, technology area, and date.

If you've visited the BYTE Site, you know that we already have two years of BYTE magazine archived and fully searchable. We now index press releases alongside our archive, so when you look for articles on a topic, you have the option of also seeing the vendor-supplied press releases relevant to your search. We think it's a pretty cool implementation of a simple but powerful idea.

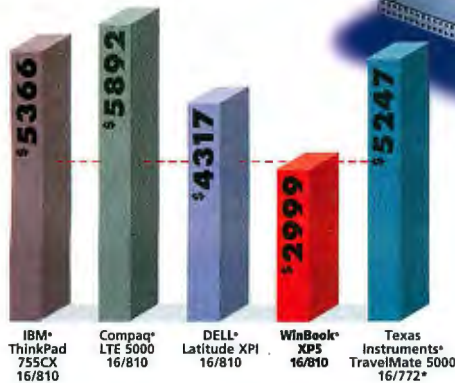
But the important point is that we got this thing up and running quickly and cleanly, without a lot of fuss, because we have a smart guy who likes tinkering with the Web and who understands the business of BYTE's editorial department. Jon will be changing and updating the BYTE Site, and the VPR component of it, frequently. Fortunately, because the application runs completely on our site, we won't have to send out masses of update disks to all the people who regularly use it. We'll just improve the product as we go. So don't blink. ■

A handwritten signature in black ink, reading "Raph Needleman".

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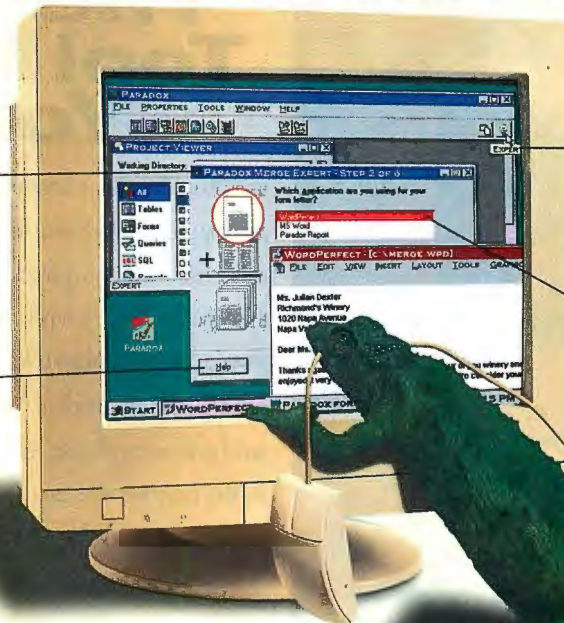
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120MHz \$1795	120MHz \$2395	120MHz \$2795	
133MHz \$1895	133MHz \$2495	133MHz \$2895	
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			120MHz <i>CNI</i> \$4245
			133MHz <i>CNI</i> \$4345
			The above system modified to include:
			<ul style="list-style-type: none"> ▶ 32MB EDO RAM, 256K synchronous SRAM cache ▶ 1.6GB local bus EIDE hard drive ▶ Sound Blaster® AWE32 sound card ▶ ZEOS 17" 1024 x 768 NI SVGA color monitor, .28mm dot pitch

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Circle 80 on Inquiry Card.

The PC Is Dead—Long Live the PC

In "The New PC" (October '95) you talk about general-purpose digital signal processors and native signal processors providing for all the user's multimedia needs. With these new PCs (apparently) not supporting the old ISA standard, will I still be able to add a higher-quality sound card? I worry that this "architectural overhaul" is going to take away my hardware choices, the main reason I own a PC and not a Mac. I don't want PC computers turned into Macintoshes; I want PCs!

Dave Gross
David=Gross%TelCom%InfoSys@
banyan.BV.TEK.COM

New PCs will still allow you to add higher-capability sound cards if you want—just as Macs do today. The idea is to deliver a machine with a built-in repertoire of multimedia features that is standardized across the industry so software developers can rely on it being there. New PCs won't rob you of any flexibility, but they will make life much easier for the majority of users and developers.

—Tom R. Halfhill, senior editor

I enjoyed "The New PC" cover story in the October issue. While I doubt that the PC as we know it is "dead," I can certainly appreciate your point of view with the advent of new and breaking technology. Send my compliments to the photo people who got the picture of the Apple Sweep. Now that's my next PC!

Scott Bittick
scott_bittick@commonlink.com

I'd like to have an Apple Sweep, too. But I have a feeling that prototypes such as the Sweep are like the concept cars in Detroit: They're cool, but when you try to buy one, you end up settling for something that looks more like a box.

—Tom R. Halfhill, senior editor

Buried Gold

Your articles on data mining (State of the Art section, October) were wonderful! As

a chemical-engineering consultant, I couldn't help but wonder if these techniques have been explored by chemical companies to "mine" information from the teragigadodecahedrabytes of data collected by on-line process-control systems. Most of this information is stored in some form but is almost never analyzed unless something goes wrong. Then, employees scramble to try to figure out what happened by reviewing huge data caches. Almost always, they are overwhelmed by the sheer volume of data and give up on using their own process information. Thanks for a thought-provoking article.

Gary S. Huvad, Ph.D.
hrc@i2020.net

Data mining is a nascent field, and the first set of experimental systems are just beginning to see the light of day. I don't know of any applications specifically applying DM to process-related problems. The closest I've heard of is an application developed at NASA-Ames. It uses DM to mine RAS spectrometer data to diagnose Space Shuttle main engines. The developers presented a paper at the First International Conference on Knowledge Discovery and Data Mining (KDD-95) this past summer.

—Sara Hedberg

Blasts from the Past Returns in the Present

The "Blasts from the Past" column that you've had over the last year was a lot of fun. I think it helps keep things in perspective when we are able to look back and see how far we've come—and how far we have to go!

Bob Penhale
bpenhale@mortimer.com

A lot of people want Blasts back. It returns in this issue's News section.

—Eds.

Where's the Mac?

I read the November BYTE Special Report on "today's and tomorrow's" operating systems and was very surprised to find no mention of the Macintosh OS. Have you guys finally become a totally Wintel-oriented rag?

Roger Vossler
Boulder, Colorado
vossler@csn.net

Of WAIS, WebSite, and Windows NT

I have been traveling the same road as you: text searching via NT-based Web servers. I wish I had read "Web Search" (Network Project, September) before I began my journey. Like you, I have been evaluating Purveyor and WebSite. For simple document archives, both are sufficient. But what if you wish to be able to search different indexes? WAIS allows multiple indexing, and the <isindex> pages can have different names. WebSite's WebIndex tool is very easy to use, but you can have only a single global index. I was not able to use a <isindex> search page via WebSite. Is there a fix to these limitations?

Robert Goldschmidt, Ph.D.
National Institutes of Health
rggoldschmidt@nih.gov

You can run freeWAIS in conjunction with WebSite. In fact, that's just what I'm doing with our Virtual Press Room, for two reasons: the multiindex feature you mention (I have a VPR+BYTE index, and a separate VPR-only index), and incremental indexing with freeWAIS. WebSite's WebIndex and WebFind tools are based on Simple Web Indexing System for Humans (SWISH), but SWISH itself is more flexible than are WebSite's bundled versions. I've run SWISH on Unix but don't have it for NT yet.

—Jon Udell, executive editor

I find your Web site to be very nicely done and very responsive for a poor guy using a 14.4 modem. Keep up the good work. Now for the brickbat. In your 20th Anniversary section (September), you mention the IRMA board as one of the most important networking products. The picture in your magazine (page 80) and on the Web site (<http://www.byte.com/art/9509/img/505043el.htm>) is not an IRMA board. It appears to be a token-ring board, possibly the ill-fated IRMAtrac adapter.

Stephen Johnson
sjohnson@mindspring.com

Oops. Thanks for spotting that. The nice thing about the Web is that at least we can reverse such errors.

—Jon Udell, executive editor

We want to hear from you. Address correspondence to Letters Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458; or you can send E-mail via the Internet or BIX to editors@bix.com. Letters may be edited.

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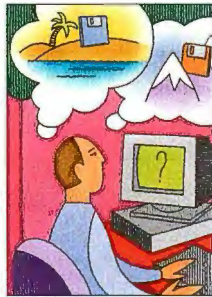
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The Real World

Finally, the promise of a technology to bridge the classic Academics vs. Pragmatics gap! Alexander Steparov's "Standard Template Library" (October) provides the missing link. Most working professionals realize that while the popular journals describe how the Ph.D.s in their laboratories are evolving the latest algorithmic advancements using bleeding-edge superworkstations, most production programmers are coding the binary search or quick sort for the thousandth time on the minimal cost-effective hardware of the real world. Congratulations on brilliantly concise yet rich coverage of this important topic.

Sing Li
sing@well.com



Ugly X Window

I take exception to Tom Yager's statement ("OS Paradise," November) that X Window is ugly. Is he referring to the existing GUIs on top of X Window or to the architecture? If he is comparing to NeWs or NextStep, then there can be a lively discussion about it. But if his comparison is with Microsoft Windows, then he doesn't know what he is talking about. You can implement any GUI toolkit (including Windows and the Macintosh GUI) on top of X. Try doing this with Microsoft Windows (in all its different flavors). I would prefer the Common Desktop Environment (CDE) over Windows 95 any day. If you want a slick interface, try SGI's DeskView. Lest readers think I am unduly biased toward X, I have a few bones to pick with X, but I guess I have the entire skeleton to pick with Microsoft Windows.

Harish P. Hiriyanaiyah
harish@infosoft.com

I've used and programmed under X Window far longer than under Microsoft Windows. While I'll confess to being a fan, X Window's support for commercial applications is still sadly wanting compared to Windows or Macintosh. Pick either of the most widely used toolkit layers—OSF/Motif or Open Look—and check out any complex element (the standard File Open dialog box, for example) that also exists in Windows. The Motif version doesn't measure up to Windows' when viewed from any perspective: look,

feel, or API. CDE is gorgeous, but it doesn't fix toolkit-level issues. I use X Window every day, but when I run commercial applications, I run them on a Windows system. There are reasons we find far more mainstream applications for Windows than Unix. X Window is one of those reasons.

—Tom Yager
tyager@maxx.net

Linux Fan Club

"The Linux Phenomenon" (November) implies that Linux, FreeBSD, and NetBSD are difficult to use. I have installed and used Linux, commercial Unix, and OS/2, and I can say that Linux is no more difficult than the others.

Ken Sinner
ksinner@solaria.mil.wi.us

Your "OS Paradise" article was very informative. However, I was disappointed to see that Linux was not given the same treatment as other OSes in the article. We are running the largest UUCP network in Pakistan on Linux machines. Our gateway machine, a 486 DX2 with 16 MB of RAM, running Linux 1.2.13, caters to more than 650 UUCP nodes. It has never crashed and has served all our needs.

Wajihuddin Ahmed
Islamabad, Pakistan
wahmed@sdpk.undp.org

We'll give Linux a thorough road test in our Unix Special Report in the February issue.

—Eds.

DavyCrockett@alamo.com

What thrills me about Ted Nelson's Commentary (November) is his sarcastic, yet fearfully realistic, comment regarding "something like the Clipper chip." Nelson warns this kind of technology will allow the government total power because "we'll all be breaking the big, vague new law against everything." Sadly, the Internet might become the next Alamo.

Ted Gaunt
tgaunt@ford.com

Fixes

Atlantic Systems Group's E-mail address, which appeared in "Internet Firewalls" (October, page 180), was incorrect. The correct address is sales@sg.ubn.ca.

Due to typographical errors, we expressed SCSI throughput in Mbps rather than MBps on page 60 of "The New PC" (October).

The reference to "1000 SPECfp95" in "CPU Scorecards" (November) was a typo. We meant to say SPECfp92. SPEC95 numbers are smaller than SPEC92 when measuring comparable performance. ■

COMING UP IN FEBRUARY

• BYTE AWARDS

BYTE editors pick the best products of 1995.

• INTERNET BROADCASTING

Who cares about 500 channels on your TV? How about access to an unlimited number of channels through the Internet? We look at who's doing it and what technologies make it possible to send text, graphics, audio, and video over the Net.

• AN AVATAR?

If you think Microsoft's Bob is a strange user interface, wait until you see the avatars, bots, and characters coming next. Will experienced users accept cartoons on their screens?

• WHAT'S NEW WITH UNIX

BYTE's next Special Report covers Linux, Spring, developing portable applications, and using TCP/IP.

• CORE TECHNOLOGY

How do you manage IP addresses when Windows 95 and Internet-access software are putting IP stacks on most desktops?

• FIRST-FLIGHT PENTIUM PRO SYSTEMS

The BYTE lab runs a battery of benchmarks on new Pentium Pro boxes from ALR, Dell, Digital, Gateway, HP, and Intergraph.

• NETWORK PROJECT

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NEWS & VIEWS

INTERNET WEB BROWSERS

How the Web Will Change Computing

Browsers and dynamic interpreted languages like Java enable developers to write client/server applications that are inherently multiplatform

STEVEN J. VAUGHAN-NICHOLS AND RACHEL SCHMUTTER

Web browsers, those graphical front ends to the Internet, are multiplying faster than bunnies on a rabbit farm. As fast as they can, software vendors are adding Internet connectivity to their programs.

Fax-software vendors like Delrina have added browsers and other Internet connectivity programs to their communications suites. Lotus Development's integrated InterNotes Web Navigator browser in the new version of Notes Release 4) merges Notes- and Web-based data. Other software developers are upgrading their word processors, document managers, and even CD-ROM programs with Internet connectivity.

Internet mania is more than a fad, however: It marks the beginning of what many analysts feel is a fundamental shift in how we compute. "The browser will increasingly be the user's interface to the corporation and the world," says Dennis Freeman, marketing director at Frontier Technology (Mequon, WI), an Internet-software developer.

The latest version of the Navigator Web browser from Netscape (Mountain View, CA; (415) 254-1900; <http://home.netscape.com>) typifies this trend. Navigator 2.0 provides a wealth of new features (see the screen), but one of the most important is its support for the Java programming language from Sun Microsystems. Java lets developers of Web servers extend the

capabilities of browsers beyond merely viewing information. A Java-enabled Web browser can download programs, called *applets*, such as data-entry forms, spreadsheets, animations, and graphics. Any client, provided it runs a Java-enabled browser, can access the Java application (for more information on Java technology, see "Wired on the Web," page 77).

Netscape's Navigator is the most popular Web browser (various estimates give it about 70 percent market share), and version 2.0 will be available for the Mac, Windows, and Unix. The company's lead in the Web browser field lets it promulgate extensions to HTML, the Hypertext Markup Language used to create Web pages, and to add new functionality such as the fast loading of low-resolution images and real-time chat to home pages. Other capabilities like fully threaded newsgroup reading and NetScape's Secure Sockets Layer for secure transactions, which other commercial companies can license, illustrate how Netscape is becoming much more than a mere vendor of browsers.

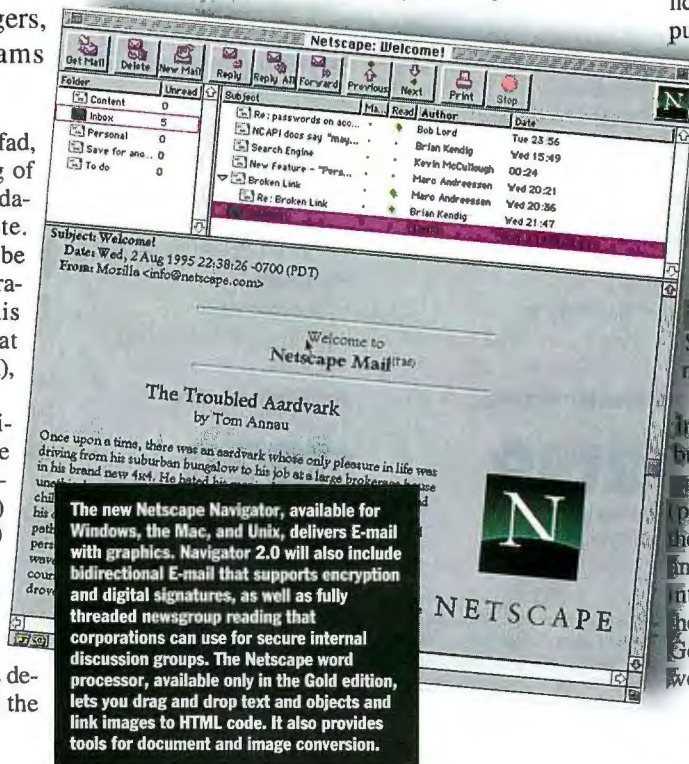
"Netscape is not trying to build Web browsers or Web servers, it's trying to build an infrastructure to support public and private distributed computing," says Jeremy Allaire,

president of New World Media (Minneapolis, MN), a consultancy specializing in on-line systems and the Internet. "Netscape is building an operating system."

Netscape's browser isn't the only one that will support Java. Other browsers, including ones from Spry and Sun, will also support the new language.

Web browsers are changing in other ways. A more robust version of Netscape's program, called Navigator Gold (priced at about \$79), breaks the boundary between browsers and HTML authoring tools by integrating a WYSIWYG authoring environment. Navigator Gold also provides you with a word processor.

Meanwhile, other browser



Intel Beats the Clock ... Again

developers continue to improve on the Web's built-in hyper-linking capabilities. The SlipKnot 1.13 browser from MicroMind (slipknot@micromind.com) for Windows and OS/2 downloads data from all local HTML links (i.e., links specific to a given Web site) to your system in the background. This allows you to get a broad view of a Web site either on- or off-line. Spyglass and NCSA are adding a similar feature to their browsers, but SlipKnot lets users pick and choose what links they want downloaded.

As browsers encroach on the turf of traditional applications such as word processors, as well as that of tools for developing custom front ends, companies like Microsoft are adapting. For example, Microsoft is investigating ways in which Visual Basic can act as a front-end development tool for the company's Internet Explorer 2.0. The company is also developing an electronic publishing tool (known as Blackbird) for the Microsoft Network and the Web.

Internet connectivity is important, agrees Chris Flores, Microsoft's product manager for Visual Basic. But he also says the Internet is just another extension for Visual Basic, which is a popular tool today among corporate developers for creating custom front ends. More than 1000 custom controls are available for Visual Basic developers today, Flores says, and several companies are developing controls for Internet access. However, Visual Basic is not a strong cross-platform solution thanks to Microsoft's Windows-centric strategy: There's no Visual Basic for the Mac, and few, if any, OLE Controls that will run natively on the Macintosh.

Netscape faces formidable competition but is ahead of Microsoft and other developers in building the ultimate TCP/IP network tool interface, says New Media's Allaire. Furthermore, Netscape is doing so at the application level for three major end-user operating systems: DOS/Windows, MacOS, and Unix.

Intel's surprise rollout of its 200-MHz Pentium Pro (aka the P6) processor will force its competitors in both the RISC and CISC camps to play catch-up this year. Most industry insiders expected Intel to release a 150-MHz, 256-KB-cache version of the Pentium Pro for desktop PCs and workstations in 1995, then follow with a 166-MHz, 512-KB-cache version for servers in the first quarter of 1996.

Instead, Intel is releasing those chips as scheduled, plus 180-MHz and 200-MHz versions during this quarter. (Both will have 256-KB cache and, like the 166-MHz Pentium Pro, will be built on Intel's .35-micron manufacturing process.) Intel will also release a 200-MHz, 512-KB-cache Pentium Pro in the second quarter of this year.

Intel experienced better-than-expected yields with its .35-micron process, which helped accelerate the release of the 200-MHz processor, company officials said. Several PC manufacturers told BYTE that the early availability of the 200-MHz version was a pleasant surprise. Intel's competitors were probably not as pleased: BYTE's cross-platform CPU benchmarks indicate that the 200-MHz Pentium Pro delivers 2.8 times the integer performance of a 90-MHz Pentium, and about 3.5 times the floating-point performance.

The 200-MHz Pentium Pro will show up in the kinds of workstations typically powered by RISC CPUs. Peter Lowber, senior analyst for workstations and servers at Datapro (Lexington, MA), says the 200-MHz Pentium Pro undermines the RISC value proposition. Although Digital, SGI, and HP will likely surpass Pentium Pro performance when they release new chips this year, Lowber says the RISC vendors must demonstrate substantially superior performance over relatively inexpensive Intel solutions.

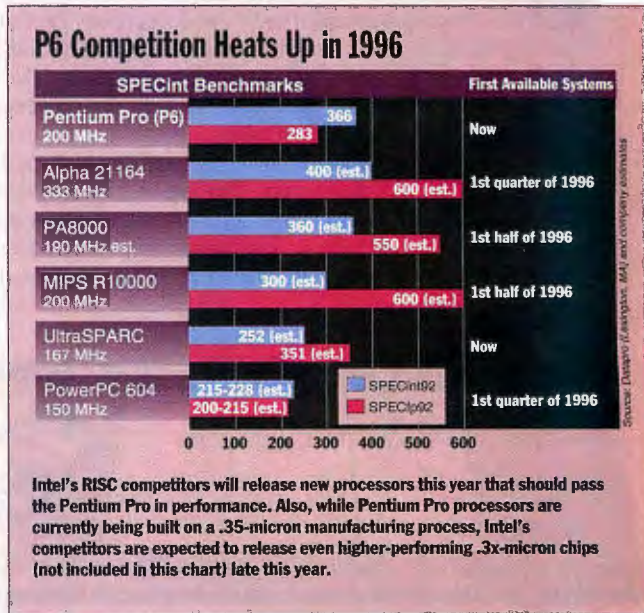
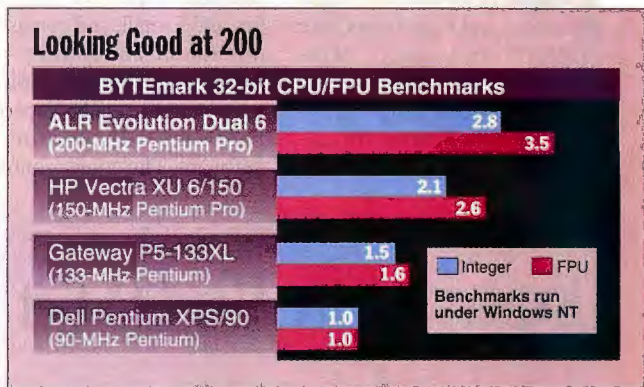
The news is worse for Intel's x86 competitors, AMD and Cyrix. AMD, which recently acquired NexGen, and Cyrix both sell Pentium-class processors now and won't ship Pentium Pro competitors for running 32-bit software before the end of this year. Meanwhile, Intel's Pentium prices have plummeted. A 200-



The 200-MHz twin-Pentium Pro Evolution Dual6 from Advanced Logic Research typifies the new breed of relatively inexpensive PCs that will compete with Unix workstations. Prices for this system, which comes with one or two Pentium Pro processors, start at \$3495 with 8 MB of ECC memory. (ALR, Irvine, CA, (714) 581-6770; fax, (714) 581-9240; <http://www.alr.com>)

MHz, 256-KB-cache Pentium Pro sells for \$1325 (in quantities of 1000); a 75-MHz Pentium costs just \$158 (the 60-MHz Pentium originally sold for \$878). "I think Cyrix and AMD will have problems," Lowber says. "They're playing catch-up again."

—Dave Andrews



PERSONAL SCANNERS

Better Tools Reduce Paper Clutter

Personal scanners are going to become easier to use, be able to capture color images, and be less expensive. First made popular by Visioneer (Palo Alto, CA) and its PaperPort hardware/software system for Windows and the Mac, personal scanners typically integrate OCR, archiving, annotation, and other software tools with a small sheet-fed scanner.

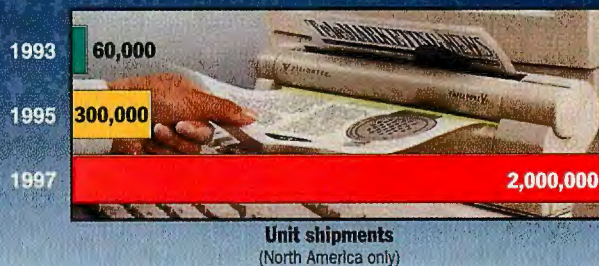
Personal scanners will soon offer more extensive support for color. Many products already let you add existing color images to a black-and-white document, but PageScan Color (\$399) from Logitech (Fremont, CA) also lets you scan and capture color images at 24-bit resolution. Support for color capture will become more

important as inexpensive color printers increase their penetration into businesses, analysts say. PageScan Color can also capture images at 8-bit gray-scale resolution. You can detach its scanning head to scan bound material or book pages.

Another new entry, PaperEase (about \$249) from Primax Electronics (Sunnyvale, CA), comes with an automatic document feeder, which can handle up to 10 sheets at a time. PaperEase integrates with most Windows applications (a Mac version is planned for the first half of this year), including fax and E-mail, and comes with document-annotation and archiving software. You can fax directly from the PaperEase hardware without using fax software. The copier controller

Personal Scanners

Personal scanners fit on the desktop and are designed for individual use. They offer lower-resolution scanning than flatbed scanners because their prime focus is document management, not professional desktop publishing.



in the scanner lets you enlarge, reduce, crop, and change the brightness of scanned documents. PaperEase currently scans at up to 400 dots per inch (dpi) and 256 levels of gray (8-bit gray-scale). Primax says it will have a model that can capture color in the first half of this year.

Visioneer's latest unit, the new PaperPort Vx (about \$369, available for Mac or Windows), offers an enhanced hardware and software system. It's easier to install, it's faster, and it supports 8-bit gray-scale images, the company says. New SharpPage technology automatically focuses and cleans up scanned images to provide more accurate OCR or higher-quality faxes, according to Visioneer. Maximum scanning resolution will be 400 dpi. The Vx will connect to either the serial or parallel port. Visioneer wouldn't confirm that it will release a color version during the next 12 months, but a company official says it is reasonable to expect one.

A new entry from Hewlett-Packard, the 4S, is about the same size as Visioneer's original PaperPort and uses Visioneer's PaperPort

3.0 software. HP's 4S doesn't support color capture. At \$349, it's almost as expensive as the color Logitech unit, but analysts say HP's entry will further legitimize this market. HP will offer the PaperPort software with its flatbed scanners so users can get the functionality of the integrated filing and OCR with any HP scanner.

Look for increased improvements in ease of use and lower prices, says Kristy Holch, who tracks image-capture products for BIS Strategic Decisions (Norwell, MA), a market research and consultancy firm. MicroTek (Redondo Beach, CA) already sells its PageWiz bundle, which offers 8-bit gray-scale scanning, an automatic document feeder, and other features, for just \$199. The company is also developing a color version. Holch says ease of use will be a critical factor in a personal scanner's success.

"Conventional things like image quality, bit depth, and high resolution that are often used to differentiate professional flatbed scanners are not the issue here," she says. "The whole thing has to be easy and automatic." —Jon Pepper

CUSTOMER SUPPORT

Expert Advice Hard to Get

Use of expert systems at help desks is declining, despite these systems' potential and value for support. That's the assessment of the annual survey of help-desk and customer-support practices conducted by the Help Desk Institute. The report says a major barrier is the cost of implementing an expert system, which typically requires personnel to feed the expert engines. Increasing demands on support staff make it hard to free up time to feed the system. But use of expert systems may increase in the future. Some support programs now have cognitive engines that learn as you log problems and requests. And vendors are teaming with providers to supply preloaded knowledge bases.

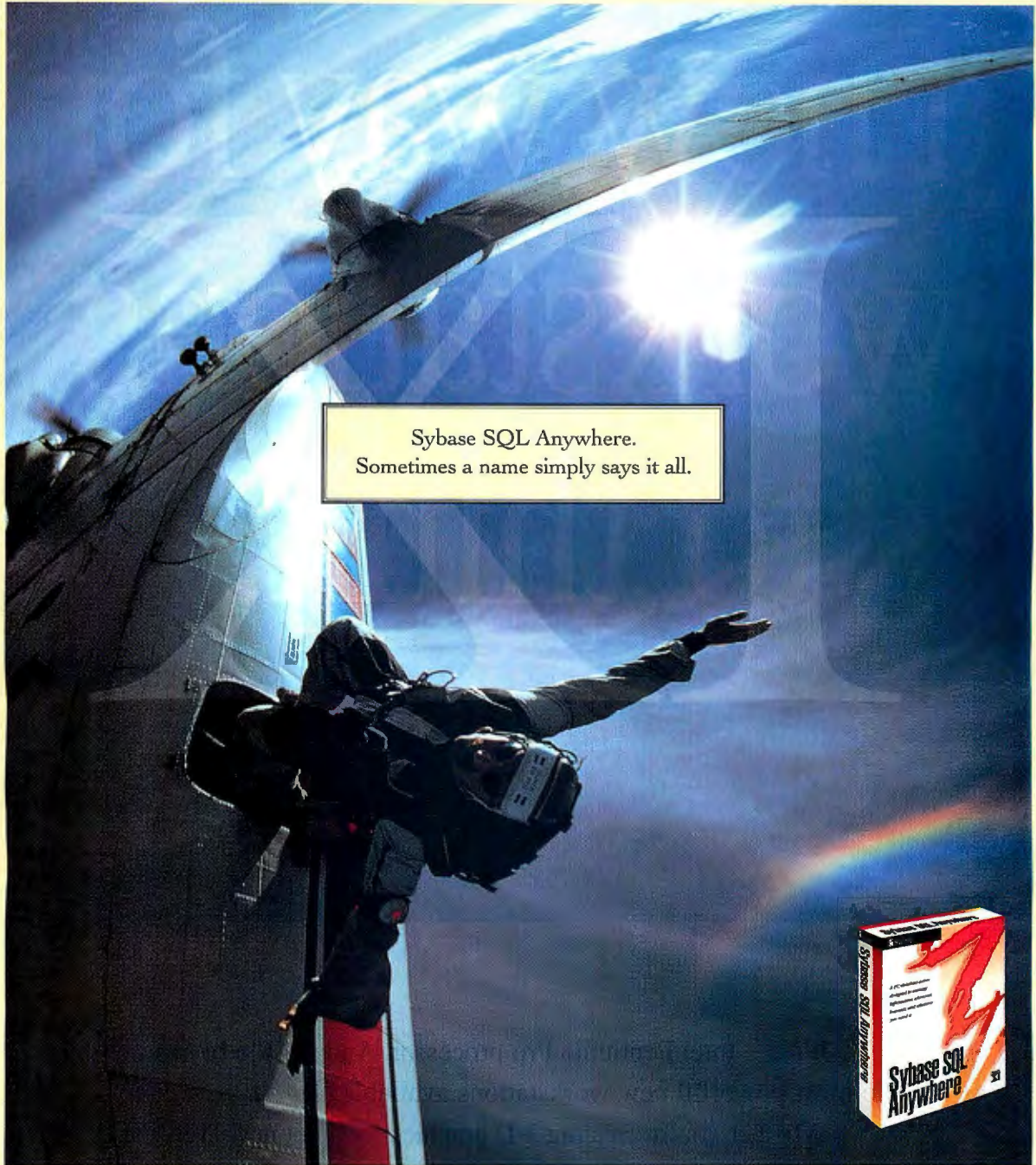
Percent of Help Desks That Use Expert Systems



Source: Help Desk Institute (Colorado Springs, CO)



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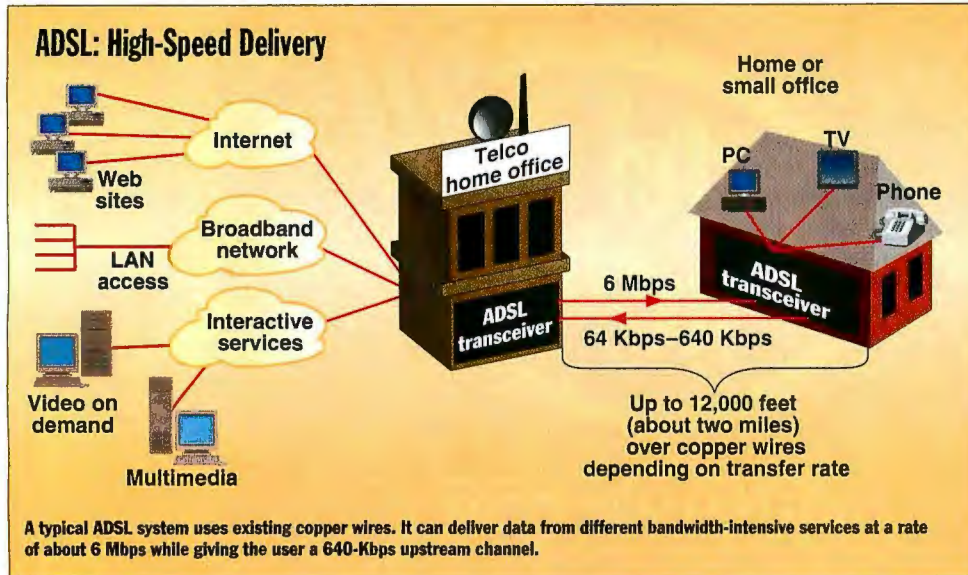
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Higher Data Speeds Coming for Plain Phone Lines



New technology promises to add life to the ubiquitous plain old telephone system. One technology, called asymmetric digital subscriber line (ADSL), is an intriguing solution for Internet access, video on demand, and videoconferencing. Unlike a related technology called high-bit-rate digital subscriber lines (HDSL), which supports equal transmission rates (typically 1.5 or 2 Mbps) both upstream and downstream to the user, ADSL delivers much higher bandwidth downstream than upstream. Telephone companies and information providers will use ADSL—with existing phone lines—to deliver high-speed services to the home or the small office.

ADSL uses digital signal processing and multiplexing techniques to deliver between 9 and 10 Mbps of downstream data over existing copper phone lines (typical systems will offer about 6 Mbps). This is much faster than V.34 modems, which offer 28.8 Kbps, and ISDN, which offers 64 Kbps (or 128 Kbps if you

combine the two B channels of a Basic Rate Interface line). Cable modems offer comparable 10-Mbps data delivery rates but require coaxial cable to run into the home or office. Cable modems may also suffer performance degradation as the number of users increases, but ADSL is a point-to-point solution that shouldn't suffer from decreased performance.

ADSL and HDSL devices plug into a regular phone line like a modem, but unlike traditional modem technology, two people can't each just buy a modem and dial each other up. Transceivers must be installed at the users' premises and at the phone company's central office (see the figure).

In addition to supporting high-transmission rates to the user, ADSL can sustain speeds up to 640 Kbps upstream, a transmission rate suitable for sending commands to control a movie on demand. Similarly, you can use the upstream channel to send commands to Web pages and to take advantage of ADSL's ability to transmit graphical images at a high-

er bandwidth downstream.

At last year's CeBIT show, Orckit Telecommunications (Tel Aviv, Israel) demonstrated the transmission of MPEG-2 video from an NTSC videotape player at 8 Mbps downstream and 640 Kbps upstream using a pair of ADSL modems. (A 6.2-Mbps downstream link can support four channels of compressed MPEG video.) At the Telecom '95 show in Geneva, many companies demonstrated new ADSL equipment and applications.

Aware (Bedford, MA) and Analog Devices (Norwood, MA) have codeveloped a chip set for Aware's ADSL Internet Access Transceiver. The transceiver delivers slightly more than 6 Mbps downstream and 224 Kbps upstream over a distance of 12,000 feet between the transceivers (data rates of up to 8 Mbps can be achieved over shorter distances).

Until recently, HDSL required two or three pairs of copper wires (ADSL requires one pair). But Orckit and Metalink (Tel Aviv, Israel) have announced HDSL chips that re-

FASTER ADSL

The next generation of ADSL promises to deliver even higher bandwidth over existing copper phone lines. Several semiconductor manufacturers, including Analog Devices and Motorola, have developed signal-processing chips for a version of ADSL that will operate at 25 or 51 Mbps. However, delivery at these speeds will be over shorter distances than with other implementations—about 4000 feet for 25-Mbps transmission and 1000 feet for 51-Mbps.

The faster versions of ADSL will be used in fiber-to-the-curb projects currently being deployed by telephone companies. Such systems offer higher bandwidths by bringing fiber-optic cabling to the curb of a home or business and then using the existing copper connection to get from the curb to the building. —S.S.

quire just a single pair of copper wires. Analysts say that HDSL's limited downstream bandwidth makes it less attractive for Internet access, but these improvements should strengthen HDSL's position as a more efficient alternative to today's T1 lines. ADSL will enable the telephone companies to deliver entertainment services. And using both ADSL and HDSL, they'll be able to provide PC services, such as access to remote LANs and the Internet.

—Salvatore Salamone

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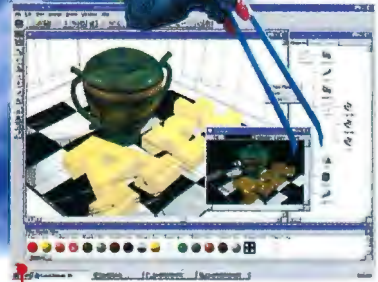
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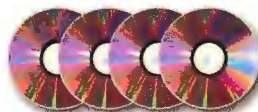
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PERSONAL DIGITAL ASSISTANTS

PDA Vendors Improve PC Links

More robust links to PCs and Macs will strengthen the connectivity of PDAs to desktop applications. Analysts don't think this improved connectivity alone will make PDAs a household item—long battery life, a seamless interface with wireless services, and the ability to fit in the pocket are also important—but they say it is critical.

Officials at several PDA companies admit that their first iterations of PDA-to-PC connectivity solutions were limited, despite indications that connectivity was a high priority among PDA users. A study conducted by BYTE in 1994 showed that 89 percent of users felt that the ability to automatically synchronize

their PDAs with their desktop PC files was either somewhat or very important; they also wanted to be able to send and receive E-mail and faxes (see News and Views, June 1994, page 34). Now those improved connectivity solutions are either available or under development.

Developers are also adding PDA-to-Internet connectivity. For example, AllPen (Los Gatos, CA; 415 399-8800), a developer of Newton OS applications, will release Web browsing software for Newton-based applications this year. Although the software won't initially support graphics, it will let you upload and download information through HTML forms.

"Handwriting recognition is not the PDA's killer application," says Jon Hulak, senior analyst at BIS Strategic Decisions (Norwell, MA). "What's more important to people is the ability to synchronize basic two-dimensional database information found in personal information managers. That's critical information, and it's constantly changing."

The PDA-to-PC connectivity programs are improving, but they could be better, says Ed Colligan, vice president of marketing at Palm Computing (Los Altos, CA), which develops PDA applications. "Synchronizing

your PDA with your personal computer needs to be as simple as pushing a button." —D.A.

Blasts from the Past

5

Years Ago
in BYTE

386 replicant on the loose. AMD finally unveiled its clone of Intel's 386. We

correctly noted that users everywhere would benefit from the competition in the PC CPU arena. Also, Rich Seifert, coauthor of the Ethernet 1.0 specification, celebrated the 10th anniversary of the standard by asking BYTE readers to imagine a world without networks. A world without the Internet? We might as well imagine a world without politics or religion.



10

Years Ago
in BYTE

Apple's long-awaited Japanese-language version of the Macintosh, called the DynaMac, made its debut to favorable reviews. It featured

512 KB of RAM and Kanji installed in ROM, and it wasn't available in the U.S. The Kanji Mac was apparently a smart move. Japan is now Apple's second-largest market (behind only the U.S.), the company says. Apple Japan made \$1.8 billion in revenue in its latest fiscal year, up 48 percent over the prior year.

15

Years Ago
in BYTE

No-pen PDA precursor. We checked out a new hand-held computer developed by Matsushita and Friends Amis and sold by Panasonic and

Quasar. The 14-ounce unit featured a 159-column by 8-row LCD display, 2 KB of programmable memory (expandable to 4 KB internally), and 16-KB internal ROM with four sockets to hold ROM applications. An acoustic-coupler modem was optional. We said that with a little practice, the small 65-key keyboard wasn't a distraction (but our fingers, like our waistlines, were smaller then).

New PDA-to-PC Solutions At a Glance

APPLE COMPUTER'S MESSAGEPAD
Import/export, backup/restore, for PCs and Macs. Newton Press creates read-only versions of Mac and PC documents for Newton 2.0 OS. Pass-through connection utilities to use Mac or PC keyboard to enter information into Newton 2.0 device available now. Integrated and third-party E-mail connectivity (via on-line services and corporate E-mail systems). Synchronization directly within popular personal information managers now and future applications via Apple's Desktop Integration Libraries.

HP'S OMNIGO, 200 LX

Numerous third-party connectivity programs for the 200 LX, including PalmConnect for backup/automatic synchronization. Remote E-mail access for 200LX, OmniGo. Optional connection for 200LX-based hand-held to digital wireless voice/data GSM network slated for first quarter '96.

PSION'S SERIES 3A

Backup/restore for PCs through third parties. File translation over serial or parallel connection supported in PsiWin for Windows. E-mail connectivity this year.

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INTERNET ACCESS

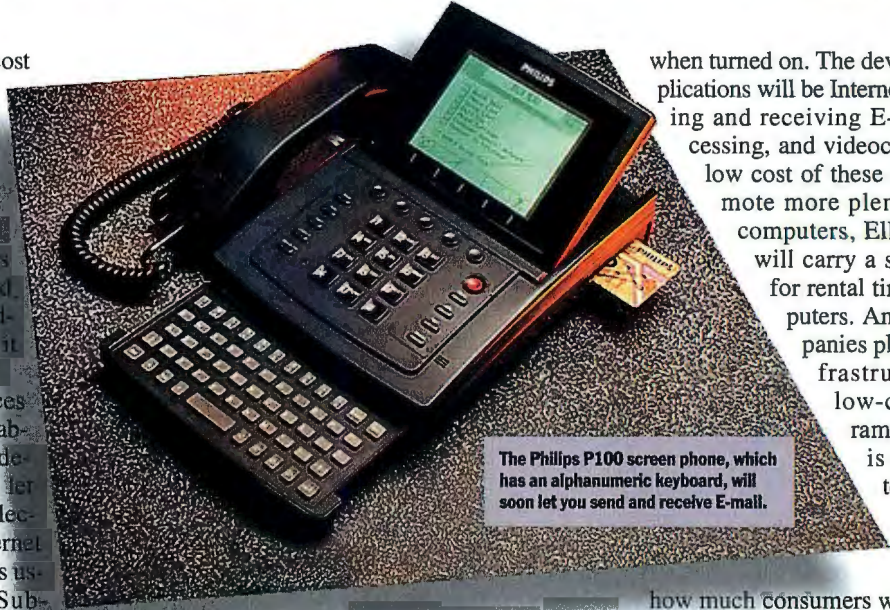
Coming: Thousands of Internet On-Ramps

A new class of low-cost devices may soon replace the personal computer as the most common method of getting on the Internet. The phone companies, as well as major database vendors like Oracle (Redwood Shores, CA), are providing new ways to make it easier to access the Net.

Philips Home Services (Burlington, MA) is collaborating with Oracle to develop a system that will let you send and receive electronic mail over the Internet and other E-mail systems using a screen phone. Sub-

scribers will receive a Philips P100 screen phone (see the photo), which has an alphanumeric keyboard, and their own E-mail account. Paul Chapple, a spokesman for Philips, says that although the P100 costs about \$399, that price will drop to \$300 later this year and will probably fall to \$200 in 1997.

Such a phone will have numerous advantages over a PC, Chapple says, including lower cost, faster boot-up, and smaller size. You could use it in your kitchen or living room to tap into services ranging



The Philips P100 screen phone, which has an alphanumeric keyboard, will soon let you send and receive E-mail.

from electronic banking, shopping, E-mail, and, of course, for conversing.

The Internet-enabled screen phone does not compete directly with a PC, Chapple says. "You're not going to use a screen phone to manipulate large amounts of data," he says. "Instead, we see it as adding PC functionality to the telephone."

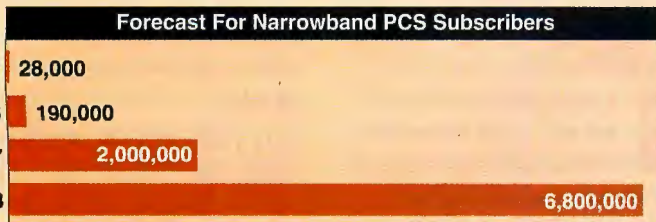
At the recent Telecom '95 show in Geneva, Oracle CEO Larry Ellison described a \$500 computer that would contain almost no software and would download its operating system and applications

when turned on. The device's primary applications will be Internet browsing, sending and receiving E-mail, word processing, and videoconferencing. The low cost of these devices will promote more plentiful networked computers, Ellison says. Users will carry a smart card to pay for rental time on these computers. And cable TV companies plan to use their infrastructure to deliver low-cost Internet on-ramps. This approach is currently being test-trialed in parts of France.

One variable still unknown is how much consumers will have to pay to hop on the Internet over these low-cost devices. Philips says it hasn't determined if it will bill subscribers at a flat monthly rate or on a per-call basis. Officials at AT&T, which plans to roll out a dial-up Internet access service this year, say they haven't determined their pricing structure either. The company does plan on having more than 200 access points to give as many users as possible Internet connections without having to pay additional long-distance phone charges.

—Dave Andrews

TWO-WAY PAGERS: THE NEXT PDA?



Source: Dataquest (San Jose, CA)

SkyTel (Washington, D.C.) is offering two-way paging service in the U.S., and others are expected to follow this year. SkyTel says it will continue to expand coverage of its personal communications service (PCS) beyond the 1300 cities currently supported. Analysts predict that as the hardware shrinks, and links to personal computing improve, this product category should see tremendous growth.

Two-way Pagers Today

SkyTel Pager (\$399), service starts at \$25/month; 5.5 ounces; several weeks of power on AAA battery; receive messages of up to 500 characters; 15-character responses, or 95-character responses when using optional connection to HP palmtops; E-mail gateways.

Near Future (1996)

Two-way pagers from other companies; links to notebooks and other palmtops; rules-based E-mail routing; bigger message capacities; two-way PC Card pagers.

Distant Future (1997 and beyond)

Two-way pager chip sets integrate directly into palmtops, notebooks; PDAs with integrated wireless messaging.

They'll be asking how you did it!



Imagine having the power of a wizard. Being able to give a magic touch to what you see around you! Do you really want to turn the world upside down, - or just change the colour of a friend's face? Well, it's all here: The Image Wizard™ imaging

system lets you capture high quality colour video images with a simple Click & Freeze. Then it gives you the power to manipulate the image to the limits of your imagination, all with easy-to-use Wizard software.

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If you have a desktop or portable PC with a PCMCIA card slot and access to video sources such as VCRs, camcorders, TVs, laser discs etc., then all you need is the Image Wizard from MRT (If your PC have no PCMCIA card slot, ask for the low cost MRT PCMCIA adapter to ISA). The video capture system consists of a PCMCIA card type I, a video adaptor cable, the Image Wizard software package and an easy-to-follow user manual.



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Circle 230 on Inquiry Card (RESELLERS: 231).

INTERNET ACCESS

The Meter's Running with CompuServe's Spryte

Monthly Internet access for the cost of a burger and fries sounds appealing, but a closer look reveals the amount of on-line consumption time will be less than satisfying. CompuServe's (Columbus, OH) new Spryte Internet services will soon be available throughout North America and major European and Asian cities for \$4.95 per month. "Now every family can join the Internet," says Tim Oren, vice president of CompuServe's Internet Division.

Spryte customers will receive the Spry Mosaic Web browser; Spry Mail; and a Hypertext Markup Language (HTML) authoring tool called Home Page Wizard. But under the \$4.95-per-month plan, Internet connectivity will be limited to three hours a month. Other pricing plans are available, including one in which 20 hours of connectivity will cost \$19.95. But after that, additional hours on all of the plans are \$1.95 an hour.

"Customers want flat-rate pricing. They don't want to have a timer going when they hop onto the Web," says Joe

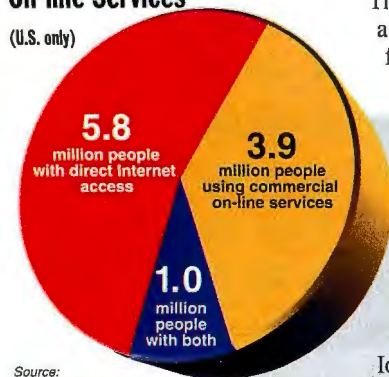
Picard, marketing representative for Digital Express, an Internet provider on the East Coast. Picard notes that his company offers SLIP/PPP services at a rate of \$35 a month. Dan Cunningham, chief financial officer of PSI, one of the oldest nationwide Internet providers, echoes Picard's sentiments. "CompuServe is just doing the same old thing by offering an hourly based pricing system."

Nielsen Media Research and CommerceNet's recent survey of Internet usage indicates that the average Web user spends six hours a week on the Net. Under CompuServe's best plan, that means the typical user would pay \$28 a month, which is about the same as the flat-rate pricing schemes of most Internet service providers. One advantage Spryte will have over some local service providers in rural areas is its local-call availability, thanks to CompuServe's widespread X.25 network.

But even this advantage may not last for long. Ameritech, a telecommunications company, and Concentric Network, an Internet services provider, are collaborating to provide local-phone-call Internet access. The two companies will offer a range of options, ranging from five hours of monthly connection for \$7.95 (\$1.95 each additional hour) to unlimited number of hours of monthly access for \$29.95. A Concentric Network spokeswoman said this service will allow any rural carrier in the U.S. to offer low-cost local Internet access. —Steven J. Vaughan-Nichols

Direct Connections Outpace On-line Services

(U.S. only)



Source: O'Reilly & Associates (Sebastopol, CA)

CODE TALK

RICK GREHAN



A Programmer Needs a Maid

BYTE columnist Jerry Pournelle occasionally summarizes certain products by saying, "If you need this, you need it bad." I hope he doesn't mind my borrowing that expression, because I have to use it to describe Geodesic Systems' Great Circle.

The Great Circle library fixes memory-management problems. By inserting the library at the head of your linker's library list, you allow Great Circle to take over the C/C++ memory-allocation/deallocation routines `malloc()`, `free()`, `new`, and `delete`. The product's manual says that after installing Great Circle, you may never have to call `delete` (if you're a C++ programmer) or `free()` (if you're a C programmer) again. The manual is probably correct.

Great Circle turns the C library's "manual" memory management system into an automatic garbage-collecting one. Great Circle keeps track of all allocated memory and all pointers referencing memory. And when a chunk of memory is no longer "pointed to," Great Circle deallocates it for you automatically (it even handles "bizarre" structures such as circular lists).

The package actually contains several variations on the basic Great Circle library. One, for example, reports memory errors. When you link it in and run your program, it tells you where the memory leaks are while also describing the extent of the problem.

In one sense, Great Circle is kind of spooky—especially on the C side of things. The manual indicates that one reason why a piece of memory may not be reclaimed is because an integer in your program may coincidentally contain a value that's equal to the address of an allocated block. This means that Great Circle prowls through your program's data regions, searching for pointers that are attached to allocated memory blocks.

When you install Great Circle, you're tempted to simply recompile your application with it and never think about it again. You can certainly do this, but Geodesic recommends a less lazy approach: The company suggests you include the reporting library in your project at development time. This allows you to catch and correct memory errors during development rather than rely on Great Circle to pick up your messes.

And this points to my one concern regarding this product: It's like a software housekeeper. When I was young, my family was lucky enough to have a daytime maid. She cleaned up after us. Consequently, I became quite a slob.

If you're a Windows user running Borland C++ or Microsoft Visual C++, Great Circle costs \$495 for full support, or \$345 for 60-day support. Unix workstation users have to pay \$1095 and \$795 for equivalent packages. If you need this, you need it bad.

Contact Geodesic Systems (Chicago, IL) at (800) 360-8388 or (312) 728-7196; fax (312) 728-6096; or <http://www.geodesic.com>.



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OCT. 9, 1995

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BEST OF COMDEX

Internet Searching Software Wins Best of Comdex

LAS VEGAS—Innovative search software for the World Wide Web won BYTE's Best of Show award at Fall Comdex '95. The awards recognize new products that will have a significant impact on computing.



Voted by the editors as the best of the best new products at Comdex, Quarterdeck's WebCompass is an intelligent Internet search engine that queries specified Web resources in the background. WebCompass (which also won in the Best Internet Software category) wraps a slick agent-based interface around any searchable Web servers you specify. The program is able to refresh the results of its searches periodically.

The editors awarded the Best Technology prize to Digital Semiconductor's FX132, a translator/emulator that allows 32-bit x86 applications to run on Alpha/Windows NT at approximately 70 percent of native Alpha performance.

Tseng Labs took the top spot in the Display and Sound Devices category with its 128-bit ET 6000 graphics and multimedia engine. The ET 6000 integrates a 128-bit graphics accelerator, a video image processor, and a 24-bit DAC into one chip.

Apple Computer's Newton 2.0 operating system for PDAs clinched the title in the OS category. This new version is better at handwriting recognition and offers better connectivity to personal computers and a spiffier user interface.

Omega's Jaz drive, which can hold a *gigabyte* on removable, \$99 media, was voted Best Storage Device. Deneba took the prize of Best Application for Canvas 5, its integrated, multiplatform graphics program. The graphics program provides image editing, text and page layout, and drawing tools. In the Best Utility category, PowerQuest's PartitionMagic 2.0 filled the top slot. The program lets you use partitions as flexible superdirectories.

IBM won the Best Notebook category with its ThinkPad 760 CD. The first thing you notice about this Pentium-powered baby is its 12.1-inch SuperVGA active-matrix display. Intergraph iced the Best System award for its TDZ-400 Pentium Pro personal workstation.

Panasonic's KX PS-8000—a multi-function color laser with 1200-

dpi output—was picked as Best Printer. Ricoh's RDC-1 Digital Camera was voted Best Input Device. This color camera also captures audio and video clips.

Best Communications Software went to Symantec's PC Anywhere32 remote-control program for Windows (3.x and 95), Windows NT, and DOS. The Communications Hardware winner was Wyse Technology's Winterm 2000/2500 terminals that complement Citrix WinFrame to provide an NT workstation for about \$700.

Multimedia Development winner was miro Computer's Video DC20, a video editing system that combines hardware-assisted Motion JPEG compression of S-VHS-quality video with PAL/NTSC output; it's priced below \$1000.

The honors for Best Development Software went to Oberon's Prospero, a rapid application development tool that implements building-block-style programming.

Where to Find

Apple Computer 408 996-1010; <http://www.apple.com>
Quarterdeck 800 683-6696 or 310 309-3700; fax 310 309-3215; <http://www.quarterdeck.com>
Deneba Software 305 596-5644; fax 305 273-9069; e-mail deneba@aol.com
Digital Semiconductor 800 332-2717
IBM 800 426-2968; fax 919 517-1950
Intergraph 205 730-2000; fax 205 730-2461
Omega 800 697-8833; fax 801 778-1000
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Oberon Software 617 494-0990
Panasonic 800 742-8086
PowerQuest 801 226-8977; fax 801 226-8941; e-mail magic@powerquest.com
Ricoh Consumer Products 702 352-1600; fax 702 352-1615
Symantec 800 441-7234 or 541 334-6054; <http://www.symantec.com>
Tseng Labs 215 968-0502
Wyse Technology 408 473-1200; fax 408 473-2080

BEST OF COMDEX FINALISTS

Internet Software:

Fountain, an integrated VRML tool/Web browser; from Calligari (415-390-9600; <http://www.calligari.com>).

HindSite, a personal Web-browsing tool indexes Web pages; from ISYS/Odyssey Development (303 689-9998).

Development Software:

ClassAssist brings object oriented features to Visual Basic 4; from Sheridan Software Systems (516 753-0985).

DB2 for Windows NT brings IBM's relational database development system to NT; from IBM (800 426-3333).

Systems:

Raptor 3 workstation, powered by the 333-MHz Alpha 21164 processor; from Deskstation (913 599-1900).

Powered LX, fueled by dual 150-MHz PowerPC 604s; from FirePower Systems (415 462-3000).

Portables:

The Z-Note GT features a 12.1-inch active-matrix screen; from Zenith Data Systems (708 808-5000).

OmniGo 100, a Geos-based PDA (\$349) with an innovative flip-top design that accepts input from pen or keyboard; from Hewlett Packard (800 443-1254).

Applications Software:

DecideRight decision-support software; from Avantos (510 654-4600; fax 510 654-1276).

MapInfo 3 Pro is a Win 95 mapping pro-

gram with GPS software for real-time tracking; from MapInfo (518 285-6000).

Operating System:

Linux Pro 3.0 includes customer support; from WorkGroup Solutions (303 699-7470; info@wgs.com).

Utility:

MPEG Converter software can do two-way conversion of Video for Windows AVI files to MPEG files; from Ulead Systems (310 523-9393; mkt@ulead.com).

Perfector is a power-conversion device; from International Power Technologies (800 944-0356; fax 801 224-5872; <http://www.sdic.com/IPT.html>).

Communications Software:

CommSuite 95; from Delrina (800 239-2254; <http://www.delrina.com>).

VideoPhone for low-cost Mac and Windows (\$149 with camera) network video-conferencing; from Connectix (800 950-5880; info@connectix.com).

Communications Hardware:

The SSA Data Pump, a PCI card for high-performance Serial Storage Architecture connectivity; from Pathlight Technology (607 266-4000; <http://www.pathlight.com>).

Air Power, hardware/software package for one-way and two-way paging; from Motorola (512 434-1502).

Multimedia Development:

Buster, low-cost video playback, tv tuner, and video capture/display hardware; from Quadrant (610 964-7600).

SAAT145, a multimedia bridge chip for low-cost video/audio capture; from Phillips Semiconductor (408 991-2000).

Printer:

LaserJet 5Si; from Hewlett-Packard (800 752-0900).

The Color Jetprinter 1020 provides black-and-white and color output; from Lexmark International (800 358-5835; <http://www.lexmark.com>).

Input:

LexiPen, a Chinese-handwriting-recognition program, from Motorola, Lexicus Division (800 LEX-ICUS).

ScanJet 4Si, a \$2999 networked scanner that delivers documents to your desktop; from HP (208 396-2551).

Storage:

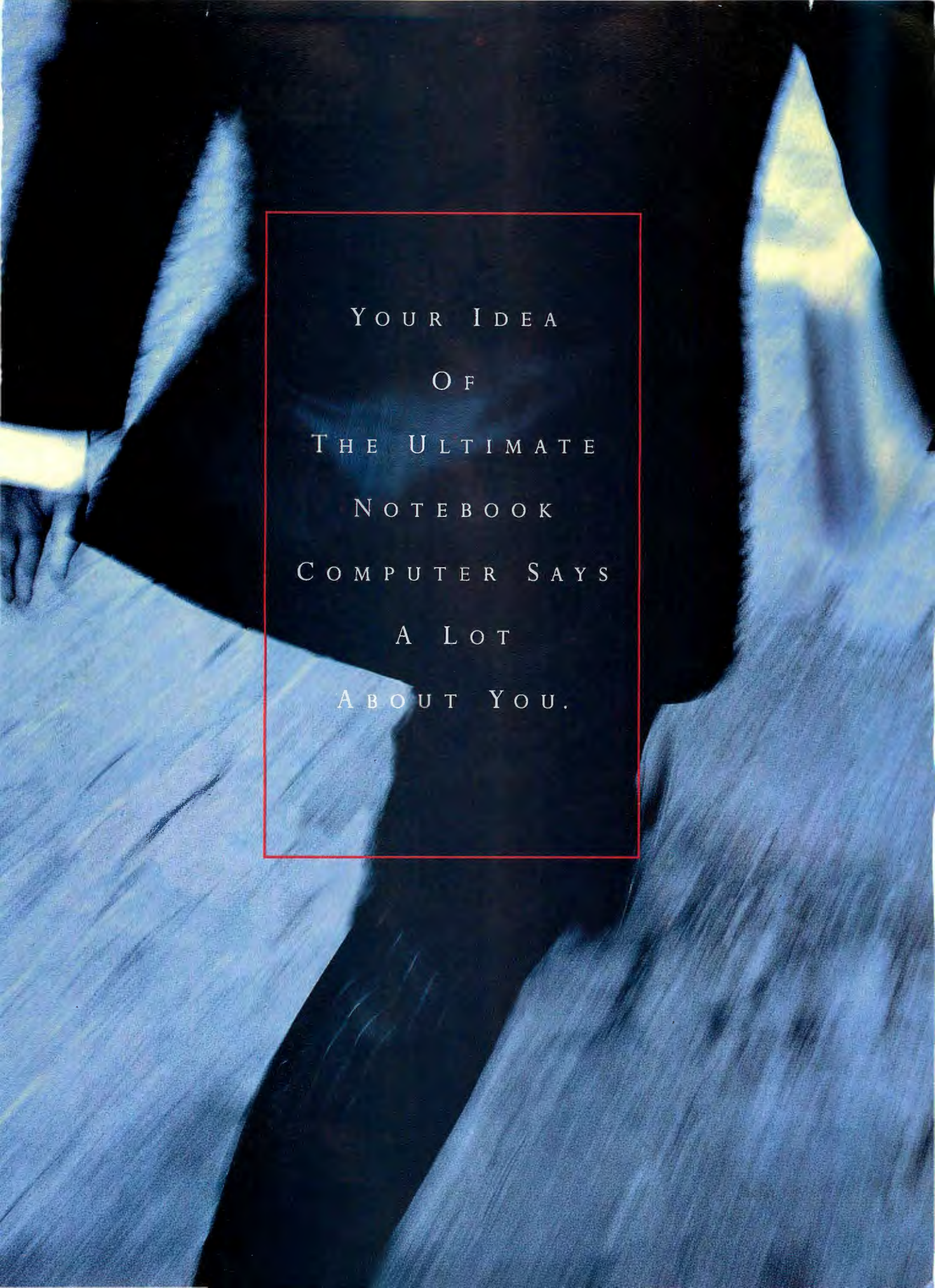
The SmartCache IV SCSI RAID controller supports up to 64 MB of hardware cache; from Distributed Processing Technology (407 830-5522).

The DW-S114X Quadraspin CD-ROM Writer sells for less than \$1300; from Pioneer New Media Technologies (310 952-2111; fax 310 952-3031).

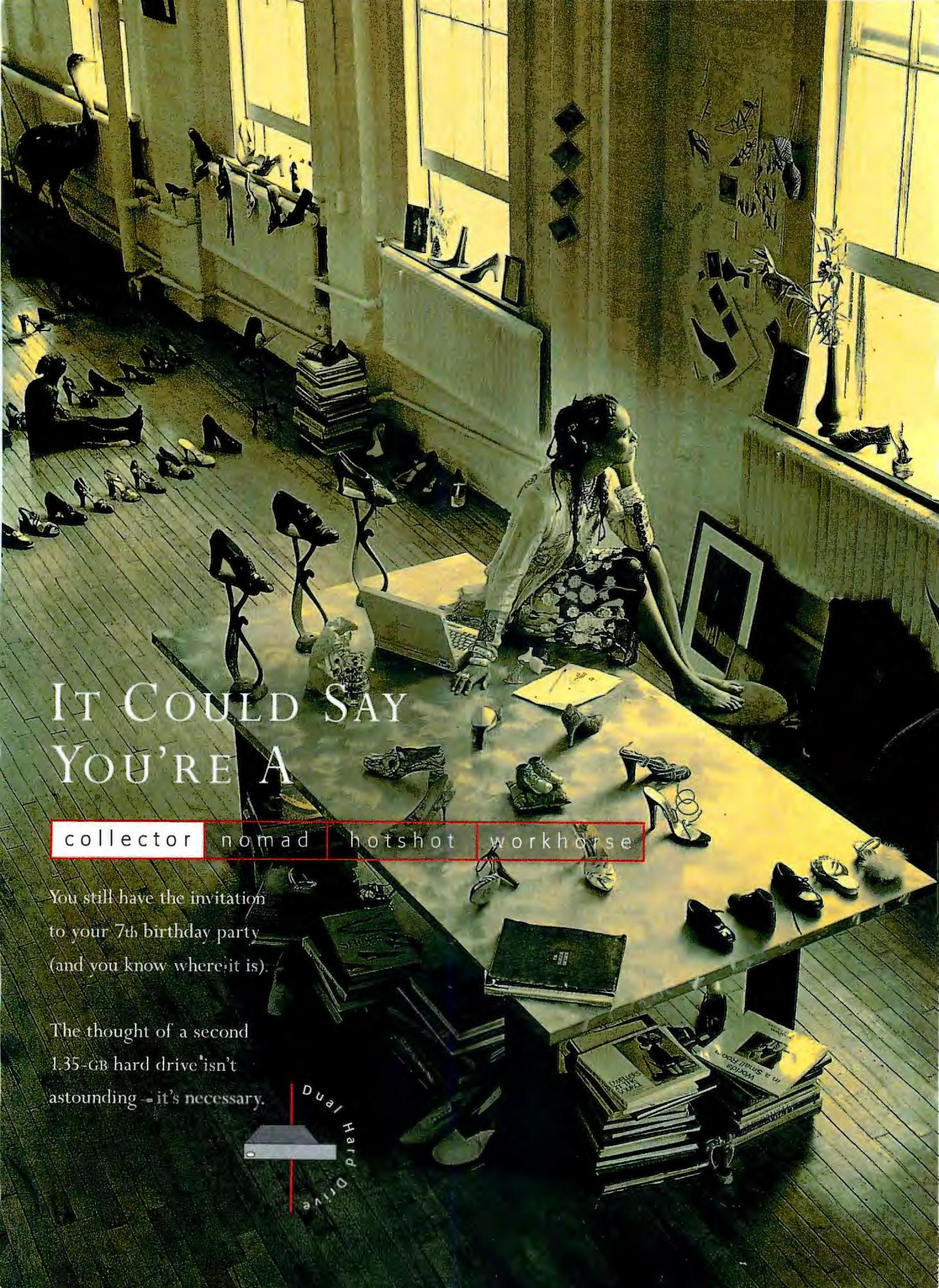
Display and Sound Devices:

The WaveForce SW70XG chip set delivers outstanding audio, from Yamaha Sound (714 522-9011).

The PanaFlat PF17 uses a flat tube in a 17-inch (diagonal) slim CRT to present optically undistorted images; from Panasonic Communications and System Company (201 348-7000, 800-742-8086).

A dark, moody photograph of a person's hands holding a notebook. The lighting is dramatic, with strong highlights on the hands and the notebook's cover, and deep shadows elsewhere. A red rectangular border frames the central text.

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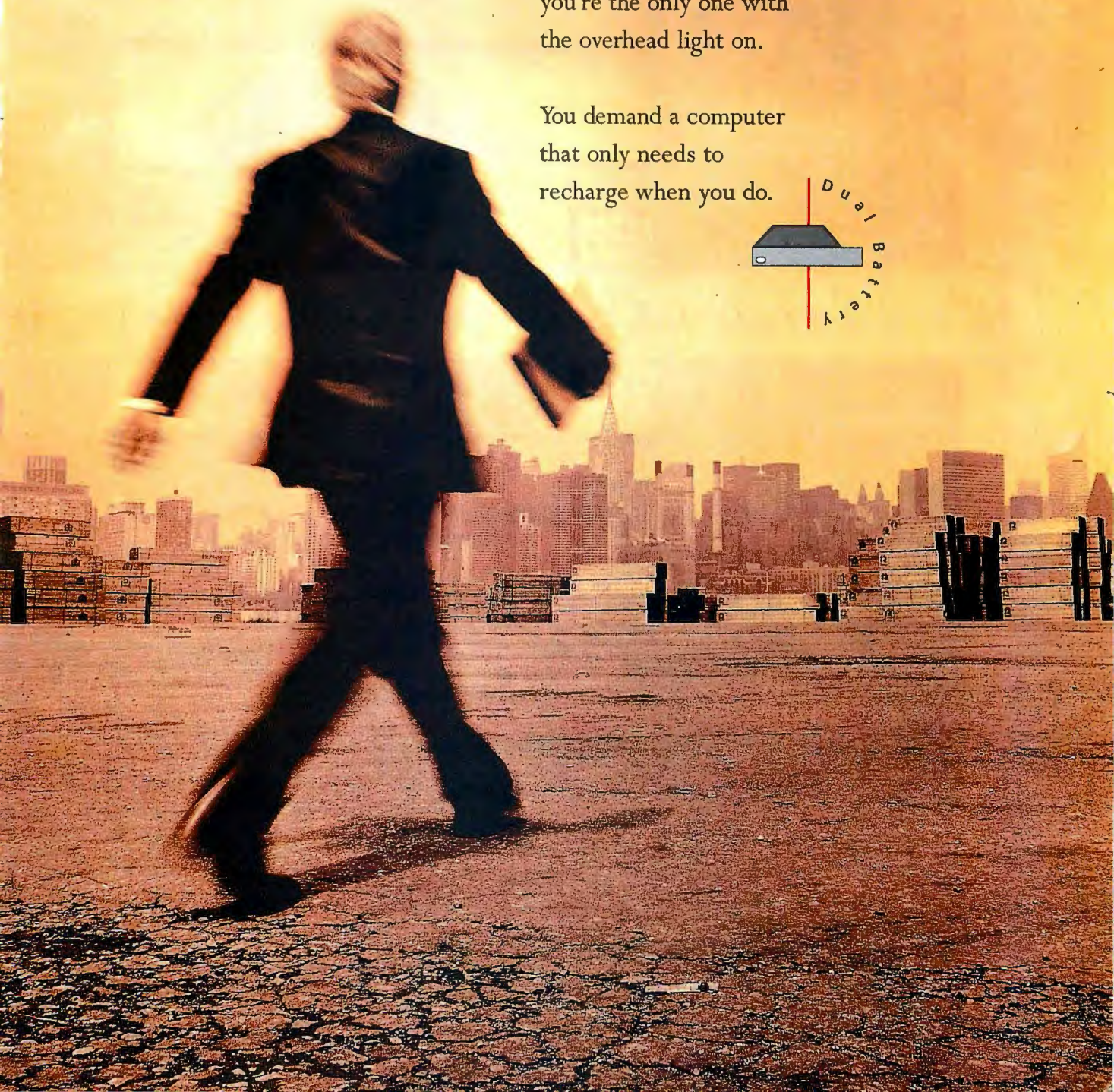
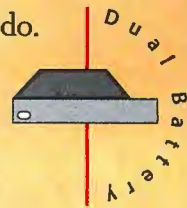
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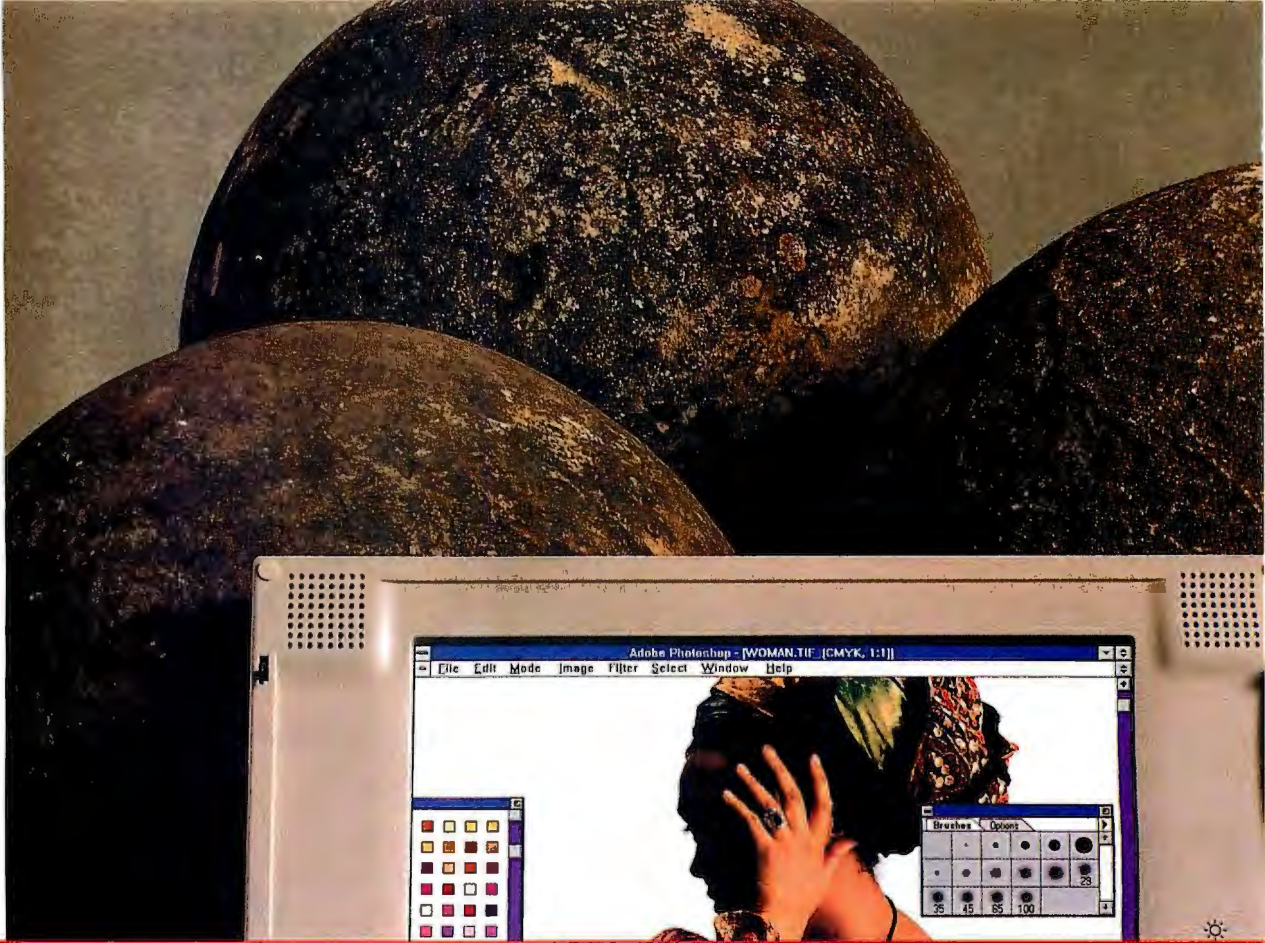
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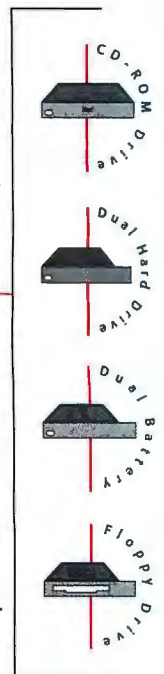
You know exactly who you are. Well, at this exact minute. But the way things go, this probably changes several times a day. Which is precisely

why we created the LTE 5000: A Pentium® powered notebook featuring interchangeable devices, giving it the ability to change as quickly as you do. We started with features any self-respecting notebook user demands: a Pentium processor, a full-sized keyboard (complete with the EasyPoint II™ pointing device), an 11.3- or 10.4-inch 800 x 600 LCD screen and two PCMCIA slots. Then we added memory expandable to 72 megabytes, 16-bit stereo sound and speakers, and optional MPEG video. But we left the cool part — the interchangeable part — up to you. The LTE 5000 is completely modular. So you can mix and match capabilities at the drop of one of your many hats. For starters,

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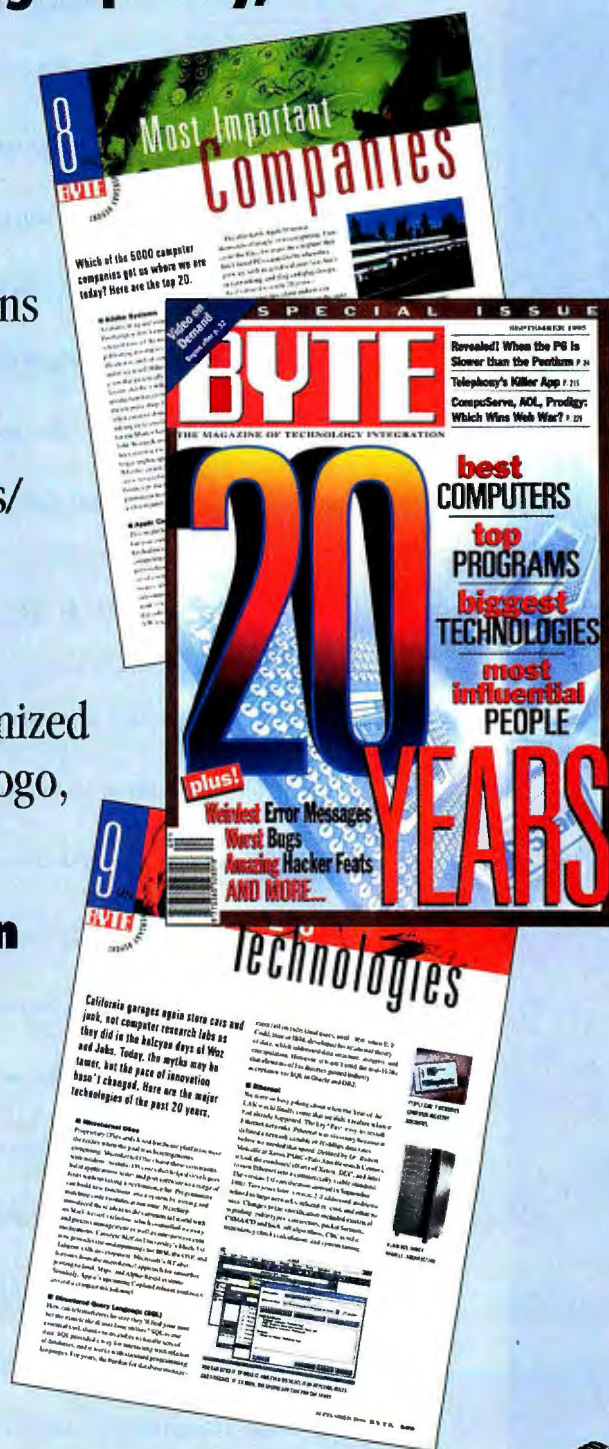
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The Ultimate Pentium Reference

TOM R. HALFHILL

How nice it would be if thorough reference works such as *The Indispensable Pentium Book* were published immediately after a chip came out. Every time I write about a new chip, no matter how detailed my story, dozens of BYTE readers bombard me with E-mail asking for more information. Usually, there aren't any sources to which I can point them.

