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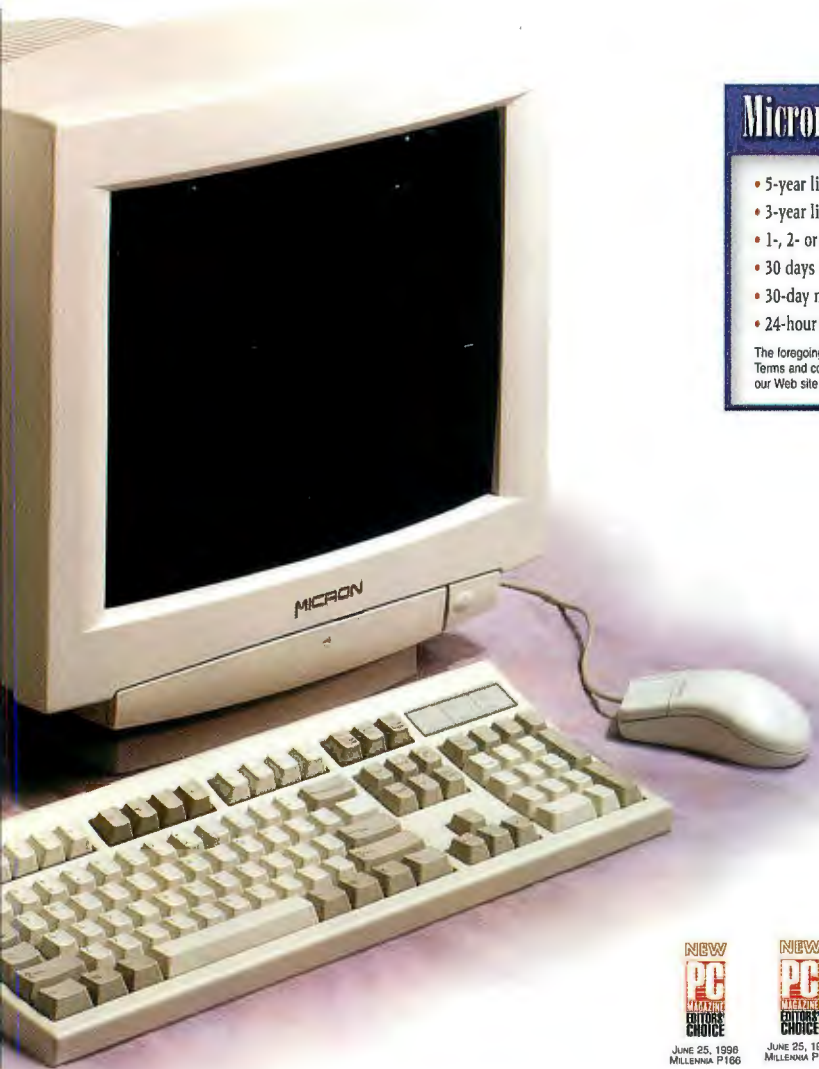

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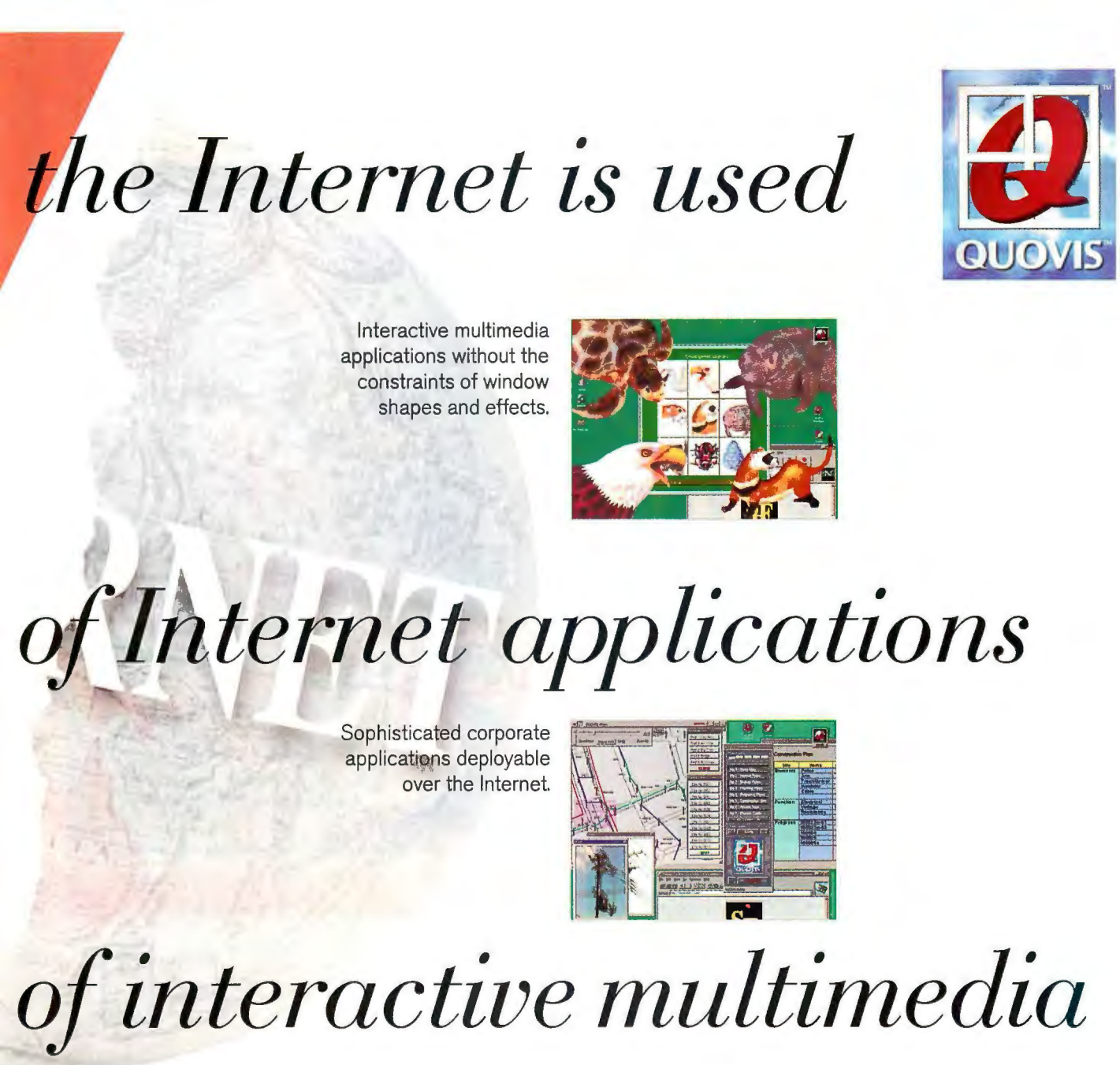

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BYTE

December 1996, vol. 21, no. 12

COVER STORY

HOW CHIPS CHANGED THE WORLD

68

By Peter Wayner

10 ways in which that sliver of silicon altered the course of Planet Earth.

Birth of a Chip

77

By Linley Gwennap

A brief history of the microprocessor, from the 4004 to today's nitro-burning rockets.

Eight Ways to the Future

85

By Robert Hummel

Technology experts agree: Change is the only sure thing about computing in the next decade.

PowerPC Speed Demon

88NA 1

By Tom R. Halfhill

Bipolar transistors give Exponential's 533-MHz PowerPC chip the performance of an Alpha at an affordable price.

EDITORIAL

Peace on the Wired Planet

14

By Mark Schlack

Flaming's one thing, but the lack of civility on-line is getting out of control.

INBOX

19

BYTE readers write about that bandwidth barrier and the future of the Internet, Web conferencing, and the search for killer software.

BITS

STATE OF THE ART

Web Development

118

This month we take an in-depth look at the technologies that will shape the Web of tomorrow.

LDAP Unites the Internet

121

By Jamie Lewis

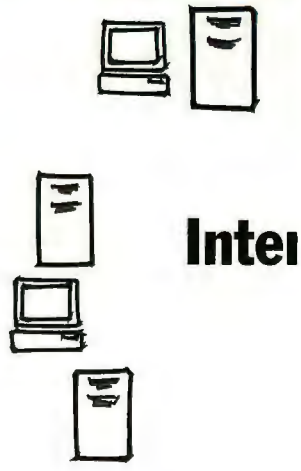
New directory services, especially Lightweight Directory Access Protocol, extend the directory metaphor to the Internet.

Internet Armor

127

By William Stallings

Secure IP lets you use the open Internet with privacy and confidence.



E-Mail Grows Up

135

By Dave Kosiur

IMAP will provide e-mail services and options impossible with the current POP.

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LAB REPORT

LAB REPORT: HARDWARE

LAB REPORT: SOFTWARE

WHAT'S NEW

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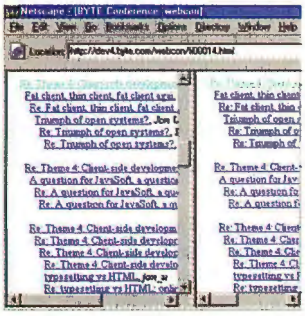

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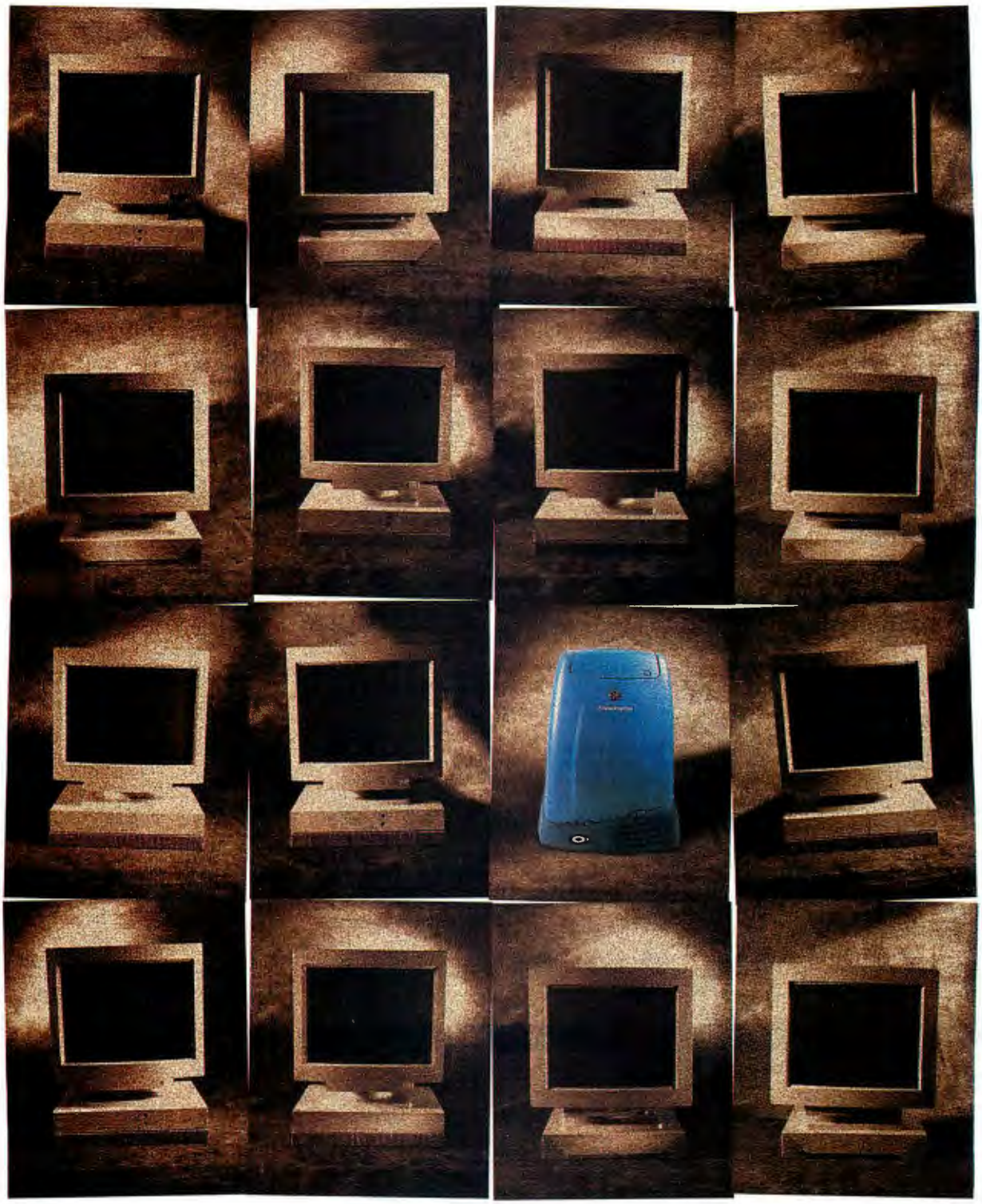

BYTE

December 1996, vol. 21, no. 12

See listing on page 193.

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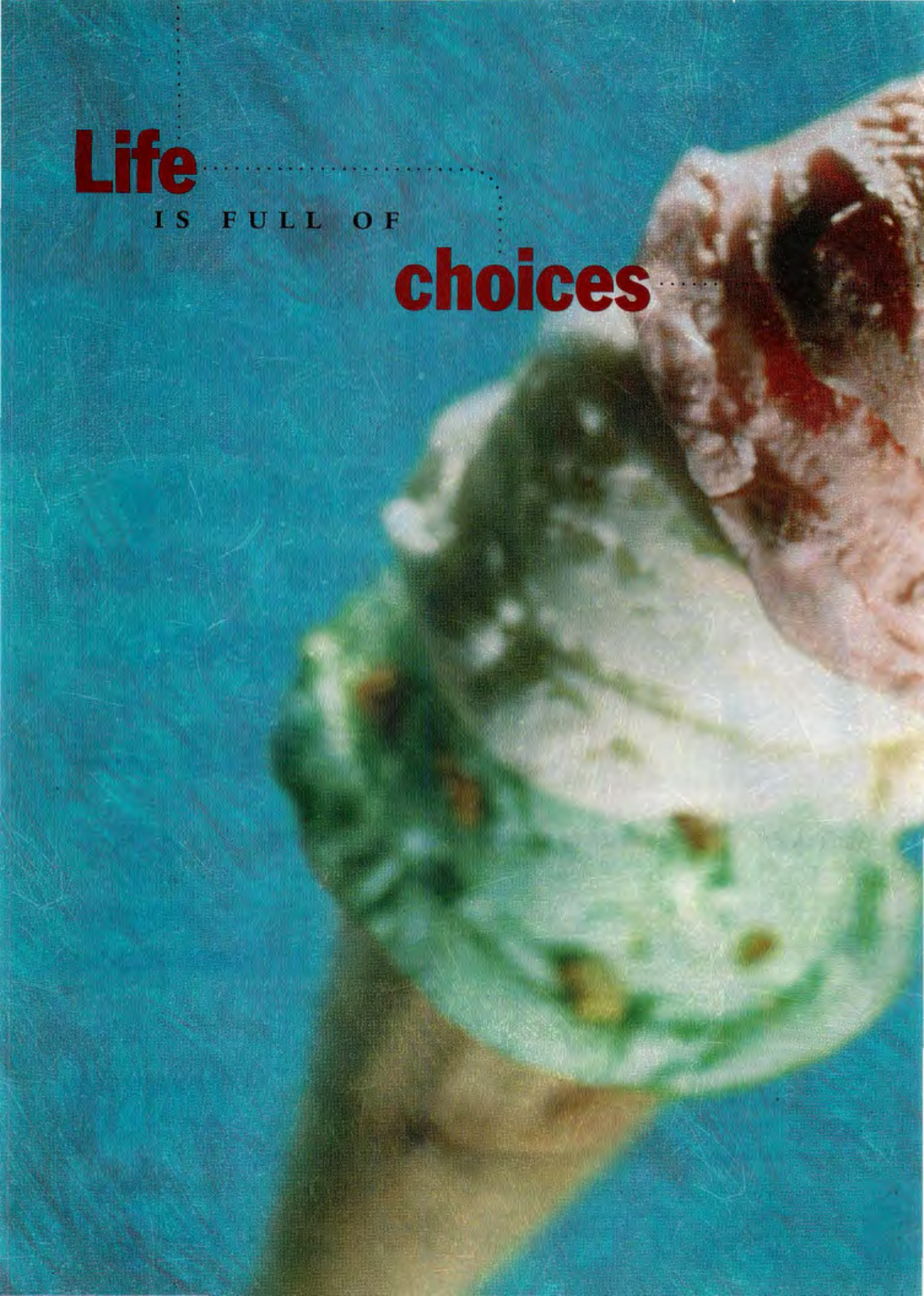
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Peace on the Wired Planet

Everyone's aunt and uncle are now using e-mail. Unfortunately, so are many hostile, aggressive, and offensive people.

It's the holiday season for many of us, and I guess I'm supposed to write some comforting words on what a great year it was and how I'm looking forward to an even better 1997. Truthfully, it was a great year, and next year will probably be cool, too.

Whew, that was easy, but now on to some tougher issues. I usually talk about technology in this space, but this month I want to talk about how we use it and misuse it.

Some people operating out there in cyberspace have totally lost their sense of humor and civility. They're taking the fun out of it for the rest of us. I'm talking about the rude, hostile tone that's showing up too frequently in e-mail. C'mon guys, this is the medium that can knit us together. It doesn't give a fringe group license to spit digitally in other peoples' faces.

Don't get me wrong—I'm all in favor of impassioned, even intemperate, debate and protest. I'm a New Yorker by birth and conviction. I prefer outspoken to agreeable, contravening conventional wisdom to confirming it.

What I don't like is when people threaten to e-mail everyone you know or work for if you don't do as they demand. Or people who accuse you of being corrupt or vicious if they disagree with you. Or people who conduct spamming campaigns, clogging your already-clogged inbox with hundreds of childish flame messages because you're not validating what they swore to their boss was true.

Now it's not enough to disagree with someone. Statements that are merely controversial become "such nonsense" or "totally ignorant" or "an embarrassment." Bathroom language, sometimes even violent language, comes into play. My first reaction was, "Oh, talk radio has come to the Net." But e-mail lacks even that rough democracy, in which callers must at least brave the listening public and risk on-the-air ridicule.

Make no mistake, the Net is going in two directions at once. More and more people are enmeshed in stimulating and lively e-mail threads, conferences, newsgroups, and chats.

Unfortunately, out here on the information highway, we also have a growing number of virtual drive-by shooters who are more interested in hit-and-run than in fighting for their point of view. I know, because I reply to most of these information vandals. I point out what I perceive as the fallacies in their arguments, own up to the parts I think they're right about, and attempt to further the dialogue. Almost without exception, I get no reply.

Our standard should be, "Would you say these things to a total stranger, face-to-face?" Certainly not in my experience, at least not if you wanted to continue the conversation. And that's just the point. If e-mail is going to continue to grow into a conversational medium that dissolves distance and culture, it needs to have some level of civility. E-mail is a tool. Archimedes said, "Give me where to stand, and I will move the earth," not "Give me where to stand, and I will toss the earth around until I get my way."

It's not a new problem, nor one on a par with world hunger or AIDS. We certainly won't solve it with laws or e-mail filters or censorship. It's an issue of community: our community. It's time to exert some community pressure and make this behavior socially unacceptable—in the same league as obscene phone calls.

It's time to exert some pressure and make this behavior unacceptable—in the same league as obscene phone calls.

A lot of highfalutin words have been written about the global village and the digital revolution. It's up to us to keep it from becoming the digital equivalent of CB radio. (A quick refresher course: This was a popular portable two-way radio medium of the 1970s that was choked by rude people who were making vulgar comments about female drivers). Refuse to be spammed into silence! For those of you who must flame, be responsible enough to provide some light along with the heat.

If we're going to be the builders of a new technoculture, let's do it right.

Mark Schlack

Mark Schlack, Editor in Chief
mschlack@bix.com

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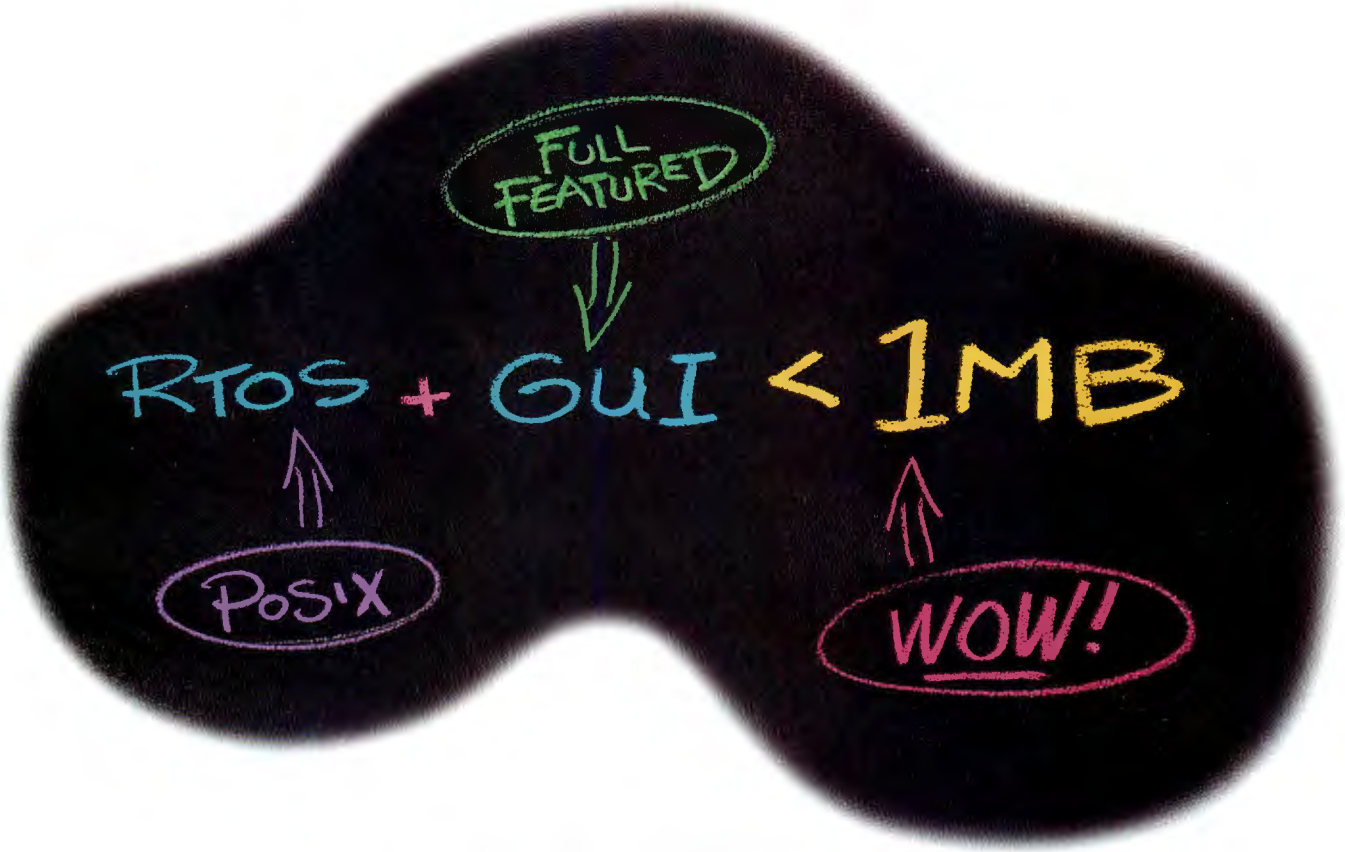

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New Software: Dead or Alive?

Mark Schlack's statement in "Wanted: New Software" (October editorial) that "The search for the killer desktop app is dead" is parochial and wrong. The desktop software industry continues to generate new and interesting applications. Web browsers began as an esoteric niche only a few years ago and are blossoming into central desktop utilities. As Internet connectivity improves, the impact of Web site and Web publishing software will be increasingly apparent. Sure, calendar managers have been around since CP/M, but the current generation of integrated scheduling, communication, and group coordination software is a new beast. PointCast is not just a screen saver but a fundamentally new media, infinitely customizable, with modest bandwidth requirements and no material or supply costs. RealAudio is not there yet, but when Internet bandwidth improves to the point that sustained nearly CD-quality audio is feasible, it will be another killer app.

David J. States
Institute for Biomedical Computing, Washington University, St. Louis
states@ibc.wustl.edu

Well, I did say we are in "a golden era of OSes, server software, Web stuff, and development tools," so I think we agree on a good deal of what's exciting today. But I have to take issue with you about group scheduling. Calendaring software remains entirely proprietary (there's no standard file format, for example); you can't access the data through either the Web or any programmatic interface. In fact, the industry is having to invent new e-mail that can be addressed on the Web just to enable things like community scheduling. This class of software also typifies my complaint about important repositories of information that have a low level of intelligence. Many e-mail packages are bundled with group scheduling. How many will let you set up a rule to forward your in-house e-mail to an Internet address when you're on the road? Don't get me started—we ought to be able to do more with the vast processing power we now have.
—Mark Schlack, editor in chief

Which Bottleneck?

First I read Tom Halfhill's wide-ranging feature "Break the Bandwidth Barrier" (September cover story). Then I read Mark Schlack's editorial about the new fast networks at Boston College—clearly a major step forward. Then I had an uncomfortable thought: Many households will soon be able to connect to the Internet with 10-Mbps Ethernet-like links. Where are all those bits going to come from? When I request a multimedia offering from the

Disney or the Silicon Graphics site, they will have to dedicate a 10-Mbps stream to me. If all the other people requesting the service start at different times, the bandwidth of the server will have to be massive! Perhaps your next feature could cover this end of the problem.

Alan C. Pickwick
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When you request data, the Web server receives your request and schedules it in priority to other such requests. It doesn't service your request to the exclusion of all others but shares its bandwidth—which is limited by its own connection to the Internet—among all users. If the aggregate bandwidth of all simultaneous requests for data exceeds the capacity of the server's own connection, then somebody is going to wait. This will get worse as the number of Internet users, and the amount of bandwidth they have, increases. That's why broadband modems are only part of the total solution; there will always be a bottleneck somewhere. Broadband modems, however, move that bottleneck off the desktop for the first time.
—Tom Halfhill, senior editor

Fat Prospects

"Break the Bandwidth Barrier" offered the best explanation I have seen yet of the real-world prospects for ultrahigh-speed communications. I especially liked the perspective you gave in the introduction, showing what broad bandwidth will mean by comparing it to improvements to CPU speed, RAM,

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and so on. Thanks for the good work.

Glen W. Koehler
Associate scientist, University of Maine Cooperative Extension
Orono, ME

I enjoyed the opening comment in "Break the Bandwidth Barrier," asking readers to imagine a 15,000-MHz processor, 1600 MB of RAM, etc., for $20, and the new types of applications that capability would spawn. I personally think that the next new word processor releases will have enough fatware to bring that system to its knees, like they have done to 486s with 8 MB!

Daren Coppock
Executive vice president, Oregon Wheat Growers League
http://www.owgl.org/

Shrink-Wrapped Software

Regarding "Wanted: New Software," all my recent applications provide everything including the kitchen sink, take up megabytes of disk space, and work slower than the previous versions. I would prefer fewer bells and whistles, with tighter, faster code and no bugs! I hate to keep paying $100 to $200 per upgrade for what I receive in return. Mark, carry this message back to the software industry.

Michael S. Youngblood, Ph.D.
Proprietor, Icon Graphics
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Adventures in JavaScript

"JavaScript Adventures" (August) offered a refreshingly real-world approach, but it contained some minor discrepancies, and I found it a bit too critical of JavaScript. First, author Rex Baldazo is correct that the `document.clear()` method doesn't work consistently in any version of Netscape. However, there is a simple work-around: Use `document.open()`, which also clears the window, then write the new window's content, then use `document.close()` to finish the display. He also overlooked a much larger issue, though: Once you use `document.open()` (or `document.clear()`, if it worked), the current document—and hence the currently running script—disappears. Thus it would not be appropriate for the first example, although it is very useful when dealing with multiple windows or frames. Finally, JavaScript's documentation is incomplete and does include some errors, as does the language itself. However, JavaScript is a young language that was still officially beta at the time of your article, so this can be expected to improve. In the meantime, there are Java books that are comprehensive and address the problems.

Michael Moncur
Author, Web Workshop: JavaScript *(Sams.net)*
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The `document.open()/document.write()/document.close()` *work-around is well known. As you point out, though, it overwrites a page and will erase your script unless the script is in one frame and writing to another. If it worked as advertised,* `document.clear()` *would let a script manipulate its own page without the risk of destroying itself. While JavaScript may be a young language, Netscape and others have been pushing it as a way to develop real-world Internet and intranet applications. With JavaScript moving to Netscape servers as well, it is vitally important that it be well documented and, more important, that it work as advertised. Sadly, your last observation is also correct: Third-party documentation has often been more useful than Netscape's own.*
—Rex Baldazo

Praiseworthy Distortion

In "Beyond Benchmarking" (August) you state that one of the reasons SPEC92 gave distorted results was that the whole of a program could sometimes fit into the CPU's primary cache. Surely this is not a distorted result but is rather praiseworthy. Our expectations have been submerged by today's monster programs.

Derrick Simmons
West Sussex, U.K.

Death Spiral

"Push Me, Pull You" (September Web Project) is a pearl. In three pages Jon Udell managed to bring in the "notification problem," object-oriented Web programming, Perl, data structures, and more. I've experimented with Web conferencing systems, and each time I've run into the notification problem. Average users will check a site once or twice, but if they don't "get" something (i.e., a new message), they won't check again. We missed this phenomenon in the past because most BBSes and newsgroups had huge audiences, so there was enough activity to avoid this "death spiral." Soon all Internet e-mail systems will support URL recognition. A subscriber-controlled notification mechanism, like the one you built, will work with e-mail URL recognition to build a nice collaborative mechanism. I'd like to be able to choose which discussions to subscribe to, and to receive intelligent notification of messages consisting of the subject, author, date, and perhaps one line of text. Notification could be based on activity thresholds, time intervals, or some combination of the two.

John Faughnan
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I have run into just the "death spiral" problem you mention. (See news://dev4.byte.com/321FB220.78E@dev5.byte.com or http://dev4.byte.com/jocon/_msg00084.html.) That spurred me to implement a notification scheme to help keep these conferences going. On the news side, people can cc the author of the post they reply to; I could have added this to the Web view as well. But an even better solution, as you suggest, is to let participants register to receive notification of any new messages and let them adjust the frequency of notification, as they can in the Virtual Press Room (VPR) system I described in my September column. Thanks!
—Jon Udell, executive editor

Visual FoxPro Revisited

Obviously BYTE and NSTL cannot be blamed for Microsoft's bizarre "marketing" of Visual FoxPro (September Inbox), but you should have been more careful when stating that VFP "is not on the same level as the products we evaluated" when it comes to building

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client/server front ends. Those of us who have worked with VFP and at least one of the other tools evaluated know that this is untrue. VFP has a superior local prototyping/remote deployment paradigm, its object model is very decent, and it is multiplatform.

R. Soto
Intelmatica@Expreso.co.cr

No-Mix MMX

To the impressive technical detail Tom Halfhill presented in reply to John Michael Williams' letter about MMX programming (September Inbox), I would like to add one point: Using the Empty MMX State (EMMS) instruction costs 100 cycles. As you must perform this action to clear the in_use attribute of the FPU stack registers, embedding FPU code along with MMX is plain suicide for your program.

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FIXES

The features table on page 129 of "Running on NT" (October) contained a typo. There should have been no check mark for Win 95 in the row labeled "Runs on PowerPC-, Mips-, and DEC Alpha AXP-based RISC systems." The same article listed http://www.microsoft.com/hwdev/ as the URL for Microsoft's hardware compatibility list. The correct URL is http://www.microsoft.com/hwtest/.

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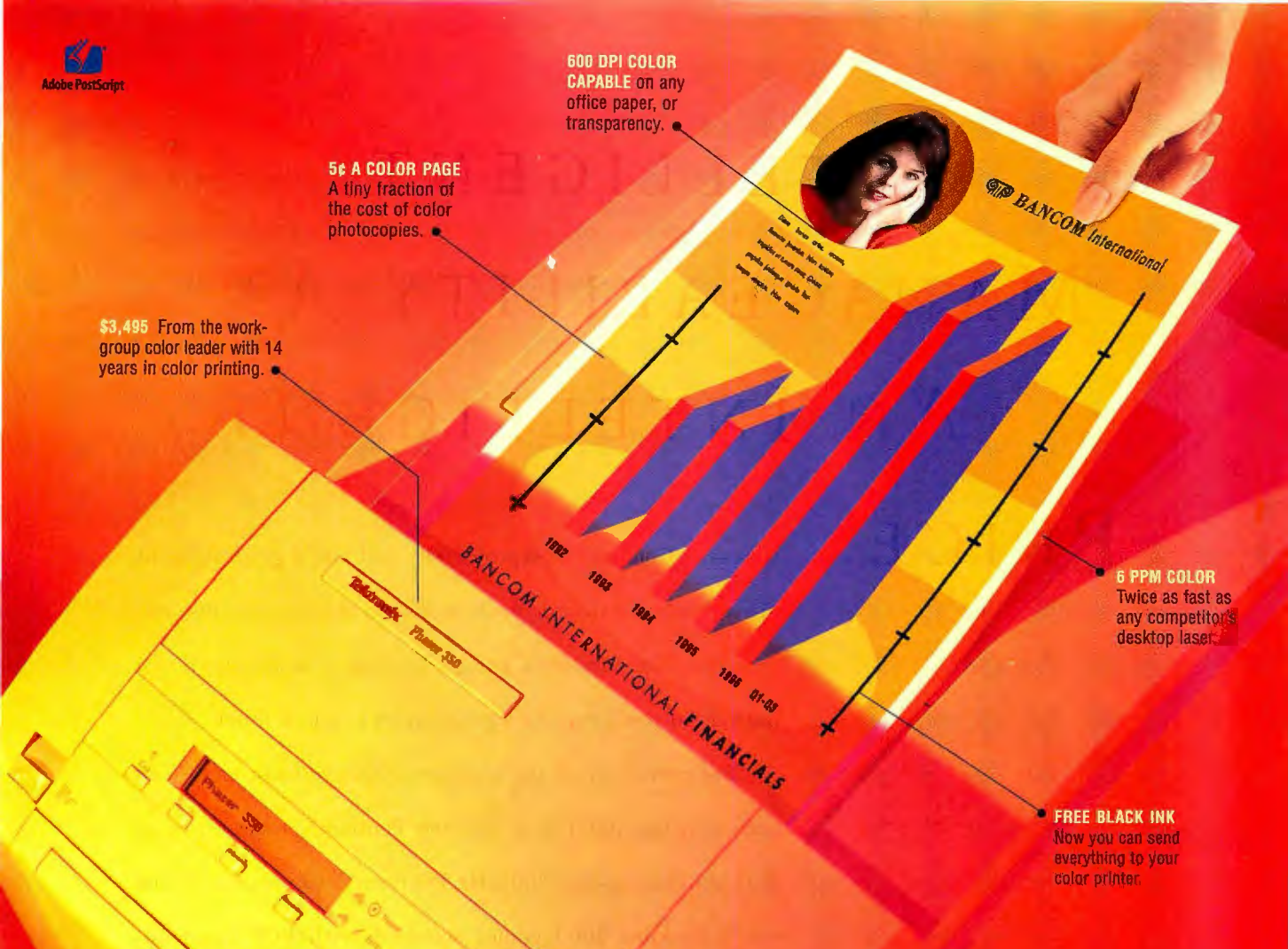

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Double Trouble for 56-Kbps Modems

Real-world limitations and questions of compatibility lurk beneath emerging 56-Kbps modem technologies.

New modem technology promises to let you surf the Internet almost twice as fast as you can with current 33.6-Kbps analog modems, but in some cases your connection won't be any faster than the fastest you get today. And it appears that the market may have to sort out incompatibility problems.

The 56-Kbps modem technologies, such as the one from Rockwell Semiconductor Systems, take advantage of the Public Switched Telephone Network's (PSTN's) shift toward becoming a digital network. Now that many Internet service providers (ISPs) and corporations connect to the Internet over high-speed digital (e.g., T1) lines, the only analog portion of a connection occurs over the copper wire that's between your home or office and the local phone company's central office. Yet current modems treat the entire PSTN as an analog system.

Due to distortion that impedes the pulse-code-modulation process, analog-to-analog communications top out at 33.6 Kbps. But when the only analog portion of a communications session is the local loop, you can theoretically send 64 Kbps from ISP to end user without having to upgrade the local phone company's equipment, as you do with ISDN.