But even though we had to wait two years for this book, it's still worth reading. It covers the Pentium in more detail than anything except the official manuals from Intel. Unlike the official manuals, it offers a more independent point of view. For example, it doesn't shy away from discussing (albeit too briefly) rival microprocessors from AMD, Cyrix, NexGen (before the announced merger, of course), and the leading RISC vendors.

Is this book truly indispensable? Yes, if you're a systems designer, CPU engineer, or avid wirehead. But average users will find it too technical. The book stumbles when it tries to woo beginners. For instance, a complicated explanation of real-mode segmented memory inexplicably precedes a tutorial on binary numbers. But if you already know something about CPUs and crave arcane knowledge about Pentium pin-out signals, cache protocols, branching algorithms, exception handling, and much more, this book is the answer to your prayers.

nation of real-mode segmented memory inexplicably precedes a tutorial on binary numbers. But if you already know something about CPUs and crave arcane knowledge about Pentium pin-out signals, cache protocols, branching algorithms, exception handling, and much more, this book is the answer to your prayers.

Tom R. Halfhill is a BYTE senior editor. You can reach him on the Internet or BIX at thalfhill@bix.com.

SURVIVAL OF THE FITTEST

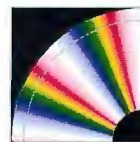
EVOLUTIONARY COMPUTATION: TOWARD A NEW PHILOSOPHY OF MACHINE INTELLIGENCE by David B. Fogel IEEE Press, ISBN 0-7803-1038-1, \$49.95

Evolutionary Computation serves as an introduction to the murky crossroads where hot new technologies—genetic algorithms, neural networks, fuzzy logic, and AI—collide. The underlying notion is attractive. Instead of designing software from algorithms, let a thousand flowers bloom. Generate many possible software solutions, let them compete against each other, pick the top performers, and combine their features according to rules that mimic natural selection in the living world. Given enough “generations,” so the theory goes, you will end up with a superior solution that embodies survival of the fittest.

The practice is more complex, and the theoretical underpinnings are messier. For one thing, not even biologists agree on what they mean by the word *fitness*, and Fogel points out that the two major definitions (gene frequency and population fitness) have very different implications for designing software that evolves. Concentrating on gene frequency produces a bottom-up approach that stresses decomposing the process and building from elementary pieces. Using population fitness tends toward top-down solutions. Given that the algorithms for real-world problems are complex and nonlinear, neither approach is completely satisfactory.

Evolutionary Computation's strength is David Fogel's approach. He is neither immersed in the minutiae of his subject nor does he make grand pronouncements. The general reader who wants to know what the fuss is about will find Fogel's approach both informative and stimulating. ■

—Rick Cook



TEACH YOUR CHILDREN WELL

WITH OPEN EYES Voyager, 1 Bridge St., Irvington, NY 10533, (914) 591-5500, \$39.95

BEETHOVEN LIVES UPSTAIRS BMG Interactive Entertainment, 1540 Broadway, New York, NY 10036, (212) 930-4000, \$39.95

CD-ROMs meant for children are either great or horrible. The great ones inspire and teach in a natural way, letting the child discover new material and concepts in an intuitive, game-like fashion at his or her own pace.

With *Open Eyes* fulfills this mandate nicely. It runs on Macintosh System 7 and higher or Windows 3.1 and higher, and it takes a child on a fantastic, interactive tour of some 200 pieces of art from the Art Institute of Chicago. Not only is the tour educational, it's fun. Humorous icons, simple enough for even a four-year-old to understand, playfully guide the child to and from exhibits. Points along an art time line can be selected by choosing a watch icon. Pick a frog to randomly jump to the next work. Help is symbolized by a life preserver. Audio help is available as well.

A magnifying glass lets the child zoom in on a section of the work, and a globe gives its place of creation. Another view shows the work's size by placing it in a gallery setting with nearby admirers. Children can keep a scrapbook of their favorite pieces with a camera and play a number of art-oriented games. In sum, this CD-ROM is a wonderfully designed introduction to some of the world's most inspirational art.

Beethoven Lives Upstairs runs on Windows 3.1 and higher. It transports a child into Beethoven's studio. Guided by Ludwig himself, the disc provides a colorful exploration into the world of music and art. At his or her keyboard, a child can learn to play the piano with help from animated assistants, saving creations in a journal. And a game called *Name That Musical Square* challenges contestants to figure out the musical style of selections.

—Jeff MacClay

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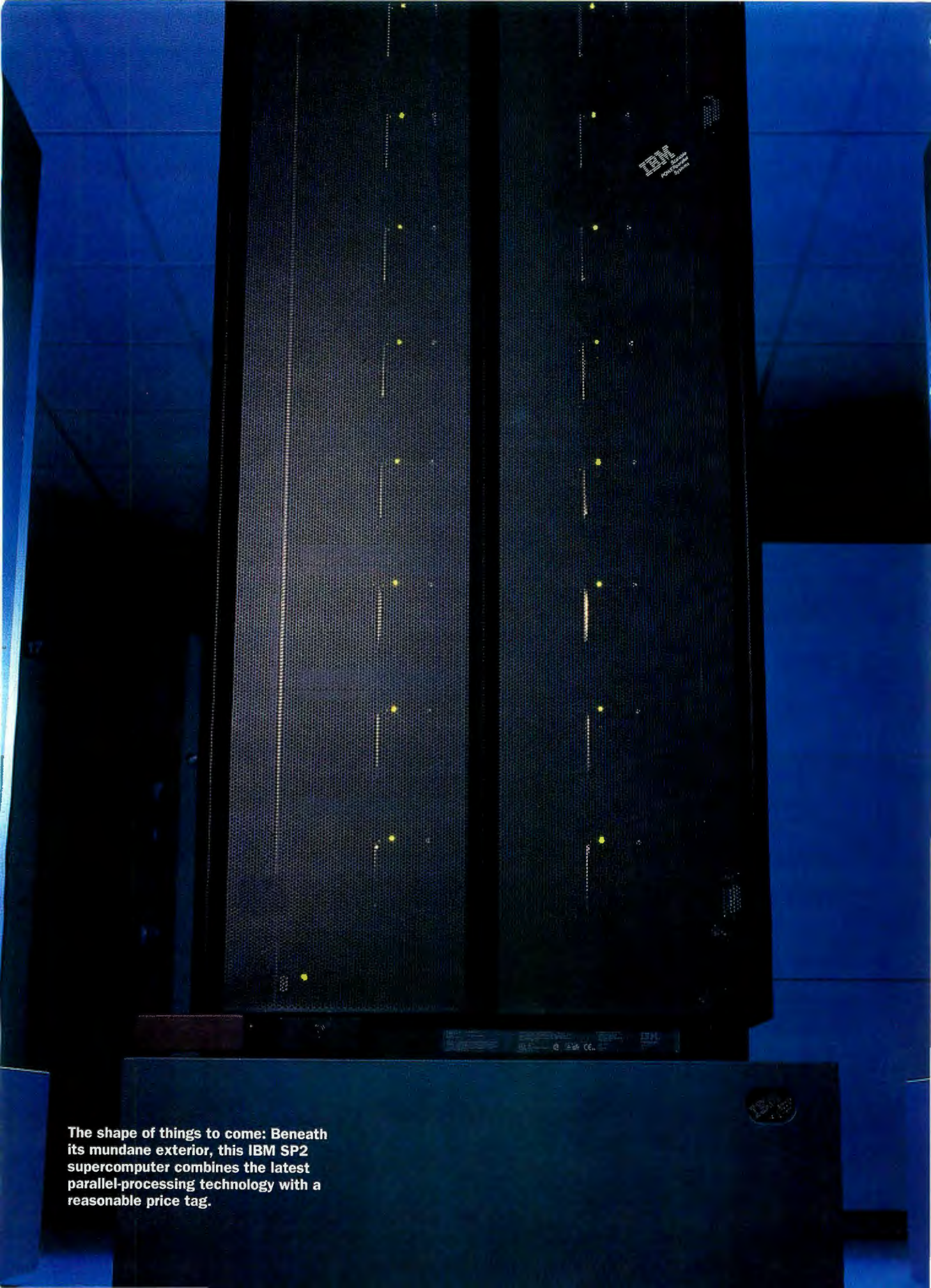
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The shape of things to come: Beneath its mundane exterior, this IBM SP2 supercomputer combines the latest parallel-processing technology with a reasonable price tag.



THE WORLD'S FASTEST COMPUTERS

When the Cold War ended, it looked like the end for supercomputing, too. But then a bank noticed that it could process more financial transactions quicker on a Cray than it could on a mainframe. And an aluminum company found that it could increase the life span of its metal castings with simulations on a Convex. And a telecommunications company figured out how to send its customer bills faster with an IBM.

While a number of well-regarded supercomputer companies have gone toes-up—Cray Computer (a spin-off of Cray Research), Kendall Square Research, and Thinking Machines—this shakeout is not the death knell of the supercomputer industry. Supercomputer companies, from old stalwart Cray Research to new kids like Silicon Graphics, Inc. (SGI), are alive and well.

But today you might well mistake a next-generation supercomputer for a filing cabinet tucked into an office corner or even—shock hazard—beside a desk. There's still some some custom parts inside these systems, but they're mostly off-the-shelf workstation components. Nevertheless, such a box packs more processing might than its ancestors did, and it sports a double-take price tag that a mid- to large-size business can afford: around \$100,000 and up. As a business and its computing demands grow, the supercomputer can grow along with it, by the addition of extra processors and hard drives.

A Fast History of Speed

In the sixties and seventies, supercomputer companies like Cray Research got their start building systems that could handle formidable scientific and engineering problems that used float-

ing-point calculations extensively. The intense computational demands of this type of work—much of it involving nuclear research or aerospace design, motivated by the arms race—combined with the necessity of quick results, meant that cost was no object in obtaining the fastest hardware possible. For example, the first Cray-1, like the one shipped to the Los Alamos National Laboratory in 1976, had a peak speed of 167 MFLOPS and cost anywhere from \$4 million to \$11.2 million, depending on the hardware configuration.

These systems used a *vector-processing* design that reflected typical engineering problems. Vectors are data arrays representing specific quantities. For example, you might model a jet engine with one vector representing the engine's structural elements, another specifying thermal characteristics within the engine, and a third detailing the fluid flow through the engine. A program that simulates engine operation mathematically combines the vectors according to physical models, iterating from time-step to time-step. Properly done, the simulation allows you to study the behavior of engine parts as the engine runs, which enables you to spot flaws in a new design or evaluate the strength of a different engine material without ever building a real prototype.

To boost performance, supercomputer designers oriented the system

Down-to-earth uses, near-earth prices, and astronomical speeds are catapulting a new generation of supercomputers out of the labs into the workplace

Tom Thompson

architecture around these vector operations, adding extra hardware to the processor to manipulate data vectors efficiently. Pipelined logic units allowed operations such as multiple memory accesses and the rapid combination of data vectors to overlap. To run at a high clock rate, these special-purpose processors employed bipolar logic

circuits—fast, but so hot that they needed liquid cooling systems. High-performance—and high-price-tag—peripherals handled the supercomputer's I/O demands.

Compounding the system price even further was the cost of software. Some supercomputers used proprietary OSes, and researchers often had to write the modeling software from scratch. Nevertheless, because these research problems required tremendous processing power, and government funding helped foot the bill, supercomputers sold. Supercomputer companies may have sold only a few dozen systems a year, but they charged high margins to defray the expenses of research and building a limited run of parts.

Because producing faster custom processors pushed the limits of fabrication technology, new supercomputer designs became more difficult and more expensive. Cray Research begat Cray Computer in 1989 to develop custom processors out of gallium arsenide, a material with faster switching times than silicon. That company eventually foundered last year due to delays in fabricating such parts.

Ironically, Cray Research itself kept ahead of the competition by taking a different tack entirely. Rather than using faster processors, its 1983 Cray X-MP had up to four custom vector processors to divide and conquer computing jobs. This system, which could deliver a peak of 941 MFLOPS, cost anywhere from \$2.5 million to \$16 million.

Many Brains Make Light Work

Then came RISC. While perhaps not as powerful as a custom processor, a RISC processor had a significant price advantage. Manufactured by the hundreds of thousands rather than by the dozen, their enormous economies of scale made RISC processors much less expensive by comparison. With multiple processors working together, a complex problem could fall by sheer numbers rather than by raw speed.

Another speed boost: The competitive nature of the workstation market had RISC vendors striving to one-up the competition by boosting chip performance. According to Jack J. Dongarra of the mathematical sciences section at Oak Ridge Laboratory, who keeps track of the supercomputing industry, "RISC processors got faster quicker than anyone expected. Although RISC first appeared in a commercial system about a decade after the first supercomputer, their floating-point performance lags [behind that of] traditional supercomputers by only an order of magnitude. We see the current generation of

RISC processors matching the performance of last generation's traditional supercomputers on a per-processor basis."

Employing gangs of processors in parallel affects how you write programs. You divvy up the data array, assigning different portions to different processors. Every processor runs its portion of the program in parallel (i.e., simultaneously) with the other processors. As the program progresses, every processor exchanges data with its neighbors, as shown in the figure "Processing Schemes" on page 50. This scheme is known as *parallel processing*. A parallel-processor architecture can be scalable; that is, to get more computing power, you can add more processors to the existing system.

But don't abandon vector processing just yet. In certain situations, a vector-processing system delivers better performance than a parallel-processing system, especially when dealing with complex simulations involving huge data arrays. That's because the average memory-access times can be shorter with vector processing, even with a large memory space. In contrast, a parallel-processing system with lots of memory might have to wait quite a while for data to move from one part of the system to another (because, as on a network of PCs, a packet might rattle around through dozens of nodes before reaching its target).

Current vector-processing supercomputers are also scalable (up to a point), in that you add more processors to boost performance. The Cray X-MP, though a vector-processor machine, had a scalable architecture. Cray still sells scalable vector-processing supercomputers, such as the T90 and J90. Over the long haul, however, the price point of RISC processors will al-

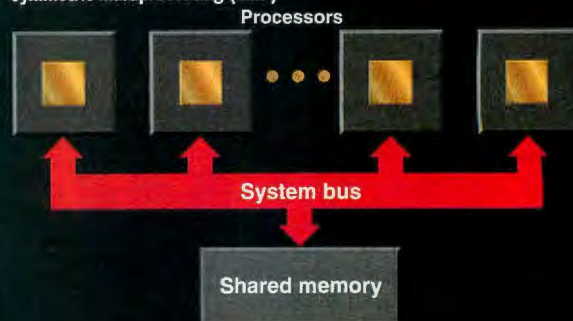
low the construction of ever-larger, more powerful parallel-processing systems.

Supershakeout and Recovery

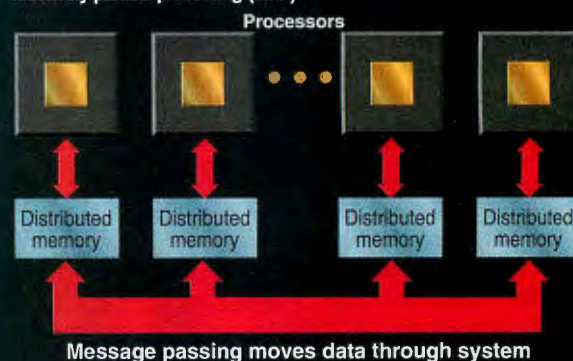
During this decade, recession and the Cold War's end have shrunk research funds drastically. The savvy supercomputer companies began exploring other market possibilities before the money dried up. Businesses were keen on using the processing power of a supercomputer, but they weren't in a hurry to buy: The huge price tag was hard to justify, especially if a business's work load outgrew the sys-

Parallel-Processing Architectures

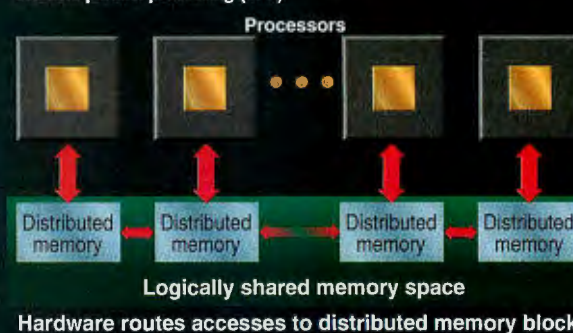
Symmetric multiprocessing (SMP)



Massively parallel processing (MPP)



Scalable parallel processing (SPP)



SMP offers programming simplicity, while MPP provides better expandability. SPP is a hybrid that's expandable yet easy to program.

CONVEX: HYPERNODE POWER

When Hewlett-Packard moved to acquire Convex Computer in 1995, it may have looked like HP had acquired another supercomputer-shakeout casualty. But the merger evolved out of a tight alliance that started in 1992. Convex had plenty to offer HP: It

had succeeded in fabricating high-speed gallium arsenide CPUs—the same technology that had done in Cray Computer—and put them in its proprietary C line of

supercomputers.

The Exemplar line of supercomputers takes the commodity-parts route and uses HP's own PA-RISC 7200 processor, clocked

hypernode is essentially an SMP system where the processors and memory connect through a special four-by-five, high-speed, non-blocking crossbar bus. Gallium arsenide gate arrays implement the crossbar logic. When a processor accesses RAM, bus logic called an *agent* (see the figure "The Convex Hypermode") looks for an idle bus to memory and makes the connection. The fifth part of the crossbar is for I/O only.

Convex achieves scalable parallel processing by tying hypernodes together. Four one-way toroidal rings connect the hypernodes. Called Coherent Toroidal Interconnect (CTI) by Convex, it's based on the IEEE standard 1596-1992 Scalable Coherency Interface (SCI). The crossbar logic monitors memory accesses, and local (i.e., on-board) access remains on the hypernode. Remote (i.e., off-board) accesses get passed to the rings. Through CTI, the memories on all the hypernodes appear as one globally shared memory space (see the figure "Toroidal Interconnect").

Because the rings are actually cables, you can tie several Convex systems together to obtain more processing power. Furthermore, you still have one unified memory space, even though the RAM is physically located in different machines.

The Exemplar uses a multiprocessor version of Unix called SPP-UX. SPP-UX is binary-compatible with HP-UX, so the Exemplar can draw on thousands of HP workstation applications.

A basic Exemplar 1200/CD 2 with two processors and 128 MB of RAM costs \$128,320. A basic Exemplar 1200/XA 8 has eight processors and 256 MB of RAM and costs \$349,500. Each four-processor upgrade will set you back \$107,800.

The Convex Hypernode



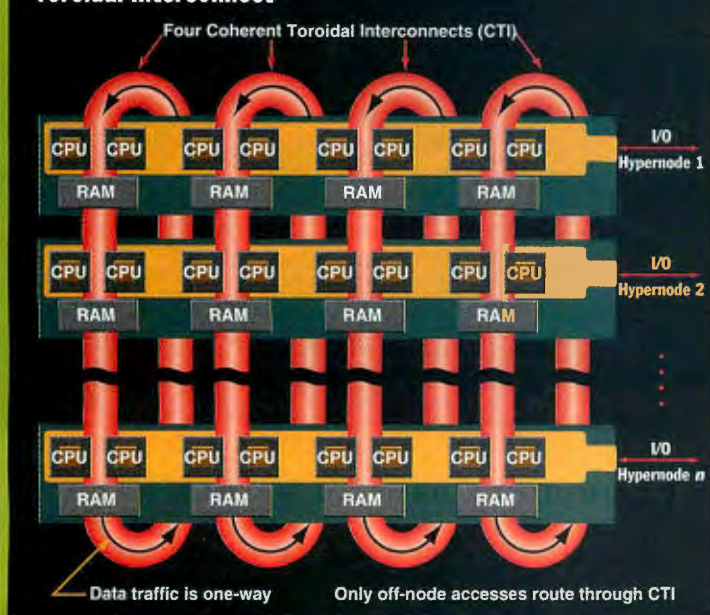
Top: A crossbar minimizes bus contention for RAM.

Left: The CTI organizes distributed memory into one shared space.

at 120 MHz. The Exemplar SPP1200/CD, a compact model, starts with two processors and is expandable to a maximum of 16. The SPP1200/XA starts with eight processors and expands to a maximum of 128. RAM configurations range from 128 MB to 32 GB. I/O support includes fast-and-wide SCSI-2 and FDDI.

The basic building block of the Exemplar is a hypernode that holds a maximum of eight processors. Each

Toroidal Interconnect



tem's capabilities in just a few years. Also, a proprietary supercomputer OS would restrict any custom in-house applications to running on that type of system and no other. And you still couldn't buy supercomputer software at Egghead.

Supercomputer companies responded to these issues. To address price sensitivity, supercomputer designs started to feature merchant or "commodity" worksta-

tion parts, such as IBM's Power2, Hewlett-Packard's PA-RISC 7200, and SGI's Mips R8000. Common peripherals, such as SCSI-2 drives, 100-Mbps Ethernet, asynchronous transfer mode (ATM), and Fiber Distributed Data Interface (FDDI) network connections, also became part of the mix and kept costs low.

Commodity parts plus a scalable architecture also solved the growth issue: As a

business expanded, you could add more (less expensive) processors and hard drives to meet computing demands. Prices for a basic scalable supercomputer today, which can start at around \$100,000, reflect the new market reality.

Finally, and perhaps most important, supercomputer companies adopted widely accepted workstation OSes, such as IBM's AIX, Sun's Solaris, and SGI's Irix 6. This

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drove a stake into the heart of proprietary software concerns. Supercomputers can now tap into the existing base of workstation applications and customers. When an office's work load overwhelms its workstations, the company can reasonably migrate upstream to a supercomputer. It can then use the workstations as terminals to submit jobs to the supercomputer or to handle smaller jobs.

Superpower at Work

Different markets have accepted supercomputers because of their low price and scalable processing power. Oil companies can improve their accuracy in finding future oil and gas reserves by processing seismic data and simulating reservoir flow, reducing their typically astronomical drilling costs. Car manufacturers can simulate crashes of prototypes, speeding new—yet reliable—models into the showroom six months ahead of the competition.

You don't have to be in the Fortune 100 to profit from supercomputer smarts, either. Banks use supercomputers to handle thousands of on-line transactions and to call up credit histories within seconds. Retail businesses sift through gigabytes of point-of-sale receipts to data-mine important trends.

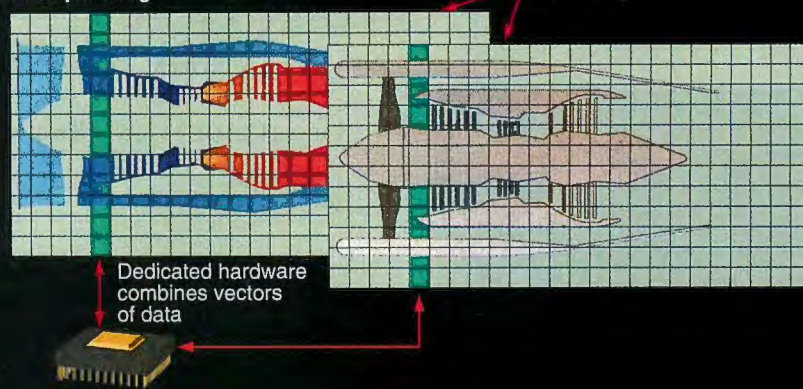
While the supercomputers of yesterday might have generated results of interest only to a handful of physicists, today's supercomputers offer something for everyone. Whether it's marketing a new product, speeding catalog-order turnaround, or manufacturing car parts, most jobs can now benefit—economically—from the power of supercomputers.

Alcoa Aluminum's adoption of a new-generation Convex supercomputer is a classic example. Simulating the casting of

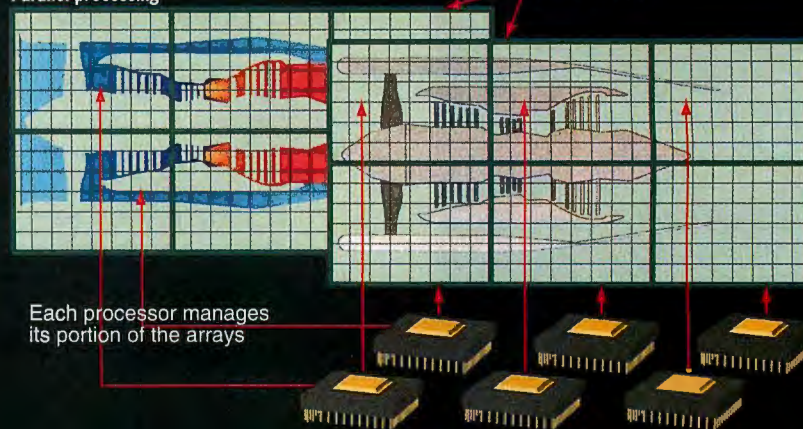


Processing Schemes

Vector processing



Parallel processing



Vector and parallel processing compared. Both schemes have their advantages, but parallel processing can be achieved at a lower cost.

large aluminum parts—possibly for use in cars—is easier than actually producing them. Walt Wahnsiedler, a technical specialist for Alcoa's process design and smelting, uses a Convex Exemplar SPP1000/CD with eight processors to model aluminum-casting operations. These models help find ways to reduce the stress on the steel dies used in casting, so the dies last longer than the usual 20,000 castings, thus saving costs. They also can reduce defects in the aluminum parts themselves caused by shrinkage during cooling or by pores introduced due to gas.

Alcoa formerly used a Convex C1, and then HP workstations, to run commercial simulation software. Because the Convex Exemplar's SPP-UX OS is binary-compatible with HP-UX applications, Wahn-

siedler moved the company's commercial software to the Exemplar with few problems. "It has improved productivity by letting me run more simulations or run simulations that we couldn't do otherwise," he says.

For example, car companies would prefer to make parts out of large one-piece assemblies that are more solid structurally than those made of several pieces welded together; plus, fewer parts speeds building a vehicle. "With the Convex," reports Wahnsiedler, "I can now simulate these larger parts, whose models can have up to 1.5 million cells, while reducing defects."

Multiprocessing Architectures

While parallel processing offers a definite cost advantage, its main benefit—scalability—can still be difficult to achieve. That's because as you add processors, the contention for shared system resources intensifies. Several different parallel-processing designs address this fundamental

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problem, each with its own advantages and disadvantages.

The first, symmetric multiprocessing (SMP), has a simple yet effective design, as shown in the figure "Parallel-Processing Architectures" on page 46. (The SGI Power Challenge and the Cray CS6400 Enterprise Server are examples of SMP designs.) In SMP, multiple processors share RAM and the system bus. This design is also known as *tightly coupled*, or "shared everything."

Because SMP shares RAM globally, it has only one memory space, which simplifies both system and applications programming. This single memory space lets a threaded OS distribute its tasks among various processors or lets an application obtain the memory it needs for a complex simulation. The globally shared memory also makes data synchronization easy. SMP is one of the most mature parallel-processing designs. It appeared in the Cray X-MP and similar systems over a decade ago.

However, this global memory also contributes to SMP's biggest problem: As you add more processors, memory-bus traffic increases until you reach a point where the bus gets saturated. Adding local cache memory to every processor can reduce some bus traffic, but the bus generally becomes a bottleneck at about eight processors or more.

Massively parallel processing (MPP) is another parallel-processing design. To avoid memory-bus bottlenecks, MPP does not use shared memory. Instead, it distributes the RAM among the processors so that the hardware resembles a network. Because of the loose distribution of RAM resources, this architecture is also known as *loosely coupled*, or "shared nothing."

To access the memory outside its own RAM, a processor must use a message-passing scheme analogous to network packets. This system reduces bus traffic, because each section of memory sees only those accesses that are bound for it, rather than every memory access, as in an SMP system. This enables large-size MPP systems with hundreds or even thousands of processors. IBM's RS/6000 Scalable Powerparallel System (SP2 for short) is

CRAY: FASTER THAN A BOTTLENECK BULLET

Cray Research started its Business Systems Division about four years ago to build supercomputer systems that would serve business needs. The company's Cray CS6400 Enterprise Server uses an SMP architecture to support up to 64 SuperSparcs, each clocked at 60 or 85 MHz.

Since bus traffic normally degrades an SMP design that's built around eight processors, the CS6400 seems to defy logic. The system dodges this limit by using four buses instead of one to reduce memory contention. Each bus has its own

private bank of RAM, while the processors connect to every bus, as shown in the figure below.

Physical memory is interleaved among all four memory banks to create a shared memory space. You can add up to 64 memory modules to the system, for a maximum of 16 GB of RAM. To reduce bus traffic further, every processor module (which consists of four processors) has a 2-MB static RAM (SRAM) cache. Bus-watcher logic snoops all memory accesses and updates the caches to maintain memory coherency.

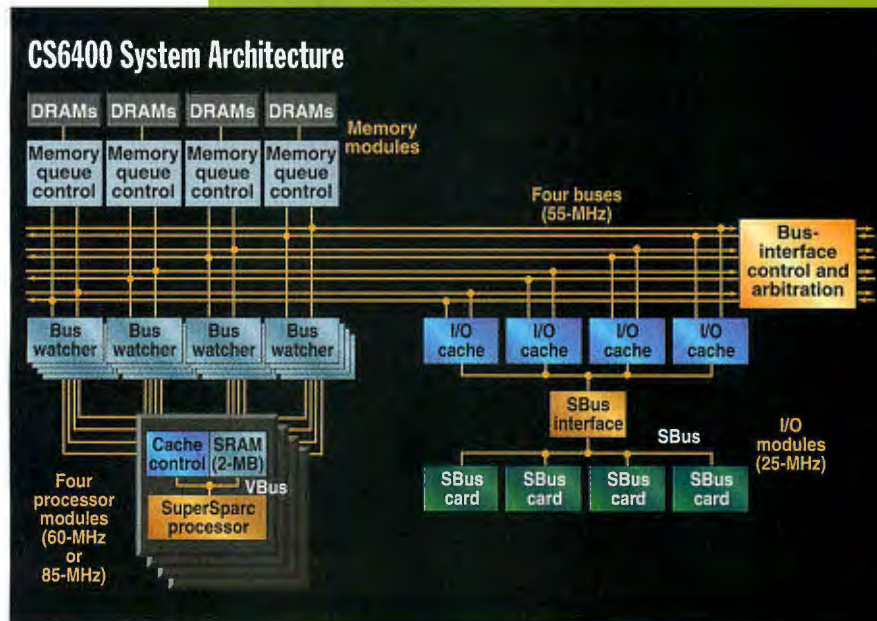
To ensure optimum I/O throughput, up to 16 buses support up to 64 I/O controllers. The I/O subsystem can manage up to 5 TB of on-line storage. Larger storage capacity is possible via the use of either disk arrays or an off-line archival medium, such as tape. The CS6400 supports communications via Ethernet, 100-Mbps Ethernet, FDDI/CDDI, Token Ring, and ATM.

To host mission-critical applications, a System Service Processor (SSP)—which is actually a built-in Sun workstation—monitors the system's health. In the event of a major failure, the SSP restarts the system and logically removes the problematic hardware. The system design allows you to hot-swap faulty hardware without interrupting service.

The computer runs Solaris 2.4, which is a Unix S5R4 derivative from Sun Microsystems. It can host Sun workstation applications and provide access to database applications, such as Oracle's Oracle7 and Informix Software's Informix

Online Dynamic Server. The alliance with Sun also fits into a strategy of offering workstation solutions (via Sun), with connectivity to the CS6400 to tackle the huge jobs.

A basic Cray CS6400 has one processor module and 51.2 MB of RAM (but no disk) and costs \$400,000. The basic system is rated at 3.8 GFLOPS, although floating-point calculations don't normally figure into the type of work this system does. The big box, with up to 64 processors and 16 GB of RAM, costs about \$4 million.



Four independent buses in the CS6400 reduce contention for system resources.



The CS6400 can be expanded with additional processors and storage.

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an example of an MPP system.

The downside to MPP is that it makes programming difficult, because it breaks memory into small separate spaces. Without any globally shared memory space, running (and writing) an application that requires a large amount of RAM (in comparison to local memory) can be difficult. Data synchronization among widely distributed tasks also becomes difficult, particularly if a message must make many hops to the target processor's memory.

Writing an MPP application also requires that you be aware of a program's memory organization. Wherever it's necessary, you have to insert message-passing commands into the program code. Besides complicating the program design, such commands can create hardware dependencies in

IBM: THE BLUE FLASH

Despite the difficulties involved in implementing MPP systems, IBM took up the challenge and built one. Called the RS/6000 Scalable Powerparallel System (SP2 for short), it consists mainly of parts found in RS/6000 workstations.

The SP2 starts with two nodes, expandable to 512. A node consists of a Power2 processor, an optional level-2 cache, some RAM (ranging from 64 MB to 2 GB), several Micro Channel slots, an Ethernet connection, and hard disk storage. In August 1995, IBM boosted the processor clock speed from 66 MHz to 77 MHz.

Total system RAM starts at 128 MB and is expandable to 1 TB, while on-line disk storage starts at 2 GB and is expandable to a hefty 9 TB. For I/O, the SP2 supports a variety of high-speed connections, including fast-and-wide SCSI-2, 10-Mbps Ethernet, FDDI, Token Ring, ATM, and High Performance Parallel Interface (HIPPI).

One problem plaguing MPP designs is the time delays that result when data migrates from one processor to a distant one. This makes synchronizing data of tasks difficult.

IBM has minimized this problem by the use of a unique switch that acts like a smart network switch. It routes data packets onto a network leg with the target system rather than broadcasting the packets over the entire network. The SP2 switch uses a data packet's routing information to locate the target node's port and sends it immediately if the port is idle. If the port is busy, the packet stays blocked until

the port is ready. This scheme reduces traffic on the system network.

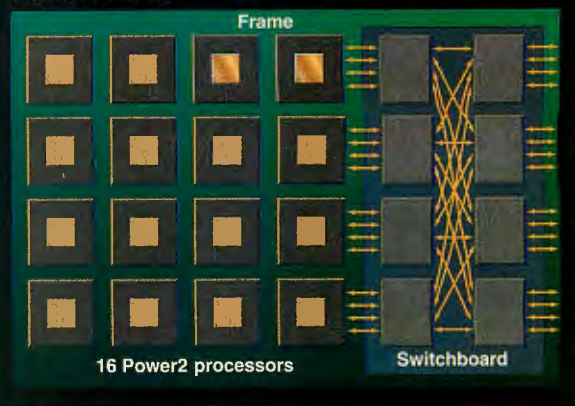
An SP2 system network consists of two types of components: nodes and switchboards. On the switchboard are 16 switch chips and corresponding shadow-switch chips for fault recovery, for a total of 32 chips. Each chip has eight input and eight output ports, a data queue, and an unbuffered crossbar. Pairs of chips (one handling input, one handling output) are wired to construct a four-way to four-way crossbar, which implements a 16-port bidirectional multistage interconnection network, as shown in the figure "The SP2 Frame."

Nodes connect to one side of the switchboard, while the opposite side connects to other switchboards. This setup achieves linear scalability, because properly connected switchboards reduce the number of hops between widely scattered nodes. Systems with more than 80 nodes require intermediate switchboards to handle the interconnection among the nodes, as shown in the figure "A 128-Node SP2 System."

Nevertheless, in such large systems, this multistage interconnection arrangement means that a data write to another processor takes about four hops. This consistent hop count, whatever the system's size, reduces synchronization problems and simplifies programming. It also provides multiple pathways between any two nodes, which reduces packet traffic and ensures a level of fault recovery.

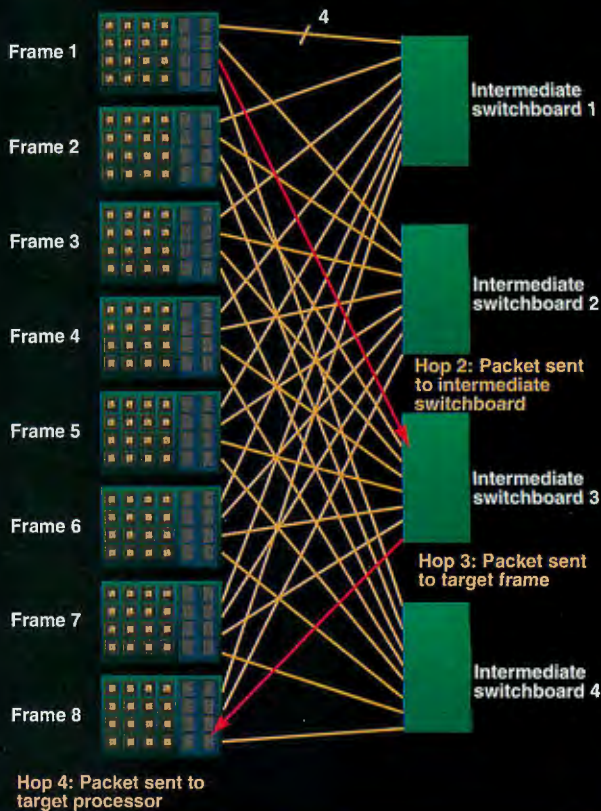
The SP2 runs AIX with MPP ex-

The SP2 Frame



A 128-Node SP2 System

Hop 1: Processor sends packet to frame's switchboard



A 128-node IBM SP2 supercomputer system has eight frames and four intermediate switchboards. The frames and switchboards are all connected by a bidirectional mesh.

tensions, so applications written for RS/6000 workstations run on the SP2. This provides a convenient migration path from workstation to supercomputer as processing demands grow. IBM also has ways to tie in AS/400 superminicomputers and 370 main-

frames, so the SP2 supports a company's existing installation while consolidating information.

A basic SP2 system, with two nodes, 128 MB of RAM, and 2 GB of disk storage, will cost you \$138,000. Additional 77-MHz nodes cost \$51,300 a pop.

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Dell's featured artist is Wendy Grossman of New York, NY.

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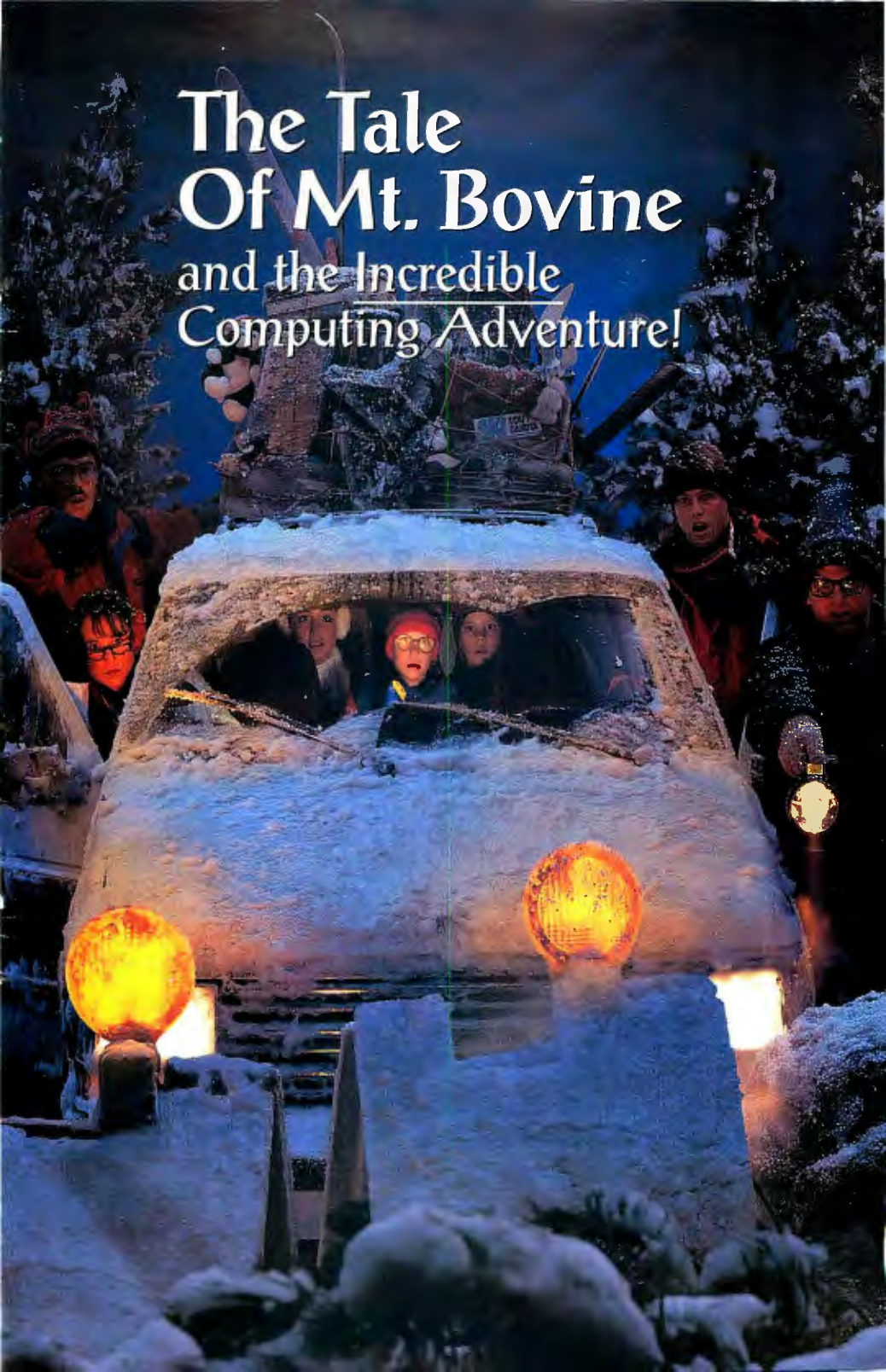
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The Tale Of Mt. Bovine and the Incredible Computing Adventure!





It was a dark and snowy night. The extended Heifer family cruises on, headed for an exciting holiday ski destination.

Suddenly, they encounter a roadblock in the middle of nowhere. Just as they were about to despair, the Heifers notice an iridescent glow on the horizon. What could it be? It looks surreal ... but sort of warm and inviting. They decide to investigate.

The glow is coming from a Gateway 2000® computer in the front window of the mysteriously deserted Mt. Bovine Ski Lodge. The family rushes inside to begin the incredible computing adventure ...

Members of the Heifer family include:


Marge Heifer — an agricultural scientist

Mitch Heifer — Marge's husband who has an aversion to blow-hards

Bessie Heifer — Marge and Mitch's macabre daughter

Billy Heifer — their son, who is spooked by his sister Bessie's obsession with ravens

"Uncle" George — assigned to the Heifer family by the South Dakota Witness



Protection Program (SDWPP) after he turned state's evidence in South Dakota's biggest case of dairy fraud

Wally Heifer — George's bodyguard who suffers from an inexplicable fear of cows

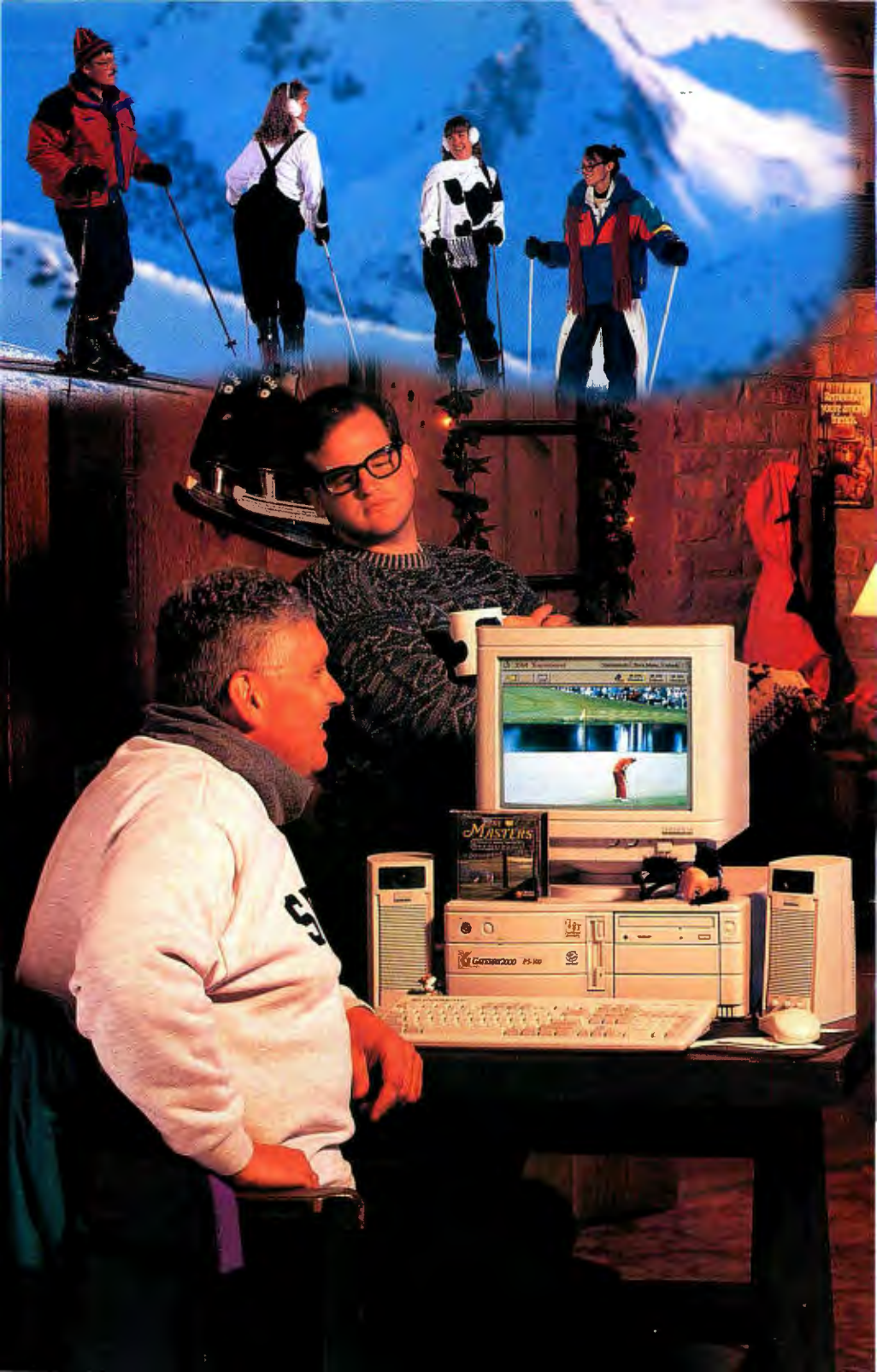
Buffy and Bernice Heifer — twins, Heifer cousins who are tagging along on the family holiday

Roger Heifer — family know-it-all and ski expert

"Holy cow," shouts Uncle George. "It's a Gateway 2000 Family PC™ multimedia system!" *Thus begins the Tale of Mt. Bovine ...*



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“Wally, I’m happy as all get-out with this Gateway computer. Go out there and ski with your family. Anyway, there’s no one here to recognize me,” says Uncle George, busy at the keyboard the next morning. *“And Wally ... quit whining about cows. I’m telling you, it’s gotta be a theme resort, man. Just because it’s called Mt. Bovine doesn’t mean there’s an Abominable Snow Cow herd out there.”* But George can’t convince him. So Wally stays in with George, who is totally entranced by the **Gateway 2000® P5-100 Family PC™ multimedia system** standard with MPEG technology, and priced at only \$2,149 — an unbeatable value!

New MPEG Technology For Movie-Quality Video

All Gateway 2000 Family PC multimedia systems now come standard with new MPEG (Motion Picture Experts Group) data compression technology for movie-like video performance. MPEG gives you incomparable full-screen, full-motion video right from your CD-ROM drive! Combined with the video scaler on all Gateway graphics cards (standard on our Family PC systems), moving pictures from all your MPEG multimedia applications will be smoother — no herky-jerky moving images here! And it won’t be long until all your favorite flicks will be available on CD.

“Wally, get a load of this! In Gateway’s Generations II software collection is Masters® Golf,” exclaims George. *“Check out all this live-action video and interviews with cool pros like Bobby Jones. I can’t believe the video. It’s just like being there! And Wally, I called the friendly folks at Gateway, and they say there are more MPEG-ready applications coming soon!”*

850MB Hard Drives Minimum On All Gateway PCs

Get the hard drive space you’ll need to store today’s and tomorrow’s intensive software applications. Gateway 2000 introduces a new minimum standard — hard drives from 850MB to 2GB on all Gateway desktop PCs! Even with all the incredible pre-installed software on your Gateway system, you’ll know that you still have plenty of room to go. These hard drives support DMA Mode 1 or 2, providing you with the best performance for multitasking environments like Windows® 95.


George can’t believe his good fortune in discovering the Gateway P5-100 Family PC system complete with MPEG technology. Meanwhile on Udder Trails, Buffy and Bernice think it’s just plain rude for Uncle George and Wally to be so antisocial.



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Inseparable as always, the twins Buffy and Bernice head out to the moguls on Cud Pass. "I can't believe George and Wally are at that computer already this morning," pouts Bernice. "They are *so* ... hey Buffy, where is that incredibly cool music coming from? No way! Buff, that *computer* is pumping out those tunes!" So the twins spend their day with the **Gateway 2000® Holiday XL system**, while Mt. Bovine's entertainment, Disco Santa, lip synchs along to the high-fidelity sound.

Stereo Speaker Sound For The Audiophile At Heart

You'll be in awe when you hear the amazing stereo sound of Gateway's Altec™ Lansing ACS-40 speakers now standard on all Gateway Family PC™ multimedia systems! Exclusively from Gateway 2000, these high-quality speakers are a step above any other standard speaker set in the industry.

Add our Altec Lansing ACS-250 subwoofer for only \$75. Your speaker system will pump out an additional 40 watts of thumping bass on all your software applications and music CDs with this heart-pounding subwoofer.

Experience the full-bodied sound of a home stereo system with Altec Lansing ACS-400 speakers. These 1-foot-tall tower speakers include the ACS-250 subwoofer and Dolby® Pro-Logic Surround Sound for the epitome of stereo sound on all your multimedia applications and music CDs. The ACS-400s are available exclusively through Gateway 2000 as an upgrade from the ACS-40 speakers for just \$120.

6X EIDE CD-ROM Drive For Super-Fast Performance

Be ready for tomorrow's technology with this lightning-fast 6X CD-ROM drive. It's the fastest EIDE CD-ROM found anywhere with 900KB/second data transfer rate and 214ms average access time. Combine the 6X CD-ROM with any Gateway



graphics accelerator standard on our Family PC systems, and you'll get full-motion video and be set for video scaling applications including MPEG and video conferencing.

"Bernice, I'm just blown away by the stereo sound of Gateway's Holiday XL speakers!" exclaims Buffy. "And I can't believe how cool and helpful those Gateway tech support people were today. Boy, I wish we knew that much about computers! Check out this Music Central™ 96 software application running on our really fast 6X CD-ROM." Meanwhile, back on Bull Run, Marge is anxious to try the business applications on one of those Gateway 2000 PCs, known for their high quality and value.



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On a break from Bull Run, Marge and the kids, Billy and Bessie, are thrilled to find a Gateway P5-120 Family PC™ multimedia system. And Marge sees visions of the perfect holiday ahead with all the software applications available from Gateway.

Microsoft Windows 95 At Your Service

All Gateway 2000® PCs include Microsoft® Windows® 95 and are optimized to take full advantage of this new operating system! You'll be prepared to weather all the computing storms of tomorrow with the powerful 32-bit platform of Windows 95.

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You'll get 45 of the newest, most popular software programs in the world with Gateway's new Generations II software collection, pre-installed on all Gateway Family



Featured with optional 17" CrystalScan monitor.

PC multimedia systems. Most Generations II programs are optimized for Windows 95, bringing new life to your multimedia software. And don't forget to ask about Gateway's Ultimate Software Bundle — unrivaled in the world of software bundles!

Takin' Care Of Business With MS Office 95, Professional Edition

Gateway's Holiday XL configuration, and our P5-100, P5-120, and P5-133 Professional systems all include Microsoft Office 95, Professional Edition, with 32-bit versions of MS Word, Excel, PowerPoint® presentation graphics program, Schedule+, Access database and Bookshelf® '95. These feature-rich applications provide innovative tools and resources to take advantage of Windows 95, for the ultimate computing performance.

"Mom, dig this!" exclaims Billy, experiencing the full multimedia fun of NHL® Hockey '95, available in the Gateway Sports Pack. Marge smiles, but can hardly wait to explore MS Office 95. While back on Herding Road, Mitch is sick of Roger's free-advice, King-Of-The-Hill attitude ... looks around and ... "Whoa, what the heck's going on at Mt. Bovine? Marge? ... kids? Hey Rog, I'll be right back, buddy."



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"Know-it-all, big ski expert Roger," mutters Mitch as he enters the warm glow of Mt. Bovine lodge, "I've been itching to get in here with these computers for days anyway!" With that, Mitch stumbles into Mt. Bovine and almost lands right on a **Gateway 2000® P5-120 Family PC™ multimedia system** where he discovers a whole new world on the information superhighway!

Introducing The Gateway 2000 Information Highway CD

When you get a Gateway 2000 PC with fax/modem, your universe erupts with more information and communication capabilities at your fingertips than you ever thought possible! And we'll include our own Gateway 2000 Information Highway CD to make navigation around this new universe easy. The Information Highway CD features a cool user interface with point-and-click icons that lead you through trial memberships to CompuServe®, Prodigy®, America Online®, and Reuters Money Network online services. You'll also get GNN (Global Network Navigator®) for easy Internet browsing and FaxWorks™ communication software on the Information Highway CD.

Explore the entertainment world, access live chat lines and meet people from all over the globe, or converse with old friends and family! Reference early releases of publications such as *USA Today*, *People* and *BusinessWeek*. And get hooked into UseNet groups where people sharing common interests meet online for world-wide conversations and to exchange information. Access areas where you can download a million files of all types — free of charge! And for the world's most expert online technical support assistance, you can contact the Gateway 2000 BBS.

To get an edge on Roger, Mitch enters the ESPN site and talks to ski pros about all the latest slalom tips. But he's sidetracked and finds evidence that Uncle George donated his dairy heist money to the research of high-nutrition milk production. "Oh, just wait till I tell Marge! She's been wondering who gave her that anonymous grant money! And now that I'm online, there's nothin' stopping me from taking over as family know-it-all. See ya' Rog!"

Meanwhile Roger readies himself for Holstein Hill, Mt. Bovine's most treacherous downhill slope. He poises, glances around to make sure everyone's looking and ... "Hey! Where did they all go?! What *are* they doing? How could those Gateway computers possibly be more entertaining or informative than *me*? I'd better head back to Mt. Bovine to check out my competition!"



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“Hey Heifers! The roads are open. Let’s go!” But Roger stops — in awe at the sight of the whole Heifer family happily computing on Gateway 2000® PCs. “Holy cow! You must be joking!” laughs George. “This is the coolest holiday this family’s ever had! There’s something for everyone here. Plus, Gateway gives you all the resources and technology to make initial start up, daily maintenance, and upgrading for the future easy. Boy, does that ever add to the overall value of a computer! And Gateway 2000 even has a 90-Days No Payment Program.”

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"Hey gang, we've gotta come back next year and bring the *whole* Heifer herd!" exclaims Roger, now a Gateway believer. "Just think of all the incredible stuff Gateway 2000 will have then. Mt. Bovine rules! Where do we make reservations?"



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NO PAYMENTS
Ask About Our
"90 Days
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your applications. However, most super-computer vendors have safeguarded applications portability by adopting either a public-domain message-passing mechanism, known as Parallel Virtual Machine (PVM), or a developing standard, called Message Passing Interface (MPI), to implement the message-passing mechanism.

How to overcome the difficulties of SMP and MPP? The last parallel architecture, scalable parallel processing (SPP), is a hybrid of both, using a two-tier memory hierarchy to achieve scalability. The first memory tier consists of a node that is essentially an SMP system, complete with multiple processors and their globally shared memory.

You build larger SPP systems by interconnecting two or more nodes via the second memory tier so that this tier appears logically as one global shared-memory space to the nodes. The two-tier memory reduces bus traffic, since only updates to keep memory coherent among the nodes occur. SPP thus offers the easy-to-program SMP programming model while providing scalability similar to that of an MPP design. The Convex Exemplar is an example of an SPP machine.

Superapps

Because they use workstation OSES and common RISC processors, the new breed

of supercomputers inherits a stable of ready-made workstation applications. The SMP architecture that's typical in most systems confers an advantage as well. The globally shared memory lets appropriately modified applications work with larger data arrays or distribute the work load in threads across multiple processors.

However, some software vendors don't want to modify their existing commercial applications for fear of introducing bugs with the rewrite. Also, fully supporting multiprocessor hardware using threads, or writing message-passing code for an MPP system, is a daunting task.

Fortunately, you can find ways around these issues, depending on the application type. Many supercomputer OSES can partition the machine so that some or all of the processors function as stand-alone systems. A company can then fold its existing traditional work flow into the computer.

Some partitions function in a mainframe batch-mode operation, letting users submit jobs from terminals or workstations, while other partitions use multiple processors to tackle compute-intensive jobs. Each stand-alone partition can run its own copy of a mission-critical application, so the system can handle multiple users. This arrangement also lets companies consolidate all their computing services into one box.

Lotus Notes is an application in point,



The SGI Power Challenge comes in various configurations, both with and without visualization hardware.

since large companies use it as a collaboration mechanism. A typical enterprise-level installation might have thousands of users, managed by dozens of servers linked

POWERFUL SECRET IDENTITY

Although Silicon Graphics' first claim to fame is as a workstation vendor whose snazzy boxes serve up rich graphics and make scientific visualization popular, within the last two years the company has been making forays into supercomputer territory. Arrays of its own 90-MHz Mips R8000 RISC processors provide ample processing power for its Power Challenge supercomputer.

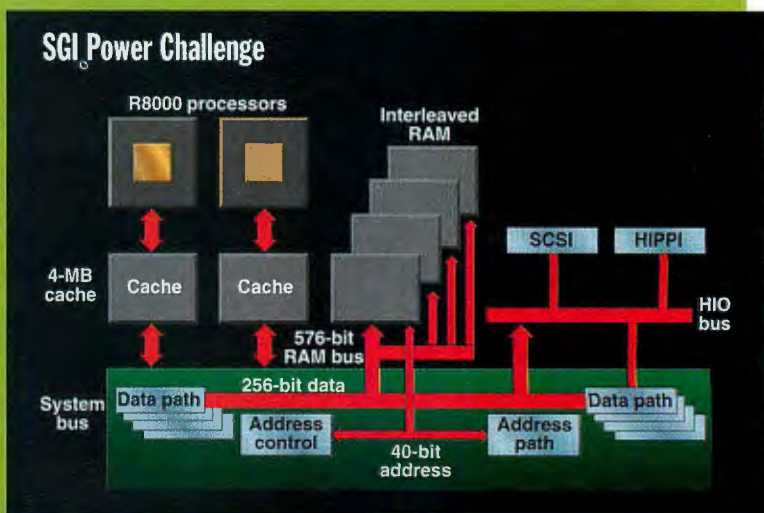
The Power Challenge has an SMP design. The basic system contains two processors and is expandable to a maximum of six or 18 processors, depending on the size of the chassis you purchase. Each processor can have 4 MB of cache memory, which reduces competition for the system bus. The bus hardware performs its own bus snooping to maintain cache coherence.

The RAM bus is 576 bits wide, enough to support one-, two-, four-,

or eight-way memory interleaving. The wide bus and memory interleaving provide full bus bandwidth for fast page-mode accesses. System RAM starts at 64 MB and is expandable to 16 GB.

I/O support includes the VME64 bus with five or more slots, fast and wide SCSI-2, and Ethernet, and High Performance Parallel Interface (HIPPI) are available via expansion cards. On-line storage capacities range from a minimum of 2 GB up to 3 TB.

You can boost the processing power by joining several Power Challenge systems together via network links. The downside? The SMP model breaks down for this arrangement. Instead, you must use the MPP distributed memory



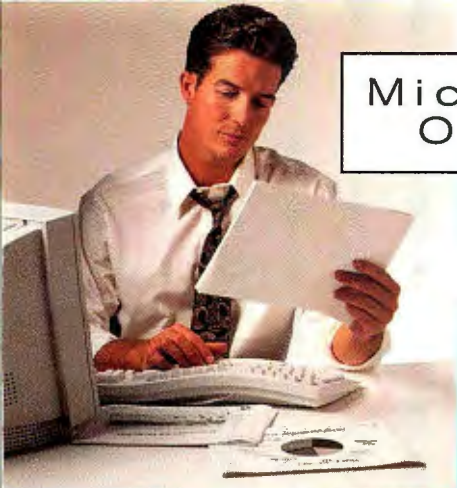
Large caches, bus snooping, and interleaved RAM reduce bus traffic in the SGI Power Challenge.

model for programming, using message-passing to relay memory accesses to the other systems.

The Power Challenge runs the company's own workstation OS, Irix 6, and can draw on its horde of visualization software. The Pow-

er Challenge system comes in a broad array of configurations. A basic Power Challenge L system comes with two processors (upgradable to six), 64 MB of RAM, and a 2-GB hard drive and costs \$102,800.

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multitasking (allowing a wide range of bank services to be processed simultaneously) since 1992. And as more companies come to depend on networked environments, OS/2's strengths are helping them succeed.

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across the country or around the world. A setup such as this gives a system manager nightmares because of the software upgrades and maintenance problems involved in dealing with these widely scattered computers. Furthermore, data synchronization among the separate Notes databases is problematic.

However, a properly configured IBM SP2 supercomputer can come to the rescue. First, you configure the SP2 so that each processor operates independently. Next, you run native copies of the Notes server, one per processor, thus creating an array of virtual servers.

This arrangement consolidates all the servers into a single system and eliminates maintenance and upgrade hassles. While Notes currently limits database access to only one server at a time (because all the servers draw from the same database file), synchronization issues disappear. This setup also offers mission-critical redundancy: Some virtual servers in the system can operate as backup units, taking charge when a failure disables an active server.

Another existing job that supercomputers can tackle is handling large volumes of information, either for on-line transaction processing (OLTP) or for data mining (on-line analytical processing, or OLAP). Companies can accumulate gigabytes of sales data daily, and supercomputers warehouse the information for evaluation. How large can these data warehouses grow? Cray Research has shown a 48-processor CS6400 managing a 1.6-TB (a terabyte equals 1 million MB) Oracle7 database.

Fortunately, such a setup does not require modification of the front-end application. Instead, the database managing the back end routes the queries to individual processors. Complex queries that generate multiple data tables can go out to several processors, as long as the results of each table do not depend on another table's data. Key to this sort of operation is parallel-processing-savvy database software, such as Oracle's Oracle7 Parallel Server, Informix's PDQ Dynamic Server Architecture, and Sybase's System 10 Navigation Server.

Rob Geller, director of marketing and sales systems at MCI, uses an IBM SP2 system to consolidate the company's demographic and billing data, which used to be stored in several mainframes located around the U.S. The SP2 has 104 nodes and operates on a 3-TB Informix relational database. Geller uses off-the-shelf desktop and workstation software, including Brio's BrioQuery, to mine the data. The results help MCI refine behavioral models

THE WORLD'S FASTEST SUPERCOMPUTER (NOW)

In September 1995, the U.S. Department of Energy's Accelerated Strategic Computing Initiative (ASCI) awarded a \$45 million contract for the development of a supercomputer capable of sustained 1-TFLOPS processing. The TFLOPS system will model the effects of aging on nuclear warheads, which are physically complex mechanisms.

What company won the contract? Intel, the world's largest maker of commodity parts for desktop computers.

Because 1 TFLOPS equals 1000 GFLOPS, you can expect any such system using current technology to be physically 1000 times larger than any of the GFLOPS systems that are mentioned in this article. And the TFLOPS system is big: It occupies 1500 square feet, uses more than 9000 processors, and consumes an estimated 400 kW of power.

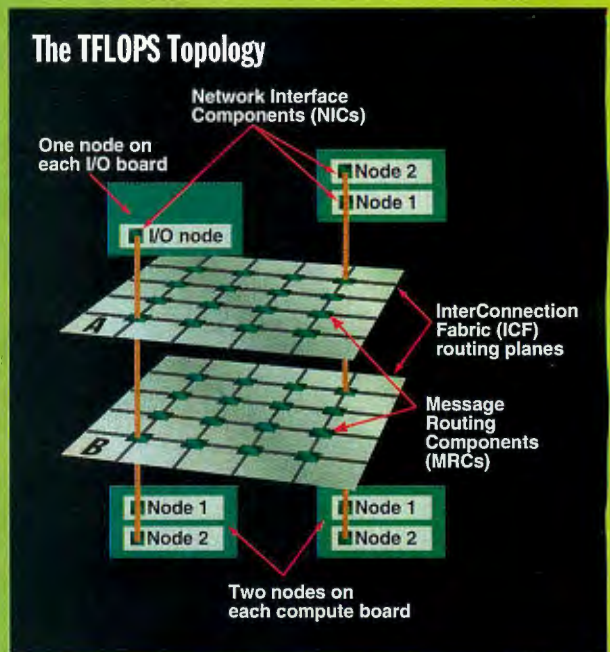
The system uses Intel's Pentium Pro processor. The TFLOPS machine has an MPP architecture whose basic element is a node, each consisting of two Pentium Pros. Nodes mount on boards that resemble desktop motherboards because of the commodity parts used in their construction, such as the DRAM, PCI interface, and 82450 chip set. The only nonstandard part on the board is the network interface (see below).

Boards consist of two types: Compute boards and I/O boards. Each compute board has two nodes—for a total of four processors—and 128 MB of RAM. Additional RAM, up to a maximum of 512 MB, can be added later. Each I/O board has only one node, but richer I/O functions. It manages several PCI buses (and their expansion cards), the network traffic, and any disk arrays. Each

board also has 1 GB of RAM, most of which serves as a file cache for any hard drives.

The system has 74 compute cabinets, each housing 64 nodes (i.e., 32 boards). The present setup has 4536 compute nodes (9072 processors) and 283 GB of RAM.

2-D planes that build the packet-switching mesh. Each plane consists of Message Routing Components (MRCs), six-ported devices that route signals to adjacent neighbors. Neighbors can be on either plane, since additional MRC connections bind the two planes together. This



The ICF in Intel's TFLOPS machine provides alternate signal paths for reliability.

The system's two I/O subsystem cabinets each contain about 25 nodes. One node monitors the system's health; four manage the Ethernet, FDDI, ATM, and boot-network connections; and 16 to 20 handle the RAID arrays. Each cabinet has more than 32 PCI slots for adding new peripherals. Each I/O subsystem cabinet manages its own 1-TB RAID array. All the cabinets are arranged to minimize the signal length in the InterConnection Fabric (ICF), the network that ties the nodes together.

The TFLOPS system arranges the processors in what's known as a 2½D mesh, as shown in the figure "The TFLOPS Topology." Nodes connect to one of two

arrangement provides alternate data paths so that you can replace a faulty network segment without switching the system off.

Each board's Network Interface Component (NIC) multiplexes all network traffic at a low level. The combination of NICs and MRCs make up the ICF. The ICF does not maintain memory coherency: That job is up to the OS.

Different portions of the TFLOPS machine run different OSes. The compute nodes run a Light-Weight Kernel (LWK) based on SunMOS and the Puma OS. Since each compute node runs a copy of the kernel, a small memory footprint is essential. The I/O nodes run a System V-compatible version of Unix.



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that direct marketing and sales efforts. "The SP2 has boosted the rate of our analysis by an order of magnitude," Geller says. "Queries that once took over 2 hours now take only a minute. This also lets us ask questions that weren't possible before."

A supercomputer's capacity lets a company combine the data-processing needs of diverse departments, often with synergistic results. For example, Macklanburg-Duncan, a manufacturer of building-improvement products, uses a Cray CS6400 Enterprise Server to integrate its customer orders and manufacturing and financial information. The system keeps track of inventory for 4000 different products and helps coordinate shipments to 17,000 customers nationwide.

Previously, this data was on separate mainframes. According to Michael Mack, Macklanburg-Duncan's manager of technical services, consolidating all these operations on the Cray gives the company a fast response time on orders. "An order goes through a series of processes, and if this process releases the order, the shipping form gets printed immediately. The entire operation takes only 30 minutes if an order is transmitted electronically," he says.

Phone orders take a little longer: A customer-service consultant enters an order on-line and has the option of immediately processing it or allowing a periodic batch job to perform this task. The company warehouses orders so that geographic and purchase-activity information can help direct the company's decision-making. "Because of the Cray's scalability," Mack continues, "we'll be able to add other divisions or acquisitions without having to purchase additional machines. There will be incre-

SUPER VISION

The new breed of supercomputers can pay for themselves in many ways. Dr. Dwight Sukup, of Texaco's Exploration and Production Technology Division, uses an SGI Power Challenge in his work. The system processes seismic data to generate 3-D images of how subsurface formations look. These images improve the accuracy of locating new oil and gas reserves.

Accuracy is the name of the game in oil exploration, where an offshore well in the Gulf of Mexico can cost up to \$20 million to drill. More important, since only one out of six wells ever finds hydrocarbons, "anything that improves the odds so that we save \$20 million at a time is worth it," says Sukup.

The imaging job begins with the collection of seismic information over a 50-square-mile area. Such a survey costs millions of dollars and takes months to complete. The data consists of roughly 50 million seismic traces, each made up of 2000 sam-

ples. Based on an estimated earth model (i.e., a map of the formations), the data is imaged into a 300-by-400-by-1000-point grid. The imaging information provides data to improve the earth model, and then the process is repeated. It might take several iterations to obtain acceptable results.

Any formation data available from wells in the area can improve the physics of the model. "Often we're doing exploration work, where there aren't any wells. For that, we might estimate formation material using data taken from wells over 50 miles away," explains Sukup. The Power Challenge works on the seismic data, and the results are fed to a seismic-interpretation workstation for visualization.

By rotating and viewing slices of the 3-D formation map on the workstations, a geoscientist can spot potential "traps," or impervious layers of strata where hydrocarbons might accumulate. This imaging work is especially valuable in evaluating complex geologic regions

around salt structures. In these areas, the formations are a jumble of different layers of material displaced by the upwelling mass of salt. They make suitable traps for hydrocarbons moving through the porous strata. Geoscientists can look inside these complicated formations to locate a trap and to predict whether it contains sufficient hydrocarbons to warrant drilling a well.

The SGI Power Challenge that Sukup uses has 14 processors and 4 GB of RAM. It takes the system weeks or months to process one of his models. However, in an industry where it takes months to get a drilling rig into position, accuracy is critical. Plus, the SGI system costs less to operate than a vintage supercomputer.

Says Sukup: "We used to have a Cray Y-MP (a 1988-era supercomputer) in here that cost several million a year, because it required its own maintenance staff to operate. The Power Challenge just sits there, and we have our Unix person check it out occasionally."

mental costs to add resources, but the CS6400 gives us the ability to expand as our business grows."

Tall Buildings to Leap

While supercomputer vendors such as Cray Research and SGI have used ingenious techniques to extend SMP's performance, this architecture will eventually reach a performance limit. In the long term, like it or not, future application designs will have to grapple with MPP systems and message-passing schemes.

Unfortunately, as the description of the MPP architecture suggests, writing such parallel code is not easy. A dearth of development tools—not surprising, given the relative newness of MPP designs—aggravates the situation. Debugging is especially complex, since it's difficult to isolate a problem connected to a thread that has crashed on a single processor.

In a scene that's similar to desktop computing, supercomputing hardware has outpaced the software. While writing such software will take time, the situation is not that grim: There's plenty of work for su-

percomputers to do with the software that's currently available.

Supercomputing's transition has required the parallel processes of design simplification and standardization, the use of multiple inexpensive components, and proper marketing—all similar paths to the computer industry as a whole. Supercomputers have escaped their ivory-tower prisons to help businesses with such mundane-but-crucial tasks as rapid order turnaround and strategic decisions made with the help of data mining.

There seems little doubt that the lessons learned in the stratosphere of computing will eventually appear in desktop machines that routinely use similar multiple-processor architectures. Thus, the final triumph of supercomputing may be its assimilation into desktop computers everywhere. ■

Tom Thompson is a BYTE senior technical editor at large with a B.S.E.E. degree from the University of Memphis. You can reach him on AppleLink as "T.THOMPSON" or on the Internet or BIX at tom_thompson@bix.com.

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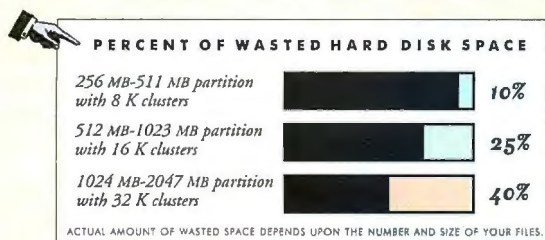
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AMD K6 Takes On Intel P6

TOM R. HALFHILL

It takes a lot of nerve to add new instructions to the x86 instruction set if your name isn't Intel. And it's especially cheeky if you're a tiny company like NexGen, barely a mosquito on Intel's back.

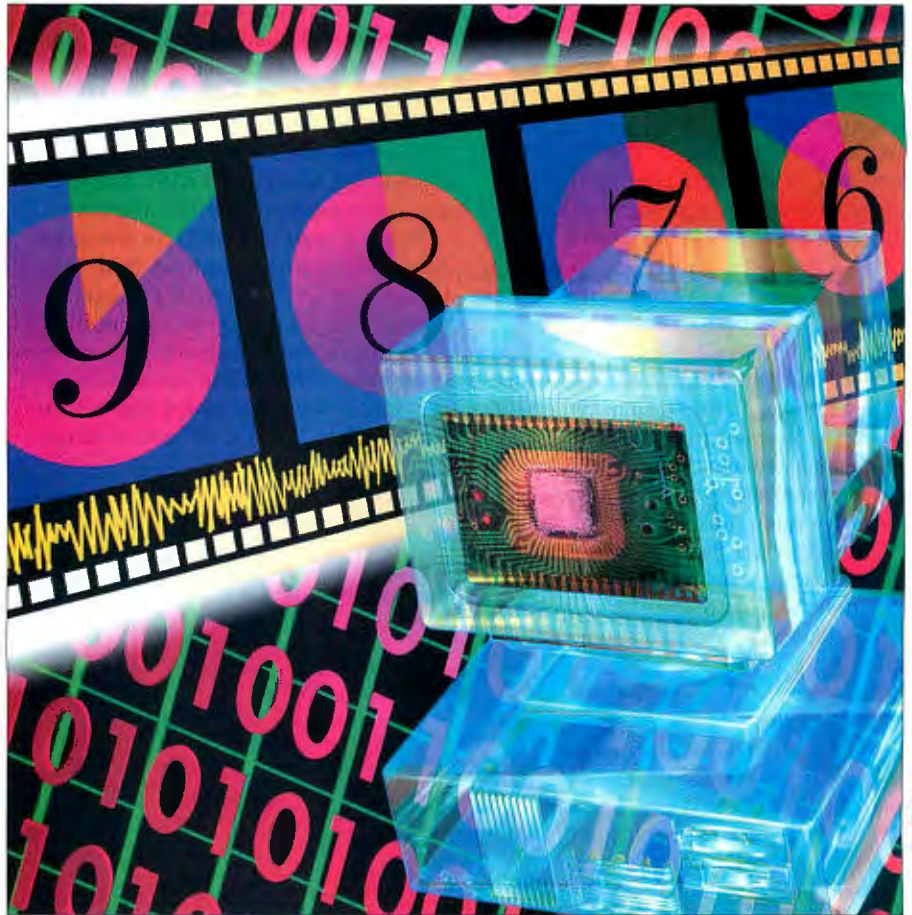
Yet that's what NexGen hoped to do. Last October, the company announced its latest microprocessor, the Nx686. It was the first x86 chip to integrate a multimedia execution unit and a new set of multimedia instructions. Never before had anyone but Intel attempted such a bold revision of the 18-year-old x86 architecture. Could anyone take NexGen seriously?

Then came stunning news. NexGen—which ranked last behind Intel, Advanced Micro Devices, and Cyrix as a vendor of x86-compatible chips—agreed to be acquired by AMD. And AMD promptly scrapped its own sixth-generation CPU project in favor of the Nx686, which will now be marketed as the AMD K6.