But one problem with this technique is that a number of factors, including problems with equalization and overhead in T1 lines (e.g., robbed bit signaling), reduce the theoretical maximum that you can achieve to 56 Kbps from the ISP or corporation to the home and just 30 Kbps from the home back to new central-site modems (which will also need to be upgraded). ISPs must have a digital connection to the network, and Rockwell's scheme will not tolerate any digital conversions on the network, such as those that take place in U.S.-to-Europe communications. With such conversion, the connection bit rate backs down to today's slower speeds.

A second problem: standards. Several modem companies will release fast modems based on Rockwell's technology. And Rockwell says it will submit its technology to international standards bodies. But Paul Kraska of modem vendor Multi-Tech says that releasing prestandard modems is "horribly immature."

Other companies, such as Lucent Technologies, U.S. Robotics, and Motorola, are working on similar, but not identical, technologies. Those companies also say they will submit their technology to standards committees. But with modems slated to arrive in 1997, possibly a year before the final standard, the industry may find itself once again staring at a slew of modems that don't work with each other. Multi-Tech will introduce a 56-Kbps modem at Comdex, based on Lucent technology. But Kraska adds that the company will do so reluctantly. "If our competitors introduce 56-Kbps modems, we have to as well," he says. "We can't afford not to." **–Dave Andrews**

Internet TVs Arrive

Internet TVs that offer built-in Web browsing and e-mail will come in at least two varieties. One, seen here, is a TV from Zenith that sells for about $1000 and includes built-in Internet software from Diba (Belmont, CA). Other, less expensive solutions (about $350) will consist of boxes that attach to your existing TV set. Companies such as Philips Consumer, Samsung, Sony, and Zenith will begin shipping Internet TV products this fall.

Contents

Call Centers Deliver Data on Time

Whether it's serving as a help desk, an inbound order center, or an outbound marketing operation, the call center can be the best source of real-time marketing and market intelligence that a company has. The payoff for computer-telephony-integration (CTI) systems linked to the corporate LAN is true, up-to-the-microsecond details on buying trends, customer complaints, accounts-receivable data, and other business basics.

CTI traditionally lets users connect a computer or server on a LAN to a phone switch. The computer then moves calls around and gives agents a "screen pop," showing data about the caller. But this is yesterday's news.

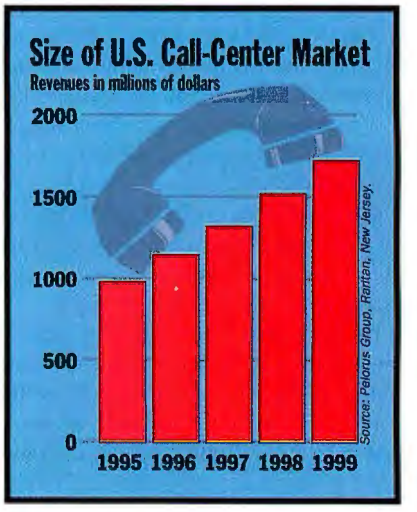
Today, the computer is grabbing a much larger share of the CTI equation. Call-center managers are switching from telephony-tied operations to ones that gather data from wherever it originates and from whatever medium it's generated in. Thinking of the call center's traditional role as a group of phone-answerers is passé, says Max Fiszer, director of product marketing for CTI solutions at Siemens Communications ((800) 765-6123). Call centers today take "calls" over cable-TV networks; via fax, modem, and the Internet; and from other computer-centric sources.

"We're moving to the age of CTI as an enormous *C*, a small bit of *T*, and total *I*," says Bob Deurr, manager of CTI products for Rockwell International ((630) 960-8000). Deurr says that in the call center of the future, companies will manage transactions that include everything from a caller's initial contact with a company to the delivery of products by way of a package-delivery system.

AT&T is now field-testing a new service that lets Web surfers initiate a phone call with a customer-service agent from within a browser. Traditional networking-oriented firms, such as Artisoft ((520) 670-7100), are reorienting their R&D to focus on the growing communications/computer-telephony business.

Fiszer agrees that the big challenge in this trend is the integration of all the different parts of call centers: "The challenge is to make integration simple and standardized so that we don't need 50 applications for each of 50 platforms."

As call-center commerce moves to the Web, several firms are rolling out Web-based call-center solutions. For example, NetSpeak's ((407) 997-4001) WebPhone can be used with an automatic call distributor (ACD) in a call center. A customer's call made through the Internet from a PC appears like any other inbound call to the ACD, but it can be identified on the agent's console as an Internet call. NetSpeak provides server software and desktop applications, allowing a real-time voice connection from the Internet.



Teloquent's ((508) 663-7570) Open @gent allows firms to use corporate intranets as the backbone of a call center. The company's Web Call Center lets inbound calls reach agents while the caller browses the Web. **–Curt Harler**

future watch

Super-Storage for the Next Century

A new storage and networking standard that combines the best of the competing Serial Storage Architecture (SSA) and Fibre Channel–Arbitrated Loop (FC-AL) standards could reign as the supreme Ultra-SCSI replacement. Commercial products based on the proposed interface may appear in 1998 or 1999. A proposal for Fibre Channel–Enhanced Loop (FC-EL) was expected to be made to the American National Standards Institute in October.

The new universal interface wil probably combine transport-layer attributes from the current SSA standard, such as the ability to allow several data transfers to occur at once, with a 1-Gbps interface. FC-EL proponents say the new standard will eliminate confusion over which serial storage technology will prevail. "FC-EL truly brings the best of both worlds together," says Roger Nixon of Xyratex's Storage Solutions Group (Havant, Hampshire, U.K., +44 1705 486 363), which sells SSA storage systems and will release FC-AL products in 1997.

Bug of the Month

Look Out for that Slipstream Fix!

Intense competition and the rapid pace of development in the PC industry create problems for corporate IS managers trying to establish some degree of consistency throughout their PC inventory. Systems purchased from one vendor delivered months—or even weeks—apart might contain different motherboard and BIOS revisions and several brands of hard drives and video cards.

Such inconsistencies turn system upgrades, connectivity, and user-support issues into a management nightmare. And now it seems the beleaguered IS manager can't even count on consistency between identical PCs purchased at the same time. One IS manager at a mid-size company, who spoke to us on condition of anonymity, reported receiving two new PC servers from a major PC vendor, only to discover that just one of the two apparently identical machines would run Windows NT. The other repeatedly locked up.

Both machines were clearly marked with identical motherboard and BIOS revisions and subsystem components. Several days of troubleshooting by phone, plus a visit from a manufacturer representative, failed to resolve the problem.

In the end, the mystery was solved when the IS manager switched system BIOS chips. The manufacturer later confirmed that undocumented BIOS changes had rendered the system unusable with Windows NT.

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Holiday Gift Sampler

When we asked vendors to send us products for consideration for this year's holiday gift section, we received a wide variety of merchandise. Some of the submitted products, such as new accounting programs, database-access tools, and a new compiler, smacked a little too much of work. But we received some more-festive ideas as well. Here's a sample of products to give you ideas for holiday presents.

Men of Clay

The Neverhood lets you travel through realistic 3-D clay animations.

Forget the singing California Raisins. Never mind Gumby or Gromit. The Neverhood ($49.95) may be the ultimate adventure game for fans of clay animation. As the head of an army of Klaymen, you are the protagonist in a humorous clay world filled with dozens of puzzles that you must solve to fulfull your destiny and defeat the evil Klogg. Stop-frame animation enables your Klaymen to lope through a landscape filled with amazingly realistic 3-D clay sets, where they face a man-eating venus fly trap and other surprises. The action scenes are pure slapstick comedy—the attack of the crustacean is hilarious—and the visual and sound effects are first-rate (as one would expect from the first interactive game from DreamWorks Interactive [(310) 234-7000]). The game requires a Pentium 75-MHz PC, 8 MB of RAM (16 MB is recommended), a quad-speed or faster CD-ROM, and an SVGA display. The Neverhood succeeds on the merits of its adventure-game challenges, but the production quality of this romp breaks the mold for its genre. **–Rob Mitchell**

Find the Perfect Beer

Everything else is on CD, so why not a virtual world tour of the world's best beers? That's the premise behind Michael Jackson's World Beer Hunter ($34.95), a Windows CD-ROM from Discovery Channel Multimedia ((800) 678-3343; http://www.multimedia.discovery.com). Your host is a genial beer expert (the other Michael Jackson). There's plenty to learn here, backed by audio and video clips, and you can select beers by region. It includes links to a "beerhunter" Web site (http://www.beerhunter.com). Other favorites: a pub crawl and a list of the 10 beers Jackson would want to have on a desert isle. Informative and recommended. –Jon Pepper

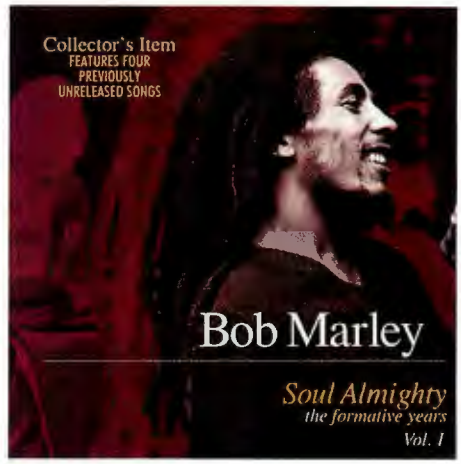
Be A Guitar Hero

Now guitar players can have as much fun with computers as people who play MIDI keyboards. G-Vox ($379 for the basic package) from Lyrrus ((215) 922-0880) is a hardware/software combo for Macs or Windows PCs that lets you connect any guitar (acoustic or electric) directly to a PC. Plug into the serial port and use any of the G-Vox software series to learn to play guitar or play along with some guitar greats. This package includes full MIDI support. Great for anyone who loves guitars and computers. **–J. P.**

New Robot Kits Are More Mobile

Here's a gift that's both fun and educational. The last time we looked at the A K Peters ((617) 235-2210; akpeters@tiac.net) Mobile Robot Kit, you had to add the motor and wheels yourself to create your own mobile robot. The new version ($500) now includes the brains for creating a robot (processor, memory, and sensor circuitry) plus the body (motor, wheels, chassis, and other parts). As you program the robot on either a PC or a Mac, you learn about how to make it react to the physical world (e.g., using infrared to avoid collisions or to seek light). The company plans to add support for sonar in 1997.

Program your own robot to react to light, dark, whistles, or obstacles.



New CD-ROMs Bring Music to Life

Does someone on your list spend after-dark hours prowling the Net instead of the nightclubs? If so, then new "cybrid" CD-ROMs from the Graphix Zone ((714) 833-3838; http://www.gzone.com) might be just the groovy thing. These discs combine multimedia elements with links to related on-line sites. Herbie Hancock Presents Living Jazz ($39.95) covers the music's history by playing back bits of tunes, interviews (such as the Doors' Ray Manzarek explaining how "Light My Fire" was based on "Ole Coltrane"), and rare film clips. Click on the Connect button, and your browser fires up and takes you to the Living Jazz home page, which links to other Web sites that cover jazz. You can also download material from the Living Jazz site to your hard disk. But make sure your recipient has at least a six-speed drive. Anything slower, and you could transcribe a Coltrane solo in the time it takes to get from one screen to another. Willie: The Life and Music of Willie Nelson ($39.95) has Internet links but no downloadable extras. Harassing IRS agents also not included. Or you can check out the latest enhanced CDs, such as the Graphix Zone's Bob Marley: Soul Almighty—the formative years ($17.98). You can view great interviews with early producers. **–Dennis Barker and Dave Andrews**

Ski-Area Screen Saver

If your friend likes to hit the slopes, he or she will be interested in the Ski Area Screen Saver ($19.95) from Cylogic ((800) 295-6442; http://www.cylogic.com/skidata/). During a spare moment, this one lets you browse some of your favorite ski resorts, such as Killington and Alta. Cowabunga!

Questions? Ask the Net!

Want more gift ideas? Then check the Internet. Practically anything you want is available through the Web. Want hard-to-find audio CDs? Check out http://www.cdnow.com. Want some good wine? See http://www.virtualvin.com. Or just go to any of the Web-search engines, such as Lycos, Yahoo, and AltaVista, and ask away. You'll probably find it. Or you can check out Egghead for holiday greeting cards with computer themes created by cartoonist Bruce Bolinger.

Digital Cameras Give an Instant View

Digital cameras are rapidly evolving from expensive toys to viable and affordable image-capture devices. But beyond lower prices and improved quality, the trend currently driving the market is the inclusion of LCD screens in just about every camera that's out or about to be released.

Six new products will sport LCD displays this fall. These products include offerings from Casio, Epson, Kodak, Olympus, Ricoh, and Sony and rumored models from Pansonic and even Sega.

Why LCDs? Credit their immediacy, convenience, and pure gadget appeal.

Sony's new DSC-F1 features an LCD and support for TV output for presentations.

Cameras with LCDs let you view the images you've snapped and delete those you don't like. Casio's QV-10, the first product to offer an LCD, has drawn rave reviews, despite marginal picture quality.

One impressive new device, Sony's ((800) 476-6972) DSC-F1 ($849), features innovations in a high-quality product. With 640- by 480-pixel resolution, the DSC-F1 can store up to 108 images at its lowest JPEG compression ratio, or 30 to 58 images using higher compression modes at the same resolution.

The DSC-F1 has a 1.8-inch LCD that you can use to review pictures or to frame your next picture. The camera also lets you take "continuous" action photos.

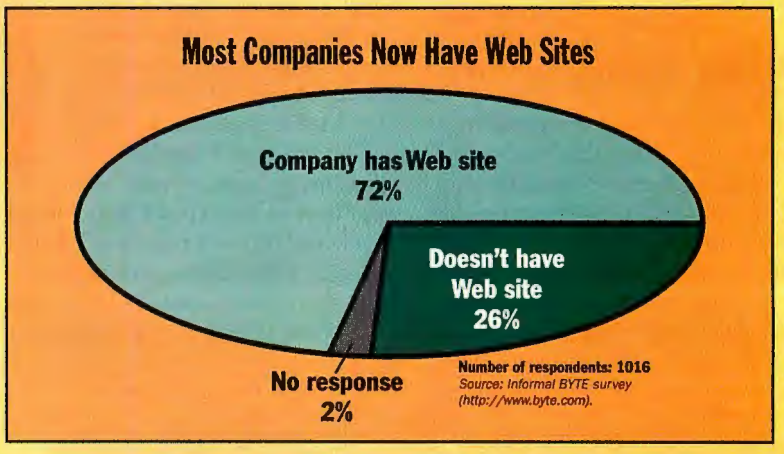
Both of Olympus's ((800) 622-6372) offerings, the D-300L ($899) and the D-200L ($599), have 1.8-inch LCDs and Olympus optics. The D-300L can store 30 images at high resolution (1024 by 768) or 120 images at standard resolution (512 by 384). It has built-in flash and red-eye reduction. The less-expensive D-200L stores images at a lower resolution (640 by 480) but, like the D-300L, it includes auto-flash and auto-focus. Both are lightweight and stylish and let you use the LCD for picture review or to frame an image.

Epson's ((310) 782-0770) $499 PhotoPC 500 is a smaller, higher-quality version of the company's PhotoPC camera. It can store 30 images at 640 by 480 resolution. With proprietary memory modules, you can store up to 100 or 200 images, depending on the resolution you use. The 1.8-inch color LCD ($199) is optional and snaps onto the PhotoPC 500.

Add to these offerings two enhanced models from Casio ((201) 361-5400) that are based on the QV-10 design (the $679 QV-30 and the $699 QV-100), Ricoh's ((800) 225-1899) RDC 2 ($900), and the Kodak ((716) 724-4000) DC 25 ($499), and it's quite clear that there's no shortage of choices for LCD-based digital cameras. Expect to see this trend continue, with new players joining in over the next six months. In the digital-camera world of the 1990s, image may not be everything, but instant image may well be. **–J. P.**

Survey

Web-site development software and HTML (e.g., page-creation) software lead the list of planned intranet purchase items.



The survey results shown in these two charts suggest that most companies plan to add new applications to existing Web sites.

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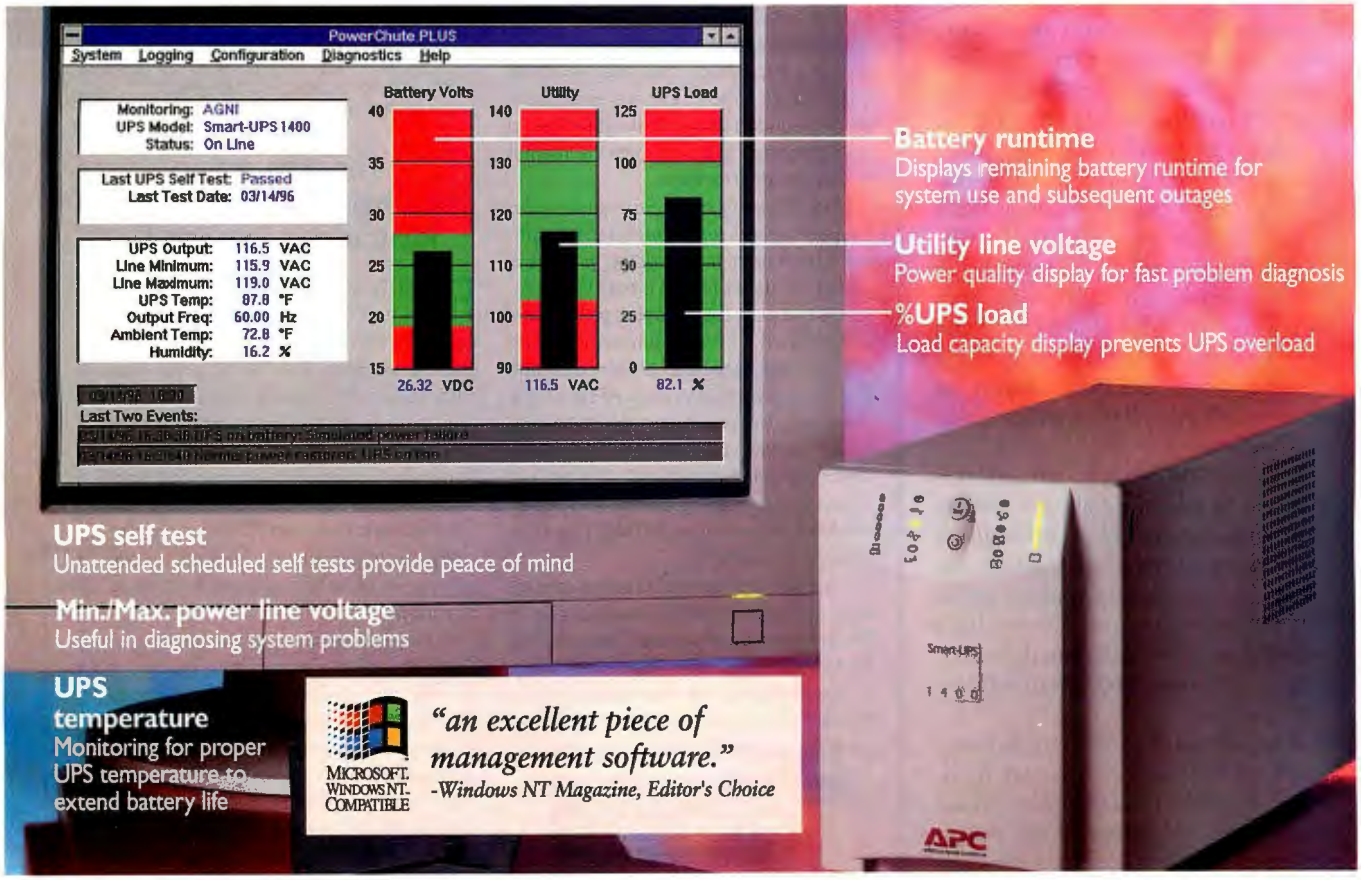

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According to Microsoft, "A UPS is an important part of any deployment of Windows NT systems..." Fortunately, APC provides the most comprehensive protection against the single largest cause of NT data loss—power problems. APC's PowerChute® *plus* for Windows NT and APC Smart-UPS combine to give you the power management features necessary to make SURE you're protected.

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- Environmental/power monitoring-allows you to quickly diagnose power problems and thus decrease network downtime without the expense of an electrician.

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Apple Achieves Notebook Parity

With the PowerBook 1400 series, Apple catches up with the rest of the notebook-computer industry. The 177-MHz 603e PowerPC processor at its heart isn't news, nor is the integral PC Card slot that supports Type II or Type III cards. But the expansive 11.3-inch display (in either dual-scan passive-matrix or active-matrix) is a major improvement, as is the equipment bay, which can hold a CD-ROM drive module. The PowerBook 1400 series enables you to copy a file from a CD to the hard drive, eject the CD-ROM drive module, pop in the standard-issue floppy drive module, and then copy the file onto a floppy, all without restarting the computer.

The CD-ROM drive, 32-bit-pixel display, and QuickTime make the 1400 an ideal multimedia machine. Although the hardware supports 16-bit CD-quality stereo sound, the computer's built-in speaker is only monaural: You have to plug a pair of external speakers into the audio-output jack to obtain full stereo sound for a presentation.

While the 1400 catches up to other notebook designs with regard to hardware, Apple ((408) 996-1010; http://www.apple.com) adds some unique design touches that make it stand out. For starters, you can boot from a Type III PC Card, which allows every person in a sales force to put his or her own customized OS, applications, and data on a PC Card that plugs into the Power 1400. Adding memory or an internal expansion card, such as a modem or an Ethernet adapter, is a snap. You slide a panel aside and remove five screws and a plate, and you have ready access to the computer's internal expansion slots. With only a Phillips-head screwdriver, in minutes you can add Focus Enhancements' Ethernet adapter or a similar expansion card.

The PowerBook 1400 carries an attractive price tag. A basic system with 12 MB of RAM, a 750-MB hard drive, and a dual-scan display costs $2500. A fully loaded 1400 with 16 MB of RAM, a 1-GB hard drive, an active-matrix display, and a CD-ROM drive module sets you back only $3500. **–Tom Thompson**

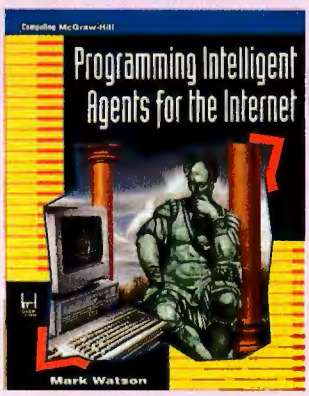
Book Reviews

Do What I Bid

The word *agent* is used by many people to mean many things. Some folks want agents to be artificially intelligent quasi-beings that somehow reason—or at least give the impression that they're doing something sentient. Others embrace a more grounded and realistic goal: They'd like software programs to roam the Internet and gather data for them.

Mark Watson's book, *Programming Intelligent Agents for the Internet*, falls into the latter camp. It describes, in source-code-level detail, how to create C++ programs that can plumb the Net, gather data, and present a cogent summary to their master. The first several chapters describe how to wrap up the Winsock API in a C++ class so that it's easy to include in later projects. This class becomes the foundation for the rest of the book, which explores downloading, indexing, and parsing Hypertext Markup Language (HTML) files from throughout the Net.

The final chapter shows how you can create your own customized newspaper using the tools developed earlier in the book. This system will revisit major Web sites of your choice, download the information, and reformat it for your screen. The code for accomplishing this is interlaced with text that



describes the strategy at a high level. You can also grab the code directly from the disk that's bound into the book.

You should be ready and willing to read C++ code if you dig into this book. So, if you want to build and customize your own tools, it will give you many examples of how to structure your applications and code. **Peter Wayner** *is a BYTE consulting editor based in Baltimore, Maryland. His latest book is* Disappearing Cryptography: Being and Nothingness on the Net *(Arcadia Press, 1996). His home page is at http://access.digex.net/~pcw/pcpage.html.*

The Absurd, Incomprehensible, and Ridiculous Exposed

Read *Dave Barry in Cyberspace*, and not just because it mentions Jerry Pournelle's BYTE column on page 4. In this book, Dave Barry, the Pulitzer prize–winning, nationally syndicated humor columnist, comes out of the closet and admits that he is, in fact, a complete computer geek. Known for his keen appreciation of the absurd and ludicrous in human life, Barry now turns his wit to the world of computers. Naturally, he strikes gold, the computer world holding one of the largest deposits of absurdity known.

In this volume, Barry exposes, with naive charm, such features of the ridiculous as incomprehensible manuals (and alleged technical assistance), Web pages devoted to Captain & Tennille, and the C:> prompt.

Besides being very funny, the book contains some real insights about the computer technology underlying Barry's observations. An example: Why are computers so absurdly difficult to use? Simple: Most geeks would rather diddle with computers than do anything productive with them (which I nominate as "Barry's Law"). And why is that? Because computers are largely by and for men (proof: the most popular games involve killing anything that moves, and the most popular use of the Internet is to distribute dirty pictures), and men love to tinker endlessly with inanimate objects.

Some mild profanity and sexual references might cause you to keep this book out of the hands of young children. Otherwise, read, enjoy, and laugh knowingly at this fun-house-mirror view of the world of computers. **–Edmund X. DeJesus**

Programming Intelligent Agents for the Internet
by Mark Watson;
McGraw-Hill;
ISBN 0-07-912206-X;
$39.95

Dave Barry in Cyberspace
by Dave Barry;
Random House;
ISBN 0-517-595753;
$22

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"Optima++ marks a leap forward over traditional C++ tools." *Rich Dragan, Windows Sources, June 1996*

"Powersoft's new development tool makes creating corporate applications with C++ an optimal experience." *Dan Rogers, Software Development, September 1996*

"Optima++ is a powerful product that combines the ease of use of VB's component metaphor with the speed and power of C++." *Steve Jackson, Visual Programmer++, September 3, 1996*

"Powersoft has scored a home run." *Dan Rogers, Software Development, September 1996*

"Optima++ represents a breakthrough in visual programming not only for C++ developers, but for all users of fourth-generation language (4GL) client-server [illegible] tools." *Rich Levin,*

"Superb integration; innovative component-oriented tools; superior execution speed; nonproprietary language." *Peter Coffee, PCWeek, June 10, 1996*

"With Powersoft's Optima++ visual tool, C++ development for Windows has never been easier." *Sean Gallagher, Information Week, May 6, 1996*

"A C++ Tool That Cures VB Envy" *Rick Grehan, BYTE, October 1996*

"Optima++ provides direct ODBC support, meaning classes and bound controls call the ODBC API directly, without an intermediate layer such as VB's Jet engine or Delphi's IDAPI." *Steve Jackson, Visual Programmer++, September 3, 1996*

"[Optima++] puts the fastest compiler that we've found to date into an environment that is both approachable and productive." *Peter Coffee, PCWeek, March 18, 1996*

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PCWEEKLABS ANALYST'S CHOICE JUNE 10, 1996 Optima ++ Developer 1.0

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Browse the Web with Your Eyes Closed

Surfing the Web can be extra challenging if you can't see your screen. Thousands of blind or visually impaired computer users access the Web using speech, braille, or screen-enlargement hardware and/or software. If you have a PC and a visual disability, you probably know that it's possible for you to access the Web, but most Web sites won't work well with your adaptive equipment.

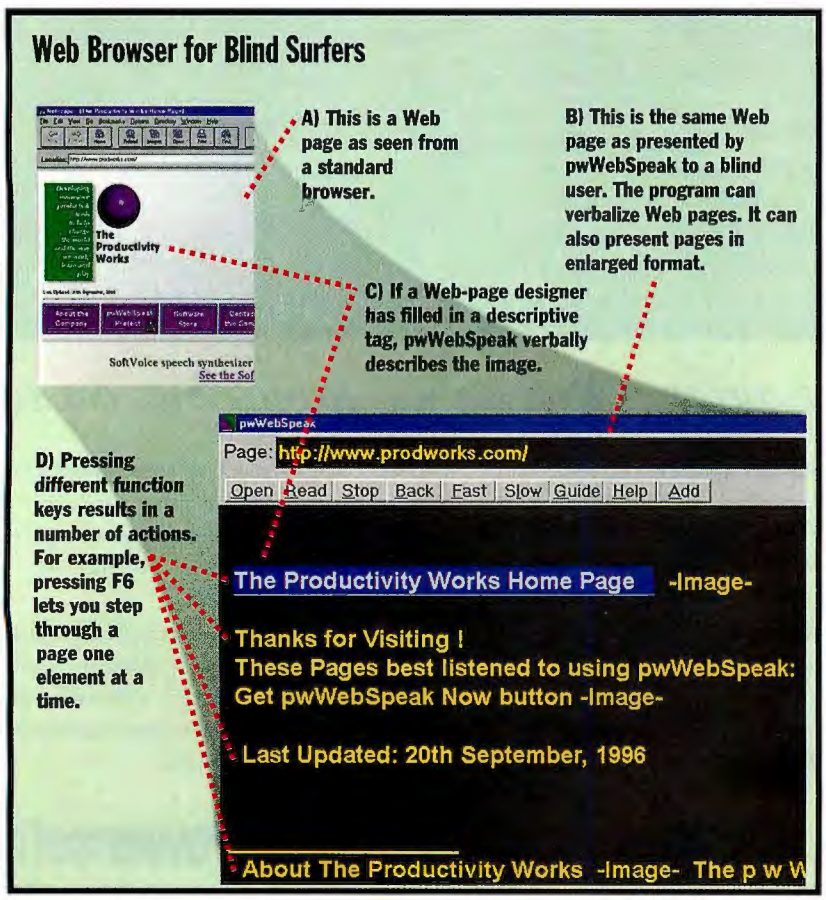
Webmasters who don't add descriptive tags to the elements in their pages make it more difficult for adaptive programs. But awareness about adaptive technology is increasing in the computer industry. Microsoft is leading an ambitious effort to make adaptive technology more mainstream, and Netscape is investigating ways to make its software better support accessibility products. The company's Active Accessibility program will make future versions of Windows and related applications more accessible to users with vision impairments. Software developers can use the Accessibility SDK, slated to ship in November, to write adaptive Windows programs.

The flagship Active Accessibility product is Microsoft Internet Explorer (MSIE) 3.0, which has hooks to enable the screen-reader software used by the blind community. MSIE works with synthesizers, braille displays, large print programs, and other assistive technology.

The Productivity Works ([609] 984-8044; info@prodworks.com) wrote its pwWebSpeak Web browser for the blind from scratch. The browser has its own built-in speech processor and doesn't require a separate screen-reader program. The browser parses a Web page's Hypertext Markup Language (HTML) code to present the information in a more speech-friendly manner. And pwWebSpeak can drive a variety of speech synthesizers, including the Sound Blaster voice card.

With the awareness of adaptive technology among mainstream software developers increasing, the future may loom a bit brighter for computer users with disabilities.

–Joe Lazzaro



cd-rom review

Lots of Words

Here are two CD-ROMs for people who love words. Merriam-Webster's Vocabulary Builder (MWVB) guides you through a series of exercises that will strengthen your English vocabulary. Each lesson introduces the common roots of a group of words and leads you through

Merriam-Webster's exercises are a fun way to build vocabulary.

playful exercises that skillfully reinforce what you've learned.

The lessons are fun. The program pronounces each new word, gives a definition, uses the word in a sentence, and asks to you to complete fill-in-the-blank, synonym/antonym-type exercises that keep track of your progress. After a few weeks of 15-minute daily drills, you'll be amazed at how many new words you've mastered.

Random House Webster's Unabridged Dictionary CD-ROM recently came out in version 2.0. Enhancements include voice pronunciations, line-art illustrations, and a choice of English, French, or Spanish as the language of the dictionary interface. The dictionary contains more than 316,000 entries, of which 1500 have been updated. A more powerful search engine lets you, for example, find any word that came into English after 1890 or any date you specify.

–Rich Friedman

Merriam-Webster's Vocabulary Builder
Merriam-Webster, (800) 828-1880
$29.95

Random House Webster's Unabridged Dictionary CD-ROM
version 2.0 (for Windows 3.1 and 95)
Random House, (800) 733-3000
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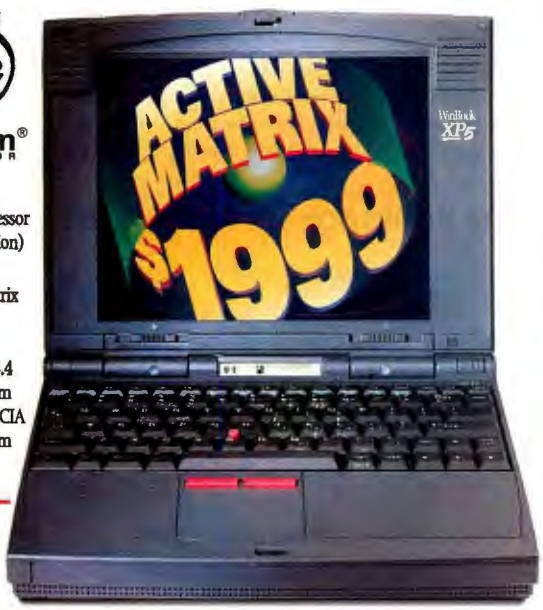

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Forgery Woes Force Move to Private Conferences

Hurdles in implementing universal digital-signature verification for Internet newsgroup-style message conferences may lead to an increasing use of privately hosted discussion groups on the Internet. The problem today is that it's easy to forge your identity, including your e-mail address, when posting to an Internet newsgroup. By changing options in Netscape Navigator, for example, you can post a message to a newsgroup that appears to be from someone else.

This problem recently affected the newsgroup-search service Dejanews. Dejanews stores about 90 GB of newsgroup messages and lets you search for newsgroup articles from a Web browser by author name, subject, and other parameters. The service (http://www.dejanews.com) at one time also allowed you to post to newsgroups from the Web, but after complaints that people were abusing the service by posting wacky messages to newsgroups under forged identities, the company temporarily disabled Dejanews' ability to let you post.

Officials at Dejanews say that implementing a solution, such as PGP or some other encryption technique, would be difficult. First, the solution would have to be scalable enough to handle the thousands of articles that are posted on a daily basis. It would also have to be intuitive, easy to manage, and universal.

"For any of this to work on public newsgroups, the thousands of servers that carry news would have to implement the same security mechanisms," says Gregory Smirin, product-line manager for Digital ID services at Verisign, a provider of authentication products and services. It would also need to happen gradually, as security could be perceived as censorship and meet strong resistance.

All of this means that privately hosted, nonreplicating Internet conferences will become increasingly popular. Managing the encryption keys for a smaller population is easier than for a larger one. Plus, in a private conference, it's easy to delete inappropriate messages. **–D. A.**

Datapro Report

Banks Eye PC Banking and the Internet

Although automatic teller machines (ATMs) and telephone services are currently the most popular on-line banking services, the future of on-line banking growth lies in PC banking and the Internet. According to Datapro's 1996 international survey of banking-technology issues, 67 percent of banks offered ATMs in early 1996, and 52 percent provided telephone-banking services.

But based on survey results, only 2 percent of banks that don't already have ATMs plan to install them in 1997, compared to the 21 percent and 19 percent that will offer PC banking and Internet banking, respectively (see the table "New On-Line Banking-Service Plans" above).

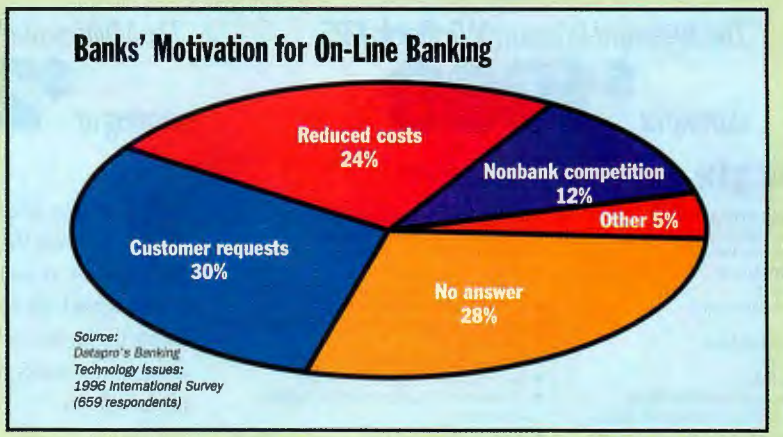
Banks are moving toward on-line banking, which includes ATMs, phone and PC banking, the Internet, screen phones, and interactive TV, primarily due to customer requests (see the figure "Banks' Motivation for On-Line Banking" below). But reduced operations costs is another motivation for banks to adopt electronic banking services.