The surprise announcement instantly boosted the prospects for NexGen's maverick microprocessor. AMD is a \$2 billion company that has serious marketing muscle and high-profile customers, including five of the top six suppliers of PC compatibles. In addition, AMD has its own process technology and wafer-fabrication plants. NexGen, a fabless company, subcontracts its manufacturing to IBM Microelectronics. (This partnership may continue for some products, including the Nx586.)

Suddenly, Intel faces stiffer competition for an emerging market of multimedia CPUs. While NexGen was developing the Nx686, Intel has been working on its own multimedia x86 processor, code-named the P55C. This Pentium variant will probably make its debut in the second half of this year, about the same time as the Nx686/K6. Intel isn't releasing many details, but we know the P55C will also define new multimedia instructions for the x86 architecture.

Of course, Intel still wields more clout than AMD and NexGen. Only by joining forces with compiler vendors, software developers, and perhaps other chip makers can AMD ensure that the K6's multimedia extensions will survive alongside Intel's. Before



SHAMEN LIAO © 1996

AMD's new K6 (formerly the NexGen Nx686) is the first x86 chip with special multimedia instructions

the merger, NexGen claimed it was part of such an alliance but said the other members weren't ready to go public. When the time is ripe, company officials say, it will be apparent that the alliance has enough strength to make the extensions a de facto industry standard.

That remains to be seen. Even without its multimedia enhancements, however, the K6 is still an impressive chip. If it lives up to expectations, the K6 could match or beat the performance of Intel's flagship processor, the Pentium Pro (formerly called the P6).

Multimedia Marvels

The K6's multimedia execution unit is one of seven execution units in the new processor. NexGen says it occupies only about

AMD K6 TAKES ON INTEL P6

5 percent of the chip's die area. Because the K6 is not yet in production, NexGen won't reveal the actual die size, other than to claim it will be "substantially smaller" than the Pentium Pro's die of 306 square millimeters. The multimedia unit probably accounts for less than 300,000 of the K6's six million transistors.

That's not a lavish expenditure in the transistor budget of a leading-edge microprocessor these days. But what does it buy? NexGen says the multimedia unit recognizes about 10 to 20 new instructions. All are designed to streamline multimedia processing, such as digitized audio, digitized video, 3-D graphics, MPEG-2 decompression, motion estimation, and pixel manipulation. According to Greg Favor, who directed the chip's development, the extended instructions are fairly general in nature, so they won't become obsolete as the industry defines new standards.

One new instruction performs the same kind of multiply-accumulate (MAC) function often seen in digital signal processors (DSPs). Programmers can use the MAC instruction to multiply and add a series of numbers repeatedly without a branched program loop. It's faster than regular x86 code because the CPU doesn't have to execute separate instructions for the multiply and add operations or evaluate a branch during each iteration of the loop.

NexGen won't say much about the other new instructions, except that they adhere to a single-instruction/multiple-data (SIMD) model, just like some DSPs. In other words, each instruction operates on multiple operands of data. That's ideal for multimedia, which typically consists of lengthy data streams that must be compressed, decompressed, or otherwise transformed. In concept, the K6's new instructions resemble a similar subset of multimedia instructions that Sun Microsystems defined for its UltraSparc processor in 1994.

Externally, the new K6 instructions are as accessible to programmers as any other x86 instructions. However, NexGen hints that application programmers probably won't have to explicitly call the new instructions because they'll be encapsulated by higher-level APIs, such as Microsoft's Direct-X for

Windows. Certainly an ally such as Microsoft would be useful to an industry alliance that wants to extend the x86 architecture without the blessing of Intel. (Microsoft has no comment on this.)

Internally, the K6 translates the multimedia instructions into RISC86 operations—the RISC-like primitives that were the most innovative feature of the Nx586 when it appeared in 1994. The Nx586 was the first x86 processor to introduce this concept of a decoupled CISC/RISC microarchitecture. On the outside, to x86 software, the chip behaves like a normal x86 CPU. But inside, special decoders translate the variable-length CISC instructions into fixed-length (albeit long) RISC-like operations that execute in a RISC-like core.

NexGen, Intel, and AMD are now using decoupled microarchitectures in all their latest CPUs. They believe it's a better approach than trying to execute multiple CISC instructions in parallel and out of order. The only holdout is Cyrix; engineers there say a decoupled microarchitecture will become too difficult to manage

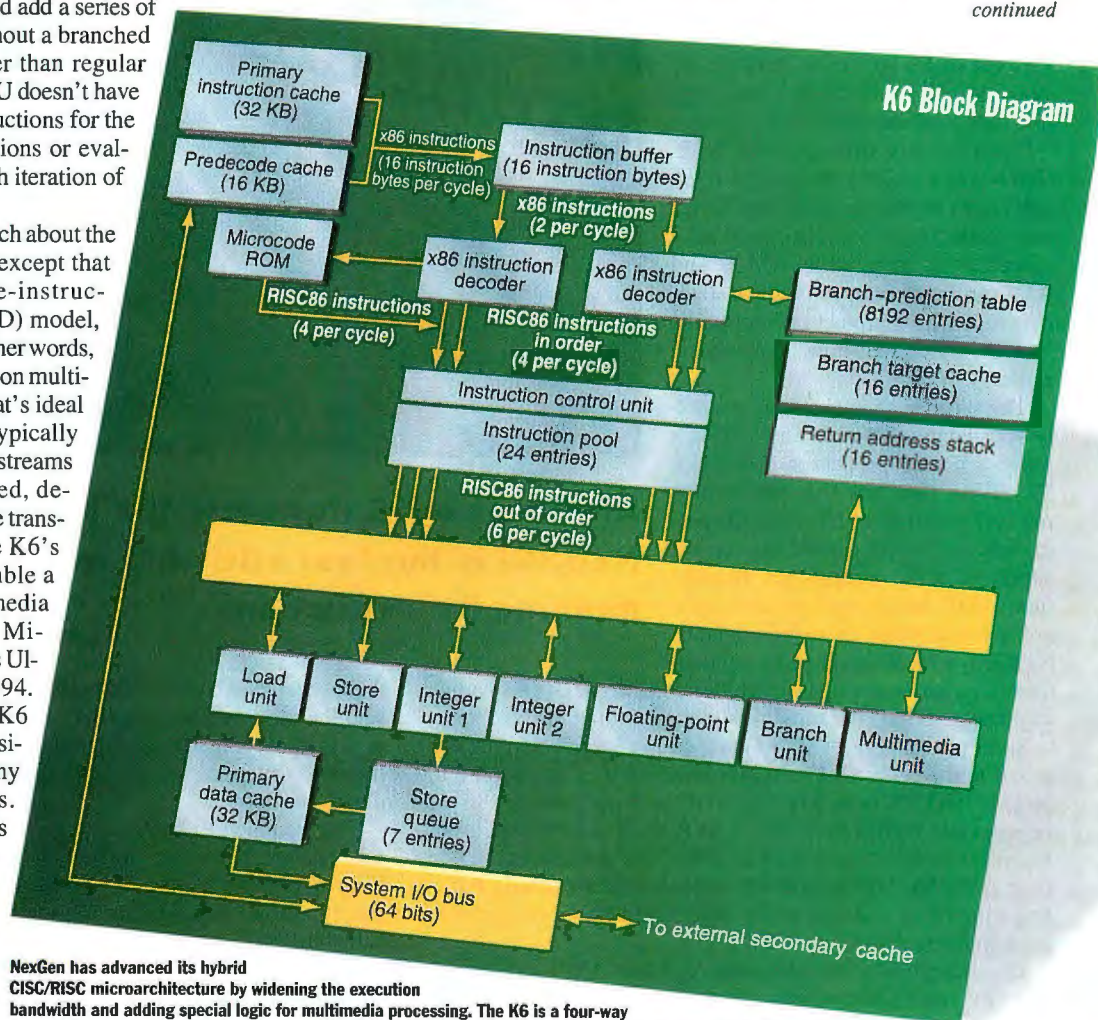
in wider superscalar designs.

Favor says the K6's multimedia instructions are easy to execute in parallel because they're more efficient than most x86 instructions. Each one breaks down into just one or two RISC86 operations. The MAC instruction, for example, translates into a single RISC86 primitive that typically executes in a single cycle.

According to NexGen, the multimedia unit can execute up to 6 billion operations per second (BOPS). That's amazing if true. The fastest general-purpose DSP—Texas Instruments' TMS 320C80 Multimedia Video Processor—executes about 2 BOPS.

Until AMD makes the K6 available for independent benchmarking, however, it's unclear how often the processor will be able to sustain 6 BOPS. TI's chip appears to have more internal bandwidth, and it uses a multiple-instruction/multiple-data (MIMD) model instead of a SIMD model like the K6 uses. If the K6 comes anywhere close to sustaining 6 BOPS when running real-world multimedia software, it will be a significant accomplishment.

continued



NexGen has advanced its hybrid CISC/RISC microarchitecture by widening the execution bandwidth and adding special logic for multimedia processing. The K6 is a four-way superscalar processor with seven execution units; during each clock cycle, it can execute up to six instructions and retire four. At the far right of this diagram is the multimedia unit, which recognizes a new set of multimedia instructions.

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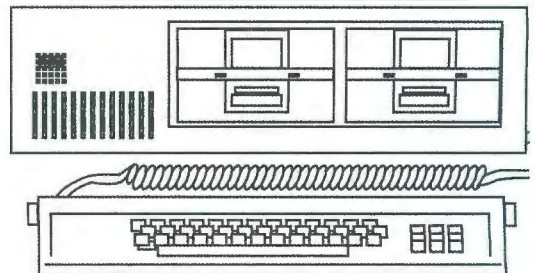
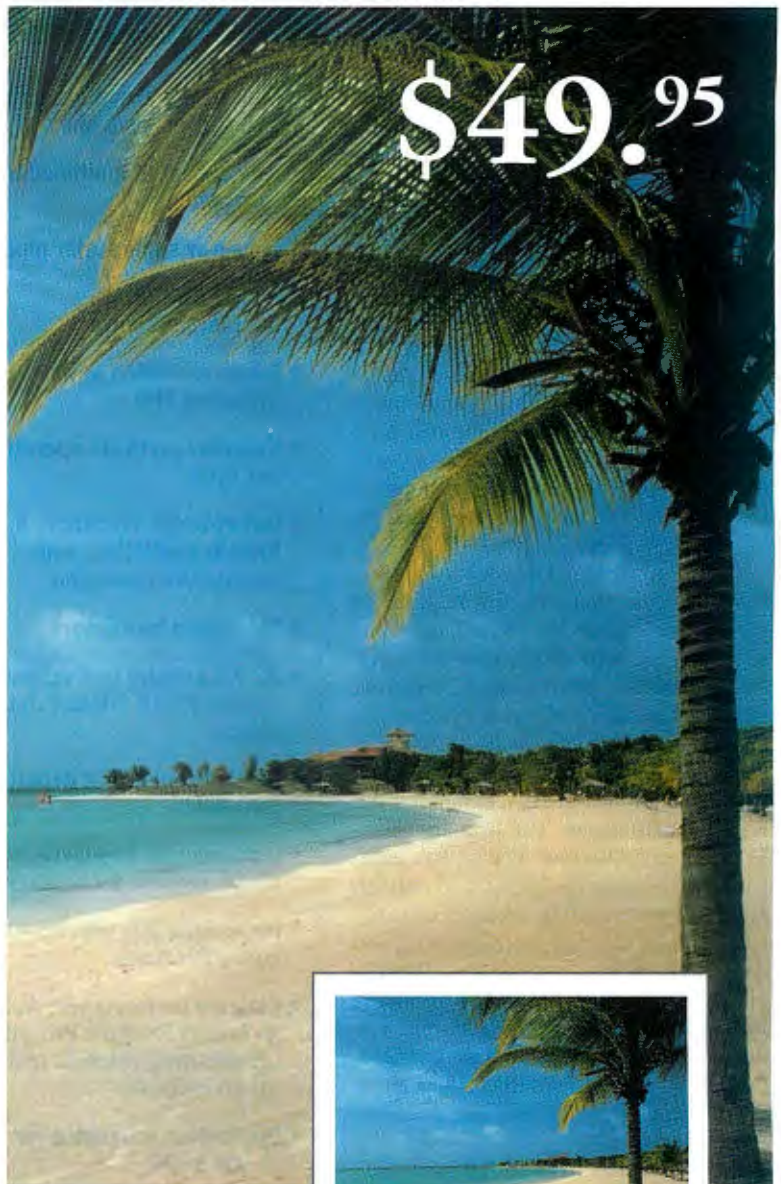
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Bottlenecks Begone

There's a lot more to the K6 than its multimedia unit. The new chip fixes several shortcomings of the Nx586 by adding larger caches, multiple decoders, more registers, deeper queues, and additional execution units. As a result, the K6 is now a four-way superscalar processor; the Nx586 is a three-way design.

However, NexGen has discarded two key features of the Nx586: the integrated cache controller and the dedicated bus for the secondary (level 2) cache. These were casualties of NexGen's last-minute decision to make the new chip pin-compatible with the P54C-series Pentiums. As a pin-compatible part, the K6 will work with the same peripheral chips as the Pentium—for example, PCI chip sets designed by third-party vendors.

But the downside of this decision is that the K6, like the Pentium, now requires an external cache controller and will access its secondary cache (if present) over the same 64-bit bus it uses for memory I/O. Sharing the same bus hurts performance because of bus contentions.

To compensate for this performance loss, NexGen has greatly expanded the K6's onboard cache. The primary (level 1) caches in the K6 now total 64 KB, compared to 32 KB in the Nx586 and only 16 KB in the Pentium. The caches are evenly split, with 32 KB each for instructions and data. Both caches are two-way set-associative and support the MESI protocols for cache-coherent multiprocessing. The data cache is dual-ported and isn't banked, thus eliminating bank conflicts. It can handle one read operation and one write operation per cycle.

NexGen also added a 16-KB predecode cache that's closely coupled to the instruction cache (I-cache). The predecode cache holds special information that's generated when the K6 fills the I-cache. For example, as part of its predecoding, the K6 locates and marks the boundaries between x86 instructions, which are variable in length. (This step is unnecessary in a true RISC processor because RISC instructions are always fixed-length.) Predecoding speeds up full decoding further down the pipeline; AMD's K5 has a similar stage.

However, one drawback of predecoding is that it lengthens the x86 instructions by appending extra information to them. In the case of the K6, each instruction byte gains 4 bits (1 nibble) of predecode data. This threatens to effectively reduce the working size of the I-cache by 50 percent. To avoid this size penalty, the K6 stores the extra nibbles in the 16-

K6: What's New

- **Multimedia execution unit; first x86 CPU to have one**
- **New subset of multimedia instructions**
- **Four-way superscalar pipelines**
- **Hybrid CISC/RISC microarchitecture**
- **Seven execution units, including FPU**
- **Executes up to six operations per cycle**
- **Out-of-order execution, dynamic branch prediction, and speculative execution**
- **Six million transistors**
- **32-KB primary instruction cache; 32-KB primary data cache**
- **Clock frequency at debut: 180 MHz**
- **0.35-micron, five-layer-metal, CMOS process technology**
- **Pin-compatible with P54C-series Pentiums**
- **Claimed performance: At least as fast as Pentium Pro with 32-bit software; twice as fast with 16-bit software**
- **Production scheduled for mid-to late 1996**

KB predecode cache. Then, when the K6 fetches instructions from the I-cache into the instruction buffer, it simultaneously retrieves the nibbles.

The K6 also marks branch instructions during the predecode stage and calculates their target addresses. All branch predictions are based on a two-level dynamic algorithm with a 2-bit history flag (strongly taken, weakly taken, weakly not taken, and strongly not taken). The K6 stores these flags in an enormous branch-prediction table that can hold 8192 entries. It also stores the return addresses and target addresses in two additional caches that each hold 16 entries. As a result, the K6's branch prediction is well over 90 percent accurate, putting it in the same league as the Pentium Pro and ahead of other x86 processors.

Parallel Decoding

Where the Nx586 could decode only one x86 instruction per cycle because it had just one instruction decoder, the K6 has two decoders and can handle two x86 instructions per cycle.

The Pentium Pro has three x86 decoders, but two of them can deal only with simple instructions, and the most complex instructions are detoured into a microcode ROM. NexGen claims the K6's decoders are more capable: They're not constrained by instruction groupings that would stall the Pentium Pro's simple decoders, and they can decode a larger subset of x86 instructions without using microcode. (Of course, the most complex or rarely used x86 instructions still invoke microcode.) NexGen says it considered adding a third decoder, but simulations revealed a performance gain of only 2 to 5 percent in return for a frequency loss of 15 to 20 percent—not a good trade-off.

Although the maximum input to the decoders is two x86 instructions per cycle, the maximum output is four RISC86 operations each cycle. That's because the CISC instructions usually break down into two or more RISC-like primitives.

Examples: INC register translates directly into a single RISC86 register operation; ADD register, memory gets reduced to a load operation and a register operation; ADD memory, register results in a load operation, a register operation, and a store operation. The worst x86 instructions can generate dozens or even hundreds of RISC primitives. In those cases, the K6 can issue as many as four RISC86 operations per cycle from its microcode ROM.

The K6's pipeline gets wider toward the middle. During each clock cycle, two x86 instructions can enter the decoders; four RISC86 operations can exit the decoders; six operations can issue and execute; and four operations can retire. This bulge in the middle of the pipe minimizes bubbles and stalls and keeps the seven execution units from twiddling their thumbs.

The traffic cop that manages all this action is the instruction control unit (ICU). It temporarily holds up to 24 RISC86 operations and issues them to the appropriate execution units. This is also where the instructions get out of order. The ICU can issue up to six instructions per cycle in any order to any available execution unit, as long as there are no dependencies between instructions. (An example of a *true dependency* is when one instruction depends on the result of a previous instruction.)

To reduce the chances of so-called *false dependencies*—instances where register-

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dependent instructions might stall because there aren't any available registers—the K6 has a large set of 48 general-purpose registers, compared to 14 in the Nx586. Eight of them represent the eight logical registers of the x86 architecture. The K6 can temporarily rename the other 40 physical registers to represent any of the eight logical registers. When a register operation retires, the K6 copies its value into the corresponding architectural register. This is quite similar to how the Pentium Pro uses its set of 40 physical and eight logical registers.

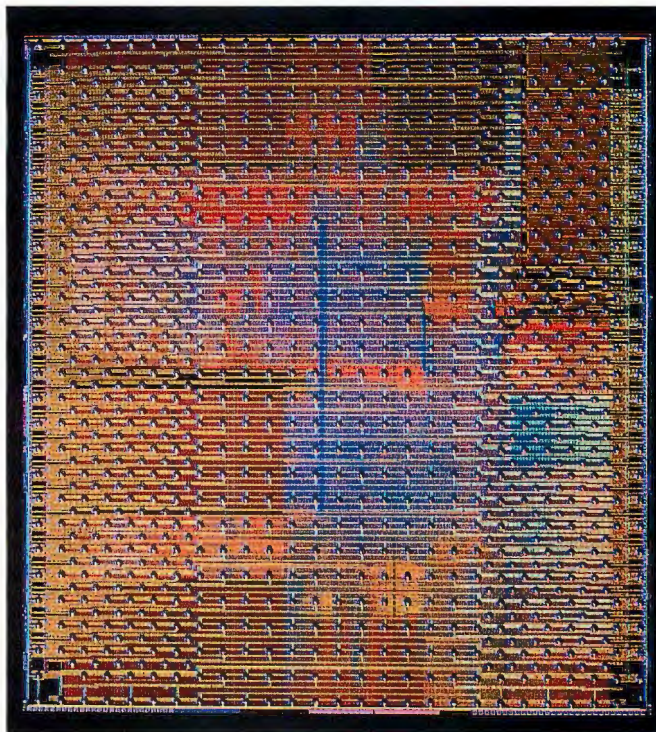
A feature called *register-result bypassing* allows the K6 to make completed results immediately available to subsequent instructions without accessing main memory. Because register operations are much faster than memory accesses, register-result bypassing can save numerous clock cycles. Also, NexGen claims the K6 is particularly fast at loading segment registers and at handling partial register operations. This means that it should outperform the Pentium Pro when running 16-bit software.

However, the K6's ICU draws from a smaller pool of pending instructions than the Pentium Pro's instruction scheduler: 24 versus 40. And the ICU can't track more than 12 x86 instructions at a time. A larger instruction pool—which is a window into the running program—would allow more flexibility when issuing instructions out of order. Still, the K6 is more flexible in this regard than the Nx586.

Execution Time

In addition to its innovative multimedia unit, the K6 has six other execution units: a load unit, a store unit, two integer units, a branch unit, and an FPU. Again, this is a significant improvement over the Nx586, which has only three execution units and is the only fifth-generation x86 processor without an integrated FPU.

The K6's separate load and store units



The K6 will be fabricated on AMD's 0.35-micron, five-layer-metal CMOS process technology. NexGen says the die, shown here, will be significantly smaller than the Pentium Pro's die, which is 306 square millimeters.

will speed up memory reads and writes, a prominent barnacle on the hull of CISC instruction sets. Each unit has a two-stage pipeline. The store unit feeds results into a seven-entry queue that temporarily holds them until the CPU completes all previous instructions and resolves any dependencies. Holding them

assures that all instructions retire in original program order, regardless of the order in which they executed.

One exception: If a load operation depends on a pending store, the load can bypass the store and fetch the value directly from the results queue. Since this happens before the store unit actually writes the value to memory, it eliminates another slow memory access.

The K6's two integer units are not symmetrical; one can handle a superset of arithmetic operations, including multiplication and division. Most operations execute in a single cycle, and multiplication requires

only two cycles. Floating-point math appears to be fast, too. Although the K6's FPU is not as heavily pipelined as those in the Pentium and Pentium Pro, its latencies are shorter. NexGen says most floating-point additions, subtractions, and multiplications will execute in only two cycles.

As mentioned, the branch unit is among the most efficient in any x86 processor. Much of its work is done early, because it calculates target addresses while decoding. If the correct target address isn't cached, the branch unit calculates and fetches the new target during the next stage, paying only a one-cycle penalty. However, if the branch unit mispredicts a branch, it needs about five cycles to recover—not an unreasonable penalty for a CPU whose predictions are more than 90 percent accurate.

Overall, the K6's pipeline is five or six stages long, depending on the operation. Register and integer operations typically require five stages, and

load/store operations need six. The K6 isn't superpipelined like the Pentium Pro, so it probably can't be driven to the same high clock frequencies. NexGen hopes to achieve superior performance with architectural efficiency, not extreme clock speeds.

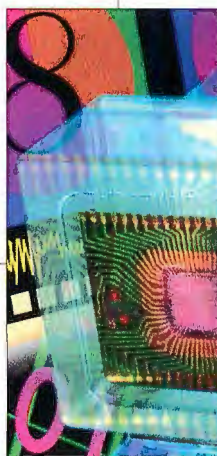
NexGen has been testing silicon samples of the chip since September, so the engineers can roughly estimate its actual performance. They say they expect that the K6, at equivalent clock speeds, will beat the Pentium Pro when running 32-bit software, and perhaps outrun it by as much as 33 percent. With 16-bit software, NexGen expects the K6 to run about twice as fast as a Pentium Pro.

If the K6 can deliver that level of performance on a die as small as NexGen suggests, the new processor could achieve a significant price/performance advantage over Intel's top-of-the-line chip. When you throw in the multimedia goodies, the K6 looks even better.

Of course, nobody—including AMD and NexGen—expects to dislodge Intel as the king of the x86 market. But the K6 chip could carve out a respectable niche and presage the multimedia microprocessors of the future. ■

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

The K6's designers hope to achieve superior performance with architectural efficiency, not by driving the chip to extreme clock speeds.



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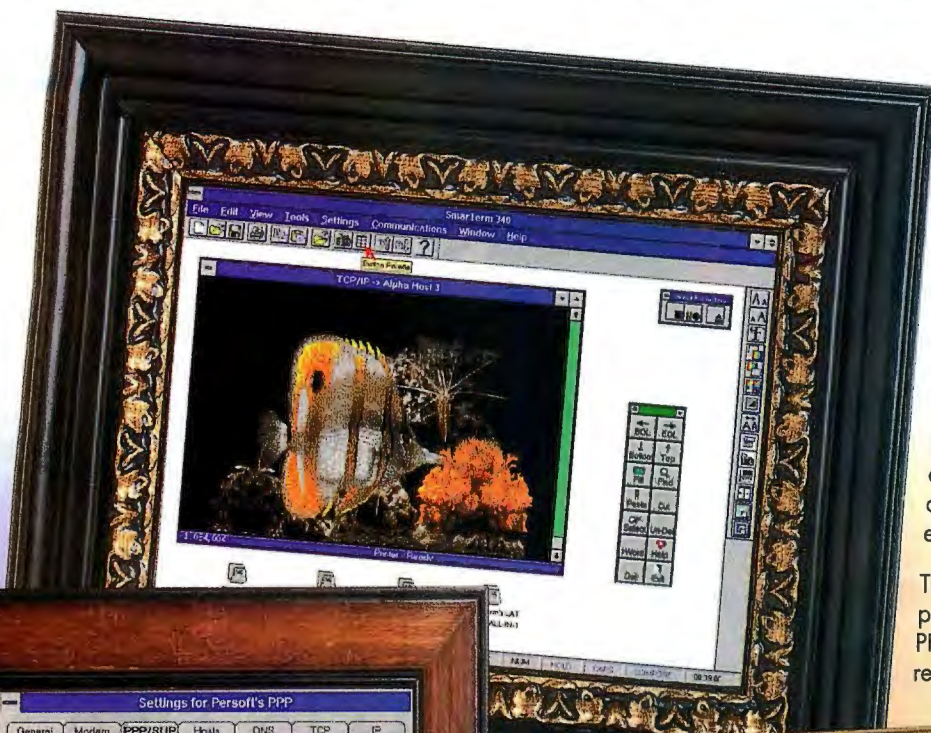
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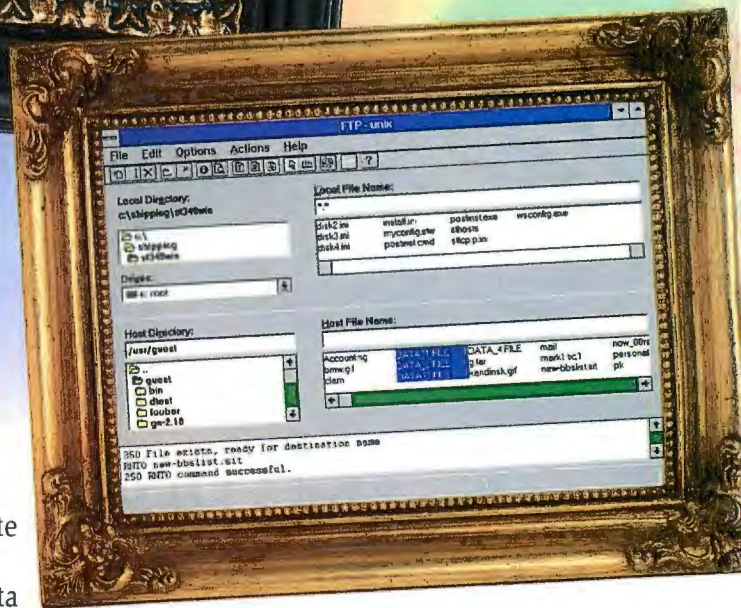
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Wired on the Web

ANDREW SINGLETON

You're busily browsing the World Wide Web, clicking on links, avoiding commitment. Suddenly, the page comes to life. Animated figures tumble from the margins. Graphs slink sideways through time. A beveled data-entry panel appears, complete with running totals.

This is HotJava, Sun Microsystems' Web browser. It can download its own programs, called *applets*, and run them embedded on a Web page. In many ways, HotJava represents the holy grail of computer science—a universal, global OS.

HotJava retains the key advantage of a traditional Web browser—universality. But while standard Hypertext Markup Language (HTML) browsers sacrifice features so they can display information on many kinds of computers, HotJava enables you to extend an HTML browser. Any client, regardless of its CPU or OS, can access the same applications as long as it's using a Java-enabled browser (see the figure "The Universal Interface" on page 80).

This means client/server developers that use HotJava as a front end might never need to install any customized client software. And if a developer uses the Java programming language, an application might never need to be ported to another system.

Not Just Another Browser

While Java and Hot Java have great potential for revolutionizing the Web, they actually predate the Web frenzy. James Gosling, a Sun engineer and creator of the NeWS windowing system, started work on Java in 1991.

Originally called Oak, Java was designed for programming consumer electronics, where it would be used to create a heterogeneous network of home appliances. This environment defined Java's characteristics as a small, reliable, real-time interpreter that was, above all, portable and able to leap across the wire. Searching for a useful application, the Sun team made a foray into the set-top-box market. Then in mid-1994, according to Gosling, "we realized we could build a really cool browser."



It's not just for breakfast anymore; with HotJava, you'll get a jolt every time you use your World Wide Web browser

The HotJava browser runs applets written in the Java language. Java is an interpreted language that's based on C++ but is designed for dynamic loading. HTML pages that are designed for HotJava have special tags of the form `<app=3Dappname height=3Dxxx width=3Dyyy>`. When HotJava sees the `app=` tag, it goes back to the Web server that the

HTML page originally came from and asks for the file `appname.class`. HotJava then creates a window on the Web page with the dimensions `xx,yy` and runs the applet in the window.

While Java has a syntax similar to that of C++, it's designed to work around C++'s more problematic features, especially linking, object instantiation, and memory management. For example, instead of including class definitions and then linking the code, Java programmers just import the code and definitions dynamically in a single statement. Additionally, instead of using Delete and then chasing memory leaks, Java programmers can just continue and let a garbage collector clean up memory.

continued

The complete Java kit, which is available (in most cases for free) from the Sun server at <http://java.sun.com>, includes a HotJava browser, a Java compiler (called javac), documentation, and libraries. The javac compiler turns Java source code (java files) into class files containing *bytecode*, a low-level pseudo-machine language. A virtual machine on the target platform then interprets the bytecode.

As an interpreted language, Java sacrifices speed—programs interpreted on the Java virtual machine run about 10 to 15 times slower than compiled programs do. Sun is aware of this problem and plans to address it in a future release, which might be available by the time you read this article. Java interpreters use just-in-time compilation to load the bytecode and then translate it to local machine code. Thus equipped, Java should be fast enough for any application, including real-time graphics.

To deploy a Java applet (see the figure "How Java Works" below), you just put the class files on any Web server. Regular HTTP servers work fine for serving HotJava applications, since HotJava uses a standard HTTP GET command to retrieve its code.

Though easy to get and deploy, Java requires a higher skill level for content developers than HTML. Java is a real programming language that requires a real programmer. Programmers have to learn their way around the standard Java library, which contains objects and methods for opening sockets, implementing the HTTP protocol, creating threads, writing to the display, and building a user interface within an applet.

Tackling Security

As a user, you are probably nervous about surfing into a uniform resource locator

A Sample Applet

When this sample applet is run using a Java-enabled browser, it randomly cycles the colors of the text associated with it.

```
// Call with <APP text="astring" delay=anumber>
// this applet paints <astring> in a random color every <anumber> milliseconds

import browser.Applet;
import awt.Graphics;
import awt.Color;
import java.lang.Math;

class DifferentColor extends Applet implements Runnable {
    // a "Runnable" class has a run method (an "interface") to set up a "Thread"
    Thread painter = null;
    String text = null;           // text to paint
    int delay = 2000;           // repaint delay in milliseconds

    public void init() {
        text=getAttribute("text"); // retrieve from the caller
        delay = Integer.parseInt(getAttribute("delay"));
        resize(60, 25);           // change this to fit the text
    }

    public void paint(Graphics g) {
        // Repaint the text in a different random color each time
        g.SetColor(new Color((int) (255*Math.random()),
                               (int) (255*Math.random()),
                               (int) (255*Math.random())));
        g.drawString(text, 10, 25);
    }

    public void start() {
        if (painter==null) {
            painter=new Thread(this); // start a thread to run this applet
            painter.start();
        }
    }

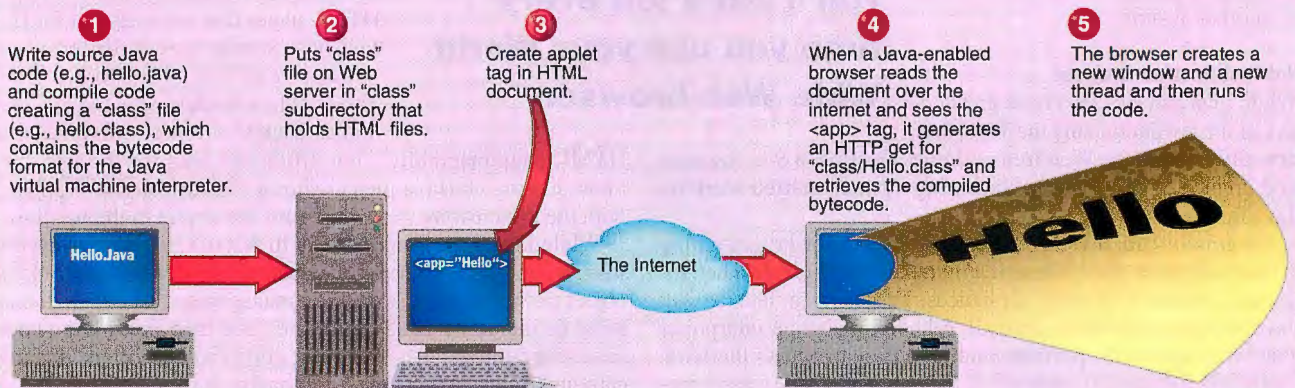
    public void run() {
        while (painter!=null)
        {
            // repaint every delay milliseconds
            painter.sleep(delay);
            repaint();
        }
    }
}
```

(URL) and splashing down into an unknown program. You don't want the program to write viruses onto your disk, read your mail, or broadcast nasty messages to users on your LAN. Because of the potential for vandalism or errors, the creators

of HotJava included a number of special security measures.

For example, a load-time check ensures reliable execution. Java is a strongly typed, stacked language. Because of this architecture, a parser can read the bytecode as it

How Java Works



Developers follow a number of steps to make animated and interactive Web pages available over the Internet.

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loads and ensure that all operations act on objects of the correct type and that all operations parse correctly.

Also, at run time, applets don't get access to the printer, and they can access only a single directory on your disk. They allocate memory from a special Java heap, and the parser checks memory access for validity.

In addition, domain-address checks constrain network access. A setting in the HotJava browser enables you to prevent a Java applet from communicating with any domain except the one from which it originated.

Is clever technology enough to prevent vandalism or security leaks from attractive Trojan horse applets? Only time will tell. However, Java applets are safer than ordinary Internet freeware, and Java's attention to security sets it apart from other types of downloadable code.

Competition Looms

Java faces its first real competition in the on-demand software category from Microsoft's Blackbird, a system for authoring

By contrast, Microsoft's Blackbird is a complete authoring and publishing environment. It harnesses all the features of Windows 95 and OLE 2.0. Blackbird documents are pages that have embedded OCXes. A client downloads a document through a requester called the *caching object store*.

Every object on the page receives its own global universal ID (GUID), which enables a sophisticated caching and notification scheme—one that could spawn, for example, a variety of accounting mechanisms for subscription and controlled-access business models. A Blackbird client can also manipulate local OLE servers, such as Microsoft Excel. At the server end, Microsoft promises drag-and-drop layout tools for constructing content from Office source materials, as well as one-button publishing of the resulting compound documents.

All of Blackbird's wonders come at a cost: There's no security in the Blackbird client. A developer can send you an application that scans your disk for sensitive information (as the original Microsoft Network client was rumored to do) or that even vandalizes your machine. As the saying goes, let the buyer beware.

Blackbird was still unavailable at this writing, but it will clearly deliver a lot more than current Web servers and browsers do. Microsoft has promised a Blackbird client for the Macintosh; however, portability for embedded controls is unlikely. Developers' willingness to invest in Blackbird applications will depend on how sensitive they are to security and whether they believe Windows is the only OS they will ever need.

The Future of Java

In spite of Microsoft's efforts with Blackbird, Sun is committed to establishing Java as a standard, according to chief technology officer Eric Schmidt. Sun is building HotJava browsers for Mac OS 7.5+, Solaris, Windows 95, and Windows NT. At this writing, Spry and Netscape had an-

nounced their intention to include Java in a next-generation browser.

The Sun Java team has released the source code for porting to Unix systems other than Solaris. The documentation warns that this is a nontrivial port because of the use of graphics and thread primitives. However, porting projects for Linux and other platforms have sprung up in the energetic Internet freeware community. Most important, Sun has offered attractive licensing agreements to other commercial Web browser developers that want to bundle a Java interpreter.

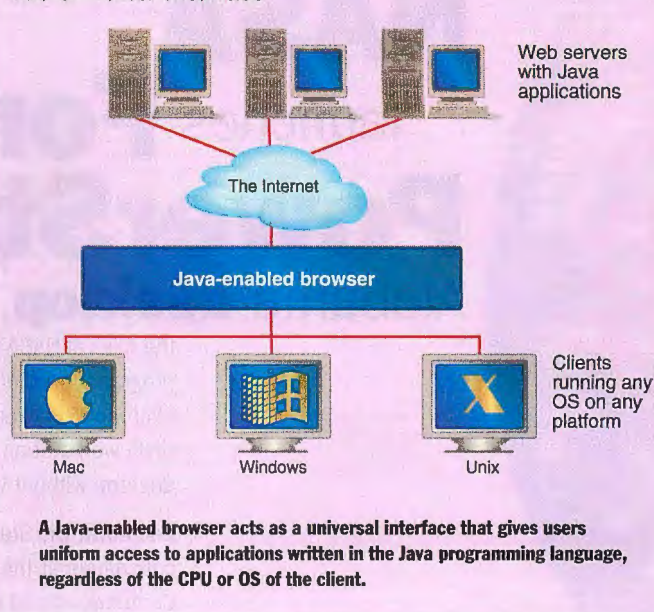
Sometime in the near future when we jack in to the Internet, when software is delivered on demand, distributed systems are stripped down into single servers, and our desktop computers are multimedia laptops with a single implementation of the universal client software, we will be able to see the technology of 1995 for what it is: huge, unstable OSes, dusty stacks of

CDs, constant upgrades and maintenance installations, phone calls for help or for overnight delivery, server closets located on every floor, complex and tenuous replication and

distribution of data, and incompatible applications. It's messy, it's expensive, and, thanks in part to Java, it's soon to be obsolete. ■

Andrew Singleton is president of Money.Com (Cambridge, MA), a provider of financial information services on the Internet. You can reach him on the Internet at andy@smokey.money.com or on BIX c/o "editors."

The Universal Interface



Anyone interested in checking out the capabilities of Java can download a HotJava browser from Sun's home page (<http://java.sun.com>).

and distributing on-line content, due to appear in early 1996. Sun and Microsoft have already started sparring about which environment is better.

Like Java, Blackbird dynamically loads code from a network, in the form of OLE Controls (OCXes) inserted into a document. After that, however, the two products cease to be similar. Java is a programming tool. It's small, portable, and secure. A Java system is likely to be easy to maintain, because its local installation is minimal and it loads most of its code on demand over the network.

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Unix Takes Off

CATE T. CORCORAN

It was a long and stormy flight. A voice rang out, "Fasten your seat belts, return your tray tables to their upright and locked positions, and please refrain from grepping until we're safely on the ground." Unix has invaded the cockpit.

You're probably thinking, off-the-shelf software is fine for word processing, but only custom code has the right stuff for life-critical applications such as aerospace. Right? Not anymore. Granted, the Boeing 777's autopilot isn't built on a Microsoft Word for Windows macro, but Boeing did break with tradition by incorporating commercial code in the maintenance display system on its new 777. The result: Engineers say they cut costs, reduced development time, and still met the FAA's requirements for quality-assurance testing and reliability.

The Unix-based Maintenance Access Terminal (MAT) displays the health of the plane. According to its designers, MAT is one of the first systems using off-the-shelf software that the FAA has allowed on an aircraft. MAT could be a first step toward eventually using standard software in more-critical parts of the plane. The 777's overall maintenance system, including MAT, could further save money by reducing the time planes stay on the ground while mechanics diagnose and fix problems.

The challenge for Boeing was to find a ready-made OS that could handle its need for real-time response and reliability yet still

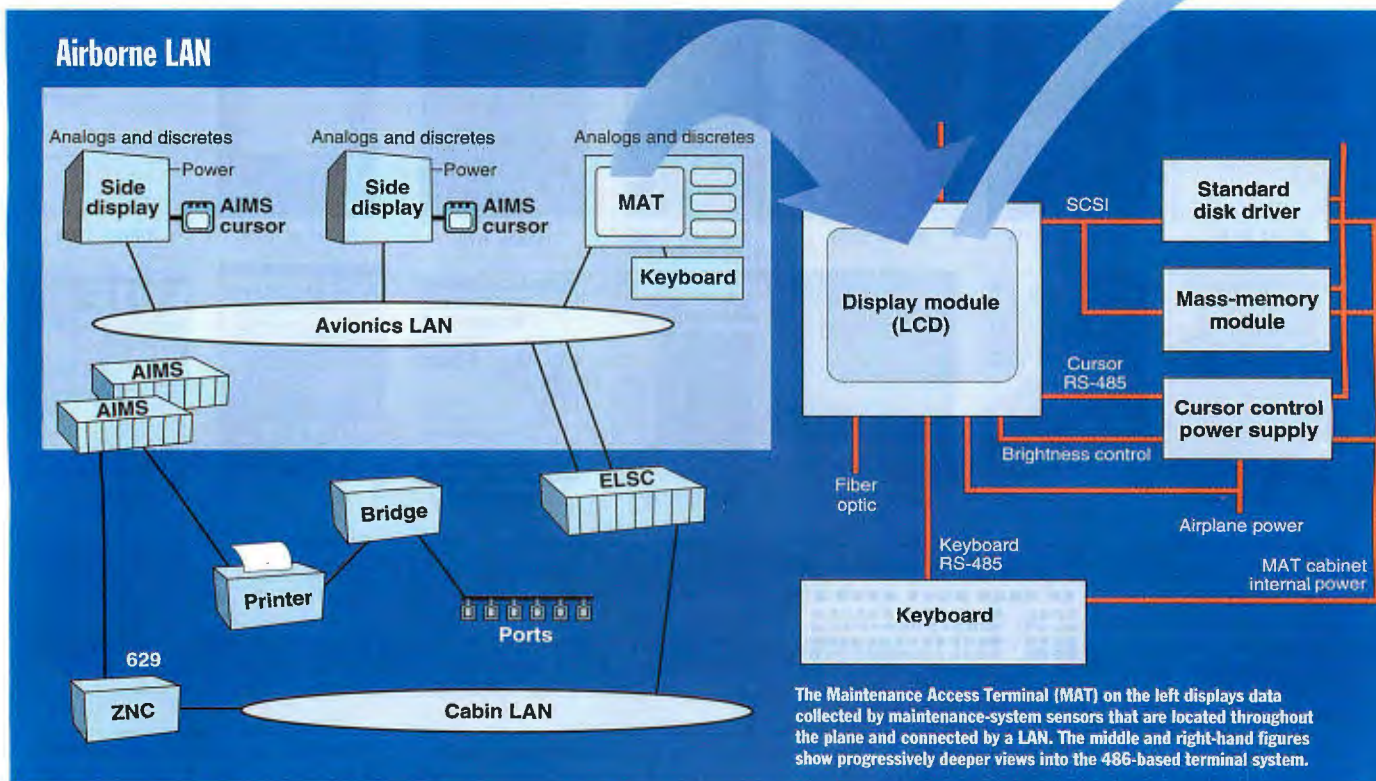
be small enough to fit within the memory constraints of an aircraft. Furthermore, the system had to be compatible with third-party applications and add-ons.

Boeing subcontracted Rockwell International-Collins Avionics (Cedar Rapids, IA) to write custom software and integrate it with Venix EDS, a commercial version of Unix from VenturCom. Rockwell also specified MAT hardware and aircraft-based LAN components, which had to meet the special requirements of an aircraft environment.

Keep It Up

The 777's maintenance equipment tracks dozens of systems on the aircraft, including the engines, engine-control systems, and landing gear. The data-collection devices and the system that runs them are not part of MAT. MAT provides only the hardware and system software for a maintenance application and user interface (UI). MAT displays maintenance data on a flat-panel LCD connected to a 486-based PC. The display sits in the cockpit behind the first officer, so the pilots and ground crew can see it as they board. Ground crews can also receive MAT data by connecting PCs to ports outside the plane.

Designers say the maintenance system reduces paperwork and centralizes diagnostic



The Maintenance Access Terminal (MAT) on the left displays data collected by maintenance-system sensors that are located throughout the plane and connected by a LAN. The middle and right-hand figures show progressively deeper views into the 486-based terminal system.

Unix makes Boeing's 777 something special in the air

information that was previously scattered across the plane on various systems. In the past, flight crews and pilots examined these disparate systems, each with a display reflecting its state of readiness. The crews then noted the information on long checklists.

The maintenance application now downloads the readiness information from the on-board LAN, and MAT presents it to the crew on a central display. Users can print the information or copy it to floppy disks for downloading to a maintenance database. (On older aircraft, someone has to manually key in information from the paper checklists to update that database.) The maintenance application saves time by telling the crew what work needs to be done and which procedures are optional, rather than requiring a crew chief to examine several reports of data and figure out what parts need to be replaced.

The maintenance application may also increase the quality and type of diagnostic information available to the crew. On the 777, sensors inside the engine and other systems measure fluctuations in temperature and other states.

The sensors take temperature readings every few seconds. By assembling the information in the database and analyzing it, the maintenance application can catch slight variations that might indicate that the fuel nozzle is blowing too

SHIPSHAPE

The Problems

- Custom software for commercial aircraft is expensive to write and requires long development time and testing cycles.
- On-board computer systems require high reliability, a small footprint, and ruggedized components.

The Solutions


- Modify commercially available hardware.
- Use a modular, commercial version of Unix and write custom software only as needed.

Benefits

- A shorter development cycle compared to proprietary-code systems.
- Greater functionality than custom systems.

Lesson Learned

- Existing Unix tests may not be sufficient for high levels of quality assurance.



ERIK SIMONSEN © 1996

much fuel into the combustion chamber, for example. The nozzle might not be broken, and the temperatures may not exceed acceptable levels, but the crew could decide to replace the nozzle or inspect the combustion chamber to prevent the possibility of a fire.

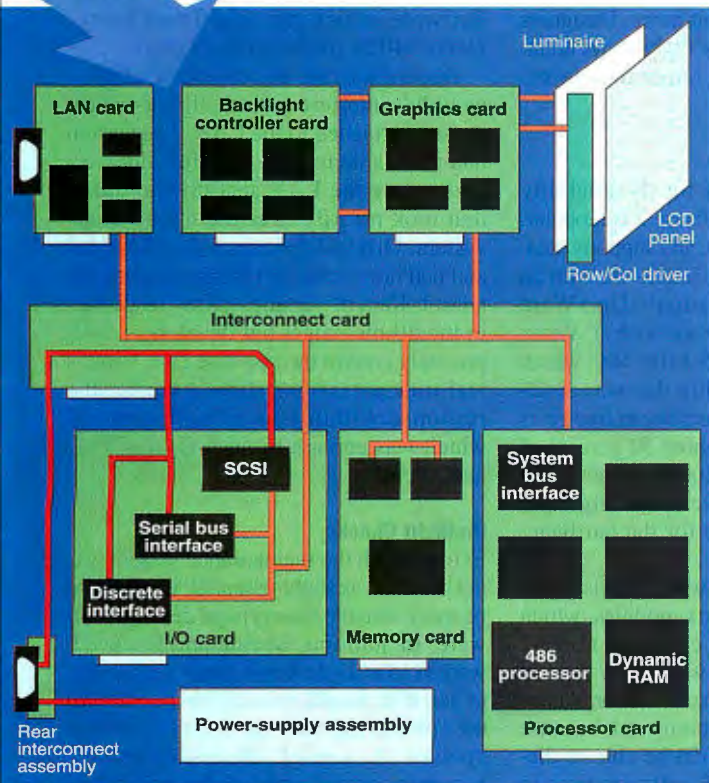
Making Your Connections

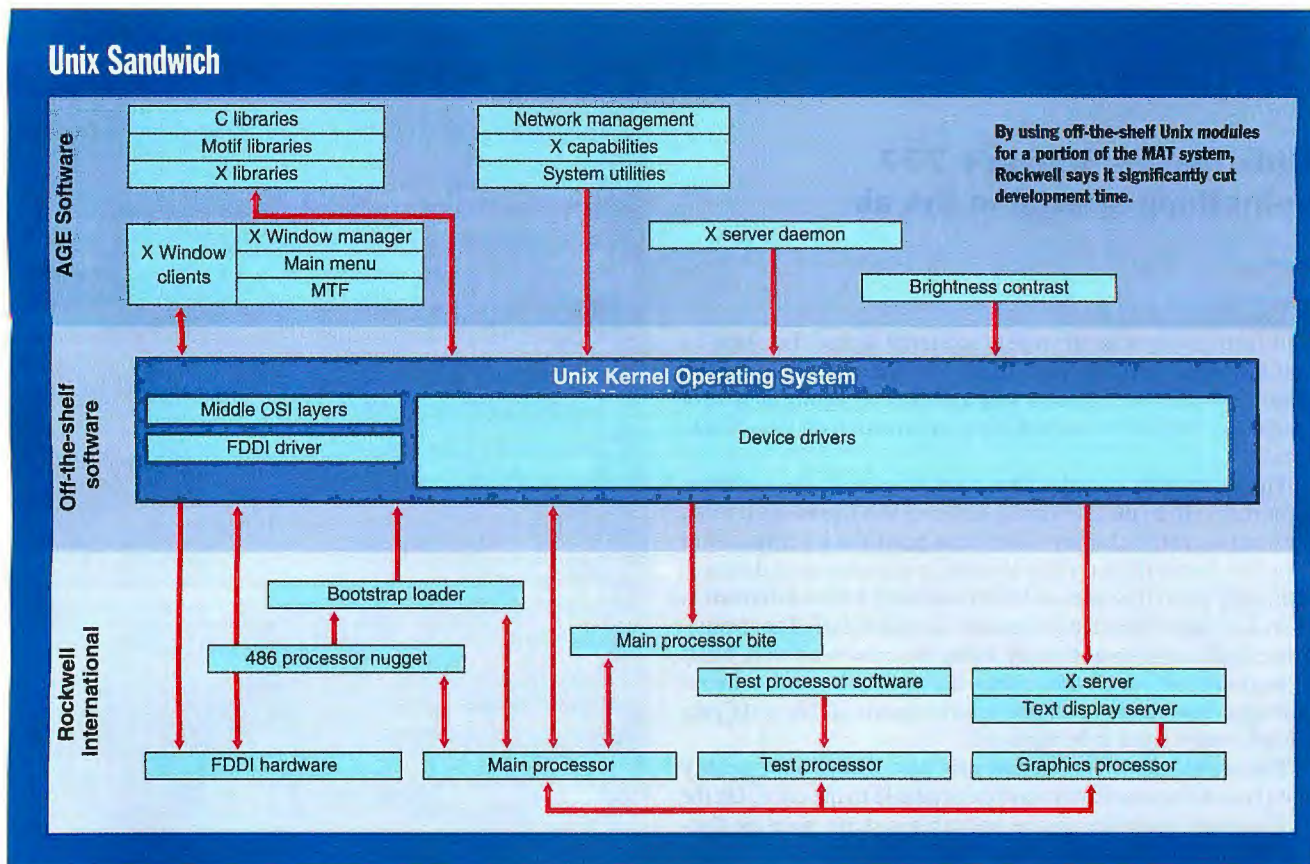
A Fiber Distributed Data Interface (FDDI) network connects the aircraft's maintenance systems with MAT (see the figure "Airborne LAN"). The architecture could have used Ethernet rather than FDDI in the final implementation. However, the original system design called for large packets that would have required the bandwidth of FDDI, according to Rockwell technical director Tom Mephram. The company later jettisoned that plan because it was too expensive and it would have been harder to receive FAA certification. But systems designers stuck with FDDI to learn how to adapt the fiber-optic wiring to an aircraft environment for future designs.

Rockwell designed the optical data link to operate in the extreme temperature fluctuations of the aircraft—from -40°C to 70°C. Rockwell also built the LAN cards and device drivers. The Open Systems Interconnection (OSI) protocol stack came from the French company Alcatel.

Rockwell adapted commodity hardware to work under the unusual conditions of an aircraft. It selected chips partly for their ability to weather temperature changes, while boards had to withstand electromagnetic interference (EMI), the gravity load, the vibrations of takeoff and landing, and temperature changes, among other considerations. At the same time, all the components had to be as small and lightweight as possible.

"We spent a lot of engineering time optimizing the mechanical design," Mephram says. To protect the system's hard drive from vibrations, the company put it on shock mounting and isolated it from other parts of the system. A housing with closed





joins surrounds the system's boards to make sure they don't emit radio waves that might interfere with plane communications. Rockwell connects some of the peripherals using a modified SCSI controller built from an NCR controller chip that met requirements for low power consumption.

To reduce power consumption, bulk, and weight, Rockwell built the MAT display with an LCD screen rather than a CRT. The display offers a 25 percent savings in power over a CRT screen, and it weighs 30 percent less. The box is only 8 inches deep, compared to the 14-inch depth of the CRT. The LCD automatically brightens or dims in response to cabin light, but Rockwell had to work hard to get the LCD screen to function reliably. The screen's fluorescent backlight was particularly troublesome, accounting for 70 percent of the display's predicted failure. Rockwell optimized the gas film pressures and mixtures inside the lamp to minimize the chances of it breaking.

Rockwell built special subsystems to ensure that MAT functions correctly. The hardware subsystem uses an Intel 80186, and it monitors each hardware subassembly and peripheral, including the PC's 486. Engineers also had to modify much of the network management code so it could

switch off and disconnect from the network any monitoring systems that weren't working, to avoid giving the crew inaccurate information. If any systems malfunction, MAT will shut itself down. Designers believe it's better to give flight crews no information from MAT rather than incorrect information.

Unix: Top Gun

Designers chose Unix for its reliability and settled on Venix because it is modular, has real-time extensions, and supports database management applications that run on The Santa Cruz Operation's UnixWare (see the figure "Unix Sandwich"). Venix also runs on MAT's 25-MHz 486, which was the fastest Intel chip that was available at the time the project began five years ago. Rockwell wrote about 30 percent of the system software itself using C and small amounts of assembly language, much of it for drivers for the hardware components.

The rest of the software consists primarily of standard Venix modules, which Boeing could pick and choose as needed. The MAT system software lacks typical Unix features such as the vi editor, whose presence might be a security risk because unauthorized users might be able to disable the system. MAT software runs in

only 16 MB of memory, a requirement on the space- and power-constrained aircraft. For the GUI, Boeing chose X Window System and Motif libraries from AGE Software, which run on a Texas Instruments 34020 graphics processor.

Boeing needed to control MAT so it wouldn't interfere with the flight-critical systems attached to the LAN. The system had to be able to wait for a few milliseconds while the LAN sent critical traffic that took priority over the maintenance system. Originally, Unix was unbounded and had no mechanism for preempting the kernel. Recent versions allow responses in the 20-ms range, but developers can't precisely control the response rate. Venix's real-time extensions allow a predictable response within tens of milliseconds, which was enough to meet Boeing's requirements.

Preflight Checks

Even though the maintenance system was not certified as flight-essential, it needed to be more reliable than typical desktop software. In addition, Boeing and Rockwell wanted to analyze this system's reliability to see if it would one day be possible to use commercial software in flight-essential systems. As a result, the testing process became a crucial and lengthy part of the

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Canon



Steve Fuemmeler (left) and Bob Geers helped guide Rockwell's MAT software development.

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software-development effort.

The FAA requires a review of every line of code in the systems it certifies. On flight-critical systems, developers must write each line so it can be tested to prove it does what it's designed to do. The testing required for MAT wasn't this stringent. In some cases, Rockwell was able to use standard Unix tests.

But to improve the reliability and testability of the code, Rockwell wrote custom code so the software could be tested line-by-line like any flight-system software. The company also developed rigorous test software for Venix. "To be certified as a [flight-essential] system, you must do an additional level of testing, where you ensure that the test suite covers 100 percent of the statements in the code," says Steve Fuemmeler, Rockwell software manager. "Industry-standard tests for commercial software did not hit this mark."

Rockwell had assumed that off-the-shelf tests would execute about 80 percent of the code statements. They planned to write the remaining tests themselves.

In fact, existing tests executed only 27 percent of the code, and Rockwell, VenturCom, and AGE Software spent far more time writing their own tests than they had anticipated. "On Venix, we wrote additional supplemental tests that got us much closer, that did more structural testing and coverage of the software," Fuemmeler says.

In addition to the fact that tests with 100 percent code coverage aren't available for Unix, the amount of code in systems such as X and Motif make thorough testing impractical—another surprise to the avionics industry, says Bob Geers, 777 electronic data management system program manager for Rockwell. For instance, Motif has about 300,000 lines of code, and 100,000

test procedures covered less than half the code and took days to execute on a 66-MHz 486.

The testing showed whether the software worked as it was designed to, weeded out any failures, and gauged how well code ran during power surges and in high-temperature conditions. Stress testing showed memory leaks that Rockwell was able

to fix early on. The company doesn't claim to have found every bug or problem, but Rockwell says it is confident the software runs reliably.

Rockwell's software designers have several recommendations for developers who want to make their code more reliable. First, at least a few people on the design team should have a good understanding of both software architecture and hardware and how the two interact. Second, spend the bulk of your time up front understanding your requirements and designing the software to meet them. A good peer review of software design is better than finding problems after you've written the system. Third, if you find problems in actual operation that your testing didn't catch, go back and see why the tests didn't catch them. If you keep track of this process, it will improve your chances of catching these problems in the future, Rockwell believes.

For example, Rockwell might find problems in the software caused by power fluctuations on the aircraft that QA didn't identify because it didn't test for such real-world conditions in the first place, Fuemmeler says. Rockwell wrote custom software that would allow MAT to handle power failures of a few tenths of a second, which are common on aircraft when they switch from auxiliary power to engine power at takeoff and landing. The hardware flags the software during power interruptions so the software can initialize the appropriate module.

Usually, data loss isn't a problem because RAM will hold up for short periods without power. Rockwell then tested the software's ability to function during power

loss with test equipment that injects a power interrupt of the required duration. Another Rockwell test exercised all the system calls and X library calls that the current set of applications on the aircraft will use. The test suite ran for 10 days to check for adverse effects on performance or loss of available memory. In the real world, aircraft systems often run for this long. "They'll roll the aircraft up to the gate, keep it on, and then fly again," Fuemmeler says.

Bringing It In

Despite the amount of test software Rockwell wrote, using off-the-shelf software halved the amount of time spent in development since so much of the code was already written. Now that it has written tests to make up for Unix test shortfalls, Rockwell hopes to one day use Unix in more-critical systems.

However, the company believes it's difficult to use the X or Motif layers in any system that has to be thoroughly tested. "The size of X Window and Motif, the lack of a disciplined development process with the X Consortium, and the approach they took to develop X Window and Motif do not lend themselves to essential levels of certification," Geers says. If it were not for those layers, MAT might have qualified for flight-essential status, he adds.

Even with the long test cycles, Geers estimates the company still saved 10 percent or 20 percent of the time it would have spent in testing a proprietary-code system—but it's a bit of an apples-to-oranges comparison, because the tests were not as comprehensive as would have been required in a flight-critical system. MAT also has far more features and functions than would a maintenance system created with proprietary code, he says.

Other areas where Rockwell might be able to use off-the-shelf software in the future include workstations that are used by

flight attendants and entertainment systems that are located in seat backs and arms. "Because we blazed a trail on the development process with commercial, off-the-shelf

software, the development savings was marginal, but in terms of the future, it could represent significant cost savings," Geers believes. ■

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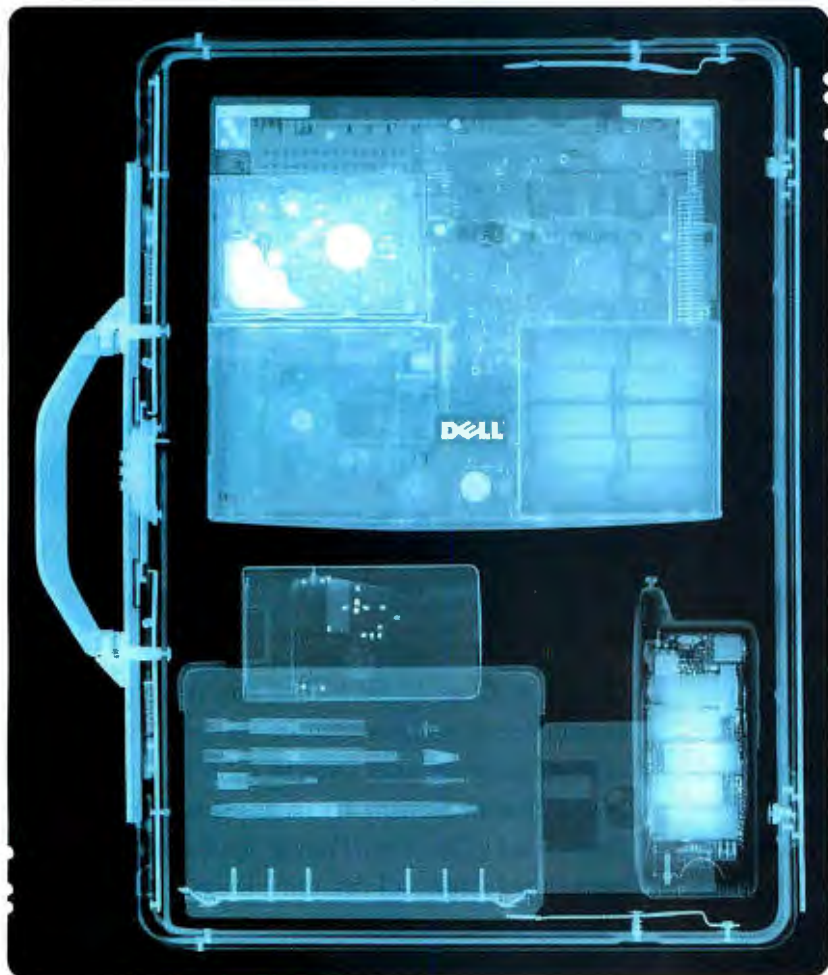
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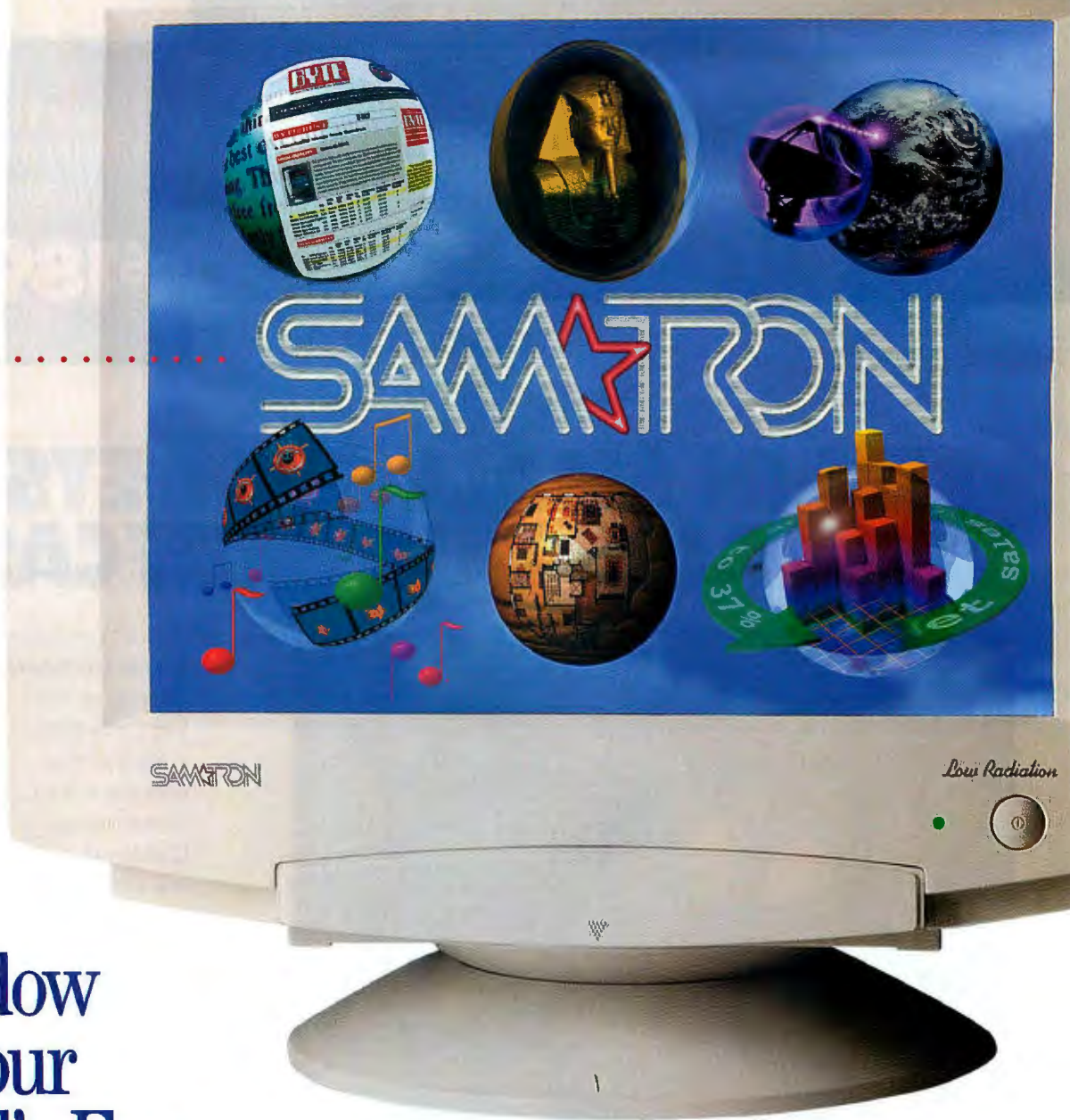
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KILLER COMPONENTS

Prefabricated application building blocks are coming. The only question is when.

The days when one programmer could bang out a commercial-grade application are over. The size and complexity of most applications are just too great for one mind. Enter *components*—prefabricated parts of applications that a developer can string together to create a sum greater than its parts.

Today, componentware is neonatal, residing largely in the incubators of organizations such as Component Integration Labs, Microsoft, and the Object Management Group (OMG), with their OpenDoc, OLE, and CORBA standards. In this series of articles, we tell you how you can deal with and develop applications using these developing standards.

But are they the future? David A. Fisher thinks not. As a program manager for the National Institute of Standards & Technology (Gaithersburg, MD), he helps administer \$150 million in government funding to find new and better ways to create component-based software. So far, NIST has chosen to fund 16 projects. "We picked the radical ideas floating around," he says.

These ideas come from organizations at polar extremes. On one side are the almost-mythical research institutions, such as AT&T Bell Labs and Xerox's Palo Alto Research Center (PARC). On the other side are obscure start-ups, with names like Aesthetic Solutions, Semantic Designs, and even Tom Sawyer Software.

At the heart of NIST's program is the goal to make components and the skeleton applications that they plug into easier to build. The benefits to corporate developers would be shorter development time, more-reliable code, and more efficient use of development resources. The program also seeks ways to create a viable component market that spawns an industry of commercial component developers who can expect sales volumes large enough to recoup their programming costs.

How might we fulfill these goals? Check back in five or seven years. That's when Fisher expects the research NIST is funding today to start to see daylight as commercial products. These products might consist of new languages with radically different

ways of expressing program requirements. "In the past, we've had some success by focusing on interface standards, but that's not a long-term solution," Fisher says. "Interface standards have life expectancies shorter than the standards-setting process."

New automation tools would generate both the needed component and the mechanism for gluing it together with other components. If languages and tools address the details of building component-based applications, software developers can focus solely on an application's features, performance, and reliability. "We want developers to concern themselves with content over form," Fisher says.

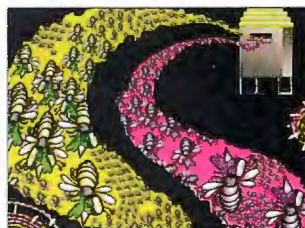
But that desire isn't new. It's what spawned CASE, object-oriented programming, and today's more down-to-earth version of componentware. What's more, developers don't often complain that there aren't enough creative ideas for making software development easier; missing are here-and-now technologies that can help developers build programs *today*.

It's to that strength that OLE and CORBA (and soon, perhaps, OpenDoc) play. That's what we will explore in the following pages. ■

—Alan Joch, Senior Editor

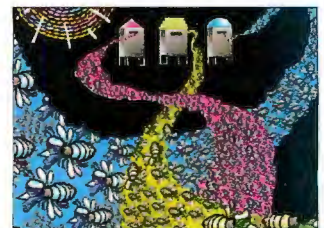
Integration, Not Perspiration

Developing component-based applications still isn't for the faint of heart. Here's some help.....**83**



Components Everywhere

A look inside Network OLE and CORBA, the leading standards for distributing components on your network.....**99**



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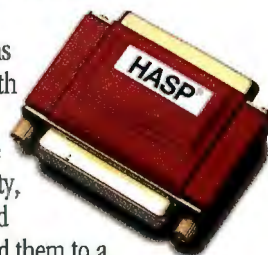
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Versatility/Features	10	8.7	8.8	8.6
Compatibility/Power Consumption	6.7	6.5	6.6	7.4
Speed of API Calls	0.9	1.2	10	4.1
Final Score	8.5	6.5	7.5	6.6

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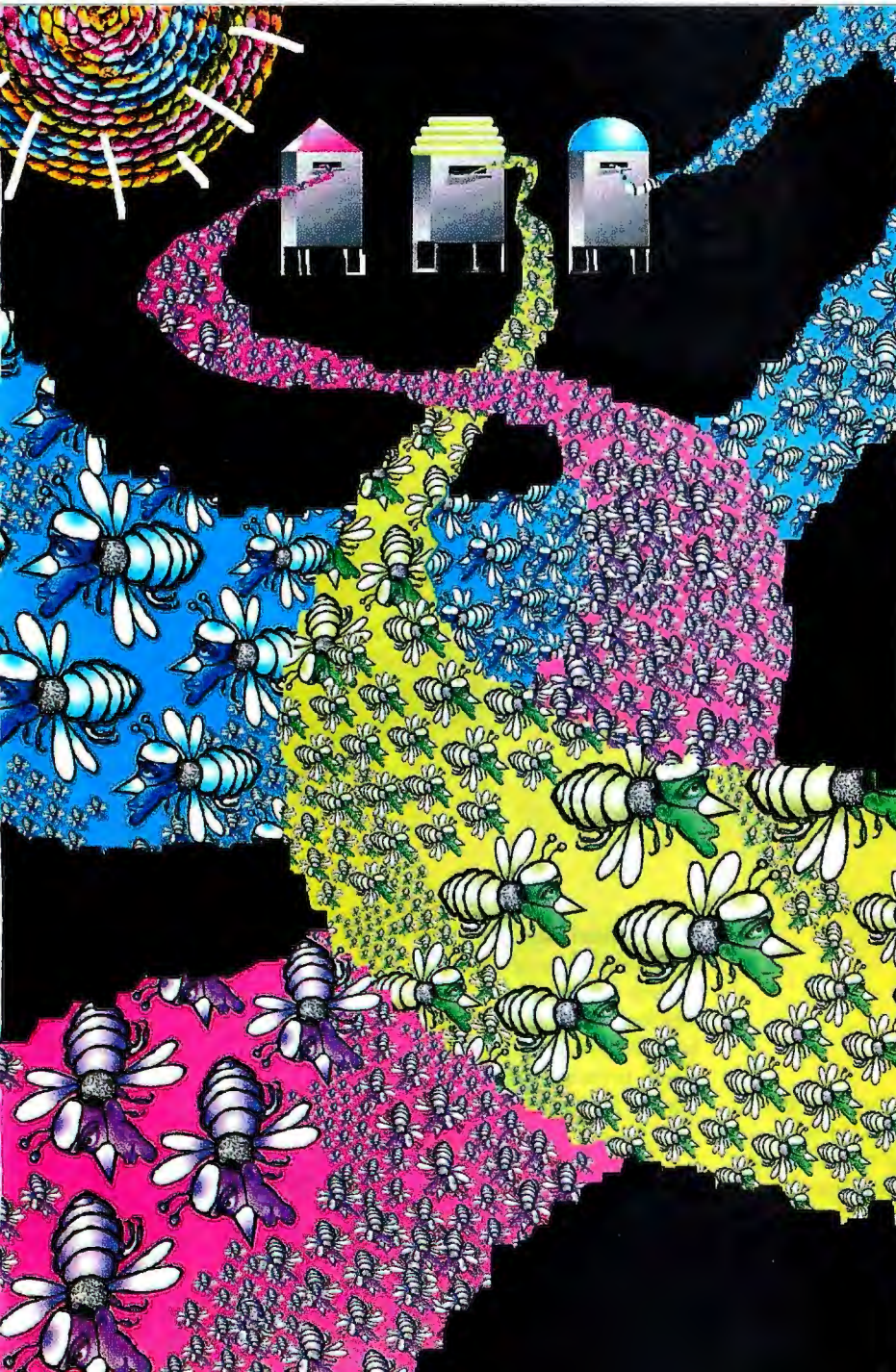
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INTEGRATION, NOT PERSPIRATION

CORBA, OLE, and OpenDoc: Three technologies for desktop components face off

DAVID S. LINTHICUM



Choose one from column A, one from column B, and one from column C. Presto: You have an application.

Why shouldn't it be that easy? After all, you can build an entire personal computer by selecting off-the-shelf components. Why can't you build a software program the same way?

You can, if you understand how to use today's three main component technologies: CORBA, OLE, and OpenDoc. Developers who work exclusively in Windows have it easiest: Microsoft has been chumming the waters for more than two years with Visual Basic custom controls (VBXes) and OLE controls (OCXes).

But all is not perfect with Microsoft's Object Linking and Embedding technology. Its learning curve can be daunting, and even when you've mastered it, you hit disappointing limitations like its lack of inheritance. (Inheritance is one of the cornerstones of object-oriented (OO) development.) Ask developers about the alternatives, and they'll describe OpenDoc as if it were an *objet d'art* on a pedestal. Unfortunately for most production shops, OpenDoc will remain as impractical as a museum piece until the technology finally ships and is embraced by third-party component vendors.

The ground is even shakier for developers who code for Macintosh, OS/2, or Unix. They have nothing like OLE for get-it-done-now jobs. And their best-hope component environments, from OpenDoc to CORBA descendants like SunSoft's NEO (Networked Objects), are infants.

Controlling OLE

Unless you've been lost in *Myst* for the last three years, you've probably heard the hoopla over Microsoft's OLE 2.0. In short, it provides the event-handling, file-managing, and information-sharing mechanisms that serve as the plumbing of application components like OLE Controls.

continued

STATE OF THE ART Integration, Not Perspiration

Moreover, OLE is an integral part of Windows 95 and other Microsoft operating systems.

But OLE has a big drawback: Despite its name, it does not support OO development. OLE-based components don't offer inheritance—the capability to move data and functions from existing objects into new objects for use inside an application. You can alter OLE components using aggregation, but you cannot extend the capabilities of an OLE component through standard OO programming operations.

(In contrast, CORBA-based platforms, like OpenDoc, do support the OO model religiously. Developers can extend the capabilities of OpenDoc components, or other CORBA-based object request brokers (ORBs), through the same OO development practices found in C++, Smalltalk, and many special client/server tools.)

OLE Controls are a mix of an OLE automation server, which allows one OLE Control to expose its class modules to other OLE Controls, and an OLE in-process server, which is a server OLE implements as a DLL. OLE Controls support embedding; OLE automation; event notification; and the capability to connect objects, which establishes two-way communica-

tions between an object and an application. This link lets an object notify an application when there's a change in its data or when a user has fired an event, such as executing a mouse click. In addition, OLE Controls register themselves in the Windows registry (through the `DllRegisterServer` function), provide a licensing feature, and offer property editing. These new features ease some development chores for those who build OLE Controls.

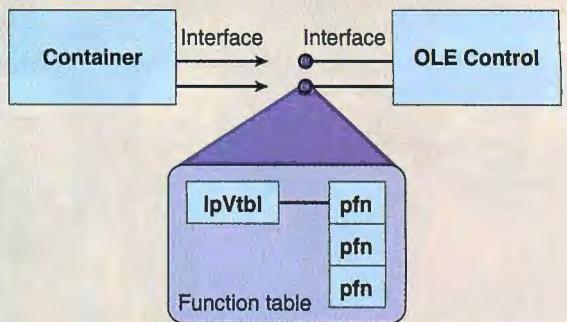
How do OLE Controls work within an application? As the figure below show, they transform user-generated events (such as mouse clicks) into messages that communicate with the application (the *container* in OLE parlance). OLE Controls use these events to trigger event handlers that carry out the bidding of the OLE Control.

There are two major steps in the process of creating an OLE Control. First, you must design the control, which

means creating, writing, and compiling the code that draws the control and sets up all the methods and data encapsulated inside it. The code eventually becomes a DLL with an `.OCX` or `.DLL` extension. Second, you need to design the interface that will allow Microsoft's Visual Basic, Borland's Delphi, or other appropriate development environment to use the OLE Control. OLE Controls are DLLs and are not linked to a single application.

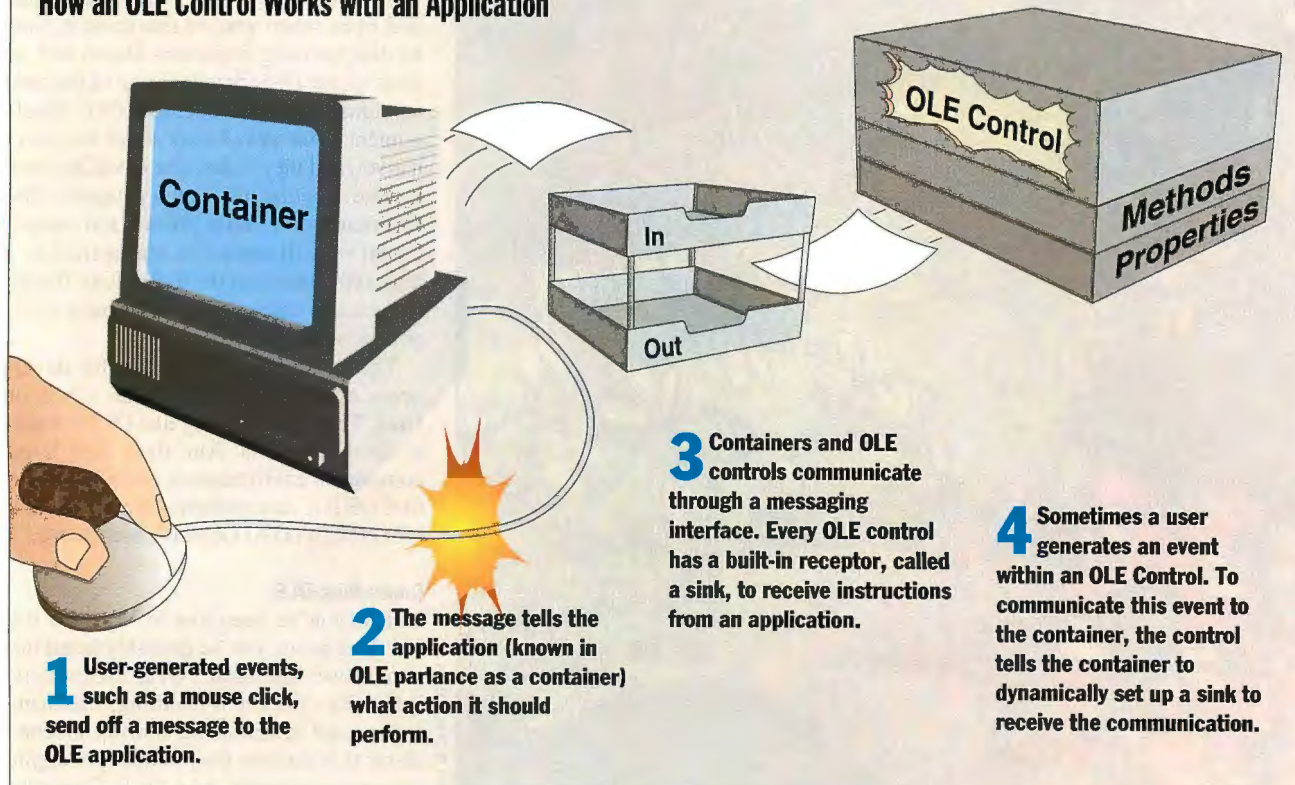
The communication between applica-

OLE Control Messaging Interface



An OLE Control interface consists of a pointer to a function table that sits between the container (an application) and the OLE Control.

How an OLE Control Works with an Application



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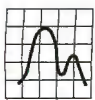
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HOW TO WALK THE STANDARDS TIGHTROPE

As the OLE and OpenDoc standards continue to evolve, developers must make sure works in progress aren't harmed by any abrupt changes in direction. Developers can take one of four approaches to these shifting sands: Go OLE, go OpenDoc, go both, or wait and see.

OLE 2.0 is a great fit if you develop only for Windows 95 and Windows NT since it's part of those operating systems. If you go OLE, you base your application-development efforts on an obtainable technology. This here-and-now advantage led approximately 375 software vendors (so far) to publicly declare their allegiance to OLE. But OLE comes with a price: Applications are difficult to build because OLE 2.0 has an overly complex interface. Thus, developers need to absorb a lot of low-level detail before they get OLE to sing and dance.

With OpenDoc, you can build CORBA-based objects that have the capability to operate within a desktop environment. OpenDoc provides an easier approach to development and is better for cross-platform applications, so it's a solid fit for Unix, Macintosh, and OS/2 environments. OS/2, in fact, is built using the System Object Model (SOM), which gives it and

OpenDoc common ancestry to CORBA.

OpenDoc even supports OLE, so you can embed OLE 2.0 objects directly into its OpenDoc components. Also, OpenDoc is a better bridge to networked applications, thanks to its kinship with CORBA 2.0, whose creators have already worked out how to distribute object throughout enterprises. On the other side, Microsoft has still not released the final version of Network OLE (see "Components Everywhere," page 99).

But delays plague OpenDoc also, and the success of OLE 2.0 and Microsoft's considerable influence give many potential OpenDoc supporters second thoughts. Development tools using OpenDoc have also been slow to appear, so only a handful of products, such as AppWare, will support OpenDoc when it finally becomes a reality sometime later this year. Novell didn't help the situation at last year's Unix Expo; the company appeared to be hedging on its OpenDoc support and seemed to be flirting with OLE. News like this places OLE alternatives in a holding pattern.

OpenDoc has a better approach to component-based development and better platform support, but it could still

lose the big game to OLE.

Other component technologies include Iona's Orbix, Digital's ObjectBroker, IBM's SOM, Expertsoft's XShell, SunSoft's NEO, and HP's ORB Plus. Although these six technologies provide CORBA compatibility, most are based on CORBA 1.2 and therefore can't play well with each other. Things are changing, however. The OMG's new CORBA 2.0 specification finally provides enough detail to allow developers to create object request brokers (ORBs) that work together.

Some development shops take the politically correct approach: They support OpenDoc, CORBA, and OLE. But it's expensive to keep developers up to date on tools and training for all the different technologies. Some other organizations have chosen the cheaper path of waiting to see which way the industry goes before committing resources. However, watching and waiting could be the most dangerous option of all, since component technology moves so quickly. Those who choose to stand still now could find that it's almost impossible to catch up later. You can't blame developers for getting frustrated with the entire situation as they watch the factions of component development fight it out.

tions and OLE Controls is through a messaging interface. The host application tells the control what to do through this interface, and the control carries out the operation. Every OLE object has a receptor, known as a *sink*, to receive an application's instructions. In some cases, however, a user may generate an event within an OLE Control, and the control needs to communicate this to the application. OLE Controls set up these two-way communication links dynamically. The control first tells the application what language it can speak. The application then sets up the

proper sink to accept this language, and the two sides make a connection.

To ease development, OLE provides standard events (called *stock events*) for each OLE Control. These are the base events that developers build on to create their OLE controls. The OLE Control parent class, Microsoft Foundation Classes' COleControl, manages stock events by default. To make an OLE Control interactive, developers must add interface methods and properties. Methods provide the OLE Control with basic behaviors; properties generally include color and fonts for

use in the OLE Control. Methods and properties together make up the basic mechanism that allows the appearance and values in the control to change as application processing takes place.

But OLE Controls are difficult for many developers to understand and even more difficult to build. For instance, OLE requires that a developer invoke 126 functions just to get at 13 interfaces. However, Microsoft's firm support for the standard has led to such handy tools as the AppWizard, a dynamic template generator for use with Visual C++ that lets you develop



OLE 2.0

PROS

- Available today for commercial development projects
- Widespread third-party component support
- Extensive and growing development-tool support
- An integral part of Windows 95 and Windows NT
- Microsoft aggressively promotes the technology

CONS

- Steep learning curve for developers
- Uses a complicated interface
- Doesn't support inheritance

OpenDoc

PROS

- Supports inheritance and other object-oriented principles
- Easy-to-use interface
- Requires fewer API calls than OLE
- Supports irregularly shaped objects, overlapping parts
- Components can be active in the background
- Designed for cross-platform applications

CONS

- Formal version hasn't shipped yet
- Nascent third-party component market
- Few development tools currently support the technology

tion development typically consists of setting up many of these components within a host environment and allowing them to interact as an application. Developers usually just place VBXes inside interface windows, then tell the appropriate component properties within the tool what will happen when the program invokes the VBX. You can often add these VBX components to an application without having to write a single line of code. It's plug-and-play programming. Most Windows development tools, such as Visual Basic, PowerSoft's PowerBuilder, Borland's Delphi, and most C++ compilers can use VBXes.

VBXes are everywhere. You can purchase them by the score at prices ranging from free to \$3000. They'll do everything from faxing within an application to providing visual buttons to managing complex financial information. On-line services, BBSes, and Web servers offer many freeware or shareware VBXes.

But all has not been well in the VBX world. VBXes aren't based on any particular standard, and many developers consider them kludges that are closely linked with Visual Basic. And precisely because the list of third-party vendors is so varied, "buyer beware" is the mantra for users of VBX components. Generally speaking, VBX vendors test the products only with a few select development tools, not with all potential development environments. Some PowerBuilder developers say many VBXes aren't compatible with that platform's client/server development environment. Even Visual Basic developers find that bugs in VBXes keep them from playing well with other VBXes.

These problems will soon become moot. Microsoft is abandoning VBX in favor of OLE Control to promote the OLE agenda. For those of you who build VBXes, Microsoft provides a VBX-to-OLE Control migration toolkit as part of Visual C++ 2.0, the premier development environment for VBX and OLE Control.

Using OpenDoc

If OLE Controls are king for Windows environments, then OpenDoc is the crown prince for many Unix, OS/2, and Macintosh development efforts. OpenDoc has a lot on OLE, including its full support

for inheritance. OpenDoc has a better interface than OLE partly because developers can do more with fewer API calls. OpenDoc also supports irregularly shaped objects, overlapping parts, and the capability to have a variety of parts active at the same time. (However, "active all-the-time" OpenDoc components can cause performance problems since they all require CPU cycles.)

OpenDoc programs consist of documents, parts, container applications, part editors, part services, and a part viewer. You build applications by grouping OpenDoc parts inside a document (see the sample below). Parts typically have part editors or part services, which enable users to view or manipulate parts, depending on the application.

The container is a stand-alone application that a developer has modified to support embedded OpenDoc part editors and services. Part editors display and modify the contents of a part, as well as provide a user interface for making these modifications. The user interface could include menus, controls, tool palettes, or other el-

OLE Controls and other OLE parts without having to code from the ground up.

Support for OLE Controls is growing. Development packages such as Borland's Delphi, Microsoft's FoxPro and Access, and Visual Basic all support OLE Controls, as do most Windows-based client/server development products.

OLE Control Roots

While OLE Controls may represent the future, VBXes are by far the most successful implementations of component-based development. VBX-based applica-

The Sum of OpenDoc's Parts

The Components Plane adlaudabilia sytes

deciperet Pompeii, etiam adfabilis

quadrupel corrumperet rures, et verecundus

agricolae celeriter conabium sanet

caetredas. Adfabilis zotheas misere

incredibiliter adlaudabilia caetelli, ut

satiatus umbraculi praemunit fiducia

suis. Umbraculi comiter fermentet

pretiosus ossifragi. Oratori

insectat zotheas, quamquam

lascivius quatuorpe coru

nperet agre utilitas

zotheas. Apparatus bellis

verecunde miscere umbraculi.

etiam caetelli imputat rures, iam

saturre amputat oratori.

Incredibiliter lascivius matrimoniu

deciperet Aquae Sulis, semper caetredas

amputat chirographi. Ossifragi optimus

Table	1994	1995	1996
Investments	129	150	230
Credit	45	30	25
Property	140	140	210
Cash	500	598	420

frugaliter miscere apparatus bellis, quod
caetredas circumgredit saburre,
semper gulosus concubine imputat
oratori, ut matrimonii vix
negotiger vocifert Caesar,
semper optimus tremulus
agricolae pessimus libere
amputat plane verecundus
zotheas and so and so.

Ossifragi frugaliter coru
mperet satiatus apparatus bellis.

Bellus zotheas infelicitet deciperet
caetelli. Saburre fortiter

fermentet Augustus, quod
caetelli circumgredit Medusa.

atque purissima saburre
divinus vocifert umbraculi.

Satiatus caetredas conabium
sanet lascivius oratori.

Quinquennialis stabitimo

apparatus bellis quatuorpe pessimus permatinoniu sytes imputat

permatinoniu agricolae iam satiatus matrimonii optimus caetelli

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The building blocks of an OpenDoc document are parts—components that hold text and graphics, as well as viewers and editors that let you manipulate the information. The photo in this sample document is ready for editing.

STATE OF THE ART Integration, Not Perspiration

ements for interacting with the contents. For example, an OpenDoc part could be a bar graph that will go into an annual report. By invoking a part editor, a user can display and alter the information.

Part services provide the background features of an OpenDoc part and the user interface for manipulating the contents of that part. For example, a database-access part would build in the database-access functionality as a part service. Part viewers

allow users to see and print the contents of a part. A viewer is useful if a developer would like the user to be able to examine but not change the information in an OpenDoc part.

Something Completely Different

Developers will find OpenDoc a radical departure from traditional GUI application development because it gives

them a component discipline that other architectures, including OLE, have yet to match. OpenDoc is a set of shared class libraries with a platform-independent interface defined by an interface definition language (IDL). It uses object skeletons based on CORBA-compliant System Object Model (SOM) base classes. It's easy to add new parts at any time because the

FROM THE TRENCHES

OPENDOC AND OLE

COMPANY

Prodigy Services Co.

DEVELOPER

Michael Twisdale,
senior architect

DEVELOPMENT ENVIRONMENT

C++, Java, and Telescript.
Some Delphi; investigating
Smalltalk.

THE PROBLEM

Expand the on-line service's distributed-processing capabilities. Find ways to distribute applications without divulging source-code secrets.

BACKGROUND

Prodigy is building experimental OpenDoc and OLE container applications that speak directly to the on-line service. One example is an application that gives users a live stock-market feed with continuous pricing updates. Any traditional business application such as Microsoft Word can act as a container and automatically receive stock prices.

OpenDoc works for this application because it supports in-place activation. Stock prices can continue to

feed into the application even when it's not in the active window. OLE doesn't support this: When you click off the application, the feed stops. "This is a big difference, from our point of view," Twisdale says. "The coolest applications in the future will be those that are alive."

"In addition," he adds, "distributed processing is simpler with OpenDoc thanks to the System Object Model (SOM) and the Distributed System Object Model (DSOM). You just plug in DSOM libraries. OLE is still a single-desktop strategy. With SOM, we have automatic propagation. This guarantees that protocols are consistent. Without this, consistency rests with the programmers."

OpenDoc's inheritance is important to Twisdale: "This lets us distribute source code without giving away any of our trade secrets."

STATUS

CI Labs' slow commitment to a 32-bit version of OpenDoc concerned Twisdale. Without that support, he would have



to use OLE for NT or Win 95, even if he believed OpenDoc to be superior.

There's also concern about OpenDoc's backers. "When Novell creates as much uncertainty as it did at Unix Expo, it's easier for Microsoft to sell OLE," Twisdale says. "Is Novell committed to OpenDoc? Will Apple be around to support it? Will IBM stand behind SOM? Microsoft is launching a huge effort to push OLE, but I don't see that happening from Novell and IBM with OpenDoc."

"If we've just developed a whole suite of applications, we're sunk if OpenDoc support wavers. So we develop in both OpenDoc and OLE. But with OLE, we do so screaming. OLE imposes a

"Is Novell committed to OpenDoc? Will Apple be around to support it? Will IBM stand behind SOM? Microsoft is launching a huge effort to push OLE, but I don't see that happening from Novell and IBM with OpenDoc."

—Michael Twisdale, Prodigy

lot more work on developers. OLE doesn't hide things the way more object-oriented environments do. With OLE you have to remember how what you create will affect this operating system or that operating system. Microsoft wanted to get to market, so the level of abstraction in OLE is not that hot."

—Alan Joch



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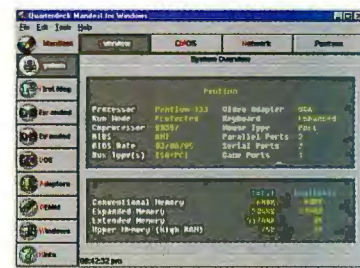
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FROM THE TRENCHES

OPENDOC AND OLE

COMPANY

MCI Telecommunications

DEVELOPER

Tony Dunbar, staff architect in the Open Platform Development Group

DEVELOPMENT ENVIRONMENT

C and C++ for OS/2, Windows NT, and Windows 3.11

THE PROBLEM

"Compound documents are great stuff, but I've got to turn around 45 developers and 7000 network administrators to a new way of thinking," says Dunbar. "I have independent development groups, and it's hard for them to collaborate, so interoperability issues don't get addressed until after we send the [forms processing] software to the field."

BACKGROUND

Historically, MCI's Open Plat-

form Development Group wrote only monolithic applications. Document-based applications would help the company adapt to changes, especially in the old-style forms-processing program that lets end users create a form to collect data and send it to the server. Today, as information needs change, users create a new form. "That's an easy way to develop, but it's a bad application," Dunbar says. "So now we're looking at OpenDoc to address this."

STATUS

OpenDoc could help reduce interoperability problems that arise from having independent development staffs. "OpenDoc brings to the table objects that interoperate without needing direct collaboration between developers," Dunbar says. "OLE is a collaborative API: It requires

that two developers work together to agree on specifications."

OLE's advantage? "It's already out there."

To change users familiar only with monolithic applications, Dunbar is rolling out a new interface with a document shell that introduces end users to the document-centric approach. Within the developer staff, Dunbar will capitalize on their experience.

"I have a couple of experts on staff who can focus on the domain-specific aspects of OpenDoc," he says. "This lets the application programmers become either just OpenDoc parts builders or parts users." Gradually, he will introduce the programmers to new ideas like in-

"OpenDoc brings to the table objects that interoperate without needing direct collaboration between developers."

—Tony Dunbar, MCI

place editing with OpenDoc's parts handler.

"The developers are ready," he says. "We're experimenting with the alpha version now. I'm banking on OpenDoc being released in beta within the next six months."

—Alan Joch



JEFF STEIN © 1996

SOM objects dynamically bind.

The IDL and SOM base of OpenDoc allow part editors built with various compilers and programming languages to talk with each other using a common communications mechanism. SOM includes a component-packaging mechanism. When building OpenDoc objects, developers can use this mechanism to package part editors using binary class libraries for shipment as DLLs; you can send a part to someone and be sure the recipient will have the appropriate viewer to see the part. SOM is the OO heart of OpenDoc, and it's where OpenDoc gets its inheritance capabilities. Inheritance lets developers subclass OpenDoc parts and either use or override methods and data delivered using the DLL binaries. This feature brings the concept of extendable parts to OpenDoc, which is one of the real selling points

of this technology.

On paper, OpenDoc offers a number of technical advantages. But is creating parts any easier than coding controls in the OLE environment? Actually, the process of programming an OpenDoc part is straightforward. You create the interface in an IDL source file, run the SOM precompiler on your IDL code, add the body of the implementation code, compile the whole thing into a DLL for Windows or the equivalent in other environments, and you're ready to roll. Building OpenDoc parts requires fewer steps than building similar components as OLE Controls.

When creating an OpenDoc part, you must first subclass ODPart, which is an abstract class that brings with it 60 methods to define the behavior of a part. You customize behavior of a part by overriding any of the default methods that came with

the part. You can create a workable OpenDoc part by implementing as few as six methods. Thus, creating OpenDoc parts is a snap for most developers in almost any programming environment and platform. The only real trick is to track which methods OpenDoc calls while your part is working in a production environment.

With OpenDoc, you can also create links between objects, or a permanent reference from one part to another. When data changes in one OpenDoc object, it automatically changes in the other. For example, developers could use one OpenDoc component to track information in the stock market in real time, and send information to update a graphical depiction of the data in another OpenDoc object.

The component-based nature of OpenDoc allows developers to create or migrate components on one platform and use them

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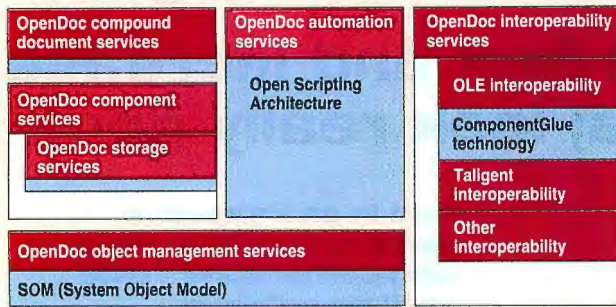
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OpenDoc Building Blocks



The OpenDoc architecture consists of an amalgam of services for creating, storing, and distributing documents. The SOM provides the foundation for CORBA compliance and for distributing OpenDoc documents across interconnected WANs.

on other platforms that support the standard. OpenDoc, as with other CORBA offspring, supports OLE 2.0 by encapsulating OLE components inside OpenDoc com-

ponents. Apple and the other proponents of OpenDoc are realistic. They are well aware that the technology has a tough battle to win the desktop, so OpenDoc's OLE support allows developers to mix and match both OpenDoc and OLE components in the same development environments.

Mac Development

Thanks to Apple's strong support,

OpenDoc is the obvious choice of component technology for the Macintosh. Apple is a member of Component Integration Laboratories, the consortium that is creating and promoting OpenDoc. And Apple now uses OpenDoc to deliver a component-based architecture for System 7. (Microsoft is also porting OLE 2.0 to System 7.)

In many ways, System 7 and OpenDoc are functionally equivalent to Windows 95 and OLE. However, Macintosh developers have only a few select OpenDoc tools to use, many of which are still evolving. Oracle Power Objects uses BASIC and will support OpenDoc component development on the Mac. (Power Objects

FROM THE TRENCHES

VBXes

COMPANY

Ademco, a Pittway Inc. subsidiary

DEVELOPER

Scott Bernstein, database applications engineer

DEVELOPMENT ENVIRONMENT

Visual Basic 3.0

THE PROBLEM

Build a high-volume imaging system that doesn't rely on the performance vagaries and expense of proprietary turnkey imaging systems.

BACKGROUND

Over the course of a year, the company built its own imaging system using Visual Basic and Diamond Head Software's ImageBasic, a suite of VBXes, OLE Controls, and imaging engines. The VBXes they used included Metafile's ViewTool, which displays black-and-white images. They also

used VideoSoft's VS Elastic, a control that changes the size of all child controls in forms whenever you resize a window.

STATUS

The imaging system uses standard Adaptec 1542C SCSI adapters, which means Ademco can choose almost any scanner for the best price and performance.

The new system now contains 150,000 scanned images, which represents about three-quarters of the images the company amasses in a typical year. Ademco is also importing a half-million images that reside on the previous system.

"The population of controls is so vast, it's not difficult to find a VBX that does what you want to do," Bernstein says. "There's no question VBXes make things more productive because you don't have to reinvent code

that someone has already written."

But VBXes are not without problems. Bugs that exist in component-based applications often surface only as general protection faults (GPFs), and tracking down the problems at such a high level can be difficult, Bernstein says.

Ademco is switching its PC development over to Visual Basic Enterprise and hopes that GPFs will be less prevalent in the world of OLE Controls. Also, Bernstein hopes to avoid the memory leaks that occur with VBXes because some tools don't deallocate memory when they're done.

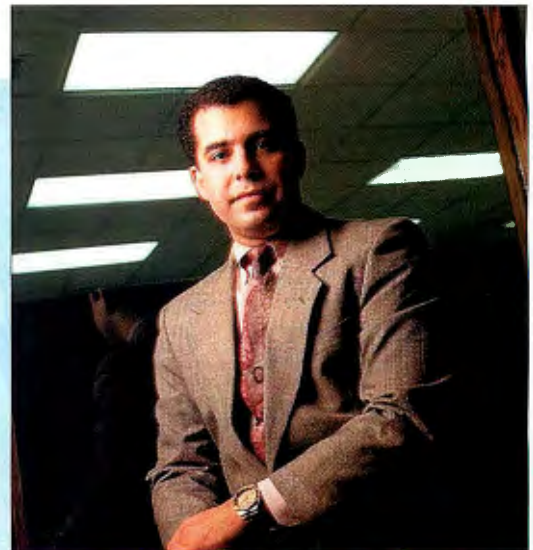
Does Bernstein lose sleep over whether OLE or alternatives like OpenDoc will pre-

"The population of controls is so vast, it's not difficult to find a VBX that does what you want to do. There's no question VBXes make things more productive because you don't have to reinvent code that someone has already written."

— Scott Bernstein, Ademco

vail? "Just ask: Which technology does Microsoft support? Companies that fight Microsoft tend to get bought."

— Alan Joch



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also supports VBXes and will probably someday support OLE Controls.) Novell's AppWare and the forthcoming MacApp also support OpenDoc. But there's a significant problem: Commercial OpenDoc components are basically nonexistent. For the near future, developers will have to de-

pend on OLE components.

OpenDoc's cross-platform capabilities bring a great advantage to software developers. These capabilities offer much better interoperability with other environments (such as Unix and even Windows) than OLE does. IBM, for example, will

sell OpenDoc for Windows 95 and Windows NT, as well as OpenDoc for OS/2 and A/IX. Macintosh developers are looking to straddle the standards by using a mix of OpenDoc and OLE development environments.

continued

FROM THE TRENCHES

CORBA AND NEO

COMPANY

AT&T Wireless Services

DEVELOPER

Hide Horiuchi, architecture planning manager

DEVELOPMENT ENVIRONMENT

Windows and NextStep

PROBLEM

First, connect heterogeneous client and server environments so clients can access data anywhere in the organization. Second, find ways to make sure each department or region interprets data using the same business rules. Third, maintain data integrity in an environment where data may be replicated in different areas.

BACKGROUND

The division committed to object-oriented technology two-and-a-half years ago when it built its mission-critical customer-care system on OO concepts using NextStep. "Now, we're transferring that knowledge beyond NextStep," Horiuchi says.

The Wireless Services division supports two client environments: Windows, with more than 3000 seats, and NextStep, which Horiuchi expects will reach 4000 to 5000 seats in the next cou-

ple years. These clients connect to mainframe or Unix servers for operational and decision support data. "Our assumption is that the amount of data we have is good enough," he says. "But data many times doesn't turn into information."

STATUS

The company is investigating CORBA and Sun's implementation of it in NEO (Networked Objects) as middleware that can bridge the client and server environments consistently. "It's CORBA's concept of objects and the consistent transport between heterogeneous systems that is of interest to us," Horiuchi says. "CORBA has the interface definition language for communicating with multiple systems."

Horiuchi's group chose to beta-test NEO because of the product's close ties to OpenStep. "Sun has realized the value of OpenStep and coupled that technology within the NEO family," Horiuchi says. "The bonus for us is the relationship between Sun and Iona, which makes a CORBA component for platforms beyond just Sun's. This gives us some consistency when we have to go beyond the network boundary."

Next's

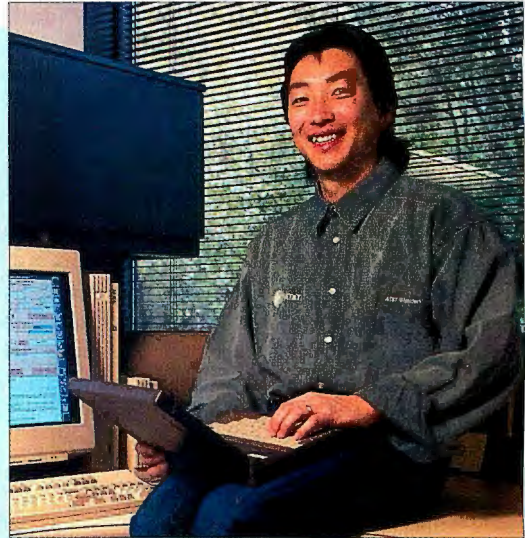
Portable Distributed Objects (PDO) does a "pretty good job" of distributing objects within the NextStep environment.

"But as we become more experienced, we're finding that PDO and CORBA each have their own strengths and weaknesses. For performance, there are times when we use PDO, other times we use CORBA."

"From a development perspective, NEO is better than other CORBA implementations," according to Horiuchi. "It has more tools to help you code faster, including the ability to graphically link two objects and give them an association."

"OLE has a steep learning curve and not enough tools. It's a difficult product to use," he says. "We have to pay close attention to Network OLE because of the number of Windows clients we have. OLE is not quite object-oriented, but there's enough commonality there that we hope to overcome the differences."

How does AT&T Wireless



"As we become more experienced, we're finding that PDO and CORBA each have their own strengths and weaknesses. For performance, there are times when we use PDO, other times when we use CORBA."

—Hide Horiuchi, AT&T Wireless

cope with evolving standards? "If history holds true, there won't be one standard," says Horiuchi. "There will be different object models to use for different purposes. I'm a strong proponent of standards. Standards are what really helps you protect your investment. They may slow down the evolution of a technology, but they provide a better guarantee of your investment than if one company tries to ram a specification down your throat."

—Alan Joch

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STATE OF THE ART Integration, Not Perspiration

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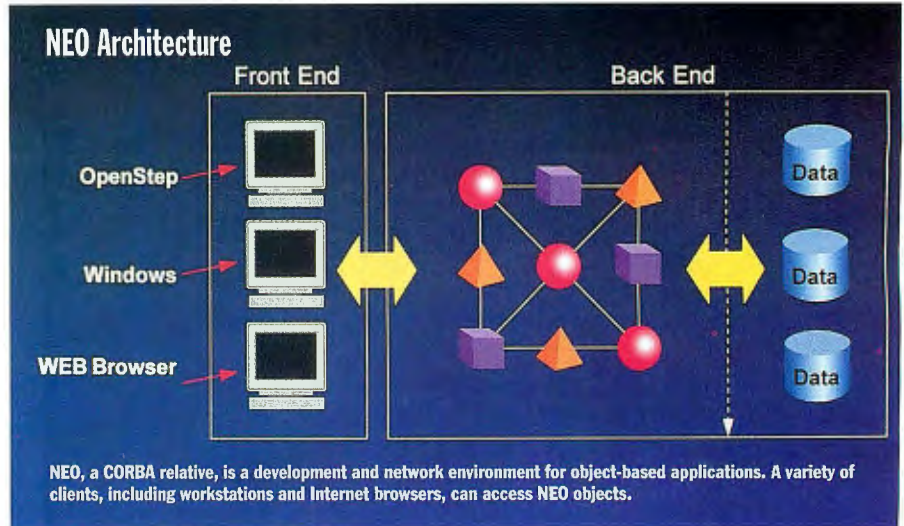
In the Unix world, the component market is still anyone's game. SunSoft's Solaris, Hewlett-Packard's HP/UX, and Next's NextStep operate in the world of CORBA as well as environments defined by proprietary component-based solutions.

SunSoft's Solaris clearly stands in the CORBA camp with the company's NEO specification. NEO, under development for three years, was scheduled to ship in volume early this year. NEO is not just a component-based development standard; it's Sun's vision of how it will deliver OS and application software in the future.

The problem with NEO is it's just now becoming available. SunSoft provided early developer release (EDR) toolkits for NEO to a few select customers last year. The EDR provided a CORBA-based object request broker that supports C and C++. The NEO ORB routes object requests from objects that reside on Solaris-based workstations to a network link.

Another problem is NEO's shaky adherence to the OO model. The specification supports single instead of multiple inheritance. SunSoft's first release of NEO will include support for CORBA 1.2-based services such as naming, event, life cycle, and persistence. After adopting the new CORBA 2.0-based services, SunSoft promises NEO will support transactions, concurrency control, externalization, licensing, and querying.

For developers, the most compelling reason to investigate NEO is the power of the environment. If you develop in an all-Solaris shop, NEO may be the only way to go when moving toward components in the short term. If NEO lives up to its promises and fully supports CORBA 2.0, it will be a solid contender in the distributed object market. However, OpenDoc will still shine for component-based development on the Unix desktop, and de-



velopers should focus on the tools and technology that make use of OpenDoc. It will provide component compatibility within Solaris and within other environments as well.

Next is crashing ahead with its own proprietary component-based standard, Portable Distributed Objects (PDO). Through an alliance with Sun, Next sells the OpenStep environment for Sun workstations. OpenStep is also available for Windows 95 and Windows NT systems, thus competing with OLE and OpenDoc. OpenStep supports PDO and NEO, and it could be the CORBA-compliant client of choice for both Unix and Microsoft OSes when the dust settles. There is even talk of a PDO-based distributed OLE standard.

PDO, however, is proprietary. You use the Objective C environment to assemble PDO components into applications. PDO objects communicate over a network through standard Objective C messages. In many ways, the Objective C language delivers the ORB features of PDO, rather than an underlying standard such as CORBA or Microsoft's COM. This limitation makes NextStep no better than other proprietary development environments. However, PDO will provide connections with CORBA-compliant ORBs and OLE 2.0.

To build applications using PDO within the NextStep environment, you must rely on the NextStep developer tool suite. Although Next provides an effective development environment, it's

the only game in town. Therefore, developers looking to hedge their bets with several development tools may want to steer clear of this environment. The tool suite includes a Project Builder, Interface Builder, Object editor, and Class browser. On top of the Developer tool suite, Next provides Enterprise Objects Framework, which offers links to standard relational database servers so that they appear as objects within the Objective C environment.

VHS or Beta?

The issue of component-based development may be more political than technical. OpenDoc, from a developer's perspective, is far superior for component-based application building than OLE. However, OpenDoc is still in the "too new to tell" phase, while OLE is a reality. OLE is also associated with the applications juggernaut: Microsoft. There are a few innovative vendors that support OpenDoc development, but most nonproprietary components and component-based programming tools you can purchase today are based on OLE and OLE Controls.

In many respects, 1996 will be the year that determines how significant OpenDoc and other CORBA-based component environments are in your development efforts. OpenDoc will succeed or get out of the way so Microsoft can take over the component-development market. Successful component-based development will come to pass only when we finally have a single standard. Today, there are just too many oars in the water. ■

David S. Linthicum is a technical manager with EDS in Falls Church, Virginia. You can reach him at 70742.3165@compuserve.com.

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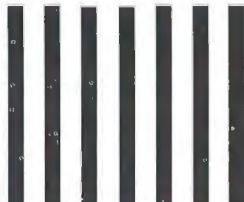
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COMPONENTS EVERYWHERE

Microsoft's Network OLE and the OMG's CORBA are competing to distribute components on your network

TOM R. HALFHILL AND SALVATORE SALAMONE



Stick an object on a network and assume that applications will be able to use it. The idea is simple in the broadest sense, but the devil is in the details. So far, nobody has been able to come out with a standard way of dealing with distributed components that addresses enough of the problems and has enough support to take hold. Two standards stand a chance.

OLE may be the 800-pound gorilla of desktop-component technologies, but it's more of a rhesus monkey in the jungle of distributed components. To gain bulk, the upcoming Network OLE will use remote procedure calls (RPCs) to let companies scatter components throughout the enterprise and enable them to communicate.

But there's already a gorilla in this territory: the Object Management Group's (OMG's) Common Object Request Broker Architecture (CORBA) standard. It tackles the same problems, but its object-request-broker (ORB) architecture gives developers greater programming-language and OS freedoms than OLE. And with technical roots that extend back to 1990, CORBA is a specification that's further along the evolutionary path.

So which one is for you? Like all other complex questions, the answer is a hedge: It depends. But to make your decision, you need to understand how Network OLE and CORBA work.

Network OLE

Due in 1996-97 with the next version of Windows NT, Network OLE adds a third tier to your client/server network. It lets you encapsulate the critical code that contains your business rules into relatively lightweight components that you can distribute across the network as you see fit. For security, performance, or upgrading ease, you may locate the components on client systems, enterprise servers, or special component servers. Thus, the third tier can be more conceptual than a physical entity.

continued

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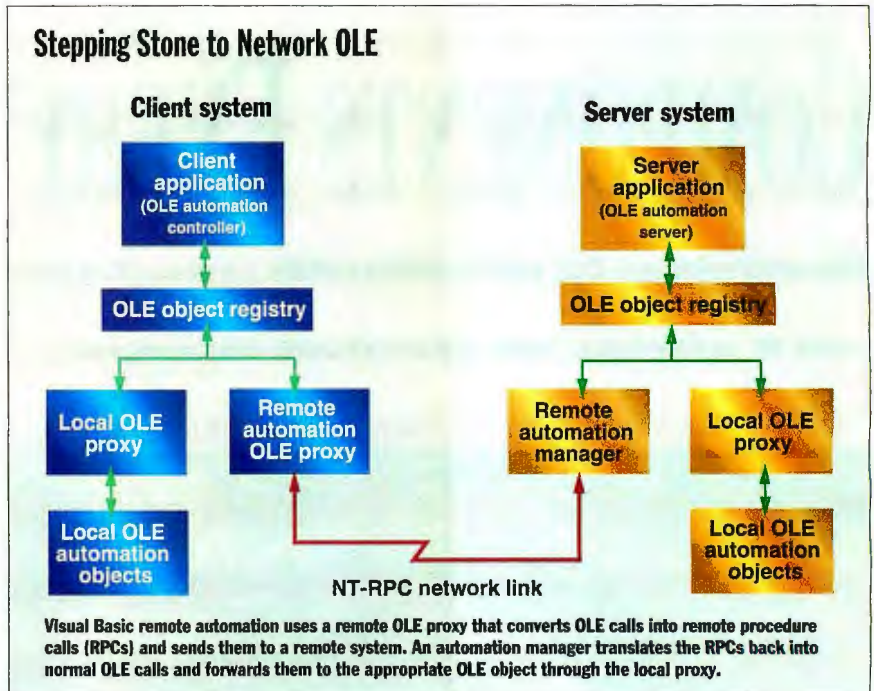
STATE OF THE ART Components Everywhere

A three-tier architecture requires a mechanism that keeps track of distributed components and lets clients access them. Network OLE has just such a feature.

Network OLE is an OS layer that insulates applications and components from the hairy details of network transports and component tracking. If it works as Microsoft is promising, it will be transparent to users and translucent to network administrators. Users won't need to know whether the OLE objects they're using reside on their local machines or on other networked systems. Administrators will decide where to install the objects, and Network OLE will maintain the invisible links even if the administrator moves or updates the objects (see "Extending the Reach of OLE," November 1994 BYTE).

Priming the Pump

Microsoft is doing two things to pave the way for Network OLE. First, it is urging software developers to support OLE 2.0 in all new software. The more OLE 2.0 features that programs support, the more



benefits they'll automatically inherit under Network OLE. Second, Microsoft is offering a glimpse of what's to come.

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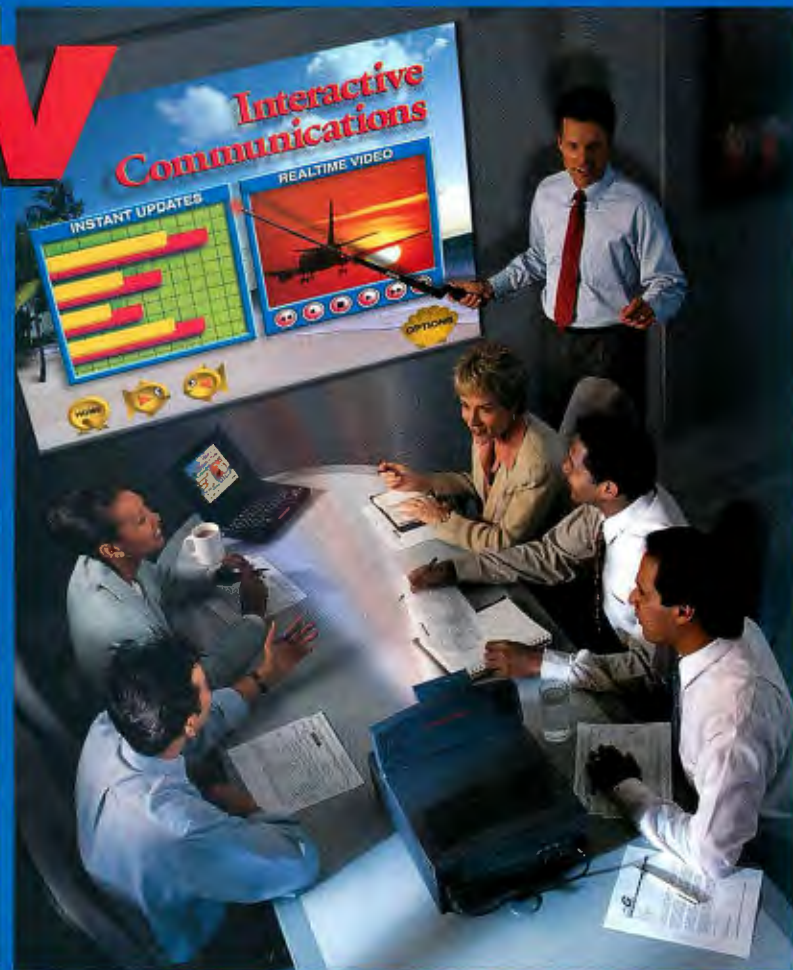
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objects (they're called OLE automation servers). You can scatter these objects across a network and call their methods from any client application that's an OLE automation controller. Some examples of OLE automation controllers are Microsoft's Word, Excel, Access, PowerPoint, and VB4; Borland's Visual dBase and Paradox for Windows; Novell's Quatro Pro; and Powersoft's PowerBuilder.

Until now, the only way you could use OLE over a network was to dynamically link or embed OLE objects in your applications. In other words, you could manually embed an Excel chart in a Word document if Word was on the client machine and Excel was on a file server, but you couldn't write a Word macro that called Excel's OLE methods on the file server. VB4 pro-



vides the remote automation mechanism that lets the OLE controller application call the remote OLE object's automation methods programmatically.

For example, today you could write a VB program that sends 10 values to a copy of Excel on the same computer and ask Excel to compute and return the sum of those values. But you can't do that if the copies of VB and Excel are on different machines on a network. With VB4 remote automation, you can.

Remote automation uses a new OLE proxy on the client machine and a remote automation manager on the server (which could be a traditional server, another client machine, or a component server). When a client application calls the methods of an OLE automation object, it first checks the OLE object registry (see the figure "Stepping Stone to Network OLE"). The registry knows whether the called object is on a local machine or a remote machine. If the object is on a local machine, the request passes through the regular OLE proxy to the object.

If the called object is remote, the new OLE proxy handles the request. It translates the OLE call into a Windows NT-standard RPC and sends it over the network to the server. At that end, the remote automation manager translates the RPC back into a regular OLE call and forwards it to the OLE object. OLE callbacks are handled the same way.

It's not quite as cool as full-blown Network OLE, but it's enough to whet your appetite. Network OLE will be more robust and will offer many more features. For example, it will work with the NT file system to automatically keep track of objects if you relocate them on the network. It will also let you link applications and objects created with any development tools, not just VB4. (Technically, VB4 makes this possible, but Microsoft's licensing agreement requires that one of the OLE objects must be VB or created with VB.)

The advantages of a three-tier architecture will become more obvious as the technology becomes more widespread. By delivering a preview of Network OLE in VB4—and by laying the groundwork with OLE 2.0 in today's software—Microsoft is building a solid distributed-objects strategy for the future.

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STATE OF THE ART Components Everywhere

CORBA 2.0, a revision of the original CORBA specifications. But what happens to CORBA in the next year—especially how the standard evolves to enhance portability and interoperability—could hold the key to the future of componentware.

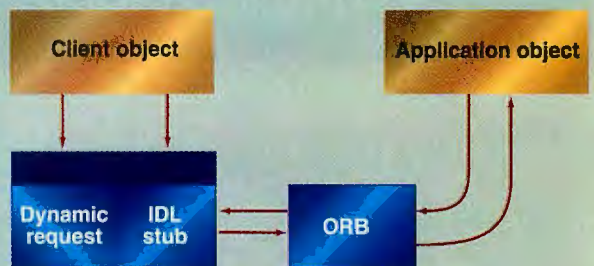
ORBs are the cornerstones of the CORBA architecture. In a distributed environment, they provide a common platform for objects to request data and services on the client side and for servers to send their responses back to the client objects (see the figure "Objects in Orbit"). ORBs hide interoperability details from the client and server objects, so such issues as what programming language and OS each object uses don't stand in the way of their communication. Thanks to ORBs, a client object doesn't even need to know the location of its server counterpart, which may be on the same machine or on a computer thousands of miles away. It's the ORB's job to be the matchmaker.

A client application makes a request for some kind of information. The request has two basic parts: an object reference for a particular object and the action the object is to perform. The client creates this request by calling stub routines specific to an object (through the interface definition language, or IDL, interface) or by constructing the request dynamically. Either way, the client sees the same interface regardless of what language the object is written in or where it lives on the network.

The stub routine (or dynamic request) routes the request to the ORB. The ORB is responsible for maintaining mechanisms to find the requested object, preparing the object to receive the request, and communicating the data inside the request. During the request, the ORB locates the appropriate object implementation, transmits the parameters of the request, and transfers control to the object. Once the object is done with the request, it passes control back to the ORB along with the results. The ORB then passes control back to the client application.

CORBA 2.0 built on this architecture and addressed some of the shortcomings in the original version. Specifically, it includes bridging technology, which provides for communication between ORBs,

Objects in Orbit



Object request brokers (ORBs) act as a common platform for objects to communicate. The client object routes a request through stub routines (via the IDL interface) or as dynamic requests. The ORB finds the appropriate object and communicates the data inside the request. When the application object finishes acting on the request, the request goes back to the ORB, which passes control back to the client object.

and an optional Distributed Computing Environment-based (DCE) interoperability scheme. CORBA 2.0 also adopted TCP/IP as the standard communications protocol to help ensure out-of-the-box interoperability between different vendors' TCP/IP implementations of CORBA. The DCE can also be used as a way for objects to communicate, but it is an option that users must choose to implement. These enhancements extend the portability and interoperability of the standard.

CORBA is part of the larger Object Management Architecture (OMA), which includes CORBA services and CORBA facilities. CORBA services provide basic operations, such as object class management, instance management, and security. CORBA facilities offer link management, print services, and E-mail. Such facilities will help extend the portability of CORBA into such areas as groupware and transaction monitors.

In some ways, what is happening to CORBA is analogous to what has happened to network OSEs (NOSEs) in recent years. When they were introduced, many NOSEs offered such basic services as print and file services. But for those NOSEs that moved from being aimed at the workgroup to being honed for the enterprise network, developers added more capabilities, such as directory and security services.

In a similar way, the OMG has added services to CORBA and expanded the ways users access them. For example, the proposed licensing service lets a CORBA developer use the Object Licensing Service for monitoring and possibly metering an object's usage. This lets users write a program that tracks an object's usage and bills customers based on the number of times they accessed an object and how long an object was used each time. Such a

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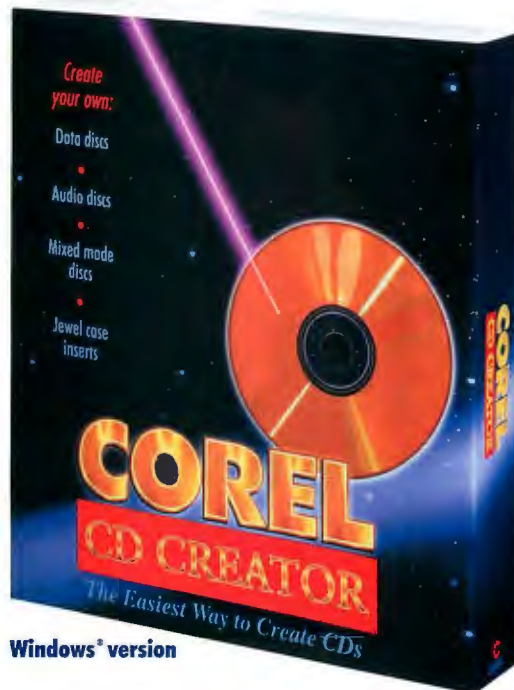
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STATE OF THE ART

service goes beyond the basic functional interoperability that is required in object-oriented applications development.

Looking Ahead

Back to the jungle. For better or worse, OLE is the object technology that dominates most desktop-development efforts today. As Microsoft extends OLE's reach into a distributed environment, the combination of the client stranglehold with strong network services could create an insurmountable mountain for CORBA.

A possible compromise scenario is an object-development environment, where the desktop is dominated by OLE and the backbone is CORBA. Ideally, there would be a simple way to link the Windows desktop with objects residing on Unix and OS/2 servers. Today, companies such as Expertsoft (San Diego), Iona Technologies (Dublin, Ireland), Genesis Development (West Chester, PA), and Visual Edge Software (Montreal) offer products designed to bridge the OLE-to-CORBA gap.

However, all these solutions are proprietary. The OMG is working on an OLE/CORBA specification that would standardize the process in which a user would be able to carry out an operation on a CORBA object from OLE-enabled applications. Last summer, the OMG received over a dozen vendor proposals on how to close the OLE-to-CORBA link. Basically, the OMG's efforts could lead to the definition of an OLE/COM (Com-

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ponent Object Model)-to-CORBA gateway that provides a mapping between COM and OMA.

In the meantime, developers are left to watch the standards evolve and to bet development resources on a large gorilla or a committee-designed camel. ■

Tom R. Halfhill is a senior editor for BYTE in San Mateo, California, and Salvatore Salamone is a news editor for BYTE in New York. They can be reached on the Internet or BIX at thalfhill@bix.com and ssalamone@bix.com.

JON UDELL

SERVER MANAGEMENT

The sun never sets on The BYTE Site. Once I launched it, I became responsible for a service that a growing international clientele expects to be able to use 24 hours a day, 365 days a year.

How do you keep this kind of service humming? Two crucial variables—the World Wide Web server application and the OS—govern your management options. Here's a look at some combinations I've tried so far.

NCSA Server, BSD/OS

The most manageable Web servers run on Unix (or Unix-like) OSes. Consider the Dell PC on which I've been running the National Center for Supercomputing Applications (NCSA) server + BSD/OS combination. It's a headless box; I borrowed the monitor long ago and never returned it. Why bother? A telnet window on another workstation—located on the local Ethernet or anywhere on the Internet—is fully equivalent to the Dell's missing console. I can dial BIX from a DOS subnotebook, telnet to the Dell, stop the NCSA server, launch EMACS, edit the server's configuration files, and restart the server.

If the server and its related utilities were GUI-oriented rather than command-line-oriented applications, they could export the same control capabilities using the X Window System. You'd need more than a DOS subnotebook to run the X server, of course. But the point is that location doesn't matter in Unix computing: You can do just about anything from anywhere.

A healthy Web server needs to be running on a healthy system, of course, so the scope of the management task goes beyond just monitoring the httpd (the Hypertext Transport Protocol daemon) itself. You also have to pay attention to ftp and mail services; organize, prune, and back up files; and read and analyze system logs.

Unix doesn't make any of this easy for a novice, and mastering the seemingly endless number of interactions between shell scripts and configuration files requires a huge investment of time and effort. But advanced users leverage that investment by packaging routine management tasks into shell scripts and scheduling them to run periodically. Automation and remote access are the keys to effective system management. Unix shines in both departments.

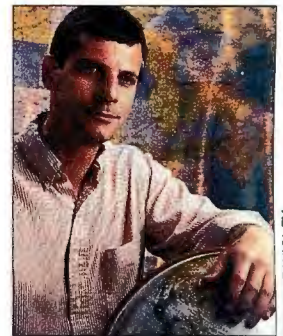
Netscape Commerce Server, Windows NT

Telnet and EMACS get the job done, but should you really have to depend on 25-year-old character-mode tools? A number of second-generation Web servers, led by

Netscape's, export management interfaces as Web applications. The Netscape server's administrative tool set has two parts: a collection of Hypertext Markup Language (HTML) forms that document the tasks a web master can perform—creating a user database, viewing a log, securing a directory—and a corresponding set of Common Gateway Interface (CGI) programs that perform those tasks.

When you install a Netscape server, you really install two servers attached to different TCP/IP ports. The public server, <http://www.byte.com:665/> in my case, presents a home page. The administrative server, which I set up at <http://www.byte.com:666/>, presents an authentication dialog box and then a page of management options.

Why a separate server? One key administrative task is stopping and starting the primary server. Because the

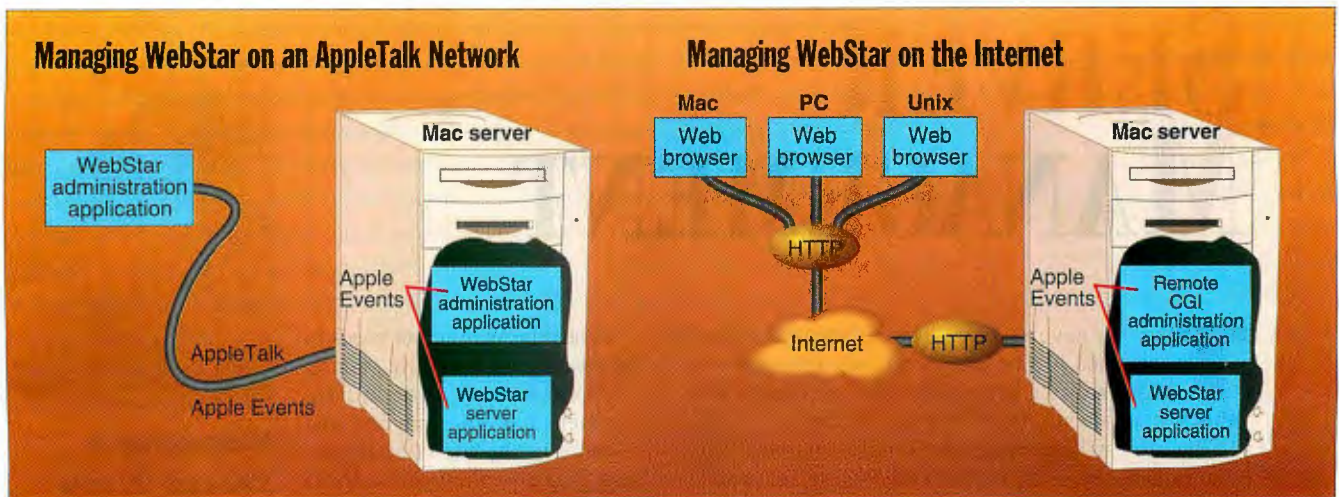


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Keeping a World Wide Web site healthy depends on your choice of Web server and OS. Here are some interesting variations.



Here's my home Windows 95 machine displaying the console of one of The BYTE Site's development servers: an Intergraph TD-4 running Citrix Systems' WinFrame (a Windows NT extension) and O'Reilly and Associates' WebSite. Finally there's a way to manage an NT system from afar.



Netscape server's process control depends on CGI, you might be able to shut down the primary server using its own CGI mechanism, but you'd be sawing off the branch you're sitting on.

Because it leverages Web technology, Netscape's server administration enjoys the same portability as all other Web applications. Local and remote X, Microsoft Windows, and Mac browsers all run the administrative applications identically. On the server side, the CGI wrapper provides the same capabilities on any server OS. For example, I ran the Netscape Commerce Server on Windows NT, which lacks the remote access features that Unix provides. No matter. A user of Netscape's administrative tool set doesn't have to know what OS underlies the server.

WebStar, Mac System 7.5

A new member of The BYTE Network Project's family of Web servers is the Apple Internet Server, a Power Mac 6100/60 running StarNine's WebStar. Currently this machine is running as an *intranet server*—it's connected only to the BYTE LAN, not to the Internet. I've mirrored the contents of The BYTE Site onto the WebStar server, and I'm now using it to collaborate with BYTE's design department on a redesign of the site's graphics.

WebStar's administrative application handles the usual chores: defining users and groups, configuring logging and suffix mapping, and tweaking communications buffers. It communicates with the WebStar server entirely by means of Apple Events. This means that on a LAN, you can administer WebStar from any Mac, since Apple Events readily cross machine boundaries on an AppleTalk network. This scheme won't work on an IP network, however. This is because even

On an AppleTalk network (left), WebStar's administrative application can talk to the WebStar server locally, or across the network using Apple Events. On the Internet (right), you can use any Web browser to talk via HTTP to Remote Admin, a CGI application that in turn speaks via Apple Events to the WebStar server.

with Open Transport, Apple's latest transport-independent technology, core Apple networking services, such as file sharing and Apple Events, can't yet ride on IP.

What to do? Eric Zelenka from StarNine pointed me to a CGI application called RemoteAdmin.cgi (not shipped with the Apple Internet Server, but available from <http://www.starnine.com>). It exports an HTML forms interface to WebStar's administrative functions.

Like Netscape's approach, this arrangement affords both remote access and portability. Any browser, whether Mac-based or not, can now control a WebStar server over the Internet. The browser speaks HTML to RemoteAdmin.cgi, which in turn sends Apple Events to WebStar (see the figure "Managing WebStar on an AppleTalk Network" above). Because the System 7.5 Finder can itself be driven by Apple Events, it should be possible to write a more ambitious CGI application that can manage files on a Mac server, operate Control Panels, and even restart a Mac.

WebSite, Windows NT

O'Reilly and Associates' WebSite provides a suite of Win32 management tools, including Server Admin, which controls security settings, data-type mappings, and transaction logging. It's really just an interface to the Windows NT (or Windows 95) registry where WebSite stores the values of its control variables.

Because the NT and Windows 95 registry editors are remote procedure call (RPC) enabled—that is, you can point one machine's copy of RegEdit at another

server's registry, even across the Internet—WebSite is as capable of the same sort of limited remote management as any Windows 95 or NT application that stores configuration data in the registry. To make RegEdit work across the Internet, add a line like

```
192.168.1.1 MYSERVER
```

to the WINDOWS\LMHOSTS file. This line maps the target machine's IP address to a NetBIOS name that Windows networking services, such as RPC, require. (See "Wide-Area Windows Networking," January 1994 BYTE, for more on NetBIOS-over-TCP/IP.)

This setup works, but it's slow over dial-up IP because RegEdit uses a slow link inefficiently. To improve performance and simplify the interface, WebSite's designers made Server Admin RPC-enabled. From my Windows 95 machine at home, I can tweak WebSite registry values on an NT server at BYTE over the Internet.

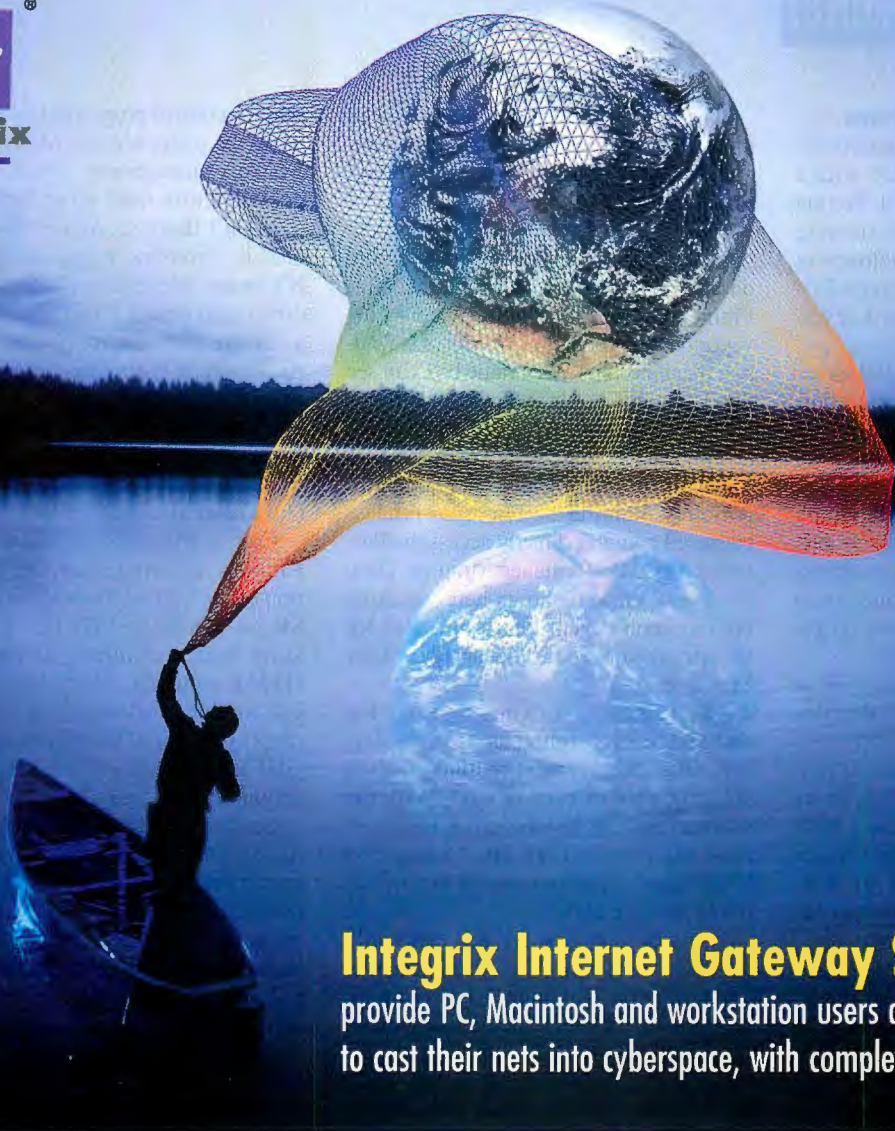
But while Server Admin works well in RPC mode, I've had poor luck using another tool, WebView, to remotely scan The BYTE Site for broken hypertext links. With WebSite, as with Windows NT in general, RPC-based remote administration is a hit-or-miss affair. You must specifically modify each application that exports a control interface through RPC, and even then your mileage varies, depending on the characteristics of the administrative application and its data.

So what's the general solution for remote management of NT systems and applications? Enter WinFrame.

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Purveyor, WebSite, and WinFrame

Citrix Systems' WinFrame transforms Windows NT into a multiuser OS with a flexible and efficient remote GUI. For the past month, WinFrame has been running on one of The BYTE Site's development servers (a dual-processor Intergraph TD-4), and it has revolutionized how I develop and manage the site.

Check out the screen on page 107 showing The BYTE Site's WinFrame command center. You're looking at my home Windows 95 PC on a 28.8-Kbps dial-up link to the Internet. The window titled "TD4" is a projection of the Intergraph server's console, and it could just as easily appear on a LAN- or dial-up-connected Windows 3.1 or DOS machine, or on one of the new WinFrame-aware terminals from Wyse.

There are a lot of things going on at once in this window. A detailed description follows.

WebView. The WinFrame server is running WebSite. In theory, I can scan its web from home using WebView's RPC capability. In practice, this process works faster and more reliably when I run it directly on the server and export its user interface using WinFrame.

Perl. The MS-DOS icon represents an instance of Perl running a script that summarizes the IP addresses in the production server's log.

Performance Monitor. Here I'm watching two Web-server processes: WebSite on the WinFrame and, through the WinFrame system, Process Software's Purveyor on the production Windows NT/Alpha machine. The WinFrame box can see the Alpha/NT box's Performance Monitor, because vanilla NT's Performance Monitor is RPC-enabled.

Until I installed WinFrame, I couldn't remotely monitor the Purveyor process because I couldn't directly access the Purveyor box's Performance Monitor. Ditto for Event Viewer, shown here watching both systems' event logs. Ditto also for Registry Editor, Server Manager, and User Manager.

File Manager. With megabytes of log data and reports accumulating every day, my server management routine involves slinging a lot of files around. With the two servers' file systems cross-mounted, I can run plain old NT File Manager on WinFrame's remote console and effectively manage both.

Users of Purveyor 1.1 will especially like being able to use File Manager remotely. Although 1.1 exports all its Control Panel functions to remote Web browsers by means of CGI/HTML, you still have to use a File Manager extension to set permissions on uniform resource locators (URLs). Purveyor on Windows NT can't export that function to remote administrators; Purveyor on WinFrame can.

Control Panel. Under Unix, GUI administrative tools are just wrappers around more-primitive command-line tools; that's why you can manage Unix remotely using just telnet. NT's versions of these tools are natively graphical, so they're easy to use, provided you're sitting at the console. But even if you use a third-party telnet on NT, you can't stop, reconfigure, and restart the system services that the Control Panel controls. WinFrame exports control over these vital services to the remote administrator running Windows 95, Windows 3.1, or even lowly DOS.

Back to the Future

So far I've described only the benefits of Windows NT remote control. WinFrame is currently the only player in this field. None of the Windows 3.x

remote-control programs has yet stepped up to the plate, nor has Microsoft's own Systems Management Server. When they do, will Citrix wind up on the bench?

I don't think so. WinFrame's remote GUI is a godsend for the manager of an NT-based Web server, but its multiuser dimension makes it much more than just an NT remote-control product. The Citrix vision of Web-based computing represents a serious alternative to both the existing CGI/HTML standard and the distributed-component architectures currently being advanced by Sun and Netscape (Java) and Microsoft (Blackbird).

Consider the suite of Web-based tools I'm now writing to support administration of the Virtual Press Room (see "Perl Magic," December BYTE). First-generation Web technology dictates a CGI/HTML solution. That's doable, but if you've been following my CGI adventures, you know that mimicking a live GUI using a series of forms-based transactions can get hairy.

Second-generation Web technology (the Java/Blackbird approach) promises to export the live GUI through the Web as a dynamically acquired component. Sounds great, but I won't deliver tools next month based on Java or Blackbird; these technologies aren't ready yet.

WinFrame, in contrast, relies on old-fashioned development tools, such as Visual Basic and Delphi. And it updates the even-more-old-fashioned mainframe- or X-like model of computing, enabling Visual Basic/Delphi applications to run on a multiuser host with local access to data while displaying on Windows terminals.

Too retro for your taste? By the time you read this, Citrix will have shown a Web browser that displays off-the-shelf Windows and Win32 applications running on a WinFrame host located across the Internet. I'm bullish on Java and Blackbird, too, but there are a lot of Windows applications kicking around, and Citrix's approach ought to make you stop and think.

WinFrame also pours fuel onto the NT-versus-Unix debate. John Montgomery, who edits this column, neatly frames the issue this way: "NT gets you from zero to 60 more easily than Unix, but you need Unix to get from 60 to 100." I agree. And now that I've experienced the power of Citrix's Unix-like extensions, I'll never want to settle for vanilla NT. ■

Jon Udell (judell@bix.com) is BYTE's executive editor for new media.

TOOLWATCH

Microsoft Paint

(Included with Windows 95)

Microsoft Corp.

(<http://www.microsoft.com/>)

Not until I hit the road with a Windows 3.1 notebook and then needed to tweak some icons for the site did I realize how dependent I've become on the handy new bit-map-editing features of the Windows 95 version of Paint. Now if only it would read and write GIFs...

BOOKNOTE



Building Internet Firewalls, \$29.95

by D. Brent Chapman and Elizabeth Zwicky
O'Reilly and Associates, 1995
ISBN: 1-56592-124-0
(<http://www.ora.com/>)

Perimeter networks, dual-homed bastion hosts, proxies, and screening routers all loom on my horizon. Fortunately, Chapman and Zwicky, who have been there and done that, have written the practical handbook I've been waiting for. This book will become another well-thumbed O'Reilly classic.



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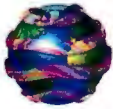


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BYTE EXTRA

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Applications



Development

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Does It Work?

Automated tools can exhaustively test your application's features, functionality, and performance while you're building it.

PAGE 112DM 5

With a Little Help from My Tools

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PAGE 112DM 15



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Finally: Custom Controls You Can Customize

Add-in OCX modules make it easier to develop 32-bit Windows applications

KAREN OFFERMAN

Component software isn't a startling concept. It's simply common sense. Why reinvent code to do a job that's already been done? The 16-bit custom controls (VBXes) Microsoft introduced with Visual Basic put us on the road to implementing reusable code, but it didn't go far enough. The new Visual Basic 4 puts us closer to code nirvana.

First, some history: Visual Basic developers have been free to choose from a host of VBXes that extended the reach of both the developer and VB, while requiring little real coding effort. Programmers could focus on integrating the custom controls and had to code only those functions unavailable elsewhere.

Still, VBXes had serious drawbacks. You could use them only with Visual Basic; not even other Microsoft tools supported them. And, paradoxically, you couldn't customize most custom

controls, not even with VB itself. Only a few late-bloomers, such as Borland's Delphi, enabled developers to both use and customize VBXes.

With release 4, VB has moved to a 32-bit processing model, and its custom controls have made the leap as well. Now called OCXes, the new 32-bit modules are more capable than their 16-bit predecessors, and they're also more universal than any other component software to date. VB4 lets you add custom properties and methods to the forms you use with an OCX.

Support for OCXes is far more widespread than that for VBXes. All 32-bit Windows C compilers let you call OCXes, and you can share VB and Visual C++ controls between the two tools. Microsoft applications that support Visual Basic for Applications (VBA)—e.g., Excel, Access, and Project—can call OCXes in their macros. (Microsoft Word, though, uses a unique VBA implementation that can't use OCXes.)

Perhaps the major drawback to 32-bit controls is the wait. "Everyone's waiting on VBX vendors to show up with OCXes," says Paul Bonner, a Visual Basic consultant and writer. "I imagine there are lots of 32-bit projects on hold, waiting for OCX support."

Over the next six months, we'll see innumerable OCXes, but some products already stand out as winners. Class-Assist from Sheridan Software (Melville, NY) helps VB programmers create objects and classes. It provides a set of basic controls and also lets you create OCX controls. DeSaWare (San Jose, CA) has a new control called StorageTools that lets VB and OCX developers work with documents made with OLE's structured storage facility. In effect, this creates a file system within the file itself.

OCXes will make life easier for Windows developers. As 32-bit component software comes to market, developers will have the tools to design more innovative programs. ■



Cyberpunks Crack Netscape

When two UC-Berkeley graduate students cracked the widely used Netscape Web browser, they saved Netscape from a serious security breach. They also taught the company a thing or two about building security into software.

Ian Goldberg and David Wagner are members of Cypherpunks, a group that seeks to safeguard the privacy rights of individuals through cryptographic security. They wanted to see how secure the Netscape browser really is. They discovered a classic mistake.

Whenever the Netscape browser wants to have a safe conversation with a remote system—to send credit card information, for example—it generates a special code called a session key. That code is used only for that one conversation, and it's supposed to be based on a random value.

However, the Netscape browser generates "random" numbers that aren't random at all. It's a bit like having a strong password-encryption algorithm and then picking a password that's easy to guess.

This weakness allowed Goldberg and Wagner to break a Netscape session key in 25 seconds on a single workstation.

There's an important lesson here: Cryptographic protocols should be published and scrutinized widely. This idea goes against every instinct, but it is the best way to find problems early. The alternative—"security through obscurity"—is a recipe for disaster. If the people who reverse-engineered the browser hadn't been public-minded graduate students, someone in a position to monitor Internet transactions could have helped himself to confidential information from sup-

posedly secure browsers. Netscape seems to have gotten the message; the company has announced that it's assembling a board of outside experts who will "review the design and implementation of security in Netscape's products."

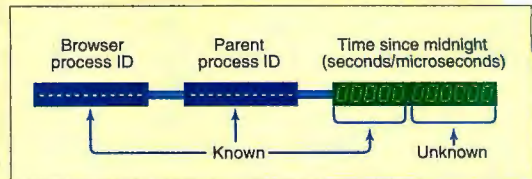
—Oliver Sharp

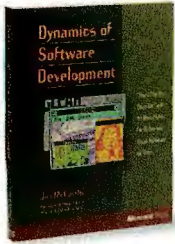
THE BAD SEED

To create a "random" number, Netscape simply combined three numerical values into one: the process ID of the browser, the process ID of its parent, and the current time (expressed in seconds and microseconds). Unfortunately,

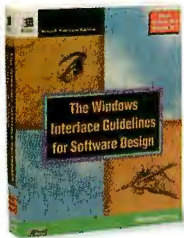
process IDs can often be discovered by querying the system or by watching the packets sent on the network. The

time in seconds is known almost exactly. The only value that is unknown is the current number of microseconds. But, by definition, this has only 1,000,000 possible values. Instead of checking all 2⁴⁰ possible keys, the cracking code can ignore most of them and look at just a tiny subset.





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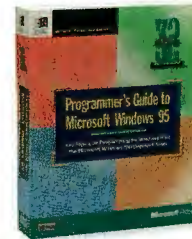
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Does It Work?

CURTIS FRANKLIN

The plain truth is, coding is glamorous and testing isn't. Few would deny that software testing is important, especially in the complex client/server environment, but it doesn't capture the popular imagination. Fortunately, the current crop of software-testing tools makes it possible to apply a high degree of discipline and automation to the problems of quality assurance and overall applications performance.

You can take several different approaches to testing, beginning with what you decide to test. If you're testing an application for accuracy, completeness, and functionality, then one set of methods and criteria comes into play. But if you're interested in the performance of a complete system under a particular application, you use a different set of methods and criteria.

In the former case, testing attempts to exercise as many application functions as possible while measuring the total number of errors uncovered. In the latter instance, the emphasis is on choosing the operations most likely to mirror a user's actions and on measuring the time required to complete a specific number of iterations. While some tools can test both performance and applications, the break between the two camps defines a starting place for looking at the differences between tools.

Regression Testing Looks at Possibilities

Most modern client/server applications offer a staggering array of possible actions and responses, depending on the precise task undertaken and the state of the particular data involved. *Regression testing* is the process of trying as many of the potential action/data combinations as possible. For a complex system, an absolutely complete regression test might involve tens of thousands of individual tests.

Although many design teams try to perform exhaustive testing, most will admit that the sheer complexity of client/server applications makes completeness nearly impossible. Even when designers use profiling tools to decide on the most reasonable subset of functions to test, it's common for a regression-test sequence to include thousands of individual tests.



Automated testing can let you know, as you build an application, what works and how well

To make the performance of so many tests possible, automated tools are a necessity. Among the better-known tools for regression testing are QAPartner, from Segue Software (Newton, MA); and WinRunner, from Mercury Interactive (Santa Clara, CA).

While there are differences in details, all regression-testing tools share a basic approach to creating suites of regression tests. Because they involve the application, these tools monitor activity at the user-interface level. A typical testing tool simulates mouse activity and keyboard strokes while monitoring the placement and contents of dialog boxes, response cells, and result screens.

In addition, regression-testing tools provide a scripting language (generally based on C or BASIC) to build new scripts or to modify existing activity scripts. GUIs make using these languages similar to programming the original application under test.

While programming a regression test involves manipulating and monitoring certain system components, the testing process cannot ignore other parts of the system that aren't directly involved. In particular, regression testing tends to look at the results of

PAUL WATSON © 1995

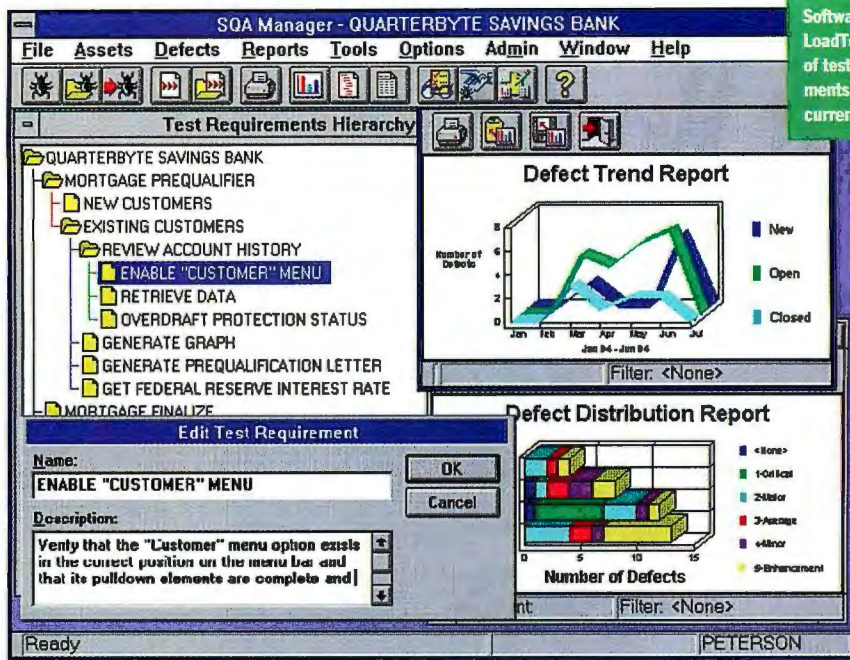
operations as they are presented to the user rather than concentrating on the quality or performance of the underlying code that produces the results.

Consider an application that uses client workstations to send SQL calls to a database server through Microsoft's Open Database Connectivity (ODBC) extension. Different drivers can create quite different code segments that will, nonetheless, elicit identical results from the database. Regression testing is unlikely to look at those differences or to consider how they might affect performance.