These results may demonstrate that banks are attempting once again to tap into the home-banking market. Perhaps now is the time that the retail-banking trend will begin to show more growth. **Jannette Alston** *is a senior analyst, financial services industry, at the Datapro Information Services Group (Delran, NJ). For more information, call (609) 764-0100 or contact http://www.datapro.com. The survey is a report from Datapro's Financial Industry Technologies & Trends: World View, Datapro's new information service.*

New On-Line Banking-Service Plans

	Early 1996	Late 1996	1997	1998	No answer	No plans
ATM	67	4	2	1	13	14
Telephone	52	12	8	4	11	14
PC banking	19	19	21	8	17	18
Internet	7	17	19	6	21	31
Screen phone	3	3	5	2	31	56
Interactive TV	1	1	4	4	32	58

Source: Datapro's Banking Technology Issues: 1996 International Survey. (Questionnaires mailed in early 1996.) Contact Datapro for the full version of this report.



Customer requests and reduced operations costs are the primary motivation for banks' move toward on-line banking.

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Blasts from the Past

5 Years ago in BYTE

BYTE looked at the new version, 2.0, of OS/2, and we liked its ability to multitask DOS applications while offering better crash protection for Windows programs. We noted, however, that 32-bit OS/2 software was still waiting in the wings. We also delved inside Apple's QuickTime multimedia extensions for the Mac OS.

10 Years ago in BYTE

We looked at graphics algorithms and modems that ran at speeds up to a whopping 2400 bps. US Robotics' Courier 2400 listed at $699. New products for the Amiga highlighted Bruce Webster's Christmas column.

15 Years ago in BYTE

We wrote about how to get the most out of the color graphics features of the Atari 400 and 800. We also extolled the virtues of on-line databases that let you access data without having to drive to the library.

20 Years ago in BYTE

What was on Santa's list? Perhaps more memory. We printed an article that discussed how to squeeze the fat out of text strings. In addition, we wrote about do-it-yourself weather stations. Advertisers such as Sol Systems touted $995 make-it-yourself small-computer kits.

Tuned Into the Web

Sangam Pant, vice president of engineering at Lycos, discusses how best to find sights and sounds on the Web.

BYTE: *Lycos recently added sound- and picture-specific searching. How do you do this?*
Pant: As we do with regular HTML text searching, our spiders get documents and create abstractions of them. In creating the abstract, a spider figures out things such as key words. It also looks for some specific fielded information, such as who's the author of the document and what's the title of the document.

But more important is that it figures out the key words and phrases in the document. We use computer heuristics to determine the importance of these words and phrases within the document. The advantage of creating the abstract is size. You're not storing the whole document; you're only storing a portion of it. Another advantage is that you don't violate any copyright laws because you're not storing the document.

And last—but not least—is that it helps us figure out what the critical pieces of the document are. We also compare the number of times a word appears in a document compared to the average number of times the word appears in other documents to determine relevance.

BYTE: *From the abstract, how do you identify images and sounds? I'm assuming that you do more than just look for extensions, such as AVI and GIF.*
Pant: Anybody can do the extension matching and say this is a GIF, versus a WAV, versus an AVI file. That's the easiest part of it. We go a step further than that because we treat pictures, sound, and documents as similar objects, but we look at the characteristics of these objects. And we look at what describes the picture and sound file itself.

BYTE: *So you analyze text that acts as a caption for an image or sound?*
Pant: Right. But not only do we look at that, we look at the content of the page itself that contains the embedded object. If the entire page is talking about computers, and a person doing a search wants a picture of the computer, it makes sense that the image in question is a picture of a computer. You can take it a step further and say that if you have 15 links pointing to the GIF and all those links are from computer-oriented sites, your certainty that this is a picture of a computer goes up drastically. Links carry the most important information.

BYTE: *Are you actually doing the equivalent of optical character recognition on the image? For example, does your engine look at just the bit map and determine, for example, that it's a girl with a cat?*
Pant: Not in the current version, because that's computationally very extensive. Think of all the little pictures on the Web. Trying to catalog them all—and for each picture basically using some kind of optical character recognition to figure out whether this is of a particular object or not—becomes extremely difficult. I believe the technology exists, but I don't think it's available to be deployed at the volume you're talking about.

My take on this personally is that we should move the onus to the person who creates the image. What I would really like is a standard that says that when you create the image, a bunch of metatags that describe the image get created along with it. That would make everybody's life a lot easier.

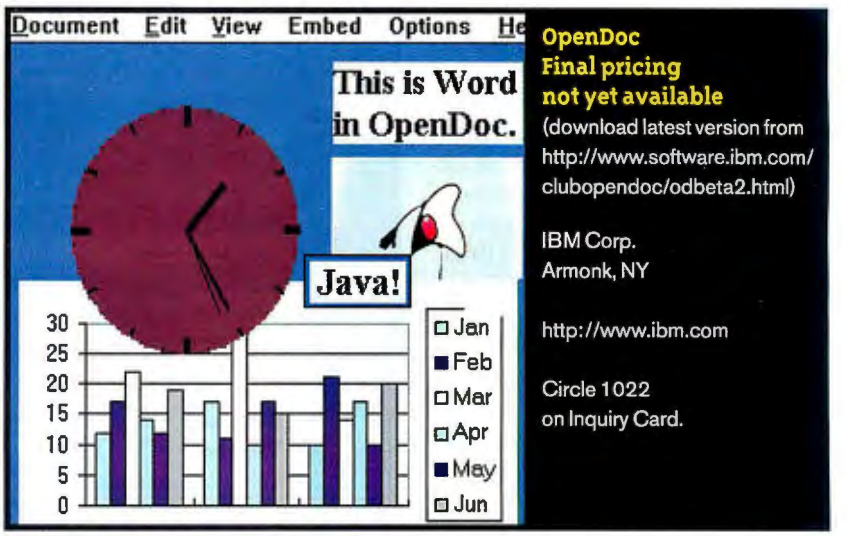
For more information, see http://www.lycos.com

Cross-platform OpenDoc comes closer to reality as IBM releases the Windows 95 and NT toolkits. ***By Peter Wayner***

An Open Window for OpenDoc

Even Microsoft knows it: The desktop paradigm is quickly giving way to a network-centered computing world. While OpenDoc refers to an open standard for building a document-centric (versus application-centric) interface, the real power of component technology will be manifested when intelligent, platform-independent applets begin interacting across LANs and WANs. IBM has delivered a key part of the puzzle with the second beta version of its OpenDoc toolkit for Windows 95 and NT.

By enabling reusable components, OpenDoc saves you time and effort. For instance, there's no need to write a text editor for your application; simply include a text object (called a *part*) in the document, and OpenDoc ensures that all calls to it invoke the built-in text editor. Ideally, you can create a range of objects to mix and match in different documents. You can also build extensions to OpenDoc that become available to every component in an OpenDoc application.



An OpenDoc container can have multiple parts, all live at the same time.

We found that IBM's latest beta release is an improvement over its predecessors in both performance and features. Besides VisualAge C++, the new beta supports Visual C++ and ActiveX, as well as any other System Object Model (SOM)–compliant compiler. To create a new part, you just fill in a few boxes and let a new tool, PartMeister, produce the C++ OpenDoc interface code.

Developers need only drop the new OpenDoc WebPak and Multimedia PartPak components into their applications to enable support for Hypertext Markup Language (HTML), Java applets, and Netscape plug-ins. With the multimedia components, an application gains support for a range of media files.

Since we were testing a beta version of the toolkit, we found many more bugs than we'd like. For instance, there's some confusion when an object asks to be edited in place in a document, and other portions of the document can obscure menus. Plus, screen updating is often done incorrectly. But these are easily fixable.

For now, OpenDoc should be of great interest to developers in cross-platform shops, since it's available for OS/2 Warp, Mac OS, AIX, and Windows 95 and NT. Corporate programming teams will be particularly attracted to OpenDoc as a strategy for building specialized, reusable parts and deploying them throughout an enterprise. As it matures into a network-aware, platform-independent framework, OpenDoc could revolutionize the software industry by delivering a true component architecture for enterprise applications. B

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

Peter Wayner is a BYTE consulting editor and freelance writer living in Baltimore, Maryland. You can reach him at **pcw@access.digex.net.**

TECH FOCUS

Wrapping Up OLE

For all the OLE-versus-OpenDoc battling, in the end the two might coexist peacefully. IBM's latest OpenDoc release can embed OLE components and vice versa.

OpenDoc becomes even more attractive in a networked environment. Most industry players except Microsoft support the Common Object Request Broker Architecture (CORBA) as an open standard for cross-platform component interaction. OpenDoc is based on IBM's CORBA implementation, called System Object Model (SOM), which ensures that OpenDoc parts will interact with other CORBA-compliant components across a network. Microsoft is relying on Network OLE and expects other vendors to fall in line. We'll see.

Microsoft raises the suite standard with better, smarter, easier-to-use productivity applications. By Steve Gillmor

Toward a More Productive Office in '97

With Office 97, Microsoft adds more user-friendliness and automation to ever-greater Web integration. Shared code, suite-wide Visual Basic for Applications (VBA), and the new Outlook collaborative information manager should help Office remain the market leader.

Outlook is the new hub of Office, replacing both Schedule+ and Win95's Exchange Inbox with innovative messaging, scheduling, lists, and groupware tools. AutoCreate converts e-mail to appointments or meeting requests, AutoName and AutoAddress separate input into fields, and AutoJournal records events from all Office applications.

Microsoft has streamlined the user interface with drag-and-drop toolbars, tear-off menus, and shared components. In Office Assistant, a better Answer Wizard, animated characters guide you through tasks. It's smart, but the help screens become annoying.

Much more intuitive is Word 97's Grammar Check, which highlights errors on-the-fly. The program analyzes context, correctly handling the difference between *it's* and *its* (but not *two* and *too*). Spell-It and AutoCorrect are integrated; you can right-click, replace, and add frequent misspellings in one action.

Word 97 adds versioning, in-place comments, and a split-screen, hyperlinked document map. You can wrap text around irregular objects and link text boxes across multiple pages. Word detects macro viruses and converts WordBasic macros to VBA.

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

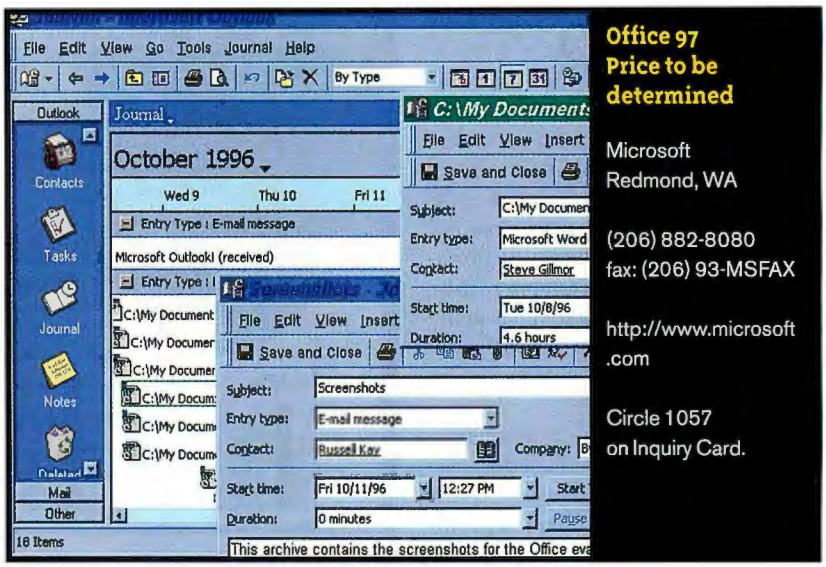
Excel 97 formulas speak English; you can type "=cost/sales" instead of normal cell references or named ranges. Formula AutoCorrect handles 15 common formula errors, such as unmatched quotes.

Excel can now rotate text, indent cells, and handle multiple undos. You can drag horizontal and vertical page breaks in Page Break Preview mode. Chart Tips identify chart elements, and you can add a table of data values below any 2-D or 3-D chart. Shared workbooks now allow interactive formatting, adding, and deleting of cells. You can track changes, merge workbooks, and create personal views without affecting other peoples' settings.

PowerPoint files are automatically compressed/decompressed on saving/launching—with no perceptible speed hit. Multimedia additions include action buttons, a kiosk mode, voice narration, and AVI movie support. An intelligent Expand Slide feature takes too-busy text screens and generates multiple slides with comparable hierarchy. The Slide Finder lets you preview, retrieve, and archive slides on a network. Spell-It, VBA, and a macro recorder now join PowerPoint, and one PowerPoint file can store multiple slide shows.

The Access 97 database reflects Microsoft's Web strategy with Internet and partial table replication, a new hyperlink data type, and static and dynamic Web publishing of forms, reports, and queries. If a form or report has no VBA code, Access creates a fast-loading "lightweight" version, and the Make.MDE command speeds things up even more by removing source code.

Office 97's new features, especially such unique tools such as the Journal's Timeline view and AutoPreview, which displays the first few lines of messages and documents, show how Microsoft thinks we'll work in the future. B



Outlook, the newest Office application, helps integrate many tasks.

Steve Gillmor, of Southern Digital, has extensive experience with groupware applications. You can reach him at **sgillmor@aol.com**.

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

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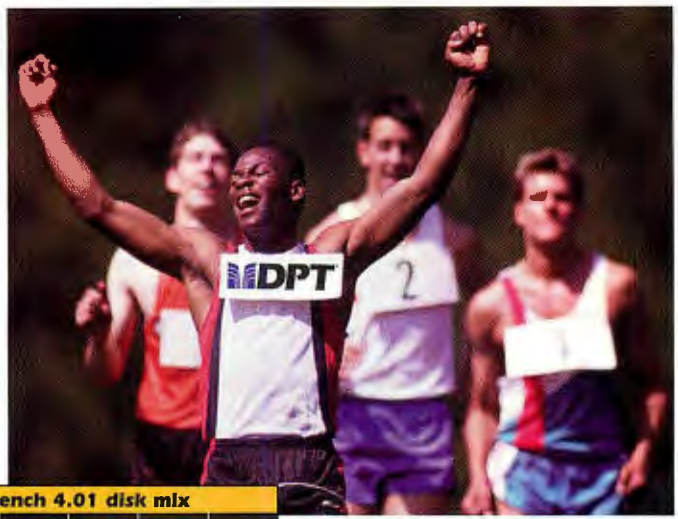

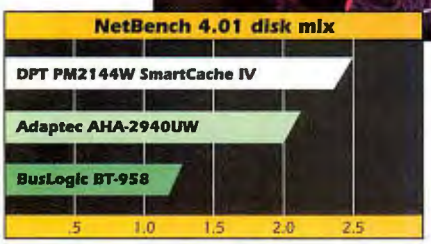

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It's Unix inside! The SPARCplug is a SparcStation-compatible add-in for Pentium systems. By Tom Yager

The Power of Fusion

When you're building an Internet server, whether for internal or external access, you face a dilemma: Some software packages run best on Unix, while others benefit from Windows NT's ease of use. Many shops (including mine) mix operating environments to gain access to all the best software. But this solution is costly, in terms of both cash and space.

Ross Technology offers an innovative solution to the problem of multiple OS personalities: Run Unix and NT in the same box—not alternately, but simultaneously. Ross's SPARCplug is a SparcStation 20–class workstation housed entirely in a full-height, 5¼-inch drive enclosure. (The unit that Ross supplied for this review was already built into a Dell Optiplex PC.) You can also buy the SPARCplug unit alone and do your own integration. In that case, the only drawback is that you have to add a special connector to your power supply. Ross documents the required modifications.

The SPARCplug's fusion with the host PC is managed entirely through a 10Base-T Ethernet cable. As you do when developing Internet applications in a non-networked environment, you simply bridge the SPARCplug's Ethernet port to your PCs with an included cable. To reach the outside world, you must connect both systems to your LAN. Communicating between systems in this way reduces the hassles of more proprietary methods (e.g., SCSI), but it slows all your transfers down to the speed of the Ethernet link. For most of us, that's about 1 MBps.

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

The SPARCplug appears to Sun's Solaris OS as—and is purportedly 100 percent compatible with—a Sun SparcStation 20, even down to the SBus and MBus expansion cards. Ross supplies a connector panel that lets you attach a Sun-compatible keyboard and mouse; it also connects you to the SPARCplug's on-board digital audio. There's no display connection on the back panel, however; Ross gives you a patch cable that connects the SPARCplug's serial port to the host PCs. You can view the SPARCplug's console through the serial port during the boot process and then connect via X Window System once Solaris is running.

The SPARCplug fits into a full-height, 5¼-inch drive bay. 10Base-T Ethernet connects it to the PC.

Ross deserves considerable credit for innovation. The SPARCplug outstripped my performance expectations, helped by its 128 MB of RAM and dual 100-MHz SPARC CPUs. This configuration also ships with some serious software: Netscape's FastTrack Web server, Netscape's Navigator Gold browser and authoring tool, and Hummingbird's eXceed X Window Server and Maestro NFS server. All that comes packaged in a Dell 133-MHz Pentium system with 32 MB of RAM for a list price of just over $10,000. That price, by the way, does not include the extra 64 MB of RAM included with the review unit. Pricing for that upgrade was not available at press time.

The best prospects for the SPARCplug are users who must run Solaris/SPARC applications. Having Windows NT a mouse-click away eliminates the downside of choosing only one OS. I am solidly impressed by the SPARCplug, but there's one drawback, besides slow data transfer to and from the PC host: excessive noise. This is definitely not a system for a developer's desk. The triple fans set up an amazing racket for such a small chassis. But even if you have to invest in some earplugs, the SPARCplug is an excellent value. Even if you don't much value the PC, a dual-processor SPARC system for $10,000 is worth lining up for. B

Tom Yager is a freelance writer and consultant based in Fort Worth, Texas. He can be reached at **tyager@maxx.net**.

Photoshop 4 automates many procedures and adds new layers of features, making it more powerful and easy to use. By Joy-Lyn Blake

A (Re)Touch of Genius

Long the graphic artist's first choice for image manipulation, Photoshop is now even better than before. Release 4.0, which I worked with in beta form on a PowerMac, incorporates more functions and is easier to use. Two areas stand out: combining operations and undoing.

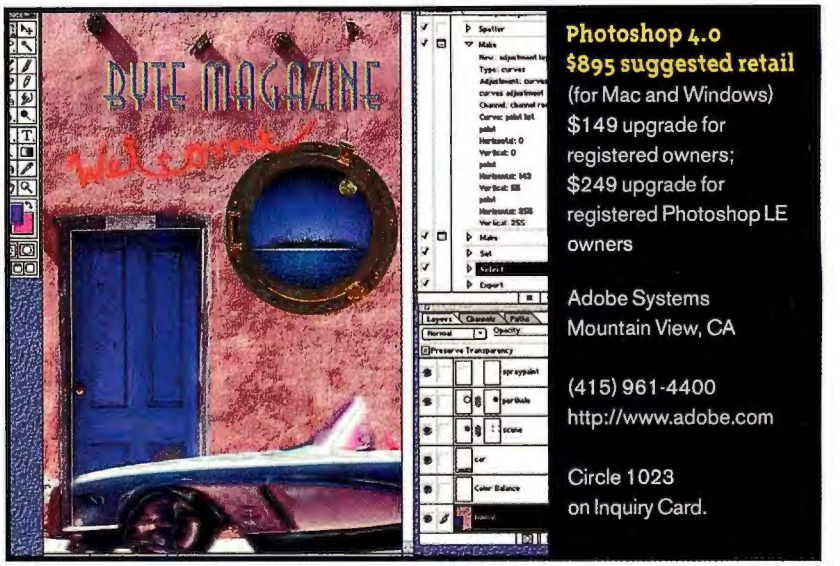
The batch processing capability in Photoshop's customizable "action lists" is welcome. Selecting "New Action" from the action palette brings up a dialog box that lets you start recording—the action list includes those steps you click "OK" on and excludes those you cancel. Make a mistake and you can always "Record Again" with new parameters. These actions are stored in files for future use, and you can append them to another action list. Dialog steps can be toggled on or off, depending upon what you want to do to the image you're working on, which is important if the settings vary from image to image. The action palette supports drag-and-drop, so you can quickly customize actions and create new ones. The actions have ties into OLE Automation and AppleScript.

Some of Photoshop's flexibility comes from its ability to manipulate an image in layers. Two new layer formats extend this power. Layer masking lets you control which areas of a layer are hidden or revealed. The mask can apply to the entire layer or to a selection within the layer. The adjustment layer also acts as a mask; you can make changes to a layer—to see the effects of the alterations—without actually changing the image. You can make color and tonal adjustments without degrading image quality. You can't merge adjustment layers, and a single layer can specify only one type of change, but these layers provide enormous flexibility. However, adjustment layers won't work with a masked layer.

Until someone finds a way to support multiple undos in a raster domain, the "free transform" capability will have to do. One step can combine scaling, perspective, and rotation, and a single command will undo everything.

Photoshop now includes guides and grids to simplify layout and alignment. Plus, dragging the slider control on the navigator palette scales the image quickly in continuous zoom levels from .13 to 1600 percent. The filter menu now includes Adobe's updated Gallery Effects collection of 32-bit brush strokes, distortions, and textures.

The only annoying feature I found is the way Photoshop handles text, insisting on placing each new item of text in its own layer. You can fix this after the fact, but it's no fun to "merge down" 13 layers of text or to turn off all except the text layers and "merge visible." Despite this minor flaw in the program, I've already put in my order for the shipping version. B



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Joy-Lyn Blake is a production associate in BYTE's New Media department. You can reach her at **joylyn@bix.com.**

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

Acorn's OS is ideal for embedded applications, yet it scales up to operate desktop computers. ***By Stewart Palmer***

A RISC OS for All Seasons

RISC OS is a general-purpose 32-bit OS developed over a 10-year period by Acorn Computers. Originally intended to offer an easy-to-use GUI environment for users of the Acorn RISC machine–based (ARM) desktop computer, it has evolved into a low-footprint, general-purpose OS. Acorn designed it to execute entirely from ROM and share resources. Thus, a fully configured system requires only 4 MB of RAM to function. Such a system can be operational in seconds after being switched on. It is therefore an ideal vehicle for low-cost, high-performance applications on a variety of platforms, ranging from simple embedded systems to set-top boxes to network computers. However, RISC OS's modular architecture allows it to scale up in capabilities so that it can drive multiprocessor workstations.

Kernel Features

Since RISC OS began on ARM-based systems, it operates on ARM610, ARM700, ARM7500, and StrongARM microprocessors. RISC OS's compact code size and high performance come from the use of ARM assembly language, although portions of it are in C. Many of RISC OS's services (e.g., file systems, font rasterizer, and GUI) are implemented as system expansion modules. You can separate and recombine these modules in a variety of ways to produce new versions of the OS that meet the specific needs of a particular hardware environment.

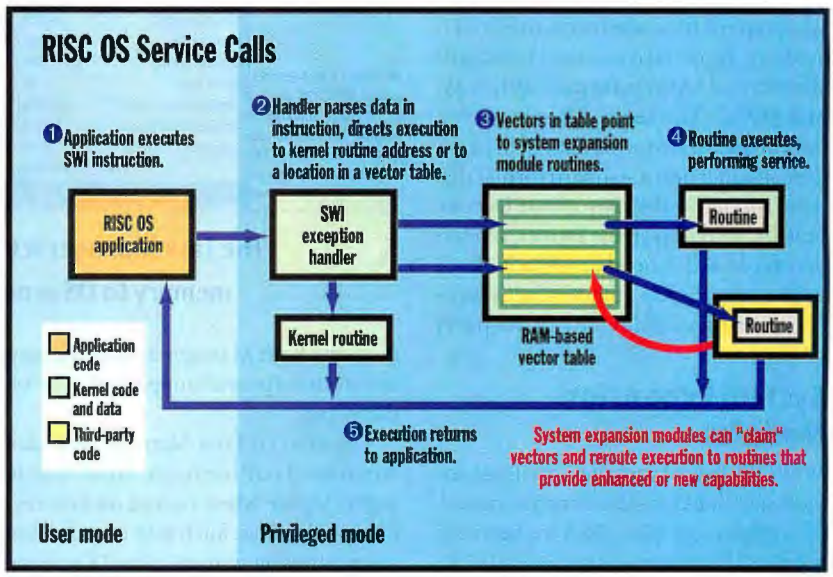
The kernel provides basic services such as memory allocation, interrupt handling, and DMA services, plus video-display generation and control. Memory is dynamically allocated from a free pool. Memory blocks are assigned one of several protection levels to limit a program's access to certain areas of memory.

RISC OS runs primarily in three of the four execution modes that the ARM processor supports. These privileged modes are interrupt mode, fast interrupt mode (a high-priority interrupt), and supervisor mode. You activate the latter mode by a processor-specific software interrupt instruction (SWI) that RISC OS uses to enter system routines or system expansion modules. RISC OS also uses certain SWI calls to communicate with different parts of itself or to converse with applications. The fourth mode is, of course, the unprivileged user mode that RISC OS applications use.

RISC OS implements multitasking by using a cooperative mechanism, where only one process is active at a time and must periodically yield the processor so that other processes get execution time. Neither the kernel nor system expansion modules are multithreaded. However, because much of the OS code is interrupt-driven, major OS processes get enough processor time to operate effectively.

Like OS service calls, modules use the SWI instruction as their entry point. Because RISC OS's SWI handler uses a RAM-based interrupt vector table to route most system calls, you can modify this table to reroute calls to another module. (Not all kernel calls get directed through the vector table, and you can't modify such routines.) A system call lets you "claim" a vector, making it easy to add a module that offers enhanced capabilities to existing services, or provide new OS functions, as shown in the figure "RISC OS Service Calls." Modules must be both relocatable and reentrant. These requirements enable a module to be loaded into any section of memory (relocatable) and its code to be shared by several applications (reentrant), thus making the best use of memory.

Acorn built networking into the OS. It is largely based on BSD 4.4 Unix. Unlike



The mechanism for handling service calls allows new features to be added easily to the OS.

Unix, RISC OS offers well-defined interfaces so that drivers or protocol stacks integrate easily into the kernel. TCP/IP is included as standard, with support for peer-to-peer networking that allows the easy sharing of disks and printers. NFS is also available, as are LAN Manager protocols (over NetBEUI or IP). A common desktop filer interface gives you a seamless view of all attached network resources.

Acorn Replay offers both application developers and users a simple, layered architecture dedicated to rendering time-based media such as audio and full-motion video. The Replay architecture is interrupt-driven and incorporates a clipping module that allows full and partial overlays of video windows on the desktop. The initial layer of the architecture is a Recognizer that determines what type of file container is to be operated on. Supported containers include the native ARMovie format, AVI, WAV, and MPEG. The second Replay layer, the Fetcher, transforms data held in the file container into a standard format that is interpreted by the appropriate Decompressor. A final layer, the Painter, renders decompressed data into a window. Each layer of the Replay architecture is capable of being extended by third-party developers.

System Expansion Modules

While the kernel provides low-level services such as I/O, system expansion modules implement RISC OS's higher-level services. Such services include file I/O, drawing and maintaining a GUI, and responding to user events. While RISC OS has many system expansion modules, I'll describe only two of them here.

The most visible and complex system expansion module is the Windows Manager. Responsible for implementing RISC OS's windows, icons, menus, and pointing device (WIMP) graphic interface, it is frequently referred to as the Wimp. Besides drawing and maintaining RISC OS's GUI, the Wimp also handles user events, starts and terminates applications, supports the cooperative multitasking mechanism, implements an applications intercommunications protocol, and performs some memory management. In short, it is the linchpin of RISC OS's operations. Many other system expansion modules (e.g., the Font Manager and the Replay architecture) provide support services for the Wimp.

WHERE TO FIND

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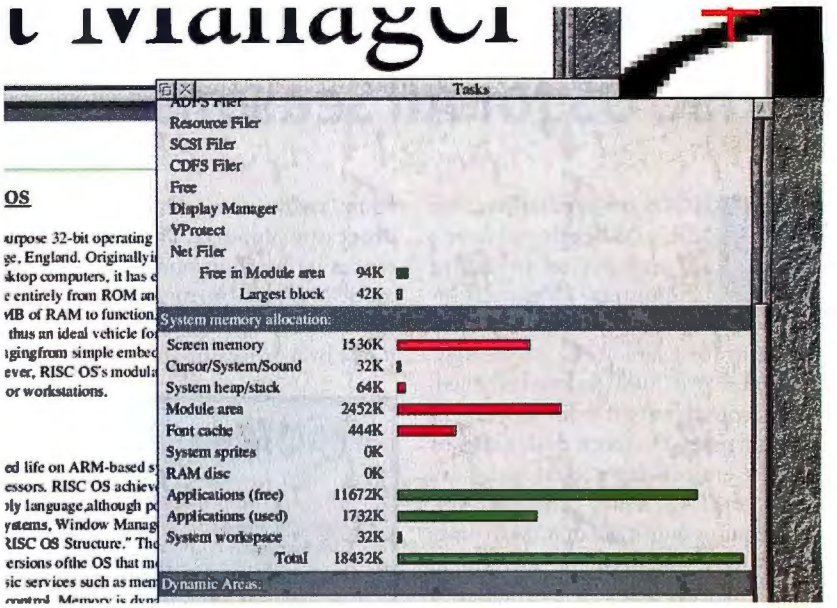


The Task Manager lets you dynamically assign memory to OS processes or applications.

The RISC OS Font Manager provides antialiased outline fonts. Small text is highly legible when viewed on low-resolution displays. Such text even retains its crispness on systems using TV screens because of an antitwittering algorithm.

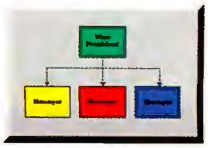
Applications and Environment

RISC OS applications use a suite of common facilities to render data, communicate with each other, and interoperate. These facilities are conducive to a consistent programming style. A comprehensive style guide ensures that all applications offer a similar look and feel to the user. A memory-based save/load protocol implements an applications intercommunications mechanism and uses a disk-based scrap file to handle large amounts of data. This save/load protocol lets you drag and drop data from one application to another, which enhances the system's overall ease of use. It also is the cornerstone for crafting applications that execute a few functions extremely well and link seamlessly with other applications that provide additional functions as needed.

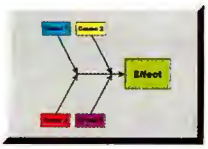
A Task Manager lets you dynamically alter the amounts of memory allocated to system resources and applications (see the screen). If you choose to antialias text at an unusually large point size, you can increase the amount of RAM devoted to the system's font cache by dragging a slider bar on the Task Manager display. You can deallocate this memory by the same method when no longer required. Similarly, you can create and delete a RAM disk of any size as necessary by dragging on a slider bar.

RISC OS's functions are both modular and scalable, which lets the kernel play the embedded program in a consumer device. RISC OS components are finding their way into new generations of multimedia kiosks, navigational aids, and mobile communications devices. When combined with its GUI, a file system, and multimedia modules, RISC OS also can command desktop computers or workstations. While its dependence on ARM processors once may have seemed limiting, the emergence of high-performance StrongARM-based systems has begun to change this situation dramatically. B

Stewart Palmer is design engineering manager at Acorn Risc Technologies. You can reach him at **spalmer@art.acorn.co.uk**.



Human resource tools like organization charts and relationship diagrams



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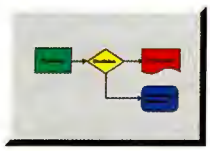

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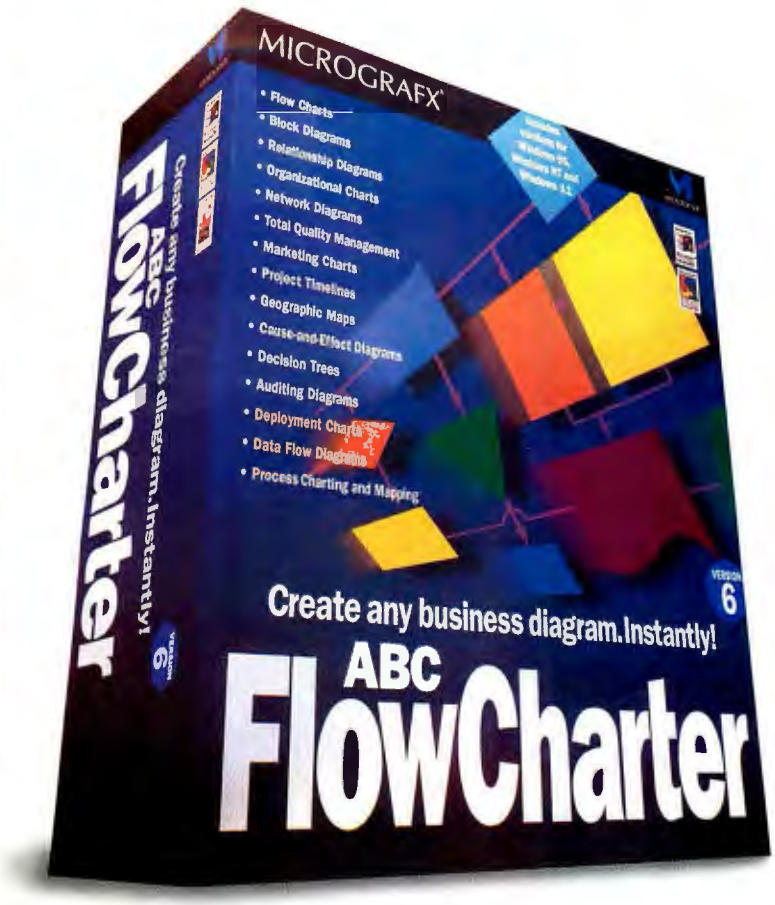

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A look at several techniques for getting the remote office worker connected via ISDN. ***By Jeffrey N. Fritz***

The Complete ISDN Telecommuter

The primary objective of telecommuting is to set up an environment in a worker's home that's analogous to the environment he or she finds in the office. Typically, that means a computer connected to the corporate network, along with a telephone and some form of fax service. Therefore, when designing a comprehensive telecommuting solution, careful attention has to be given to all three of these categories—networking, voice, and fax.

Placing an additional analog line in the telecommuter's home is one of the most commonly used methods for supplying an integral telecommuting solution. Such a line can be switched from voice to modem to fax, either manually or by installing an automatic line-sharing device switch, such as Black Box's Automatic Sharing Device-4, or ASD-4 (see the figure "The Analog Solution" at right).

As the figure illustrates, this approach is cost-effective and easy to implement. But it also has disadvantages, particularly for remote LAN access. Analog modems require long training periods of 10 to 20 seconds before they can begin transferring data. And once a connection is made, throughput speeds are limited.

The ISDN Connection

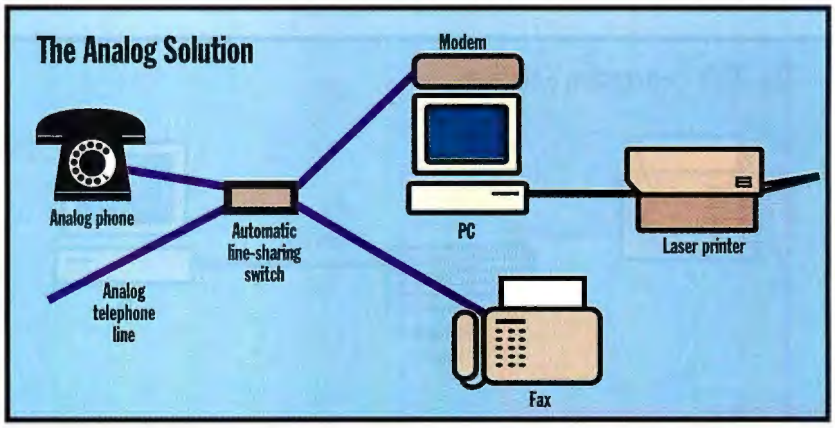
Because of analog's disadvantages, ISDN is often a preferred telecommuting solution—if it's available and can be obtained at a reasonable cost. Basic-rate ISDN offers two B (bearer) channels at 64 Kbps each and one D (delta) channel at 9.6 Kbps. By using data compression and combining the two B channels, ISDN is capable of 10 times the throughput of a 28.8-Kbps modem. Moreover, ISDN's local connection time is measured in milliseconds.

Another telecommuting method takes advantage of a number of ISDN products that allocate one of the ISDN B channels for analog devices. ISDN terminal adapters, such as the BitSurfr Pro from Motorola and the Adak 221, incorporate an RJ-11 telephone jack that allows you to plug an analog telephone, modem, or fax machine directly into an ISDN device. This allows you to make analog calls to and from such devices via the ISDN-based connection. It's important to note that some of these devices won't allow you to receive analog calls, as described below.

The figure "The ISDN Conversion Solution" on page 54 illustrates such an arrangement. Since the terminal adapter is the device that handles the conversion from ISDN to analog, any analog phone or fax will work—including internal PC fax modems.

Yet another method is to employ a mix of ISDN and analog lines to support voice, fax, and data services. As the figure "The Hybrid Solution" on page 54 shows, each device is connected to a single line dedicated to that device. Voice service can be supplied via either an analog or ISDN line, depending on the desired features each service offers. But it requires the installation of multiple phone lines, making it costly and complex to support.

Intelligent channel-contention ISDN devices, such as the Ascend Pipeline 75, automatically take care of call control and on-demand bandwidth management. When the user wants to make an analog voice call or send a fax, the ISDN device recognizes this. It automatically releases one of the B-channel network connections for use in the analog call.



All of a home office's equipment can be placed on a single line with a line-sharing switch.

During the call, network throughput will slow down to the single B-channel rate of 64 Kbps, but the connection will stay in place.

When the user hangs up, the device releases the B channel that was used for the analog connection. The network connection can then automatically recover the extra bandwidth. If the additional bandwidth is not necessary at that moment, the ISDN device may simply decide to leave the channel down, keeping it open for other calls.

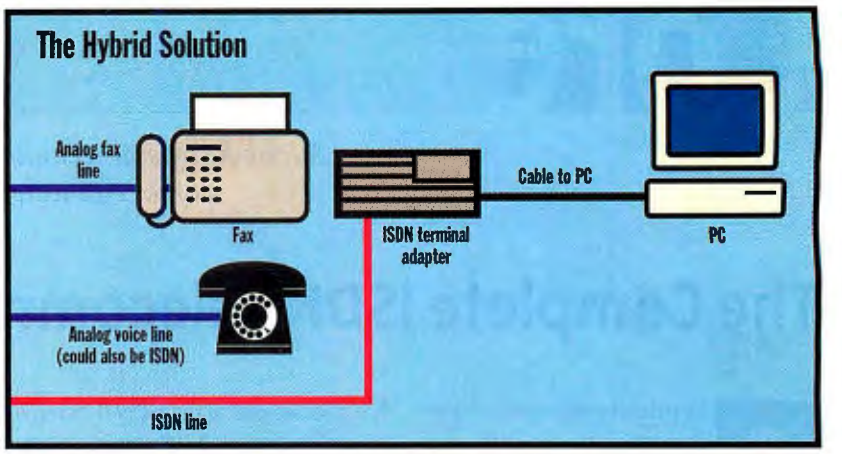
The telecommuter knows nothing of the magic that's occurring behind the scenes to make all this possible. Having been given simultaneous, nonblocking

access to data, voice, and fax services, the worker sees only the ability to work at home in much the same way as he or she would in the office.

Ringing Voltage Issues

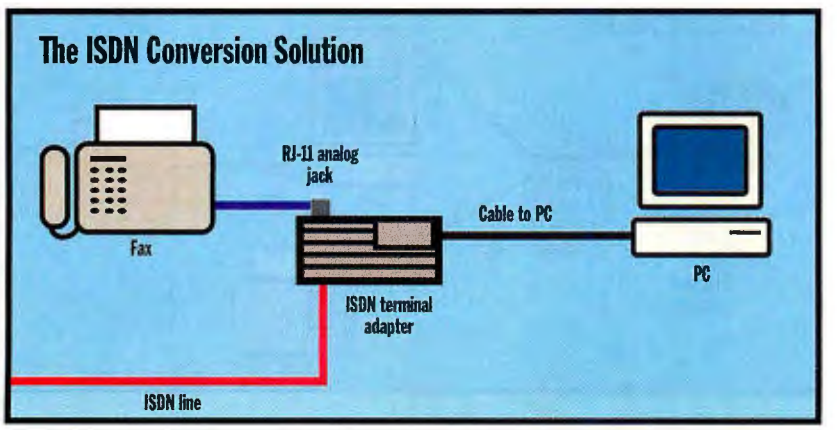
On an analog telephone line, the phone switch creates a ringing voltage that signals an incoming call. This voltage, typically at 100 V, causes the phone's bell mechanism to operate. When you pick up the handset, or when the modem or fax machine goes off-hook, a switch in the device turns off the ringing voltage, and the connection begins.

ISDN signals its connections entirely through the packet information that is placed on the D channel. Therefore, an ISDN device must generate a ringing voltage for any attached analog devices. This requires a much larger power supply than is normally necessary for the ISDN device alone. In addition, the ISDN device must be continually powered in order to support analog calls.



An ISDN/analog-line combination can best support a mix of office equipment, but it can be costly.

To keep the cost and size down, some ISDN devices do not support ringing voltage. This allows connected analog devices to make, but not receive, calls. If incoming calls are important in your work, be sure to check the specification on the ISDN device you're considering before making a purchase.



Some ISDN devices provide connections for analog office equipment.

Remote-Access Security

It's a simple fact of life that remote connections, whether ISDN or analog, increase the security risk to the corporate network. Therefore, absolutely no one should be allowed to obtain access to the network without first having to enter both an account number and a password.

If passwords are considered the first line of defense, then callbacks are usually considered the second line of defense. When a remote user wants to establish a network session, a network host verifies that he or she has supplied a legitimate account number and password. At that point, the network-side device drops the connection and calls the user back at a preassigned phone number.

The new caller ID service provided by the telephone companies is a great deal like callback security, but without the need to dial the remote user. On call setup, caller ID passes the remote user's number to the remote access device. A network device can be configured to accept only recognized numbers and reject all other calls.

The Internet Engineering Task Force (IETF) has defined two security protocols, Password Authentication Protocol (PAP) and Challenge-Handshake Authentication Protocol (CHAP), which are specified in RFC 1334, "PPP Authentication Protocols." Both allow authentication of a remote device beyond caller ID through the PPP connection.

PAP provides only basic user/password authentication, while CHAP is more robust. The latter sends a "challenge" to the remote unit that's attempting to make a connection to the network. The remote unit responds with a prearranged calculated numerical value. The authentication device checks the response against its own calculation of the expected value. If the values match, the authentication is acknowledged; otherwise, the connection is terminated.

Unfortunately, some remote devices default to no security when they're first installed or if they are reset. This creates a security hole that can catch members of a network staff completely off-guard. Therefore, it pays to be sure that any new network device, or any device that has been reset from its previous configuration, is not offering unauthorized outsiders the opportunity to get a free ride on your network. B

Jeffrey N. Fritz is responsible for new technology development and the operational management of WINnet, the West Virginia University network. He is the author of Remote LAN Access: A guide for networkers and the rest of us *(Manning Publications/Prentice-Hall PTR, 1996) and* Sensible ISDN Data Applications *(West Virginia University Press, 1996). You can contact him by sending e-mail to* **jfritz@wvu.edu**.

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The 64-bit MIPS R4300i RISC processor powers a compute-intensive consumer game system. ***By Satya Simha***

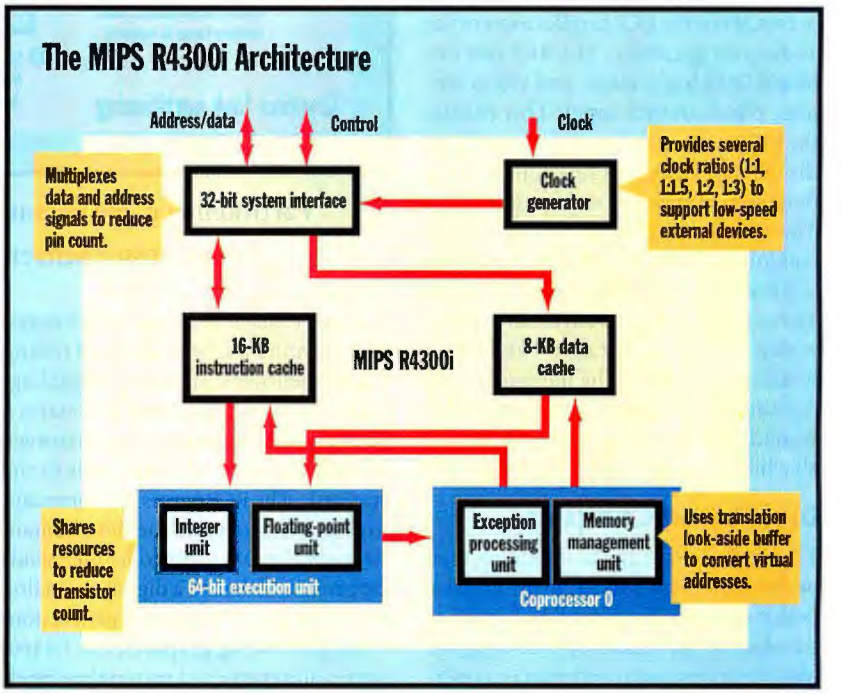
Super Mario Chip

If you buy your kids the new Nintendo 64 game machine, prepare thyself to be envious: Their graphics processor will stomp all over your desktop computer's. The N64 delivers visually realistic 3-D images and very high-quality audio, thanks to the 64-bit RISC processor—something you'd normally expect to find in a spare-no-expense high-end server or workstation—at the core of its design. This processor, the MIPS R4300i, provides a number of distinctive characteristics that enable high performance in a mass-market device, all while reducing its overall cost and power consumption.

A Tour of MIPS R4300i

The R4300i derives much of its microarchitecture from MIPS Technologies' R4400, a workstation-class microprocessor. The chip is code-compatible with the MIPS I, II, and III instruction sets. While the design was tailored to reduce the chip's cost and power consumption, the R4300i still has a number of workstation-caliber features. For example, the processor can operate in either 32-bit or 64-bit mode. Besides a 64-bit integer data execution unit, the R4300i also contains—surprise!—a 64-bit FPU.

The R4300i has a single-issue, five-stage instruction pipeline that handles both integer and floating-point instructions. The pipeline minimizes the latencies of load and branch operations so that they have a single-cycle latency. To keep the pipeline filled, the processor has two large on-chip caches: a 16-KB instruction cache and an 8-KB data cache, both of which are 64 bits wide. Both caches are direct-mapped and store physical tag addresses, which reduces the address-matching circuitry and avoids address contention. Specific memory pages in each cache can be locked, which boosts performance by storing frequently accessed items. A system coprocessor contains a memory management unit (MMU) that supervises both caches, as shown in the figure "The MIPS R4300i Architecture." The R4300i supports a virtual memory space of 1 terabyte (40-bit addresses). However, to reduce the complexity of the design, the processor does not supply on-chip support for a secondary cache or multiprocessing.



This 64-bit processor provides an FPU and virtual memory for sophisticated consumer applications.

The R4300i has an internal phase-locked loop circuit that enables the internal pipeline frequency to be a multiple of the system clock frequency. This lets the system designer utilize slower external components (perhaps memory) yet operate the processor internally at a higher clock speed for better performance.

The R4300i is manufactured using 0.35-micron, three-layer metal CMOS technology, which reduces the die size and thereby the manufacturing costs. Both the integer unit and the FPU share the same data path, which further shrinks the die. The processor also uses a 32-bit system interface, with multiplexed address and data lines, so that it can be housed in a low-cost 120-pin plastic quad flat package (PQFP).

The R4300i operates at 3.3 V for low power consumption. The engineers also used other methods to reduce power dissipation. For example, the caches are segmented so that only the requested segment is powered rather than the entire cache. The integer unit and FPU are integrated into a single execution unit with shared resources (such as the data

path), which both reduces the die size and power consumption. In standard operating mode, a 40-MHz R4300i (running internally at 80 MHz) eats up only 1.5 W.

Building the Box

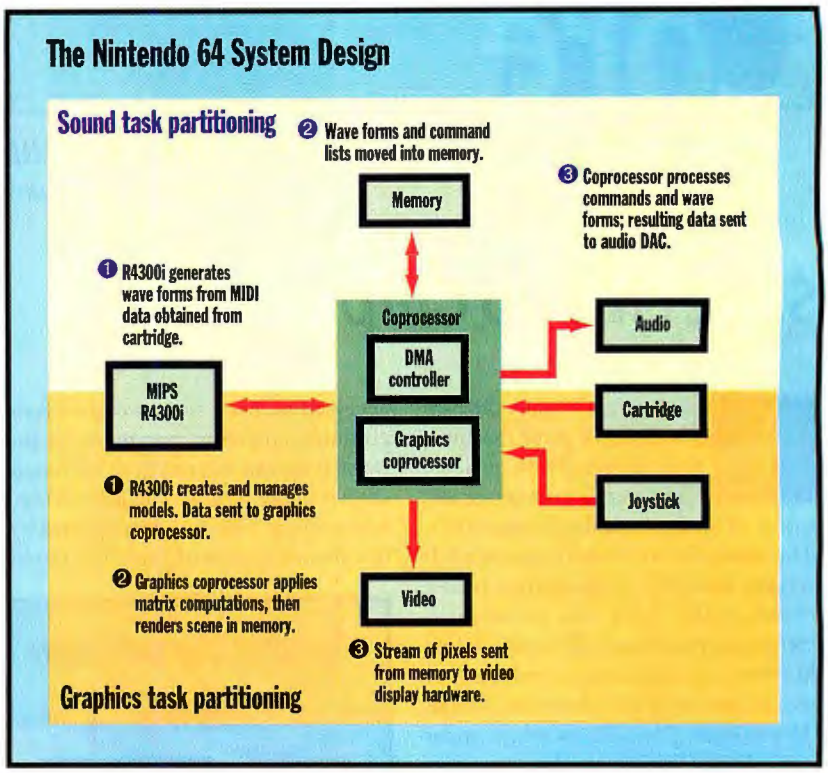
The Nintendo 64 system was designed with the objective of providing a realistic multimedia experience while keeping the unit compact and inexpensive. The figure "The Nintendo 64 System Design" shows the basic blocks used to build the device. At the heart of the system are two components: a custom R4300i clocked at 93.75 MHz and a custom MIPS coprocessor, the Reality Coprocessor (RCP), clocked at 62.5 MHz. The R4300i and the RCP interface directly to each other without requiring any additional glue logic. The R4300i supplies the processing brawn, while the RCP handles most of the audio and graphics. The RCP has onboard DMA logic, audio and video outputs, plus a joystick input. This enables the RCP to manage data transfers, create the display, and generate sound using a minimum number of supporting chips. The RCP also supports the timing and signals for a game cartridge unit. A graphics coprocessor internal to the RCP has a memory interface to external DRAM, which serves as a frame buffer and scratchpad storage. The memory interface supports a transfer rate of 500 MB per second to high-speed RAMBUS DRAMs, all while keeping the pin count low.

Divide and Conquer

The biggest challenge to obtaining high performance was how to partition tasks, both from the software and the hardware standpoint. For efficient processing, the N64 partitions audio and graphics operations into separate tasks. The R4300i works as the central controller and interrupt handler. It also handles all high-level audio processing functions. For example, the R4300i uses the FPU to synthesize high-precision audio wave forms. The RCP handles those jobs where software algorithms alone can't meet the bandwidth requirements. To generate sounds, the R4300i processes a list of musical events (for example, MIDI notes) to determine the resource and timing requirements. It then builds a digital signal processing command list, starts a DMA transfer of data from mass storage to main memory, and then goes to the next task. The RCP parses the command stream and processes the data in main memory. The DMA controller then sends the processed data to a digital-to-analog converter (DAC) for sound generation.

For generating graphics, the R4300i can readily create and manipulate models (3-D objects described as a mesh of polygons) for use in game scenes. When the game code needs to update the position and the attributes of the models, the R4300i can handle these updates in real time. The models are next forwarded to the graphics coprocessor, which performs matrix manipulation and renders the image. The R4300i's 64-bit mode gives game developers extra precision for models and other calculations without having to write high-precision algorithms or incurring a performance penalty.

The R4300i's large caches are crucial for achieving the N64 system's performance. Without these caches, the frequent memory accesses to fetch program code or data would degrade performance by as much as 20 percent. The large instruction cache allows both upper-level software routines (such as event loops) and the interrupt handlers to be locked on-chip at the same time. The data cache also assists in graphics processing because a small set of data can be stored on-chip and manipulated for every image frame.



Partitioning game operations between the R4300i and a coprocessor delivered the best performance.

Not Just for Workstations

New process technologies allow workstation-class MIPS processors to be fabricated at a lower cost and higher volume, making them appropriate for consumer machines and embedded systems. The R4300i was created specifically to suit low-end applications. Because of the chip's roots, software developers can apply their expertise to the R4300i, and hardware designers can use it to build products for new markets. B

WHERE TO FIND

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Satya Simha has an M.S. in engineering management from Stanford and an M.S.E.E. from Michigan Technological University. Prior to joining Silicon Graphics, he worked as a product definition and applications engineer in the MIPS RISC division. You can reach him in care of **editors@bix.com**.

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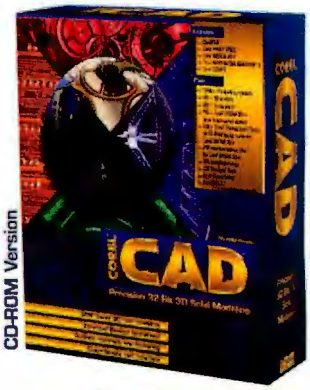

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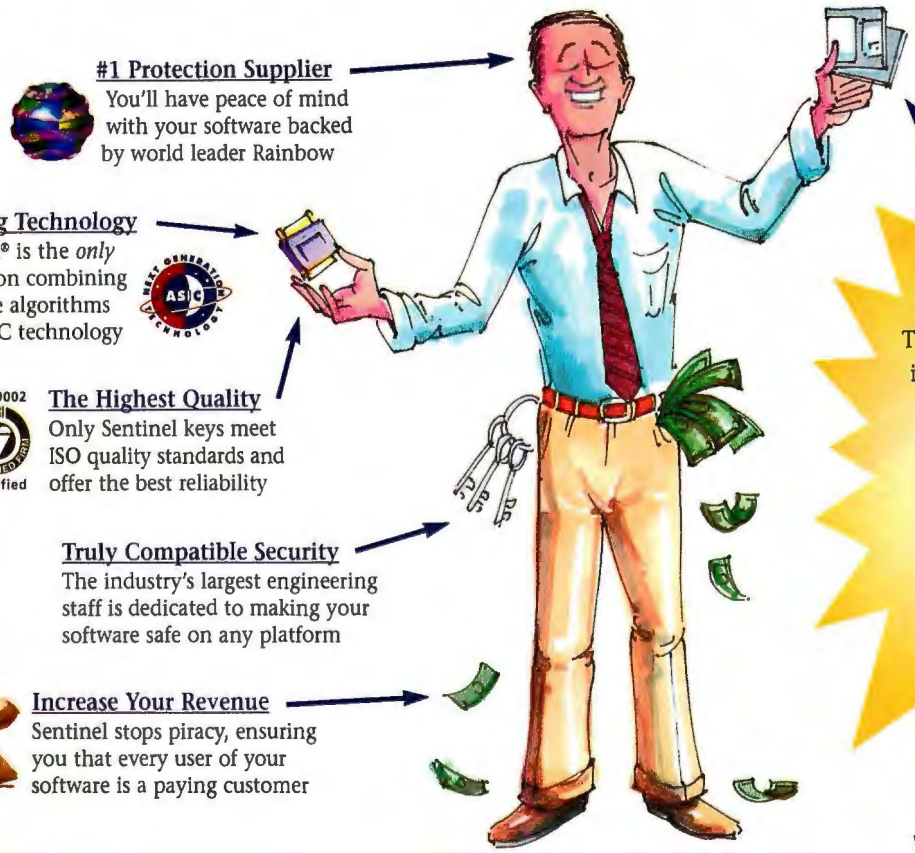

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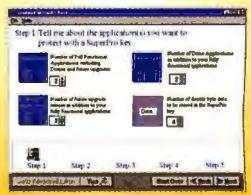

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Microsoft's 3-D API provides device-independent access to acceleration hardware. Here's how it works. ***By Stephen P. Johnson***

Direct3D Revealed

Microsoft's Direct3D, which was released in June, is the latest of the DirectX APIs available for the PC platform. Direct3D offers programmers a hardware-independent API that displays 3-D graphics and provides a mechanism whereby an application can tap into any graphics-acceleration hardware present on a system. (For more information on the Direct3D architecture, see "Must-See 3-D Engines," June BYTE.)

Because it provides OS-level support for 3-D graphics while uncoupling the hardware from the interface, Direct3D enables programs that use 3-D imagery to run on a wide variety of desktop computers. Where possible, these programs can take advantage of the hardware's capabilities to provide optimal quality and rapid generation of 3-D graphics.

It's important to note that hardware-acceleration techniques for 3-D graphics vary widely. This is because 3-D graphics is a new concept on the PC, and the intense cost constraints of the market are forcing new designs and algorithms at the chip level. Also, it can sometimes be difficult to fit a certain hardware design into Direct3D's programming model. For these reasons, expect to see wide variations in performance among the various 3-D graphics cards.

In Your Interface

How does Direct3D manage to hide the details of a display card's hardware yet allow access to acceleration features that are obviously hardware dependent? At the interface level, the low-level Direct3D API abstracts hardware features in a consistent manner that allows such portability. In addition, Direct3D consists of two types of drivers. The first type, which is at the software level, is called the hardware emulation layer (HEL). The HEL generates all graphics operations using the desktop system's processor, and the resulting pixels are sent to a DirectDraw frame buffer. (DirectDraw is a DirectX API that deals with 2-D graphics.)

The other Direct3D driver type implements a hardware abstraction layer (HAL). Chip and board manufacturers use the HAL to expose the hardware's capabilities in a device-independent manner. Through the use of a query mechanism, the Direct3D API lets a programmer obtain access to these features.

Direct3D Data Structures

Data Structure	Description
D3DHAL_GLOBALDRIVERDATA	Contains the driver's global data. The data structures that follow are embedded within this structure.
D3DDEVICEDESC	Describes the hardware's 3-D-rendering capabilities.
D3DPRIMCAPS	Describes the capabilities of a 3-D primitive (a triangle, line, or point). These reflect the 3-D attributes that each primitive supports.
D3DHAL_CALLBACKS	This structure contains a table of function pointers that implement the Direct3D HAL interface.

The hardware driver must implement all the features exposed by these query operations. It can do so by using software or a combination of software and hardware. The application chooses which driver to use—either the CPU-intensive HEL or the hardware-accelerated HAL.

Direct3D is made up of many C/C++ header files and Component Object Model (COM)–based interfaces. The header files contain many enumerated types and data structures used to convey device information to the OS. This information lets the application control the appearance of a 3-D object, such as its texture and rendering surfaces.

Several of the data structures handle the translation of device-independent API calls into device-dependent rendering calls. The table "Direct3D Data Structures" below summarizes these data structures and their use inside the driver.

Essentially, these data structures describe the capabilities of the driver's underlying 3-D-rendering chip to the OS. One structure provides entry points to the HAL functions that operate the chip's rendering engine. Usually it's easy to define these structures: You simply compare the feature-capability bits described by the Direct3D headers to the features that the chip supports and then set the appropriate bits. Implementing these chip-supported features is more difficult because of interactions among the display management software, the 3-D-rendering driver software, and the capabilities of the underlying hardware.

Building the Driver

For this article, I'll use S3's ViRGE as the sample hardware. This chip has extensive 3-D graphics capabilities, including the ability to support numerous rendering modes, z-buffer compare operations, and several texture-map formats.

You start a drawing operation by passing the coordinates of a triangle or line to the chip. Next, you set up attribute bits, such as texture mapping, z-buffer compare mode, fog, and Gouraud shading, and turn the corresponding bits in the chip's command register on or off.

continued

The ViRGE chip is a true immediate-mode 3-D-rendering chip; the moment that you complete the process of programming the command register, it starts drawing the triangle or line.

The Direct3D driver starts with a DirectDraw driver, which provides access to the card's frame buffer and any off-screen buffers that the Direct3D driver requires. Furthermore, a HAL data structure in the DirectDraw driver, DDHALINFO, contains device-capability bits that define the Direct3D driver. When a Direct3D driver is initialized, it turns on certain bits inside DDHALINFO.

The sequence of the creation of a Direct3D driver thus starts with the initialization of a DirectDraw driver. As part of its initialization process, the DirectDraw driver calls a create-driver function inside the card manufacturer's 32-bit driver, which sets up the Direct3D driver.

This function first sets the capability bits inside the DirectDraw driver. Then it builds the data structures shown in the table "Direct3D Data Structures." This function then gets data from the card's firmware and plugs it into these structures. For example, data that indicates that the ViRGE chip supports several texture maps gets placed within a D3DHAL_GLOBALDRIVERDATA field, while capability bits that describe chip features, such as z-buffer compare modes and color-dithering support, get activated in the appropriate fields in D3DPRIMCAPS.

The addresses to rendering functions get stashed in a table called D3DHAL_CALLBACKS. These addresses are returned to the DirectX software layer and serve as entry points to the driver's callback functions. A 3-D graphics operation thus invokes a callback function in this table. The invoked HAL function implements the specified 3-D operation, as shown in the figure at right.

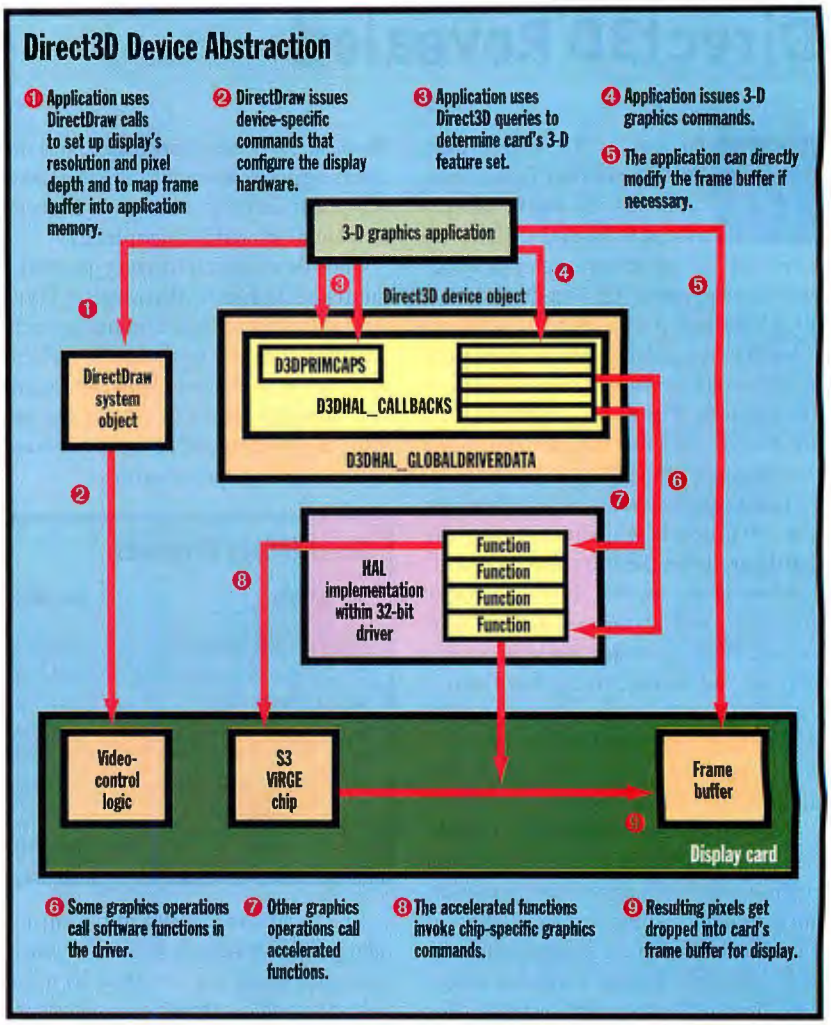
The driver must support a minimum of six callback functions, several of which deal with the context of the graphics environment. Two functions control the environment's state and its rendering characteristics. The callback of interest here is `RenderPrimitive()`; it implements the driver's actual drawing functions. This function receives geometric data via a pointer to a display list that consists of vertex data and a drawing command. The driver copies the vertex information and calls a ViRGE-specific drawing function. The `RenderPrimitive()` function is thus reduced to a `for` loop, with calls to the appropriate ViRGE drawing functions. The driver accelerates all 3-D primitive types: triangle, line, and point.

The Application's View

But what creates the DirectDraw object? The 3-D application. To set up the display's pixel depth and obtain the location of a frame buffer, the application must create a DirectDraw object. The application then queries the OS for a Direct3D system object, which is used to obtain information about all the drivers that support 3-D rendering and their capabilities.

The application walks through the list of drivers to locate the one that best fits its graphics or performance requirements. If the host system lacks a certain acceleration feature, for example, the application can respond by lowering the display's pixel depth or resolution or by eliminating certain rendering attributes, such as texture mapping.

Because access to the driver is obtained through a well-defined interface and an array of callback functions, the application programmer is never exposed to the hardware. Thus, he or she can write an application whose code runs on most any hardware combination. Such an application can also configure itself appropriately so that it runs on older or less-capable systems, which makes the program available to a larger audience. ■



DirectDraw and Direct3D hide the display hardware from the programmer.

Stephen P. Johnson assisted in the creation of Apple's Power Mac and worked on QuickDraw 3D, Apple's 3-D API. He now works on 3-D drivers and software at Diamond Multimedia Systems, Inc. (San Jose, CA). You can contact him at **STEPHENJ@diamondmm.com.**

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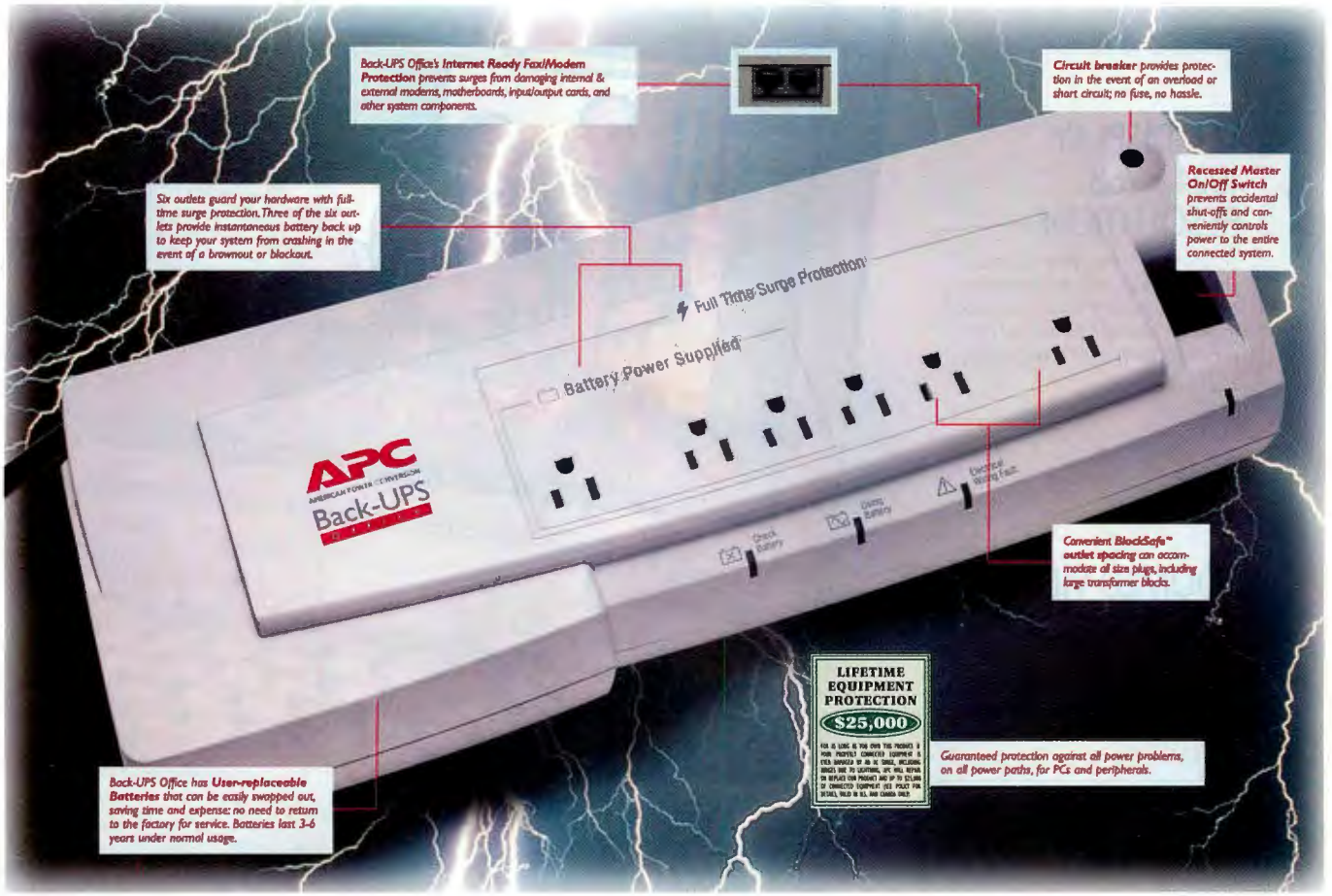

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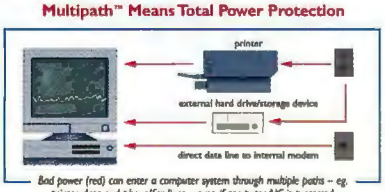

Bad power (red) can enter a computer system through multiple paths – eg. printer, data and phone/fax lines – even if computer A/C is protected.

The Multipath™ protection of Back-UPS® Office™ shields your peripherals and guards your computer from bad power on every path, providing clean, safe power (green), to your entire system.

Multiple peripherals and data lines to and from your system are vital, but dangerous. Without them, you can't do your job. However, if a power sag makes your modem drop the line while you're downloading from the Internet, or locks your keyboard before you've saved work, you lose time, money and spend another late night at the office to meet your deadline.

Back-UPS Office protects your entire system

Until now, protection for your entire system required several devices. But multi-device protection can leave you vulnerable to line noise and unwanted data glitches created by the voltage differential between outlets. Those glitches are prevented with the Back-UPS Office common voltage reference.

Back-UPS Office means true Multipath™ protection, clean, safe power to every peripheral, and instant battery backup to keep your cutting edge system and O/S from crashing. It means protection for less by integrating the security of a surge suppressor with the power of a UPS, guaranteed up to $25,000.

"Back-UPS Office [is] a shoo-in for the small-office/home-office computing market and for general desktop workstations"
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The Multipath Power Protection Advantage	Traditional Surge Protector	Traditional UPS	Back-UPS Office
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Data			•
Phone			•
Total Outlets	6	6	6
Number of Block Outlets			2
Protection from:			
Surges	•	•	•
Spikes	•	•	•
Blackouts		•	•
Brownouts		•	•
Overvoltages			•
Battery Backup to Protect:			
with Pentium 100 w/15" monitor		10	10
Battery backup for:			
PC		•	•
Monitor		•	•
Storage Devices/Zip Drives			•
Full time surge protection for:			
Fax/Modem	•		•
Laser Printer	•		•
Speakers	•		•
Protection and backup for:			
Internet or Network			•

Traditionally, protecting all your equipment meant buying a surge suppressor and a UPS. Even then, only your AC line was protected. New Back-UPS Office protects all paths to your equipment: Bulletproof Multipath protection

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How Microchips Shook the World

Ten reasons why microprocessors define the twentieth century more than any other achievement.

By Peter Wayner

Flash back to 1971. China enters the United Nations. Eighteen-year-olds win the right to vote in the U.S. A "computer on a chip" arrives that's small enough and cheap enough to fit inside business machines, toys, appliances, tools, and entertainment devices—in short, anything that is vaguely electrical.

The world hasn't been the same since.

Today, thanks to the microprocessors that have followed Intel's 4004 in 1971, we're healthier, better informed, more efficient, and, in some disturbing ways, less private than we were 25 years ago. (For details about the 4004 and other significant microprocessors, see "Birth of a Chip" on page 77. To see how technology may change in the next decade, see "Eight Ways to the Future" on page 85.) Because microprocessors have become so much a part of our lives, the real challenge is to find devices in our business and personal lives that aren't in some way computer-controlled. Small and relatively inexpensive computers have made it possible for us to track virtually any human activity, analyze any process, and control any mechanism.

As we acknowledge the microprocessor's twenty-fifth anniversary, we should also remind ourselves that computers only process data: Knowledge is another matter. The Federal Reserve may run dozens of computer-based financial models, but in the end, it's humans who decide whether to raise or lower interest rates. Similarly, years of research in artificial intelligence have produced flexible algorithms that can adapt in well-defined ways, but only humans have the ability to comprehend and grok.

What follows is our list of 10 dramatic ways that the microprocessor has changed our world. All point to one indisputable fact: Any look at the microprocessor's impact on society is only a snapshot in time. The revolution continues. *continued*

Privacy Under Fire

In the past, your private documents were only as secure as the safe you locked them in at night. Today, electronic encryption secures information on disk drives so that only authorized people can read sensitive data.