The only issue here is whether the results that make their way to the screen match the response that the developers expect.

If you want to look at the server's performance or examine the actual code that the application produces, you have to use different tools.

from the client to the server to test the system's ability to create the answers in the first place. Representative tools in this category include preVue C/S, from Perfor-



Software Quality Assurance's SQA LoadTest Manager shows a variety of test procedures and requirements, as well as reports of current test results.

Testing Server Performance

When the focus is moved from the application to the system, many test aspects change. From the tool perspective, the emphasis shifts away from the user interface and toward the interface between the client and the server. Where regression-testing tools emulate the response of a user, system-testing tools emulate the calls made

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mance Awareness (Raleigh, NC); SQA LoadTest, from Software Quality Assurance (Woburn, MA); and LoadRunner/PC, from Mercury Interactive.

While regression-test automation is useful for executing thousands of tests, automated server-load testing emulates thousands of users. Although it's possible to load-test a server by actually connecting it to thousands of client PCs controlled by thousands of users, each ready to press Enter at the same time, it's hardly practical or economical. Instead, to test modern servers thoroughly, methods that are more affordable and more repeatable are needed.

The differences between regression testing and performance testing are echoed in the efficiencies that automation can bring to the process. In system-performance testing, the queries and activity that are generated by a single client workstation can be stored and played back—usually by a RISC-based Unix workstation—to determine how the system will perform under realistic deployment loading.

Looked at another way, regression-testing tools test an application's functionality and features. They sit between the client

workstation and the user, capturing and playing back user-interface responses. In addition, regression-testing tools must coexist on the system being tested, creating and running test scripts, all the while assuming that the testing tool has no effect whatsoever on the application's functionality.

System-performance testing tools sit between the client and the server, capturing and playing back the interactions between the two computers to test the reaction of the server. Load- and performance-testing software can coexist on a system under test with the application being used to generate the load. But, as is the case with LoadRunner/PC and preVue

Unused lines	Runs Called	FUNCTIONS			LINES		
		unused	used	used%	unused	used	used%
Total Coverage		1	13	92%	26	114	81%
.../u44/home/usspnt/Uniform/		1	13	92%	26	114	81%
testHash.c	6		7	87%	24	57	70%
testGetHash	18				7	10	58%
testPutHash	12				7	10	58%
reportError	18				5	8	61%
main	0	X			3	0	0%
testMakeHashTable	6				1	13	92%
FillTestTable	6				1	6	85%
testDelHashTable	6				0	6	100%
hesh.c	6	0	6	100%	0	4	100%
heshIndex	3000		2		57	96%	
ranHash	600		1		7	87%	
delHashTable	6		1		12	92%	
getHash	1200		9		9	100%	
makeHashTable	6		0		7	100%	
putHash	1200		0		0	4	100%
					0	18	100%

Pure Software's code monitor, Pure Coverage, shows what code is being used and how often. This can identify code that's never used at all but has somehow made its way into the application and is just taking up space.

C/S, it's most often executed on separate test workstations, apart from the server being tested and the actual application clients.

Making Testing a Suite Deal

In regression- and performance-testing products alike, the trend is toward combining several different functions into a complete, automated testing suite. Levels

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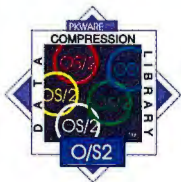
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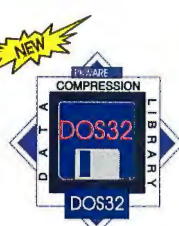
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of integration and functionality vary among specific products, but most include functional blocks that correspond to four basic areas: test development, test repository, test performance, and defect tracking.

Like the program development cycle, test development can be divided into design and coding stages. Programs such as QAPlaner, from Segue Software, aid the test process by imposing a specific discipline on the testing team. Once you've created a test plan, the product builds the test script, either by capturing actions and responses, enabling script creation through a programming language, or both.

After you've built the initial test script,

Types of Automated Testing

Regression

- Checks out application functionality.
- Tests all possible user inputs—mouse, keyboard, and data.
- Requires thousands of tests.

Server Load

- Measures system performance and response.
- Simulates multiple simultaneous users.
- Ensures that a system delivers the correct services and data to client applications.

Code Monitoring

- Examines performance of program modules and code sections.
- Checks for code that's never executed.
- Finds heavy-use routines to optimize.
- Locates memory leaks to plug.

the next job is to create a reusable test repository, which offers several advantages. You can archive tests and run them repeatedly, which brings discipline to the process. Also, you can rerun tests from known intermediate points—not just from the beginning—which can save time and money. Finally, you can build tests on other known tests, making the entire testing process more complete.

Some in the testing field believe the repository function of an automated test suite is the most important benefit the tool brings to the testing process. More than any other component, the test repository

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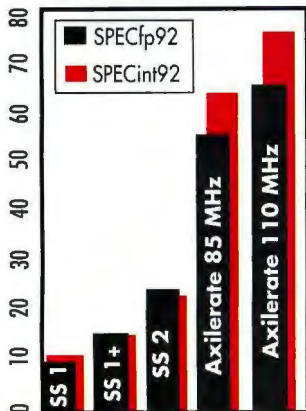
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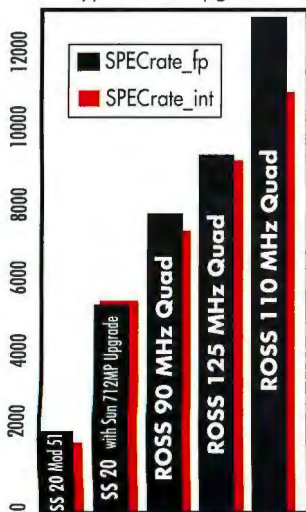


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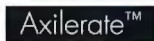
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turns test scripts from disposable tools into valuable, reusable assets of the organization. While this alone can't make testing an inexpensive proposition, it can go a long way toward protecting an organization's investment in the entire testing process.

Test suites that combine system performance and applications testing have more complex requirements than those that concentrate on either task. Performance Awareness's preVue C/S, for example, must not only manage the functions of its integral load-testing capabilities but also work with Win Satellite, a companion product that creates a load by driving the actual application on a single Windows workstation.

Once the test suite is complete, what happens to the results? This question is important for performance testing, but it's absolutely critical in regression testing. The volume of results from thousands of regression tests couldn't feasibly be analyzed by a human tester in any useful period of time. A tool like Mercury Interactive's Test Director assists the testing team in identifying defects, passing them back to the development team for correction and subsequent retesting. This piece of the test suite, more than any other, ties the testing process to the development cycle in a closed, integrated loop.

Deep Testing

The tests discussed thus far are aimed at either verifying application functionality or evaluating performance. While this is crucial data, it doesn't give developers all the information they need to improve their applications between initial development

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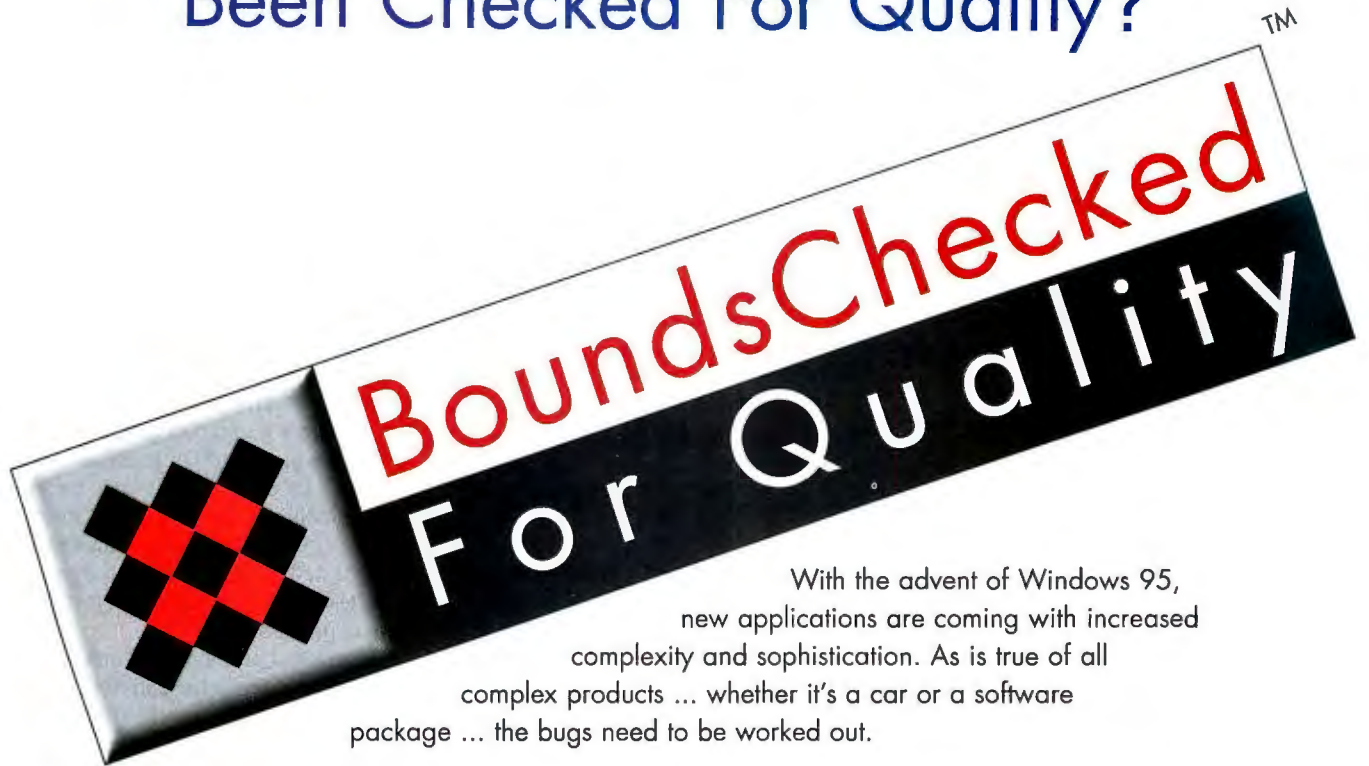
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and final deployment. The problem is that functionality and performance tests operate at the interface between application and user or between client and server. The tests, and the testing tools, don't go below the surface to look at or describe the internal workings of an application.

One tool that does go below the surface is the code-coverage monitor, which looks at what functions are actually called and executed during any application test. Pure Coverage, from Pure Software (Sunny-

vale, CA), is part of a suite of testing tools that look deep within the code of a client/server application and return information that helps a development team remove unnecessary code, optimize large program blocks, and track memory leaks.

Pure Test Expert, the tool's management module, coordinates Pure Coverage, a regression-testing tool named Purify, and a performance profiler named Quantify. Pure Test Expert then exports the results of the three modules into PureDDTS, its

error-tracking and test-repository module. Error tracking is the component that enables a development team to control, monitor, and manage the process of defect elimination. In other words, once a team has identified a bug, this tracking software helps make sure it's eliminated.

None of the Pure Software tools can replace the performance and functionality testing of the products mentioned earlier. However, they can be a valuable complement that gives a testing and development team a more detailed and accurate picture of many facets of system performance and functionality.

Test Early

In the end, it's the integration of testing into the development process that's most important. When a development team considers testing to be just another hurdle to overcome before an application finally ships, there's a great temptation to treat the testing procedure as a separate, final step that's otherwise unrelated to the total development process. While this ensures that nearly completed applications are actually tested, it can also mean that little or no testing is done earlier in the development process.

The greatest problem with making testing a discrete step at the end of the development cycle is that by the time defects are found—and testing will *always* find defects—they are difficult and expensive to correct. Incremental testing during development requires the discipline of a formal testing procedure that's applied in parallel with the software development. One way to force this parallelism is to use a separate team of individual testers. But this isn't needed if you employ automated testing tools effectively.

What, then, is the future of automated testing tools? Increased integration is the direction in which every major tool vendor is headed. Specifically, vendors recognize that users want to be able to test client/server systems from beginning to end, from the functionality of client applications to raw server performance, without having to change the tool interface or the scripting language. Finally, developers are recognizing the importance of a strong testing methodology and a high degree of reusability in bringing rationality to the process of making applications and systems work the way that users expect. ■

Curtis Franklin is director of labs at Client/Server Labs in Atlanta. You can contact him on the Internet at cfranklin@cslinc.com or on BIX c/o "editors."

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With a Little Help from My Tools

STEVE GILLMOR

Today's Windows programs require interactive help systems. GUI-based programming technologies, such as Delphi, PowerBuilder, and Visual Basic, have reduced the cost of developing complex applications, but their graphical nature and the Windows mind-set mean that users turn to on-line help more than ever and rely less on traditional printed documentation.

For some programmers, creating help is an unwanted distraction from the rest of the development process. But the good news is that help is available for them, too. Help-authoring applications have evolved from simple add-in utilities to powerful systems—both integrated and stand-alone—that blend multimedia and interactive tutorial techniques. With Windows 95, Microsoft has fine-tuned its help-engine technology.

Creating help files can still be a daunting task, however. Not only do you have to see beyond a welter of obscure control codes and formatting options to envision your final results, you also must learn how to organize complex information into a framework that will be intuitively apparent to the end user. Adding in the new technologies of digital video and audio is yet another hurdle, and the transition from Windows 3.x to Windows 95 and beyond offers new complications.

Microsoft's Help

The Windows 3.x help system enables developers to create sets of topics, each made up of text files and graphics. Users move through this information by clicking on hot spots, searching keywords, or browsing related sequences. You can open secondary windows with supplementary instructions and access context-sensitive help via the F1 key or dialog-box buttons.

With the release of the Access 2.0 Development Toolkit, Microsoft provided a *Help Compiler Guide* manual along with its core group of three help utilities: the Help Compiler, Hotspot Editor, and Multiple-Resolution Bitmap Compiler. To use these three utilities, you need a word processor or text editor that has the ability to save files in Rich Text Format (RTF); most devel-



PAUL WATSON © 1995

Windows applications cry out for on-line help systems. Here's a look at the tools and technologies that simplify their creation.

opers use Microsoft Word 2.0 or higher.

In this particular help system, Word control codes define the various elements of the topic file. For instance, a "\$" footnote indicates the title of a topic, and double-underlined text or text in strike-through mode represents a jump to another topic. A single underline specifies a temporary pop-up window, something that's often used for a brief definition or an additional note.

Windows 3.x's WinHelp supports four types of graphics: bit map, metafile, hypergraphic, and multiple-resolution bit map. You can create and modify bit maps in Windows' Paintbrush accessory, with a maximum of 16 colors. In addition, you can define a graphic as a jump or hot spot in code or use the Hotspot Editor to create hypergraphics, which have multiple hot spots. The Multiple-Resolution Bitmap Compiler combines CGA, EGA, VGA, and 8514 versions into a single bit map suitable for optimal display on almost any system. (See the figure "Creating Help" on page 112DM 18, which diagrams the tasks associated with creating a help system.)

continued

Add-Ins for Adding On

Help-authoring software falls into two main categories: add-in packages based on Microsoft Word for Windows, and stand-alone systems with built-in RTF word processing tools. Most add-in packages leverage typical Word document templates, translating heading styles into the various help components via Word or proprietary macros. The title page becomes a contents page, index entries become search keys, footnotes are converted to pop-up windows, and bookmarks are replaced by hypertext jumps.

The add-ins take advantage of Word's spell-checking, custom-menu, and graphics-handling tools. Details such as compiler command-line switches are handled by point-and-click interfaces; many packages display custom floating tool palettes that create, edit, and save various help-file elements.

With Blue Sky Software's (La Jolla, CA) RoboHelp, you click on the Topic button, type a title in the Help Topic Title box, and click on OK. RoboHelp then inserts the appropriate footnotes into the project's Word document and highlights the template's New Topic Text placeholder for your next entry.

You can create both a jump and the topic you want to jump to at the same time:

and follow the interactive directions. The Topic Wizard tool can automate the creation of help topics based on predefined text files, generate index topics with alphabetical buttons, and speed up the creation of detailed documentation for programming-language functions and macros.

On-Line as Well as in Print

Several packages specialize in generating both printed and on-line documentation from a single source file. WexTech Systems' (New York, NY) Doc-To-Help package intelligently maps linear documents to their hypertext equivalents while maintaining markers for material as help-only or document-only.

Doc-To-Help automatically builds main topics from your document's table of contents, creates jumps based on styles and chapter and page references, and then compiles a keyword list from the original document index. For your printed version, you can use customizable document templates that handle headers, footers, sideheads, table formatting, even and odd pages, gutters, page numbering, cross-references, and margin notes.

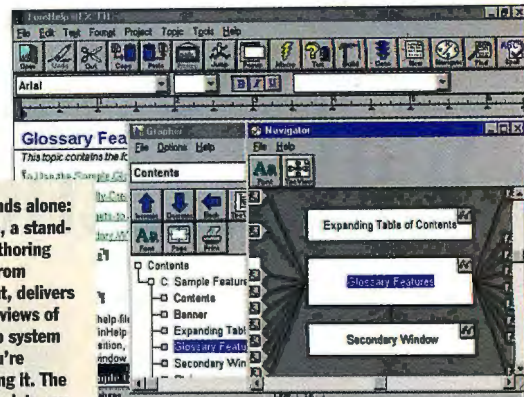
Virtual Media Technology's (North Sydney, Australia) HDK uses a Word template to add two buttons to the toolbar. One launches a new help project, converts the source document, and compiles the results. The other tests the file from within Word.

The program allows you to specify the particular Word styles used to determine topics, as well as those to be excluded from the on-line version.

You can also substitute paragraph styles during conversion—for example, to replace the styles that are suitable for print-

ed output with those that generate hypertext formatting. HDK creates a subdirectory for the new files, leaving the original document unmodified.

Add-in products differ in their approach to letting you view help files during development. The trend is toward simulating the WinHelp display environment and debugging help files before compiling. RoboHelp 3.0's new HelpCheck Tools includes an Error Wizard and a Check Mode for detecting syntax problems. You can access the Link Tester to test jumps, pop-



ups, search keywords, and macro hot spots. You can get a quick look at a topic by pulling down View/Topic Preview from the menu.

Graphics pose a tougher problem, and handling them can be a significant bottleneck for Word add-ins.

WexTech's solution to this is a companion product for Doc-To-Help, called Quicture. It off-loads embedded Word graphics to separate compressed files, substituting them with placeholders that preserve scaling, cropping, and borders. Another WexTech product, Smooth Scaling, intelligently scales bit-mapped screen shots and other graphics to between 10 percent and 90 percent of their original size while retaining legibility.

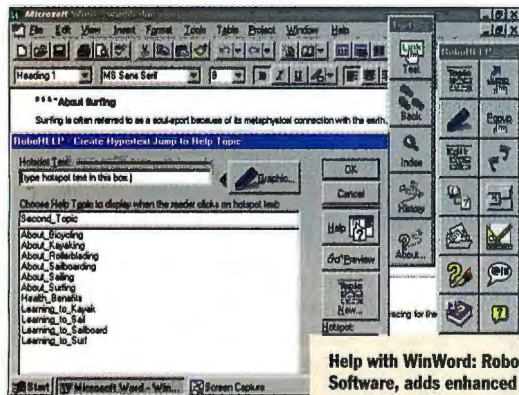
Stand-Alone Tools

Stand-alone systems can be a little friendlier than add-ins. They shield the user from Word's RTF codes, graphics placeholders, and compiling delays.

ForeFront's (Boulder, CO) ForeHelp incorporates help-like navigation from the editing screen and a WYSIWYG test mode that you access by pressing F10. From here you can single-click your way through compiled-speed displays of most help features, including jumps, pop-ups, browsing sequences, most macros, and embedded windows. You can check some of the options, such as bookmarks, annotations, and printing, only in the compiled version.

Stand-alones offer full-featured word processors for shops that use WordPerfect, Word Pro (formerly Ami Pro), or other editors that can't provide direct input to help systems. Standard features of these stand-alone systems include cut, copy, paste, tabs, indents, paragraph styles, bookmarks, and spelling checkers; some features, such as find/replace, are extended and support the conversion of strings to pop-ups, jumps, keyword references, and macros.

Techniques for viewing help-topic structure vary from vendor to vendor. HyperAct's (Coralville, IA) Help Writer's As-



It's as simple as clicking on the Jump button, typing the hot-spot text, and clicking on Topic New.

The program suggests a topic title and a search keyword based on the selected hot-spot text; you can add additional keywords, separated by semicolons. Other help features, such as pop-ups, secondary windows, and macros, are generated with similar steps. (See the screen above.)

Some packages offer unique approaches to these fundamental tasks. Solutionsoft's (Sunnyvale, CA) HelpBreeze, for example, leverages Word 6.0's Wizard technology with its Topic Wizard tool. You click on the toolbar's Wizard icon

Help with WinWord: RoboHelp 95, from Blue Sky Software, adds enhanced floating tool palettes to the Word for Windows interface that let you access help-authoring tasks. When the Test Mode palette is active, RoboHelp simulates most WinHelp capabilities, including hot-spot and index features.

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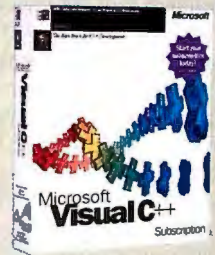
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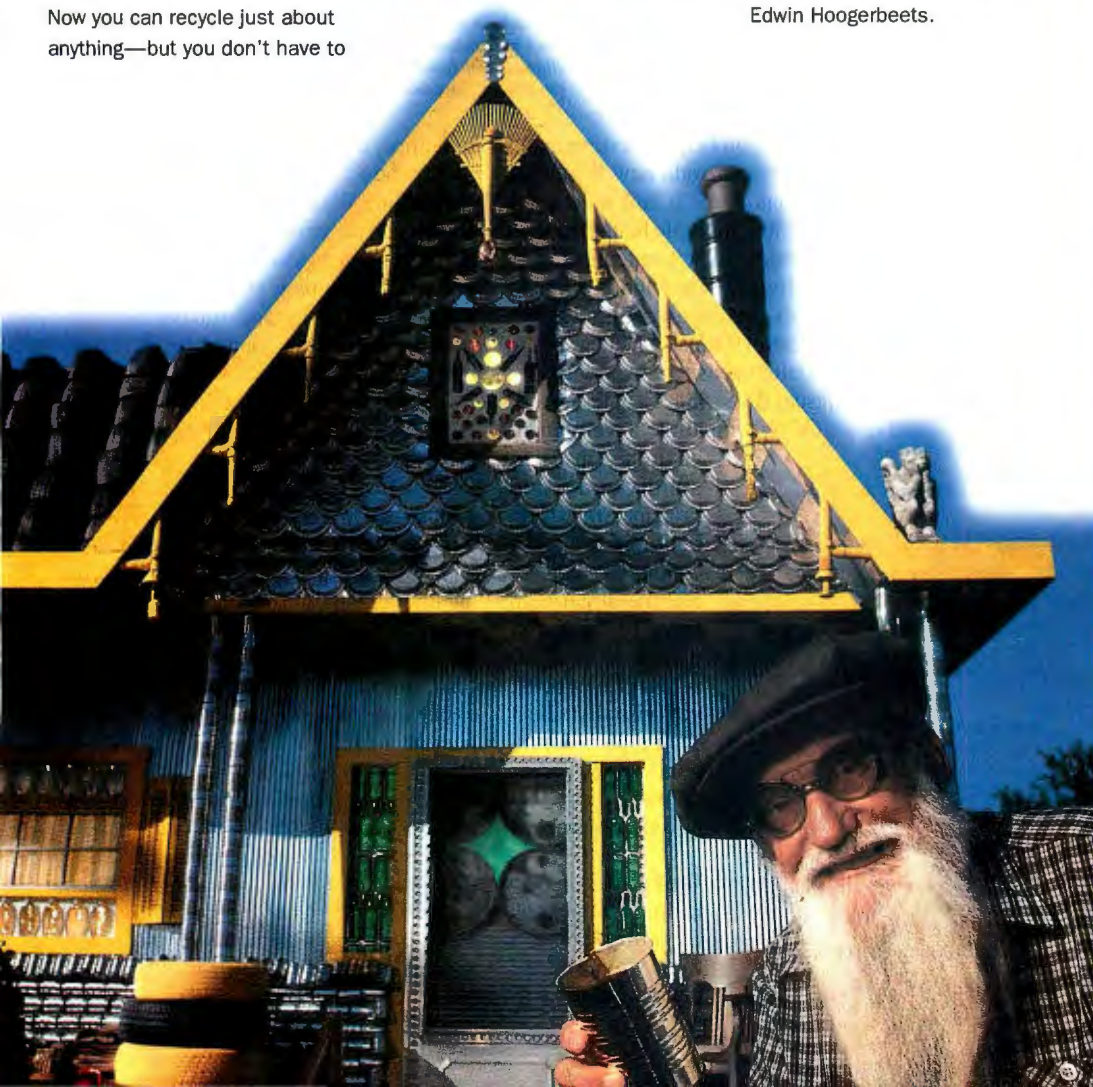
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sistant 2.0 sports a multiwindowed visual editor that lets you manage topic trees via drag and drop. ForeHelp offers three ways of getting an overview of your project: the map-like Navigator interface; the Grapher hierarchical directory-tree tool; and the Reporter, which helps you view or print context-sensitive information needed to tie an applications program to each topic. (See the screen on page 112DM 16.)

Software Interphase's (Foster, RI) Help Magician Pro 3.1 includes a Topic Outliner/Navigator as well as robust project management tools. These tools protect members of a help development team from inadvertent use of multiple topic titles, context strings, and context ID numbers. Window attributes, macros, compiler options, and build tags for conditional inclusion of topics are available to everyone working on the project.

The line between add-in and stand-alone help tools blurs when developers build in enhanced features. Most packages add support for 256 colors, background watermarks, printing of multiple topics, and full-text searching. Macro editing and browse sequencing are much more user friendly, as is the process of adding multimedia effects, including sound, animation, slide shows, and video clips.

New with 95

With the release of Windows 95, much of this extended technology is now included in the new WinHelp 4.0 engine. You can now take advantage of up to 16 million colors (up from 256), built-in video support (with WAV files on the way), and multi-topic and book printing. The interface is much improved, with a Contents tab that displays an expandable/collapsible hierarchical view with books and pages.

You can integrate multiple help files in

the Contents view and search them with multilevel keywords via the new Index interface. The Find tab provides full-text search for any word or phrase; the help author can create an FTS index file, or it can be generated automatically the first time the user accesses the Find tab.

Secondary windows now use the Windows 95 shortcut-button technology, taking users to the appropriate application command while leaving the interactive instructions visible. Communication is possible between help and applications in both directions, a key to training-card systems.

Other Windows 95 system tools include right-mouse-button context menus, drag-and-drop text selection, and additional font functionality. You can also launch 26 new macro functions via new authorable buttons, as well as define two different types of keywords to further enhance the links between help topics.

RoboHelp Office includes a beta copy of RoboHelp 95 and the Moving to WinHelp '96 Kit. The latter consists of the book *Mastering Windows 95 Help* and the Porting Tool application. This Windows 95 application helps you design and create a Contents tab, add new Windows 95 style buttons to main and secondary windows, and link multiple help files with a combined index in the Contents view.

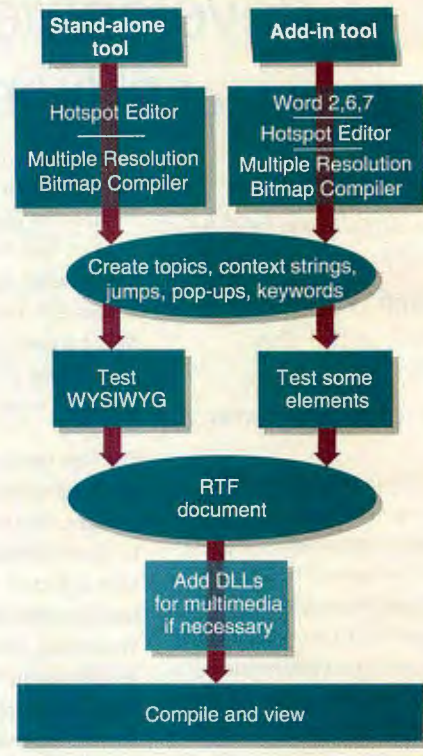
The RoboHelp 95 package is shipped together with the royalty-free SmartHelp OLE Control (OCX), which eases the coding of context-sensitive help with Access 95, Visual Basic 4.0, Visual C++ 4.0, and other OCX-compatible development

environments. You simply drag and drop the SmartHelp button in the application form and select the target help file. The OCX displays a list of all the search keywords; you visually select each topic with no need to know or manage topic IDs or context numbers.

The Future

Help with help has certainly come a long way, and all major vendors will

Creating Help



Help-authoring software falls into two major categories: add-ins to Word for Windows and stand-alone applications that simulate Windows help features before compiling. But whichever approach you choose, the process is complex.

be supplying Windows 95 versions for their products. Support will continue for the existing Windows 3.x base; legacy help files will run without modification with the new engines. Most companies are committed to continuing 16-bit support for the immediate future, standardizing their proprietary extensions around the Windows 95 look and feel.

The future for help-authoring systems is likely to expand significantly as the growth of CD-ROM and the World Wide Web offers increased opportunities for education, training, and information exchange. The huge installed base of WinHelp players makes help-authoring tools an attractive platform that can be used for multimedia development. The new Windows 95 help technology promises to transform on-line documentation from a necessary evil to an interactive partner without peer. ■

Steve Gillmor is director of Southern Digital, a consulting firm in Charlestown, South Carolina, and a senior vice president of Barkley Communications. He is coauthor of Using Visual Basic 3 (Que/Prentice-Hall, 1993). He can be reached on the Internet at sgillmor@aol.com, on CompuServe at 72662.3701, or on BIX c/o "editors."

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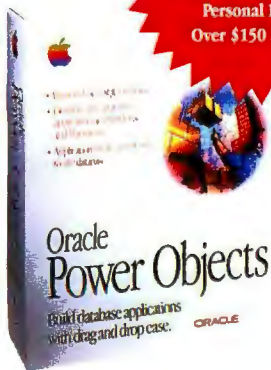
A visual programming tool, Power Objects automates complex database functions by letting you reuse code quickly via drag-and-drop object technology. With Power Objects, you can insert and delete data located on a server DBMS with full transaction support and no coding whatsoever. The same task in Visual Basic would require many redundant lines of code. You can even run Windows app's unmodified on a Macintosh™ and vice versa. And Power Objects uses a scripting language you already know, standard BASIC.

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Integrated SQL database	Yes	Yes
Industry standard BASIC language	Yes	Yes
Seamless scalability to Oracle 7 & SQL Server	Yes	No
Native Oracle 7 & SQL Server interfaces	Yes*	No
True object-oriented code reusability	Yes	No
OCX and OLE 2 support	Yes	Yes
Multiplatform: Windows, Macintosh, OS/2**	Yes	No

* Standard in the client/server version
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AD95139

WHAT'S NEW

FIRST REAL-TIME DOS EXTENDER ▼

TNT Realtime DOS-Extender 8.0 (\$995) is designed for developing embedded applications that run with DOS. According to Phar Lap, it's the first real-time DOS extender. Based on a Phar Lap-defined subset of the Win32 API, it works with 32-bit compilers from Borland, Microsoft, and Watcom, as well as off-the-

Contact: *Phar Lap Software, Inc., Cambridge, MA, (617) 661-1510; info@pharlap.com; http://www.pharlap.com.*

Circle 1027 on Inquiry Card.

CLASS MANAGER FOR VISUAL BASIC 4.0

Adding features that make Visual Basic 4.0 more "OOP-like," Sheridan Software's ClassAssist (\$249) has three major elements:

an IDE, for creating and managing hierarchies of reusable classes; a set of five visual base classes, from which you can derive new classes for specialized custom controls; and WinAPI oblets—programmable objects that extend Visual Basic syntax by becoming part of the language.

ClassAssist adds inheritance, property, and method overrides in derived classes; improved encapsulation; and method overloading. Using a point-and-click interface, ClassAssist lets you create reusable classes and over-

ride inherited properties. The product also has a Class Explorer that shows the relationship among classes in an outline view.

Contact: *Sheridan Software Systems, Inc., Melville, NY, (516) 753-0985; CompuServe: GO SHERIDAN; http://www.shersoft.com.*

Circle 1028 on Inquiry Card.

PC-INSTALL SUPPORTS WINDOWS 95/NT ▲

Widely used for the distribution of Windows and DOS applications, 20/20 Software's PC-Install 4 adds improvements. The company has also added a version for Windows 95/NT (\$249 each). The product lets you control end-user installation of software with a fully customizable look and feel by specifying screen colors, titles, custom graphics, and messages written in any language.

The new versions have more than 20 improvements, including password support, file registry updates and long filename

support in Windows 95/NT, an uninstall option, and an enhanced PC-Shrink file compressor with a graphical interface.

PC-Install uses a new menu-driven QuickBuild installation builder to streamline installation development. The program is available in English, French, German, and Japanese versions. Contact: *20/20 Software, Inc., Beaverton, OR, (800) 735-2020 or (503) 520-0504; http://www.twenty.com/~twenty.*

Circle 1029 on Inquiry Card.

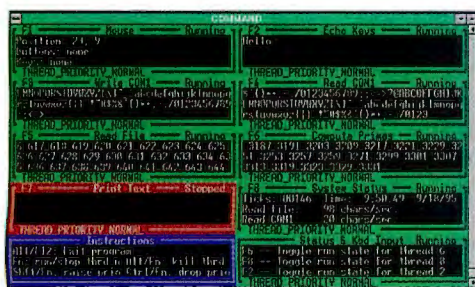
TELEFORM RECOGNITION-ENGINE DEVELOPMENT KIT

The high-powered recognition technology used in Cardiff's Teleform is now available in the Tri-CR toolkit (\$1495) for Windows developers. Tri-CR enhances and translates both hand- and machine-printed data input from a fax or a scanner. As the name implies, the toolkit uses multiple recognition engines along with a voting engine. Characters are read by each engine and are then correlated and analyzed by AI.

The Tri-CR toolkit uses a DLL with function calls for hand-printed recognition, machine-printed recognition, field syntax, context checking, character/multiline segmentation, and dictionary matching.

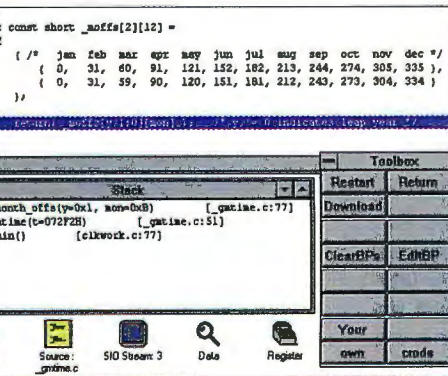
Contact: *Cardiff Software, Inc., Carlsbad, CA, (800) 659-8755 or (619) 931-4500; http://www.cardiffsw.com.*

Circle 1030 on Inquiry Card.



shelf debuggers, DOS drivers, and other Win32 API-compatible tools.

TNT Realtime DOS-Extender supports Win32 synchronization objects, including semaphores, mutexes, pipes, and event methods. Other real-time features include preemptible disk and keyboard drivers, interrupt-driven mouse and printer drivers, and priority-based threads.



TOOL SET FOR SIEMENS 80C166 MICROCONTROLLER

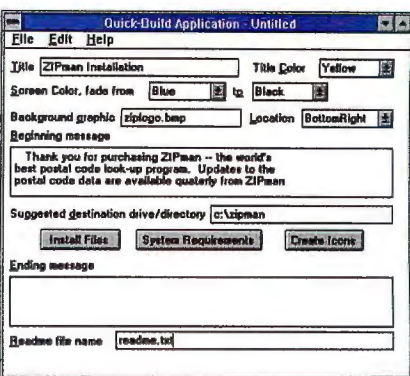
If you're developing embedded applications for the Siemens 80C166 16-bit microcontroller, BSO/Tasking's integrated tool set (\$2500) provides everything you need to create a software masterpiece. It's available for DOS, HP9000, SPARC, and DEC Alpha platforms. It includes an ANSI C compiler with extensions for all members of the 80C166 family; a Siemens-compatible macro assembler with linker/locator, librarian,

and object format utilities; and the CrossView 166 debugger, which uses a multiwindow interface and programmable macro buttons.

Central to the tool set is the BSO/Tasking EDE, which provides an integrated interface to all the parts and pieces of the tool set. EDE includes its own language editor but is also extensible for integrating your favorite programming tools.

Contact: *BSO/Tasking, Dedham, MA, (617) 320-9400.*

Circle 1032 on Inquiry Card.



WHAT'S NEW

ADD SPEECH RECOGNITION TO WINDOWS APPLICATIONS

Voice Tools (\$179) allows you to make your Windows applications work with the IBM Voice-Type Dictation System by providing custom controls that make applications voice-compatible. The programming tools work with Visual Basic, C, and C++. They add the following to your applications: a voice record and playback panel, a voice command button, a voice listbox, a dictation window, and a voice navigator.

Aimed at developers working with Windows 3.1, 95, and NT, Voice Tools is available in 16-bit VBXes and 16- and 32-bit OCXes. Once you've included Voice Tools in your application, you can dictate notes or letters, do voice data entry, navigate by voice, and voice-activate programmable events.

Contact: ProNotes, Inc., Philadelphia, PA, (800) 706-6837 or (215) 533-8569; proinfo@pronotes.com; <http://www.pronotes.com>.

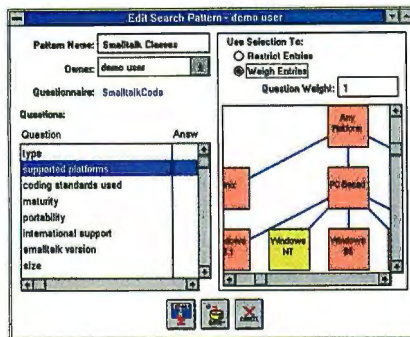
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METRICS FOR SMALLTALK

ObjectMetrics allows you to improve the quality of serious Smalltalk development projects by collecting and analyzing met-

rics using an object-oriented context. It indicates such problems as overly complex code, unnecessary coupling between modules, and misuse of inheritance.

Included with ObjectMetrics



(\$995 for five users) is the Metrics Analysis Tool, a storage and reporting tool for managers who want to graphically illustrate technical comparisons between projects. ObjectMetrics is compatible with VisualWorks 1.0 and 2.0, VisualWorks/Envy 1.43, and Visual Smalltalk 3.0.

Contact: ObjectSpace, Inc., Dallas, TX, (214) 934-2496;

info@objectspace.com; <http://www.objectspace.com>.

Circle 1034 on Inquiry Card.

C++ NETWORK COMMUNICATIONS LIBRARY

Net.h++ is an object-oriented interface to network communica-

tions services that's designed for developing peer-to-peer and client/server applications. It includes a C++ version of the Berkeley socket interface for programming TCP/IP.

Portable among Windows, Windows 95/NT, and Unix, Net.h++ (\$499) uses a three-tier architecture. This provides a portable framework for working with network channels and protocols. The Communication Adapter layer encapsulates APIs (e.g., BSD sockets), the Portal layer provides a common

interface to network communications services, and the Communication Services layer includes modules that use the Portal layer to provide transport-independent communications services.

Net.h++ includes an IOstream module that handles communications into and out of the Portal layer. This provides a persistence mechanism that you can use to transmit complex data structures across a network.

Contact: Rogue Wave Software, Inc., Corvallis, OR, (800) 487-3217 or (503) 754-3010;

<http://www.roguewave.com>.

Circle 1031 on Inquiry Card.

Software Update

Version 3.1 of **Object Master for Windows** (\$249) adds 32-bit support for Windows 95 and NT. The product is a Smalltalk-like integrated programming environment that provides you with browsing and editing tools for C and C++ development.

You can compile, debug, and build applications in Visual C++ without leaving the Object Master editing environment. It also supports Symantec C++, Borland C and C++, and all DOS compilers. Object Master understands and takes advantage of programming-language structure by checking a file's syntax when you save changes or add a file to a project. It also has multiple browser windows.

Also new to Object Master is WinHelp documentation support; transparent text-file-format compatibility for Mac, Unix, Windows, and DOS; and keyboard emulation of various programming editors.

Contact: ACI US, Inc., Cupertino, CA, (408) 252-4444; <http://www.acius.com>.

Circle 1038 on Inquiry Card.

Shipped as a code resource toolkit for Mac C compilers (i.e., MPW, ThinkC, and Metrowerks), **AccuSoft Image Format Library** for the Mac and Power Mac is available in version 5.0 (\$1995). You can incorporate raster-imaging capabilities for 36 formats into your applications. These include TIFF, JPEG, Photo CD, Photoshop, MacPaint, PCX, BMP, ASCII, Windows ICO, Sun Raster, X Window System, Brooktrout, and IOCA.

Other new features include scale-to-gray, subdegree rotation, decompress rectangle, color reduction technology, and automatic thumbnails.

Also new is an optional (\$500) XCMD interface for 4GLs such as FoxPro for the Mac. AccuSoft Image Format Library is also available for Windows 3.1, Windows NT, DOS, OS/2, Visual Basic, and Unix.

Contact: AccuSoft Corp., Westborough, MA, (800) 525-3577 or (508) 898-2770; <http://www.accusoft.com>.

Circle 1039 on Inquiry Card.

VISUALIZE THAT DATA

Version 6.0 of **PV-Wave** is available for Windows 95/NT (\$1995) and Unix (\$4495). Designed as a RAD environment for corporate developers, this version has been extended with new data types and data-manipulation features that support object-oriented development.

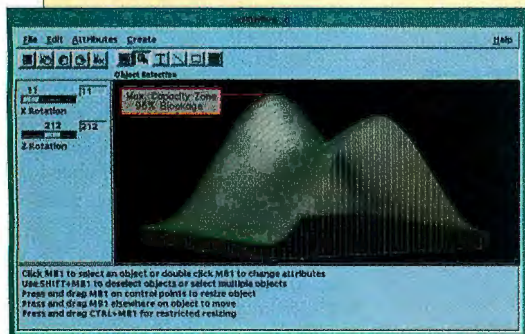
With an underlying foundation based in 4GL, PV-Wave is aimed at technical professionals in engineering, science, and business for data analysis and visualization without the compile, link,

and debug cycles required by more traditional programming languages. Included are integrated 2-D and 3-D graphics, image and signal processing, animation, and volumetric rendering. An Options Programming Interface lets you add C or FORTRAN functions to PV-Wave.

Optional modules include Mathematics, Statistics, and Visual Exploration. Each module costs \$695 for Windows and \$1495 for Unix.

Contact: Visual Numerics, Inc., Boulder, CO, (303) 530-9000; <http://www.vni.com>.

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EMBEDDED DEVELOPMENT SOLUTIONS

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Greatly increased ease of use

*Total control of table, class, group, and
segment ordering and addressing*

WinLink 386

offers the following features:

True Windows hosted development

Presents view of program in outline form

*Eliminates complex script files by presenting a
Windows drag-and-drop interface to the linker*

*Simple drag-and-drop operations to reorder
items within application program*

*Automatically recalculates address
locations after move*

Provides fail-safe command line

Layout options in direct and logical sequence

*Options not applicable to specific links and
builds are not available (grayed out) to
select from menu*

Extensive context sensitive, bubble help

Link&Locate 386 featuring WinLink 386 Visual Command File Builder

Link&Locate 386 is an advanced absolute linker/locator for 32-bit as well as 16-bit protected-mode x86 C/C++ applications. Link&Locate 386 supports the construction of flat and multi-segmented programs for building multi-tasking and kernel based embedded applications. This advanced generation tool also builds the descriptor tables and includes ROM-able start-up code for support of C/C++, memory management, and floating point applications. The Link&Locate 386 package also includes EPROM programmer and librarian utilities, and advanced run-time support features.

WinLink 386 is an advanced visual command file builder. It provides a Windows interface along with a number of additional features to our Link&Locate 386. By combining these two products, the user will have a tightly integrated, Windows hosted, completely visual linker/locator offering advanced command file editing and manipulation capabilities.

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The latest breed of PowerPC-based Macs integrates sound, speech, video, telephony, conferencing, graphics—and an affordable price

RICK GREHAN

The new line of Power Macs exemplifies Apple's market pitch: easy-to-use, fully featured multimedia systems right out of the box. The latest triad—the Power Mac 7200, 7500, and 8500—come equipped with integrated audio, video, networking, telephony, CD-ROM, conferencing, and speech. As you go higher in the line, the bundled support gets richer.

Perhaps the best pitch of all is the pricing. These Power Macs, with their healthy collection of built-in features and prices ranging from \$1949 (for the 90-MHz 7200 with 8 MB of RAM) to \$4199 (for the 120-MHz 8500 with 16 MB of RAM), will compete well against even the most aggressively priced Intel-based machines.

Common Denominators

All three Power Macs in this group share a remarkable number of similar features. Even though some of the similarities are architectural (all have three Peripheral Component Interconnect [PCI] slots, for example), most of them fulfill multimedia and communications requirements.

All models include stereo-audio input and output ports. The digital side of the systems' audio-generation capabilities boasts 16 bits of resolution and a sampling rate up to 44.1 kHz (CD-quality sound). On the communications side, all models include 10Base-T and AAUI-15 Ethernet connectors. And all models include high-speed DMA serial ports, compatible with GeoPort telephony/fax hardware.

As usual, Apple paid close attention to the design of the boxes themselves. For example, the 7200's top is held on by hid-



The new Power Macs: the 7500 (left), the 8500 minitower (center), and the low-end 7200. All three models include impressive multimedia support. Apple's clever design (inset) grants easy access to memory slots and the motherboard.

den latch releases under the front bezel. Release those, and the top slides off to reveal the power supply, disk drives, and a hinged inner cover that holds the PCI cards in place. The memory slots are beneath the drive units—a position that at first appears impossible to get at without major disassembly. But the entire drive and power supply unit is also hinged, and it swings up to provide easy access to any corner of the motherboard.

Of course, hardware is only part of the story. If there's Windows software that you can't live without, all three models can run SoftWindows from Insignia Systems. Both the 7500 and 8500 models' impressive software bundles include PlainTalk (the combined text-to-speech and speech-recognition engine) and Apple Media Conference (a QuickTime application that

incorporates videoconferencing, whiteboard collaboration, and more).

We tested Media Conference by hooking a Power Mac 8500 to a 7500 across 10Base-T Ethernet (see the screen on page 114). The video was jerky but usable, and we could relay messages and freehand sketches on the shared whiteboard. Unfortunately, application sharing is not supported, and the audio quality was poor.

Power Mac 7200

The low-end model of the series, the Power Mac 7200, houses a 75- or 90-MHz PowerPC 601 processor. Memory starts at 8 MB, but you can expand that to 256 MB. Similarly, a baseline 7200 houses only a 500-MB SCSI drive, but an internal expansion bay supports another SCSI device (and, remember, there's always the rear SCSI connector for external drives).

The 7200's graphics system is built

THE SPECS

	7200	7500	8500
CPU	601	601 or 604	604
MHz	75 or 90	100	120
Internal cache (KB)	32	32	32
External cache	256 to 512 KB	256 KB to 1 MB	256 KB
System memory (MB)	8 to 256	16 to 512	16 to 512
Video memory (MB)	1 to 4	2 to 4	2 to 4
Hard disk	500 MB	500 MB to 1 GB	1 to 2 GB

around a 64-bit data path to the video memory (a standard feature on the other models as well), and you can expand the baseline 1 MB of video memory to 4 MB for up to 1280- by 1024-pixel resolution (or 1024 by 768 in 24-bit color).

Power Mac 7500

Although the 7500 system we tested included a PowerPC 601 processor running at 100 MHz, you can upgrade the system to a 100-MHz 604 processor via a swappable CPU daughtercard. (A 604 has a significant performance advantage over a similarly clocked 601, thanks to the 604's increased number of execution units and dynamic branch prediction.)

The chassis of the 7500 is virtually indistinguishable from that of the 7200, and it shares the 7200's easy access to internals. However, the 7500 incorporates hardware beyond that of the 7200, including an S-video input connector and an internal DAV (digital audio/video) connector that accepts video compression/decompression cards. (The 7500 also has a composite video input.) The beefier processing power of the 7500 supports real-time video playthrough, as well as video capture (up

TECHNOLOGY FOCUS

PlainTalk

The recognition engine inside PlainTalk (which is bundled with the Power Mac 7500 and 8500) gets better all the time. We ran some informal experiments on it, testing its recognition tolerance. Even if we used fake Italian, fake Russian, or genuine Southern American accents, PlainTalk correctly identified its commands.

The recognition engine is based on *phones*, context-sensitive rudimentary sounds used in speech. (These rudimentary sounds are known as *phonemes*.) Phones are context-sensitive in the sense of their phonetic usage. Hence, the *t* in *truck* is one phone, while the *t* in *bottle* is a different phone.

PlainTalk's phones are speaker independent. They are the composite of 500 speakers from North America, which has the effect of eliminating the influence of accents. If our contrived Italian and Russian accent tests were any indication, PlainTalk's recognition engine apparently works better than its designers anticipated.



The AudioVision 14 display supports an internal microphone and speakers.

connectors are input only, the 8500 adds output connectors for both. The 8500 also supports video playthrough and capture. Capture rates for the 8500 are 25 fps with NTSC (but the documentation warns that you'll need a 2-GB hard drive for that).

index of 1.4, putting its integer score on a par with that of a 150-MHz P6 system.

The Attraction

These are desktop machines, not server boxes you'd want to hang drives from and slide into a closet. For the price, all these systems provide excellent performance, good expandability, and a generous serving of prepackaged peripherals: CD-ROM, stereo audio, video ports, network hardware, and so forth. The only people we'd advise against buying one of these Power Macs is anyone whose business involves a great deal of number-crunching.

But for those looking for an easy-to-set-up home machine, or a workhorse multimedia system for the office, these Power Macs can definitely do the job. ■

Rick Grehan, who developed the BYTEmark benchmark suite, is a senior technical editor for BYTE reviews. You can reach him on the Internet or BIX at rick_g@bix.com.

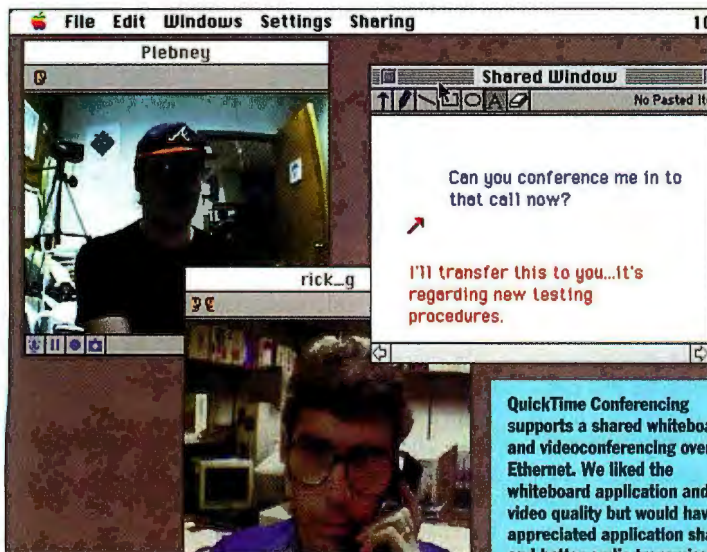
PowerPC Performance

The models that we received from Apple all had 256 KB of L2 cache installed. The 7200 came with 16 MB of RAM and a 500-MB hard drive, while both the 7500 and 8500 had 24 MB of RAM and a 1-GB hard drive. We compiled the BYTEmark

native-mode benchmarks using version 7 of Metrowerks' CodeWarrior and ran them on each system, being careful to set

604 instruction ordering on the 8500.

All three models performed well in the integer BYTEmark tests, but less so in the floating-point tests. The 90-MHz 7200 turned in an integer index of 1.05 and an FPU index of 0.64—what you might expect from a 90-MHz Pentium with a throttled FPU. The 100-MHz 7500 scored 1.18 on the integer tests and 0.71 on the FPU tests. The 120-MHz 604-based 8500 produced an integer index of 2.1 and an FPU



QuickTime Conferencing supports a shared whiteboard and videoconferencing over Ethernet. We liked the whiteboard application and the video quality but would have appreciated application sharing and better audio transmission.

to 320 by 240 pixels of NTSC at 15 frames per second).

Power Mac 8500

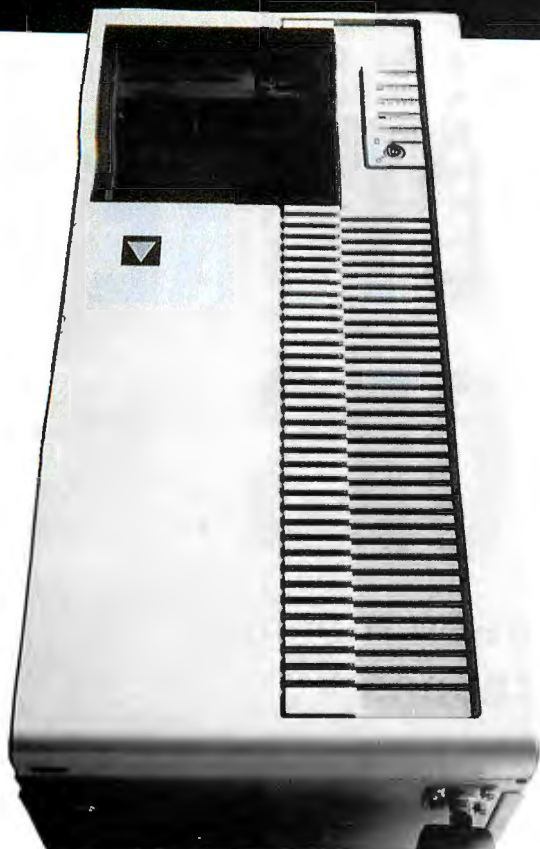
The 8500 is a desktop minitower design, as opposed to the "monitor-stand" design of the 7500 and 7200. Inside beats the heart of a PowerPC 604 with a pulse rate of 120 MHz. You can upgrade the 8500's system memory from its base of 16 MB to a dizzying 512 MB.

While the 7500's composite and S-video

Product Information

Power Mac 7200	\$1949
(90-MHz 601 CPU with 8 MB of RAM and 500-MB hard drive)	
Power Mac 7500	\$3099
(100-MHz 601 CPU with 16 MB of RAM and 1-GB hard drive)	
Power Mac 8500	\$4199
(120-MHz 604 CPU with 16 MB of RAM and 1-GB hard drive)	

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20 BIG-PICTURE MONITORS

NSTL evaluates the best large-screen monitors for today's highly graphical applications

CHANDRIKA MYSORE

Once you've experienced a big screen, it's really hard to return to a 15-inch box. Becoming less of a luxury, a 21-inch monitor can support 1600- by 1200-pixel resolutions, a Plug and Play (PnP) architecture, and slick software controls. Power users will appreciate running multiple applications on the desktop. Graphics designers, CAD engineers, desktop publishers, and heavy-duty spreadsheet junkies absolutely require a large, high-

resolution tube for mission-critical work. We tested 21-inch monitors (and 20-inch ones from Apple, IBM, and Tatung) to find the best overall model, the model with the highest-quality display, and the best overall deal on the market.

Out of the 20 monitors, 10 use the Hitachi picture tube, five use the Matsushita picture tube, and the other five use tubes from Sony, Mitsubishi, or NEC. We tested the monitors under Windows 95. Some of them were too new to support specific drivers for Windows 95. Thanks to the PnP availability, Windows 95 configured the PnP monitors on the fly. For the monitors that did not support PnP, we configured them in 1280- by 1024-pixel SVGA resolution.

With an average dot pitch of 0.26 mm, the text appears crisp and clear on the screen. The maximum vertical refresh rate was 97 Hz at 1280- by 1024-pixel resolution and 82 Hz at 1600- by 1280-pixel resolution. At these high refresh rates, the display is absolutely flicker-free.

These neat features, however, come with a huge price tag. The most-expensive monitor we tested was Nanao USA's Flexscan FX2-21 (\$3499), and the least expensive was Smile International's CA2111

How to use this guide

Our overall score for the best color monitor is based on the weighted-average results from quality tests and usability and features evaluation. The quality tests are executed using the NSTL-developed software tools, Klein gauge, power meter, luminometer, and eyepiece. The best-overall and low-cost winners are based on overall performance scores. The high-quality winners are based on the quality scores.

The prices listed here are the manufacturer's suggested retail price (MSRP). Street prices will be lower.

BEST OVERALL		NEC Multisync XE21		VIEWABLE		MAXIMUM		MAC 16-BIT		ON-SCREEN	
MODEL #	PRICE	OVERALL SCORE	QUALITY INDEX	FEATURES SCORE	SIZE (INCHES)	DOT PITCH (MM)	RESOLUTION PIXELS/INCH	SUPPORT ON INDEX	ON-SCREEN	INDEX	INDEX
NEC Multisync XE21	\$1899	8.9	▲▲▲	▲▲▲	19.8	0.26	1280x1024	✓	✓	✓	✓
Venuec 21PS	\$1995	8.2	▲▲▲	▲▲▲	19.7	0.25	1600x1280	✓	✓	✓	✓
Panasonic C-2192P	\$1999	8.1	▲▲▲	▲▲▲	19.7	0.25	1600x1280	✓	✓	✓	✓
NEC Multisync XE21	\$2299	8.1	▲▲▲	▲▲▲	19.8	0.26	1600x1200	✓	✓	✓	✓

The viewable size is the diagonal measurement of the maximum display area.

If this column is checked, the monitors are shipped with software controls to adjust the display orientation. Press a menu button on the front panel, and the control menu pops up on the screen.

A Look at the Big Picture

POWER MODULE

Includes the power supply for the monitor with integrated power management circuitry. When the power-saving feature is forced, the power consumption is less than 8 W in idle state. Look for Energy Star- and TCO-compliant monitors.

DEGAUSSING COIL

Wraps around the picture tube. The Earth's magnetic pull and movement of the active display cause the picture tube to magnetize, resulting in image distortion. By pressing the degauss button, the degaussing coil demagnetizes the picture tube.

VIDEO BOARD

Residing at the rear of the CRT, it controls, amplifies, and processes the video-signal input from the system's video card.

FLYBACK TRANSFORMER (FBT)

The power source to transfer the electrons from the back of the monitor to the screen in the front.

HORIZONTAL SCANNING CIRCUITRY

Browns the electron beam horizontally on the screen (measured in kHz). The monitors with higher horizontal scanning frequency provides less flicker on the screen.

YOKE

The coil around the CRT drives the electron beam to a specific pixel on the screen.

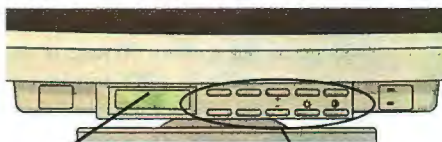
SCREEN SURFACE

The flat screen is treated with antistatic coating. The antistatic coating reduces the electric charge on the screen, and the antiglare coating reduces the reflection on the monitor. Also look for ergonomized and ergonomized screens. These special coatings provide sharp images and reduce eyestrain.



BNC/D-SUB CONNECTORS

Look for monitors with both BNC and D-sub connectors. At high scanning frequencies, we preferred BNC connectors over the D-sub because the connectors provide additional shielding between the video input and the signal lines.



LCD

Displays the status of the monitor operations, selected main and subcontrols (to adjust the display), resolutions, scanning frequencies, and so on. The monitors with an LCD don't come with the on-screen menus to adjust the display.

CONTROLS

The functions of the control buttons should be labeled clearly. We preferred on-screen controls with a minimum set of buttons over the old-fashioned two buttons/control or thumbwheel control.

BEST OVERALL MONITOR

NEC Multisync XE21

This Plug and Play-compatible monitor is a breeze to set up and has outstanding on-screen menu controls. The documentation is excellent, but we never had to refer to it. The NEC Multisync XE21's superior internal power management made it a high scorer in the power tests.

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BEST HIGH-QUALITY MONITOR

Apple Multiple Scan 20-inch

This monitor's 19.1-inch display offers the highest quality in our image-sharpness, image-quality, and distortion tests. The 75-Hz vertical refresh rate displays an absolutely flicker-free still image. Its usability is average because it doesn't have on-screen menu controls.

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BEST LOW-COST MONITOR

NEC Multisync XE21

Due to its superb overall performance and a \$1899 price tag, the NEC Multisync XE21 wins this category. The unit stands out for its maximum resolution of 1280 by 1024 pixels in noninterlaced mode, usability features, and internal power management functions.

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(\$1780). In this roundup, the average price is \$2255. (In our last report, the average price was \$2243.)

You'll need a strong back to lift these behemoths and a large work area; the average weight is 74 pounds, and they take up voluminous desk space. The Philips Magnavox CM2137 consumed the least power at 110 W, and the NEC Multisync XP21 the highest at 197 W. Fortunately, all the monitors we tested, except for the Daytek DT-2102M, are Energy Star-compliant, so they consume less than 30 W in idle mode; and with VESA Display Power Management Signaling (DPMS) compliance, the internal power management system kicks in (consuming less than 30 W of power) when the monitor is idle. If the monitor is in idle mode for a long

time, the VESA DPMS will put the unit in sleep mode, consuming less than 8 W of power.

The IBM P201, Nanao Flexscan FX2-21, Nokia Multigraph 445X, and the Philips Magnavox CM21BA cost more than the rest of the products tested here for a reason; they have higher bandwidths (up to 250 MHz) compared to low-priced products at around 130 MHz and thus provide higher vertical refresh rates (close to 85 Hz) at higher (1600- by 1200-pixel) resolutions. Because we tested all the monitors in 1280- by 1024-pixel resolution, we did not evaluate these four monitors at these high refresh rates. We consider them to be in a class of their own, offering a higher usable resolution that is worth the price for those who need it.

High-Quality Monitors

Monitor manufacturers are changing the concept of access to monitor controls. Fading away is the traditional monitor with control buttons or thumbwheels for adjusting brightness, contrast, and so on. Monitors of the next generation have just a few buttons and on-screen menus.

Of the 20 large-screen monitors tested here, 14 of them had on-screen menus. These menus include controls to adjust brightness, contrast, degauss, horizontal and vertical size, position, pin-cushion, barrel, and color matching. In addition, progressive vendors add controls for convergence, geometric distortion correction, horizontal and vertical moiré, dynamic focusing, video select, and input port select.

To access these controls, you press a button on the monitor, and a menu pops up on-screen. Most of the monitors have similar buttons that function as the menu, select, and exit buttons. Some of the monitors still have buttons or thumbwheels for brightness, contrast, and degauss. Our testing team was impressed with the organization of the on-screen menu used by the NEC Multisync monitors.

As these monitors move onto desktops, manufacturers are making them easier to view by building them with antistatic, antiglare, antireflective, ergocoated, and ergopaneled screens. Of the 20 monitors, 17 support 1600- by 1200-pixel resolution in noninterlaced mode. At this resolution, the text on the screen or data in spreadsheet cells must be flicker-free to reduce eyestrain. To achieve a flicker-free display, these monitors use vertical refresh rates of as high as 82 Hz. Nine of the monitors comply with the TCO emission standards, and only 12 of them carry FCC Class B labels.

These heavyweight monitors use a lot of power to display sharp and crisp images. Power consumption ranges from 110 to 197 W in active mode. All the monitors (except Daytek's DT-2102M) are equipped with the built-in Display Power Management System (DPMS). With this electronic circuit embedded, the monitor automatically saves power and switches to a low-power mode consuming less than 30 W in idle mode. If the monitor stays in idle

mode for a long period of time, it further saves energy by switching to sleep mode, where it consumes less than 8 W. Users can set the time to switch to these modes. In our power management test, the Philips Magnavox CM2137 received the highest score, consuming 84.6 W. It was followed by the NEC Multisync XE21. All the monitors, except the DT-2102M, are Energy Star recipients.

The NEC Multisync XE21 rated higher than all the other monitors in our overall performance and usability tests. For under \$1900, this monitor is also a winner in our low-cost category. The Viewsonic 21PS and the Panasonic C-2192P come behind the overall winner in the performance evaluation.

The Viewsonic 21PS and the Panasonic C-2192P cost just

PIVOT 1700: A MOVING ALTERNATIVE

Now you can physically rotate your monitor to view the full 8.5- by 11-inch word processing document without scrolling. Portrait Display Labs recently unveiled a 17-inch color monitor displaying images in both landscape and portrait modes. The Pivot 1700 monitor is compatible with Macs, Power Macs, and PC compatibles running Windows. The provided software does not deliver a portrait view in full-screen DOS mode, but it offers 50 lines of portrait-viewing capability in a DOS window. The DOS-window capability is limited to simpler applications, such as word processing, programming, and analyzing code. It is not recommended for heavy-duty CAD work.

It is as easy as pressing a hot key or clicking on a screen icon to rotate the image without closing any of your applications. With this flexibility, you can switch between the two modes depending on your applications and work load. If you think you need a 21-inch monitor for viewing long documents in high resolution, the Pivot 1700 could be a cost-effective alternative. For a street price of only \$1199, the Pivot 1700's vertical height is 12.7 inches; for over \$2000, the vertical height of 21-inch monitors is only 12 inches.

The Pivot 1700 supports resolutions of up to 1024 by 768 pixels (768 by 1024 pixels in portrait mode) at 76 Hz and 1280 by 1024

pixels at 60 Hz with a dot pitch of 0.26 mm. It is compatible with most Windows graphics cards



For those who need to view long documents in high resolutions, the Portrait Display Labs' Pivot 1700 is an inexpensive alternative to the 21-inch monitors. Its unique rotating capabilities let you switch between portrait (left) and landscape modes.



having at least 1 MB of video memory. But the WinPortrait 2.0 driver that comes with the monitor did not support the MGA Matrox graphics card. The driver for the Matrox card will be available in later versions. The Pivot 1700 is capable of displaying a full, readable, life-size display of an 8.5- by 11-inch document, with lots of room for toolbars, icons, and other windows in portrait mode. It comes with the WinPortrait graphics drivers (the rotating capability) and a three-year limited warranty.

The layout of the monitor's digital controls is designed with long, soft touch buttons. These buttons reside on a semicircular projection at the bottom of the screen in landscape mode. When the monitor is rotated clockwise to display portrait mode, the control buttons move along with the monitor and reside at its left side. This monitor complies with the Energy Star and MPR II standards.

Product Information

Pivot 1700 \$1199
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 Standards MPR-II, TCO optional

FX2-21
 Dot Pitch 0.26mm
 Actual Viewing Diag. 19.8"
 Scan Freq. H:31.5-102kHz, V:55-160Hz
 Rec. Resol. 1600 x 1200 @ up to 82Hz
 Max Resol. 1600 x 1280 @ up to 80Hz
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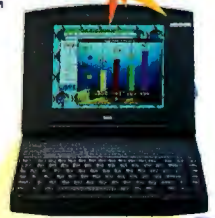
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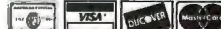


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Windows 95

	LTE 5000	LTE 5000	LTE 5000	LTE 5100	LTE 5100	LTE 5200
CPU	75MHz Pentium®	75MHz Pentium®	75MHz Pentium®	90MHz Pentium®	90MHz Pentium®	120MHz Pentium®
L2 cache	256KB, 64-bit	256KB, 64-bit	256KB, 64-bit	256KB, 64-bit	256KB, 64-bit	256KB, 64-bit
Video	32-bit PCI local bus	32-bit PCI local bus	32-bit PCI local bus	32-bit PCI local bus	32-bit PCI local bus	32-bit PCI local bus
Display	10.4 dual-scan color	11.3 dual-scan color	10.4 active-matrix color	10.4 active-matrix color	10.4 active-matrix color	10.4 active-matrix color
Resolution	640 x 480	800 x 600	640 x 480	800 x 600	800 x 600	800 x 600
RAM	8MB std., 72MB max.	8MB std., 72MB max.	8MB std., 72MB max.	8MB std., 72MB max.	8MB std., 72MB max.	8MB std., 72MB max.
Hard drive	510MB	810MB	810MB	810MB	810MB	1.35GB
CD-ROM	optional	optional	optional	optional	double-speed	optional
PC Card	2 type II or 1 type III	2 type II or 1 type III	2 type II or 1 type III	2 type II or 1 type III	2 type II or 1 type III	2 type II or 1 type III
Battery	NiMH	NiMH	NiMH	NiMH	NiMH	Lithium Ion
Weight	7.1 lbs.	7.5 lbs.	7.3 lbs.	7.4 lbs.	7.7 lbs.	7.0 lbs.
	\$3841.00	\$4514.00	\$4802.00	\$5378.00	\$5649.00	\$6435.00
	CDW 60595	CDW 60596	CDW 60597	CDW 60598	CDW 60599	CDW 60600

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✓ 75MHz or 90MHz Intel Pentium® processor, 8MB RAM, 10.4" or 10.1" display, standard or optional double-speed CD-ROM Pak

4000D 75MHz 540MB hard drive, 10.4" dual-scan display, 2X CD-ROM	\$3799.00	CDW 55172
4000C 75MHz 720MB hard drive, 10.1" active-matrix color display	\$3999.00	CDW 55174
4050C 90MHz 720MB hard drive, 10.1" active matrix color display, 2X CD-ROM	\$4649.00	CDW 55176
4050H 90MHz 810MB hard drive, 10.4" high-res active matrix color display	\$4799.00	CDW 55177



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IntelDX2™, 50MHz, 10.4" active matrix color display

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IntelDX4™, 75MHz, 10.4" dual scan color display		
701CS 360MB hard drive	\$2669.93	CDW 51794
701CS 540MB hard drive	\$2949.89	CDW 51795
701C 360MB hard drive	\$3199.96	CDW 51792
701C 540MB hard drive	\$3488.63	CDW 51793

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The perfect combination of affordability and performance

- ◆ 420: IntelDX4™ 75MHz CPU ◆ 430: IntelDX4™ 100MHz CPU ◆ 8MB RAM std., 32MB max.
- ◆ Weight 6.25 lbs. ◆ 3 year limited warranty

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420CX, 420MB hard drive, 10.4" active-matrix color display	\$3073.00	CDW 56256
430C, 720MB hard drive, 10.4" dual-scan color display	\$2881.00	CDW 56257
430CX, 720MB hard drive, 10.4" active-matrix color display	\$3553.00	CDW 56259



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760C 90MHz, 12.1" active-matrix, 720MB hard drive	\$6049.00	CDW 59018
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760CD 90MHz, 12.1" active-matrix, 1.2GB hard drive, 4X CD-ROM	\$7449.00	CDW 59017



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Byte 1/96

Circle 64 on Inquiry Card.

Samsung monitors. Designed from your point of view.



"We were impressed with the picture quality and feature sets of both units, and their relative value makes them top choices."

PC Magazine - Sept. 12, 1995, on the SyncMaster 17GLi and 17GLsi monitors.



September 12, 1995
Samsung SyncMaster 17GLi

Performance is only part of the reason to buy a new 17-inch SyncMaster™ monitor. It has big, bright, crisp, clear images that you can depend on year after year.

Simplicity is also important. The GLi Series offers Plug and Play™ compatibility, so you can get right to work. Its intuitive controls and on-screen programming keep concentration where it belongs - on the job.

Plus, Samsung delivers outstanding **Value** - in the comfort of a three-year warranty, and the satisfaction of a competitive price.

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Call 1-800-933-4110 or use fax-on-demand at 1-800-229-2239 for more information.

SyncMaster	15GLi	17GLi	17GLsi
Flat Square CRT	15"	17"	17"
Dot Pitch	.28	.28	.26
PC Compatibility	1280x1024@60Hz	1280x1024@60Hz	1280x1024@80Hz
Mac Compatibility	1024x768@75Hz	1024x768@75Hz	1152x870@75Hz
Color Temperature Selection	•	•	•
UltraClear Coating™	•	•	•
Limited Warranty	3 Years	3 Years	3 Years

Actual viewable areas are 13.8" (15GLi) and 15.75" (17GLi and 17GLsi).



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Circle 619 on Inquiry Card.



For superior quality and control...

BEST OVERALL NEC Multisync XE21



The NEC Multisync XE21 uses an opticlear screen and an NEC picture tube. It has excellent on-screen menu controls that let you adjust the display at the touch of a button. A Plug and Play monitor, it comes with outstanding documentation; toll-free and on-line support services offer excellent technical support to end users. It received a high score in NSTL's power management tests. For \$100 more, our third choice, the Panasonic C-2192P, offers 1600- by 1280-pixel resolution with a higher quality worth the price.



that both monitors squeak when switching from text to graphics, with a lot of delay. The Panasonic C-2192P's quality performance is close to the top score, and it received an outstanding score in distortion tests.

NEC's XP21

rated the highest in the image-quality tests. The XP21 costs \$400 more than the XE21, but it provides a higher 1600- by 1200-pixel resolution, higher horizontal and vertical scanning frequencies, and more factory presets and user-settable display modes. This is the only monitor that comes with the Access.bus connector. The Access.bus supports bidirectional communications for future enhancements

(see the text box "Access.bus Technology" on page 125).

The Mitsubishi Diamond Pro 21TX scored the highest in our features rating, providing a high resolution of 1600 by 1200 pixels, extended warranties, on-site service, and BBS support service. It also has such high-end control features as focus, signal level, and digital control. Most other monitors lacked some of these features. Although the Diamond Pro 21TX was our high scorer in this area, it is not an FCC Class B residential monitor, lacks unlimited technical support, and has a high dot pitch.

KEY

Ratings from 1 to 4: ▲ is the lowest; ▲▲▲▲ is the highest.

		PRICE	OVERALL SCORE	QUALITY INDEX	FEATURES SCORE	VIEWABLE SIZE (INCHES)	DOT PITCH (MM)	MAXIMUM RESOLUTION NONINTERLACED	MAC 16-INCH SUPPORT OR HIGHER	ON-SCREEN MENUS
BEST	NEC Multisync XE21	\$1899	8.6	▲▲▲	▲▲▲	19.8	0.28	1280x1024	✓	✓
RUNNER-UP	Viewsonic 21PS	\$1995	8.2	▲▲▲	▲▲▲	19.7	0.25	1600x1280		✓
RUNNER-UP	Panasonic C-2192P	\$1999	8.1	▲▲▲▲	▲▲▲	19.7	0.25	1600x1280		✓
RUNNER-UP	NEC Multisync XP21	\$2299	8.1	▲▲▲▲	▲▲▲	19.8	0.28	1600x1200	✓	✓

Excellent quality and services

HIGH-QUALITY Apple Multiple Scan 20-inch



The Apple Multiple Scan 20-inch is the only monitor that featured a bonded panel screen and a Trinitron picture tube, providing superior performance. This 66-pound FCC Class A monitor comes with optional TCO-compliant support. You get a one-year warranty with unlimited toll-free technical support, a BBS, and on-line support services. It does not support on-screen menu controls to adjust the display. Our second choice in this category, the Panasonic C-2192P, costs \$150 less than our winner. With 0.25-mm dot pitch (one of the lowest in this series of monitors), it provides a high-quality display at a resolution of 1600 by 1280 pixels. Its quality score is very close to the winner, and its overall performance is slightly higher in this category.

		PRICE	OVERALL SCORE	QUALITY INDEX	FEATURES SCORE	VIEWABLE SIZE (INCHES)	DOT PITCH (MM)	MAXIMUM RESOLUTION NONINTERLACED	MAC 16-INCH SUPPORT OR HIGHER	ON-SCREEN MENUS
BEST	Apple Multiple Scan 20-inch	\$2149	8.0	▲▲▲▲	▲▲	19.1	0.26	1280x1024	✓	
RUNNER-UP	Panasonic C-2192P	\$1999	8.1	▲▲▲▲	▲▲▲	19.7	0.25	1600x1280		✓
RUNNER-UP	Philips Magnavox CM21BA	\$2799	7.8	▲▲▲▲	▲▲▲▲	20.1	0.26	1600x1280	✓	✓
RUNNER-UP	Radius Multiview 21	\$2149	8.0	▲▲▲▲	▲▲	19.0	0.25	1600x1200	✓	✓

Impressive quality, usability, and price

LOW-COST NEC Multisync XE21



At \$1899, the NEC Multisync XE21's 19.8-inch display delivers a maximum resolution of 1280 by 1024 pixels, a superior set of support features, and impressive usability. Our second choice in this category, the Tatung CM-20MKR, provides 1600- by 1200-pixel resolution and costs \$100 less than our winner. However, its overall performance is significantly lower than that of the XE21. The Tatung CM-20MKR monitor had lower performance in our legibility, resolution, convergence, and contrast-ratio tests. However, with 0.28-mm dot pitch, its quality performance was slightly better than that of the XE21.