But encryption also creates the possibility that criminals could electronically hide important evidence. In the U.S., federal law-enforcement officials are pushing a plan for people to give a copy of all encryption keys to the government, which will keep the keys under wraps unless there's a need to read some encrypted data. According to these officials, the encryption threat is so great that the U.S. government should continue its fight against exporting encryption technology beyond its borders.

Encryption will also provide the underpinnings for widespread electronic commerce, which could give consumers unlimited access to a world marketplace and an electronic audit trail for recovering lost or stolen funds. Nevertheless, our privacy also could be assaulted by credit-card companies, banks, and others who can easily assemble detailed dossiers on our spending habits. For example, employers in some states can legally refuse to hire cigarette smokers because of the cost of providing health care. Taken to an extreme, electronic records of spending habits could lead to a job interview such as this:

Employer: "Are you currently a cigarette smoker?"

Applicant: "No comment."

Employer: "Then would you care to explain why you bought that 20-cigarette pack of Marlboro lights at 12:32 p.m. on June 14, 1997, at the Zippee Mart on Fourth and Oak?"

In the end, blind-signature schemes for digital cash and anonymous messaging using Secure IP (Internet Protocol) may be our best hope for shopping without the aid of Big Brother.

Business

The Electronic Workplace

The outward signs are everywhere: PCs on every desktop, laser printers in every workgroup, electronic spreadsheets and databases bolstering every business decision. The modern office looks and works differently from its predecessor of 25 years ago, thanks to the microprocessor.

At first, computers simply translated traditional ways of working into some electronic analogy that may or may not have improved efficiency. Gradually, however, computers inspired us to work differently. Groupware products and intranets using cheap microprocessor-based computers now provide seamless communication and make it possible for managers to control larger and more diverse groups.

The good news is that many office products have never been cheaper (after adjusting for inflation). The bad news is that many companies need fewer managers, which narrows advancement paths for many people. What's more, as workgroups become geographically dispersed, some workers find themselves cut out of essential meetings. The synergy of the water cooler disappears.

Medicine

Computed Tomography for Everyone

Every day in hospitals throughout the world, computed-tomography (CT) scanners save lives by showing doctors a 3-D map of the inner body. Microprocessors aren't the only types of computers that can do the mathematics to construct these 3-D images, but microprocessors are why CT scanners have proliferated in recent years.

Early CT machines ran large minicomputers that were expensive to build and maintain, but the newest scanners use high-end workstations for processing muscle. For instance, Picker Nuclear Medicine (Highland Heights, OH) formerly powered its scanners with an Ardent Titan 1500 minicomputer that needed dual multiprocessors to generate 32 MFLOPS at peak performance. Today, the company uses a Digital Equipment Alpha workstation with a single microprocessor that can produce over 133 MFLOPS of floating-point performance. These workstations are also highly optimized for graphics, which allows real-time manipulation of 3-D images to help doctors evaluate the health of organs and zero in on diseases.

And perhaps most important, microprocessors have helped lower the cost and shrink the size of CT machines, which makes them more widely available than ever. In fact, outpatient CT centers now are common in many urban areas.

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News Gathering Becomes Collaborative

News was once something that came down to us from a handful of media outlets like a daily sermon from the mountain. The Internet levels the mountain. Almost anyone can now be a publisher, and some of the most late-breaking news and diverse opinions now arrive via electronic 'zines and e-mail lists. Usenet newsgroups also contain news nuggets often mixed with terabytes of yammering foolishness.

Major newspapers are responding by blending their traditional print products with on-line information from their own Web sites. Reporters now receive e-mail correspondence from larger cross sections of sources to broaden the reporting of their stories. When the *New York Times* ran a major week-long exploration of downsizing in America earlier this year, it sponsored conferences at its Web site. Elizabeth Osder, content development editor, says the printed edition actually included some quotes and information from the electronic discussions in the stories that ran later that week. Also, Microsoft's joint venture with NBC News points to a similar blending of TV news and Web sites for information delivery.

Nevertheless, printed publications won't disappear anytime soon. The Web is great for conferencing, research, or for poking around randomly for information, but newspapers and magazines are still more convenient to read and faster to browse. Paper has great bandwidth.

DNA's Mysteries Unzipped

Biologists still don't completely understand DNA, but they've made great strides in the last decade, thanks to microprocessors. The mathematics of sequencing large parts of the genome has spawned a new field of computational molecular biology. Special silicon chips make it possible to speed sequencing even more.

The benefit: Researchers can now use genetic profiles to predict which individuals are more likely to contract certain diseases. But cheap and effective genetic tests can make people uncomfortable. For example, some U.S. soldiers recently refused to have their cells included in a military DNA database because they feared the data hidden in their DNA could be used against them later. Similarly, will health insurers be able to resist the temptation to deny coverage to those with a predisposition to, say, diabetes?

E-Mail Distributes Democracy

Electronic mail opened up the corporate world by replacing formal chains of command with fast and more interactive communications (even though words may often be misspelled, sentences may be filled with questionable grammar, and thoughts may not always be fully formed). All of this relies on microprocessors in desktop machines and in modems that move the information.

Then there's "Dilbert." Scott Adams, the comic strip's creator, uses e-mail to receive ideas for future cartoons from readers. A few of "Dilbert's" cartoon predecessors relied on snail mail for input from readers, but thanks to e-mail, "Dilbert" may be the most interactive cartoon ever. Of course, this can be painful if you are a manager whose new initiative, "Totally Quality, Total Equality," becomes the target of a future "Dilbert" episode.

Smarter Automobiles Now Rule the Road

Gone are the days when driving a powerful car meant you burned gas like it was free and fussed over a carburetor for hours. Microprocessors now run the engines so efficiently that many standard-size cars get up to 30 miles to a gallon and enough torque to make passing fun. And as a bonus, the latest engines can go for 100,000 miles without a tune-up, thanks to the microprocessors.

The technology doesn't end there. Air bags open when a microprocessor detects impact. Car CD players fight skips by reading ahead several seconds and filling in lost gaps before it's time to play the data. Which processors do car makers favor? Many of the CPU families we're familiar with in our desktop systems have versions that serve as embedded processors. This includes the PowerPC, Motorola's 680x0 line, and many Intel chips. What's next for semiconductor-managed cars? Auto makers are exploring custom OSes to network the dozen or more CPUs common in automobiles. Talk about the infobahn.

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Easy (Too Easy?) Credit for All

Twenty years ago, credit cards were for a privileged few because verifying transactions was tedious. If you made a large purchase, the store clerk called a central operator and read the value over the phone. Thanks to microprocessors, the dangers and inefficiencies of cash-only transactions are disappearing, but in their place we have credit-card debt that is strangling some people who have found that plastic is too easy to use.

For better or for worse, the microprocessor allows for cheap terminals at practically every cash register in the country. Embedded microprocessors built around old versions of the x86 line and modems running at 2400 bps cost little. Because stores can now verify every transaction, finance companies can easily enforce credit limits and stop fraud. This lowers the risk of putting credit cards into the hands of millions of people worldwide. Consider growth rates in this decade alone. In 1990, Visa reported carrying $174 billion through its networks, but by 1994, the company processed $293 billion, an average annual growth of 17 percent. What's more, credit cards pay for even the most mundane purchases. Ten years ago, practically all grocery purchases were in cash. By August 1995, low-cost supermarket verification terminals helped Visa carry $1 billion in grocery charges.

Worldwide Dial Tones

Cellular phones—the lifeline for both road warriors and stranded hikers—are just microprocessors hooked up to a radio antenna and optimized for processing radio signals. For example, Motorola's VeComp chips, the next generation of processors designed for wireless networks, use a PowerPC core. The core runs the phone's OS and handles details about calling numbers. The chips also come with a single in-struction/multiple data (SIMD) array of ALUs for digital signal processing.

Although the beep of cellular phones has had a substantial effect in industrialized nations, changes elsewhere are even more extraordinary. Large parts of Africa may never be wired for traditional phone service, because cellular systems are substantially cheaper to launch. The microprocessor has made it possible for some countries to go from almost no phones to ubiquitous phone service.

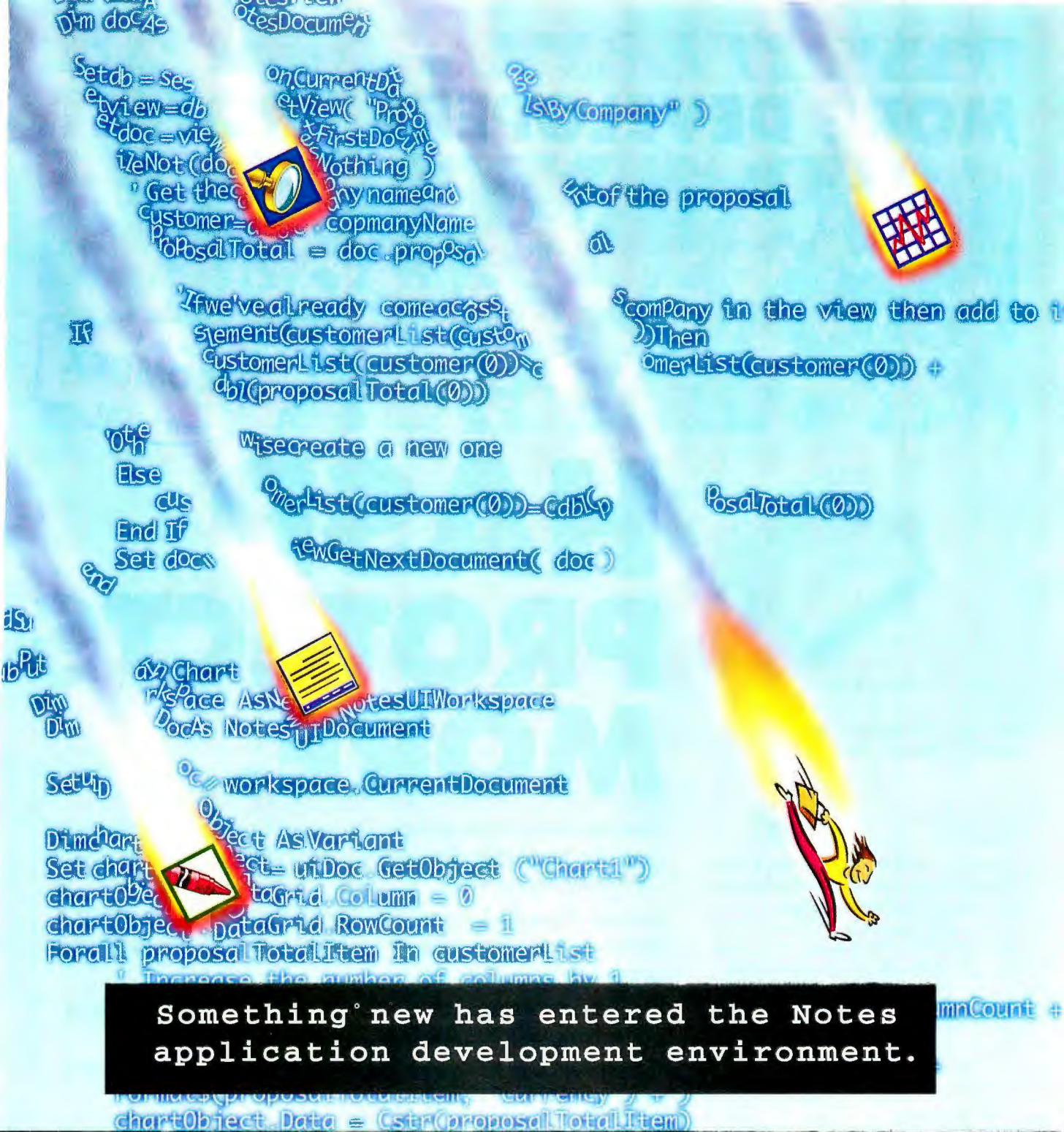
Peter Wayner is a BYTE consulting editor. Contact him at **pcw@access.digex.net** *or* **editors@bix.com.**

Animation Opens Up a New Dimension

The microprocessor dramatically changes how artists produce animation by making it possible to create true, 3-D worlds that move. Previously, artists constructed animated cartoons using 2-D creatures moving against a fixed 2-D background like a game of cardboard cutouts. Advertisements have embraced this technology as well: Every product seems to get up, morph, and dance across the screen today.

The result is more-realistic-looking animation and some reduction of the immense amount of resources needed to produce cartoons. For example, *Toy Story* used the smallest staff of any animated Disney feature to date, yet it was entirely 3-D. Disney and Pixar estimate that they used over 800,000 hours of computing time on Silicon Graphics workstations and Sun SparcStations to build the final 500 GB worth of pixels that audiences viewed in the film.

SCREENS: © WALT DISNEY COMPANY, DISNEY'S ANIMATED STORYBOOK: TOY STORY



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Birth of a Chip

In only 25 years, the microprocessor has become the life-support system of the modern world.

By Linley Gwennap

Even in 1971, Intel wasn't shy about its accomplishments. Then only a four-year-old start-up known primarily for memory chips, the company proclaimed "a new era in integrated electronics" when it launched the 4004, the world's first commercial microprocessor. For once, an advertising claim proved to be prophecy rather than hype. The 4004 offered approximately the same performance that the ENIAC, with 18,000 vacuum tubes, did in 1946. The 4004's low cost ($200) and tiny size (12 mm^2) enabled engineers to create new categories of world-changing products. Nevertheless, skeptics predicted that the market for a single-chip computer would also be tiny. After all, the total computer market was only thousands of units, and the 4004 was so primitive that part of its package was wood.

But the computer-on-a-chip became bigger than any one company. And chip architects continue their relentless quest to squeeze ever more power out of microprocessors.

Laying Down the Law

The 4004 sprung from Intel cofounder Robert Noyce's realization that the IC manufacturing processes for memory chips could be used for logic circuits as well. But what would be the right logic product? That question had been on Noyce's mind—and that of Intel cofounder (now chairman) Gordon Moore—for almost a decade. Shortly after Fairchild shipped the first IC in 1961, several industry visionaries realized it was only a matter of time before someone built a complete computer on a single chip. Most famously, Moore, then with Fairchild, predicted the number of transistors that could be placed on a single chip would double every 18 months, a rule so strong that it has held for 30 years and is now codified as Moore's Law.

In 1969, Moore and Noyce received an auspicious visit from Busicom, a Japanese company that was in the process of developing a desktop calculator. Busicom wanted Intel to design a set of 12 specialized chips for the device. Instead, Intel officials suggested that the calculator be built around a single general-purpose computing chip, which eventually became known as the 4004.

The 4004 design team included Ted Hoff, Stan Mazor, and Federico Faggin (who were all recently inducted into the Inventors Hall of Fame for this work). They borrowed many concepts from the larger computers of the day. But their resources were limited: To fit a computer onto a chip, they had to reduce the size of both the internal data paths and the external data bus to 4 bits rather than 16.

This design minimized the number of transistors that were needed for the storage and calculation units and helped fit the device into a 16-pin package, the largest that was available at the time. By contrast, today's Pentium processor requires a 296-pin package with a 64-bit external data bus. Intel's reduction of an entire CPU into a single chip meant that even low-cost devices could be programmable, which significantly reduced the cost and effort needed to design products and add new features.

Not having to be concerned about compatibility with existing computers, the team created a set of 45 instructions, many still familiar to modern programmers. Rather than encoding

Progress and Pitfalls

Intel 4004
INNOVATION: First "computer-on-a-chip"
APPLICATIONS: Arithmetic, i.e. Busicom calculator
PROBLEMS: Limited resources

'70s Intel chip manufacturing

Intel 8008
INNOVATION: 8-bit bus width; first to implement interrupts
APPLICATIONS: Dumb terminals, calculators, bottling machines
PROBLEMS: Interrupts worked poorly

Texas Instruments TMS 1000
INNOVATION: On-chip memory
APPLICATIONS: Low-cost embedded applications
PROBLEMS: Programmers couldn't add external memory

Intel 8080
INNOVATION: 10x performance of the 8008; separate address and data buses
APPLICATIONS: Altair computer (first PC); traffic light controller
PROBLEMS: Difficult to program

Intel 8086
INNOVATION: 16-bit bus width
APPLICATIONS: Desktop and portable computing
PROBLEMS: Convoluted addressing scheme

Motorola 68000
INNOVATION: 16-/32-bit chip powerful enough to handle advanced graphics
APPLICATIONS: Apple Lisa ('83), Unix workstations, home videogame machines
PROBLEMS: Integer unit and external data bus only 16 bits wide

all instructions in 16 bits, the team crammed the smaller ones into 8 bits. This compact encoding made the most efficient use of the 256-byte ROMs available for program storage; the entire code for Busicom's calculator had to fit into four of these ROMs, or just 1 KB. Once the 4004's design was finalized, Intel engineer Faggin converted it into actual transistors and created the physical layout.

Next Generation

The 4004 soon begat bigger and faster microprocessors. Before the 4004 was even completed, Hoff and Mazor began work on an 8-bit version called the 8008. The new chip both pleased and frustrated product designers. For example, the 8008 was the first microprocessor to include interrupts, but they never worked well. Intel's encore to the 8008, the 8080, arrived in 1974. Where the 8008 multiplexed the address and data onto a single bus, the 8080 offered separate buses, simplifying system design. Also, the 8080 provided a much better implementation of interrupts. The 8080 was an 8-bit processor, but certain instructions operated on pairs of registers and processed 16 bits of data at once. While compatible with the 8008, the 8080 added new instructions and features, pushing the transistor count to about 6000. The chip could address a then-enormous 64 KB of memory (today's Pentiums address 2 GB).

4004 vs. Pentium Pro

	4004	Pentium Pro
Transistors	2300	5.5 million
Die size	12 mm^2	196 mm^2
Transistor size	10 microns	0.35 microns
Clock speed	750 kHz	200 MHz
MIPS rating	0.06 (1)	440
Memory capacity	4 KB	64 GB
Package size	16 pins	387 pins

(1) estimated

After the 8080 appeared, Gary Kildall of Digital Research saw the potential for low-cost computing devices and created an operating system called CP/M. This software simplified basic user tasks such as creating, executing, and debugging programs. By 1975, hobbyists and industrial users could purchase an 8080-based CP/M system from Altair and others for well under $1000.

Microprocessor competition blossomed. Faggin and Masatoshi Shima, who had managed the 8080 project at Intel, left to form Zilog. That company's Z80 chip, which was compatible with the 8080 and thus with CP/M, became popular in low-cost computers. Motorola soon introduced the 6800, and Texas Instruments, National Semiconductor, and Fairchild launched their own microprocessors, most of which were used in embedded applications.

Finally, the largest computer maker in the world paid attention to the ground swell of interest in low-cost computers. After considering microprocessors from Motorola, Zilog, and others, IBM selected the Intel 8088 as the engine of its new personal computer, the IBM PC, introduced in '81.

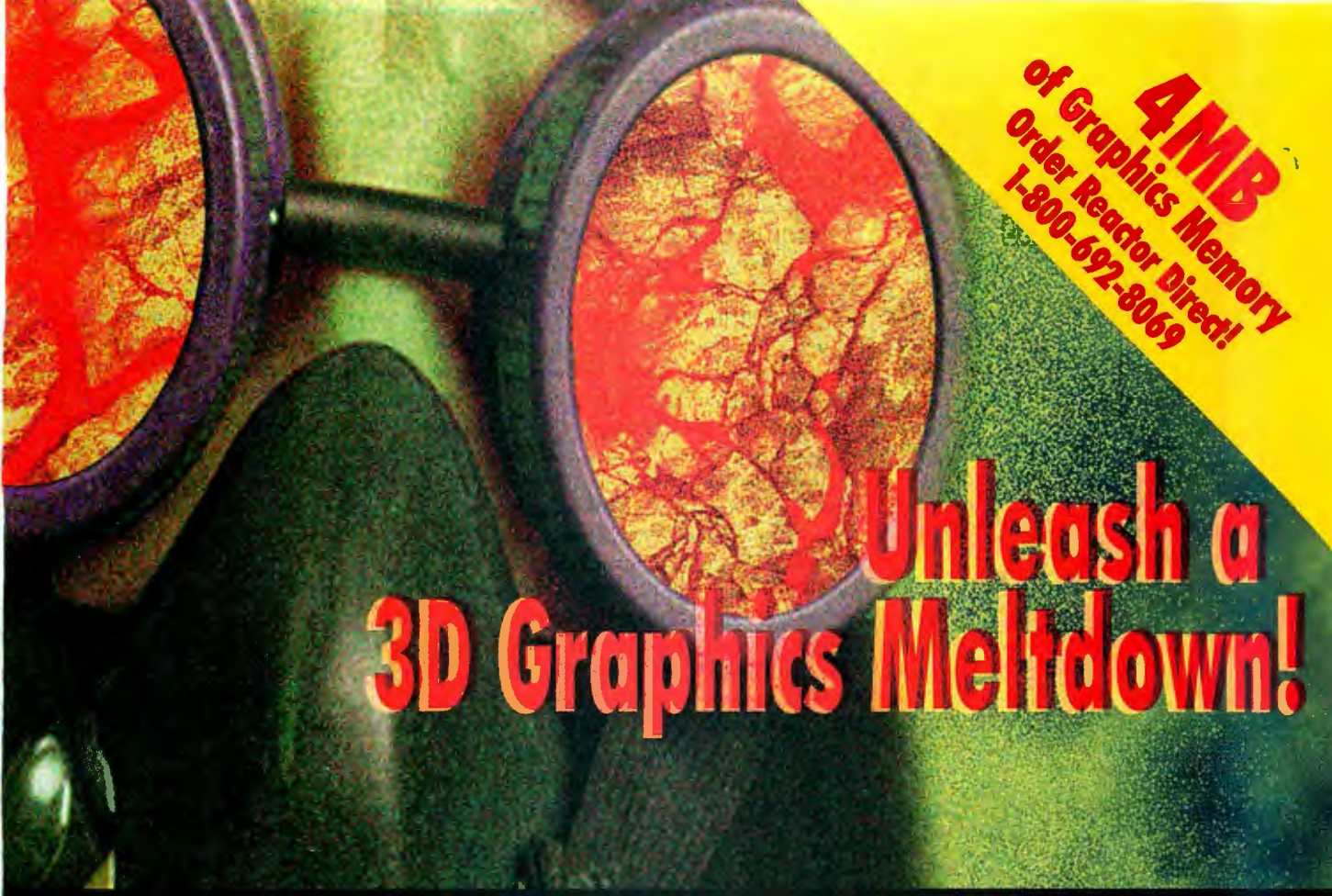
In 1978, Intel developed two sibling devices, the 8088 and the 8086, as upgrades to the popular 8080. The 8086 had 29,000 transistors, six times more than the 8080, enabling a host of new features, including multiplication and division. By speeding multiply and divide operations, the 8086 performed more-complex calculations (e.g., in a factory setting, calculating the proper rate to pour steel based on its temperature). All computations were available in 16-bit forms, multiplying by 10 the performance of the 8-bit 8080. The designers wanted to extend the address space to 1 MB, but this required 20 bits of address. To retain compatibility with the 16-bit 8080 addresses, Intel added 4-bit segment registers, creating a convoluted addressing scheme that is still the bane of programmers today.

The key difference between the 8086 and the 8088 was the external data bus: The 8086 used a 16-bit bus for better performance, while the 8088 offered an 8-bit bus to reduce cost and retain compatibility with 8080 system designs. The original IBM PC used the 8088; later versions used the 8086 as well.

The popularity of these systems spawned a legion of clone vendors using the 8088 and 8086. Intel was the main beneficiary, although some of the spoils went to Advanced Micro Devices (AMD), a licensed second source for the chips.

The Simpler, the Better

A new microprocessor design philosophy emerged in the early 1980s. RISC called for simplified instruction sets with a fixed instruction length and consistent encodings. The decreasing cost of memory allowed a move to 32-bit instructions rather than the 8- and 16-bit encodings typical of Intel's x86 instruction set. With larger transistor counts available, RISC developers were able to increase the size of the on-chip register file



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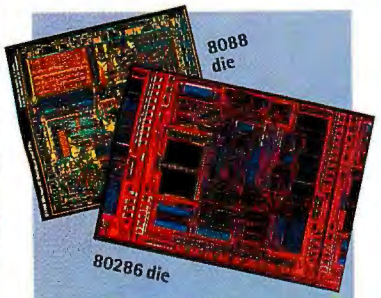


Intel 8088

INNOVATION: 16-bit internal architecture with 8-bit external bus

APPLICATIONS: IBM PCs and clones

PROBLEMS: Same convoluted addressing scheme as the 8086

Intel 80286

INNOVATION: Added memory protection; 16 MB of addressable memory; 1GB of virtual memory

APPLICATIONS: Standard PC CPU

PROBLEMS: Couldn't do page faults, lacked virtual memory

Intel 386 DX

INNOVATION: 64 terabytes of virtual memory; 32-bit bus; 4-GB addressable memory

APPLICATIONS: Desktop PCs

PROBLEMS: Didn't yet have an on-chip FPU or on-chip cache

MIPS Computer Systems R2000

INNOVATION: First motherboard-level RISC chip for workstations

APPLICATIONS: Unix workstations; later, midrange computers

PROBLEMS: Difficult to program; incompatible with PC software

Sun Microsystems SPARC

INNOVATION: An open RISC architecture

APPLICATIONS: Laptops to workstations to supercomputers

PROBLEMS: Required multiple chips due to pair of CMOS gate arrays and external FPUs

Intel i486

INNOVATION: First x86 with on-chip cache, FPU, and pipelined instructions

APPLICATIONS: Desktop PCs, CAD

PROBLEMS: Lacked advanced techniques of some RISC chips

to 32 registers rather than the eight available in Intel's chips. These and other changes were intended to improve performance without increasing chip cost.

Early RISC research included IBM's 801 processor (which was never commercialized) and academic projects at Stanford and Berkeley led by professors John Hennessey and David Patterson, respectively. It is no coincidence this work was done in research rather than commercial product environments; the radical changes in design caused the chips to be incompatible with all existing systems and software.

But a few visionary companies began nurturing the technology. Hewlett-Packard hired Joel Birnbaum and other members of the 801 team to develop PA-RISC. Sun, then a fledgling workstation maker, incorporated much of Patterson's work into its SPARC architecture. Hennessey and others founded MIPS Computer Systems to commercialize the Stanford work.

Apple has now converted its entire product line to PowerPC processors, which are sold by both Motorola and IBM, to give RISC chips 6 percent of the overall PC market. Since the rest of the PC market remains resolutely in the Intel/Windows camp, it is unlikely that this share will rise significantly over the next few years.

In the past few years, several vendors have introduced new RISC product lines intended for embedded applications rather than computers. The Sega Saturn video game machine, for example, uses SH processors from Hitachi; the Apple Newton uses a chip designed by Advanced RISC Machines (ARM). In total, these embedded products consume more RISC processors than all computer systems combined, and this area will grow over the next several years.

Dirt-Cheap Chips

If Moore's Law holds true for the next 25 years, microprocessors in the year 2021 may be as much as 1000 times more powerful than the Pentium Pro chip. Computers built around such processors would be ablt to perform highly accurate simulations, enabling them to predict future events. They'll also understand and synthesize spoken

Microprocessing's Edsel

After completing the 8080 in 1974, Intel turned its attention to a much more ambitious device, which eventually came to be known as the Intel 432. This processor, which could support object-oriented software, was years ahead of its time. It loaded and stored data using one or more levels of pointers, giving software great flexibility in how it organized memory. Each data element had an associated type (integer, character, pointer, etc.), and the processor always checked that each data value was of the correct type before using it. The 432 also supported features– such as memory error correction, multiprocessing, and fault tolerance–that would not become common for another decade or more.

Due to its complexity, the design of the 432 took much longer than anticipated. When Intel finished the initial version of the chip in 1977, the company realized that wading through pointers and checking data types completely bogged down the system. Performance on typical applications was five to 10 times slower than on competitive processors. The 432, still entirely too slow, didn't hit the market until 1980, where it sank without a trace, becoming one of the most spectacular failures in microprocessor history.

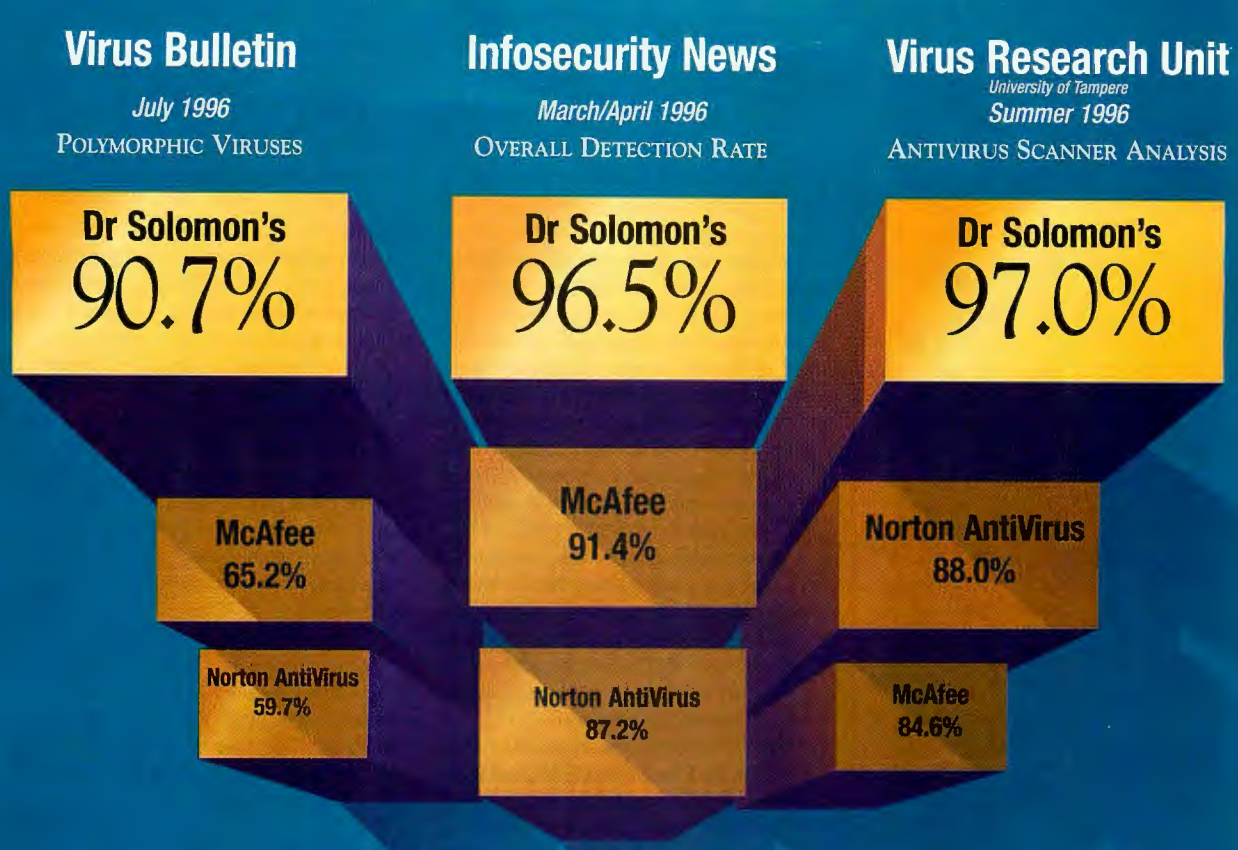
When Intel realized the 432 was in a deep hole, it rushed to staff a new project that would become the 8086. The company assigned two engineers to develop the instruction set and basic design of the chip and gave them just three weeks to complete the task. The 8086 went into production in 1978, just one year after its conception. Its design became the basis for the x86s used in all IBM-compatible PCs to date.

Perhaps because of its rushed origins, the 8086 has many unusual features. The programmer's options were limited because certain instructions were tied to specific registers: the ADD instruction can access only register A, the LOOP instruction uses only register C, etc. And the segmented addressing allows confusing situations, such as two program addresses pointing to the same location in memory, or the same address pointing to two different memory locations. Although some of these quirks have been fixed in later processors, programming x86 chips remains a challenge.

Ahead of Its Time

The 432 supported:

- Object-oriented software
- Data store using multiple pointer levels
- Memory error correction
- Multiprocessing
- Fault tolerance



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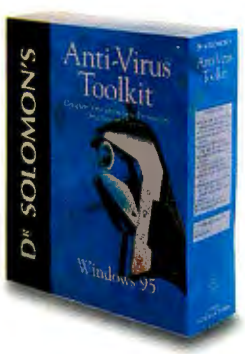

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Intel i960CA

INNOVATION: First superscalar chip

APPLICATIONS: Primarily embedded applications

PROBLEMS: Fairly expensive

Digital Equipment Corp. Alpha 21064

INNOVATION: 200-MHz clock

APPLICATIONS: Workstations and servers

PROBLEMS: Ran hot; expensive

IBM and Motorola PowerPC 601

INNOVATION: First out-of-order execution microprocessor

APPLICATIONS: Apple Macintoshes, desktop PCs, servers

PROBLEMS: Programs not usually written for out-of-order execution

Intel Pentium

INNOVATION: Dynamic branch prediction; 64-bit external data bus and 32-bit address bus

APPLICATIONS: Desktop PCs and network servers

PROBLEMS: Ran very hot

Digital Equipment Corp. Alpha 21164

INNOVATION: First to execute four instructions per cycle and the first with three on-chip caches

APPLICATIONS: High-end desktop PCs, workstations, and servers

PROBLEMS: Runs hot; expensive

Intel Pentium Pro

INNOVATION: Has CPU chip and cache chip in same package

APPLICATIONS: High-end desktop computers, graphics workstations, servers

PROBLEMS: Expensive

How to Turbocharge Chips

Chip architects have wrung out performance in microprocessors in two basic ways: improved manufacturing techniques that boost clock rates and additional circuits that mean chips can do more work per clock cycle.

Early microprocessors took several cycles to execute a single instruction, and the number of cycles varied depending on the type of instruction. In the mid-1980s, a key innovation of RISC processors was to overlap instructions in a pipeline so that each took only a single cycle to execute. Intel and other CISC vendors figured out how to add pipelining to their chips, starting with the 486 in 1989.

As manufacturing processes continued to improve, more and more circuits could fit onto a single chip, so designers began adding capabilities like superscalar execution. In 1989, Intel introduced the i960CA, which could execute not one but two instructions per cycle, making it the first superscalar processor.

By 1995, the state of the art was four instructions per cycle. This summer, IBM introduced a six-instruction microprocessor. By doing more work in parallel, overall performance improves significantly. The complexity of superscalar chips adds to their cost, but since chip prices drop continually, this hasn't been an issue except in low-cost embedded applications.

Even though processors can execute several instructions per cycle, today's software typically executes one instruction at a time (for compatibility with older processors). If an instruction cannot be executed immediately (for example, because its data must be fetched from external memory), most processors grind to a halt until that instruction can be completed.

To get around this problem, several new microprocessors, including the PowerPC 604 and Pentium Pro, implement out-of-order execution. If one instruction has to wait, the processor simply begins work on the next instruction instead of stalling. This subsequent instruction thus completes before the first instruction, reversing the order that was originally intended. In order for everything to appear to the software to be executing in the correct order, the CPU must be smart enough to know when this shuffling is appropriate.

Designers have also taken advantage of the growth in transistor volume. In the 1980s, vendors began adding memory management units (to handle large programs) and floating-point units (to handle large calculations) onto their microprocessors. Today, some microprocessors contain special circuits to connect directly to memory and I/O chips.

Cache memory is another popular way to take advantage of burgeoning transistor counts. By the early 1990s, microprocessors with several kilobytes of on-chip cache became common. This memory responded much quicker than external memory, so if critical data were kept there, the CPU could operate more efficiently. Over time, designers increased the size of this memory. Digital's 21164 Alpha processor contains 112 KB of cache organized as three separate memories.

Next year's processors will have even more transistors, CPUs will execute more instructions per cycle, and out-of-order algorithms will get more efficient. In time, developers may build new instruction sets that allow programs, rather than the processor, to put instructions into superscalar groups. This new technique will eliminate the complex grouping and out-of-order circuitry found in current superscalar processors. Intel is expected to take this path with its Merced (aka P7) processor, which is due to be released in 1998 or '99.

The World According to Moore

Transistor counts that double about every 18 months enable new chips to do more work per clock cycle.

Year	1971	1974	1978	1982	1985	1989	1993	1995
Chip	4004	8080	8086	80286	386DX	486	Pentium	Pentium Pro
Transistors	2300	6000	29,000	134,000	275,000	1.2 million	3.1 million	5.5 million[1]

[1] for CPU, excluding cache

words and render photorealistic 3-D images.

Perhaps more important, the performance of the $1 microprocessor could also increase significantly in 25 years. Even dirt-cheap chips will be many times more powerful than today's Pentium Pro. These low-cost chips will provide intelligence to many everyday devices that interact with users mainly through speech. Microprocessors have already brought tremendous changes to society, but hold on tight—the ride's not over yet. B

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Eight Ways to the Future

Technology leaders agree: Change is the only sure thing about computing in the next decade.

By Robert L. Hummel

Twenty-five years ago, IC engineers fired the first shot in a technology revolution that changed our world. Their ammunition: the first commercial microprocessor.

Today, the revolution lives on as the rate of microprocessor-induced change in our lives accelerates rather than shows any signs of subsiding. Faster processors at relatively low prices, new and better semiconductor manufacturing techniques, and more imaginative software could make the next generation of computing even more eye-popping than the first.

How significant has the microprocessor's impact been? Many people rank it among the top inventions of not only this century but of any century. For some people, microprocessors surpass even the wheel among mankind's achievements.

"When we add human vision, innovation, insight, knowledge, and wisdom in the form of software to the microprocessor, we can see that [the impact has been] so much more than even the wheel," asserts Marc Andreessen, vice president of technology for Netscape Communications. "And we've only begun to scratch the surface of what the microprocessor makes possible," he adds.

ILLUSTRATION: JOHN UELAND © 1996

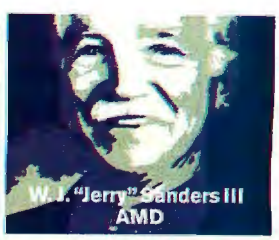
Other experts, including Intel's Andrew S. Grove, now president and CEO of the company that gave us the first commercial microprocessor, see the computer-on-a-chip as part of broader and more significant technologies. "I would compare the microprocessor unit (MPU) to the invention of language and not the wheel. Both language and the MPU are allowing us to think and invent in new ways."

Dan Dobberpuhl, senior corporate consulting engineer at Digital Semiconductor and a key architect of the Alpha processor, believes that the more significant inventions were the stored-program digital computer, the transistor, and the integrated circuit. "The first microprocessor represented the technology evolution of those three basic inventions," Dobberpuhl says. Adds Doug Engelbart, legendary inventor of computing technology and founding director of the Bootstrap Institute: "If you look at the whole array of digital technology, the microprocessor is just a part of that. Nanotechnology will eventually take us way beyond [microprocessors]."

Whether you believe the microprocessor compares to the wheel, or to a more modest invention—like, say, movable type—its impact has touched nearly everyone in the last quarter of a century. What will the next 25 years bring? No one we know is foolhardy enough to tackle that question. But we tracked down four other technology experts (in addition to Andreessen, Grove, Dobberpuhl, and Engelbart) whose decisions can shape, shake, or shatter the computer industry in the more immediate future (see page 88 for biographies of our participants). We asked them to peer five to 10 years into the future. In the following pages, they discuss how microprocessors may spawn more powerful PCs, ubiquitous portable computing devices, home LANs, and a global information network that may even make the world a better place to live. Of course no one knows for certain what the future holds, but if the ideas of these individuals are any indication, computers and our lives will continue to become more intertwined with each passing year.

The Future of Microcomputing

	 Marc Andreessen Netscape Communications	 David Chaum DigiCash	 Dan Dobberpuhl Digital Equipment Corp.
What will the standard PC offer in five years?	**It will have a thin, rich-color screen; process spoken commands; integrate voice, video, and screen-sharing with powerful visualization tools; run about 10 times as fast as today.**	This is sort of like asking, in 1896, what the office typewriter will look like in 1996.	**Eight times faster per CPU (with symmetric multiprocessor options), four times more memory, flat-panel touch displays, speech recognition, eye tracking, and videoconferencing.**
What new features will come in 10 years?	Another factor of 10 in performance and storage capacity. People will wear computers tied to lightweight "mirror shades"-style displays.	[See #1]	Forty times faster per CPU (four-way SMP, gain depends on software), 16 times more memory, and [who knows what else?].
Will tomorrow's computers be predominately general-purpose or specialty (i.e., Web PC) systems?	**Specialty systems may outnumber PCs in five years, but even more important will be ubiquitous computers for flexible, secure access to your information, wherever you go.**	The location of disk drives is not the issue. But seamless downloading and full associative linking of software and information, together with a suitable payment method, holds enormous promise.	**They will coexist. Over time, specialty devices will dominate because they'll be cheaper. General-purpose devices will remain important, especially in business and technical applications.**
How will microprocessors change our homes in the next decade?	At least one-third of American homes will integrate entertainment systems and satellite, cable, Internet, energy, and lighting technologies with networked information by the end of 10 years.	**Integrated systems will access text, voice and video messaging, interactive entertainment, and electronic commerce. But let's hope that our children still learn to program!**	Embedded microcontrollers are already pervasive. In 10 years, they'll be linked by wireless networking within the home, leading to all sorts of wild possibilities.
What kind of new GUIs will more powerful processors make possible in 10 years?	**The idea of a GUI is too restrictive. Imagine an immersive user interface that leverages global, real-time, multimedia, and networked information.**	Many people will be able to communicate verbally with a portable digital "representative": an on-line business agent and personal secretary. Some representatives will be at home in 3-D virtual worlds.	**There are only so many things to be done with GUIs. The real advances will be in how the computer gets its inputs from humans, with things like speech recognition, eye tracking, etc.**
How important will the Internet be in five years?	The Internet will have begun to disappear, like electricity and telephony, into the woodwork. And it will [be accessible] everywhere, in wired or wireless forms.	**At least as important as the combination of phones, TV, radio, printed publications, and PCs are today.**	Demand for high-performance internetworking will continue to outstrip the ability of the communications infrastructure to actually supply it.
How long will Moore's Law continue to be relevant?	**Through 2020, when we will see a discontinuous improvement in performance rejoining a new Moore's Law curve based on a transition toward molecular nanotechnology.**	The enormous investments already made should allow current chip technology to continue its price/performance trend for five to 10 more years.	**For at least 10 years. The rates of improvement are likely to drop off somewhat, however, due primarily to economic considerations rather than technical limitations.**
When will quantum effects and other problems require radically new chip technologies?	Probably until about 2007. By that time, however, dramatically new chip technologies based on quantum dots and tunneling will have begun to arrive.	**I'm not sure we will be forced to develop nanotechnology, but I sure hope we do.**	Quantum effects are here today and must be taken into account. But they won't force fundamental changes within the 10-year horizon.
Will we manufacture chips in zero-gravity environments in orbital fabs anytime soon?	**Only as an unlikely and distant possibility. Nanotechnology will have begun to bear fruit before zero-gravity chip manufacturing makes sense.**	There's some future for it, but the extent of it remains to be seen.	**No.**
What will be the next "sea change" in computing?	A secure, truly mobile agent language—way beyond Java—will eliminate the Tower of Babel that prevents us from harvesting more of the benefits of computing and communications today.	**We may experience a gradual drift into a surveillance society. Alternately, cryptography and digital "representatives" will protect our privacy while allowing participation in cyberspace.**	The merging of cellular phones, portable computers, and high-speed networked servers offers many exciting possibilities.

 Doug Engelbart, Bootstrap Institute	 Federico Faggin, Synaptics	 Andrew S. Grove, Intel	 Jerry Rogers, Cyrix	 W. J. "Jerry" Sanders III, AMD
The standard PC may well be your personal PC rather than the office PC. It will probably be a descendant of the network computer that we're talking about today.	**Eight times more RAM, eight times more magnetic storage, four times faster processor speed. Built-in support for teleconferencing and intelligent databases.**	Multiple video windows for desktop conferencing, intelligent agents for filtering and finding information on intranets and the Internet, rich 3-D graphics. All managed remotely.	**The office PC will have a speech-enabled human interface with the ability to access, process, and store information all over the world.**	It will likely operate in the range of 300 to 700 MHz. Its performance will scale linearly with frequency, so a 500-MHz PC will be five times as fast as today's 100-MHz PCs.
Surgically implanted?	Seamless integration of computing and communication, pattern recognition for speech, and simultaneous language translation for simple sentences.	**Any answer, from anyone, is science fiction.**	The desktop PC will disappear, replaced by a pocket-size mobile device with 10 times the power of contemporary PCs.	**The networking infrastructure will begin to catch up to the capability of personal computers. Currently, this infrastructure hobbles their capability.**
The network computer is going to be the general computer. The idea of locking up all your resources in one box will disappear.	**The general-purpose PC will continue to be dominant for the foreseeable future, but there is room for specialty systems.**	The PC will still be the mainstream machine, but there will be a wide range of specialty peripherals that connect to it.	**In five years, the vast majority of computers will be general-purpose PCs. In 10 years, the volume computer will be a hand-held device for wireless, e-mail, and Internet communications.**	In five years, there will be some fragmentation toward specialty devices. But because this is a cost-driven industry, general-purpose computers will dominate.
Home-based education, communications, collaboration, and telecommuting will expand. Appliances, lighting, and other things in our homes will become more flexible.	Our homes will enjoy on-demand entertainment, virtual reality games, and a critical mass of multimedia and interactive education software with the associated social impact.	**In five years, you'll play games on a PC instead of a TV, do homework on a PC instead of on paper, and communicate via your home PC.**	In five years, homes will have a central PC serving as the communications backbone for the family. In 10 years, there will be a major shift to personal mobile communications and computing.	**Fat pipes will make our phones and TVs more PC-like. Ever more powerful microprocessors will enable computers to become a central communications tool or port in our homes.**
GUIs are metaphors of yesterday's way of living—a desktop, a folder, and so on. We need to think of ways to connect humans to [information] that are not related to the underlying system.	**We'll manipulate simulated 3-D objects and navigate in a 3-D cyberworld. The computer will have the senses of touch, hearing, and sight, making possible human-like interactions.**	Ever-increasing processor performance enables ever more photorealistic and 3-D GUIs. I expect that this trend will continue.	**Dramatic improvements in microprocessor performance will finally bring computing to a new human-interface era of speech and virtual reality interfaces.**	Untrained speech and handwriting recognition will be commonplace. Motion picture-quality video and 3-D graphics with surround-sound will be directed by voice command.
Eleven on a scale of 10. That kind of communication is priceless and inevitable. We absolutely have to think of the future with a public, global, high-speed network.	It will have major social impact and vast technological and economic consequences. It will promote peace by bringing people together and will restructure the communications infrastructure.	**Humans subtract out powerful mediums—such as radio and TV—from their experience and focus on the content. The Internet will be the same way, vastly important, and just there.**	The Internet will become the primary source of information, training, and customer support both at home and at work.	**The Internet will be as ubiquitous in our lives as cable television is today.**
The limit for miniaturization, speed, and low cost [is] beyond where semiconductors can go. In 10 years, another technology might replace semiconductors.	**For at least another 30 years, Moore's Law will progressively slow down, from doubling every one-and-a-half years now to doubling every two years starting in five years, and so on.**	It will be stable—for at least the next 15 years.	**Three-dimensional imaging and rendering, speech, Internet agents, and the human interface will drive the almost insatiable desire for computing power indefinitely.**	While it becomes increasingly expensive and the slope of the line may flatten a bit, I don't see an end to the progression over the next 10 years.
We'll run out of gas in 10 years. Eventually we'll be arranging individual molecules.	A factor of 1000 in circuit density; a factor of 100 in chip area. From one active layer to multiple active layers, up to 100 layers; overall a factor of 1,000,000.	**Again, for at least the next 15 years.**	The challenge is to drive on-chip voltages to 1 V as we approach 0.1-micron gate geometry to avoid quantum effects. This trend will probably continue for 15 years before we hit the brick wall.	**Silicon has legs. We will still be using it below .1 micron!**
Zero-gravity is great for some things, but what? On many processes, gravity has negligible effect. Surface tension, for example, can be a greater factor.	**While research may be important, I see insignificant manufacturing in space for at least the next 20 years.**	No.	**Capital costs of space manufacturing are and will remain prohibitive for the foreseeable future. It's also hard to find people with both manufacturing and astronautical skills.**	Truly a dumb idea. In our cost-driven industry, there would not be an acceptable economic return.
Improving the collective IQ for people who want to collectively work on tough problems. That's the grand challenge. The first one to do it wins, and the real winner is humanity.	Computers with sensory-motor capabilities that turn into autonomous, intelligent machines capable of purposeful and intelligent behavior in the real world.	**If I knew that...**	The human interface will finally fulfill the ease-of-use model for everyone to feel comfortable. The interface will consist of sophisticated speech recognition and synthesis and virtual reality.	**Fat pipes. The fifth wave of computing, i.e., public-network computing, will realize its full potential when bandwidth is as cheap as bits.**

Our participants are:

Marc Andreessen
Vice president of technology, Netscape Communications Corp.
At age 22, Andreessen cofounded Netscape and used his undergraduate work on Mosaic, a prototype Web browser, as the foundation for Netscape Navigator.

David Chaum
Chief of technology and chairman, DigiCash B.V.
Chaum is the founder and chairman of DigiCash, a developer of electronic cash payment systems. He formerly was the head of the Cryptography Group at CWI, the Dutch nationally funded center for research in mathematics and computer science. Chaum also founded the International Association for Cryptologic Research.

Dan Dobberpuhl
Senior corporate consulting engineer, Digital Semiconductor, Digital Equipment Corp.
Dobberpuhl led the company's RISC development effort, which produced the Alpha processor architecture. He was a design leader for a variety of VLSI projects, including the PDP-11 and MicroVAX 2.

Doug Engelbart
Founding director, Bootstrap Institute.
Best known for developing an innovative wooden mouse in 1963, an integrated hypertext/groupware system, and numerous other concepts now at the core of computing, Engelbart's work at the Bootstrap Institute centers on bringing companies together to collaborate on new technologies.

Federico Faggin
President and CEO, Synaptics Inc.
As an Intel engineer, he created the physical layout of the 4004, the first commercial microprocessor. Later, Faggin founded Zilog, the developer of the Z80 processor, and in 1986 he helped launch Synaptics, which develops pattern-recognition and neural network systems.

Andrew S. Grove
President and CEO, Intel Corp.
Grove became Intel's president in 1979; in 1987 he was named chief executive officer. He holds several patents on semiconductor devices and technology.

Jerry Rogers
President and CEO, Cyrix Corp.
When Rogers helped found Cyrix in 1988, the company was primarily a designer of math coprocessors. Four years later, the firm started making microprocessors.

W.J. (Jerry) Sanders III
Chairman and chief executive officer, Advanced Micro Devices.
Before cofounding this semiconductor firm in 1969, Sanders held a variety of positions in the engineering, sales, and marketing departments of Motorola Semiconductor, Douglas Aircraft, and other companies. B

Robert L. Hummel is a programmer, consultant, and author. You can reach him at **rhummel@monad.net.**

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PowerPC Speed Demon

Exponential Technology's 533-MHz bipolar microprocessor will breathe new life into the PowerPC architecture and the Macintosh.

By Tom R. Halfhill

There's an old joke about a computer so fast it can execute an infinite loop in 10 seconds. Exponential Technology's new PowerPC-compatible X704 chips aren't *quite* that fast, but their clock speeds of 466, 500, and 533 MHz make you wonder if that joke might come true.

You can bet that Intel isn't laughing. Exponential's CPUs will munch on Pentium and Pentium Pro chips for breakfast. What's more, the X704 appears to have plenty of headroom for future performance gains. It's actually a conservative design that doesn't push the limit of what's possible.

Until now, the only microprocessor announced at 500 MHz was Digital Equipment's Alpha 21164, an exotic and expensive chip for high-end workstations and servers. The 21164 still has an edge in performance. At 500 MHz, it delivers an estimated 15.4 SPECint95, compared to Exponential's estimate of 11 to 13 SPECint95 for the X704.

But Intel's swiftest Pentium Pro chip, currently at 200 MHz, offers only 8.09 SPECint95. Intel will introduce a faster version by the time the X704 ships in the second quarter of 1997, but the Pentium Pro still won't threaten the X704's performance lead among relatively affordable desktop computers and servers.

The X704 is compatible with the PowerPC 604 from IBM and Motorola and meshes well with existing 604-based system designs. By mid-1997, when the X704 appears in new Macs, Mac clones, and PowerPC systems that retail for around $5000, it may become the chip of choice for desktop publishing, image editing, software development, and other CPU-intensive tasks.

Those aggressive prices are possible because Exponential expects to sell the X704 for about $1000. That's roughly $500 less than the price of a 433-MHz Alpha (the 500-MHz Alpha's price wasn't set at press time). The X704 will debut at about the same introductory price as the 66-MHz Pentium in 1993 and the 150-MHz Pentium Pro in 1995. Yet it will hit the ground running at clock speeds unprecedented for a mainstream CPU.

ILLUSTRATION: RALPH BUTLER © 1996

Mood Swings

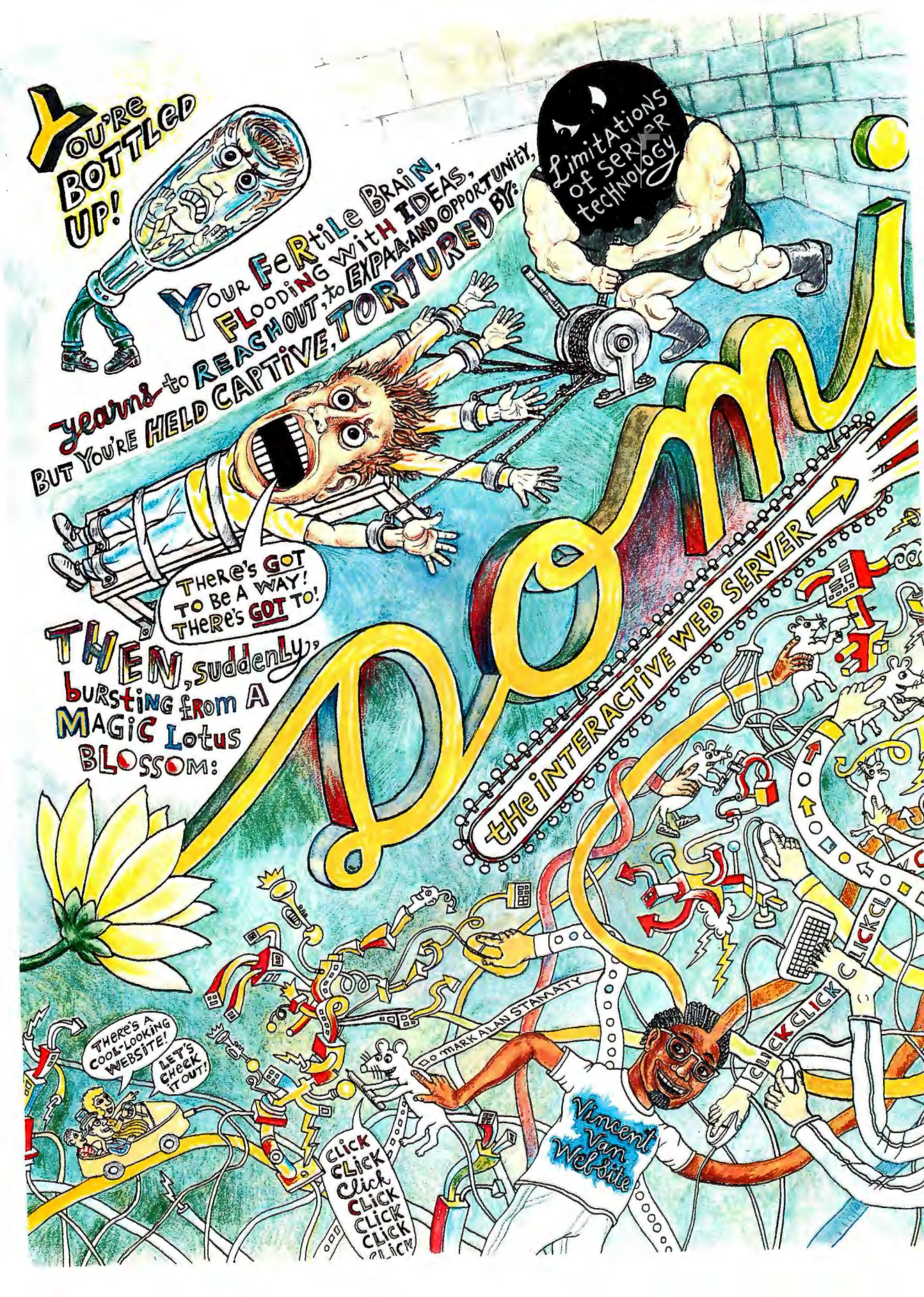
Exponential's secret weapon is bipolar logic. As reported earlier in BYTE (see "Watch Out: 500-MHz PowerPCs Planned for 1997," May), Exponential's design combines fast-switching bipolar transistors in the logic circuits with economical CMOS transistors in the memory cells.

Bipolar transistors switch states by swinging between two intermediate voltages, while CMOS transistors must alternate between their minimum and maximum voltages (see the figure "Bipolar's Speed Advantage" on page 88NA 4). The smaller voltage swing (about 0.5 V) translates into higher clock speeds.

The result: The X704 is a model of speed and efficiency. Remarkably, it's made on a 0.5-micron fabrication process. Intel makes both the Pentium and Pentium Pro at 0.35 micron, and by next year it will move to 0.28 micron, with 0.25 micron soon to follow. Likewise, IBM and Motorola are phasing in 0.35-micron PowerPC chips, and 0.25 micron is coming in late 1997 or 1998. Yet Exponential expects to keep the X704 at 0.5 micron until mid-1999.

One reason may be that bipolar transistors run hotter and therefore can't be packed as closely together (more on this later). Exponential says CMOS chips need smaller and smaller geometries to reach higher clock speeds, while the X704 already runs comfortably at 466 to 533 MHz on its current process. Moreover, the 0.5-micron process is less costly than the newer, smaller processes. And it's probably easier for Exponential to find a fab partner if the X704 does not need leading-edge technology. (Exponential isn't yet naming its partner, but it's an Asian semiconductor manufacturer.)

Even at the relatively large geometry of 0.5 micron, the X704


You're BOTTLED UP!
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has a small die of only 150 square millimeters. It has only 2.7 million transistors (partly because bipolar logic gates don't require extra transistors for speed buffers), less than half as many as the Pentium Pro. What's even more impressive is that only 700,000 of those transistors are bipolar logic—the rest are CMOS memory cells in the caches. To put this into perspective, the X704 has roughly the same number of logic transistors as an Intel 486.

Design Simplicity

By today's standards, the X704 is almost a back-to-nature RISC chip. It's considerably less complex than a 604, 604e, or Pentium Pro. It's not superpipelined, and it omits such fancy features as speculative execution, instruction reordering, and register renaming. The primary (Level 1, or L1) instruction and data caches are surprisingly small—only 2 KB each. The X704 has three-way superscalar execution and branch prediction, but nowadays that's nothing special.

What *is* unusual is an integrated secondary (Level 2, or L2) cache. At 32 KB, it accounts for most of the chip's transistors and 80 percent of the CMOS transistors. The only other CPU with an integrated L2 cache is the Alpha. (Although the Pentium Pro has an L2 cache in the same package as the CPU, it's still an external cache on a separate die.)

Exponential integrated the L2 cache because a processor as wickedly fast as this one is in perpetual danger of starvation. At its peak rate of three instructions per cycle, a 533-MHz X704 executes 1.6 billion instructions per second. It won't be easy for a typical system bus running at a poky 50 or 66 MHz to keep this extraordinary core fed with instructions and data.

Exponential is tackling this problem in several ways. In addition to the internal caches, the X704 needs an external L3 cache, ranging from 512 KB to 2 MB, for best performance. The write-through L1 caches are direct-mapped for the fastest possible access, and the unified L2 cache is eight-way set-associative and has a write-back mode. There's also a burst mode and built-in cache coherency for multiprocessor systems.

The X704 also supports bus speeds as fast as 100 MHz. However, only the 500-MHz chip can drive the bus at that rate. In most systems, the 466- and 533-MHz chips will limit the bus to 66 MHz, because 100 MHz doesn't yield an even clock-divisor ratio. Clearly, the X704-500 will be the golden CPU for I/O-intensive servers.

But don't get too excited yet. Designing a system that runs at such high bus speeds is tricky. Apple, like most system vendors, has never made a motherboard faster than 66 MHz. The X704 will probably isolate those higher bus speeds on a daughtercard that plugs into a slot on the motherboard. Apple's high-end Power Macs and similar Mac clones already support such a daughtercard, so users can upgrade their CPUs.

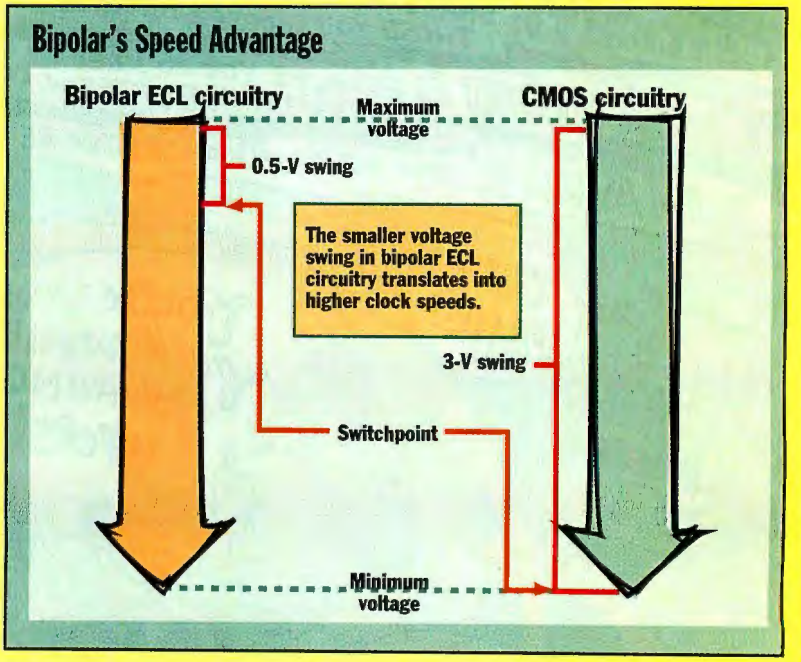
That means some Mac owners will simply plug in a new daughtercard to get an X704. The only drawback is that current systems put the L2 cache (which acts as an L3 cache for the X704) on the motherboard. It can't run faster than 66 MHz.

Exponential's future solution is an in-line cache managed by a new ASIC on the daughtercard. The ASIC will contain an L3 cache controller and dual ports. One port connects the 100-MHz CPU bus to synchronous-burst static-RAM (SRAM) chips in the L3 cache, which are also on

A Bipolar Twist

Today's general-purpose processors use CMOS for both logic and memory. Although Intel uses a bipolar-on-CMOS, or BiCMOS, process for the Pentium and Pentium Pro, the bipolar elements play a minor role. And because Intel's BiCMOS process is primarily CMOS, the bipolar transistors don't reach their full potential. In fact, Intel will abandon BiCMOS in favor of pure CMOS next year.

Exponential's approach to BiCMOS is quite different. Instead of bipolar-on-CMOS, it's CMOS-on-bipolar. The bipolar process dominates the design, even though the CMOS transistors outnumber the bipolar transistors. The result: Fast-switching bipolar transistors help the X704 achieve its impressive 466- to 533-MHz clock speeds.

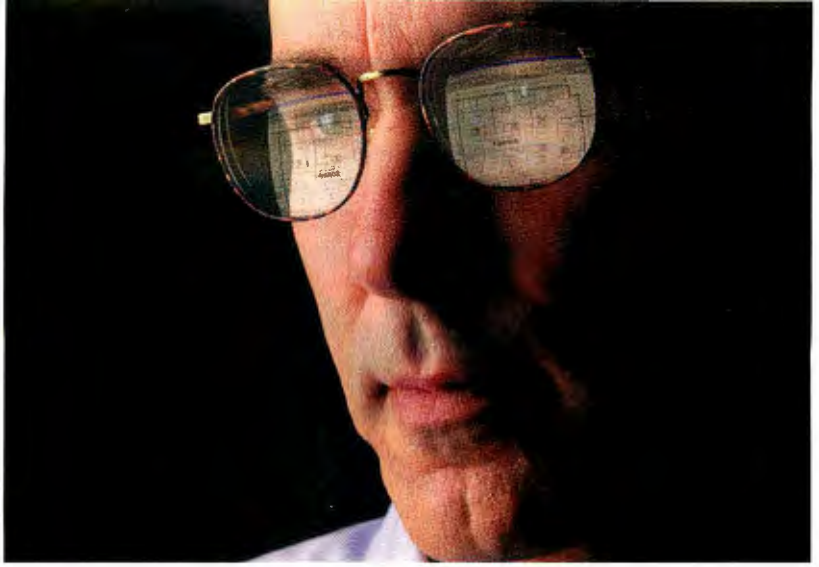


To change states, CMOS transistors switch from highest to lowest voltages. Bipolar transistors change at an intermediate voltage.

X704 Dossier

- *Price: $1000*
- Performance: 11 to 13 SPECint95*
- Volume production in Q2 1997
- Core speeds: 466, 500, and 533 MHz
- Bus speeds: 50 to 100 MHz
- PowerPC 604–compatible bus
- 0.5-micron BiCMOS process
- Die size: 150 square millimeters
- 356-pin ball-grid-array package

*Based on company estimates.



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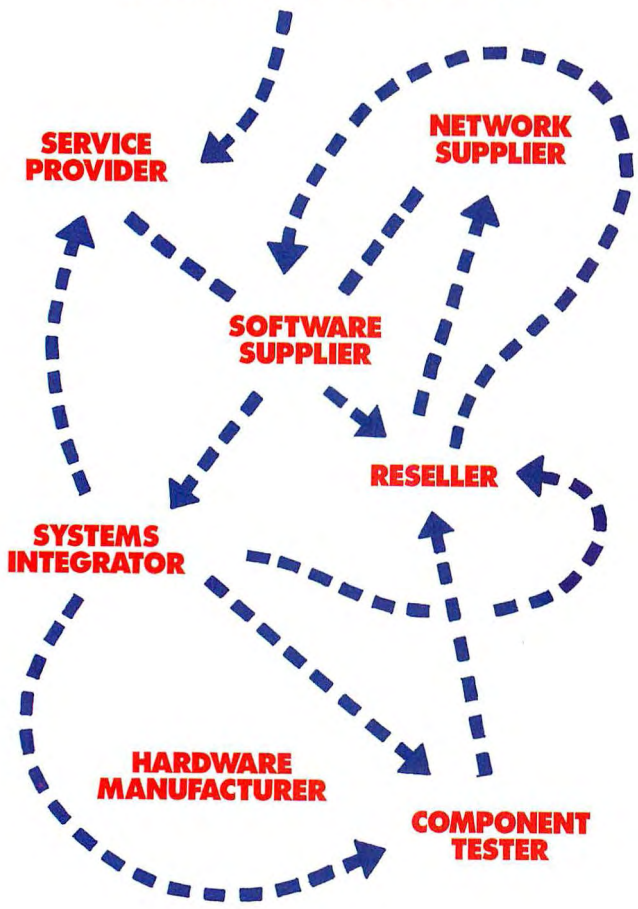

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the daughtercard. The other port bridges to the 66-MHz system bus through the daughtercard slot. This would effectively segregate the difficult 100-MHz bus and L3 cache on the daughtercard.

Another measure of the X704's simplicity is that it has only four execution units: an integer unit, a load/store unit, a branch unit, and an FPU. The X704 can execute all integer instructions (except multiply and divide) in a single cycle. The instruction decoder can issue up to three instructions per cycle to the execution units, which can process a load/store, a branch, and an integer or floating-point instruction during each cycle.

Hot Chip

Bipolar transistors offer performance advantages, but one drawback is heat.

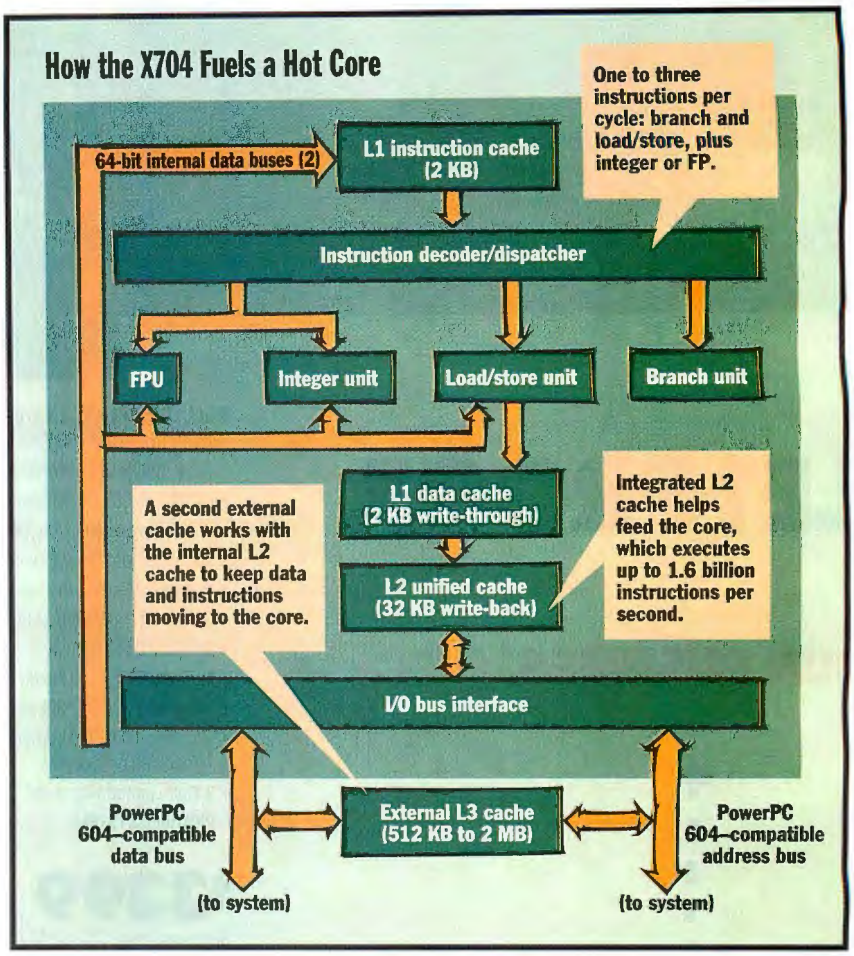
Product	Power dissipation
PowerPC 604	16.5 W
Digital Equipment Alpha 21164	37 W
Exponential X704	75 to 85 W
Standard light bulb	60 to 100 W

The instruction pipeline is only six stages long—less than half the length of the Pentium Pro's superpipeline. This allows the X704 to recover more quickly from stalls and mispredicted branches.

Although the X704 is compatible with the PowerPC 604, it's noticeably less complicated. That leaves room for Exponential to boost the performance of future chips in two ways: by improving their microarchitectures and by shrinking their components smaller than 0.5 micron for even-higher clock speeds.

Exponential could hit two possible roadblocks, however. First, a more advanced microarchitecture could defeat the purpose of fast-switching transistors if the additional complexity bogs down the pipeline. For Exponential, simpler might always be better.

The second potential roadblock is heat. The X704 is a hot chip in more ways than one: Power dissipation is a scorching 75 to 85 W. It's practically a light bulb. That kind of heat could make it very difficult to squeeze the transistors closer together without causing trouble. However, Exponential says it's confident that future bipolar chips will migrate to 0.35-, 0.25-, and even 0.18-micron processes.



A simple CPU. The X704 has only four execution units: FPU, integer, load/store, and branch.

Coping with the extra heat will also require some careful system design, but nothing that's out of the ordinary. The X704 works in existing Power Mac 9500 boxes with the standard 390-W power supply; all it needs for cooling is a new fan to blow air across the CPU's modest heat sink. However, this is one chip that you won't see in a laptop, unless users are willing to wear asbestos trousers and tow a wheelbarrow full of batteries.

PowerPC Boost

Exponential's speed demon could not come at a better time for the PowerPC Alliance. Wisely, IBM and Motorola have licensed Exponential the patents it needs to make the X704 without getting mired in legal squabbles. The X704 will anchor the high end of the PowerPC line while IBM and Motorola continue to serve the bulk of the market with the 603e, 604e, and 620, which are approaching 300 MHz. For high-end Mac users, who have an insatiable appetite for CPU power to handle their graphics-intensive applications, the X704 offers horsepower that an x86-based system can't match.