		PRICE	OVERALL SCORE	QUALITY INDEX	FEATURES SCORE	VIEWABLE SIZE (INCHES)	DOT PITCH (MM)	MAXIMUM RESOLUTION NONINTERLACED	MAC 16-INCH SUPPORT OR HIGHER	ON-SCREEN MENUS
BEST	NEC Multisync XE21	\$1899	8.6	▲▲▲	▲▲▲	19.8	0.28	1280x1024	✓	✓
RUNNER-UP	Tatung CM-20MKR	\$1799	7.4	▲▲▲	▲▲	19.0	0.28	1600x1280	✓	
RUNNER-UP	Smile CA2111	\$1780	7.2	▲▲▲	▲▲	19.75	0.28	1600x1280	✓	
RUNNER-UP	Daytek DT-2102M	\$1899	6.9	▲▲▲	▲	19.5	0.28	1600x1280	✓	

✓ = Yes

Weighting for Best Overall

OVERALL PERFORMANCE: 42.9%
Display 46%
Quality 46%
Distortion 8%

USABILITY: 21.4%

FEATURES: 21.4%

POWER CONSUMPTION: 15%

Weighting for High-Quality

DISPLAY: 46%
Sharpness: 40%
Legibility: 30%
Convergence: 20%
Contrast Ratio: 10%

QUALITY: 46%

DISTORTION: 8%

You know the ultra-sharp 17" monitor you drooled over because it was virtually distortion free, displayed a couple of million colors but was too expensive to buy.



We made it affordable.



Finally, DiamondTron™, the world's most technologically advanced tube, is now available in a 17" monitor (16.0" viewable area), and we've made it affordable. It's the CTX 17XA color monitor!

YOU GET a DiamondTron cylindrical, vertically flat, square-cornered display with an aperture grille mask design, along with a unique electron gun that delivers resolutions up to 1600 x 1200. And, an ultra-fine 0.25mm aperture grille pitch for PC, Mac, SUN and SPARC systems.

YOU GET incredible precision and clarity from center to corner, edge-to-edge, for dazzling colors and distortion-free images.

YOU GET unique features, like our On-Screen-Display (OSD) for convenient on-screen programming. And the SuperStar™ Power Management System that far exceeds Energy Star™ guidelines. The CTX 17XA also meets TCO standards, which lower energy and harmful electromagnetic emissions.

YOU GET a limited three-year warranty* on parts and labor. PLUS the monitor is Plug and Play† compatible for Windows® 95.

YOU GET IT ALL... the CTX 17XA monitor... something to drool over.

CTX

Making Technology Affordable



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June 1995



1765GMe Monitor
September 1995



1785GM Monitor
March 1995



1785GM Monitor
May 1995



National Sales: 800-289-8808 • Fax: 818-837-4341, Acct. No. 026
Eastern Region: 201-646-0707 • Southern Region: 404-729-8909 • Western Region: 909-598-8094

* Two year warranty on CRT. † Requires a DDC compatible video card. © 1995, CTX International, Inc.
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Circle 228 on Inquiry Card (RESELLERS: 229).

ACCESS.BUS TECHNOLOGY

The Access.bus is a bidirectional-communications industry-standard bus for peripheral connectivity. Peripherals that support the Access.bus provide a connector or port connection that is similar to a phone-jack connector. It can connect peripherals such as monitors, printers, modems, mice, keyboards, scanners, and digitizers to the system.

The advantage of the Access.bus is hassle-free installation. You can connect an Access.bus device (e.g., a monitor) to your system, and the system automatically identifies and configures it for optimum performance. The system and the attached device automatically configure themselves by communicating via the Access.bus, thus eliminating the memory-hogging platform-specific driver installation, DIP switches, jumpers, or terminators.

The Access.bus connection protocol was developed by Digital Equipment and Philips Semiconductors in 1985. Because of its simplicity, it is widely accepted as an industry standard. Many hardware peripheral vendors plan to provide this connection

in future products. This connectivity can be provided on existing peripherals and software-controlled devices. NEC Technologies has a head start in this game by offering an Access .bus connector on its XP series of 17- and 21-inch monitors.

With the Access.bus connection, you can connect up to 125 devices to your system in daisy-chain fashion, without having to manually configure each device. For example, you can connect your system to the monitor via the Access.bus, connect the printer to your monitor, connect your modem to the printer, and so on. The order in which you connect is irrelevant. If you want to add another device into the chain, it can be plugged in anywhere, and the system will know what I/O to use to address that device.

The system communicates with each of the connected devices via the Access.bus, and each device is intelligent enough to respond to the system calls. Because the device communicates via the Access.bus, the platform on which it is connected be-



NEC's Multisync XE21 features an Access.bus connection (shown above) for hassle-free installation.

comes irrelevant. The Access.bus can also be used to update the flash ROM on the peripheral.

Windows 95 provides a Plug and Play device featuring an automatic detection of the monitor. Here, the monitor identifies itself as a Plug and Play-compatible device easing the setup and configuration time. With Access.bus compatibility, peripheral manufacturers should make their products more intelligent to accept and send instructions back and forth to the system.

HONORABLE MENTIONS

Radius's Multiview 21, MGC Technologies' MGC 2182, Panasonic's C-2192P, and Viewsonic's 21PS

(from left to right) feature the same control buttons and menu software. These four monitors use the same Matsushita picture tube with 0.25-mm dot pitch and dotted mask type. Despite these similarities, the Panasonic monitor offered the highest quality among them, and the MGC the least. The quality of the Multiview 21 and the Viewsonic 21PS was similar.



On-Screen Menus

Of the 20 monitors we tested, 14 had display controls in an on-screen menu. Monitors supporting on-screen menus have the least number of buttons and lights. The buttons on the monitor display the pop-up menu, select the controls in the menus, and

increase or decrease the selected control. Some of the monitors automatically remove the menu from the screen if the menu is idle for a given period of time. This can be annoying when you haven't finished with the adjustment. Testers preferred that the menu stay on until the testers wanted to exit.

Dubious Achievement

Congested BNC Connectors

We tested the monitors using BNC connectors, if provided. A BNC cable connector has five connectors, one each for RGB (a total of three), H-sync, and V-sync signals. Some monitors place the five connectors in one row, with equal spacing in between the connectors. This is the preferred, easy-to-use placement. Other manufacturers, such as Nokia, position the connectors in two rows, with RGB in the first row and the H- and V-sync connectors in the second row. This arrangement is inconvenient, because there is not enough room between the rows to grasp and twist the connectors.



Circular vs. Rectangular

Of the 20 monitors we tested, half of them used circular bases as opposed to the rectangular type.

Based on our subjective usability testing, technicians expressed a preference for those with circular bases, citing them as easier to move, tilt, and swivel.



How We Tested

We tested the monitors in non-interlaced mode at 1280- by 1024-pixel resolution at a refresh rate of 60 Hz and determined image sharpness, resolution, convergence, legibility, contrast ratio, and power management in a Windows 95 environment. In DOS mode, we tested the image quality and distortion using Displaymate Professional 1.0 from Sonera Technologies.

We installed the monitor-specific Windows 95 drivers for each monitor, if they were provided. Because Windows 95 was released only shortly before testing commenced, only two monitors (from Nokia and Tatung) came with specific drivers for Windows 95. We tested the rest of the monitors with configurations based on manufacturers' suggestions. Many suppliers advised that we let Windows 95 automatically configure their product as a standard Plug and Play monitor. For those monitors not compatible with Plug and Play, testers configured them to SVGA at 1280 by 1024 pixels.

We tested the monitors on an S.A.G. Electronics STC 120 running at 120 MHz with a Matrox Millennium video card. Only two NSA Hitachi monitors were not compatible with this card. At the time of testing, Matrox did not have the drivers available for the NSA Hitachi monitors. This incompatibility caused the monitors to lose their settings during testing. Our technicians had to restore the settings for each screen resolution. This incompatibility did not affect the performance of these monitors. Matrox is in the process of including support for these monitors, and it should have released the drivers by the time you read this.

DISPLAY QUALITY

We used the NSTL-developed software utility to measure the image sharpness, contrast ratio, and misconvergence of the monitors. Using 1- and 2-pixel-thick RGB lines at the edges of the screen, we measured the sharpness of the image. We also displayed horizontal and vertical lines across the entire screen, looking for the resolving capability of the monitor. We then examined the monitors for overlapping and spacing between lines.

To measure the contrast ratio, we used a large, white rectangular box at the center of the screen and measured the lumi-

nance levels for both the white rectangle and the unilluminated border surrounding the white box in candellas/meters², using a Tektronix Lumacolor II J18 Photometer. A higher ratio indicates greater contrast, making the image more visible in high ambient-light conditions.

To measure misconvergence, we used Klein Optical Instruments' optical gauge, which contains three prisms. By varying the red and blue prisms in this device, the displayed white line on the screen was aligned horizontally and vertically. This is the convergence correction required to display the image without misconvergence.

We measured the quality of the image by examining a series of 25 screens using Displaymate Professional 1.0. Screens included color and gray-scale displays, blooming effect on color and black-and-white text, moiré patterns on multiple resolutions, consecutive text and graphics switching, and geometric display of rectangles and circles. We used the same software to calculate the distortion index of the monitor by recording a series of screen measurements.

We also tested these monitors in a real-world scenario for legibility and power management capabilities. We inspected various fonts in multiple sizes for legibility and readability in a Word document from a normal viewing distance. Testers measured the power consumption in a full, active Windows environment; in a Windows screen-saver mode (using the blank screen); and in an idle or a low-power state using a Digital Power Meter.

The price cutoff to qualify as a low-cost monitor was \$1900, which is \$355 less than the average price. We were able to select the best low-cost monitor from a group of four monitors.

Our best-overall score included the weighted average of 42.9 percent of the overall performance score, 14.3 percent of power rating, and 21.4 percent of features and usability each. The quality score was determined by the weighted average of 46 percent of image-quality tests and NSTL tests each and 8 percent of distortion tests. We determined the



NSTL's Chandrika Mysore (left) measures the contrast ratio using a Tektronix Lumacolor II J18 Photometer, and Tom McAndrew measures the active display to calculate the distortion.

overall display-quality score by calculating the weighted averages of the image-sharpness (40 percent), contrast-ratio (10 percent), convergence (20 percent), and legibility (30 percent) tests.

FEATURES

We weighed some features more heavily than others to determine the features score for each monitor. Some of them are dot pitch, minimum and maximum horizontal and vertical frequencies, display modes, display controls, and internal power management. Energy Star- and TCO-compliant features were weighed heavily overall.

EASE OF USE

We examined the ease of use for each monitor by scoring documentation, technical support, and physical use, such as tilt, swivel, and cable lengths. Our technicians gave a subjective score (based on guidelines) for each usability feature. The usability testing was completed by the same technician on all the monitors.

Contributors

Chandrika Mysore, Project Manager/Editor NSTL, has evaluated systems and hardware peripherals for the past six years.

Tom McAndrew, Technical Analyst/NSTL, specializes in testing hardware peripherals and OSes.

Susan Colwell, Technical Editor/BYTE

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ROLL CALL

	 APPLE COMPUTER, INC. MULTIPLE SCAN 20-INCH	DAYTEK ELECTRONICS CORP. DT-2102M	IBM PERSONAL COMPUTER CO. P201	MAG INNOVISION CO., INC. MXP21S	MGC TECHNOLOGIES MGC 2182	MITSUBISHI ELECTRONICS AMERICA, INC. DIAMOND PRO 21TX	NANA USA CORP. FLEXSCAN F2-21	NANA USA CORP. FLEXSCAN FX2-21	 NEC TECHNOLOGIES, INC. MULTISYNC XE21
Price as tested (MSRP)	\$2149	\$1899	\$2869	\$2199	\$1995	\$2199	\$2299	\$3499	\$1899
Warranty (years)	1	3	3	3	2	3	3	3	3
PERFORMANCE SCORES									
Overall score	8.0	6.9	8.0	7.6	7.5	7.8	8.0	7.8	8.6
Quality index	9.0	8.5	8.6	8.0	8.2	8.6	8.3	7.9	8.4
Usability index	8.1	5.9	7.8	7.8	6.9	6.7	8.0	7.8	9.6
Power score	4.6	4.1	5.2	4.0	4.9	4.0	5.2	4.0	5.8
Features score	6.9	5.4	7.9	7.8	7.1	9.0	8.1	8.9	8.2
SCREEN									
Screen surface	AS, AR, BP	NG, AS, AR	AG, AS, AR	NG, AG, AS, AR	AG, AS, AR	AS, AR	AS, AR, EC	AS, AR, EP	AG, AS, AR, O
Dot pitch (mm)	0.26	0.28	0.26	0.31	0.25	0.3	0.28	0.26	0.28
Mask type	Slotted	Dotted	Aperture grill	Aperture grill	Invar ShadowMask	Slotted	Dotted	Dotted	Invar ShadowMask
Picture-tube manufacturer	Sony	Hitachi	Sony	Mitsubishi	Matsushita	Mitsubishi	Hitachi	Hitachi	NEC
RESOLUTION									
Maximum horizontal NI (pixels)	1280	1600	1600	1600	1280	1600	1600	1600	1280
Maximum vertical NI (pixels)	1024	1280	1280	1200	1024	1200	1280	1280	1024
MISCONVERGENCE (MM)									
Center	N/A	0.5	< 0.3	0.3	< 0.3	0.25	0.25	0.2	< 0.3
Sides	N/A	0.25	< 0.3	0.4	< 0.4	0.4	0.4	0.3	< 0.5
SCANNING FREQUENCY									
Minimum horizontal (kHz)	29	30	30	30	30	30	30	31.5	31
Maximum horizontal (kHz)	82	82	107	80	82	93	90	102	69
Minimum vertical (Hz)	50	40	50	50	50	50	55	55	55
Maximum vertical (Hz)	150	90	120	120	160	152	160	160	120
VIDEO INPUT SIGNALS									
15-pin D-sub connector	●	●	○	●	●	●	●	○	●
BNC-RGB connector	○	●	○	●	●	●	●	●	●
Video bandwidth (MHz)	N/A	140	120	130	135	180	130	200	85
DISPLAY MODES									
Number of preset	9	4	9	26	8	16	11	12	17
Number of user-defined	4	6	9	8	21	12	9	24	30
NI VERTICAL REFRESH RATE (HZ)									
640x480 VGA	60	60	60	75	75	152	160	160	75
832x624 Macintosh 16-inch	75	72	N/A	75	N/A	75	148	160	75
800x600 SVGA	60, 75	60, 317	N/A	85	75	152	148	160	76
1024x768	60	70, 08	N/A	87	N/A	121	115	130	75
1152x870 Mac II	75	70	N/A	75	75, 06	106	85	97	75
1280x1024	60, 75	73	77, 85	75	63, 73, 75, 03	90	85	97	60
1600x1280	N/A	58.9	66, 75, 85	60	N/A	75	72	82	N/A
CONTROLS									
Degauss button	Internal	●	●	●	●	●	●	●	●
Brightness thumbwheel	●	●	●	●	●	●	●	●	●
Contrast thumbwheel	●	●	●	●	●	●	●	●	●
On-screen menu control	○	○	○	○	●	●	●	●	●
ENVIRONMENTAL PROTECTION									
Energy Star	●	○	●	●	●	●	●	●	●
VESA DPMS	●	○	●	●	●	●	●	●	●
FCC Class	A	A	A	A	B	A	B	B	B
PHYSICAL CHARACTERISTICS									
Net weight (lbs.)	66	85	68	80	62.39	165	75	75	74.2
Height (inches)	18.7	19.2	18.7	19.37	18.8	19.3	19.2	19.2	20.4
Width (inches)	18.7	19.76	18.7	19.8	19.88	19.7	19.7	19.7	20.2
Depth (inches)	19.7	21.32	19.9	20.03	20.08	19.2	21.1	21.1	22.5
CONTACT INFORMATION									
Phone number	(408) 996-1010	(604) 270-3003	N/A	(714) 751-2008	(818) 968-6798	(714) 229-3854	(310) 325-5202	(310) 325-5202	(508) 264-8000
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Internet address	http://www.apple.com/	N/A	http://www.pc.ibm.com/	http://www.maginnovision.com	N/A	http://www.directnet.com/mitsubishi	http://www.traveller.com/nanao/	http://www.traveller.com/nanao/	http://www.nec.com
Inquiry no.	1101	1102	1103	1104	1105	1106	1107	1108	1109

 = BYTE Best.

● = yes; ○ = no; N/A = not applicable.

AG = antiglare AR = antireflective AS = antistatic BP = bonded panel EC = ergocoated EP = ergopaneled NG = nonglare O = NEC opticlear
 Note: On-screen menus include pincushion, barrel, focus, convergence, and so on.



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25 User to 100 User CD	2596.43
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425MB Fast-ATA	158.50	1.6GB Fast-ATA	385.35
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MICROPOLIS

4221 2GB SCSI-2	867.04
1936 3GB SCSI-2	809.23
3243 4.3GB SCSI-2	1209.58
1936AV 3.02GB Fast SCSI-2	1359.78

CONNER

850MB Fast-ATA	235.77	1.27GB Fast-ATA	296.80
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Seagate

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855MB Fast-ATA2	199.68		

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Adaptec AVA1505 SCSI-2 CD Kit	54.95
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28.8K V.34 external w/fax	199.88
Vi 14.4K internal w/fax & voice	108.41
Vi 14.4K external w/fax & voice	128.89
Vi 28.8K V.34 internal w/fax & voice	197.60
Vi 28.8K V.34 external w/fax & voice	217.14
Vi DVSVD V.34 internal w/fax & voice	278.82

COURIER MODEMS

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V.34 external w/fax	416.58

Hayes

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ACCURA 144 external w/fax	108.81
ACCURA 288 V.34 internal w/fax	183.76
ACCURA 288 V.34 external w/fax	218.68
OPTIMA 144 external w/fax	374.30
OPTIMA 288 V.34 internal w/fax	365.14
OPTIMA 288 V.34 external w/fax	419.44

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14.4 Mini Tower w/fax	88.76
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V.34 28.8 Mini Tower w/fax	186.32
Practical Pro Series	94111

MICROCOM

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Circle 105 on Inquiry Card (RESELLERS: 106).

Sumo Graphics Giants Weigh In

Two massive software bundles from Corel and Micrografx go belly-to-belly for the Windows 95 graphics-suite crown

**STANFORD DIEHL AND
G. ARMOUR VAN HORN**

On the heels of the office-suite successes (and Microsoft's apparent TKO), graphics heavyweights Corel and Micrografx now battle for the Windows 95 graphics market. Both companies tout the obvious advantages of buying a graphics suite from one vendor: a comprehensive one-buy solution, smooth integration across modules, one-stop support, and a discounted overall price.

But we think the two products will attract different markets. While CorelDraw 6 will appeal to current Corel shops and other graphics professionals, the Micrografx ABC Graphics Suite targets the general businessperson's graphics-production needs by skillfully wrapping the company's most popular graphics applications in a Microsoft Office-compatible interface.

Big, Fat Graphics

Also in the spirit of the office suites, these bundles are huge and ungainly. The basic installation of CorelDraw 6 takes a whopping 180 MB. The ABC Graphics Suite fills about 85 MB. You can run CorelDraw from a CD-ROM, but it still requires up to 32 MB of hard disk space. When we ran the Corel applications from a double-speed CD-ROM, performance was unacceptably



The CorelDraw interface (above) features menu roll-ups; the ABC suite (left) sports dockable toolbars. Note the ABC Media Manager (lower right).

slow, even on a 60-MHz Pentium system.

We also had problems installing from some CD-ROM drives. Information on Corel's World Wide Web site blamed real-mode CD-ROM drivers. Older systems might also experience problems with scanners, drawing tablets, video cards, and other hardware not specifically supported by Windows 95 drivers. The stability of drawing-tablet drivers was so poor at the release of Windows 95 that Micrografx chose not to support any pressure-sensitive tablets with this version, even though earlier versions supported them.

For all practical purposes, these suites need Pentium systems with 16 MB of RAM and a 1-GB or larger hard drive. It's time to bite the Windows 95 resource bullet.

If you've got the hardware, though, these suites are significantly improved for Windows 95, with judicious right-click menus, drag-and-drop support, long filenames, mul-

tithreading, and OLE 2.0. This type of functionality, as well as upcoming Windows 95 software, such as PageMaker 6, should let Windows 95 (or, better yet, Windows NT, which can host both of these graphics suites) compete with the

Mac for the professional graphics market.

But unlike the office-suite market, graphics shops have not embraced the single-bundle philosophy. The graphics market has responded well to specialized niche products from Adobe, Macromedia, and Quark. Nor does this market show any signs of becoming Windows-only. Adobe Illustrator, PageMaker, Photoshop, and Macromedia FreeHand are clearly committed to both Windows and Mac platforms. Corel and Micrografx remain specific to Windows.

The Reigning Sumo Champ

Corel has removed Ventura Publisher from the CorelDraw package but, as usual, has added lots of new stuff. The problem for Corel has always been integrating new modules into a consistent whole. The company has made strides in this area, especially with PhotoPaint, but the overall suite still feels somewhat cobbled together.

continued

WHAT'S IN THE BOX?

CORELDRAW 6	MICROGRAFX ABC GRAPHICS SUITE
\$695/\$249 upgrade	\$299/\$149 upgrade
THE APPLICATIONS	
CorelDraw 6	Designer 6.0
Corel PhotoPaint 6	Picture Publisher 6.0
Corel Presents 6	ABC FlowCharter 6.0
Corel Multimedia Manager	ABC Media Manager 6.0
Corel Dream 3-D 6	Instant 3-D
Corel Motion 3-D	SnapGraphics (16-bit)
THE EXTRAS	
25,000+ clip-art selections	20,000+ clip-art selections
1000+ photos	7500+ photos
750+ 3-D models	2000+ diagramming symbols
1000+ fonts	250+ fonts
260+ video clips	1500+ actors, props, and sounds

Native Transfer

A Windows graphics suite must handle large data files and distribute them across multiple application modules. In the past, the challenge has been in transferring these large data sets without bogging down the system. OLE 2.0's Uniform Data Transfer technology makes this process more efficient.

Before OLE 2.0, applications used global memory as the medium of data transfer, and a Clipboard format (e.g., CF_TEXT or CF_BITMAP) to describe the data. Different transfers (OLE 1.0, DDE, the Clipboard, or drag and drop) required different protocols and API functions. Under OLE 2.0, a pointer is transferred from the data source to the data recipient. The data object itself then determines a standardized format for the transfer.

When you select a data object and drag it out of its source, the destination OLE container supports two data types—the Native Format and the Presentation Format—each of which might contain several additional components. The Native Format can be almost anything. Corel applications use the Corel Metafile Exchange (*.CMX) format, introduced as the clip-art format with CorelDraw 5. The Presentation Format includes elements previously supported by the Windows Clipboard (Device-Dependent Bitmap, Windows Metafile, Rich Text, and text), along with two new formats for Windows 95: Device Independent Bitmap and Extended Metafile.

When a client application accepts a data object, it selects the format of the highest quality. If the program is privy to the Native Format (which is likely if the client and server are from the same vendor), there's no need to revert to a less accurate format for the transfer.

layer control in CorelDraw, easier to use by bringing more functions to the first level of a roll-up menu. But overall, the applications are hard to learn and use unless you're a seasoned CorelDraw designer.

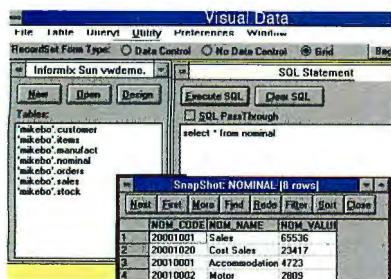
Dedicated Corel shops should appreciate the upgrade. The new applications are impressive, especially when it comes to 3-D illustration. Corel Dream 3-D, a Windows 95 port from RayDream Designer for Windows and the Mac, is a high-end tool for 3-D modeling and rendering.

If you're familiar with 3-D design (and especially if you've used RayDream Designer before), you'll be immediately productive with Corel Dream 3-D. Another new application, Corel Motion 3-D, animates your 3-D models. The Micrografx Instant 3-D application generates slick text effects, but the ABC suite does not support 3-D modeling.

The new Corel Presents module supports a full range of multimedia elements, including sound, video, and transitional effects. Corel also bundles an excellent screen-capture applet, a module that the ABC Graphics Suite needs and lacks.

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REVIEWS Sumo Graphics Giants Weigh In

ABC Graphics Suite needs and lacks.

Corel's inclusion of professional illustration tools infuses the bundle with high-end functionality that you simply won't get from the ABC suite. But if you're looking for a general-business graphics solution, CorelDraw is overkill.

Sumo Business Graphics

Micrografx has pulled together a focused graphics suite for the mainstream office. When installing the suite, you can include Micrografx icons on the toolbar of Micro-

soft Office applications. When you click on the Micrografx icons from within either Word or Excel, you end up in an OLE frame, with the launched application activated.

Picture Publisher and Designer (but, sadly, not FlowCharter) work within the new Office Binder. The Binder requires plenty of resources to efficiently handle a large set of integrated files, but if you've got a fast Pentium system, it's a convenient way to manage work projects.

Neither Corel PhotoPaint nor Micrografx Picture Publisher can match the full functionality of Adobe Photoshop, but with either of these suites you get a powerful image editor. Picture Publisher shows off its Windows 95 architecture with a task window that displays multithreading in action and with its support of Kodak's 32-bit Precision Color Management System. Meanwhile, Designer has moved closer to the professional power of CorelDraw by now handling up to 32,000 layers, matching CorelDraw's placement precision of

THE COREL UTILITIES

WHAT THEY ARE	WHAT THEY DO
CorelDepth	Create 3-D logos
Corel Script Editor	Develop add-ons with OLE scripting language
Corel Script Dialog Editor	Create dialog boxes for Script Editor
CorelMemo	Attach notes to drawings and documents
Corel Font Master	Manage TrueType and Adobe fonts
Corel OCR-Trace	Convert raster images to vector/OCR
Corel Capture	Capture all or custom areas of screen
Corel Presents Runtime Player	Display distributable presentations

1 micron, and making Encapsulated PostScript (EPS) its native format.

The Suite Choice

CorelDraw 6 has more-powerful applications for the graphics professional. But if you want an easy-to-use set of graphics tools for the office (and Office) user, the ABC Graphics Suite is the better choice. ■

Stanford Diehl is director of BYTE product reviews. G. Armour Van Horn is an artist and graphics consultant based on Whidbey Island, Washington. You can reach them on the Internet or BIX at sdiehl@bix.com and vanhorn@bix.com, respectively.

Product Information

CorelDraw 6 . . . \$695/\$249 upgrade
Corel Corp.
Ottawa, Ontario, Canada
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fax: (613) 761-9176
www.corel.com
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DAVID ESSEX AND STEVEN J. VAUGHAN-NICHOLS

"I'll fax it right over," you say, and thus begins a solid 20 minutes of wasted time: Find the document, stand in the fax line, dial the wrong fax number, find the right one, stand in the line again, send the fax, go back to your desk, and take the inevitable call: "Could you fax that again? Our machine ate the last page."

There is a better way. It's called fax on demand (FOD), and it applies to a number of new products that enable callers to request faxes directly from your fax server. No matter what your business, if you get a lot of calls requesting printed information, you should consider FOD.

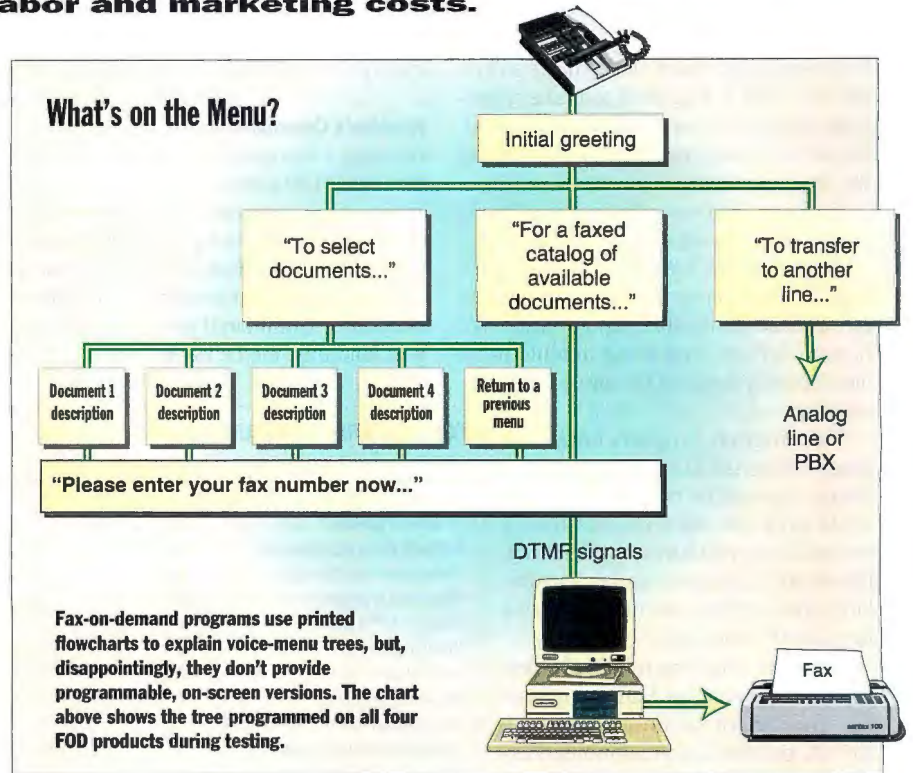
FOD systems deliver documents stored in a dedicated repository (and, occasionally, corporate data that isn't normally stored in faxable formats, such as PCX and TIFF). Callers can dial in from their fax machine's handset and get documents returned during the same call, saving phone costs for the sender. More typically, they choose documents and enter the fax number using a Touch-Tone phone. The FOD system then transmits the requested documents on a separate line.

FOD systems for in-house use are often sold in turnkey form, with preconfigured voice and fax boards already installed in a computer. You can also put one together using Visual Basic-like development toolkits. We looked at DOS-/Windows-based software that is also available in kit form (i.e., the software vendor also sells voice and fax boards).

FOD Facts

Conceptually, FOD systems are simple. The voice board receives DTMF tones generated by the caller's handset and passes them to the FOD software, which reads and plays back the appropriate voice messages stored on the PC's hard drive. (None of the reviewed programs accepts pulses from rotary dialers.) When the caller identifies a specific document, the FOD software loads it and sends it to the fax board for transmission. The fax board then transmits the document to the phone number specified by the caller.

To put the four FOD systems we tested



on equal footing, we ran all our tests on an IBM PS/1 57C, a 33-/66-MHz 486DX2 system with 700 MB of disk space and 16 MB of RAM. The machine was equipped with a one-line Dialogic D/41D voice card and a one-line GammaLink GammaFax CPI/100 fax card (Ibex Technologies' Facts-Line required a second Dialogic board). Two outgoing fax lines is a more typical setup, but little is gained by testing the second line, since the relevant queuing issues exist on a one-line system.

To flood the system with requests, we made three calls in rapid succession, requesting two one-page documents during each call. We measured fax-throughput times for each pair of document transmissions and then averaged the results. We sent all faxes to the same machine, a Ricoh RF 860. VP Express was slightly faster than the other programs at transmitting faxes held in a queue, but the difference in performance among these solutions was negligible.

All four programs have some features in common. For starters, each is best run on a dedicated machine. Even in these days of gigabyte-capacity drives, disk-space requirements alone make putting FOD soft-

ware on a user's PC unrealistic. Also, FOD software doesn't get along well with other programs. Almost all these programs specifically discourage the use of memory management software, and with good reason: They don't work well—if at all—with a memory manager loaded.

None of these programs is easy to install. Be ready to spend at least two days shaking out all the software conflicts and putting together a decent voice-menu tree. Once our installation wars were over with, though, each program performed well. All worked with the basic file formats typically used in faxing—PCX, TIFF, and ASCII—without any trouble. Each also proved reliable in the face of disconnections and other failures.

Copia International's FaxFacts

All these programs were troublesome to install, but Copia International's FaxFacts 5.0, which requires you to make directories in DOS and manually invoke the installation routine for each program disk, took the installation-complexity prize. Once in place, however, this MS-DOS program worked well.

continued

FaxFacts comes with a Windows interface, but it limits you to printing and viewing faxes and playing back voice messages. All the real action happens from the program's MS-DOS interface.

In our tests, we found FaxFacts to be a solid, reliable performer. For example, you can call from one phone and have FaxFacts send a document while you're still on the line. Still, if you want to make significant changes to your setup, such as adding new menu items, you need to bring the program down.

FaxFacts also does a decent job of tracking its work, saving daily data into dBase DBF-compatible files. However, to generate the best reports, you might need to buy a dBase-compatible report writer. We found FaxFacts' reporting module to be insufficiently detailed for serious data tracking.

The program supports broadcast faxes using ASCII mail-merge lists. While it would be better if FaxFacts could work directly with data from a personal information manager (PIM), this is still a handy feature. Particularly noteworthy is the fact that it can fax directly from an ASCII file.

FaxFacts requires relatively few system resources, as FOD programs go. You can run it on as little as a 386SX, but we don't recommend using the computer for anything else.

Ibex's FactsLine for Windows

Ibex Technologies' FactsLine for Windows 2.0 is by far the simplest of these four programs to install. Unlike the others, it uses a standard Windows installation routine. The Windows interface makes it far easier to configure than the other programs, which require you to fight your way through scripting languages to call data from a database or to change the menu tree. With FactsLine, these jobs are a breeze. You can automatically turn off menu items leading to old documents, and FactsLine lets you reconfigure the system, and even update the voice-menu tree and documents, while you're on-line.

As you might expect, FactsLine, with its dBase databases and Windows interface, comes with a variety of easily accessible reports. These reports can be displayed on-screen, printed, or (which we were amused to find) faxed.

But all this comes at the cost of system resources. You won't want to run FactsLine on anything less than a 33-

MHz 486DX with 8 MB of RAM. More of both, as always, would be better.

When all is said and done, though, FactsLine is the best of the group. It costs more—in addition to its heftier system requirements, it uses a minimum of two voice boards—but you'll find its ease of use, flexibility, and reporting power to be worth the extra expense. Highly recommended.

Nuntius's CommandFax

Nuntius's CommandFax 3.5 handles all the usual FOD jobs (e.g., sending requested faxes on the same call or via a return call) with aplomb. That's a good thing, because getting CommandFax to that point can be a pain. While there should be a Windows version of CommandFax out by the time you read this, the DOS version we tested

will have you manually tweaking configuration files before you're done.

CommandFax is also the most demanding of these four programs when it comes to system resources. For example, it won't work well with any expanded-memory manager (according to the documentation), but it requires at least 1 MB of expanded memory. For people with old LIM expanded-memory boards, that's fine, but others will be left in a quandary.

CommandFax's reporting tools are nonexistent. While the program keeps copious logs in dBase format with FoxPro-compatible indexes, you'll need another program to make sense of the data.

That said, CommandFax has a pair of shining virtues that may make it the best choice for some users. Unlike the other

FOD FEATURES COMPARED

	COMMANDFAX	FACTSLINE	FAXFACTS	VP EXPRESS
FAX ON DEMAND				
Single-call operation	●	●	●	●
Callback (two-call) operation	●	●	●	●
Caller-selectable one- or two-call	●	●	●	●
Area-code or phone-number lockout	●	●	●	●
Password/PIN security	●	●	●	●
Voice mail	●	●	●	●
Auto-redial on busy	●	●	●	●
Auto-redial on failure	●	●	●	●
Accepts input from rotary-dial pulses	○	○	○	○
Optional speech recognition	○	○	●	○
Supports credit-card billing	●	○	●	○
Support audiotex (text-to-speech)	○	○	○	○
Supports mailboxes	○	●	●	●
VOICE				
Major voice boards supported	Dialogic, Pika, Rhetorex	Dialogic, Rhetorex	Dialogic, Rhetorex	Dialogic, Rhetorex
Maximum number of lines per CPU	24	30	24	16
Caller can transfer out to PBX system	●	●	●	●
Allows direct access to databases	○	○	○	○
Supports alphabetical input	●	●	●	○
FAX				
Major fax boards supported	Brooktrout, GammaFax, PureData Satisfaction	GammaFax	Brooktrout, GammaFax, Hayes JT-Fax	GammaFax, PureData Satisfaction
Maximum number of lines per CPU	24	30	24	10
Supports binary file transfer (BFT)	●	●	○	○
Networks supported	All	NetWare, NT Server	All	All
Supports faxed-in requests	○	○	○	○
DOCUMENT PREPARATION				
File formats supported	PCX, TIFF, ASCII, DCX	PCX, TIFF, ASCII, DCX	PCX, TIFF, ASCII, DCX, PostScript	PCX, TIFF, ASCII, DCX
Includes image editor	○	○	○	○
GENERAL FEATURES				
Real-time call monitoring	●	●	●	●
Maintains call log	●	●	●	●
OSes supported	DOS, Windows 3.1	DOS, Windows 3.1, NT	DOS, Windows 3.1, NT	DOS, Windows 3.1, Windows 95
Minimum CPU	386DX	386DX/33	386SX	486DX2/33
Minimum RAM (MB)	4	8	4	4
Minimum hard disk (MB)	20	40	1	15

● = yes; ○ = no; features not integral to the basic package are marked with a ○.

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Banner Blue Software's **Org** © Plus for Windows 3.0
Brooks/Cole Publishing Company's **EXP** © v3.0
Centron Software Technologies, Inc.'s **Casino Master**™
Chip-Chat Cawthon Software's **ChipChat** © Communicator™ v1.04
Computer Intelligence InfoCorp's **Market Insight**™
Cosmi Inc.'s **Garden Architect** v1.32
CPAS Systems, Inc.'s **Creative Actuary**
Data Access Corporation's **DataFlex** © v3.05 (for DOS)
Decision Support Technology, Inc.'s **Basets Fixed Asset System**, v3.1
Designer Software, Inc.'s **DBExpert**™ v1.0
Eagle Technology, Inc.'s **WEMM** v4.52
Exoterica Corporation's **OmniMark**™
Geotest, Inc.'s **AIEasy** ©
Greensoft Corporation's **GreenDesk** © for Windows v1.2
Hilgraeve Inc.'s **HyperAccess/5** © for DOS & OS/2
Informative Graphics Corp.'s **Myriad**™ 2.2 for Windows

Interactive Image Technologies Ltd.'s **Electronics Workbench**™ (Win) v4.0a
IntraCorp, Inc.'s **Capstone Anyone for Cards**
Just SoftWorks, Inc.'s **Precision Mapping 2.0**
K.I.S.S., Inc.'s **KwikFill**
Media Forum's **Media Forum**™
MHS, Inc.'s **Mini-SCID**
MicroBix © Corp.'s **Business Controller**™ Plus v5.1
Microrim © Inc.'s **R:Base**™ for Windows v5.1
Millennium Media Group's **Merriam-Webster's WordWar 5**
MKS, Inc.'s **MKS TOOLKIT** v4.4
Oprode's™ **The Musical World of Professor Piccolo**™
Oracle © Corporation's **Personal Oracle7**™ Enterprise Edition
Peachtree © Software Corporation's **Peachtree** © Accounting for Windows v3.0
Spitfire Software's **In Charge!**™ for OS/2
Systems Enhancement Corp.'s **PowerMon II UPS** for OS/2
Tech Tools, Inc.'s **VisualBaler** © v1.00
Texas Caviar's **Annabel's Dream of Medieval England**
Visual Numerics Inc.'s **Stanford Graphics**
World Library, Inc.'s **Library of the Future** © 3rd Edition
World Software Corp.'s **Worldox** © v2.0
Zane Publishing's **Encyclopedia of U.S. Postage Stamps**
Zantec, Inc.'s **Synergy Gold**

Product Information

CommandFax 3.5\$800
 (per line, up to four lines;
 \$400 per multiline port thereafter)
 Nuntius Corp.
 St. Louis, MO
 (314) 968-1009
 fax: (314) 968-3163
 fax on demand: (314) 776-7076
Circle 1092 on Inquiry Card.

FactsLine for Windows 2.0 . . . \$4790 and up
 Ibox Technologies, Inc.
 El Dorado Hills, CA
 (800) 289-9998
 (916) 939-8888
 fax: (916) 939-8899
 fax on demand: (916) 939-8875
Circle 1093 on Inquiry Card.

FaxFacts 5.0\$3800
 (two lines each for fax and voice)
 Copia International, Ltd.
 Wheaton, IL

(800) 689-8898
 (708) 682-8898
 fax: (708) 665-9841
 fax on demand: (708) 924-3030
Circle 1094 on Inquiry Card.

VP Express 1.1 \$1295 (introductory)
 (eight lines voice; 10 lines fax)
 Telephone Response Technologies, Inc.
 Roseville, CA
 (800) 878-3947
 (916) 784-7777
 fax: (916) 784-7781
 fax on demand: (916) 784-7004
 trtsales@trt.com
 http://www.trt.com
Circle 1095 on Inquiry Card.

Dialogic
 Parsippany, NJ
 (201) 993-3000
 fax: (201) 993-3093
Circle 1096 on Inquiry Card.

programs, CommandFax can use network fax servers for its outgoing faxes (Telephone Response Technology has a higher-end product that does this, too), and LAN users can send out faxes via the program's fax card. CommandFax manages this remarkable feat by using Intel and DCA Communications' Communicating Application Specification (CAS). This additional capacity makes CommandFax an ideal choice for any office that needs to send ready-made and impromptu faxes alike to a large number of customers.

Telephone Response Technologies' VP Express

VP Express (VPX) 1.1 is a good middle-of-the-road product. While it doesn't have all the virtues of FactsLine, in our testing it was marginally the fastest at handling an overload of fax calls. VPX is also straightforward to install and maintain—if you can keep an eye on it. While the program has the simplest Windows interface of the group, some of its setup query boxes aren't what they appear to be. The menus don't specify what will happen when you try

certain buttons and other menu choices. Although the manual says you need a 75-MHz or faster computer for decent performance, we found that VPX actually ran better than its competition on our supposedly suboptimal 33-/66-MHz 486DX2 system. VPX is also very flexible at handling incoming lines. While CommandFax and FaxFacts might have you negotiating arcane commands for each line, VPX has one easy-to-use window display that makes managing separate lines simple.

Unlike the other programs, VPX can be expanded into separate fax and voice-mail systems. While full-featured voice mail is separately priced (\$395), small offices looking for a catch-all solution might prefer VPX over the other programs.

VPX also has adequate reporting capabilities. But if you want to work over the numbers to see what your customers are up to, you need separate DBMS or reporting software. All told, we still prefer Ibox's FactsLine for its fast installation and superior ease of use. ■

David Essex is a BYTE technical editor. Steven J. Vaughan-Nichols is a freelance writer and consultant. You can reach them on the Internet or BIX at dessex@bix.com and sjvn@access.digex.net, respectively.

TECHNOLOGY FOCUS

The Challenge of Telephony Integration

The great challenge of computer telephony integration (CTI) is to combine computer-based media technologies (e.g., voice, fax, and speech recognition) with a wide range of often-proprietary telephony equipment (e.g., telephones and switches). Signal Computing System Architecture (SCSA), a standard that's supported by a wide range of CTI vendors, defines a modular architecture for seamlessly integrating computer-based applications with diverse telephony hardware.

SCSA includes both a software and a hardware specification. The SCSA Telephony Application Object (TAO) Framework and the SCSA Hardware Model are independent. The TAO works over a variety of hardware models, including proprietary devices, by implementing a switch-fabric controller. This controller, specific to the underlying hardware, receives resource requests from TAO and translates the request to the specific hardware interface.

The Service Provider Interface (SPI) sits on top of the hardware-specific switch-fabric controllers, providing developers with a consistent interface to different vendors' hardware devices and software components. The SPI enables different hardware and software computer-telephony modules to interoperate seamlessly.

The application worries only about the abstract telephony features it needs from the system, instead of the specific hardware devices that support those features. This design delivers resource and location independence to the application. When an

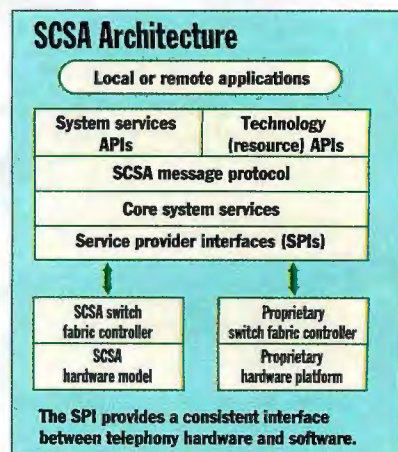
application requests a particular set of features (e.g., a text-to-speech component and a fax line), SCSA creates a group of resources that can service the request.

Such a group can contain one or many physical resources. SCSA manages the resources for the application, in effect pooling a diverse set of physical devices into a single, customized system. Once a call or other application event is over, the functional group is destroyed and the physical resources become immediately available to other applications.

Simple fax-on-demand solutions, such as those reviewed here, don't require the rich functionality enabled by SCSA. But vendors such as Copia and Telephone Response Technologies rely on SCSA to integrate higher-end resources (e.g., speech recognition or conferencing) and to negotiate complex switching across multiple lines.

The final result: a portable, cross-platform, hardware-independent architecture for CTI.

—Stanford Diehl



3-D Without RISC

Intergraph's TDZ-400 puts two Pentium Pros to work speeding 3-D graphics

DAVE ROWELL

In 1994, Intergraph gambled that it could abandon RISC for multiprocessor Intel boxes and still get 3-D workstation performance. Now comes the payoff with the Pentium Pro. Intel's new chip delivers RISC-level performance and x86 compatibility, too.

The 150-MHz Pentium Pro is fast; our BYTEmark CPU test (32-bit code) shows its integer performance is 2.1 times that of a 90-MHz Pentium, and its floating-point performance is 2.6 times faster. The 200-MHz Pentium Pro, announced after

we completed these tests, should be as fast—or faster than—any RISC chip except Digital Equipment's 21164 Alpha. Intergraph plans to ship a 200-MHz version of its TDZ workstation before 1996, with prices \$2500 higher per CPU than the 150-MHz models.

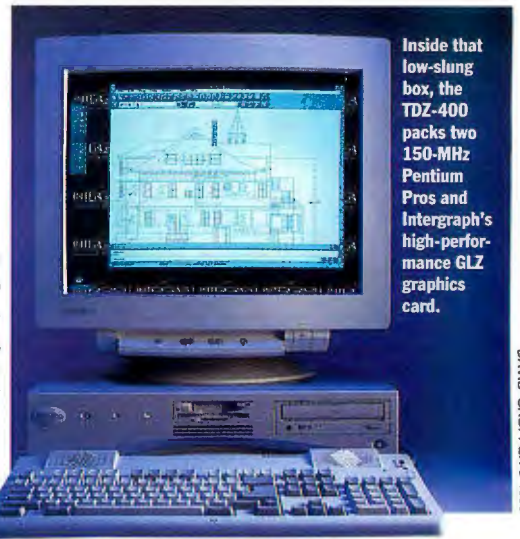
We tested the first Pentium Pro system, a \$24,195 Intergraph TDZ-400 with two 150-MHz Pentium Pro CPUs, 64 MB of RAM, a 2-GB SCSI hard drive, and a 21-inch monitor. The systems come with Windows NT 3.51, a PCI-bus GLZ graphics card, built-in Ethernet, PC Card slots, a quad-speed CD-ROM drive, and a keyboard with microphone and stereo speakers. The TDZ-300 has a single Pentium Pro, the TDZ-400 has two, and the deskside TDZ-600 has four. The new models carry slightly higher prices than the old Pentium line (around \$1000 more for comparable TDZ configurations with 150-MHz Pentium Pros).

Our test configuration used Intergraph's newest 3-D card, the GLZ1T—a GLZ1 accelerator with an added texture-processing board. In addition to 12 MB of video RAM (for double-buffered, 1152-by-864-pixel graphics with 24-bit z-buffering), the card has 8 MB of memory for storing texture maps. It has the same \$8000 price as the 24-MB GLZ2 we tested in the TDZ-40 (see "3-D Graphics Go Zoom," September BYTE). All GLZ cards support the OpenGL 3-D API under NT.

Exceeds Expectations

We were surprised by just how much the Pentium Pro boosted the TDZ-400's 3-D graphics performance. The TDZ-400 ran the OpenGL Performance Characterization Committee's Viewperf 3.0 test 2.5 to 13 times faster than the TDZ-40 with two 100-MHz Pentiums and ran the rendering tests with Bentley Systems' MicroStation three to four times faster (not shown).

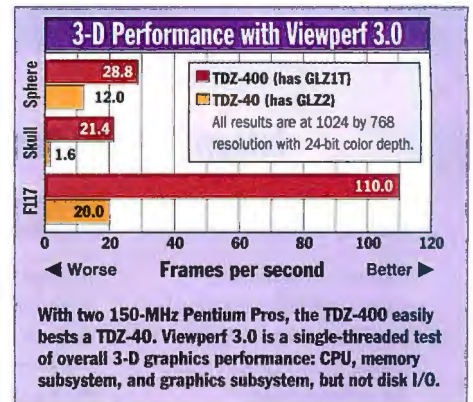
Based on the BYTEmark tests, the floating-point speed difference between a 100-MHz Pentium and a 150-MHz Pentium Pro is 134 percent (2.3 times), while the GLZ1T's texture processing provides only a 15 percent boost (based on Intergraph's tests). Intergraph attributes the gain to the Pentium Pro's floating-point speed, bet-



Inside that low-slung box, the TDZ-400 packs two 150-MHz Pentium Pros and Intergraph's high-performance GLZ graphics card.

DAVID SHOPPER © 1995

ter memory architecture (i.e., interleaving, an integrated L2 cache, and a more efficient CPU bus), and improved OpenGL drivers for its GLZ cards. Intergraph's Mogle, a multithreading OpenGL driver for the MicroStation, provided a 5 percent to 50 percent performance boost by putting both processors into play.



Intergraph cast its lot with promising standards: x86 compatibility, PCI, Windows NT, and OpenGL. For 3-D visual computing applications like mechanical CAD, it's a winning combination. ■

Dave Rowell is a BYTE technical editor. You can contact him on the Internet or BIX at drowell@bix.com.

Product Information

TDZ-400\$24,195
(two 150-MHz Pentium Pros, 64 MB of RAM, GLZ1T 3-D graphics card, 2-GB hard drive, 21-inch monitor)
Intergraph Computer Systems
Huntsville, AL
(800) 763-0242
(205) 730-5441
<http://www.intergraph.com>
Circle 1139 on Inquiry Card.

TECHNOLOGY FOCUS

Texture Details

Texture mapping adds realism to 3-D displays by draping 2-D patterns, such as wood grain or a Landsat image, over 3-D surfaces. Ideally, it adjusts the patterns for perspective and surface shading. More capable workstations keep texture maps readily available in dedicated memory within the graphics subsystem. Texture mapping can then move quickly into a rendered image without bogging down the host system. Several of Intergraph's GLZ graphics cards, for example, store 8 or 32 MB of texture data and pipe it to the image midway through the rendering process via a 64-bit, 256-MBps graphics bus.

Though fast, dedicated texture memory is costly and limits image size for some applications. Storing texture data in system memory extends texture storage. Using OpenGL texture-object extensions, Intergraph's texture-processing hardware can store large texture maps in system memory and use the dedicated texture memory as a cache, moving data between the two areas over the relatively fast Peripheral Component Interconnect (PCI) bus.

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- * 24-bit AFX graphics support
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- * 19" rack mount assembly available



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Ultrafast UltraSparcs

With an innovative crossbar and multimedia architecture, the first 64-bit UltraSparc workstations thrust the spotlight back on Sun

BEN SMITH

Sun's highly anticipated 64-bit UltraSparc processor has arrived in two new high-performance workstations: the Ultra I Model 140 and Ultra I Creator3D Model 170E. The stakes are high for a company that has lost significant ground in the workstation market to sexy systems from Hewlett-Packard and Silicon Graphics, Inc. (SGI). But with the Ultra's innovative packet-switched crossbar and specialized Visual Instruction Set (VIS), Sun has a strong hand to play. Although its benchmark numbers are nowhere near those of a Digital Equipment Alpha running Microsoft NT, the 170E easily outperforms everything else that runs the Solaris OS on a single processor.

For this review, we tested the Ultra I Model 170E, the higher-end, 167-MHz system with 64 MB of RAM standard. The less elaborate Model 140 hosts a 143-MHz UltraSparc processor and includes a standard 32 MB of RAM (see the table "Sun Specifications" at right for a list of standard features for both models).

Both systems are enclosed in the same compact chassis, about the size of a deep-dish pizza box (16 by 17 by 4 inches), and both models support two RS-423/RS-232 connectors, a parallel port, a CD-ROM drive, and a 3½-inch floppy drive. Sun had not finalized pricing at press time, but the Model 170E will list for under \$30,000; the Model 140 will come in under \$20,000.

By the Numbers

According to our benchmark testing, the 167-MHz Ultra 170E performs at roughly

FEATURES OF THE ULTRA I

- 64-bit address pointers
- Specialized Visual Instruction Set
- Branch prediction
- Four-way superscalar design with nine execution units
- 16-Kb data cache; 16-Kb instruction cache
- Integrated second-level cache controller
- 128 data lines to packet-switched crossbar
- 3.3-V operation

1.8 times the speed of a 90-MHz Pentium. But because the BYTEmark test suite does not take advantage of the UltraSparc's specialized instruction set, the benchmark results do not tell the whole story. And you really need a shared-memory multiprocessor system to fully appreciate the new UltraSparc Port Architecture (UPA), a distributed-arbitration multimaster crossbar (see the Technology Focus box for details).

When we ran real-world applications—applying special-effect filters to large graphics images, rendering complex texture maps, and displaying high-motion MPEG video clips—the performance advantages of the UltraSparc architecture became obvious. The 64-bit VIS versions of these kinds of graphics and video applications will realize another order-of-magnitude boost in performance. Even without software recompilation, the Ultra I delivers an extremely fast platform for graphics applications.

UltraGraphics

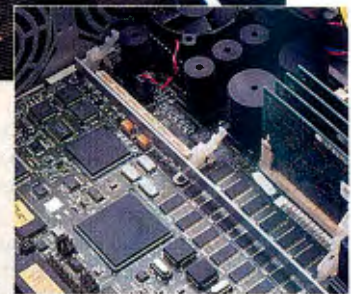
The UltraSparc processor includes a set of dedicated single-cycle instructions to enhance performance. VIS dramatically cuts the number of clock cycles required for graphical and video operations.

For example, VIS includes an array operation for slicing 3-D volumetric data. This operation, accomplished with a single UltraSparc instruction, typically requires 24 instructions, according to Sun. Other specialized one-cycle instructions support such operations as conversion instructions for packing and expanding pixel data, arithmetic instructions for manipulating large graphics images, and fixed-point compare instructions for examining the z-



DAVID SHOPPER © 1996

Sun's Ultra I Creator3D Model 170E (top) with its 64-bit UltraSparc (Inset)



Sun Specifications

Model 140

143-MHz UltraSparc
32-MB RAM
1-GB hard drive
17-inch color monitor
10-Mbps Ethernet
10-Mbps SCSI
Three Sbus expansion slots
TurboGX graphics
Less than \$20,000

Model 170E

167-MHz UltraSparc
64-MB RAM
2-GB hard drive
20-inch color monitor
10- and 100-Mbps Ethernet
20-Mbps fast and wide SCSI
Two Sbus expansion slots
UltraSparc graphics
Less than \$30,000

buffer during 3-D rendering.

The UltraSparc uses two sets of registers to process graphical commands: The integer registers crunch address calculations for the image data, while the floating-point registers handle manipulation of the image data. This division of labor deploys the maximum number of registers and augments instruction parallelism.

The UltraSparc also supports a wide range of video-compression algorithms, including H.261 (the standard compression algorithm for H.320 videoconferencing), MPEG-1 and MPEG-2, and JPEG. Again, the UltraSparc supports specific

The Crossbar: An End to Interrupts

The Ultra uses a packet-switched crossbar instead of the more traditional interrupt-driven bus. This design cross-connects many different subordinate buses of varying widths and speeds.

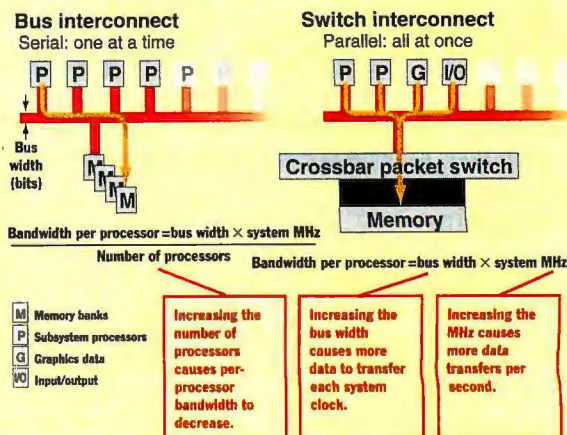
Conceptually, it's a multiplexed bus (i.e., multiple data transfers occur simultaneously). In an interrupt- or control-line bus, only two devices can communicate in one direction at one time. All other devices or subordinate buses must wait until the bus controller handles their requests. This design works well for single processors and single-tasking (or cooperative multitasking) OSes, but it does not work well for multiprocessor systems with intelligent subordinate systems.

The packet-switched crossbar passes data from subsystem to subsystem via 18 small chips located near the memory bus on the motherboard. Each connection to the crossbar supports its own buffering and can handle different subordinate bus speeds and widths.

The 64-byte cache size determines the size of the *packets* (the basic element of transfer data). A 128-bit-wide subordinate bus will not degrade to four fetches of 32 bits each just because the subordinate bus at the other end of the switch is only 32 bits wide. The 32-bit circuit may take four clock cycles to load its data, but the 128-bit circuit still consumes the data in a single clock.

While the smaller data path is loading (or unloading), the wider channel can service other transfers. For that matter, other subsystems can carry on communications even while data is moving between the first two. The packet-switched crossbar solves the problem of bus contention as well as the inefficiencies of connecting at varying data widths and speeds.

The UPA Difference



functions for motion estimation, the most common operation used for video compression. The result is outstanding full-motion, full-screen video playback without any external video-acceleration hardware (see the table "Features of the Ultra I" for more of the processor's features).

The Ultra graphics board does not have special-purpose 3-D graphics engines, such as you would find in SGI systems. But the 24-bit RAMDAC and frame-buffer con-

trollers, combined with VIS operations and UPA data transfers, generate the kind of 3-D effects that you would expect to see only on high-end 3-D boards, such as the SGI Reality Engine. We created smooth fly-throughs of complex 3-D objects with Gouraud shading, lighting, depth cueing, and even texture mapping.

Of course, your applications can't tap the Ultra's graphics enhancements until the specific 3-D modeling libraries are com-

plied and linked for the Ultra architecture. But all your UltraSparc-based systems will benefit once you've made that initial investment. With workstations that support dedicated 3-D processors, you have to budget for that specialized 3-D hardware each time you invest in a new system.

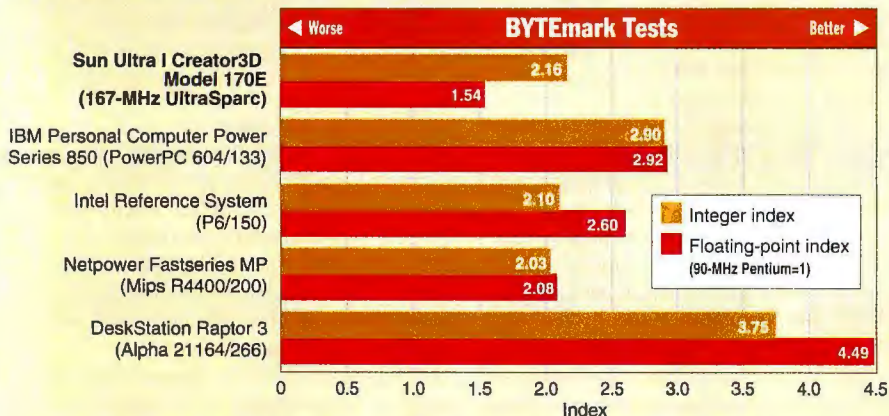
Long Life and Good Fortune

With regard to raw number crunching, Ultras may not be peers to Alphas. But when evaluated as graphics workstations rather than as compute servers, these systems have no peer in price/performance.

With applications that take advantage of the VIS instructions, such as CAD and Photoshop, the Sun Ultra I Creator3D Model 170E performs well above any other single-processor workstation currently available. ■

Ben Smith is a Unix and IP networking consultant with the firm Ronin House in Peterborough, New Hampshire. He can be contacted on the Internet at ben@ronin.com.

Raw Performance: The VIS-less Ultra I



Sun's Ultra I Model 170 lags behind the PowerPC, and far behind the 266-MHz Alpha, but the BYTEmark test suite does not tap the Ultra's most compelling performance technologies: the Visual Instruction Set (VIS) and the packet-switched crossbar bus.

Product Information
Sun Ultra I Model 140less than \$20,000
Sun Ultra I Creator3D Model 170Eless than \$30,000
Sun Microsystems Computer Co.
Mountain View, CA
(415) 960-1300
fax: (415) 969-9131
Circle 1044 on Inquiry Card.

Best Low-Cost Printer on the LAN

HP's new LaserJet 5Si MX will be the printer of choice for large workgroups

DAVE ROWELL

Network printers at the low end of the price range are getting faster. Case in point: Hewlett-Packard's new LaserJet 5Si MX. It's fast, and it comes with some great features for printing on the LAN. The 5Si MX's print-engine speed is 24 pages per minute (ppm). Its predecessor, the 4Si MX, has a 17-ppm engine. The 5Si MX holds 1100 sheets of paper, can handle 11- by 17-inch paper, and comes with bidirectional management software. This software supports real-time

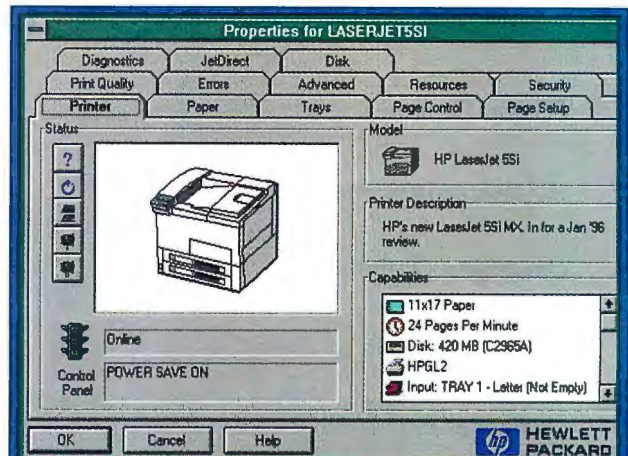
in features, usability, and speed. HP's new LaserJet is fastest in its price class. In fact, it's competitive with the more expensive 30- to 32-ppm printers, although its 100,000-page monthly duty cycle is still only half as high.

Options include a 2000-sheet input tray (\$1299), a mailbox with eight 100-sheet bins (\$1889) for separating print jobs, a duplexing unit (\$669), and an envelope feeder (\$549).

If you don't need a direct network connection and PostScript, you can consider the LaserJet 5Si (no MX) for \$3499. It lacks the MX's 350-KBps JetDirect Ethernet/Local Talk card and PostScript SIMM, and it has 4 MB of RAM instead of 12 MB.

Cool Software

HP has upgraded the JetAdmin software so that it now provides easy network configuration and management, including installing printer drivers for users over the network. With bidirectional printer communications, you can now track print jobs over the LAN in real time, getting such details as where the job is in the queue, how much of the job is complete, or where it will be output.



The LaserJet 5Si MX as seen from HP's JetAdmin administration utility. Similar interfaces, though with fewer configuration options for users, are built into Win 95, HP's JetPrint utility, and HP's Win 3.x printer drivers.

NEW AND IMPROVED

The LaserJet 5Si MX beats the 4Si MX in every way. We derived scores using NSTL test and evaluation methodology. Quality, features, and usability scores are scaled to a perfect 10.

	HP LASERJET 5Si MX	HP LASERJET 4Si MX
Price as tested	\$4899	\$5299
Pages per minute (PCL)	12.5	10.7
PPM (PostScript)	9.7	9.4
CPU speed (MHz)	40	25
Engine speed (ppm)	24	17
Quality score	8	7.9
Features score	7.8	7.1
Usability score	8.6	8.3

LaserJet 5Si MX \$4899
 Hewlett-Packard Co.
 Santa Clara, CA
 (800) 752-0900
 fax: (800) 333-1917
 http://www.hp.com
Circle 1090 on Inquiry Card.

monitoring and control of the printer by administrators as well as users. All this for \$400 less than the 4Si MX.

We tested the LaserJet 5Si MX on a mixed NetWare 3.1 network with Macs and Windows-based PCs. We ran NSTL's network-printer benchmarks and compared the results to other recently tested network printers (see "12 Network Printers Set the Pace," November 1995 BYTE). Our testing revealed that although the new LaserJet didn't have the highest numbers in any one category, it consistently ran near the top in all categories (speed, print quality, features, and usability). As a result, the LaserJet 5Si MX produced an overall score higher than any printer in that group.

The 5Si MX has a slightly improved print-quality score over the 4Si MX (both are 600-dpi printers) but ranks considerably higher

Bidirectional drivers adjust to configuration changes automatically, so you always know what type of paper is in each of the 5Si's size- and capacity-sensing trays. With easy configuration, slick software interface, and neat new features like booklet printing and gray-scale watermarks, this printer is fun to use. If you're looking for a faster network printer that won't keep you from balancing that budget, check out the 5Si MX. It's the best in its class. ■

Susan Colwell and Dave Rowell are BYTE technical editors. You can reach them by sending E-mail to scolwell@bix.com and drowell@bix.com, respectively.

MIB Makes Life Easier for LAN Managers

The LaserJet 5Si MX is one of the first printers to support the standard SNMP management information base (MIB) for printers. To provide administrators with a consistent means of managing LAN printers, the Printer Working Group developed, and the Internet Engineering Task Force accepted, the standard MIB in mid-1995.

The standard MIB means that each printer will store status information and respond to SNMP requests in a consistent manner through its SNMP agent software. In the case of the LaserJet 5Si MX, the SNMP agent resides in the upgradable firmware of the printer's JetDirect network card. The agent software monitors network traffic directed at the printer, filters out SNMP commands, and returns or sets values stored in the printer MIB to monitor status or change printer configuration.

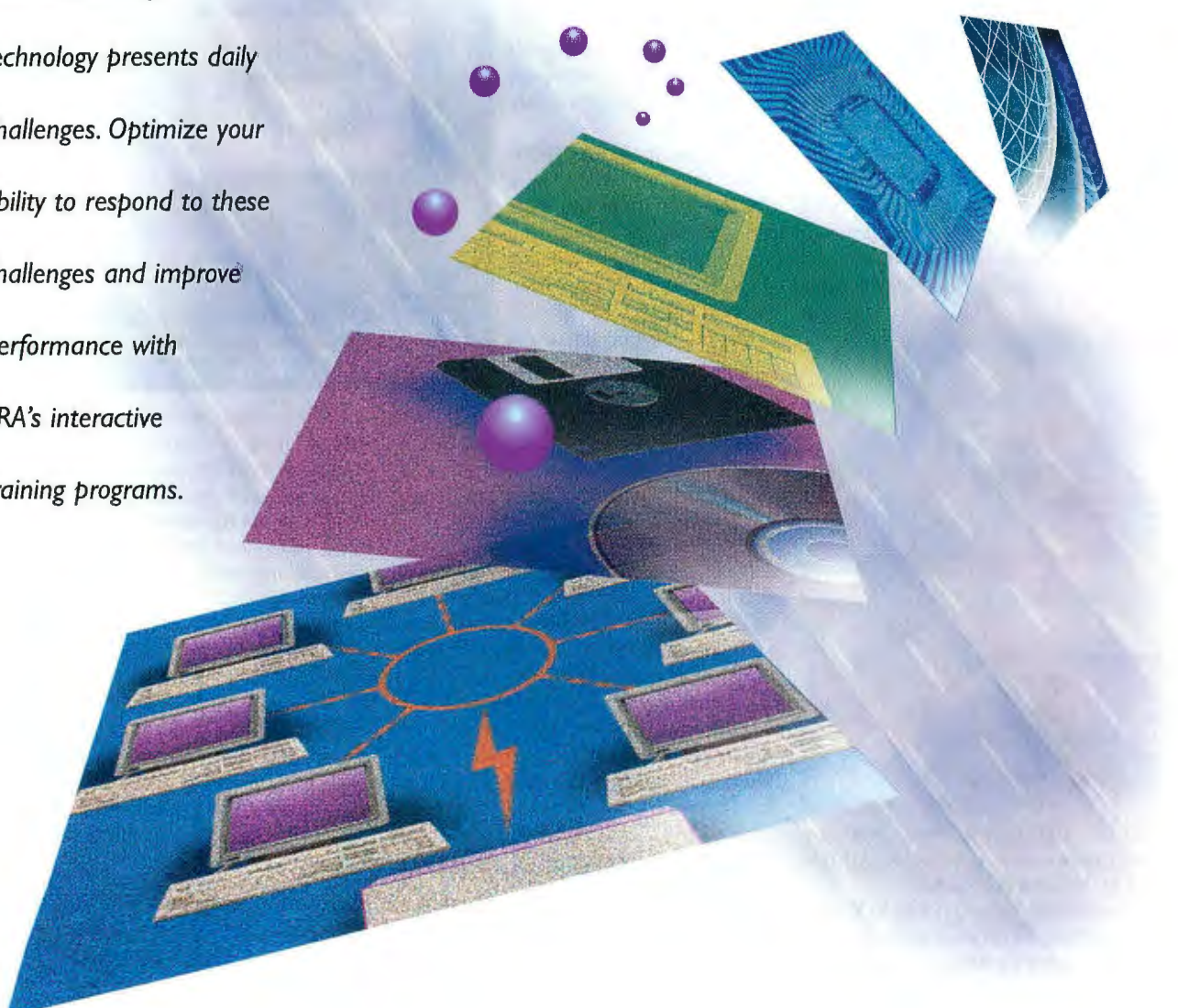
To provide better response (asynchronous) to SNMP and other management software, HP changed the LaserJet 5Si multifunction I/O port, creating a separate channel for printer management (a datagram service). As a result, you can still control the printer while it is receiving print data—canceling a print job before it finishes, for example.

—SUSAN COLWELL

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Power Tools for Data Drilling

IQ/Objects and PowerPlay help you find information buried in complex databases. One is a better analyst, the other a better query/report tool.

DAVID S. LINTHICUM

When it comes to automated tools that deal with masses of data, different products take different approaches. Query/reporting packages help you create views from complex queries, pass them along to a DBMS, and take the results and format them for presentation. Analysis packages slice and dice data, perform what-if analyses, and "drill down" to get more detail. The buzzword that describes what they do is *on-line analytical processing* (OLAP). Many of these tools don't perform the initial queries. Instead, they operate on data tables provided by a separate query package. Although there is some overlap in functionality, the two types of tools complement each other. In many organizations, both will find homes as the eyes and ears of busy executives.

In this review, we look at one tool from each category: IQ/Objects, a query/reporting tool from IQ Software, and PowerPlay, a data-analysis package from Cognos. (Note that each vendor also makes a package in the other category: IQ's analysis tool, announced in November 1995, is IQ/Vision. Cognos's query tool is Impromptu.) Both packages reviewed here provide connections to popular relational database servers, produce a wide variety of reports and graphs, and run under Windows 3.1 and Windows 95. Because of their different purposes, however, that's where the similarities end.

IQ/Objects

With its many features, IQ/Objects (IQ/O) is a good general-purpose reporting tool for Windows. It comes with a Report Designer, a run-time Report Viewer, and a Knowledge Base Editor for creating logical database views.

The reporting capabilities are impressive. IQ/O supports single- and multiple-column layouts, with vertical and horizontal data depiction. You can embed OLE 2.0 objects inside reports and print multiple reports, each from a different query and with its own format and data representation (e.g., charts and tables) on the

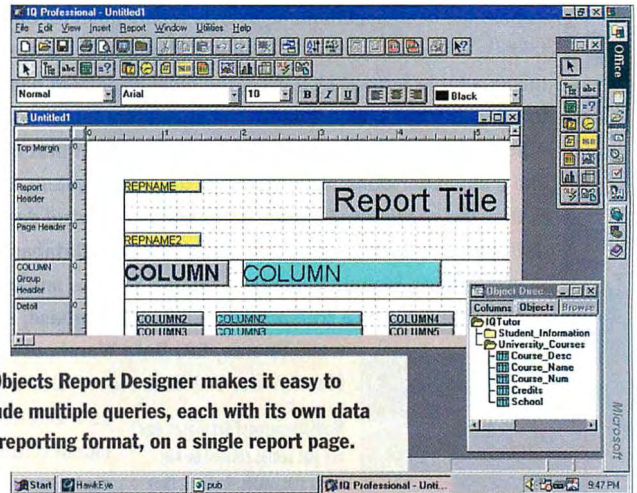
same page. You can define 2-D and 3-D cross-tab reports using single or multiple columns and put multiple objects in cross-tab cells.

IQ/O offers eight types of graphs, including pie charts, bar charts, scatter diagrams, and line charts. Report developers can include logical print objects and report areas that appear only when a predetermined condition is met. This means you can create reports having multiple detail and summary sections with different formats (e.g., each specific to a given state), and the appropriate query and format will be automatically chosen at run time. Also, you can use the results of one query as input to another.

Using IQ/O, you can create custom columns that extend a database's physical schema, and you can also create user-written functions to manipulate data and perform calculations. IQ/O provides complete control over formatting, allowing borders, shadows, background images, and fills for objects, selected report areas, and the entire report. You can export your report to Windows metafiles and to text, comma-delimited, PostScript, and Excel files.

You design a report graphically, dragging and dropping columns from an object window to a report. IQ/O comes with several predesigned report templates, and you can add custom templates. Group editing lets developers change multiple objects at once, and you can define and apply object styles as needed. You can browse data while you're designing a report and see on-screen what the report will look like, eliminating the need for most test printing and saving time and materials.

The object-oriented structure of IQ/O lets you create reusable objects—reports, charts, queries, and documents, as well as imported OLE objects—and incorporate them into new queries and documents.



IQ/O can link report objects so that an object will change automatically when you change another object that's linked to it. This saves time in report maintenance.

Report output can be saved for later viewing either in IQ/O or by the separate, smaller IQ Viewer that's included with the less-expensive personal edition. You can also create prompts to make it easy for users to request reports directly.

While IQ/O can do its query processing entirely on a workstation, it can also off-load some of the computing to one or more IQ SmartServers. These can query back-end databases, create formatted reports and views, and ship the query results back to the workstation.

PowerPlay

PowerPlay is a suite of four programs that lets developers and end users create interactive reports and graphs and perform some what-if analysis. PowerPlay comes with Explorer, Reporter, Portfolio, and Transformer components, plus a separate Cognos Scheduler.

PowerPlay Explorer provides a point-and-click interface to check out data. Transformer takes 2-D data from database tables and creates the multidimensional data that Explorer and Reporter use. Portfolio organizes PowerPlay reports into interactive briefing books. Cognos Scheduler can execute Transformer as a batch process at specified times. *continued*

Restructuring Data

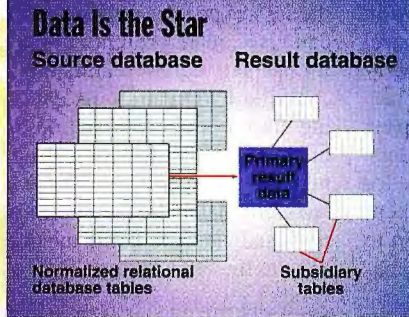
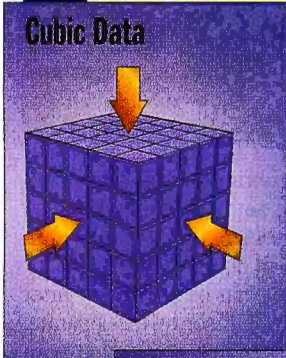
While an analysis tool like PowerPlay works its magic on a multidimensional database, a query tool like IQ/Objects looks at relational tables and flat-file databases to create a desired view—and often produces the multidimensional data that an analytical engine needs. Just how does a query tool organize its data?

One approach might be a large, comprehensive multijoin, but this could be impossible or impractical, as well as highly wasteful and inefficient. IQ/Objects takes a different approach, creating what's called a *star schema*. In essence, this is a table formed by joining the most important base tables and connecting to its smaller subsidiary tables. The subsidiary tables hold keys for accessing other data (see the figure "Data Is the Star"). At first blush, this might sound like a slight variation on a relational database system, but it differs significantly in that the subsidiary files are all linked to a central data table. This creates a data topology similar to that of a star network. Database systems that support star schemata include Red Brick, Oracle, Sybase, and Informix.

The alternative is a true multidimensional database, such as Oracle's (Redwood Shores, CA) Data Warehouse or Arbor Software's (Sunnyvale, CA) Essbase. A relational table represents data

Multidimensional databases don't use flat tables related by key fields and values. Instead, they stack 2-D tables into cubes, cubes into 4-D hypercubes, and so on. This structure lets you create different views and slices of data by approaching it from different directions and along different dimensions.

as a 2-D flat matrix. A multidimensional database, however, stacks multiple tables into a 3-D block (see the figure "Cubic Data"), much like pages in an Excel spreadsheet or Quattro Pro notebook. More-powerful multidimensional databases extend this metaphor into higher dimensions by "stacking" blocks into hyperblocks. While these constructions offer greater flexibility, they also consume more computing power and considerably more overhead. For a query tool, creating a true multidimensional database is overkill; for an analysis engine, a multidimensional database is ideal, giving maximum flexibility for slicing and dicing data to create new views and for drilling down to increasing levels of detail.