The biggest challenge for Exponential might be keeping up with demand. Problems in the BiCMOS manufacturing process could result in hordes of frustrated users. But if Exponential carries through, the X704 will significantly brighten the PowerPC's future. B

WHERE TO FIND

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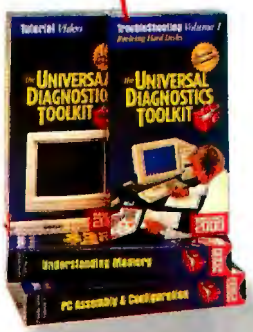

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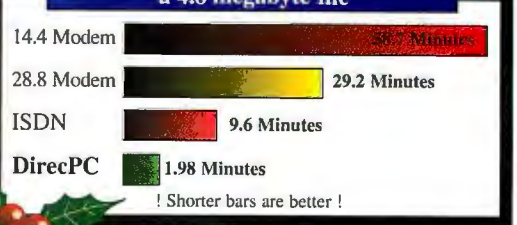

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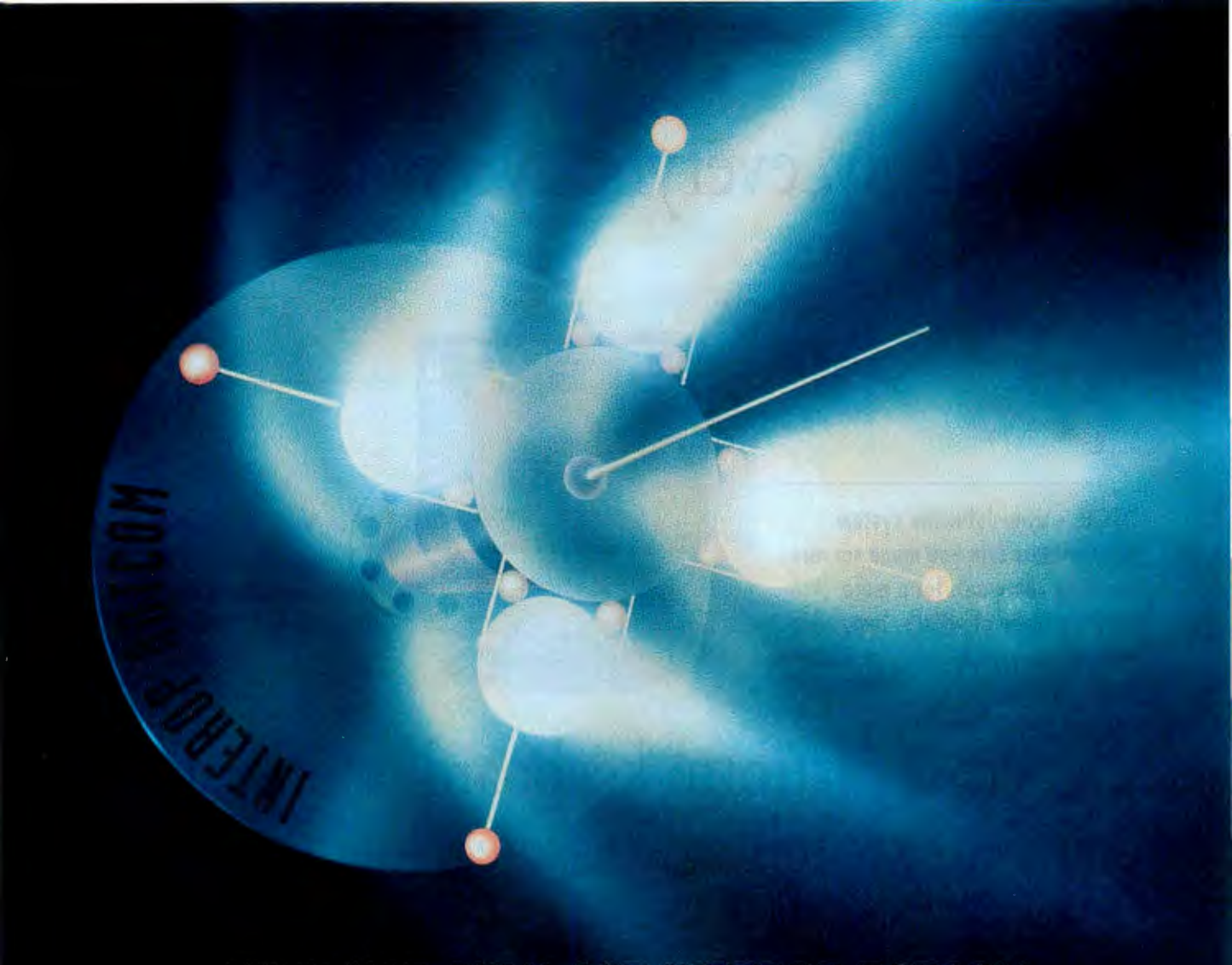

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These network lasers have the speed and capacity to handle the printing needs of any large workgroup.
By Dorothy Hudson, Jim Kane, and John McDonough

Six Laser Printers for Workgroups

Today's departmental laser printers cost less, print faster, and produce sharper output than ever before. Since we last looked at midrange network printers (November '95), several models in the under-$10,000 class have followed Hewlett-Packard's lead with the LaserJet 5Si and adopted Canon's 24-pages-per-minute (ppm) P-550 print engine. While these printers don't have the duty cycle of 30-ppm printers costing $20,000 and more, they are catching up both in performance and in paper capacity. Lexmark's 24-ppm Optra N 245 ($4199) actually performed faster in our tests than one of the 30-ppm printers we tested last year.

We tested six midrange network lasers with the speed and paper capacity to handle printing for a large workgroup. The printers—from Apple, Hewlett-Packard, IBM, Lexmark, QMS, and Xerox—range in price from $1999 to $6999 as tested. Though large, these are tabletop units, all with at least 600-dpi resolution. They have either 17-ppm or 24-ppm print engines and large paper capacities. All support forms of PostScript and HP Printer Control Language (PCL) page-description languages, and they automatically switch between the two as needed.

All the printers can detect and automatically switch between a set of common network protocols, particularly NetWare and TCP/IP. All support a variety of network operating systems and provide client software that lets users of several types of systems print and access printer status information. Several units also support hard disks that store fonts, forms, and macros—and in the process decrease the traffic on your network.

We judged the printers on the basis of four important considerations: print speed, quality of output, features, and usability for both end users and network managers. We tested for both Mac and Windows platforms.

What Matters

It's important to match the printer to the workload. You can save money by buying a printer with a lower duty cycle rating, but if you overload that printer, quality and reliability will suffer in the long run. Several of these printers now have rated duty cycles of 100,000 pages per month, which is roughly half that of the more expensive printers in the 30-ppm class.

BYTE BEST
WORKGROUP PRINTERS

Lexmark Optra N 245
was best overall with great performance and usability.

Xerox DocuPrint 4517
was the best high-quality printer.

QMS 2425Ex Print System
was the fastest Macintosh printer.

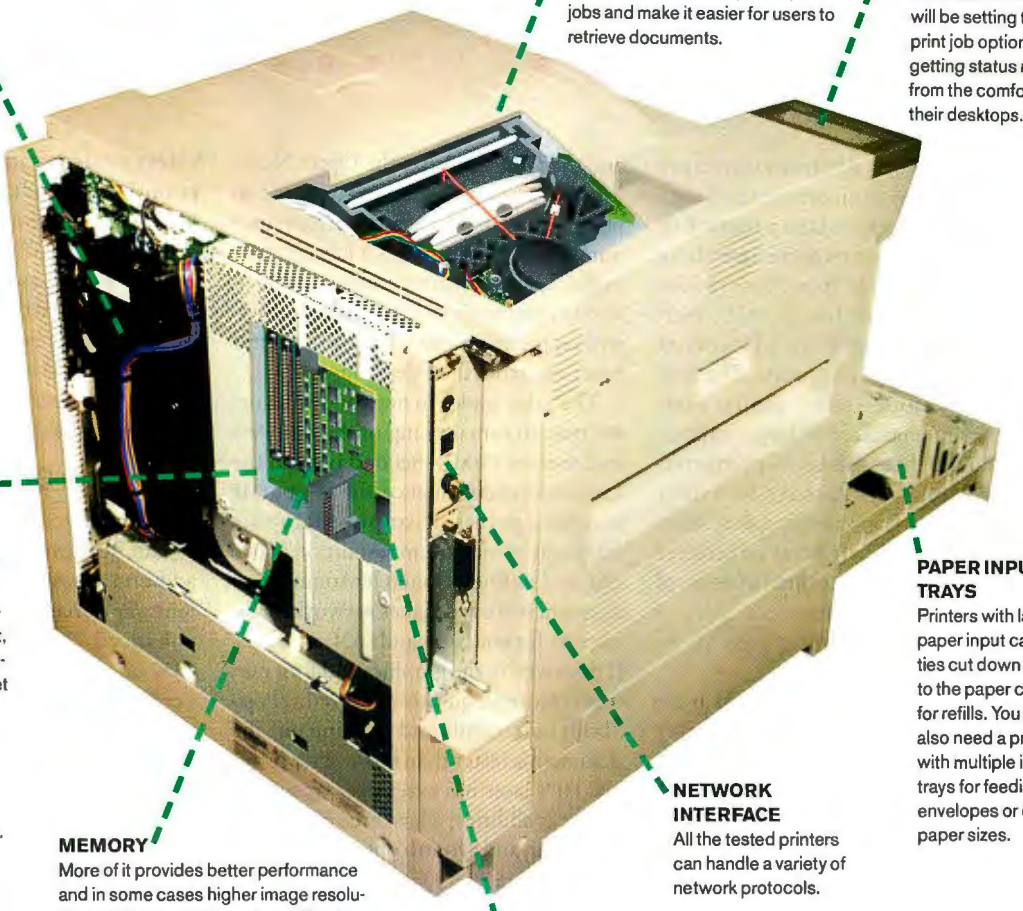
People don't want to hang around waiting while their print job lingers in the queue. A network printer with a fast print engine and adequate RAM can spool files off the system quickly and increase the overall efficiency of the network. Increased network speed means quicker release of the host system and increased user productivity. Among the printers we tested, the more expensive 24-ppm models have the speed advantage. Our own performance-sensitive scoring favors the 24-ppm printers. A 17-ppm printer might make more sense for lighter loads.

As a network administrator, only you know how much printing traffic to expect from your network-attached users. While a 24-ppm laser printer is fast enough for NSTL's 70-employee work force, it might not be fast enough for a smaller office that pumps out more documents.

Print quality is getting much better with network lasers. All the tested printers offer at least 600- by 600-dpi resolution, and many offer electronic image enhancement that increases test sharpness and gray-scale capabilities beyond the native resolution of the print engine. The Xerox DocuPrint 17 ($3300) and the Apple LaserWriter 16/600 ($2429) produced the best output; these printers are good choices if your office generates lots of documents with graphics and halftones.

One trend we've noticed with workgroup printers is that they have more sophisticated paper-handling capabilities than ones we've reviewed before. Roomy standard and optional paper trays hold from 850 to 3100 sheets of paper, which cuts down on trips to the supply room. These printers are available with optional envelope feeders and money-saving duplexing capabilities for printing on both sides of the paper. When fully configured, the HP LaserJet 5SiMX ($4899), the IBM Network Printer 17 ($1999), and the Lexmark Optra N 245 ($4199) can have five input trays hanging off them to supply letter-, legal-, and ledger-size paper.

Privacy can be a concern with a network



PRINTER ENGINE
The heart of the printer and usually an OEM product. It determines the speed paper passes through the printer (engine speed; 17- or 24-ppm with these printers), the basic resolution before any image enhancement, the toner cartridge design, and paper-handling capabilities.

OUTPUT TRAY
Some printer vendors offer optional collator bins that separate print jobs and make it easier for users to retrieve documents.

FRONT PANEL
Easy to use. With the vendor-provided software drivers, however, most network users will be setting their print job options and getting status reports from the comfort of their desktops.

CONTROLLER ELECTRONICS
Typically located on an easily accessible component board. ROM-based routines handle compression, image enhancement, and raster image processing. Most of the printers let you replace the network interface card or add a hard disk to store downloaded fonts. Here's where printer vendors differentiate their product.

PAPER INPUT TRAYS
Printers with large paper input capacities cut down on trips to the paper cabinets for refills. You may also need a printer with multiple input trays for feeding in envelopes or different paper sizes.

MEMORY
More of it provides better performance and in some cases higher image resolution. Higher-resolution printers like the QMS 2425Ex Print System support up to a whopping 128 MB of memory for 1200-dpi documents.

NETWORK INTERFACE
All the tested printers can handle a variety of network protocols.

CPU
Raw processing power is needed to print complex pages fast. Though some printer vendors use the same printer engine, they often use different processor chips.

Illustration based on HP's LaserJet 5SiMX.

printer. The Xerox and IBM models offer as an option a lockable mailbox output unit—just the thing for printing worker evaluations or other confidential documents (see Details on page 104). You enter a password at the printer front panel to open one of the locked slots. The system administrator sets up whether a slot locks or not, and who has access. The HP LaserJet 5SiMX and the QMS 2425 Print System ($6999) support multibin mailboxes for separating documents from different print jobs, providing convenience but not security.

Total Control

All the network lasers we tested come with software for managing printers from across the network. At the very least, these slick utilities let you know from your desktop system if the printer is on-line, out of paper, or busy with somebody else's print job. Some let you cancel a job that's in the queue. The utilities—Apple's LaserWriter Utility, HP's JetAdmin, IBM's Network Printer Manager, Lexmark's MarkVision, QMS's CrownAdmin, and Xerox's Document Services for Printing—are all full of features for choosing printing options.

We particularly like the easy-to-use Windows interface in Lexmark's MarkVision. As do several other of the print management utilities, MarkVision uses bidirectional communications to maintain, configure, and track the printer's status. A graphical representation of the printer's control panel and a detailed printer-status window let you know what's going on. HP's JetAdmin deserves mention because it is a 32-bit Windows 95 utility; it's also easy to install.

After setting up and using the different models covered in this Lab Report, we can say that printing over the network is getting easier and more intuitive for the end user. The rest of the good news is that workgroup printers are getting faster and less expensive.

Contributors
Jim Kane, project manager/NSTL
Dorothy Hudson, project manager/NSTL
John McDonough, technical writer/NSTL
Dave Rowell, senior technical editor/BYTE

Best Overall

WORKGROUP PRINTERS

Network administrators have many choices when picking a workgroup laser printer. Just in our roundup alone there are inexpensive 17-ppm lasers like Apple's LaserWriter 16/600, IBM's Network Printer 17, and Xerox's DocuPrint 4517 for smaller workgroups. The IBM and Xerox models share similar Fuji-Xerox print engines. For larger offices, we looked at three similar 24-ppm printers from HP, Lexmark, and QMS. As they all use the same Canon engine, they share many features. Their print controller electronics differentiate them in terms of speed and output quality.

Best Overall

We chose the Lexmark Optra N 245 as the Best Overall network laser printer because it easily provided the best performance in our Windows-based benchmarks and prints nearly flawless 600-dpi documents. Like the HP LaserJet 5SiMX and the QMS 2425 Ex, the Optra N 245 uses the 24-ppm Canon P550 engine to pump out its above-average performance numbers. The Optra has a large paper-input capacity, and its excellent MarkVision print management software lets networked users intuitively control printer functions from their desktops.

The sales leader in network printing, HP tries to remain king of the hill with its LaserJet 5SiMX. Second only to the Lexmark in performance, the 24-ppm HP machine prints crisp photographic images at its maximum resolution of 600 dpi, and its finely honed JetAdmin management software makes network printing easy for end users and LAN managers. It does well in the graphics and font performance tests, quickly interpreting PostScript commands and pushing out the documents faster than most other printers. HP's laser has extensive paper-handling capabilities; it has three input trays as standar, and a fourth optional tray provides a total capacity of 3100 sheets. Other options include a duplex unit and a high-speed envelope feeder.

The QMS 2425Ex Print System was just behind the HP LaserJet in Windows performance. It tied the Lexmark for usability and had the best features score (as it should with a $6999 price tag). Among the 17-ppm lasers, the Xerox Docuprint 4517 provided the best performance.

Best High Quality

The Xerox DocuPrint 5417 gets the nod as the Best High Quality printer. In addition to best print quality, it has excellent paper-handling capabilities. In its enhanced 1200- by 600-dpi mode, the 5417 offers 144 shades of gray at 141 lines per inch. Its Quad Dot technology alters the size of dots in an image so that you can discern them only with a magnifying glass.

The low-cost Apple LaserWriter 16/600 deserves mention because it produces documents second in quality only to those produced by the DocuPrint 17. The 600-dpi LaserWriter 16/600 is adept at printing precise lines and text thanks to Apple's FinePrint antialiasing technology. While the Apple laser produces fine documents, you should be prepared to take a performance hit relative to the faster 24-ppm printers we tested. The printer also has a small 850-sheet input capacity, but the LaserWriter 16/600 really delivers when you consider its quality/price ratio.

Best for Macintosh

The QMS 2425Ex Print System is the quickest printer in our Macintosh performance tests. Our Best for Macintosh pick, the QMS 2425Ex is a 24-ppm device with built-in decompression, a feature that allows compressed print streams without a dedicated print server. The benefit is faster printing and reduced network traffic. The printer has a 3100-sheet input tray capacity and a 100,000-pages-per-month duty cycle. The QMS CrownCopy option ($1999) lets you use the QMS 2425Ex as a copy machine.

HP Makes a Mopier

As this issue hit the streets, Hewlett-Packard was announcing a version of the LaserJet 5Si called the Mopier. What's a mopier? A printer that produces "mopies," or multiple original prints. Instead of printing a document once and then making copies on a photocopier, you print all the copies on the Mopier. Given the 24-pages-per-minute speed of this 600-dots-per-inch printer, and the fact that the print driver software sends only a single copy of the document over the network, this makes good sense in terms of saving time. HP claims the cost per page is competitive with a photocopier.

The $9549 Mopier is a specially equipped 5Si with 12 MB of RAM, a duplex unit, and a 2000-sheet paper bin. A 420-MB hard drive stores incoming documents so that it can make multiple prints from a single network transmission. Unlike the standard 5Si, the Mopier has a mailbox output-tray unit that can staple, like a business copier. The output unit has five addressable bins, a stapling bin, and a general-purpose bin. The QMS 2425Ex has a similar option. For a total of $8998, you also get a scanner and software that lets you use the printer as a copy machine.

LAB RESULTS

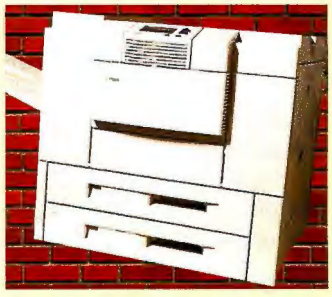
WORKGROUP PRINTER RATINGS

BEST OVERALL

Lexmark Optra N 245

The 24-ppm Optra N 245 was tops in our speed tests, though its very good print quality trailed in a tightly clustered field. The network-friendly printer supports a variety of paper sizes and has a 3100-sheet paper-input capacity. Lexmark's MarkVision management software gives users easy access to printer functions while they sit at their desktop systems. Lexmark's workgroup printer also finishes near the top in the Best for Macintosh category.

WEIGHTING



	PRICE	TECHNOLOGY	IMPLEMENTATION	PERFORMANCE	PRINT QUALITY	FEATURES	USABILITY	OVERALL RATING
Lexmark Optra N 245	**$4199**	★★★★	★★★★	★★★★★	★★★★	★★★★	★★★★	★★★★
HP LaserJet 5SiMX	$4899	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★
QMS 2425Ex Print System	$6999	★★★★	★★★★	★★★	★★★★	★★★★★	★★★★	★★★★
Xerox DocuPrint 4517	$3300	★★★★	★★★★	★★	★★★★★	★★★★	★★★★	★★★
IBM Network Printer 17	$1999	★★★★	★★★★★	★★	★★★★	★★★★	★★★★	★★★
Apple LaserWriter 16/600	$2429	★★★★	★★★	★★★	★★★★	★★★	★★★	★★★

BEST FOR HIGH QUALITY

Xerox DocuPrint 4517

The Xerox DocuPrint 4517 produces the best print quality of all the printers in our roundup. The 600- by 600-dpi printer incorporates DP-Tek's TrueRes edge-enhancement technology to sharpen the edges of letters and offers 141 gray-scale levels to tighten up halftones. Though small, the 17-ppm DocuPrint 4517 can hold 1350 sheets of paper if you add two optional 500-sheet decks. An optional 125-MB hard disk stores forms, fonts, and logos for merging with documents prior to printing.

WEIGHTING

	PRICE	TECHNOLOGY	IMPLEMENTATION	PERFORMANCE	PRINT QUALITY	FEATURES	USABILITY	OVERALL RATING
Xerox DocuPrint 4517	**$3300**	★★★★	★★★★	★★	★★★★★	★★★★	★★★★	★★★★
Lexmark Optra N 245	$4199	★★★★	★★★★	★★★★★	★★★★	★★★★	★★★★	★★★★
QMS 2425Ex Print System	$6999	★★★★	★★★★	★★★	★★★★	★★★★★	★★★★	★★★★
HP LaserJet 5SiMX	$4899	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★
IBM Network Printer 17	$1999	★★★★	★★★★★	★★	★★★★	★★★★	★★★★	★★★★
Apple LaserWriter 16/600	$2429	★★★★	★★★	★★★	★★★★	★★★	★★★	★★★★

BEST FOR MACINTOSH

QMS 2425Ex Print System

The 24-ppm QMS 2425Ex Print System edges out Lexmark's Optra N 245 as the best printer for Macintosh users. The 2425Ex Print System is pricier than the other printers, but it comes with 24 MB of RAM and a 256-MB internal hard disk. Capable of 1200- by 1200-dpi enhanced resolution, the printer comes with a standard Ethernet interface and supports a wide range of paper-handling options including a 2000-sheet input tray, a duplex unit, a 2000-sheet stacker/stapler, and a 100-envelope feeder.

WEIGHTING

	PRICE	TECHNOLOGY	IMPLEMENTATION	PERFORMANCE	PRINT QUALITY	FEATURES	USABILITY	OVERALL RATING
QMS 2425Ex Print System	**$6999**	★★★★	★★★★	★★★★★	★★★★	★★★★★	★★★★	★★★★
Lexmark Optra N 245	$4199	★★★★	★★★★	★★★★★	★★★★	★★★★	★★★★	★★★★
HP LaserJet 5SiMX	$4899	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★
IBM Network Printer 17	$1999	★★★★	★★★★★	★★★	★★★★	★★★★	★★★★	★★★★
Xerox DocuPrint 4517	$3300	★★★★	★★★★	★★★	★★★★★	★★★★	★★★★	★★★★
Apple LaserWriter 16/600	$2429	★★★★	★★★	★★★	★★★★	★★★	★★★	★★★

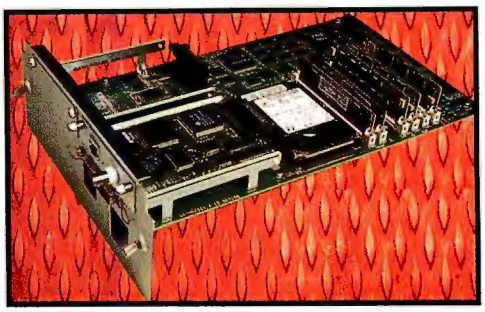
★★★★★ Outstanding ★★★★ Very Good ★★★ Good ★★ Fair ★ Poor

PHOTOGRAPHS: STEVE BELKOWITZ © 1996

Details

Privacy, Please

You can get the Xerox (shown below) and IBM printers equipped with an optional 10-bin locking mailbox/collator to secure private documents. After configuring the printer, you press an identification code at the front panel to unlock the slot containing your documents.



Quick Change

Except for the Apple LaserWriter 16/600, all the units we tested have modular printer controller circuitry that you can remove without tools. The slide-out boards make it easy to install a different network card or add a hard drive for font storage. Installing a hard drive on the IBM Network Printer 17 board (shown above) took around a minute.

Paper Handling

The paper trays in the HP, Lexmark, and QMS printers can take a variety of paper sizes. You adjust one paper dimension with a movable locking divider. The other dimension sets with a locking knob. Adjustment positions are clearly labeled. The upper tray adjusts to four sizes; the lower tray handles two additional larger sizes.

Printing Continuous Forms on a Laser

One good reason dot-matrix printers survive in the market is that they can print on continuous-form paper. Output Technology sells a laser printer that's designed to print on continuous forms. Most laser printers have a serpentine paper path. But Output's has a straight path. While it can't hammer out multipart forms like a dot-matrix model, the LaserMatrix 2405 ($5000) is kinder on the ears. Output Technology aims the LaserMatrix at companies that print long batch runs of items such as utility bills and invoices or that use the printer's straight paper path to print bar codes, adhesive labels, or thicker media that don't move well through the convoluted paper path of standard laser printers.

The printer, which supports PCL and PCL 5 emulations, did not fare well in our suite of performance and quality tests when compared to the six workgroup lasers, but it's not designed to compete with those units. The LaserMatrix has a 24-pages-per-minute (ppm) print engine with a 300-dots-per-inch (dpi) print resolution. The low- to medium-duty laser's simple design pulls the continuous media through a six-pin tractor feed and dumps the throughput onto a table or into an optional refolding stacker. The LaserMatrix is suited for overnight jobs as it can print up to 3000 sheets of paper without operator intervention.

Output's LaserMatrix 2405 has a toner system that harks back to the laser printers of yore. To replenish the toner supply, you must pour the powder from a bottle into a well. (Better dress casual.) You must also keep the unit level when moving it, as we discovered. But these are minor inconveniences to get quieter, higher-quality printing on continuous-form paper.

LaserMatrix 2405
$5000

Output Technology
Spokane, WA

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fax: (509) 533-1280
http://www.output.com/

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WHAT DO LOCKHEED AND THE WEATHER CHANNEL HAVE IN COMMON?

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When these companies were looking for speed, reliability, affordability, and ease of use for remote access and peripheral control, they chose a Comtrol serial communications board.

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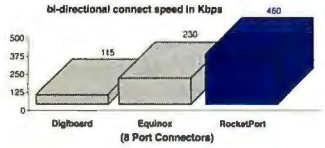
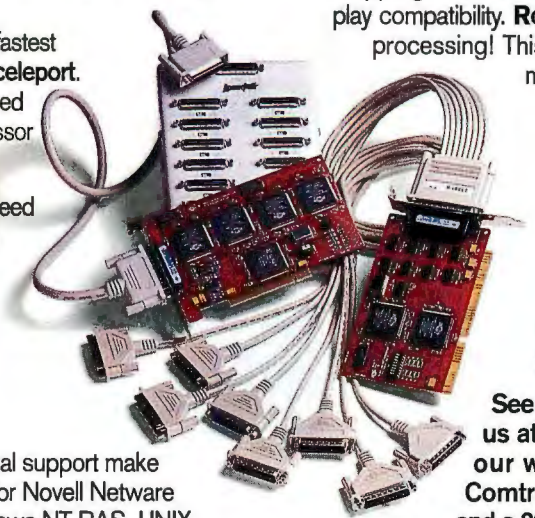
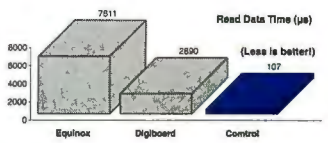




Comtrol's software drivers and technical support make it **easy to switch.** We provide drivers for Novell Netware Connect, Multiprotocol Routing, Windows NT RAS, UNIX, OS/2, and Linux. If you are already using one of these drivers, all you need to do is install your **RocketPort** card. I/O mapping eliminates memory conflicts and allows plug and play compatibility. **RocketPort** also gives you **30 times faster** processing! This host CPU efficiency allows you to add more ports or free up valuable CPU time.



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RocketPort MultiPort Serial Boards

Test Specs

We picked the best network printers by running performance tests that evaluate a unit's top pages-per-minute print speed at standard (600- by 600-dpi) resolution. We tested on both PC and Macintosh platforms. We also scored print quality, features, and ease of setup, use, and maintenance. The resulting scores are an average of weighted geometric means with scores scaled to 10 for the best-performing printer.

Performance

To get real-world performance numbers, we tested all the printers on a NetWare 3.12 network. For the PC platform, the client system was a desktop PC running Windows 95; for the Macintosh platform, we printed over the network from an Apple Quadra 640AV workstation with System 7.5 and EtherTalk installed. Our network file server used an NE3200 EISA Ethernet adapter, and the PC workstation had an Intel PCI EtherExpress 16 Ethernet adapter. We tested each printer with the drivers supplied or recommended by its vendor. We disabled all print servers, spoolers, and buffers during testing.

On the PC platform, we used a Windows applet to launch and time printing of test files with each printer. A test was complete when the last page dropped into the printer's output tray. A similar applet measured EtherTalk performance.

We set each printer to poll the network as frequently as possible to get the most consistent times attainable. The performance tests measure how fast a printer can crank out three common elements of a document: text, graphics, and fonts. The text tests represent typical business correspondence; performance in this test correlates with raw engine speed because there are no fonts or graphics for the printer to interpret. The graphics tests use bit-mapped images to simulate documents with complex graphics; they stress the printer's processor and RAM capabilities. We also use a font test to measure the speed of the printer's processor.

Print Quality

Our tests for quality of output measure how well the printers can produce a photographic image; print attractive, legible text in a wide range of sizes; and draw lines. For example, the line-squeeze test forces a printer to draw two lines increasingly closer until the gap between them vanishes, which indicates the printer can no longer make the black-to-white-to-black transition. In another part of the test we determine text legibility by having the printers produce increasingly smaller text. The test suite also gauges other print quality considerations such as how accurately the unit positions paper and how well it displays reversed text and graphics (white on black).

Other Factors

We evaluate each printer's feature set, usability, and technology to come up with our final scores. Feature details include emulations supported, the printer's maximum resolution, and what services the vendor provides with the standard warranty. We also evaluate usability based on such aspects as how easy it is to install the toner cartridge, the intuitiveness of the control panel, ease of driver installation, ease of network setup, and the clarity of the user manuals. Lastly, we judge each printer for the innovativeness of its technology.

Evaluations in this report represent the judgment of BYTE editors, based on tests conducted by NSTL, Inc., as documented in a recent issue of their monthly PC Digest. *To purchase a copy of the full report, contact NSTL at 625 Ridge Pike, Conshohocken, PA 19428; (610) 941-9600; fax (610) 941-9950; on the Internet, editors@nstl.com. For a subscription, call (800) 257-9402. BYTE Magazine and NSTL are both operating units of The McGraw-Hill Companies.*

TECH FOCUS: IMAGING

More for Your Memory

One of the costs of increasing printer resolution comes from needing more memory to represent the page image. Theoretically, a 600- by 600-dots-per-inch (dpi) printer needs four times as much memory as a 300- by 300-dpi printer to store the same raster image. A laser printer typically needs a 2-MB configuration to print a 300-dpi letter-size page, 6 MB to print a 600-dpi letter-size page, and 12 MB for a 600-dpi tabloid page. Not all that memory is used for raster image storage, but much of it is.

You may notice in perusing the features table on page 108 that IBM's NP 17 can support 600-dpi printing on legal-size paper with only 4 MB of memory. It does so thanks to something called Memory Reduction Technology (MRT) licensed from Peerless Systems. Peerless' QuickPrint integrated printer coprocessor chip works with the NP 17's Intel i960 microprocessor to perform this magic using the Peerless Systems firmware.

MRT uses a whole bag of memory-reduction tricks including display list processing, compression, and band processing. Instead of just converting the page-description language into a rasterized page image and storing it in a buffer for printing, MRT compresses the page into a compact page representation that is rasterized on the fly. MRT uses a combination of lossy and lossless compression (anywhere from 4 to 1 up to 25 to 1) and then decompression for rasterizing. The Peerless design cuts the printer's memory requirements by 8 MB.

Reducing memory requirements brings down costs, and so does integration of functions. In addition to providing a hardware assist (not required by MRT) to the memory-reduction process, the QuickPrint chip provides other functions including an IEEE 1284-compliant parallel port interface, memory controller, print engine video controller, and interface to either Intel's i960 or Motorola's 5102 ColdFire processors.

Apple Computer has its own memory compression technology. The LaserWriter 16/600 can print legal-size pages at 600 dpi with only 8 MB of memory.

WORKGROUP PRINTERS FEATURES

Vendor/Model	Apple Computer LaserWriter 16/600	Hewlett-Packard LaserJet 5SiMX	IBM Network Printer 17
Price as tested (MSRP)	$2429	$4899	$1999
Overall Score	7.2	7.8	7.4
Performance Score	6.8	7.7	6.2
Quality Score	8.5	8.3	8.1
Features Score	6.9	8.4	8.5
Usability Score	6.3	8.0	7.7
SPECIFICATIONS			
Maximum native resolution (horizontal × vertical, dpi)	600 × 600	600 × 600	600 × 600
Maximum enhanced resolution (horizontal × vertical, dpi)	600 × 600	600 × 600	600 × 600
Standard drivers	Windows 3.1; Mac	DOS; Windows 3.x, 95, NT; Mac	Windows 3.x, 95, NT; OS/2; Mac; AIX, OS/400
Engine manufacturer, model, and technology	Canon LBP-430 electrophotographic laser	Canon P-550 electrophotographic laser	Fuji-Xerox electrophotographic laser
Monthly duty cycle (pages per month)	5000	100,000	65,000
Controller manufacturer	Apple Computer	HP	IBM
Processor/clock speed (MHz)	AMD 29030 RISC/25	AMD 29040/40	Intel 80960CF RISC/33
Standard memory/**as tested**/maximum (MB)	8/**8**/32	12/**12**/76	4/**4**/66
PAPER HANDLING			
Supported paper sizes**	LTR, LGL, A4, B5, EXEC, ENV, TRANS, ABL	LTR, LGL, A4, B5, TAB, EXEC, ENV, TRANS, ABL	LRT, LGL, A4, B5, EXEC, ENV, TRANS, ABL
Duplex printing		Optional	✔
Standard input tray capacity/output tray capacity (# of sheets)	350/350	1100/600	350/250
Number of standard input trays/maximum input trays	2/3	3/5	2/5
Envelope feeder	Optional	Optional	Optional
NOS SUPPORT			
NetWare 3.x and 4.x	✔	✔	✔
IBM LAN Server		✔	✔
Banyan Vines			✔ (Via TCP/IP only)
OS/2 Warp Server		✔	✔
Windows NT Server	✔	✔	✔
AppleTalk/EtherTalk	✔	✔	✔
CLIENT SUPPORT			
DOS	✔	✔	
Windows 3.x, 95, and NT	✔	✔	✔
OS/2		✔	✔
Macintosh	✔	✔	✔
Unix		Solaris, Sun OS, HP UX, IBM AIX, SCO Unix	Solaris, HP UX, IBM AIX
INTERFACES			
Centronics parallel	✔	✔	✔
RS-232C			
Apple LocalTalk	✔	✔	
Ethernet	✔	✔	✔
Fast Ethernet		✔	
Token Ring		Optional	✔
Auto-switching among all interfaces	✔	✔	✔
EMULATIONS			
HPGL		✔	✔
Postscript Level II	✔	✔	Optional
Intellifont		✔	✔
True Image		✔	✔
HP PCL	5	4/5e	5e
Auto-switching among emulations	✔	✔	✔
FONTS			
Number of resident fonts/resident typefaces	64/29	80/80	47/47
Number of resident bitmapped fonts/resident scaleable fonts		1/44	2/45
Downloadable font support	✔	✔	✔
MANUFACTURER'S RATINGS			
Noise in high-speed draft mode (decibels)	52	57	49.5
Engine speed (PPM in monochrome w/ letter-size paper)	17	24	17
Energy Star-compliant	✔	✔	✔
Voltage (120 or 220)	Both	Both	Separate models
FCC Classification	B	B	B
DIMENSIONS			
Width × length × height (inches) w/ standard tray configuration	16.7 × 16.9 × 12.1	21 × 20.5 × 21.3	17.4 × 16.5 × 11
Weight (lbs.) w/ standard tray configuration	40	99	40.9
CUSTOMER SUPPORT			
Warranty length (years)/coverage	1/P,L,F,R	1/P,L	1/P,L,R
Phone	(408) 996-1010	Call local Hewlett-Packard dealer	(404) 238-1234
Toll-free phone	(800) 538-9696	(800) 752-0900	(800) 426-3333
On-line address	http://www.apple.com/	http://www.hp.com/	http://www.ibm.com/
Inquiry number	**1025**	**1026**	**1027**

BYTE = BYTE Best ✔ = yes

Warranty: P = parts; L = labor; F = freight to repair center; R = return to customer.