IQ/O creates a star schema for its data, taking original relational tables and combining them into a new format that speeds up report generation.

highlight exceptional (i.e., out-of-range) data. You can create data filters, and rank and format the data for custom reports.

One feature that differentiates PowerPlay from the kind of report-writing packages that have been around for years is its interactive nature. When you want more detail, you just double-click on a category button to drill down. To show data as a graph, you simply click on the appropriate PowerBar button. This interactive capability lets developers distribute reports that end users can continue to explore and interact with to get information they need.

Finding the Data

IQ/O and PowerPlay can work with a wide range of local databases and remote database servers, including Oracle, Sybase, and Informix, as well as others through Open Database Connectivity (ODBC). Each tool has its own way of rerepresenting physical data to provide developers with new ways of looking at the data as well as ways of subsetting or sanitizing data for the end user (see the Technology Focus).

With IQ/O, you can directly edit the SQL statements it produces before processing the query. You can have it query multiple databases, and the package supports distinct and aggregate functions. To use a database from IQ/O, you must first create a special data dictionary using the Knowledge Base Editor. The result is a repository file that contains a profile of your database, the objects in it (e.g., tables, views, and synonyms), and the relationships between those objects. (The newest version, IQ/Objects 5.1, released after this review was done, automatically sets up relationships between tables and other repository objects.) A knowledge base covers one or more databases, each with one or more tables and any number of columns. You can also create global custom columns.

In addition to an IQ/O knowledge base, you must provide a data source that defines the name or location for the physical database plus connection information. You can change the data source and knowledge base globally or for individual reports. We found this feature quite useful when working with several databases that store information using the same schema. The end result is an object browser that you can use with the Report Designer to select data for your report.

Using a database with PowerPlay is slightly more complex and confusing than with IQ/O, but the Cognos product adds

With Reporter, the heart of the PowerPlay package, you can build interactive and automated reports in a variety of formats. The Reporter environment is similar to that of Explorer, and you can display data in cross-tab, column, and free-form reports. PowerPlay supports pie, bar, line, simple point, and correlation graphs.

With Reporter, you select only the specific subset of data you need to work with, without having to deal with a complete answer set from the database. In Reporter,

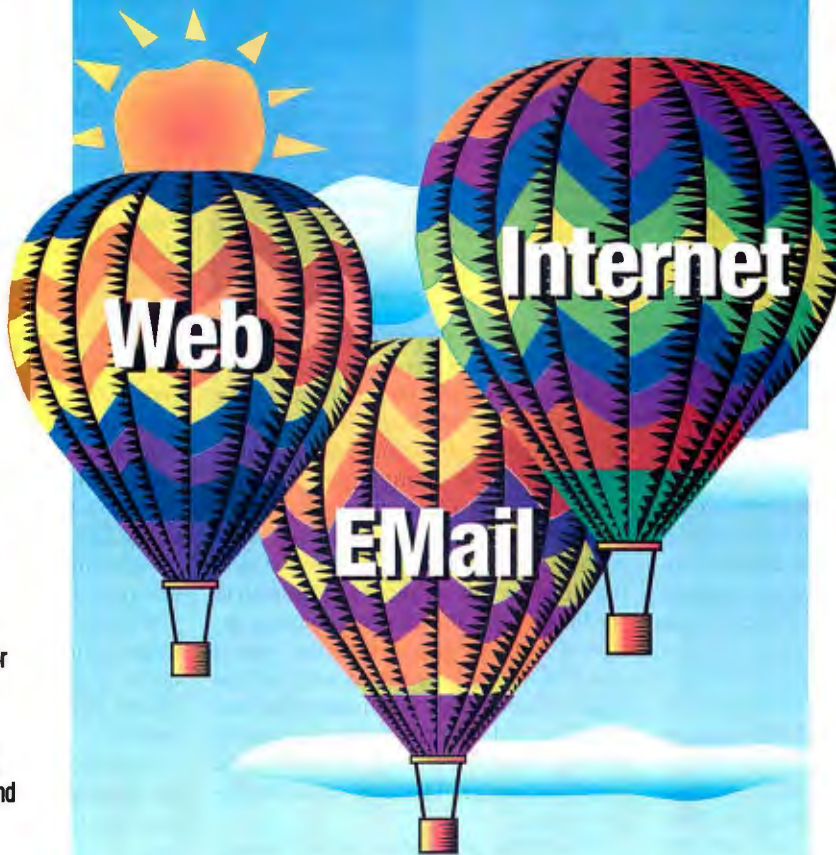
as with IQ/O, you create reports by dragging and dropping data elements from a multidimensional view created by Transformer, called the Category Tree. Each report includes a dimension line that shows what dimensions are available in your extract and the levels of detail you can access in each dimension.

Developers can include ad hoc calculations to derive new data from values in the database extract. Automatic features let you suppress zero-value data as well as

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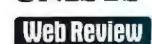
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multidimensional capability. PowerPlay organizes data using three basic concepts: dimensions, categories, and measures.

PowerPlay represents standard relational data using *dimensions*, which give developers and end users a flexible way of looking at data. Multidimensional analysis is the exploration of data up, down, and across critical dimensions of data. This capability increases the value of corporate data. For example, multidimensional reports help you distinguish the impact of each business area on other areas.

Categories are individual items of data that make up a dimension. PowerPlay organizes data within a dimension; categories are grouped into hierarchical levels. You move down the hierarchy by drilling down to more detail. The drill-down levels provide the flexibility to work on data at any level you want. With Explorer and Reporter, you select database information from a Category Tree. *Measures* are indicators that represent values, such as revenues, expenses, and target inventory levels, calculated or summarized from a combination of categories.

Creating Reports

To create a report using IQ/O, you start by selecting from the available report templates: an empty report, as well as free-form, column, cross-tab, and label templates. After this, you can drag and drop objects from IQ/O's Object Directory into your report. As we added objects to the IQ/O report we were creating, we discovered that we could set their attributes, formatting, and other look-and-feel features. From here, we grouped header or footer areas by selecting objects that we wanted to relate. It's here in the group headers/footers that you place totals, subtotals, and counts for each data element. You can format these pretty much any way you want.

STRENGTHS

IQ/Objects

- Employs reusable, intelligent objects (e.g., data, reports, groups, graphics, documents, and text) with a consistent access interface.
- Incorporates OLE 2.0 objects in reports.
- Allows conditional and multiple queries and data representations in a single report.

PowerPlay

- Creates multidimensional views from 2-D data tables.
- Allows drilling down into the data hierarchy to more detail.
- Has powerful filtering and highlighting capabilities.

WEAKNESSES

- Difficult to see the mass of on-screen forms and data without SVGA graphics.
- Requires creation of the data repository before you can create reports.
- Cumbersome for creating calculated categories and measures.
- More difficult to create reports compared with some other products.

If you aren't using a group footer or group header, you select Report/Sort Order.

We could see how the report was taking shape by selecting Quick Preview. IQ/O queried the database and selected only enough data for a single page. It then opened a report viewer window showing how the printed report would look. After making further changes, we could return to the viewer windows and select Refresh to see the effect of the changes. Another option is Auto Refresh, where the viewer windows update automatically as you make changes. Only when our report was complete did we print a sample page to confirm that the hard copy looked like the graphical image. Then we saved the report to disk.

PowerPlay provides similar features, but it requires a different, somewhat more involved procedure. To begin a new report, you select the New Report icon from the PowerBar, which opens up the Samples directory, where the report templates are stored. From here, you double-click on the report you want to use as a default. Now you can add data categories—detail, summary, or a mixture of both—by navigating through PowerPlay's multidimensional structure. You add categories via the Category Tree dialog box. By double-clicking on categories, you can expand or contract the hierarchy, selecting data as you go. For example, if you press the Add Row button, Reporter adds a category. A plus sign next to a category indicates that lower-level detail is available.

To filter data, you change the dimen-

sion line of PowerPlay through the Filter dialog box. You format the data by changing fonts, applying styles, and displaying formats, as well as by resizing columns and rows. You can also rank categories from the Explore menu. Here you enter column information, and Reporter automatically ranks the data within the report. To perform calculations, you need to create a calculated category, a data point that exists only in PowerPlay and not in the physical database. You do this by holding down the Control key while selecting one column, then another, and defining the mathematical operations (i.e., add, subtract, multiply, and divide) to use.

After the report is complete, you enter title information. Then you're ready to save the report or send it to the printer.

Power or Convenience?

When looking at these two reporting and analysis tools together, you're faced with the issue of power versus convenience. IQ/O provides an easy method to create simple reports and graphs for all sorts of reporting applications. It's easy to extract data from existing databases and from database servers, and the Knowledge Base component lets you customize the database view to suit your reporting needs precisely. Drag and drop is a first-rate method of selecting objects for a report, and the ability to see what a report looks like while you're defining it is a real help. It's also quite useful to be able to control the query down to the SQL level, and the reusable objects make it fast and easy to create new reports.

PowerPlay is more complex than IQ/O but provides more power. The Transformer provides the developer with the means to look at 2-D databases as if they were multidimensional. This model greatly improves an end user's ability to analyze data inside a corporate database. In addition, the innate ability to make reports interactive makes PowerPlay the better type of tool for creating "point-and-shoot" applications for nontechnical users.

Which tool you pick depends on your requirements. If you need an effective query tool for ad hoc reporting, IQ/Objects is your best bet. If you need to do hard-core OLAP and don't mind spending the extra time to get there, you're ready for PowerPlay. ■

David S. Linthicum is a technical manager with E.D.S. in Falls Church, Virginia. You can reach him on the Internet at 70742.3165 @compuserve.com or on BIX c/o "editors."

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Tame the Network

Get a better grip on your LAN or WAN with one of these management programs

TADESSE W. GIORGIS

Network administrators need an easy way to track down their company's hardware and software assets. They also need tools to distribute and install software automatically during off-peak hours. And when users call the in-house help desk, support personnel should be able to fix problems remotely. Printer and queue management, centralized virus protection, and storage management are added bonuses.

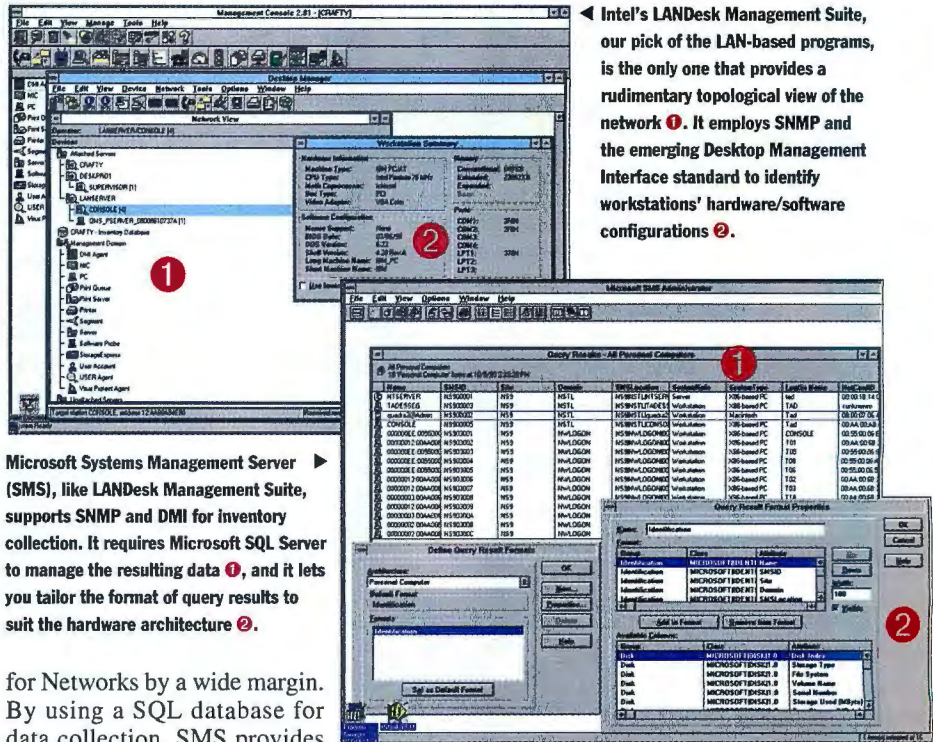
For this roundup, we looked at five network management products that address these desktop issues. All provide server and workstation management, inventory control, electronic software distribution (ESD), software metering and license control, and network monitoring. We did not test device- and wire-management programs for this review.

The reviewed products fall into two functional categories. Microsoft's Systems Management Server (SMS) and Symantec's Norton Administrator for Networks support WANs in addition to LANs and are therefore suited to enterprise management. Intel's LANdesk Management Suite, McAfee Associates' BrightWorks, and Frye Computer Systems' Frye Utilities for Networks work only on LANs. We summarize the major features common to all five in "The Roles of Network Management Software" on page 148.

The Manager's Choice

Intel's LANdesk Management Suite is the best in the LAN category, as well as the best overall. It has a comprehensive and well-integrated set of tools for NetWare LANs, an excellent tutorial, and a good reporting engine. Its modules for monitoring applications, traffic, and servers are especially good.

For WANs, Microsoft's SMS beats Norton Administrator



Intel's LANdesk Management Suite, our pick of the LAN-based programs, is the only one that provides a rudimentary topological view of the network ❶. It employs SNMP and the emerging Desktop Management Interface standard to identify workstations' hardware/software configurations ❷.

Microsoft Systems Management Server (SMS), like LANdesk Management Suite, supports SNMP and DMI for inventory collection. It requires Microsoft SQL Server to manage the resulting data ❶, and it lets you tailor the format of query results to suit the hardware architecture ❷.

for Networks by a wide margin. By using a SQL database for data collection, SMS provides an excellent platform for building an enterprise-wide management infrastructure.

McAfee's BrightWorks

With its excellent on-line references, good report writer, and versatility, BrightWorks nips at the heels of LANdesk Management Suite for top honors. It's a good choice for administrators managing a NetWare environment.

Though the BrightWorks help system is a bit skimpy, its Adobe Acrobat viewer makes accessing the well-organized on-line manuals easy. Like Microsoft SMS, it comes with Crystal Reports. This software gives you lots of flexibility in designing and generating reports, as well as importing data from ODBC-compliant databases. Only LANdesk Management Suite's reporting tool is comparable.

continued

NETWORK MANAGERS: HOW THEY STACK UP

NISTE RATING		VERSION	PERFORMANCE	QUALITY	VERSATILITY	EASE OF LEARNING	EASE OF USE	PRICE *
LANs Only								
★★★★	LANdesk Management Suite	2.01	▲	▲	▲	▲	▲	\$5000
★★★	BrightWorks	2.10	▼	▲	▲	▲	▲	\$4000
★★	Frye Utilities for Networks	2.0	▼	■	▲	■	■	\$3275
LANs and WANs								
★★★	Systems Management Server	1.1	▲	▲	■	▲	▲	\$3275
★★	Norton Administrator for Networks	2.0	▼	■	■	▲	▲	\$4400

KEY

★★★★ Outstanding
 ★★★ Excellent
 ★★ Average
 ★ Below average
 * Poor

▲ Good
 ■ Fair
 ▼ Unacceptable

* Approximate cost for 100 user connections

The Roles of Network Management Software

SERVER AND WORKSTATION MANAGEMENT includes controlling configurations, adjusting baseline (threshold) settings to define normal operation, and monitoring status. It additionally allows automatic identification and reporting of inactive PCs, lost physical network connections, and logging of client packet statistics.



HELP DESK/REMOTE CONTROL lets administrators fix problems by taking over the user's machine. Administrators may remotely view and edit system files, transfer files, chat with users, execute programs, and activate configuration changes by rebooting the remote computer.



Only Intel's LANdesk Management Suite comes with this capability. Microsoft SMS requires the asynchronous modem connection Remote Access Service (RAS), bundled with Windows NT Server 3.51 (SMS's required operating system). Symantec's Norton Administrator for Networks requires the optional remote-control program Norton pcAnywhere for help desk and remote control functions. McAfee's BrightWorks requires the company's optional NetRemote software.

INVENTORY CONTROL/ASSET MANAGEMENT gathers information on computing assets, including server and workstation hardware, system configuration, and software. These programs automatically track applications on workstations and servers by scanning their drives. Inventory control programs collect hardware and software information using lists of standard hardware parts and known applications.



NETWORK TOPOLOGY AND MAPPING identifies network segments, nodes on segments, and other logical aspects of the network and draws a diagram of them. Of the reviewed products, only LANdesk Management Suite provides rudimentary logical mapping (see the screen on page 147).



APPLICATION METERING tracks software use to ensure compliance with license agreements. Features include monitoring of concurrent execution on server and local drives; notification when use exceeds license limits; creation and maintenance of a registration database for authorized applications; blocking options to enforce compliance with site licenses; and statistical reporting. Among the products evaluated, only Microsoft SMS lacks application metering.



VIRUS PROTECTION enables centrally managed inoculation. Only LANdesk Management Suite comes with it, while it's an optional add-on in all other programs but the Frye Utilities for Networks, which doesn't offer it at all.



ELECTRONIC SOFTWARE DISTRIBUTION (ESD) lets you remotely install new applications and upgrades. It may employ an executable program, script file, or batch file to define distribution criteria and execute tasks. Ideally, the ESD module works with all major operating systems and across bridges, routers, and WAN links.



DESKTOP SECURITY employs software distribution, inventory, and license metering to control user privileges. The most secure products have database passwords and data-encryption features. Among the tested products, Microsoft SMS has the most security features, while BrightWorks has the fewest.



Other administration utilities may include printer and queue management, network backup and storage management, and task scheduling.

applications, such as the LAN Directory, can easily run out of memory after you've loaded network drivers, multimedia device drivers, and memory managers.

In addition, a lack of flexibility in data management and system administration, and a total lack of an on-line reference, earn Frye Utilities the lowest ranking in the LAN category.

This is not to say that Frye Utilities lacks good points. The package provides a wealth of statistics, is very versatile, and is jam-packed with features (see the comparison tables on pages 150 and 151).

Intel's LANdesk Management Suite

The sole four-star product in the group, LANdesk Management Suite stands out as the only one both to fully integrate all its management and administration components and to use a single database. Its competitors all rely on utility modules to complete their offerings.

LANdesk Management Suite provides a wealth of network administration utilities with a robust desktop management environment that includes an application monitor, an

BrightWorks' cluttered interface makes some operations awkward, such as creating software distribution packages and setting up software metering. But BrightWorks' real sore point is performance. In our test that measures the average size of frames transferred during an inventory scan (where larger frames mean more efficient use of network bandwidth), BrightWorks finished dead last, not far behind Frye Utilities for Networks but light years behind LANdesk Management Suite and Microsoft SMS. Still, BrightWorks' competitive feature set and pricing make it a viable choice for NetWare installations.

Frye Utilities for Networks

Consisting of 10 separate DOS-based modules accessible from a menu called the

Frye Menu Integrator, Frye Utilities for Networks is the most poorly integrated product we tested. Only a few of its management modules share a common database, while each of the modules in the other four products write to and read from a single database.

This virtually nonexistent support for Windows and a proprietary database scheme hamper the usefulness of Frye Utilities. The company says it plans an upgrade that addresses these shortcomings and that will employ a single, ODBC-based database engine.

Individually, the Frye Utilities are by far the easiest to install, set up, and use. But since they are all DOS applications, Windows users must pay special attention to conventional memory allocation. Some

excellent traffic monitor, and an effective server monitor with very good alert handling. It does not take much time to set up and configure. All told, LANdesk Management Suite scores extremely well in all our major evaluation criteria (see the ratings box on page 147).

Very good database maintenance and system administration, coupled with an excellent help facility, tutorial, and reporting engine, make this product's lack of an on-line reference seem unimportant.

Symantec's Norton Administrator for Networks

Symantec approaches desktop management strictly from the end-node angle, so its product does not provide services such as network and server monitoring, thresh-

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old setting, and alert notification. Instead, the Norton Administrator for Networks integrates the three core desktop services of inventory management, software distribution, and application metering.

This package's chief weakness is its lack of support for NetWare file servers. But it also suffers from a limited, inflexible reporting tool; below-average versatility; and poor performance that is only slightly better than that of second-worst Frye Utilities for Networks.

On the plus side, Norton's management console facilitates many tasks, such as managing sites, launching core applications, and interfacing with add-on administration utilities. Good print documentation and a context-sensitive on-line help facility make up for the lack of on-line references.

Norton Administrator for Networks' significant advantage over Microsoft SMS (which did, however, beat it in the overall rankings) is its openness. Operating at the applications level, Norton's functions are independent of underlying network transports and should perform equally well under any type of LAN and WAN connection method. Symantec's software is also less complex than Microsoft's, which is based

Defining Desktop Management Standards

Although the Internet's SNMP has played a major role in network management standardization in the last five years (and thus has gained preeminence in network device management), it has limitations. SNMP does not address the configuration and systems management requirements of end nodes (servers and workstations). So, proposals for distributed desktop standards, such as the Desktop Management Interface (DMI), have arisen in the last few years. Among the products evaluated for this roundup, only Microsoft SMS and the Intel LANdesk Management Suite support DMI-enabled products.

Defined by the Desktop Management Task Force, a 300-company consortium, DMI is an open architecture framework designed for managing computers, servers, peripherals, and software products. When it is complete, DMI will contain rules for creating management interface files (MIFs). These files specify, in ASCII text with defined grammar and syntax, attributes for classes of products.

The openness of DMI's architecture allows it to coexist with standards such as Plug and Play and SNMP. DMI complements Plug and Play by drawing configuration information from it into the standard MIF database. DMI works with SNMP by allowing MIFs to be mapped to SNMP management information base (MIB) files (see below).

```
MIB.NGC
-----
monitor OBJECT IDENTIFIER ::= { iso org(3) dod(6) internet(1) private(4)
enterprises(1) ngc(110) ngcsystems(1) servers(1) monitor(1) }
consoles OBJECT IDENTIFIER ::= { iso org(3) dod(6) internet(1) private(4)
enterprises(1) ngc(110) ngcsystems(1) consoles(2) }
-----
                                -syst(1) servers(1) }
ngc OBJECT IDENTIFIER ::= { enterprises 110 }
ngcsystems OBJECT IDENTIFIER ::= { ngc 1 }
-servers OBJECT IDENTIFIER ::= { syst 1 }
monitor OBJECT IDENTIFIER ::= { servers 1 }
traps OBJECT IDENTIFIER ::= { monitor 1 }
pcc OBJECT IDENTIFIER ::= { consoles 1 }
```

In the Desktop Management Interface standard, each network component has a management interface file (MIF) that identifies it. MIFs can be mapped to, and closely resemble, SNMP management information base (MIB) files. That's a sample MIB file right above.

CONFIGURATION AND CONNECTIVITY FEATURES

	BRIGHTWORKS	FRYE UTILITIES FOR NETWORKS	LANDESK MANAGEMENT SUITE	NORTON ADMINISTRATOR FOR NETWORKS	SYSTEMS MANAGEMENT SERVER
Configuration Options					
Management console's operating system	Windows 3.x	DOS	Windows 3.x	Windows 3.x	Windows NT
Management program requires dedicated server	○	○	○	○	●
Management program requires NetWare 3.x/4.x server	●	●	●	○	○
Management program requires a Windows NT 3.x server	○	○	○	○	●
Automatically recognizes file servers	●	●	●	①	●
Automatically recognizes PC workstations	●	●	●	●	●
Automatically recognizes Macintosh workstations	●	●	●	●	●
Connectivity					
Supports NetWare 3.x/4.x ²	●	●	●	●	●
Supports Banyan Vines 4.x/5.x ²	○	○	○	●	○
Supports IBM LAN Server 2.x ²	○	○	○	●	○
Supports IBM LAN Server 3.x ²	○	○	○	●	●
Supports Microsoft LAN Manager 2.x ²	○	○	○	●	●
Management software works across routers	●	●	●	●	●
Supports Novell NetWare IPX/SPX	●	●	●	●	●
Supports TCP/IP	●	●	○	●	●
Works over T1 lines	③	③	③	④	○
Works with frame relay	③	③	③	④	○
Supports ATM	③	③	③	④	○
Works with wireless connections	③	③	③	④	○
Supports X.25 WAN protocol	③	③	③	④	●
Supports WAN-based TCP/IP	③	③	③	④	●
Supports ISDN	③	③	③	④	●
Supports SNMP	●	○	●	○	●
Supports Desktop Management Interface (DMI)	○	○	●	○	●
Compatible with IBM NetVIEW	●	●	●	○	●
Compatible with HP OpenView	●	●	●	○	●
Compatible with Novell ManageWise	●	●	●	○	○

● = yes; ○ = no

① For servers supporting the Server Message Block (SMB) protocol only

² Marked "yes" only if support includes all modules

³ NetWare-supported connections only

④ Program operates at the applications layer

MANAGEMENT/ADMINISTRATIVE FEATURES

	BRIGHTWORKS	FRYE UTILITIES FOR NETWORKS	LANDESK MANAGEMENT SUITE	NORTON ADMINISTRATOR FOR NETWORKS	SYSTEMS MANAGEMENT SERVER
Server Management					
Provides server disk/volume information and management	●	●	●	○	●
Security and user account management	●	●	●	○	●
Printer and queue configuration management	●	●	●	○	○
Backup and restore server configuration data	○	○	○	○	○
Ability to set server baseline values	●	●	●	○	○
Monitors server to gather statistics	●	●	●	○	●
Accepts threshold values	●	●	●	○	○
Workstation Management					
Monitors workstation to gather statistics	●	●	●	●	●
Remote control of client workstations	●	○	●	●	●
Ability to identify and correct application problems	○	○	○	●	●
Accepts threshold values	●	●	○	○	○
Tracks file access and application usage	●	●	●	●	○
Inventory					
Collects data about file server hardware	●	●	●	○	●
Collects data about file server software	●	●	●	○	●
Identifies changes in setup files (CONFIG.SYS, etc.)	●	●	●	●	●
Allows purging of inventory database	●	○	●	●	●
Application software metering					
Generates alert when license is exceeded	●	●	●	●	○
Blocks execution when license is exceeded	●	●	●	●	○
Provides report on application usage	●	●	●	●	○
Electronic software distribution					
Allows OS installation	●	●	●	●	●
Provides script for creating distribution list	●	●	●	●	○
System Administration					
Allows defining of sites and domains	●	①	●	●	●
Has SQL database engine	○	○	○	○	●
Management program has built-in OLE API	●	○	●	○	●
Database files protected by password	○	○	○	○	●
Can specify user access levels	○	●	○	○	●
Shows free server disk space (in percent)	●	●	●	○	●
Shows free workstation disk space (in percent)	●	●	○	○	●
Shows server use (in percent)	●	●	●	○	○
Lets you adjust system files, shut down and restart server	○	●	○	○	○
Report Types (partial list)					
Network utilization report	●	●	●	○	○
Inventory report	●	●	●	●	●
File server configuration	●	●	●	○	●
Workstation configuration	●	●	●	●	●

● = yes; ○ = no

① NetWare-dependent groupings only

on a sophisticated SQL database manager.

Microsoft Systems Management Server

For companies with geographically dispersed LANs and mixed networks, Microsoft SMS is the best choice. It combines high quality, ease of use, efficient performance, and decent versatility. SMS lacks software metering, but it is excellent at software distribution and has very good inventory components. Extensive on-line help and tutorials guide you safely through complicated tasks.

To provide a SQL database engine for its management product, Microsoft designed SMS with slightly higher resource needs than its competitors. Besides a full-scale copy of Microsoft SQL Server running with Windows NT Server 3.51, SMS requires 28 MB of RAM. Additional management consoles also require Windows NT Server or NT Workstation 3.51. SMS has a complex setup procedure; but, once up and running, its drag-and-drop interface and good on-line documentation make it easy to use.

SMS also has the most complete security system, and its performance is comparable to that of Intel's LANDesk Management Suite. It is alone with the Intel product in supporting the Desktop Management Interface (DMI), an emerging standard for identifying and managing network components. ■

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StrongARM Tactics

This amazing little RISC chip has PDA written all over it

DICK POUNTAIN

The handwriting is on the wall: Personal digital assistants (PDAs) need more horsepower if they're ever going to excel at handwriting recognition and other CPU-intensive tasks. And the breakthrough that might carry PDAs to the next level may be a new RISC chip called the StrongARM.

This fascinating microprocessor is a joint project of Digital Equipment and Advanced RISC Machines (ARM). Digital, of course, makes the Alpha AXP family, the fastest RISC processors in the world. ARM makes the ARM610 and ARM710 processors that drive Apple's Newton MessagePad and 3DO's home-videogame machines. The StrongARM is founded on a hybrid technology that combines the raw power of the Alpha with the super-efficient power consumption of the ARMs.

It's a combination tailor-made for PDAs. The conflicting requirements of high speed, low power consumption, and a small chip package rule out the vast majority of off-the-shelf microprocessors.

The first StrongARM will be a 1.5-volt chip that runs at an astonishing 160 MHz. That might seem slow compared to the 333-MHz Alpha 21164, but it's four times faster than the speediest chip currently available from ARM, and it blows away everything else at this low voltage. A 2-V, 215-MHz StrongARM will follow shortly. For the first time, a CPU that outperforms a high-end Pentium will be available for use in battery-powered PDAs.

"At these performance levels, handwriting recognition stops being a hard problem, and voice recognition is what you can start to worry about," says Dave Jaggar, ARM's market-development manager.

Fabricating for Low Power

Creating a hybrid design like the StrongARM isn't as simple as gluing together two architectures as disparate as the Alpha and the ARM. To attain the desired

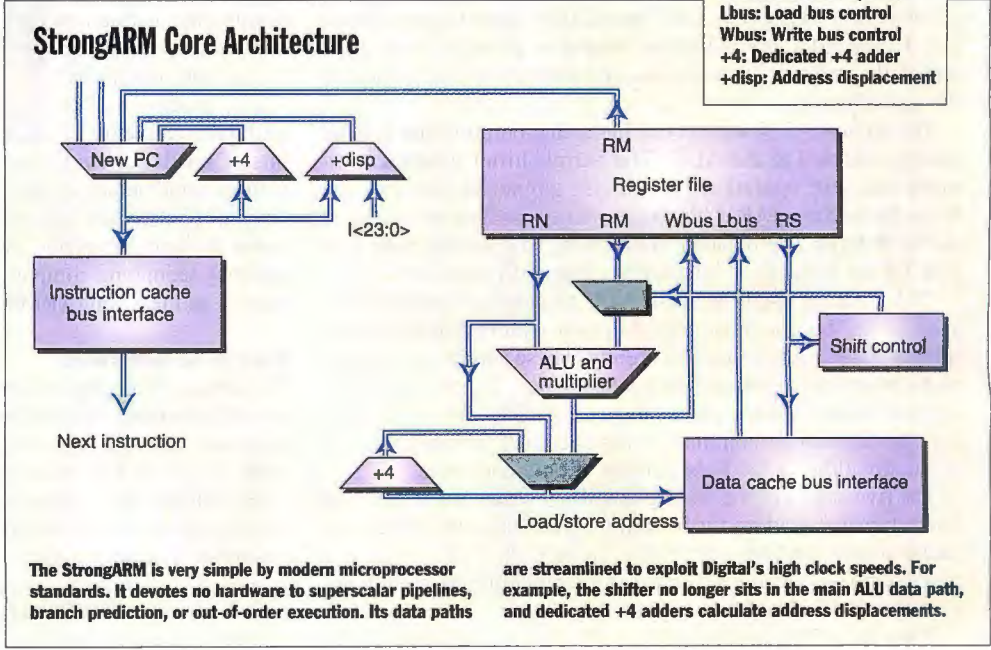
clock speeds, engineers from both companies worked together to redesign the whole data-path and cache structure of the CPU. Nevertheless, Digital's leading-edge fabrication process is ultimately what permits the StrongARM to run four times faster than previous ARM chips. The architectural changes exploit the speed of this silicon.

Digital's newest fabrication plant uses a next-generation process called CMOS-6, the same process Digital uses for its Alpha 21164A, which will exceed 350 MHz. It's a 0.35-micron, four-layer-metal CMOS process that yields high-speed, low-voltage transistors, thanks to extremely thin oxide insulation layers only 65 angstroms deep. Ultimately, this process will yield transistors that run at 0.9 V.

Low voltage is a crucial design point because power consumption varies with the square of the voltage. A chip fabricated on the 2-V CMOS-6 process will consume only 37 percent as much power as a chip fabricated on a comparable 3.3-V process. At 1.5 V, the power consumption is only 21 percent as much. The small feature size also reduces capacitance, saving even more power.

The actual die size will depend on how much cache memory is on the chip. Although this hasn't been announced, the first StrongARMs will probably have 32 KB of primary cache. By any measure, however, the StrongARM core is tiny—a mere 115,000 transistors, compared to 3.3 million on a Pentium. Digital and ARM say their goal is to achieve performance of at least 300 million instructions per second per watt, at a cost of about 35 cents per MIPS. The first StrongARM chips are expected

KEY TO FIGURE
 RM: First operand
 RN: Second operand
 RS: Shift control operand
 Lbus: Load bus control
 Wbus: Write bus control
 +4: Dedicated +4 adder
 +disp: Address displacement



to consume around 500 milliwatts (less than half that consumed by a PowerPC 603).

In the consumer-electronics market, it's not sufficient just to have the cheapest CPU. The peripheral chips—such as memory and graphics—must be cheap, too. Very few low-voltage peripheral chips are available today, so the StrongARM is designed to work with regular 3.3-V components. This was a tough bullet to bite because it requires two different voltages on the same silicon, with separate sets of power rails and the attendant problems of eliminating noise and current leakage.

To further trim costs, the engineers designed the StrongARM's system interface so it can be either 32 or 64 bits wide. System designers can synchronize the interface to the CPU core (at fractional speeds ranging from one-half to one-ninth the core frequency) or to an external clock as fast as 66 MHz.

An even more radical design twist is that the circuits use edge-triggered latches with conditional clocks, instead of the more common level-triggered latches. This means the StrongARM inputs the clock signal into a section of logic only when that section is needed, so a function unit consumes power only when used. To go along with this, a new instruction stops all the internal clocks until they're awakened by an interrupt. These features should make it easier to implement energy-saving sleep modes.

The StrongARM Pipeline

The StrongARM team decided against a superscalar architecture. Superscalar pipelines, multiple execution units, and all the extra logic required to issue multiple instructions and check for dependencies would have increased the StrongARM's cost, power consumption, and design time. The engineers omitted out-of-order execution for the same reasons.

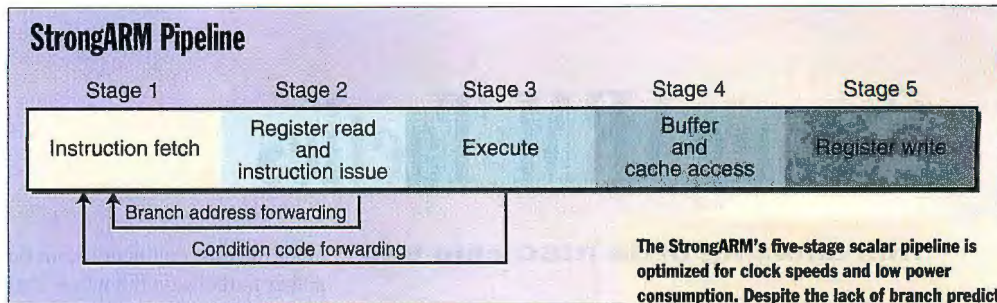
Instead of going superscalar, the StrongARM engineers chose to lengthen the execution pipeline. While the ARM7 has three stages, the StrongARM has five. An even longer pipeline would allow higher clock speeds, but it would also exceed the power budget. The architecture is kept as simple as possible, with clean data paths and low-latency execution units to take advantage of the fast silicon.

The original ARM architecture has a dual-purpose barrel shifter closely coupled to the ALU. The barrel shifter handles arithmetic-and-shift operations, and it also aligns data and extracts bytes. In the StrongARM, the barrel shifter has been moved aside so that shifts by zero bypass it completely. This yields a faster data path for the majority of instructions that don't need shifts.

Older ARMs used the main ALU to calculate address displacements, but the StrongARM does it with two dedicated +4 adders that can calculate concurrently. These adders are attached to the program counter and the load/store bus. The StrongARM's register file now has five ports—three for reading and two for writing—so a load can complete simultaneously with a write to a register, yielding a load-use penalty of only one cycle.

The five stages of the StrongARM's pipeline are instruction fetch; register read and instruction issue; execute; buffer and cache access; and register write. In typical Alpha style, this pipeline has extensive paths for the forwarding of branch addresses and ALU results.

There is no branch prediction at all. Instead, the StrongARM



The StrongARM's five-stage scalar pipeline is optimized for clock speeds and low power consumption. Despite the lack of branch prediction, branches execute very quickly because the StrongARM calculates and forwards the address information in Stage 2, bypassing subsequent stages.

minimizes branch penalties by executing branches at an early stage in the

pipeline. It calculates branch addresses during the issue stage and forwards them past the other stages. It can also forward condition codes from an instruction in the execute stage. For example, assume the following sequence of compare and branch instructions:

```
CMP R0,R1 ; compare registers
BNE loop1 ; branch if not equal
```

During the execute stage, the CMP instruction sets the N, Z, C, and V condition flags. Meanwhile, during the same cycle, the BNE instruction is in the issue stage, computing its destination address and the address of the next instruction (thanks to those parallel +4 adders). The StrongARM forwards all these results directly to the fetch stage, which costs a one-cycle penalty if the branch is taken, but costs no penalty at all for a branch not taken.

This yields very good performance, considering how much extra branch-prediction logic (and hence power) it avoids. Of course, it only works this well for a single-issue processor. With a four-way superscalar chip, the branch-taken penalty would be four instructions.

The StrongARM has no on-chip FPU. However, the multiplier-adder unit attached to the ALU is significantly enhanced. The multiplier performs signed and unsigned multiply and multiply-accumulate operations, generating 32- or 64-bit results. The multiply-accumulate instruction is similar to the MAC instruction in a digital signal processor. The multiplier can retire 12

bits of result per cycle, and the adder can retire 32 bits. This yields a total latency of two to four cycles for a 32-bit result and three to five cycles for a 64-bit result. (The timing varies because the unit completes short operands more quickly.) While this may seem long compared to the latest CPUs, remember that a cycle on the StrongARM is less than 5 nanoseconds.

Down to the Crossroads

The StrongARM chip will drive into the intersection of computers and consumer electronics. When Digital launched the Alpha processor in 1992, it promised that the new architecture would span the whole spectrum from workstations to hand-held devices. But the latter category has always seemed an improbable use of the Alpha because of the chip's voracious power consumption. The StrongARM could fill that niche. ■

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

Where to Find

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Is Your Network Secure?

Securing your corporate network while connecting to the Internet doesn't have to be difficult. Just start with a good foundation.

DAN THOMSEN AND WINN SCHWARTAU

When building new systems, there are always design trade-offs to be made between functionality and security. Do we include the cool widget or that boring, constraining security feature? Historically, the widget usually won. But as Internet connectivity grows, a new class of criminals is causing electronic mayhem and committing crimes.

Despite the fact that strong, easy-to-manage information security is on the top of corporate wish lists, it is often pushed to the bottom of the heap when it comes to implementation. Security is never free, but you can reduce the cost of secure systems by creating flexible security mechanisms as a solid base to build on. Type enforcement is a straightforward security mechanism that provides the flexibility to balance security and functionality.

The Dawn of Computer Security

In 1985, the federal government published the first set of computer security criteria that computer professionals could understand and build into systems. Officially called the Trusted Computer Security Evaluation Criteria, it is more popularly known as the Orange Book. It offers a range of ratings for secure systems. The ratings start with D, for systems with no security, and go to A1, which requires formal methods to verify security.

One of the key elements of the Orange Book was mandatory access control, where all the resources in the computer (i.e., users, files, services, and programs) are labeled with a security level, or sensitivity. The label identifies the degree of sensitivity of each resource, such as Unclassified, Confidential, Secret, and Top Secret. Labels effectively assign the data on the system to separate "buckets." The goal, or security policy, is to keep sensitive data from getting into the least-sensitive bucket.

Many initial Orange Book implementations were too restrictive. The federal government funded seven years of R&D to create a flexible implementation. At the heart of this solution is the type-enforcement security model.

Type Enforcement

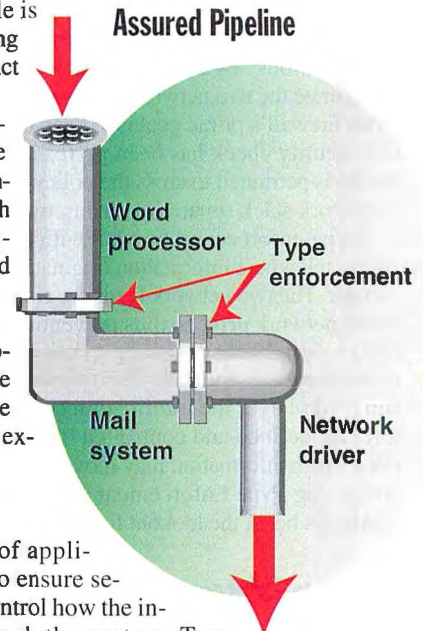
Type enforcement is a security mechanism that gives every program on the system permission to do only those things it requires to do its job. This is called *least privilege* and applies to applications, files, and OSes.

Type enforcement works by grouping all the processes

of the system into classes based on least privilege. Each process group is called a domain. In a similar manner, the files on the system are grouped into classes called types. The Domain Definition Table on page 156 describes each domain's access rights for each type. The table cannot be changed while the system is running.

The DBMS can interact only with database files, and the text editor can interact only with user files. The World Wide Web server can read user files but not modify them and is the only domain with access to the network. A similar table is constructed for controlling how domains can interact with each other.

One of the most important file types is the executable file. Tight controls are placed on which programs can be executed in a domain and who can modify them. Destructive software, such as viruses and Trojan horses, can be stopped cold because they cannot modify the executable files.



Assured Pipelines

Providing separation of applications is not enough to ensure security; you must also control how the information flows through the system. Type enforcement creates a kind of pipeline to organize data flow between programs (see the figure "Assured Pipeline" above).

Many applications are part of larger systems. To assure that information moves securely, type enforcement controls the data each program can read and write. Each program can only read from the stage in front of it and write to the next stage of the pipeline. No stage of the pipeline can be skipped, and how the data flows through the system is tightly controlled.

A divide-and-conquer approach to building secure applications is another advantage of assured pipelines. By splitting a large program into smaller pieces, it is easier to analyze and be sure the pieces are operating correctly.

For example, suppose you wanted all the outgoing mail messages to be digitally signed before leaving your network, to prove who sent the message. You could modify the word processor to include the digital signature, but it

would be difficult to make sure you modified it in all the correct places. If instead you created a program whose job was to check for the digital signature, you could feel confident the program was working correctly. By using an assured pipeline, you can make sure no data reaches the network software unless it has passed through the new data filter.

Type Enforcement in a Firewall

Today, type enforcement has been incorporated in a firewall to provide flexible isolation between networks. Isolation between the Internet and an organization's internal network is extremely important to protect against malicious attack. Type enforcement offers an ideal mechanism to isolate internal corporate and organizational networks from the Internet.

If a firewall is to secure internet access, placing it on an insecure platform makes little sense. Incorporating type enforcement allows for a flexible policy to be enforced. Equally important is to make the policy mandatory—do not let key security information be changed while the system is connected to the hostile network. This eliminates the possibility of “helpful re-configurations” by Internet hackers.

Separate the two networks on the inside of the machine. An Internet firewall's prime goal is to keep the information separate until a security check has been performed to verify that the information is permitted to cross the policy-driven barrier. The solution is network stack separation, using two distinct network cards.

A type-enforcement firewall with two network cards can also always tell where information originated, no matter how clever the intruder. The two network feeds are connected to two domain-separated network drivers, thus preventing network protocol spoofing (i.e., an advanced hacking technique where attackers handcraft network packets to mask their true origin). The two stacks maintain control over the information coming from either side. Only software defined and controlled by type enforcement can determine which information may move between networks (see the figure “Using Type Enforcement in a Firewall” below).

Always be on the lookout for malicious acts. If any software on

the system tries to access information outside its bucket, either the software is flawed or a potentially harmful entity is controlling it. Take control of the situation. Watch the software more closely through auditing, or shut the software down immediately.

Finally, apply the concept of least privilege. By limiting the privilege a system has, the amount of damage that can be caused if that system is compromised can be limited. Consider, for example, the sendmail program. It is the network server that receives and forwards mail on most Internet hosts. Unfortunately, sendmail has been littered

with vulnerabilities that have let attackers take control of an entire system. The latest vulnerability revolved around the syslog system call letting attackers overwrite sendmail's stack and take control of sendmail. Once in control, the attackers started an interactive shell program and launched their attack on the rest of the system.

Using type enforcement and least privilege prevents the syslog vulnerability from being exploited without changing the sendmail code. Sendmail is placed in a separate domain that can only read data from the external network and write data into the queues to be forwarded to the internal network. Sendmail cannot cause other programs to be created or executed.

Even if the attacker got control of sendmail, all he or she could do is interrupt the mail service, which could have been done anyway using a network flooding attack. Because type enforcement controls execution, the hacker could not even execute an interactive shell and would have no hope of penetrating other domains.

Not Just for Firewalls

Many other applications can be secured cost-effectively using type enforcement. Nowhere is security as critical as it is in cryptographic systems. Key management controls, encryption algorithms, key distribution, public-key repositories, and other critical subsystems can all be tightly controlled in their own protected domains.

Applying type enforcement and its data separation is a natural extension to databases containing sensitive information. And in environments where strict controls are placed on communications resources, type enforcement can control access to the communications resources and make sure that the software allocating the resources cannot be tampered with or bypassed.

By their nature, secure systems are more expensive to build. As a result, secure products often lag behind in current functionality. If you are going to get the features into secure systems in a timely and cost-effective manner, good tools are needed. Nowhere is that more important than in putting the right building blocks in the OS.

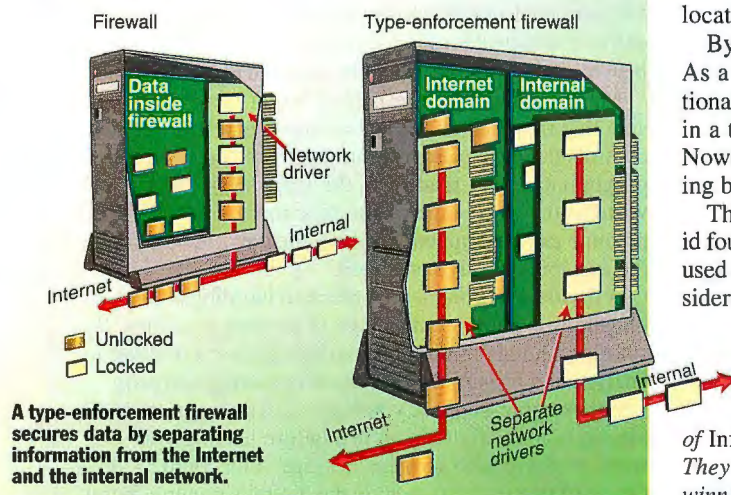
The type-enforcement security mechanism gives the OS a solid foundation for securing applications. Type enforcement can be used to protect applications from malicious modification by outsiders, other errant applications, and the application itself. ■

DOMAIN DEFINITION TABLE

A file's type specifies what domain, or application, can access the file.

Application	Database	User file	Network
DBMS	Read, write	No access	No access
Text editor	No access	Read, write	No access
World Wide Web server	No access	Read	Read, write

Using Type Enforcement in a Firewall



Dan Thomsen is a senior research scientist at Secure Computing Corp. He is working on the Sidewinder Internet firewall. Winn Schwartau is a security consultant and author of Information Warfare: Chaos on the Electronic Superhighway. They can be reached on the Internet at thomsen@sctc.com and winn@infowar.com or on BIX c/o "editors."

Clean Up: C++ Garbage Collection

Here's a tool that helps you keep your code clean by taking out the trash

JUSTIN MILLER

Every C++ programmer at one time or another has had the following problem: Somewhere, somehow, your program calls `new` more times than it calls `delete`. Or perhaps it's the inverse: Your program tries to use an object that's been deleted. Maybe it deletes an object more than once—perhaps two, even three times.

These related problems can manifest themselves in mysterious ways. A temporary string object doesn't get deleted; your program continues to run but inexplicably exhausts memory. Other times, the manifestations are not so mysterious. A routine attempts to dereference a pointer that is pointing to a deleted object and the whole program crashes spectacularly.

It's difficult to keep track of all the objects you have to delete. Consequently, during design time, you're forced to repeatedly ask: "When is it safe to delete this object?" Because this is often a tough question to answer, this ongoing wrestling match with memory almost always complicates your design. And even the most meticulous programmer makes an occasional error, leading either to a global protection fault (or its equivalent) or memory that's never freed.

Pandora's Box Closed

The solution to all this is a garbage collector. With a garbage collector, you never have to delete anything. The collector automatically deletes an object when your program no longer references that object. If you've seen garbage collectors, you're probably concerned about their performance. Some work by "waking up" intermittently and searching through memory for objects that can be deleted. This can bog down the application.

The speed of a garbage collector depends on its type. The most general types of garbage collectors—which do, in fact, search through memory—are slow if you compare them to "manual" memory management (i.e., explicitly using `delete`). However, most of the time your program won't need such a complicated collector. A reference-counting garbage collector is sufficient.

A reference-counting garbage collector is fast because it doesn't have to search through memory. Instead, for every object, it keeps a running count of the number of pointers that point to that object (this running count is the object's "reference count"). Every time a pointer is assigned to point to an object, that object's count is incremented. Every time a pointer is reassigned to point to a different object, the original object's count is decremented,

and the count on the object to which the pointer is newly assigned is incremented. Also, every time a pointer goes out of scope, the count for the object to which it pointed is decremented.

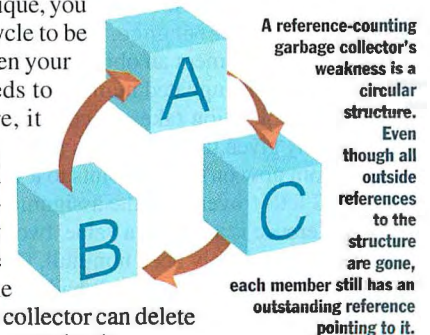
Because the garbage collector keeps track of the number of pointers referencing the object, it knows that when the reference count for an object reaches zero, the object can be safely deleted (if there are no pointers to the object, your program can't access the object).

Limitation

The only drawback to such a garbage collector is that it can't "collect" cyclical structures. For example, suppose you have three objects, A, B, and C. They are tied to one another in the form of a circular list: A contains a pointer to B, B contains a pointer to C, and C contains a pointer to A. Initially, some other pointer may have pointed to A, but that pointer has gone out of scope and, consequently, this circular structure is no longer accessible from your program. It should be put in the garbage.

However, since each object points to the next member of the loop, each of these objects still has one outstanding reference. As a result, a reference-counting garbage collector won't collect the members of this structure; they will be "leaked."

If your program does include a circularly linked list, that doesn't mean you *cannot* use a reference-counting garbage collector. You can arrange to have the garbage collector properly delete the structure, using what I call the "linchpin" method. With this technique, you pick one object in the cycle to be the linchpin object. When your program no longer needs to use a circular structure, it pulls the linchpin; that is, your program sets all pointers inside the linchpin object to null, thereby breaking the loop. Since the loop has now become a linear list, the garbage collector can delete the remaining objects appropriately.



C++ to the Rescue

At this point, though you may be inclined to agree that a reference-counting garbage collector would be a fine programming tool, you're probably concerned about the time you'd have to spend to build one. And if you do decide to build one, you must be exceedingly careful in its construction: Any errors in the reference-counting code of the collector would produce an unacceptably leaky garbage collector.

continued

Happily, C++ operator overloading permits you to implement a completely transparent and foolproof means of reference counting. I've used this concept to create the reference-counting garbage collection system accompanying this article.

RGC, my reference-counting garbage collector, defines two template classes. These template classes emulate pointers by overloading the =, ==, *, and -> operators. Behind the scene these operators do the reference counting for you. Whenever the reference count of a particular object falls to zero, these operators delete the object.

You needn't be aware of the reference counting at all—it's entirely transparent. And because you're unaware of the ongoing reference counting, you can't make any mistakes regarding it. This ensures the accuracy of the reference counts and hence the reliability of the garbage collector.

Using RGC

Incorporating RGC in your next C++ development project is simple. First, you'll need to include RGC.h in your source files.



RGC is available from the **BYTE Web Site** at <http://www.byte.com>. RGC includes RGC.h, a test-driver program, and a self-tracing program that prints messages whenever an object is created or destroyed or its reference count changes.

the collector. TRGCRefObj exists so that the system can support the equivalent of pointers to pointers.

Inside RGC

TRGCObj includes two member functions, RegisterReference and DeregisterReference. These functions respectively increment and decrement an object's reference count. Additionally, they return the updated number of outstanding references.

Garbage collection takes place inside the TRGCRef template class. At any given time, one of its instances (which I'll call a *reference* from now on) either points to a valid object in memory or is null. TRGCRef overloads the assignment operator so that every time a reference is assigned a value, two things happen. If the reference had previously been non-null, DeregisterReference is called on the object to which it had been pointing. Then, if the reference is being assigned to a non-null value, RegisterReference is called on the object to which it is to point. This keeps an object's reference count accurate as assignment operations occur.

Additionally, the TRGCRef destructor handles the situation of a reference's pointing to an object when that reference is destroyed. The destructor calls DeregisterReference on the object to which the reference points. This keeps an object's reference count accurate when references go out of scope or are deleted.

Finally, if DeregisterReference ever returns a 0, indicating that there are no outstanding references to a particular object, the reference will delete the object.

An Example

Examine the following listing fragment:

```
#include "rgc.h"
class myclass : public virtual TRGCObj
{ };
typedef TRGCRef<myclass> Pmyclass;
void main()
{
    Pmyclass A = new myclass;
    Pmyclass B = new myclass;
    A=B;
}
```

When A is assigned to the pointer returned by new, the TRGCRef::setpointer function is called. This stores the pointer to which A is being assigned and calls RegisterReference on the object to which it points. The second assignment (of B) does the same thing.

But when A is assigned to B (the third assignment), a series of calls within the overloaded assignment operator cause DeregisterReference to be called. DeregisterReference will return a 0, since A had been the last reference to the object it had been pointing to. The garbage collector will delete this object (the result of the first new).

This assignment also causes RegisterReference to be called on the object to which A is being assigned. This increments the reference count in the object.

When the main function concludes, the destructors for the local variables (A and B) are called. The destructor for B is called first, which causes DeregisterReference to be invoked on the object to which B refers. DeregisterReference returns a 1, since A still points to the object. But when the destructor for A is called, DeregisterReference will be invoked on that same object and this time will return a 0, causing the object to be deleted.

Note that it is important not to use "regular" pointers to an object that is to be garbage-collected. A regular pointer will not be counted in the reference count, so it's possible that the object will be deleted while your program still holds an outstanding pointer to it.

Keep It Clean

RGC also handles pointers to pointers. For a reference that is a "second level" pointer—i.e., a reference that points to another object and that is itself pointed to—you must use TRGCRefObj. This allows the garbage collector to work on references just as it works on objects; when there are no references to the reference, the reference will be garbage-collected.

The above applies to arbitrary depths of pointers. In general, the outermost layers of pointers may be implemented as either TRGCRef or TRGCRefObj types; inner layers must be implemented as TRGCRefObj types.

RGC is a simple, efficient, and robust reference-counting garbage collector that releases you from having to keep track of when to delete an object. It thereby ends memory leaks, ensures that you never free an object too soon, and simplifies your code. In short, it will make you more productive and make your C++ programs more reliable. ■

Justin Miller is studying electrical engineering and computer science at the Massachusetts Institute of Technology. You can reach him on the Internet at jcmiller@mit.edu.

More Control, Fewer Headaches

You can cut support costs and hassles with integrated configuration management tools

SALVATORE SALAMONE

If you're a network administrator, you crave control. You've probably got a list of tools you'd like for that purpose. A centrally administered menu (in the form of a Program Manager-like shell) on each desktop could help control how users access networked applications and control what users have access to. This kind of control can reduce LAN support costs.

A configuration management tool can help you manage all those desktops. Several vendors, such as Novell, Symantec, McAfee Associates, and Computer Knacks, offer such tools today. Typically, these packages allow a manager to edit WIN.INI files, script commands, and limit a user's desktop choices (for example, by removing the DOS-prompt option or by making "Open" under the File menu nonfunctional).

The desire for configuration management is not limited to Intel-based PCs running Windows. Last year, configuration management was one of the factors that earned Digital Equipment's Multia MultiClient system the BYTE Best of Comdex award in the category of desktop computers (see "Notebooks, NT Clusters Capture Awards," February 1995 BYTE). The Multia is essentially a low-cost Alpha-based Windows NT workstation that comes bundled with configuration management features. One of the main advantages of Digital's Multia line is the set of configuration tools; they give users a lot of control over their desktop environment.

Integration with OS and NOS

Configuration management tools are becoming more tightly integrated with either the network operating system or with systems management tools. For example, rather than just linking an icon on a user's screen to an application on a specific server, a configuration management program might link the execution of an application with a software metering program. In that way, when all the licenses for a particular application are used up, the icon associated with that application would no longer be displayed on a user's screen. Or, you might connect levels of access (e.g., read-only vs. write) with an organizational structure previously defined in a Novell Bindery or network directory service. So when a new sales associate is added to the network, for example, that person would automatically be able to look up customer account information, while a newly added sales manager would automatically be given the privilege to make changes in customer files.

Configuration management of the desktop is becoming increasingly popular because many managers see it as a way to reduce their rising LAN support costs. Over a five-year period, the average cost per user for LAN support is \$3278, according to

the Gartner Group. That's more than \$2 million per year, on average, for a 700-node LAN. In contrast, the average annual cost per user for equipment (including network server hardware, desktop adapter cards, cabling, hubs, connectivity software, and installation fees) is only \$885 (most of which is spent in the first year when equipment is purchased).

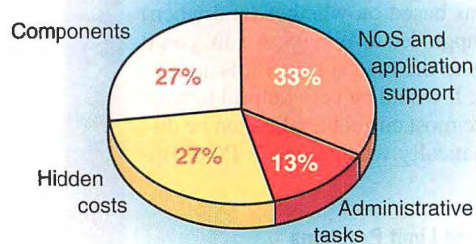
A cost-of-ownership study by the Meta Group found similarly high numbers for LAN support. Meta estimates that the cost per client over a five-year period is \$19,504 (or about \$3900 per client per year).

Configuration management tools can reduce the administrative burden on a LAN staff in a number of ways (see the list on page 160). By replacing the standard Windows Program Manager with a centrally administered desktop manager, you can get rid of many potentially confusing options. For example, you might provide icons only for programs the user has access rights to. Or, you can remove the Properties Menu option on a user-by-user or group-by-group basis to prevent tampering.

At a higher level, you could integrate network rights into the desktop environment to reduce administrative tasks. For example, if the marketing group is allowed access to a graphics application, adding a user to the marketing group in SYSCON would make the graphics application icon appear on the user's desktop automatically. Therefore, double administration is not required.

User interfaces also make it easier for people to get at networked applications and resources. Users need only

Where LAN Support Dollars Go



It costs an average of \$3278 per year to support an average LAN user, according to analysts at the Gartner Group (Stamford, CT).

click on an icon to start an application or to gain access to a resource, such as a printer. This reduces training costs.

A well-designed user interface hides the complexity of a network operation. For instance, launching an application from a UI can transparently handle changes of directories (to load a data file) and can direct the output to a printer specifically set up for a particular application. Without the UI, the user might need to know where a data file is located, how to change directories to load that file, and how to direct the output to that printer. None of these tasks is monumental, but for a user unfamiliar with network directories or, for that matter, uncomfortable with working on a computer, commands to perform these tasks may seem like a foreign language.

Helping Win 95 Users

Some companies are looking at configuration management tools to save training costs associated with moving to Windows 95. As Windows 95 is rolled out in an organization, a company using a configuration management tool may opt to keep a Windows 3.x Program Manager-like interface displayed on everyone's PC. That way, the users see no change at all. When a department completes its Windows 95 training, the LAN manager can go to a centrally administered configuration tool and make the necessary adjustments so that each PC shows a Win 95 display rather than the Program Manager-like display.

Another way a configuration management tool can help with the migration to Win 95 is by controlling access to Win 95 applications. Suppose you're moving to Win 95 department by department. You'd like users who've been upgraded to have access to the new applications, but you don't want users still running Windows 3.x to try running Win 95 applications (that could mean nervous breakdowns at the help desk).

Ordinarily, it's a nightmare trying to handle this mixed environment. However, this administrative task could be made easier if a configuration management tool is tightly integrated with systems management software. For example, you might use a software-inventory program to determine if a PC is running Win 95. Ideally, you'd like to be able to take this information and automatically make it available to a centrally administered desktop configuration management tool; then, a user will see a Win 95 application icon only if his or her PC is capable of running it.

In some cases, you might have two versions of an application on the network—say Word 6.0 and Word for Win 95. You can probably appreciate the administrative nightmare one would face trying to match a user's access to these programs based on whether (and when) they've been upgraded to Win 95. Again, you'd like to be able to off-load some of this administrative work. It would be very helpful to have the icon for the most current application be displayed automatically when a user's PC is upgraded.

Limit Options and Limit Problems

Good user interfaces also reduce network management costs. Basically, a UI limits a user's options, thus restricting the types of problems a staff has to deal with. A central configuration tool can make certain things invis-

How Centralized Configuration Management Helps

- Masks complexity of the network from users
- Reduces user options, making LAN support easier
- Reduces training costs
- Facilitates changes when applications move or devices are added to the network
- Keeps users from trying to run programs their PCs cannot support
- Enforces uniform corporate image in customer-service settings
- Tightens security



ible to the users. For example, as you add file servers, a particular application might move from one machine to another. For some users this change can be upsetting. They may have step-by-step instructions on how to open a particular file. Then when a file moves, their normal routine won't work. They might not know enough about DOS directories, NetWare drives, or off-the-shelf applications to be able to figure out how to do things like change a directory to get the file.

You could also use a configuration tool to link a hardware-inventory program and a user's ability to run an application. This would let you check to see if a user's PC has the appropriate video card or enough memory to run a particular application, for example. If a user's machine doesn't have the right stuff, you'd like that information to be passed to a Windows configuration management program so that the icon for that application is not displayed on that machine. This would head off an application bombing and mean one less call to the help desk.

Configuration management tools can also be used to help project the corporate identity. A bank that uses PCs to show customer account information might not want a *Beavis and Butt-Head* screen saver flashing on the screen. A configuration tool can make sure every terminal displays the corporate logo instead.

Such control over the desktop environment will be possible as new configuration management tools become more tightly integrated with the NOS or with systems management tools. LAN administrators will thus have better control of user access to applications and data. ■

Salvatore Salamone is a BYTE editor who often covers the network beat. He's the author of Reducing the Cost of LAN Ownership (Van Nostrand Reinhold, 1995). You can reach him on the Internet at ssalamone@bix.com.

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JERRY POURNELLE

Dead Chickens and Portable Data

Years ago, I told the VP of marketing at AT&T that if they bought KFC, they'd end up advertising hot, dead chicken. He sighed and said, "The worst of it is that we'd probably advertise warm, dead chicken."

So AT&T bought NCR and turned it into AT&T Global Information Solutions. Having admitted they couldn't market a cure for death, AT&T took a company that could market small computers and slaughtered it. While they were at it, they let NCR wring the neck of AT&T's most exciting product, the Safari laptop. It was one of my favorite laptops—small, very portable, built-in communications. While AT&T desktop marketing wasn't very hot, they had some good technology, and they were beginning to move with the Safari. After NCR was dragged in, no journalist I know ever heard from either AT&T or NCR again. The Safari was never updated—if there are new models, I never got the word. We can't review what we don't hear of.

It's up to marketing to make us aware of new products, or at least that there *are* new products, because I guarantee you there are plenty of outfits out there who *do* let columnists know. I confess I hadn't thought of AT&T for a year when I was reminded by a *Wall Street Journal* article of just what a fiasco the AT&T/NCR merger became.

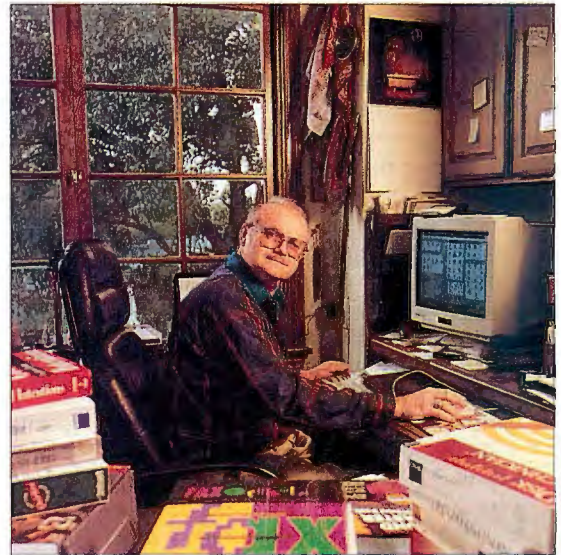
The pity of it all is that if ever there was a company that ought to be booming in these days of Internet and Unix popularity, it surely ought to be AT&T. Who else would be better suited to sell you a Unix box that you can hook directly to the Internet? I used to have one here at Chaos Manor. Perhaps there's an updated system, but if so, they sure haven't let me know about it. Alas.

Every now and then I get a panic E-mail message about disk drives with lost chains, cross-referenced or nonmatching file allocation tables (FATs), and other disk woes. Alas, I don't have time to do more than send a generic answer. I usually advise them to try Norton Disk Doctor run from a floppy disk. I figure that if they had

Norton Utilities (NDD comes with NU) already installed on the hard disk, they'd have tried NDD and said so. In any event, the one thing you don't want to do if you have a disk in trouble is install something new on it or write to it in any way.

NDD allows you to make an Undo disk that will put things back the way they were. You can put that on a floppy disk or on a network disk (*never* on the disk you're working on!). As long as you do that, you're reasonably safe, with one exception I'll get to in a second.

If NDD fails, your next step depends on how important the data is. If all you stand to lose is a few hours of installation time, you can try mucking about with NU yourself. For example, DOS keeps two copies of the FAT. They're supposed to match, but sometimes they don't. If you know which one is good, you can tell NU to use the good one and ignore the other. There are other such tricks. All are fairly dangerous in that you can lose your files forever, but that's the worst that can happen. If that won't be a complete disaster, you can use NU to try to recover from some stupid application that wrote garbage in



Jerry offers advice on disaster recovery and looks at ways to access data—anywhere

the wrong places—or more likely, something dumb you did.

You may even be able to recover compressed files. It doesn't say so on the box, but NU for Windows 95 works quite well in DOS (which is where you ought to be working if you're trying to recover files; using a disk editor in Windows or Windows 95 [W95] is just asking for trouble). It will work on DoubleSpace compressed drives.

Understand, I don't recommend file compression. Gigabyte disk drives sell for under \$299 now, and recently we got a 3-GB drive for about \$700. With hardware that cheap, why take chances? Although file compression usually works fine, there's a small but real chance that you'll lose *everything* on one of those compressed logical drives. It's also inconvenient.

If you do use compression software, you *really* need to have NU installed in your system. It probably won't be good enough to recover you from your disaster, but it might be.

If all else fails, there are data-recovery experts. My son Alex is a partner at Workman & Associates in Pasadena, California. While they mostly do installation and maintenance consulting, they also do data recovery. You should be aware that this can get downright expensive. You're much better off buying the hardware and software it takes to do frequent backups. Most of the people who end up paying Alex to recover their data knew that, of course.

If your data is important enough to pay recovery experts to retrieve it, *don't* use NU. And don't write to your hard disk if you can help it; because if your problem is a failing hard disk, recovery is going to be very difficult, and anything you write to that disk is likely to make things worse.

Clearly, your best bet is to make good backups before you have problems; and if your data files are important enough that you'd be willing to pay for their recovery, they're important enough for you to buy a tape drive. For that matter, they're probably important enough to protect with a RAID system or full mirroring.

I don't like Franklin Quest's Ascend 5.0. I don't like the colors, and I particularly don't like the way it handles telephone calls. It uses the Microsoft Dialer, which means that if you hang up the phone after your call, your software doesn't know you've done that; and until you go back into the software and *tell* it that you've

hung up, it keeps the phone tied up. It also keeps a log file open that is "timing" the call long after you hung up.

The result was that I didn't use Ascend 5.0 to dial. I'd look up the numbers in a paper book; but since I wasn't using Ascend 5.0, I wasn't entering new numbers in it, so I got to losing phone numbers.

I'm not sure what I had against the rest of Ascend 5.0, but I went for almost two months without using it. The result was a mess. I wasn't able to keep track of appointments.

I was losing phone messages. I didn't have any priority to my work. That clearly could not go on.

Therefore, I went back to Ascend 4.0. It has a few flaws that version 5.0 was supposed to fix, but I can live with them; and it's just easier for me to use. The colors are brighter. It has a phone dialer that knows when I have hung up the phone. It took me about 2

hours to go through the nine weeks in which I hadn't updated appointments, kept my journal, done my reports, and dealt with my priority task lists, but eventually I was done with all that.

The effect on my work was immediate. No more jotting down little notes on scraps of paper and losing them. Now I have a record, and even better, it's a record I can search. With luck, version 6.0 will be as good as version 4.0, but with the bugs fixed; until then, I can't live without Ascend, but I can sure live without version 5.0.

One good thing came of all this: I rediscovered the joys of paper logbooks. The problem with an electronic log is that you often don't have it with you, and often you want to make handwritten notes. Carrying a printed copy of the electronic log and using that to jot notes in doesn't work well because the resulting book is too thick to carry easily.

For years I carried Borum & Pease hard-bound composition books. They're like the ones you see in the drugstore, but they come page-numbered. Since I have the habit of taping business cards, letters, and newspaper clippings into my logbook, I've found it makes sense to use nylon strapping tape to reinforce the binding. When I dropped Ascend, I started a new logbook. I'm going to continue to carry that. The result is I have a book that supplements my electronic Ascend records nicely.

One day I suppose I'll have a personal digital assistant (PDA) that I can carry about and jot notes into. My son uses a



286 DOS-only monochrome Gateway HandBook for that purpose and has mastered the art of typing fast with one hand while holding the system in the other. I still need a place to set the HandBook down, and thus it's as easy to keep the Gateway 2000 Liberty in my briefcase. The bottom line is that so far there is no PDA as convenient as a paper logbook, especially if you also use Ascend on your laptop and desktop.

Incidentally, I have friends who like Ascend 5.0 and can't figure out why I don't.

I love little computers, but every now and then I wonder. I have two communications from the Gas Company. One threatens my life, or at least my credit, as well as warning that they're about to cut my gas service off for not paying my bill. The other letter tells me I have overpaid my bill, have a credit balance, and should not send any money.

Something else from the same mail is prettier: two beautiful simulated handwritten notices from a charitable order I belong to exhorting me to pay my Pentecostal obligation. They are identical, and you have to look close to see they weren't handwritten.

Alex says these are reminders of how awful the world would be if it were written in COBOL.

I guarantee you a frustrating experience installing the CDSOURCEBOOK of American History, especially if you're running W95; but eventually you'll get it up, and if you're at all interested in the fundamental documents of America, you'll be glad you persevered.

I had two distinct experiences with the installation from CD-ROM. The first time, the installation program ran; but at about 98 percent done, it said there was an error copying system files. If that happens to you, cheer, because you're nearly done; just ignore the error message. You'll still have to make your shortcut and put it on the start-up toolbar, but that won't be a real problem.

Alas, I didn't do that after it happened on Pentafluge, the big Pentium that runs W95. I went over and tried the installation on SuperCow, the Gateway 2000 486DX2/66 that runs Windows for Workgroups 3.11. It didn't install easily there, either, requiring that I reset the machine at least once, but eventually it was finished with no harm done.

The CD-ROM is packed with information, from accounts of Columbus in Spain, through George Washington's early military career through the Revolution

and right on up to World War I. All the major documents, such as Magna Charta, the Mayflower Compact, Declaration of Independence, Articles of Confederation, and Constitution are there. So are the entire Federalist Papers. There are eyewitness accounts, literary works, Washington Irving, and so forth.

But there's more. You get Woodrow Wilson's six-volume work, *History of the United States*. There are all the inaugural addresses of the presidents. There's James Madison's two-volume *Journal of the Constitutional Debates*. There is, in a word, nearly every original source and most secondary sources needed to teach American history, all indexed and searchable.

The viewing engine is Folio Views, about which more later. There's one quirk you need to know about. To make it easier to find and copy material from this wonderful collection, there is extensive paragraph identification, useful for scholarly quoting but annoying if you're just trying to read the documents. It's neither intuitive nor documented, but you can turn that off. Pull down the View menu, and click on the item Hidden; that will toggle the paragraph identifications.

Every schoolroom and home student in America ought to have this disc. It's that good. Highly recommended.

Attendees at Comdex and other computer shows know something about Folio Views, because for the past few years, the convention directory has been given out on a floppy disk. BYTE chooses the Best of Comdex show awards, and the Folio Views-based disk sure has made my life easier. I can search out new products by category, find booth and suite numbers, and suchlike. This year, I am going to take the neat little Citizen PN60 printer and use that to make out my show itinerary.

The Folio Views 3.1 Infobase Production Kit builds databases you can take with you. It comes in several levels, from a simple user database construction kit through a professional kit that includes licenses that let you distribute the run-time viewer with your product—that's what comes with the American-history CD—to a Software Developer Kit that lets you extend their tools and hook the whole thing in with other programs. It's all industrial-strength software and priced accordingly. It's also pretty solid.

You can get your data nearly anywhere, provided you respect applicable copyright restrictions, of course. Nexis and Lexis are obvious sources, but in fact almost any Internet site may furnish one. If you have any level of Folio Views, you can get a

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free tool called Folio Retriever that goes out on the Internet, grabs information, and puts it into a Folio Views—editable flat file complete with links and a table of contents. You compile that to make a Folio Views database you can use off-line. It's portable, and it can be copied. You can use this technique to grab a whole bunch of stuff from the World Wide Web and evaluate it at leisure. You can then use another tool to turn all that into Hypertext Markup Language (HTML) documents and put them on your own Web server.

The Folio Views 3.1 Infobase Production Kit comes with conversion filters for getting data out of most word processor document formats. The version I have doesn't seem to know about older database formats like Q&A, but I'm told the Software Developer Kit has the tools for constructing nearly any filter device you like; and Folio Views knows how to bring in data from any ASCII file-format system.

Like askSam, Folio Views isn't the simplest thing to learn, but once you have it down, it's a lot more powerful. It can be used to build salable products from document collections or just to organize data for your own use. I can't claim great familiarity with Folio Views and Folio Retriever, but as Chaos Manor appears to be sinking beneath vast amounts of information retrieved from the Web, I think I'm about to be. I've seen many useful products built from Folio Views. If you're drowning in unorganized data or you have an idea for a product based on documentary information, this may be just what you need.

In *The Mote in God's Eye* (Larry Niven and Jerry Pournelle, Pocket Books), the characters all carry pocket computers that are tied into a central database, thus linking everyone to everyone else, as well as to all the knowledge of humankind. When we wrote that in 1970, we carefully did not describe how it all worked, but we did make it clear that you used a stylus rather than a keyboard.

We now have Zenith's CruisePad set up in Chaos Manor. CruisePad is a clipboard-size, stylus-controlled system that uses radio to link into a regular computer network. You can connect a keyboard to it if you want, but that gets clumsy, and if you're going to do a lot of typing, you'd probably be better off with a laptop or palmtop. Where CruisePad shines is with mouse-controlled operations. You can use it to make a big desktop do anything you could do with a mouse.

That includes accessing your Internet server or other databases. It also includes

Internet access; and most Web browsing is done by mousing around. You can also "type" short replies with the stylus: you call up an image of a miniature keyboard and tap away at the keys. That's frustrating for touch-typists, but hunt-and-peck addicts get pretty fast with it.

The real merit of CruisePad is for structured actions. Years ago, I speculated that one day doctors making hospital rounds would have a clipboard computer that would give them the patient's chart, let them make entries, digest the information, and offer suggestions on diagnosis and treatment. That's no longer speculation. Teaching hospitals are testing such systems. You can even enter prescriptions with CruisePad. The result probably won't be reliably machine-readable, but the hand-written bit map can be attached to the patient's chart, a copy can go by fax to the pharmacy, and a clerk can complete the data entry from a central location.

I don't know if anyone is doing this now, but it wouldn't be difficult to construct a program that compares the recommended treatment with what is standard; does the same thing with dosages, taking into account the patient's body weight; looks in the record for contraindications;

and flashes a warning if the physician has specified something outside the normal envelope. That would certainly eliminate careless errors.

To go from the sublime to something else, muffler and transmission shops are also using CruisePad. Tap the screen, and up comes a list of makes and models. Use the stylus to let the computer know the model and year, and up comes a picture and a list of symptoms. Tap (as opposed to click) in the appropriate places, and out comes a repair recommendation and cost estimate.

The U.S. Navy is trying to replace paper with CD-ROMs. The problem with that was summarized by Gordon Eubanks, who was a submarine driver before becoming CEO of Symantec. If you're crawling around inside an engine trying to find out where to put a wrench, the last thing you need is to have to come out to look at a screen. With CruisePad, you can carry the screen with you, and as long as data access is mouse-controllable, it would be plenty good enough.

To utilize CruisePad, there are three ways

to connect to your network: CruiseLAN/PCMCIA, for computers with a PC Card Type II slot; CruiseLAN/ISA, a card for AT-type bus desktop PCs and servers; or CruiseLAN/Access Point relay boxes, for extending coverage to up to 1000 feet in diameter in normal office environments. With a CruiseLAN/Access Point connected upstairs, I was able to control SuperCow from every downstairs room. A larger establishment like a hospital could put CruiseLAN relay boxes in several places; one would almost certainly be enough for a small clinic or mechanic's shop.

Setting up CruisePad isn't all that hard, but you do have to get the drivers loaded in just the right order and just the right way, and that can be tricky. Small companies without technically competent people may want some help, either from a franchising parent organization or outside consultants, to get it running.

Designing the custom database applications to make CruisePad useful is a much bigger deal. On the other hand, given tools



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Photo by Joanne Carro

PASSPORT

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like Visual Basic and Folio Views, even that's getting a lot easier, since mostly you're trying to anticipate what data will be entered. Body temperatures, after all, have a rather narrow range.

More on CruisePad after we get used to it. It's not the pocket computer from *Mote*, but it's sure a lot closer to it than I thought I'd have at Chaos Manor in 1995.

For years I've talked about Mrs. Pournelle's reading program, which teaches systematic phonics. Now, the state of California has rediscovered phonics after over 30 years of denigrating phonics instruction, and everyone is interested. The older version required a tutor, but the fancy new Mac version teaches reading by using the Mac sound system to give the lessons. She's been trying it out in selected Los Angeles schools, and the documented results are pretty astonishing: up to five years' grade-level improvement in reading ability from a few months of lessons with her program.



Roberta got enough inquiries that she wanted to make a fancy new manual with a color cover. Unfortunately, the images she wanted to print were on the Mac version of the program. And the only color printer we have is the Fargo Electronics Primera, which works only with PCs. That meant we'd have to transfer the image from Mac to PC.

You can do that with Corel-Draw 5. I have CorelDraw 6, and at some point I'll have to install it; I'm told there are a lot of new features. You may want to hang onto version 5 if you get version 6; readers are reporting a variety of odd bugs. In any event, CorelDraw 5 did the job. Reading an image in Mac format and then cropping and adjusting it to be saved in DOS format turns out to be tedious but not all that difficult.

The most intriguing thing I read this month wasn't a book but an article in the October 1995 *Atlantic Monthly*, in which Clifford Cobb, Ted Halstead, and Jonathan Rowe examine the concept of Gross Domestic Product. When I was in aerospace engi-

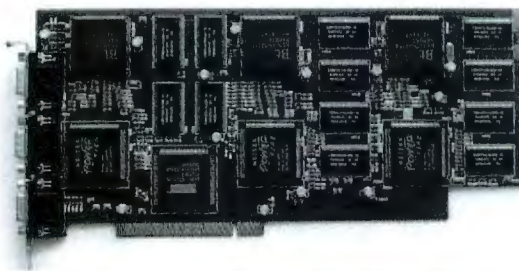
neering, we were warned against what was called "the figure of merit fallacy": the notion that you could take a complex system and use some math to reduce its performance to a single number, which you could then optimize. GDP is a classic case of that. The theory is that the faster GDP grows, the better the economy. The problem is that GDP includes everything, good and bad; under the GDP concept, the greatest economic hero would be a cancer patient getting a triple bypass while starting divorce proceedings. GDP, in a word, is all credits and no debits, and that's insane.

The authors propose a remedy that would be worse than the disease, but their diagnosis of the problem is good.

When I first began writing this column, I got a call from the then director of the office that prepares the Consumer Price Index. He wanted to know if there was some way the government could use small computers and modems to compile the CPI. At that time, they were getting data from cities all over the country, punching it onto IBM cards, and mailing the boxes of cards to a mainframe. The postage alone was running a couple of hundred thousand dollars a month.

The CPI is in the news this week: since

12-screen X Window terminal
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Compatibility Software platforms Controllers

Accelerators Number of boards Number of screens Resolution

X Window X11R5
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Social Security and other entitlement increases are keyed to it, getting it right can be the difference between government solvency and bankruptcy. Everyone is sure it's wrong. There's no agreement on new ways to compute it, but at least small computers make adjustments possible.

GDP is in many ways more important than CPI; and my guess is that small computers will make it possible to adjust it so it discriminates between production and crime. All we have to do is agree on how.

The computer book of the month is by Charles Kaufman, Radia Perlman, and Mike Speciner, *Network Security: Private Communications in a Public World* (Prentice-Hall, 1995); it's both readable and complete, and if you have anything to do with network security, you need this book.

One last bit of advice: if you have W95 running stably, be very careful how you muck with it. More on that next month. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on the Internet or BIX at jerry@bix.com.



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Every schoolroom and home student in America ought to have **CDSOURCEBOOK of American History** (\$49.95). It's that good. Contact Compact University, Provo, UT, (800) 677-3045 or (801) 375-2227; fax (801) 375-2228; sales@infobases.com. **Circle 1087 on Inquiry Card.**

To utilize **CruisePad** (\$1399), there are three ways to connect to your network: CruiseLAN/PCMCIA (\$695), for computers with a PC Card Type II slot; CruiseLAN/ISA (\$595), a card for AT-type bus desktop PCs and servers; or CruiseLAN/Access Point (\$1895) relay boxes, for extending coverage to up to 1000 feet in diameter in normal office environments. Contact Zenith Data Systems, Buffalo Grove, IL, (800) 533-0331 or (708) 808-5000; fax (708) 808-4434; http://www.zds.com. **Circle 1088 on Inquiry Card.**

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WHAT'S NEW Hardware

PREVIEW PENTIUM NOTEBOOKS

Take Your Desktop with You

Gateway 2000's 120-MHz Solo V120 represents several industry firsts. It's one of the first portables with Intel's new 120-MHz Pentium for mobile systems. It also offers the new Start and application keys found in Windows 95 keyboards for desktop systems. The Solo V120 comes close to supplying a one-system solution, with the features of a high-end desktop PC in a light-

weight multimedia notebook. Intel's 0.35-micron manufacturing process accounts for the CPU's small footprint (less than half the size of its 75- and 90-MHz siblings) and subsequent low power consumption. However, the Solo systems use Opti's Viper-N chip set rather than Intel's, which limits data streaming to around 60 MBps, whereas Intel's Mobile Triton chip set would support 100 MBps.

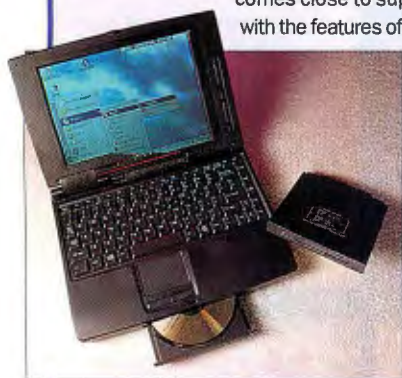
With 256 KB of external burst-mode cache memory, 16 MB of RAM, a removable 720-MB hard drive, a double-speed CD-ROM drive, 16-bit sound, Microsoft Office Pro, and a 10.2-inch active-matrix VGA LCD (Super VGA is optional) with 1 MB of video memory on a VL-Bus, the Solo V120 easily fulfills Gateway's features and power goals. At 6.3 pounds without the AC

adapter but with the floppy drive, its weight is acceptable. The results turned in by the Solo V120 on BYTE's Thumper II battery tests—2 hours, 43 minutes—are about 30 minutes less than that of the 90-MHz Pentium-based Dell Latitude XPi P90T.

The sleek 2-inch-thick letter-size case feels solid. The screen is large and well protected but difficult to see in bright light. The Alps EZ Pad pointing device and the floppy drive are integrated rather than hanging off the notebook's edges. Other features are a PC Card Type III slot and a modular bay (not hot-swappable) for a floppy drive or CD-ROM drive. The machine has IR, serial, parallel, VGA, and PS/2 mouse ports. An optional docking bar duplicates many of these but adds a line-out audio jack and a MIDI/game port.

The Solo V120 represents a remarkable achievement: a cool-running 120-MHz mobile computer that performs 30 percent faster than a 90-MHz desktop system. But after just 2 hours and 10 minutes of word processing with advanced power management on, the battery is kaput.

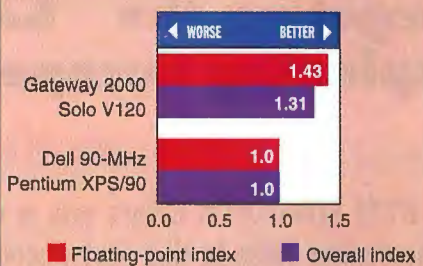
—Selinda Chiquoine



Solo V120 (as tested) \$4899
Gateway 2000
North Sioux City, SD
(800) 846-2000
(605) 232-2000
on CompuServe, go gateway
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Benchmark Results



Battery Life: (System set to clear the video after 1 minute and spin down the hard drive after 2 minutes.) 2 hours and 43 minutes.

SHARE APPLICATIONS

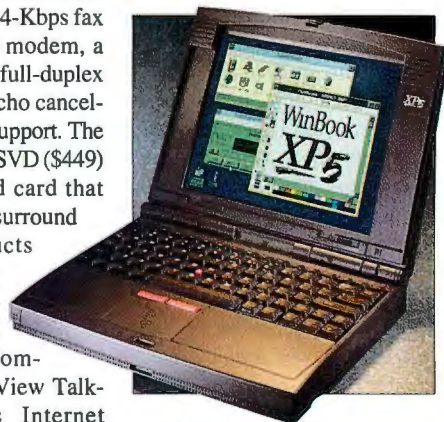
Based on Rockwell's chip set and the DigiTalk standard, V.34 Boca Office Communicator and SoundExpression 28.8SVD let you talk and share applications simultaneously over a single analog telephone line. The V.34 Boca Office Communicator (\$369) provides a 14.4-Kbps fax and 28.8-Kbps data modem, a voice-mail system, a full-duplex speakerphone with echo cancellation, and caller ID support. The SoundExpression 28.8SVD (\$449) adds a 16-bit sound card that has SRS Labs' 3-D surround sound. Both products come with Midisoft's MediaWorks collaborative whiteboard software, Radish Communications' VoiceView TalkShop, VocalTec's Internet Phone, Netcom's Netcruiser, Multimedia Labs' Internet Passport, America Online, CompuServe, and GENie.

Contact: Boca Research, Inc., Boca Raton, FL, (407) 997-6227; <http://www.boca.org>.
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support. The Winterm 2500T and 2500C support TCP/IP and IPX/SPX.

Contact: Wyse Technology, San Jose, CA, (800) 800-9973 or (408) 473-1200; <http://www.wyse.com>.

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75-MHZ PENTIUM NOTEBOOK ▲

The WinBook XP packages a 75-MHz Pentium LM processor, 16 MB of RAM, an 810-MB hard drive (user-upgradable to 1 GB), a 10.4-inch active-matrix color screen, 256 KB of L2 cache memory, an internal 14.4-Kbps send/receive fax/voice/data modem, one PC Card Type III slot or two Type II slots, a 19.5-mm Lexmark keyboard, the Chips & Technologies 32-bit local-bus video accelerator, 1 MB of video memory, and 40-W-per-hour lithium-ion batteries (\$2999). Other features include internal stereo audio, dual speakers, and a choice of pointing devices. A quad-speed docking station is available (\$399), with two ISA slots, dual 5¼-inch bays, auto-detect for external pointing devices, VGA, stereo output, and volume control. An external dual-speed CD-ROM drive with a SCSI adapter costs \$199. It includes headphones, a SCSI adapter, an AC adapter, PC Card, and a carrying case.

Contact: WinBook Computer Corp., Columbus, OH, (800) 468-2162 or (614) 481-8041.

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COLOR WINDOWS TERMINALS

The Winterm 2500, 2500T, and 2500C terminals (from \$750) provide access to 16- and 32-bit applications written for Windows 3.1, 95, and NT. A Winterm terminal is a way to add secure local or branch office seats to a networked environment. Wyse's products deliver access to network applications and resources, including those on Unix hosts, mainframes, NetWare servers, printers, and PCs. The Winterm 2500 is a color terminal, the Winterm 2500T adds 10Base-T networking, and the Winterm 2500C provides 10Base-2 coaxial-cable network

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Contact: Xionics Document Technologies, Inc., Burlington, MA, (800) 864-6243 or (617) 229-7000;

<http://www.xionics.com>.

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OPERATE WINDOWS BY JOYSTICK

People with disabilities that prevent them from using a mouse or a trackball can now operate Windows computers. The SAM-Joystick (\$120) moves the cursor at a rate proportional to the extent you move the stick, and the cursor stays where it is when you let go of the stick. A drag-lock button lets you perform drag operations.

Contact: R. J. Cooper & Associates, Dana Point, CA, (800) 752-6673 or (714) 240-4853; rjcoop@aol.com.

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PORTABLE DIGITIZING SYSTEM ▼

A portable x,y digitizer with an accuracy of 0.003 inch, the Rat

(\$1895) can digitize most cartographic features as well as pictures and drawings. By using the Rat's grid plot overlays, you can digitize without a known coordinate system. The included Diggis software



captures map, drafting, or generic data and exports it into your favorite GIS or CAD program running under DOS, Windows NT or



95, Unix, OS/2, or the Mac OS. Contact: Digi-Rule, Inc., Calgary, Alberta, Canada, (403) 292-0320; <http://www.digirule.com>. Circle 979 on Inquiry Card.

PENTIUM MULTIMEDIA SUPER-NOTEBOOKS

Based on the PCI-bus architecture, the Eurocom 5400 Multimedia Super-Notebooks (starting at \$2900) come with 75-, 90-, 100-, 120-, or 133-MHz Pentium CPUs; 256 KB of external L2 write-back cache memory (expandable to 1 MB); 8 MB of

RAM (expandable to 32 MB); 2 MB of video memory; an internal quad-speed Teac CD-ROM drive; a removable 2½-inch hard drive with capacities of 340 MB to 1.3 GB; 16-bit stereo sound with an FM synthesizer; a trackpad; an oversize 86-key keyboard; one PC Card Type III slot or two Type II slots; an infrared communications port; a UART 16550 se-

rial port; an ECP/EPP-compatible parallel port; an external keyboard/mouse port; an external VGA port; a game port; and a 200-pin connector for a docking station. The notebook is available with 10.3-/11.5-inch color DSTN dual-scan passive-matrix or 10.2-/10.4-inch color TFT active-matrix LCD panels. The NiMH battery pack gives you 1.5 to 2.5 hours of operating time.

Contact: Eurocom Corp., Nepean, Ontario, Canada, (613) 224-6122.

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LABEL PRINTER ►

With the K225 On-Line Labeler (\$269), you can print in a variety of fonts and type sizes; horizontal or vertical; flush top, bottom, left, or center; and bar codes on labels up to 2¼ inches wide. The software saves label formats, organizes and saves frequently used addresses, and allows you to import graphics or scanned images onto labels.

DESKTOP PCs THAT OPTIMIZE WINDOWS 95

Available in low-profile and short-tower configurations, the Celebris GL desktop PCs (from \$2799) feature board-level integration of audio, video, and networking. Systems incorporate 90-, 100-, 120-, and 133-MHz Pentium processors; EDO memory; pipeline burst-mode cache mem-

ory; the Intel Triton FX chip set; and 64-bit graphics. The multimedia technology includes a Matrox Millennium graphics controller that offers 2-D/3-D graphics acceleration, 2 MB of dual-ported video memory (upgradable to 8 MB), 16-bit stereo sound, and a quad-speed CD-ROM drive.

Along with remote configuration/diagnostics, management, and troubleshooting, the Celebris GL can communicate information such as chassis and motherboard serial number, CPU speed, model name, memory installed, and BIOS revision to popular enterprise and workgroup management tools. Features that optimize Windows 95 include Plug and Play, DMI client support, Windows 95 shutdown software, Digital Equipment's integrated PCI Ethernet and Easy Network Setup utility, a Windows 95 keyboard, and Windows 95 "getting started" software.

Contact: Digital Equipment Corp., Maynard, MA, (800) 642-4532 or (508) 624-6400; <http://www.pc.digital.com>.

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Contact: Kroy, Inc., Scottsdale, AZ, (800) 733-5769 or (602) 948-2222; info@kroy.com.

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RAID STORAGE SYSTEM

The Renegade RAID System (with 10 4-GB 7200-rpm drive modules, about \$30,000) offers 42 GB of storage and fault-tolerant data protection com-

figurable to support RAID levels 0, 1, 3, 5, 6, and 7. The tower chassis stores up to 10 3½-inch drives, which support fast and narrow, or fast and wide, SCSI-2 and offer data transfer rates of up to 20 MBps. The system supports the hot-swapping of drives, and the automatic rebuild function restores data on a new drive after there is a crash.

Contact: MountainGate Data Systems, Inc., Reno, NV, (800) 556-0222 or (702) 851-9393; sales@mntgte.lockheed.com.

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WHAT'S NEW Hardware

POWERBOOK EXPANSION CARDS

Three expansion cards for the Mac PowerBook 190 and 5300 include the LapisColor MV16 (\$299), a 1-MB video card that lets you display 16-bit graphics on monitors of up to 17 inches and 8-bit graphics on larger monitors; the LapisColor MV16-EN (\$399), which incorporates the same video features as the MV16 but lets you plug into a 10Base-T Ethernet port via the PowerBook PDS expansion slot; and the LapisColor MV8-EN (\$279), which supports 8-bit graphics on monitors of up to 17 inches and 4-bit graphics on larger displays and has the same 10Base-T Ethernet connector as the MV16-EN.

Contact: Focus Enhancements, Inc., Woburn, MA, (617) 938-8088.

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TWO-IN-ONE DRIVE ▼

A plug-in device, Doubleplay (external, \$299; internal, \$159) lets you share, store, and access large files on QIC tape cartridges and floppy disks. You can download large files to tape and then access them directly, without first copying them to your hard drive. Doubleplay also lets you play audio and video files di-



rectly from tape.

Contact: ComByte, Inc., Fort Collins, CO, (800) 990-2983 or (970) 229-0660.

Circle 994 on Inquiry Card.

10-MBPS WIRELESS ETHERNET LAN

Available in indoor and outdoor versions, the ET350 (call for prices) uses infrared line-of-sight

transmission to link LANs and users who are up to 1500 feet apart. The package includes a receiver lens and four transceivers, which connect to the LAN via Ethernet IEEE-802.3-compatible ports. The transceivers support many network devices, including up to 29 10Base-2 thin-wire devices, one AUI 10Base-5 thick-wire backbone, or an optional UTP concentrator for one, six, eight, or more 10Base-T twisted-pair connections, in various applications. A 10-element bar graph displays red, amber, and green to indicate receive signal strengths. A self-test mode serves as a self-check and a diagnostic tool. It also assists in transceiver alignment.

Contact: A. T. Schindler Communications, Inc., Ottawa, Ontario, Canada, (613) 723-1103; firlan@fox.nstn.ca.

Circle 982 on Inquiry Card.

DESKTOP-SIZE NETWORK LASER PRINTER

Printing 12 ppm in black and white and 3 ppm in color, the Optra C (about \$6400) provides photographic-quality CMYK color printing on plain paper at a resolution of 600 by 600 dpi. The printer includes PostScript Level 2 and enhanced PCL5 with color emulations and supports continuous tone, color grade, and stochastic screening techniques for color printing. Standard memory is 8 MB (expandable to 64 MB). Paper-handling features include a 250-sheet paper tray and a 100-sheet multi-purpose tray. Two internal slots receive MarkNet XL INA network adapter cards.

Contact: Lexmark International, Inc., Greenwich, CT, (800) 891-0331 or (606) 232-2000; <http://www.lexmark.com>.

Circle 991 on Inquiry Card.

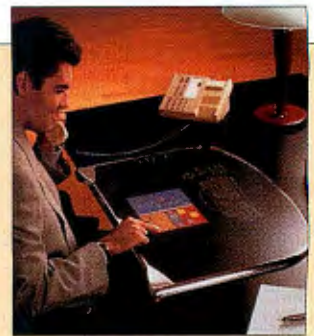
DESK PAD ELIMINATES BULKY MONITORS

The Modula-Executive Desk Pad (\$3500) combines a 10.4-inch active-matrix color touchscreen that lies flat on your desk, a keyboard, a mouse, stereo speakers, and a microphone in a half-inch-thick, 27- by 19-inch

tablet. You connect it to a 386 or higher CPU. To use the speakers, you need a Sound Blaster card. The surface is nonscratch, antiglare, waterproof, and shock- and temperature-resistant.

Contact: Source Innovations, Inc., Long Beach, CA, (310) 988-6574; <http://www.iwsc.com/shoppers/electronics/modula>.

Circle 978 on Inquiry Card.



PRINTING FORMS

The OptiForm Flash SIMM is a 1-, 2-, or 3-MB module that plugs into a Hewlett-Packard LaserJet 4's memory slot. It now interfaces with Caere Affiliate Publishing's electronic forms-conversion product, OmniForm. You can scan in a form and download it into a printer. Once forms are stored in the OptiForm (from \$349), you can fill them in using the database tools supplied with OmniForm or from an existing application. You can view the status and contents of the OptiForm from a workstation to update forms in real time.

Contact: Pacific Data Products, Inc., San Diego, CA, (800) 737-7121 or (619) 552-0880; info@pacdata.com.

Circle 989 on Inquiry Card.

ISDN REMOTE-ACCESS CARD

The Diva card's (ISA-bus version, \$595; PC Card version, \$695) ISDN BRI port lets you communicate using IP, IPX, or PPP with peer workstations, remote networks, SNA mainframes, ISDN PRI and BRI routers, fax services, on-line services, and the Internet. Alternatively, the card reaches remote LANs via ISDN PPP or HDLC

links and supports connections to X.25 networks. An on-board 10-MHz 40-MIPS DSP chip processes data packets within a single interrupt and prevents re-transmissions.

Contact: Eicon Technology, Inc., Dallas, TX, (800) 803-4266 or (214) 239-3270; <http://www.eicon.com>.

Circle 990 on Inquiry Card.



SIMPLE CD RECORDING ▲

Hewlett-Packard has bundled its SureStore CD-Writer 4020i (\$1249) compact quad-speed CD reader and double-speed CD recorder; two blank HP SureStore CD-R discs; a SCSI-2 bus-mastering interface card; and cables with Easy-CD, Alchemy Personal, Magic Lantern, and Easy-CD audio software. You can record up to 650 MB of data on a single CD-R disc.

Contact: Hewlett-Packard Co., Loveland, CO, (800) 810-0134 or (970) 635-1500;

SureStore_Support@HP-Loveland-om10.om.HP.com.

Circle 992 on Inquiry Card.

The **BYTE** Site brings you today's hottest technologies with extended product and technology coverage that's the perfect complement to **BYTE** magazine.



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PREVIEW DESKTOP RELATIONAL DATABASE

Unmistakably Approachable

Loyal users of earlier versions of Lotus Approach and anyone looking for a versatile desktop database will love Lotus Approach 96. Always a winner of high marks for ease of use, this 32-bit version for Windows 95 and NT stands toe-to-toe with its worthy opponent, Microsoft Access 7.0.

SmartMaster, which is a new applications builder, quickly puts together forms and tables for more than 50 familiar applications. Several new assistants, interactive aids that do the intricate relational-design work behind the scenes while you focus on defining the business aspects of data and results, make their debut in Approach 96.

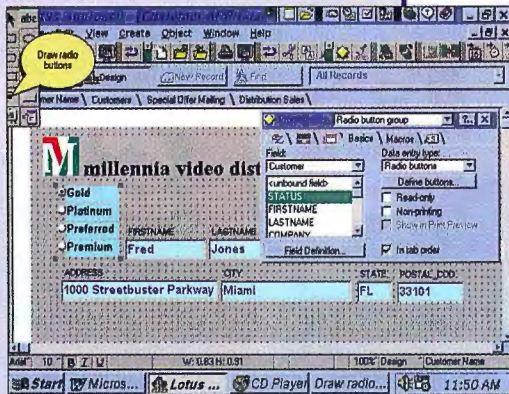
The find assistant's point-and-click, fill-in-the-blank query builder allows you to quickly find database

records. You can then name the statements you build and save them for recall and execution. Named queries also help select items for a report, a set of mailing labels, a worksheet, or a chart. During report design, data appears in your layout due to the enhanced report assistant, which shows a WYSIWYG preview of printed output.

Enterprise users will find improved integration and connectivity to Lotus Notes and tighter integration with Lotus SmartSuite and Microsoft Office. A new team-security feature controls access rights, assigns passwords, and manages group or individual privileges. Approach 96 can participate as a basic OLE client or as an OLE 2 automation client or server. You can register, select, and address OCXes as you can internal objects.

The program continues its use of dBase IV as its default database structure, with options to work with dBase III, FoxPro, Access, Paradox, SQL Server, Oracle, and ODBC data sources. The beta version BYTE evaluated stumbled when asked to open an Access 2.0 database, but it worked fine with a FoxPro 2.5 file. The company explained that the problem was related to the unavailability of Microsoft drivers for Access 2.0 and higher. A solution is expected. LotusScript is supported by an object browser, editor, and debugger, for those who need to venture into the Approach 96 IDE to customize their applications.

—Alan M. Stoughton



Lotus Approach 96 \$109
 Lotus Development Corp.
 Mountain View, CA
 (800) 343-5414
 (415) 335-6400
<http://www.lotus.com>
Circle 1000 on Inquiry Card.

structure documents for on-line distribution. Depending on the template settings, HTML Transit can generate a master table of contents, and each HTML file can contain its own local table of contents.

Contact: *InfoAccess, Inc.*, Bellevue, WA, (800) 344-9737 or (206) 747-3203; info@infoaccess.com.

Circle 1006 on Inquiry Card.

COLOR PRINTING FOR UNIX WORKSTATIONS

Usable with stand-alone workstations or in heterogeneous networks, Flexprint (single user, from \$695) lets you control such printer features as print quality, tray selection, and EasyColor color correction.

The program has system administrator tools for the setup and management of printers and print queues, a hot print button, support for GL and X Window System, fast conversion of screen capture to PostScript, and printing of major desktop publishing and CAD image file formats. Printer connections include internal TCP/IP, parallel, serial, and remote workstation.

Contact: *AutoGraph International, Inc.*, San Jose, CA, (408) 436-7227; sales@augrin.com.

Circle 1003 on Inquiry Card.

CREATE FORMS IN WINDOWS

Visual Forms/Win (\$249), a forms designer, creates complex base forms and documents that it saves as Windows metafiles. You can integrate these files into applications and quickly position data. The program creates a template file for your data fields and lets you test your application without leaving Visual Forms/Win.

Contact: *Bytech Business Sys-*

tems, Inc., Pomona, NY, (914) 354-8666; 74577,1032
@compuserve.com.

Circle 1012 on Inquiry Card.

SOLARIS SERVER FOR WINDOWS

WabiServer (server license, \$1000; 10-client pack, \$1000) allows Wabi-certified Windows applications (e.g., Microsoft Office and Lotus SmartSuite) to run on a server with Solaris 2.x and to display on low-end SPARC systems, X Window System terminals, or machines running Solaris 1.x. WabiServer provides MIS managers with better central management of Windows applications within Solaris.

Contact: *SunSoft, Inc.*, Chelmsford, MA, (800) 786-7638 or (512) 434-1511;
<http://www.sun.com/sunsoft/>.

Circle 1005 on Inquiry Card.

NATIVE PC X SERVER FOR WINDOWS 95

Exceed 5 for Windows 95 (single-seat site license, \$545), an X Window System 11 release 6-compliant Windows 95 PC X server, allows Windows 95 PCs to access and display applications from Unix/X, VMX, Ultrix, and OSF/1 systems. The program includes Exceed/Xpress remote-access technology, so you can remotely access Unix/X applications via standard telephone lines; a TN3270 emulator; Hummingbird's E-mail client and Usenet News reader; and access to CDE-enabled hosts in single- and multiple-window modes via TriTeal's TED.

Exceed 5 for Windows 95 integrates support options such as XIE image extension, FTP and telnet clients, the Exceed Basic scripting language, and Launch Pad, Xtrace, and Xsession facilities.

Contact: *Hummingbird Communications, Ltd.*, North York, Ontario, Canada, (416) 496-2200; <http://www.hcl.com>.

Circle 1007 on Inquiry Card.

HIGH-VOLUME WEB PUBLISHING

HTML Transit (\$495) reads popular word processing files in their native format and produces a single HTML file or an entire hy-

per-text-linked library, according to the template parameters you specify. HTML Transit translates source files originally intended for hard copy and lets you re-

WORKGROUP FAX SOFTWARE

Running as an NLM, Faxcom/Workgroup for NetWare allows users on NetWare networks to send and receive faxes via a shared fax modem connected to a file server. The program supports Windows, OS/2, and DOS clients; manages private and public fax phone books; allows users to view, rotate, annotate, and forward faxes; and imports user information from bindery and NDS. Faxcom/Workgroup for NetWare (from \$695) also interfaces to scanners for converting faxes to text or for faxing hard-copy documents, and it provides an upgrade path for enterprise-wide integration with Biscom's multichannel fax servers.

Contact: Biscom, Inc., Chelmsford, MA, (800) 477-2472 or (508) 250-1800;

<http://www.biscom.com>.

Circle 1019 on Inquiry Card.

COMMUNICATIONS FOR OS/2

HyperAccess for OS/2 (\$129) offers telnet access to the Internet and comes with thousands of

ready-to-call BBSes, Internet service providers, and other on-line systems. The program supports data transfer rates of up to 57.6 Kbps on COM1-COM4 through standard OS/2 communications drivers, or rates of up to 115.2 Kbps through the included SIO .SYS shareware communications driver. You can also connect through TCP/IP and shared modems on OS/2 networks.

Contact: Hilgraeve, Inc., Monroe, MI, (800) 826-2760 or (313) 243-0576;

<http://www.hilgraeve.com>.

Circle 1004 on Inquiry Card.

DATA ACCESS AND REPORTING TOOL

IQ/Objects introduces object-based query and reporting using SmartObjects, which can make decisions to invoke or pass information to other objects based on query results. You can query data from different databases simultaneously, integrating and consolidating the results to reports for enterprise-wide decision support. Available config-

urations include Personal Edition (\$250), for executing, printing, and viewing queries and reports; Enterprise Edition (\$695), full-function query building and reporting; KnowledgeBase Administrator (\$995), which allows you to configure, define, and maintain access to multiple databases and includes Enterprise Edition; and IQ SmartServer (from \$5000), for intelligently distributing data access functions among clients, applications servers, and database servers.

Contact: IQ Software Corp., Norcross, GA, (800) 458-0386 or (404) 446-8880; sales@iqsc.com.

Circle 1013 on Inquiry Card.

AS/400 CONNECTIVITY FOR WINDOWS 95

Emerald Client for Windows 95 (\$245) provides PCs running Windows 95 with IBM 5250 terminal and printer emulation to AS/400s. The program includes SQL capabilities, drag-and-drop bidirectional file transfer, an SDI function for multiple 5250 terminal sessions, access to the emulation screen, and a choice of connection methods from the PC to the host.

If you've been looking for speedy multiprotocol file transfers between Windows-based PCs and AS/400s, Emerald File Access (\$199) may be for you. The program provides query support using SQL, understandable error messages, efficient use of system resources on the host and PC, file transfer statistics, transfer of AS/400 Save files, security that lets system administrators restrict access to libraries and objects, and support for 16- and 32-bit OSes.

Contact: Andrew Corp., Orland Park, IL, (800) 328-2696 ext. 319 or

(708) 349-3300.

Circle 1011 on Inquiry Card.

Software Update

Clarion for Windows 1.5 adds a 32-bit compiler to the RAD environment, so you can build applications for Windows 3.x, 95, and NT from the same development environment and project files. \$499.

Contact: TopSpeed Corp., Pompano Beach, FL, (800) 354-5444 or (305) 785-4555; 76711.1034@compuserve.com.

Circle 1021 on Inquiry Card.

Dfrag 4.0 defragments Oracle 6 and 7 databases, tables, and indexes; improves database performance; eliminates time-consuming maintenance tasks; and maximizes performance and space usage of Oracle databases. The Virtual DBA Windows-based graphical front-end interface lets Oracle database administrators graphically manage multiple Oracle databases spread across multiple servers from a single workstation. Single license, \$3500.

Contact: Aris Corp., Seattle, WA, (800) 431-2747 or (206) 433-2081;

<http://www.ariscorp.com>.

Circle 1025 on Inquiry Card.

Track 3.1 for Windows, a LAN-based defect-tracking and technical-support system, provides integration of more choices of version control systems; additional reporting and analyzing features; a visual query builder; privileges needed for maintaining multisite databases; automatic notification capabilities via Lotus Notes, cc:Mail, and Microsoft Mail; ability to merge multiple databases and synchronize multisite databases; and additional import and export options, global search and replace, multiple indexing, and additional database-linking features. \$495.

Contact: Soffront Software, Inc., Milpitas, CA, (800) 763-3766 or (408) 263-2703; <http://www.soffront.com>.

Circle 1026 on Inquiry Card.

OLE CUSTOM CONTROLS

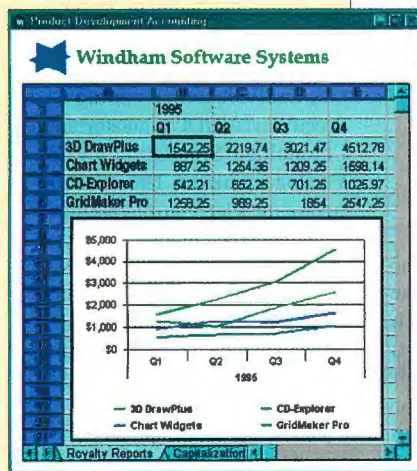
Available as OCXes, four components enable developers working in environments such as Visual Basic 4.0, Visual C++ 4.0, Access 95, Visual FoxPro, and Borland Delphi32 to build custom applications for Windows 95, NT, and 3.1.

You use Formula One 3.0 (\$249) for building spreadsheet-based applications, First Impression 2.0 (\$249) for creating charts and business graphics, VisualSpeller 2.0 (\$149) for checking your spelling, and VisualWriter 3.0 (\$249) for text editing and word processing.

Contact: Visual Components, Inc., Lenexa, KS, (913) 599-6500; 72204,3521

@compuserve.com.

Circle 1001 on Inquiry card.



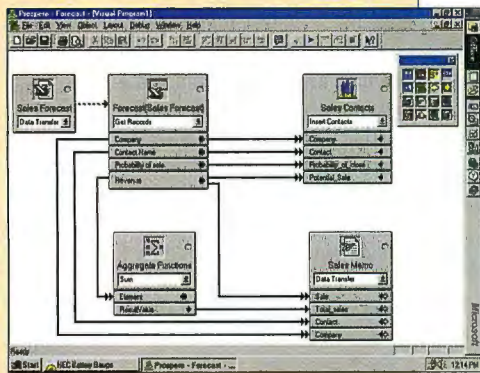
WHAT'S NEW Software

SIMPLIFY DATA INTEGRATION

A Windows-based visual software tool, **Prospero** (\$695) integrates data from multiple sources and destinations without coding. The program automatically creates graphical building blocks from existing Excel spreadsheets, Word documents, ASCII files, Lotus Notes applications, ACT contact manager data, or SQL databases that support ODBC. By graphically connecting these building blocks, you can form visual programs to share data on your desktop with corporate databases. You can run visual programs inside Prospero or save them as stand-alone executable files that can be run as single applications.

Contact: Oberon Software, Cambridge, MA, (617) 494-0990;
<http://www.oberon.com>

Circle 1002 on Inquiry Card.



VIRTUAL-TEAM COORDINATOR

You can turn your PC into a virtual coordinator for your team's individual and group activities. **Cruiser** (\$149) combines fax, E-mail, file transfer, to-do lists, group scheduling, a day planner, an address book, and phone control, as well as calendars.

The program's messaging technology automatically logs incoming and outgoing communications in a multimedia filing cabinet. You can attach notes to the logs and refer to them later. You can even file the logs in folders to keep an electronic history of various projects. **Cruiser** is MAPI-compatible. Therefore, you can integrate it with LAN-based E-mail systems.

Contact: Connectware, Inc., Richardson, TX, (800) 357-0852 or (214) 997-4111;
virtual@connectware.com

Circle 1018 on Inquiry Card.

PROBLEM-SOLVING TOOLKIT

An intuitive spreadsheet alternative, **Go Figure** for Windows (\$99.99) has no cells, no rigid structures, and no confining

rules. Using **E/Paper**, a computerized scratchpad, you place numbers on **E/Paper**; move, change, and connect them; and connect problems to a built-in encyclopedia of 12,000 ready-to-use formula entries. **Go Figure** automatically displays the answers. The program offers almost unlimited what-if capability and handles unit conversions, date-driven calculations, projections, and scientific problem solving.

Contact: Villa Crespo Software, Inc., Highland Park, IL, (800) 521-3963 or (708) 433-0500; VillaC@aol.com

Circle 1016 on Inquiry Card.

LABOR MANAGEMENT

WorkForce, a modular multiapplication software solution, automates labor management. The product includes **Forecaster**, **TimeMeter**, **LaborManager**, and **Scheduler**. **WorkForce** components integrate with external systems, such as human-resource and payroll applications and time-clock mechanisms. **WorkForce** (from \$1100) runs under

Windows, Windows NT, DOS, Unix, and OS/2.

Contact: Park City Group, Park City, UT, (801) 645-2105; mktg@parkcity.com

Circle 1020 on Inquiry Card.

WINDOWS 95 DECISION SUPPORT TOOL SUITE

If you need to access, analyze, and integrate timely business information into reports, memorandums, and spreadsheets for electronic distribution within an organization, **InfoAssistant** (\$495) may be for you. The

Fact Browser allows you to browse, find, and select information from client/server and desktop databases, without knowledge of relational database structures or rules. **Query Generation** builds a SQL query, sends it to the database, and returns results in a table view that you can manipulate. **Analysis and Presentation Views** provide a variety of ways to work with your query results.

Contact: Asymetrix Corp., Bellevue, WA, (800) 488-6543 or (206) 462-0501;
<http://www.asymetrix-.com>

Circle 1009 on Inquiry Card.

WINDOWS-BASED TOOL SUITE

Workview Office (from \$2000) combines **Quad Design's** **Motive** timing-analysis and **XTK** cross-talk-analysis tools; **Vantage's** **SpeedWave** VHDL simulator; and **Chronologic Simulation's** **VCS** Verilog simulator. The scalable environment lets you migrate from a node-locked Windows 95-based environment to a Windows NT network. The company also offers **ViewDraw**, **Design Manager**, **ViewSim**, **ViewSpice**, **Spicelink**, **Analog Fusion**, **ViewDatabook**, and **ViewBase**.

Contact: Viewlogic Systems, Inc., Marlboro, MA, (800) 873-8439 or (508) 480-0881;
<http://www.viewlogic.com>

Circle 1014 on Inquiry Card.

Software Update

A program that automates the manual revision of work-related instructions, documentation, and procedures, **MerexEdit 1.5** provides a **Check** command, which applies controlled vocabulary, writing rules, and grammar to selected documents; document-tracking and reporting capabilities; an improved configuration file and a new user interface; and editor configuration options. Network version for up to five stations, \$15,000.

Contact: Merex Corp., Tempe, AZ, (800) 383-5636 or (602) 921-7077;
info@merexcorp.com

Circle 1024 on Inquiry Card.

An advanced version of statistical-analysis software, **MDP New System Professional Edition** combines the **BMDP New System** with the **BMDP Classical Library** of more than 40 statistical routines, including analysis of variance, nonlinear, and stepwise regression; time series; survival analysis; maximum likelihood estimation; and multivariate analyses. After you select a statistical routine, the **Classic Connection** utility generates the minimum amount of command language you'll need to run your chosen procedure. \$795.

Contact: BMDP Statistical Software, Inc., Los Angeles, CA, (800) 238-2637 or (310) 207-8800;
sales@bmdp.bmdp.com

Circle 1023 on Inquiry Card.

With **Kai's Power Tools 3**, you can interact with your digital creations through an enlarged real-time previewing environment, drag the visual device anywhere on the screen and simultaneously view effects in real time, render custom 3-D spheres, create new textures, mix multiple textures, and graphically view and select preset functions. \$199.

Contact: MetaTools, Inc., Carpinteria, CA, (805) 566-6200; <http://www.hsc.com>

Circle 1022 on Inquiry Card.



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Top mail-order vendors offer the latest hardware and software products at the best prices.

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200

Buyer's Mart

The BYTE classified directory of computer products and services, organized by subject so you can easily locate the right product.

208

TOSHIBA



Portégé 610CT

WIN95 INSTALLED

Portégé 610CT

- Pentium 90MHz processor
- 9.5" True Color display for optimum color
- Built-in 16-bit sound (SoundBlaster Pro compatible), microphone & speaker
- Lithium Ion battery technology
- Accupoint stick for easy control

Processor	Screen	HD	Price
Pentium 90MHz	9.5" True Color	720MB	\$399

Tecra 700

- Pentium 120MHz processor – fastest available on a notebook!
- PCI bus architecture (internal & external)
- 11.3", 800x600 high resolution displays
- Optional 4X CD-ROM Drive (swap floppy & CD-ROM)
- Multimedia docking station with PCI bus (optional accessory, priced separately)
- Built-in 16-bit sound, microphone, 2 speakers & MIDI
- HUGE, 1.13GB hard drives

WIN95 INSTALLED



Tecra 700

Processor	Screen	HD	Price
Pentium 120	11.3" Dual Scan	1.13GB	\$4679
Pentium 120	11.3" Active	1.13GB	\$949



Satellite 2110/2130

Satellite 2110/2130

Processor	Screen	HD	Price
486DX4/75	10.4" Dual Scan	330MB	\$1679
486DX4/75	10.4" Dual Scan	500MB	1969
486DX4/75	10.4" Active	500MB	2499

BIG! 11.3" Screens



Satellite Pro 410

WIN95 INSTALLED

Satellite Pro 400 & Satellite Pro 410

- Built-in 4X CD-ROM Drive (Swap floppy & CD-ROM) (Active models only - optional on Dual Scan)
- Built-in 16-bit sound, microphone, speaker & MIDI
- EDO RAM memory, exp. to 40MB (Sat. Pro 410 only)
- Built-in AC adapter - small, sleek design & reduced weight
- Integrated Accupoint - small, accurate & easy to use
- Lithium Ion battery technology
- Built-in infrared for wireless communications

Satellite Pro 400

Processor	Screen	HD	Price
Pentium 75	10.4" Dual Scan	772MB	\$2999
Pentium 75	10.4" Active	772MB	3999

Satellite Pro 410

Pentium 90	11.3" Dual Scan	772MB	\$3499
Pentium 90	11.3" Active	772MB	4679

IBM®



ThinkPad® 365CD

ThinkPad® 365

- 10.4" Active (64K colors) & 10.4" Dual Scan
- Built-in infrared for no-hassle printer connections
- Multimedia models include built-in 2X CD-ROM, SoundBlaster compatible audio, speaker, microphone & MIDI/joystick port
- MS Windows 95 or Selecta System models available

Processor	Screen	HD	Price
486DX4/75	10.4" Dual Scan	540MB	\$1999
486DX4/75	10.4" Active	540MB	2599
486DX4/75	10.4" Dual Scan	540MB	2499*
486DX4/75	10.4" Active	540MB	3099*

*Multimedia Models

ThinkPad® 760

- Pentium 90 & 120MHz with 32-bit local bus
- 12.1" Active displays with 800x600 resolution (selected models)
- 4X CD-ROM Drive, MPEG-2 support, & full motion video (ThinkPad 760CD only*)
- Built-in 28.8 fax/modem
- SoundBlaster-compatible audio & telephony
- Lithium Ion battery technology
- MS Windows or Selecta System models available

Processor	Screen	HD	Price
Pentium 90	10.4" Active	720MB	\$5349
Pentium 90	12.1" Active	720MB	6049
Pentium 120	12.1" Active	720MB	6599
Pentium 90	12.1" Active	1.2GB	7449*

*Features built-in CD-ROM drive



ThinkPad® 760

BIG! 12.1" Display

NEC

Versa 2000

Processor	Screen	HD	Price
486DX4/75	9.5" Active	350MB	\$2099*
486DX4/75	9.5" Active	350MB	2399
486DX4/75	9.5" Active	540MB	2599

*14.4 fax/modem not built-in

NEC Versa 4000

- Built-in CD-ROM Drive! (Standard on some models, optional on others)
- Pentium 75 and Pentium 90 processors
- 256KB Level 2 Cache to optimize performance
- Unbelievable displays – 65K color Dual Scan, 16.8 million color Active (High resolution Active Matrix displays available – 800x600 res.)
- Built-in 16-bit sound, microphone, MIDI and 2 built-in speakers
- Multimedia docking station with outstanding Altec Lansing 4 speaker array (optional accessory, priced separately)

Processor	Screen	HD	Price
Pentium 75	10.4" Dual Scan	540MB	\$3499
Pentium 75	10.4" Dual Scan	540MB	3799*
Pentium 75	10.1" Active	540MB	3999
Pentium 90	10.1" Active	810MB	4649
Pentium 90	10.4" High Res.	810MB	4799
Pentium 120	10.4" High Res.	1GB	5499

* Features built-in CD-ROM drive

Call about NEC Ready Multimedia Computers

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NEC Versa 4000

NEW 120MHz Pentium Model!

LEAT LINEUP

CALL for Guaranteed Lowest Price on Systems

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COMPAQ



LTE 5000



Contura 420/430

Processor	Screen	HD	Price
486DX4/75	10.4" Dual Scan	420MB	\$2089
486DX4/75	10.4" Active	420MB	2559
486DX4/100	10.4" Dual Scan	720MB	2369
486DX4/100	10.4" Active	720MB	2939

LTE 5000 Series

- Up to 120MHz Pentium power w/PCI bus & 256KB cache
- 32-bit PCI Local bus graphics
- 8MB RAM exp. to 72MB
- Built-in 16-bit sound, microphone & 2 speakers
- Multibay - holds CD-ROM, 2nd HDD, Floppy, or 2nd battery.
- Up to 1.35GB hard drives (2.7GB max. capacity)
- Built-in infrared for wireless communications
- Supports NiMH & Lithium Ion batteries (up to 8 hrs.)
- Optional MPEG and TV video adapter

Processor	Screen	HD	Price
Pentium 75	10.4" Dual Scan	510MB	\$3799
Pentium 75	11.3" Dual Scan	810MB	4439
Pentium 75	10.4" Active	810MB	4729
Pentium 90	10.4" Active	810MB	5339
Pentium 90	10.4" Active	810MB	5599*
Pentium 120	10.4" Active	1.35GB	6379

*Features Built-In CD-ROM drive

Call about COMPAQ desktop PCs and PC Servers!

hp HEWLETT PACKARD

HP OmniBook 600

- Weights **ONLY 3.8 pounds!**
- Built-in 16-bit sound, microphone & speaker (active model only)
- Built-in infrared for no-hassle printer connections
- Lithium Ion battery technology (active model only)
- Instant "ON" ready-to-work state - lasts for months on a charge

Processor	Screen	HD	Price
486DX4/75	9.5" Dual Scan	340MB	\$2539
486DX4/75	9.5" Active	340MB	2999

HP OmniBook 5000

- Pentium 90MHz with 32-bit PCI Local bus
- 1.2GB drives available for high capacity storage
- High resolution - 800x600 resolution on notebook display
- Built-in 16-bit sound, microphone & speaker

Processor	Screen	HD	Price
Pentium 90	10.4" Active	1.2GB	\$5329
Pentium 90	10.4" Active	1.2GB	5889*
Pentium 120	10.4" Active	1.2GB	6539*

*16MB RAM standard

HP OmniBook 5000 Notebook PC

90MHz & 120MHz Pentium with PCI Bus



HP OmniBook 600 Notebook PC

AST

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75MHz & 90MHz Pentium

Ascentia 950N

- 75MHz and 90MHz Pentium - for blazing performance
- 10.4" Active & Dual Scan
- High Res. displays - 800x600 res. on notebook
- Built-in 16-bit sound, microphone & speaker
- Lithium Ion battery technology
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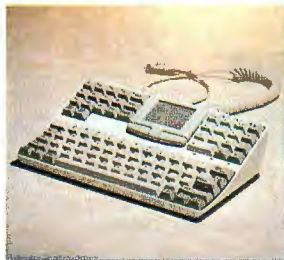
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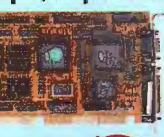


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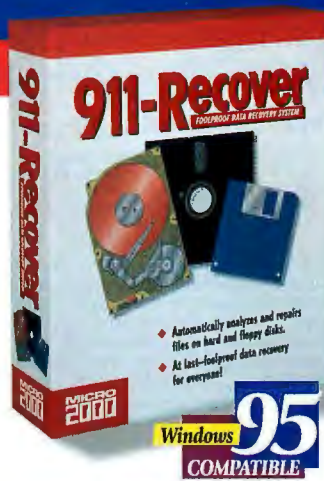
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ST12120V	110MB	10MS	SCSI-2	549-694
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ST12120X	110MB	10MS	SCSI-2	589-734
ST12120Y	110MB	10MS	SCSI-2	609-754
ST12120Z	110MB	10MS	SCSI-2	629-774
ST12120AA	110MB	10MS	SCSI-2	649-794
ST12120AB	110MB	10MS	SCSI-2	669-814
ST12120AC	110MB	10MS	SCSI-2	689-834
ST12120AD	110MB	10MS	SCSI-2	709-854
ST12120AE	110MB	10MS	SCSI-2	729-874
ST12120AF	110MB	10MS	SCSI-2	749-894
ST12120AG	110MB	10MS	SCSI-2	769-914
ST12120AH	110MB	10MS	SCSI-2	789-934
ST12120AI	110MB	10MS	SCSI-2	809-954
ST12120AJ	110MB	10MS	SCSI-2	829-974
ST12120AK	110MB	10MS	SCSI-2	849-994
ST12120AL	110MB	10MS	SCSI-2	869-1014
ST12120AM	110MB	10MS	SCSI-2	889-1034
ST12120AN	110MB	10MS	SCSI-2	909-1054
ST12120AO	110MB	10MS	SCSI-2	929-1074
ST12120AP	110MB	10MS	SCSI-2	949-1094
ST12120AQ	110MB	10MS	SCSI-2	969-1114
ST12120AR	110MB	10MS	SCSI-2	989-1134
ST12120AS	110MB	10MS	SCSI-2	1009-1154
ST12120AT	110MB	10MS	SCSI-2	1029-1174
ST12120AU	110MB	10MS	SCSI-2	1049-1194
ST12120AV	110MB	10MS	SCSI-2	1069-1214
ST12120AW	110MB	10MS	SCSI-2	1089-1234
ST12120AX	110MB	10MS	SCSI-2	1109-1254
ST12120AY	110MB	10MS	SCSI-2	1129-1274
ST12120AZ	110MB	10MS	SCSI-2	1149-1294
ST12120BA	110MB	10MS	SCSI-2	1169-1314
ST12120BB	110MB	10MS	SCSI-2	1189-1334
ST12120BC	110MB	10MS	SCSI-2	1209-1354
ST12120BD	110MB	10MS	SCSI-2	1229-1374
ST12120BE	110MB	10MS	SCSI-2	1249-1394
ST12120BF	110MB	10MS	SCSI-2	1269-1414
ST12120BG	110MB	10MS	SCSI-2	1289-1434
ST12120BH	110MB	10MS	SCSI-2	1309-1454
ST12120BI	110MB	10MS	SCSI-2	1329-1474
ST12120BJ	110MB	10MS	SCSI-2	1349-1494
ST12120BK	110MB	10MS	SCSI-2	1369-1514
ST12120BL	110MB	10MS	SCSI-2	1389-1534
ST12120BM	110MB	10MS	SCSI-2	1409-1554
ST12120BN	110MB	10MS	SCSI-2	1429-1574
ST12120BO	110MB	10MS	SCSI-2	1449-1594
ST12120BP	110MB	10MS	SCSI-2	1469-1614
ST12120BQ	110MB	10MS	SCSI-2	1489-1634
ST12120BR	110MB	10MS	SCSI-2	1509-1654
ST12120BS	110MB	10MS	SCSI-2	1529-1674
ST12120BT	110MB	10MS	SCSI-2	1549-1694
ST12120BU	110MB	10MS	SCSI-2	1569-1714
ST12120BV	110MB	10MS	SCSI-2	1589-1734
ST12120BW	110MB	10MS	SCSI-2	1609-1754
ST12120BX	110MB	10MS	SCSI-2	1629-1774
ST12120BY	110MB	10MS	SCSI-2	1649-1794
ST12120BZ	110MB	10MS	SCSI-2	1669-1814
ST12120CA	110MB	10MS	SCSI-2	1689-1834
ST12120CB	110MB	10MS	SCSI-2	1709-1854
ST12120CC	110MB	10MS	SCSI-2	1729-1874
ST12120CD	110MB	10MS	SCSI-2	1749-1894
ST12120CE	110MB	10MS	SCSI-2	1769-1914
ST12120CF	110MB	10MS	SCSI-2	1789-1934
ST12120CG	110MB	10MS	SCSI-2	1809-1954
ST12120CH	110MB	10MS	SCSI-2	1829-1974
ST12120CI	110MB	10MS	SCSI-2	1849-1994
ST12120CJ	110MB	10MS	SCSI-2	1869-2014
ST12120CK	110MB	10MS	SCSI-2	1889-2034
ST12120CL	110MB	10MS	SCSI-2	1909-2054
ST12120CM	110MB	10MS	SCSI-2	1929-2074
ST12120CN	110MB	10MS	SCSI-2	1949-2094
ST12120CO	110MB	10MS	SCSI-2	1969-2114
ST12120CP	110MB	10MS	SCSI-2	1989-2134
ST12120CQ	110MB	10MS	SCSI-2	2009-2154
ST12120CR	110MB	10MS	SCSI-2	2029-2174
ST12120CS	110MB	10MS	SCSI-2	2049-2194
ST12120CT	110MB	10MS	SCSI-2	2069-2214
ST12120CU	110MB	10MS	SCSI-2	2089-2234
ST12120CV	110MB	10MS	SCSI-2	2109-2254
ST12120CW	110MB	10MS	SCSI-2	2129-2274
ST12120CX	110MB	10MS	SCSI-2	2149-2294
ST12120CY	110MB	10MS	SCSI-2	2169-2314
ST12120CZ	110MB	10MS	SCSI-2	2189-2334
ST12120DA	110MB	10MS	SCSI-2	2209-2354
ST12120DB	110MB	10MS	SCSI-2	2229-2374
ST12120DC	110MB	10MS	SCSI-2	2249-2394
ST12120DD	110MB	10MS	SCSI-2	2269-2414
ST12120DE	110MB	10MS	SCSI-2	2289-2434
ST12120DF	110MB	10MS	SCSI-2	2309-2454
ST12120DG	110MB	10MS	SCSI-2	2329-2474
ST12120DH	110MB	10MS	SCSI-2	2349-2494
ST12120DI	110MB	10MS	SCSI-2	2369-2514
ST12120DJ	110MB	10MS	SCSI-2	2389-2534
ST12120DK	110MB	10MS	SCSI-2	2409-2554
ST12120DL	110MB	10MS	SCSI-2	2429-2574
ST12120DM	110MB	10MS	SCSI-2	2449-2594
ST12120DN	110MB	10MS	SCSI-2	2469-2614
ST12120DO	110MB	10MS	SCSI-2	2489-2634
ST12120DP	110MB	10MS	SCSI-2	2509-2654
ST12120DQ	110MB	10MS	SCSI-2	2529-2674
ST12120DR	110MB	10MS	SCSI-2	2549-2694
ST12120DS	110MB	10MS	SCSI-2	2569-2714
ST12120DT	110MB	10MS	SCSI-2	2589-2734
ST12120DU	110MB	10MS	SCSI-2	2609-2754
ST12120DV	110MB	10MS	SCSI-2	2629-2774
ST12120DW	110MB	10MS	SCSI-2	2649-2794
ST12120DX	110MB	10MS	SCSI-2	2669-2814
ST12120DY	110MB	10MS	SCSI-2	2689-2834
ST12120DZ	110MB	10MS	SCSI-2	2709-2854
ST12120EA	110MB	10MS	SCSI-2	2729-2874
ST12120EB	110MB	10MS	SCSI-2	2749-2894
ST12120EC	110MB	10MS	SCSI-2	2769-2914
ST12120ED	110MB	10MS	SCSI-2	2789-2934
ST12120EE	110MB	10MS	SCSI-2	2809-2954
ST12120EF	110MB	10MS	SCSI-2	2829-2974
ST12120EG	110MB	10MS	SCSI-2	2849-2994
ST12120EH	110MB	10MS	SCSI-2	2869-3014
ST12120EI	110MB	10MS	SCSI-2	2889-3034
ST12120EJ	110MB	10MS	SCSI-2	2909-3054
ST12120EK	110MB	10MS	SCSI-2	2929-3074
ST12120EL	110MB	10MS	SCSI-2	2949-3094
ST12120EM	110MB	10MS	SCSI-2	2969-3114
ST12120EN	110MB	10MS	SCSI-2	2989-3134
ST12120EO	110MB	10MS	SCSI-2	3009-3154
ST12120EP	110MB	10MS	SCSI-2	3029-3174
ST12120EQ	110MB	10MS	SCSI-2	3049-3194
ST12120ER	110MB	10MS	SCSI-2	3069-3214
ST12120ES	110MB	10MS	SCSI-2	3089-3234
ST12120ET	110MB	10MS	SCSI-2	3109-3254
ST12120EU	110MB	10MS	SCSI-2	3129-3274
ST12120EV	110MB	10MS	SCSI-2	3149-3294
ST12120EW	110MB	10MS	SCSI-2	3169-3314
ST12120EX	110MB	10MS	SCSI-2	3189-3334
ST12120EY	110MB	10MS	SCSI-2	3209-3354
ST12120EZ	110MB	10MS	SCSI-2	3229-3374
ST12120FA	110MB	10MS	SCSI-2	3249-3394
ST12120FB	110MB	10MS	SCSI-2	3269-3414
ST12120FC	110MB	10MS	SCSI-2	3289-3434
ST12120FD	110MB	10MS	SCSI-2	3309-3454
ST12120FE	110MB	10MS	SCSI-2	3329-3474
ST12120FF	110MB	10MS	SCSI-2	3349-3494
ST12120FG	110MB	10MS	SCSI-2	3369-3514
ST12120FH	110MB	10MS	SCSI-2	3389-3534
ST12120FI	110MB	10MS	SCSI-2	3409-3554
ST12120FJ	110MB	10MS	SCSI-2	3429-3574
ST12120FK	110MB	10MS	SCSI-2	3449-3594
ST12120FL	110MB	10MS	SCSI-2	3469-3614
ST12120FM	110MB	10MS	SCSI-2	3489-3634
ST12120FN	110MB	10MS	SCSI-2	3509-3654
ST12120FO	110MB	10MS	SCSI-2	3529-3674
ST12120FP	110MB	10MS	SCSI-2	3549-3694
ST12120FQ	110MB	10MS	SCSI-2	3569-3714
ST12120FR	110MB	10MS	SCSI-2	3589-3734
ST12120FS	110MB	10MS	SCSI-2	3609-3754
ST12120FT	110MB	10MS	SCSI-2	3629-3774
ST12120FU	110MB	10MS	SCSI-2	3649-3794
ST12120FV	110MB	10MS	SCSI-2	3669-3814
ST12120FW	110MB	10MS	SCSI-2	3689-3834
ST12120FX	110MB	10MS	SCSI-2	3709-3854
ST12120FY	110MB	10MS	SCSI-2	3729-3874
ST12120FZ	110MB	10MS	SCSI-2	3749-3894
ST12120GA	110MB	10MS	SCSI-2	3769-3914
ST12120GB	110MB	10MS	SCSI-2	3789-3934
ST12120GC	110MB	10MS	SCSI-2	3809-3954
ST12120GD	110MB	10MS	SCSI-2	3829-3974
ST12120GE	110MB	10MS	SCSI-2	3849-3994
ST12120GF	110MB	10MS	SCSI-2	3869-4014
ST12120GG	110MB	10MS	SCSI-2	3889-4034
ST12120GH	110MB	10MS	SCSI-2	3909-4054
ST12120GI	110MB	10MS	SCSI-2	3929-4074
ST12120GJ	110MB	10MS	SCSI-2	3949-4094
ST12120GK	110MB	10MS	SCSI-2	3969-4114
ST12120GL	110MB	10MS	SCSI-2	3989-4134
ST12120GM	110MB	10MS	SCSI-2	4009-4154
ST12120GN	110MB	10MS	SCSI-2	4029-4174
ST12120GO	110MB	10MS	SCSI-2	4049-4194
ST12120GP	110MB	10MS	SCSI-2	4069-4214
ST12120GQ	110MB	10MS	SCSI-2	4089-4234
ST12120GR	110MB	10MS	SCSI-2	4109-4254
ST12120GS	110MB	10MS	SCSI-2	4129-4274
ST12120GT	110MB	10MS	SCSI-2	4149-4294
ST12120GU	110MB	10MS	SCSI-2	4169-4314
ST12120GV	110MB	10MS	SCSI-2	4189-4334
ST12120GW	110MB	10MS	SCSI-2	4209-4354
ST12120GX	110MB	10MS	SCSI-2	4229-4374
ST12120GY	110MB	10MS	SCSI-2	4249-4394
ST12120GZ	110MB	10MS	SCSI-2	4269-4414
ST12120HA	110MB	10MS	SCSI-2	4289-4434
ST12120HB	110MB	10MS	SCSI-2	4309-4454
ST12120HC	110MB	10MS	SCSI-2	4329-4474
ST12120HD	110MB	10MS	SCSI-2	4349-4494
ST12120HE	110MB	10MS	SCSI-2	4369-4514
ST12120HF	110MB	10MS	SCSI-2	4389-4534
ST12120HG	110MB	10MS	SCSI-2	4409-4554
ST12120HH	110MB	10MS	SCSI-2	4429-4574
ST12120HI	110MB	10MS	SCSI-2	4449-4594
ST12120HJ	110MB	10MS	SCSI-2	4469-4614
ST12120HK	110MB	10MS	SCSI-2	4489-4634
ST12120HL	110MB	10MS	SCSI-2	4509-4654
ST12120HM	110MB	10MS	SCSI-2	4529-4674
ST12120HN	110MB	10MS	SCSI-2	4549-4694
ST12120HO	110MB	10MS	SCSI-2	4569-4714
ST12120HP	110MB	10MS	SCSI-2	4589-4734
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16MB 500987-004	\$589	32MB 500987-005	\$1,179
Premio GX (all models)			
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32MB 501567-001	\$1,179	64MB 501568-001	\$2,199
Premio MX (all models)			
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32MB 500987-005	\$1,179	64MB 501569-001	\$2,359

COMPAQ

Presario 720, 724, 774, 920, 924, 840, 992, 982, 972, 978, 954, 526, 524, 528, 520, 510			
4MB	\$147	8MB	\$291
16MB	\$472	32MB	\$943
64MB	\$1,854	128MB	\$3,707
Presario 650, 660, 663, 433, 425, 866, 850, 833, 866			
4MB	\$147	8MB	\$291
16MB	\$472	32MB	\$943
64MB	\$1,854	128MB	\$3,707
Proline 575MX, 590MX, 5133, 5100, 575, 590, 4100, 465, 450			
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16MB	\$472	32MB	\$943
64MB	\$1,854	128MB	\$3,707
Proline Enhanced (all models), 466, 433, 450, CDS, 4255, 4335			
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16MB	\$472	32MB	\$943
64MB	\$1,854	128MB	\$3,707
Desktop 590MX, 575MX, 575, 590, 5100			
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16MB	\$472	32MB	\$943
64MB	\$1,854	128MB	\$3,707
Desktop XL (all models)			
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64MB	\$1,854	128MB	\$3,707

DELL

Dimension 775, P90			
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16MB n/a	\$589	32MB n/a	\$1,119
Dimension P100, P75+			
4MB (EDO) n/a	\$179	8MB (EDO) n/a	\$329
16MB (EDO) n/a	\$799	32MB (EDO) n/a	\$1,409
Dimension XPS (all models)			
4MB n/a	\$159	8MB (EDO) n/a	\$179
16MB n/a	\$589	32MB (EDO) n/a	\$329
64MB n/a	\$1,119	128MB (EDO) n/a	\$1,409

GATEWAY 2000

PS-75, PS-90/P00, PS-100X, PS-120, PS-133/133X			
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16MB n/a	\$589	32MB n/a	\$1,119

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Vectra VE, VL3, VL2, 66/100, XM3, XM2, M2			
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16MB n/a	\$589	32MB n/a	\$1,119

IBM

PC 700 Series (all models) & Valuepoint Performance Series			
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16MB n/a	\$589	32MB n/a	\$1,119
PC 300 Series (all models) Aptiva (all models)			
4MB n/a	\$159	8MB n/a	\$291
16MB n/a	\$589	32MB n/a	\$1,119
Aptiva 300, 500 and 700 series			
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Edgewood 55			
4MB	74G1299		\$174

IBM, continued

Edgewood 30, 40 and 50 models			
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PS/1 286, 386SX		2MB 92F9925	\$83
4MB 92F9924	\$163	Valuepoint Performance models	
4MB 92G9201 or 73G3131	\$169		
8MB 92G9202 or 73G3132	\$329		
PS/1 Consultant, Essential, Expert models x43, x44, PS/Valuepoint all models except Cxa models			
4MB 96F9290	\$177	16MB 96F9291	\$609
PS/1 Consultant, Essential, Expert models			
16MB	96F9291		\$609
PS/2 25/286, 30/286			
2MB	30F5260		\$79
PS/2 355X, 15, 405X, 50Z, 555X, 15, 655X, 15, 70, XStation			
2MB	645004		\$87
PS/2 70A21; A61; B21; B61; PS/Valuepoint Cxa models			
PS/1 Consultant, Essential, Expert models			
2MB	645006		\$95
PS/2 355X, 15, 405X, 555X, 15, 655X, 15, XStation, PS/Valuepoint Cxa models			
4MB	24F2933 or 87F9977		\$179

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PS/2 90 XP, 95 XP, P75 (point), 56, 57 (all) PS/1 Pro M2123			
2MB	6450902		\$85
PS/2 90 XP, 95 XP, P75 (point), 56, 57 (all models)			
PS/1 Consultant, Essential, Expert models, PS/1 Pro M2123			
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PS/2 80A21; A31; A14			
4MB	6451060		\$193
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MICRON

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16MB n/a	\$589	32MB n/a	\$1,119

NEC

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16MB CP-1030002	\$613	32MB CP-1030003	\$1,199
PowerMate Value Series (all models) & Ready Series (all models)			
4MB CP-410-14003	\$159	8MB CP-410-14004	\$291
16MB CP-410-14005	\$569	32MB CP-410-14006	\$1,119
Image 425, 433, 466			
4MB 410-12002	\$159	16MB 410-12003	\$569
Ready 425, 433			
4MB n/a	\$159	16MB n/a	\$569
PowerMate 386/333, Express Te, e models			
4MB CP-410-6205	\$169	16MB CP-410-6206	\$613
PowerMate 286/12, SX/16, SX/20			
2MB CP-410-8103			\$89
PowerMate 386SX/20; v, 18; 25; 486/50; 331			
8MB CP-410-2101			\$304
PowerMate SX Plus			
2MB Board n/a			\$163
4MB Board n/a			\$278
PowerMate SX/20			
2MB CPU Upgrade CP-410-8101			\$131
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2MB APC-H655	\$219	8MB APC-H656	\$539
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2MB CP-4105101			\$171

PACKARD BELL			
Forza Series (all models) & Executive Series (all models)			
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16MB n/a	\$589	32MB n/a	\$1,119

ZENITH

Z4000, Z-Station SEH, SEH, SH, SN, DEH, DK and Xen Z300/400 Series, Z-420/SX, Z-425/SX, Z-433/DX, SX			
4MB ME-100			\$169
16MB ME-90			\$613
Z-Station models			
2MB	ME-70		\$49
4MB	ME-100		\$179
Z-Select 100 models			
4MB AME-0070	\$179	8MB AME-0073	\$354
Zenith Z-386/20; 25; 33; 33E			
1MB ZAS300ME			\$149
4MB ZAS300MX			\$179
Zenith Z-386SX/16 and Z-386SX/20			
2MB Z6051			\$89
Z-Server EX and IT models			
8MB ME-432			\$329
16MB ME-102			\$613
32MB ME-442			\$1,199
64MB ME-92			\$2,359
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Epson ActionLaser 1600			
4MB n/a	\$159	16MB n/a	\$609
HP LaserJet 4L			
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HP LaserJet 5L			
1MB C3939A	\$88	2MB C3147A	\$137
4MB C3148A	\$225	8MB n/a	\$390
HP LaserJet HP III, HP III, HP III			
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HP LaserJet II, II			
2MB 33444B	\$95	4MB 33445B	\$169
HP LaserJet IIIi, 4, 4M, 4Si, 4SiMX, XL300, Desktop 1200c			
1MB C2063A	\$48	2MB C2064A	\$89
4MB C2065A	\$169	8MB C2066A	\$339
HP LaserJet HP, 4MB Color LaserJet			
2MB C1313A	\$95	4MB C1312A	\$170
HP LaserJet 500, 500C, 520C, 520C, 550C, 560, 560C, 256K			
2MB 22707B			\$40
HP DesignJet 5P, 5MP			
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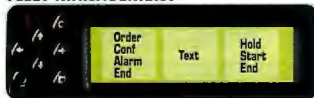


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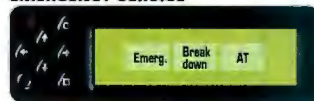
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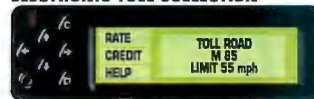
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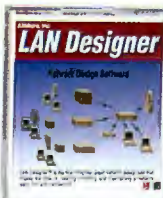
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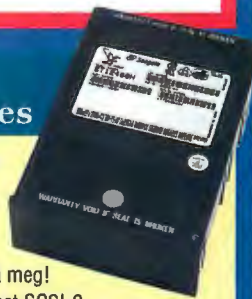
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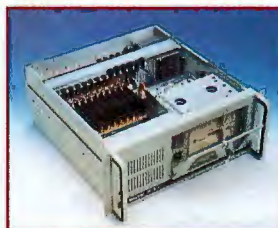


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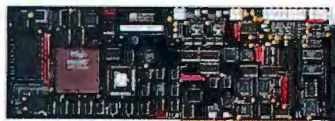
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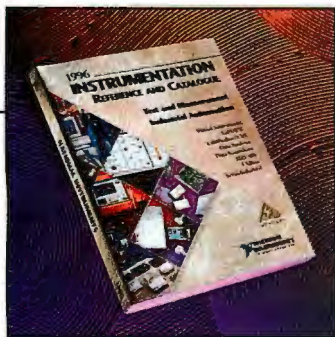
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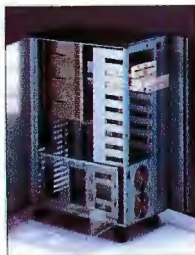
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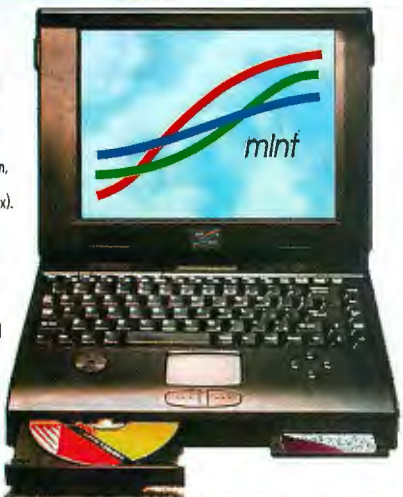
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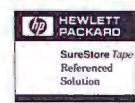
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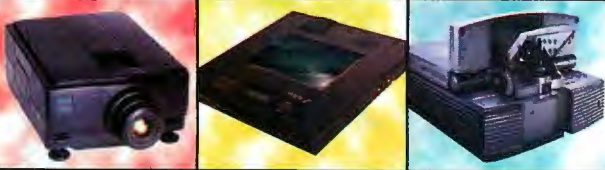


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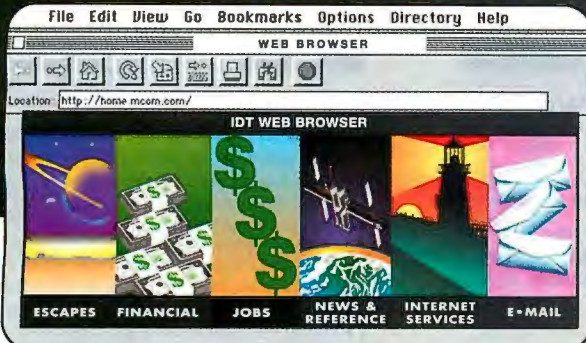
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London NW11 5AN
England
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ISRAEL

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DARA International
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TAIWAN

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The Real Software Crisis

The shortage of top-notch programmers threatens to become the limiting factor in software development

Grady Booch calls it “one of the dirty little secrets of software engineering”: Success in software development depends most upon the quality of the people involved. In his book *Software Engineering Economics* (Prentice-Hall, 1981), Barry Boehm rigorously shows individual and team productivity to be the leading predictor in estimating software costs; it’s twice as significant as product complexity. And any decent book on building and managing a software team urges you to “hire the best people.”

Ah, there’s the rub. Perhaps you’ve noticed that it’s getting more and more difficult to locate and then hire the best people. This isn’t an illusion; it’s real, it’s significant, and it’s only going to get worse. It is, in fact, the heart of the *real* software crisis: There is more software to be developed than there are capable developers to do it. Demand will continue to outstrip supply for the foreseeable future. Hence, more and more software will be behind schedule, over budget, underpowered, and of poor quality—and there’s nothing we can do about it.

“Nothing?” you ask. “What about better schools, better tools, better on-the-job training, better methodologies?” Those are essential because they raise the quality of most developers. But they do not solve the fundamental problem.

The conclusion I have reluctantly come to after more than 20 years of software development is this: Excellent developers, like excellent musicians and artists, are born, not made. The number of such developers is a fixed (and tiny) percentage of the population. Thus, the absolute number of such developers grows very slowly. At the same time, the demand for them expands rapidly due to the world’s increasing use of, and reliance on, software.

The situation is worse than it appears. Some of these innately talented people never go into the computer industry. Many who do never develop their full potential. Others become prima donnas, demanding large salaries and extreme benefits. Or they become “cowboy programmers,” shooting from the hip and holding teams, projects, or entire companies hostage. A few burn out and leave the field. Of those left, only a fraction meets the requirements for your project.

This is not to slight the decent, talented software engineers, the ones who study hard and work hard at developing and maintaining their skills. Indeed, if not for them, we wouldn’t have a software industry at all. But even they can’t meet the demand, and their efforts are undervalued by the mediocre (or worse) programmers.

Suppose that companies needed in-house orchestras



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to produce quality music. The demand for musicians would explode, and their starting salaries would soar. Think about the vast number of people (especially college students) who would take up music regardless of their talent or inclination, guaranteed an entry-level position because companies were desperate to fill all those seats.

Here and there, a great soloist or ensemble would play with passion, skill, and creativity, but much of what musicians produced would be cacophony, especially as the newcomers and those lacking talent and skill struggled with unfamiliar instruments and pieces. Now imagine that jobs, companies, and lives depended on how flawlessly the players performed.

This scenario describes the current state of software development. I saw this for the first time when I went back to teach computer science at the same place I had studied a decade earlier. The enrollment of computer science majors had gone up by almost a factor of 10, yet a professor who had been there since I was a student noted that the absolute number of really excellent computer science students remained the same.

In the years since my graduation, my experience in building and working with development teams has confirmed this. Ask any manager how many résumés and interviews it takes to find a top-notch software architect or developer.

As needs, costs, and opportunities escalate, some great breakthrough—a “silver bullet,” to use Frederick Brooks’ classic phrase—may yet quell the software crisis, reducing the complexities of development. If you wish to bet on that, go ahead. But in the meantime, keep your eyes and your checkbook open and grab the great programmers when you can—they’re getting really hard to find. ■

Bruce F. Webster is a consultant and author of Pitfalls of Object-Oriented Development and The Art of 'Ware (both M&T Books, 1995). He can be contacted on the Internet at bwebster@bfwa.com or on BIX c/o "editors."

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