Lexmark International Optra N 245	QMS QMS 2425Ex Print System	Xerox DocuPrint 4517
$4199	$6999	$3300
8.4	7.7	7.4
9.2	7.4	6.3
8.0	8.3	8.9
8.1	9.1	7.9
8.3	8.3	8.2
600×600	600×600	600×600
1200×600	1200×1200	1200×600
DOS; Windows 3.x, 95, NT; OS/2; Mac; IBM AIX	Windows 3.x, 95, NT; Mac	DOS; Windows 3.x, 95, NT
Canon P-550 electrophotographic laser	Canon P-550 electrophotographic laser	Fuji ASPMAL7 electrophotographic laser
100,000	100,000	65,000
Lexmark	QMS	Peerless
Intel i960KD-50/25	NEC VR4300/50	Intel i960/25
16/16/16	24/24/128	6/22/64
LTR, LGL, A4, B5, TAB, EXEC, ENV, TRANS, ABL	LTR, LGL, A4, B5, TAB, EXEC, ENV, TRANS, ABL	LTR, LGL, A4, B5, EXEC, ENV, TRANS, ABL
Optional	Optional	Optional
1100/500	500/500	350/250
3/5	2/3	2/5
Optional	Optional	Optional
✔	✔	✔
✔	✔	✔
✔		
✔	✔	
✔	✔	✔
✔	✔	✔
✔	✔	✔
✔	✔	✔
✔	✔	✔
✔	✔	✔
Solaris, Sun OS, HP UX, IBM AIX, UnixWare, AT&T	Solaris, Sun OS, HP UX, IBM AIX	Solaris, Sun OS, HP UX, IBM AIX, SCO Unix
✔	✔	✔
✔	Optional	
✔	Optional	✔
✔	✔	✔
✔		
✔	Optional	✔
✔	✔	✔
✔	✔	✔
✔	✔	Optional
✔	✔	✔
	✔	
4/5e	4/5e	4/5e
✔	✔	✔
145/76	131/13	35/10
12/133	6/91	1/39
✔	✔	✔
52	52	49.5
24	24	17
✔	✔	✔
Both	120	Both
A	A	A
22.2×21.9×21.5	22.3×21.9×21.3	17.4×16.5×11.4
105–108	106	40.9
1/P,L	1/P,L	1/P,L
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Lotus Notes and Microsoft Exchange seek to be unified environments for group projects, but they approach this goal differently.
By Mark Hettler

Lotus Notes vs. Microsoft Exchange

For most people, groupware is defined by one product: Lotus Notes. And though some industry analysts have heralded Microsoft's Exchange as a Notes competitor, Microsoft has instead been playing Exchange as an enterprise-wide messaging system. (Another potential competitor, Novell's GroupWise 5.0, has just been released; see our Eval in the November BYTE.) Besides these dedicated LAN- and WAN-based products, alternative platforms are emerging: the Internet, the Web, and intranets. (See the Tech Focus, "The Inter/Intranet Alternative," on page 116.)

While the term can encompass a wide range of software, true groupware must include at least these six essential functions—e-mail, on-line discussion (conferencing), document management (including version control, commenting, and revisions), work flow, group scheduling, and local replication of data—all in a client/server environment.

Lotus Notes

At its heart, Notes brings the power and convenience of database management to the storage of nontraditional, unstructured information. Each entry in a Notes database is a document, not a record, with a few information fields (author, subject, date, etc.) and the document itself, stored in rich text format (RTF) and possibly including attached files. Users can browse views (lists of documents in a database) that display the information fields. They can customize views to sort or group documents, filter displayed documents based on field qualifiers, and add fields to a view. Thus, Notes facilitates categorizing and locating documents in a way not possible in a standard file system. A server maintains all configuration and user information in a special database—the name and address book—whose documents describe all servers at the site, registered users, connections with off-site servers, special-purpose databases, and any other needed system information.

BYTE BEST
GROUPWARE

Lotus Notes 4.1
Today's Notes excels in document management and Internet integration, and it continues to break new ground while its competitors play catch-up. At best, Microsoft's Exchange is comparable to previous versions of Notes.

In the Notes architecture, mail is just a way to move stored documents. When a user composes a mail message, Notes saves it in a special database for outgoing mail. The system recognizes anything in that database as outgoing mail and routes it to its destination. Each user has his or her own mailbox, which is simply another Notes database.

Replication: I See, I See

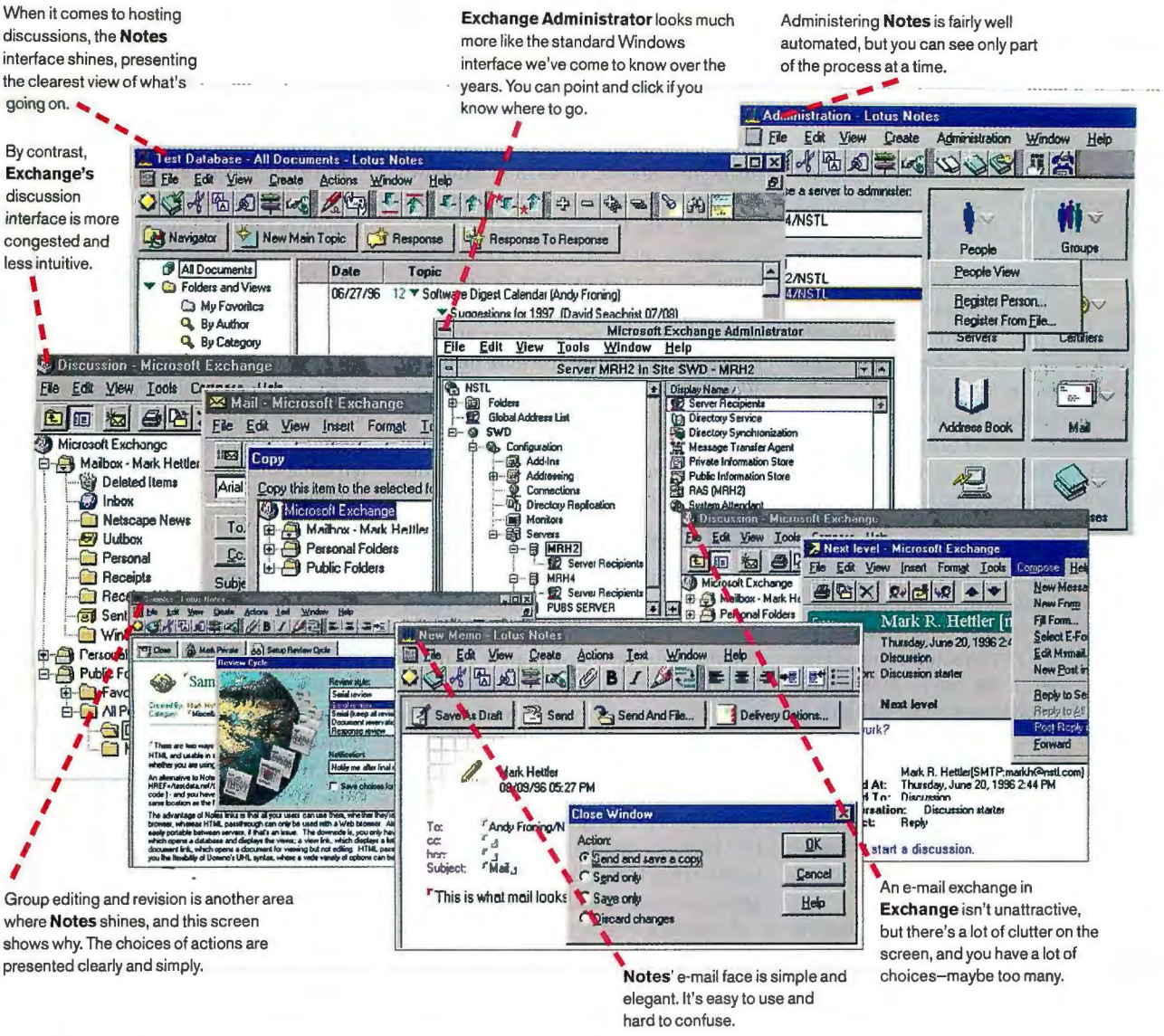
Replication is what gives Notes its unique character. The same database can exist in multiple locations; when users add, delete, or modify documents, the system synchronizes all the changes. For enterprise-wide information sharing, Notes provides replication between servers. Each server's name and address book contains connection documents specifying the servers with which to replicate, the replication schedule, and mail routing. Companies can also replicate information with their customers or other business associates.

Replication helps users who connect via modem or take Notes databases on the road. Users can initially replicate any database, selecting the documents they want to work with off-line. Once disconnected, users can create or edit documents and post mail messages to an outgoing mail database. After reconnecting to the server, the system routes outgoing mail to the server's mailbox and replicates any changes to other databases.

Databases, Work Flow, and Security

Notes provides templates to facilitate creating databases; the most common templates are for discussion, document library, and mail. All use the same underlying database storage but differ in views (forms for entering documents) and fields. Discussion databases allow quick responses to existing documents, and a default threaded discussion view groups related documents and responses. The document library lets users configure review cycles and maintain multiple versions and revision histories.

In past versions of Notes, macros could automate tasks; version 4 now includes the LotusScript language. Forms designers can add programming that executes



While Exchange and Notes do many of the same things, they look very different while doing them.

when users click a button or access certain fields, or designers can divide a form into sections, each containing the fields a particular user is to fill out. Each time a user saves the form, agents monitor the database and notify the next person on the routing list.

Notes security is certificate-based. The system provides each user with an ID file containing an encrypted key that certifies the holder as a valid user in the organization. At log-in time the locally stored ID file validates his password, eliminating the need to send passwords over the net. Each server validates the ID by the certifier key.

Hierarchical certification allows an organization to certify divisions, which in turn certify smaller units, which certify users. Servers with a common certification can replicate their name and address books, thus providing a global address book. Different organizations can "cross-certify" one another to allow exchange of information. Certification forms the basis of electronic signatures.

Documenting the Interface

With all its power, Lotus Notes is very complex and often unintuitive. Rather than point-and-click options, many configuration tasks require typing information into fields or a database. But in most cases, particularly initial setup, the printed manuals and help system provide clear, step-by-step instructions. For example, setting up the Lotus Domino software for Web access requires manually copying subforms from one template to another. (More on Domino later.) Instructions step the user through the process.

The Notes 4 user interface automates many common tasks. Server administration—registering users, editing user options, and entering server commands—is much easier. Add multiple replicas of the same database and the system creates a single icon on the desktop with a pick list. On-demand replication is an easy menu option. In setting up a second server, the system automatically produces the needed connection documents to allow replication.

continued

In addition, the Windows NT server now supports the SPX protocol, simplifying NetWare connectivity.

But a task that isn't automated or that lacks step-by-step instructions can be confusing. Adding a second communication protocol to a server requires making changes in two different places. The manual tells you what to change in the port settings dialog, but not where to find that dialog. And the only way to remove a document from the "favorites" folder without deleting it from the database is to add a button that executes a script.

During our tests, we moved user mailboxes from one server to another. Reconfiguring clients to look for mail on the new server was a major challenge. After we edited the NOTES.INI file, the client software changed the setting back to its previous value. The same thing happened after we reran the setup program and specified a new server. The only recourse was to completely remove and reinstall the client software. Later, by accident, we discovered that you have to make a change in the client's "location" configuration.

But such snafus were the exception. In most cases, users who take time with the documentation will find that following the instructions produces the desired results.

Internet Access

The InterNotes Web Publisher converts Notes forms, documents, views, and databases to Hypertext Markup Language (HTML) for publication on the Web. The InterNotes Web Navigator lets a Notes server act as a browser, saving Web pages in Notes databases. This helps Notes users who don't have Internet access and allows future reference off-line. At press time, Lotus is about to make its SMTP Message Transfer Agent add-on available for NT; it's already available for OS/2. This will allow a Notes server to function as an Internet mail server.

The heart of Notes' Internet integration is Domino, a downloadable add-on (http://domino.lotus.com) that turns a Notes server into a Web server. Domino converts Notes objects to HTML upon request, allowing browsers to access Notes forms, documents, views, and databases as if they were a standard Notes client. (See our Eval in the October BYTE.)

Lotus Notes is targeted as a cross-platform solution for a variety of operating systems. It's currently available for Windows NT, OS/2, and a variety of Unix platforms, with client software for 16-bit Windows and Macintosh. Storage and security mechanisms are completely OS-independent. Except for minor installation differences, Notes functions identically on different platforms.

Mail-Centered Exchange

Where Notes is a database manager, Microsoft Exchange is a messaging system. A major upgrade to Microsoft Mail, Exchange is designed primarily to move information from one place to another. It's essentially a mail system with storage added, whereas you can think of Notes as a storage system with mail added. Exchange provides many of the same mail features as Notes. A point-and-click interface helps set up users and connectors to transfer mail with other Exchange servers and mail systems, such as Internet mail.

Exchange begins with private mailboxes and adds public folders (mailboxes that don't belong to specific users), which are similar in many ways to Notes databases. Folder owners can determine which users have what access. Public folders serve for discussions, posting topics, and responses, and they can display a threaded discussion view. But Exchange lacks the built-in smarts of Notes' templates. There are no predefined views geared specifically to a public folder's use, no specialized interface features.

Exchange is tied tightly to Windows NT. Each Exchange user corresponds to an NT user account, and it's the OS that authenticates users. Administrators can install an advanced certification-based security system, similar to Notes', that enables electronic signatures.

In order to share information, two servers must either be in the same NT domain or their domains must have a *trust relationship*—that is, a link between them that allows one domain to recognize the user accounts of another domain, trusting that other domain to authenticate the logons of its users. Exchange refers to several servers at the same location as a site, and several sites can be grouped into an organization. Administrators view all servers within a site in a single window in the administration program; they can open other windows to administer other sites if they have the rights. But it stops there. Exchange provides no facilities for replicating public folders between different organizations. Two different business entities, such as an organization and its client, can't replicate public folder contents unless they set up their NT networking and Exchange infrastructure as though they were the same organization. Exchange can, however, route mail messages between different organizations.

A Matter of Form

Exchange's Electronic Form Designer lets you create custom forms for mail and folder postings. Designers can enhance a form's functionality using Visual Basic. A message built upon a form can display different information and functionality to sender and recipient. But while Notes just saves a form in a database, Exchange requires a cumbersome process of registering forms in the Organization Forms Registry (OFR). When we reached that point, the OFR wasn't presented as an available option. A Microsoft representative explained that we had to first configure the OFR on the server and stepped us through the process of finding and con-

GROUPWARE SYSTEMS

BEST OVERALL

Lotus Notes 4.1
Experience shows as Notes keeps well ahead of its main competitor.

	COST, SERVER LICENSE	COST, CLIENT LICENSE	TECHNOLOGY	IMPLEMENTATION
Lotus Notes 4.1	**$495**	**$295**	★★★★	★★★★
Microsoft Exchange Server 4	$1970	$54	★★★	★★★

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

figuring the OFR. But later on, the OFR again became unavailable, and this time the recommended fix didn't work for us.

Visual Basic is available only within forms. There's no equivalent to LotusScript in Notes agents. For automating system behavior, Exchange developers have only limited, predefined options, which limits Exchange's usefulness for workflow applications. Several Microsoft programs, including Word and Excel, support serial routing with Exchange, but there's no way to develop the sophisticated workflow applications that are standard fare at Notes installations. For example, a user cannot post a message to a public folder that triggers a serial routing process and presents each recipient on the list with a different set of tasks.

Interface Gotchas

Where Notes requires complex, multistep procedures and manual data entry, Exchange offers simple point-and-click choices in tabbed dialogs. But time and again, we followed the directions and got an entirely unintended result, leading to a trial-and-error hunt to discover some obscure (but vital) detail we had overlooked. For instance, adding a second server to a site is simple if you use the same service account on both servers. If you don't, however, it's almost impossible to undo the mistake short of reinstalling Exchange from scratch or granting several obscure and undocumented privileges in both Exchange and NT. We also had to experiment with granting the administrators various rights on each other's domains before the servers could communicate.

We set up several clients in a seemingly identical manner. All but one connected properly to the server. We compared settings carefully but couldn't determine why one could never connect. There's virtually no documentation on client configuration.

The server administration program lists public folders by site, not server, so it's difficult to tell where a public folder resides. If a folder's server is down, the folder will be listed but inaccessible. The system synchronizes a public folder between two servers only after replication has been set up explicitly. It's difficult to test whether replication works properly because the administrator can't tell which server's folder he or she is viewing.

The client program lists public folders together with mail folders, which might be convenient. But whenever you are

FEATURES

	Notes 4.1	Exchange Server 4
SERVER PLATFORMS		
Windows NT 3.5x, 4.0	✔	✔
Unix, OS/2, NetWare	✔	
NetBIOS, named pipes, NetWare SPX, TCP/IP	✔	✔
CLIENT PLATFORMS		
Windows 3.x, 95, NT	✔	✔
Unix	✔	
OS/2	✔	A
Macintosh	✔	✔
E-MAIL ADMINISTRATION		
X.400 routing, MAPI support, SMTP gateway	✔	✔
Automatic space reclamation	✔	
Roll forward from transaction log		✔
E-MAIL USER FEATURES		
Threaded discussion view	✔	B
Fax capability	C	✔
Voice-mail integration	C	C
Change message to task	✔	C
DOCUMENT MANAGEMENT		
Folders within folders, user-created folders	✔	✔
Full-text indexing	✔	C
Index based on categories	✔	✔
Changes stored as new document	✔	
View multiple versions of document	✔	
Index text of word processor documents	✔	C
Access documents on multiple servers	✔	✔
CONFERENCING/DISCUSSIONS		
Threaded discussion view or outline view	✔	✔
Hot link to original posting	✔	✔
REPLICATION		
Scheduled replication	✔	✔
Change-triggered replication	D	✔
On-demand replication	✔	E
Automatic alternate routing		✔
Replicate selected documents outside organization	✔	
WORK FLOW		
Serial routing	✔	C
Track messages through routing process	✔	C
Predefined routing lists	✔	C
Rules-based routing lists	✔	
SCHEDULING		
Find first open time for all participants	D	✔
Check for conflicts, request confirmation	D	✔
Assign tasks	✔	C
Accept/decline/delegate tasks	F	C
Notify of task completion	✔	C
INTERNET FEATURES		
Access Web without browser	✔	G
Store URL contents in database or folder	✔	
View folders and documents using Web browser	✔	G
Post documents to public folders using browser	✔	G
Use document links in browser	✓	
SECURITY		
Certificate-based security	✔	H
Trust relationships outside organization	✔	
Electronic signatures	✔	✔

A Can run Windows 3.x client under OS/2 3.0.
B Messages must be moved to common folder
C Available as add-on, separate, or third-party product
D To be available in version 4.5
E Local-to-server replication
F Accept or decline
G Available in future upgrade
H X.509-based certificates at message level

TECH FOCUS THE NETWORK

The Inter/Intranet Alternative

Even when Notes had no real competition, the Internet was being considered a serious alternative. Its infrastructure is designed for sharing information between sites around the world, and an ever-growing array of tools for browsing and downloading information means organizations don't need to distribute specialized software. The existing wired network eliminates the need to set up private communication links between clients and servers. Lack of security has been a traditional criticism of Internet-based information sharing, but the emergence of Secure Sockets Layer (SSL), firewalls, and encryption has made this less of an issue.

Web-based discussion on The BYTE Site

Even within local sites, organizations are seeing the value of intranets, using Web servers and browsers to share information over a LAN or WAN. Here again, Web tools preclude the need for proprietary software. Moreover, such intranets readily allow seamless access to information from the outside world.

Internet mail has become the common means by which many organizations communicate. There is some question whether current Internet-based routing between sites in an organization can handle heavy volumes of mail as efficiently as proprietary packages, but providers of Internet-based solutions should be able to address such issues.

Internet newsgroups provide discussion features and functionality similar to those of Notes and Exchange. Most readers are familiar with public Usenet forums, but news servers can also host private discussions. Newsgroups allow readers to post responses, start new topics, and display messages in a threaded view.

Where Internet and proprietary solutions diverge is in document management. Newsgroups are a convenient way to post messages and attachments, but there's no way to categorize them except the user-entered subject line. Also, newsgroups don't allow users to edit or delete posted documents or to let some postings expire and others live indefinitely.

The most common way to make information available, whether on the Internet or an intranet, is with Web pages. A Web page may contain information, or it may provide links to other pages and files for downloading. While the Web is convenient for finding and viewing information, it's awkward to manage. Making a document available on the Web requires authoring a page and providing links to the new document.

Web sites are simply unusable for group document management. Once a document is published, people can easily read it or download it, but it is nearly impossible for them to edit it. Making and saving changes involves republishing the original Web page; maintaining multiple versions involves publishing a new page for each revision. Beyond the inconvenience, there's no database for storing and organizing documents; we're back to the OS's file system, with documents scattered among directories and held together by hypertext links.

One important consequence of file system-based storage is the lack of facilities for replication between sites. Newsgroups allow the propagation of new postings to multiple sites, but replicating Web sites is more difficult. While some might argue that the Internet is designed to make information in a single location accessible to users around the world, the large number of mirrored sites already in existence points out the Net's inadequacy. Moreover, many organizations will want to have proprietary information replicated to sites in various locations protected by firewalls rather than in a single location that is accessed remotely. File transfers can move information from one site to another, but there are no mechanisms for synchronizing changes made at multiple sites.

Despite these disadvantages, the Internet is here to stay, and using Web browsers to retrieve documents will become the primary means whereby people access information. The only question is what role existing PC software technology will play in the Internet environment. Both Lotus and Microsoft are working to move their groupware technologies to the Internet, but it is uncertain how well they'll compete with products designed for the Internet from the ground up.

positioned in a public folder, selecting the toolbar's "new" button creates a new e-mail message, not a new posting for the folder. To create a new item for a folder, you must explicitly select "New post in this folder" from the Compose menu. Lastly, Exchange's Uninstall program didn't completely remove the software; a technician had to manually delete dozens of entries from the NT registry to avoid error messages on system start-up.

Which One?

Microsoft's counterpart to Domino, still in development, will integrate Exchange with Microsoft's Internet Information Server. This will combine the benefits of a full-featured Web server, including access to standard HTML files and customized Web applications, with access to Exchange mail and public folders. The Exchange server includes Internet Mail Connector, which can forward mail to Internet hosts and receive mail from the Internet.

PRODUCT INFORMATION

Exchange	Notes
$1970, server license; $54 per client	$495, server license; $295 per client
Microsoft	Lotus Development
Redmond, WA	Cambridge, MA
(206) 882-8080	(617) 577-8500
fax: (206) 93-MSFAX	fax: (617) 693-0968
http://www.microsoft.com/exchange	http://www.lotus.com
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All in all, Lotus Notes does a better job incorporating mail into its document database architecture than Exchange does incorporating document management and groupware into its messaging structure. Moreover, Notes is far ahead in terms of seamless integration with the Internet. B

Mark Hettler pioneered NSTL's coverage of SQL servers and multiuser databases. You can reach him at **mark_hettler@nstl.com**.

Evaluations in this report represent the judgment of BYTE editors, based on extensive tests conducted by National Software Testing Labs and documented in a recent issue of NSTL's monthly Software Digest. *To purchase a copy of that report, with their own evaluations and data, contact NSTL at 625 Ridge Pike, Conshohocken, PA 19428; (610) 941-9600; fax (610) 941-9950; editors@nstl.com. For a subscription, call (800) 257-9402. BYTE Magazine and NSTL are both operating units of The McGraw-Hill Companies.*

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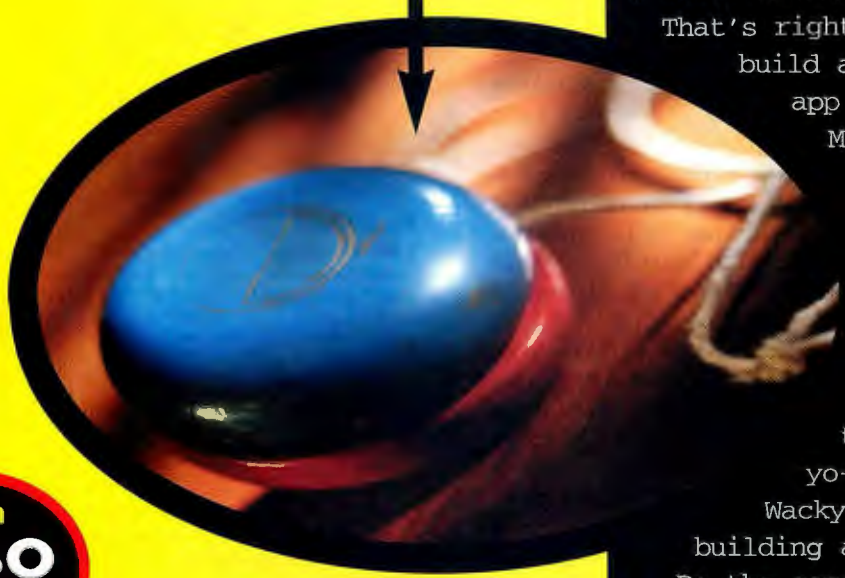

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New Tools for Internet Apps

LDAP directory services, secure IP communications, and IMAP-based e-mail will underpin tomorrow's Internet-based applications.

Building Internet applications isn't much different from building stand-alone applications. Yeah, right. The Internet is a unique platform with its own advantages and challenges for applications developers.

One measure of its uniqueness is an infrastructure that is pretty much of a black box to developers. Your applications send data packets into that box, and the box in turn sends the packets around the world.

The basic infrastructure model won't change dramatically anytime soon. So what will be different for developers of tomorrow's Internet applications? A handful of technologies will provide for faster access to network resources, more secure transactions, and better communications. These emerging technologies all depend in one way or another on manipulating in clever ways the packets you send over the Internet.

For example, you'll soon be able to extend the usefulness of directories—repositories of data, applications, and other resources. Today, directories work best at helping you find resources locally or on a LAN. Our story "LDAP Unites the Internet" explains how new kinds of directory services can help you find and manage resources strewn across the Internet as easily as if they were stored locally.

To keep your data and messages away from thieves and eavesdroppers, a new secure IP standard defines ways of encrypting parts of the packets as they travel around the Internet. This standard will be mandated in IP 6, but "Internet Armor" shows how applications developers and end users can use it now to defend their secrets against all foes.

A new e-mail protocol, Internet Message Access Protocol (IMAP), is far more adroit than the current standard, Post Office Protocol (POP), at helping you manage your inbox and for creating simple groupware applications. "E-Mail Grows Up" details how you can use IMAP to selectively retrieve messages and message parts, as well as create new kinds of Internet applications.

These three approaches for handling message packets mean that the best advice for Internet developers will be to continue to ignore the infrastructure entirely. Don't rip up the tracks; instead, customize the trains that run on them.

–Edmund X. DeJesus

LDAP Unites the Internet. . . 121

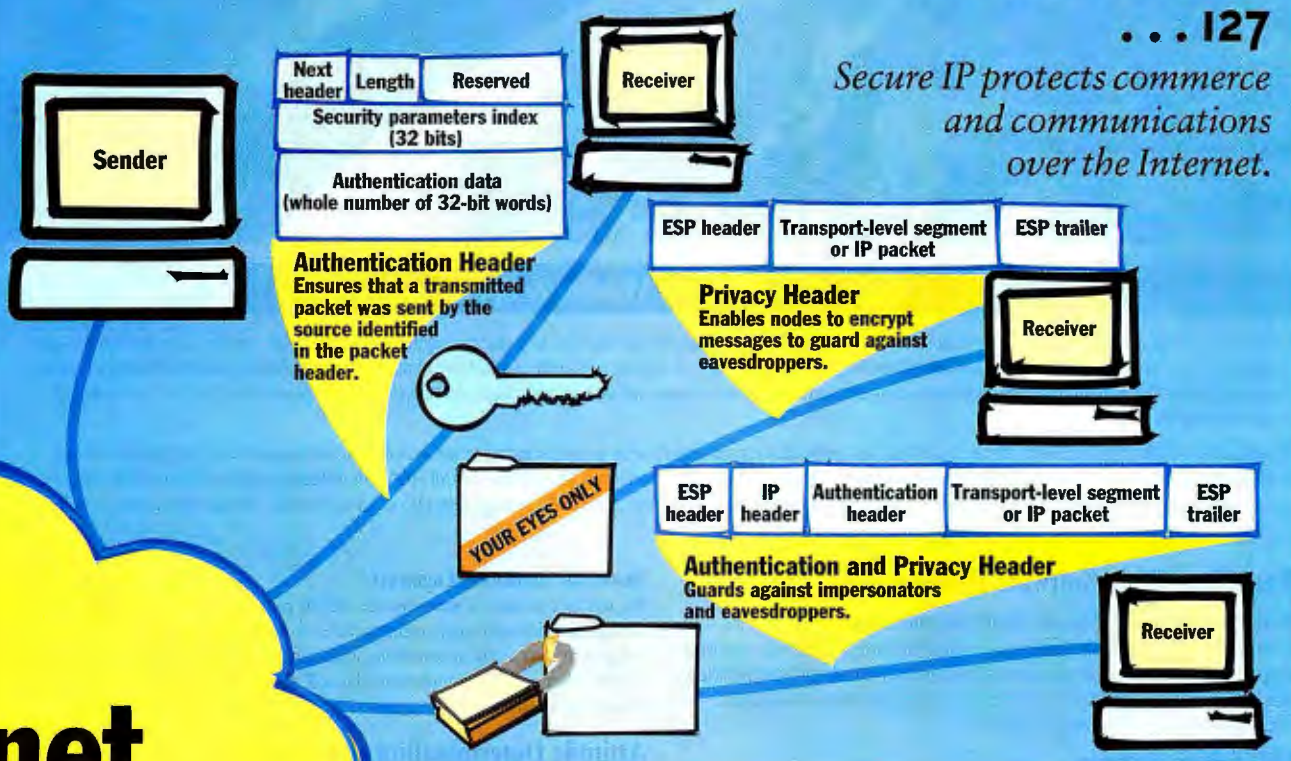
X.500 "lite" provides better Internet access to data and applications.

Three Enabling Technologies

Internet Armor

. . . 127

Secure IP protects commerce and communications over the Internet.



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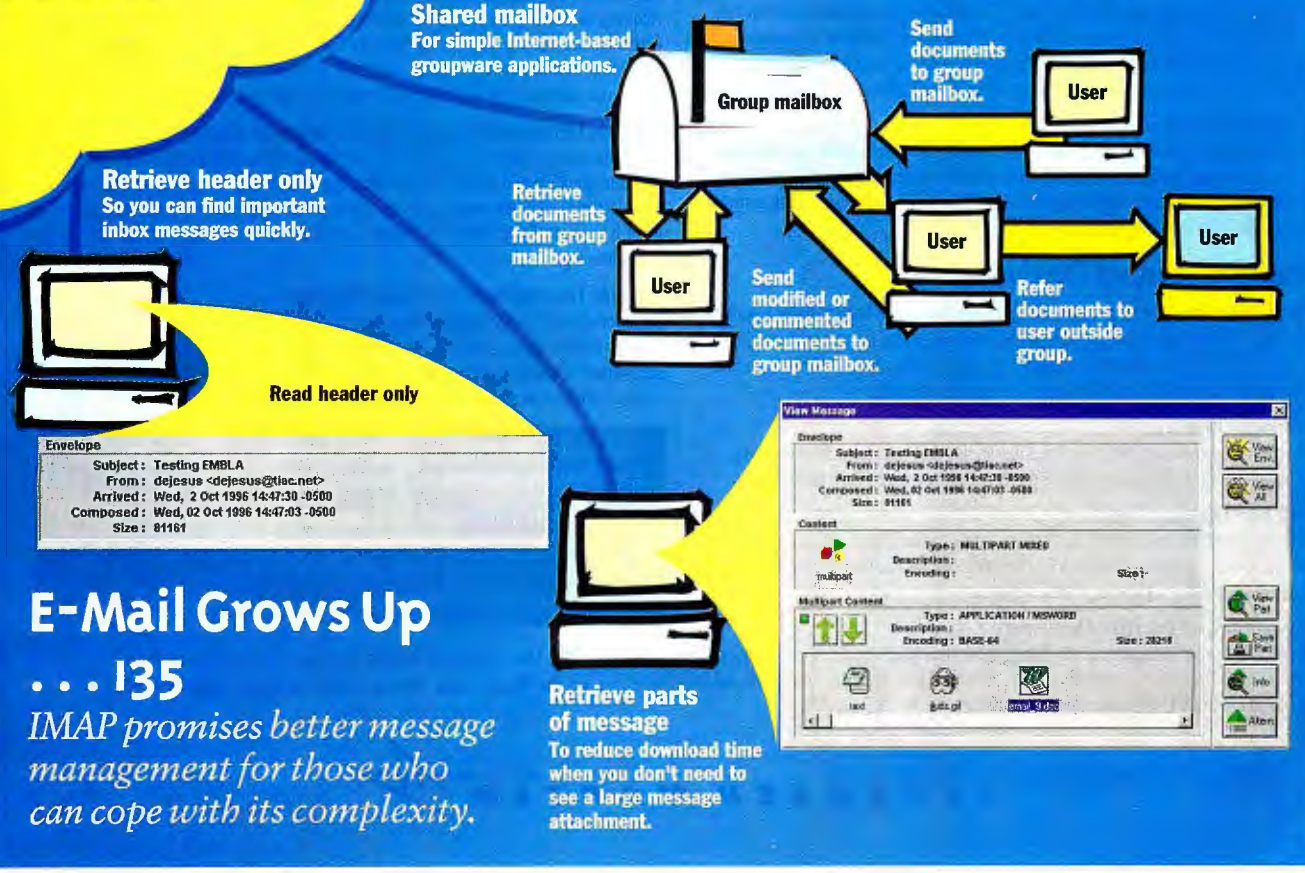

E-Mail Grows Up

. . . 135

IMAP promises better message management for those who can cope with its complexity.

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LOCKHEED MARTIN

Is LDAP the answer for better over-the-Internet access to data and applications? ***By Jamie Lewis***

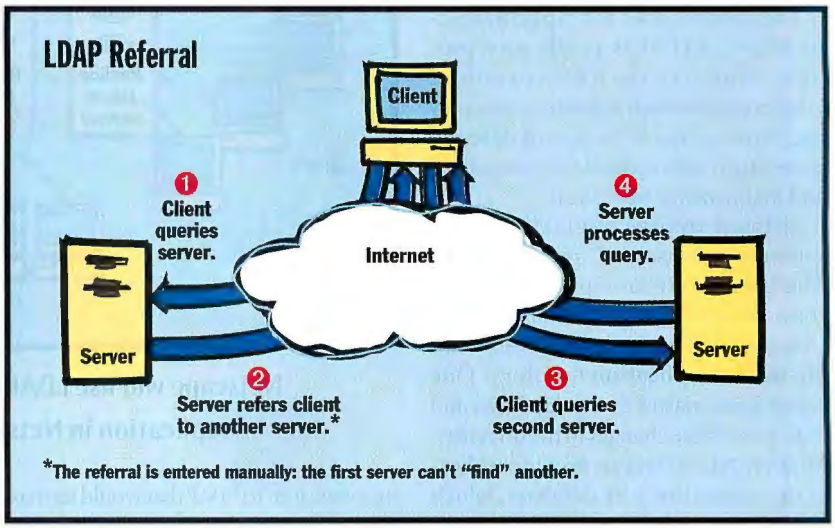
LDAP Unites the Internet

Who would have thought that directory services—the white pages of the network world—would emerge as a prime technology for enabling new Internet-based applications? Sure, directory services have always served as background guides to network services, applications, and people. Now, because companies are using the Internet for communications and to unify internal networks, directories are on the front burner for applications developers.

In many ways, the current surge in directory development can be attributed to Lightweight Directory Access Protocol (LDAP). LDAP 2, the Internet standard for directory services, is a distillation of X.500, the Open Systems Interconnection (OSI) protocol for directory and resources management. LDAP gives applications developers a vendor-independent mechanism for directory interoperability. That's important for the Internet, where public-directory access and interoperability are pressing issues, and also for the intranets, where directory integration is a significant problem.

As a result, LDAP may indeed deliver many of the benefits promised by X.500. Vendors such as AT&T, Lotus, Microsoft, Netscape, and Novell are jumping on the LDAP bandwagon. This helps make interoperable directory solutions not only possible, but likely.

LDAP is not a panacea, however, and there are holes in the range of what it offers. As vendors such as Netscape add extensions to the protocol, some people question how long it will remain a standard for interoperability.



LDAP directory replication helps you search for resources across multiple servers.

What LDAP Does

The University of Michigan developed LDAP in conjunction with the Internet Engineering Task Force (IETF). LDAP 2 is a current Internet standard; further extensions to the protocol are in version 3, which is being formulated.

The protocol's foundation is Directory Access Protocol (DAP), the X.500 standard's link between clients (directory user agents) and servers (directory service agents). As is the case with many OSI protocols, however, DAP creates so much overhead that it's not practical for use in typical DOS, Windows, and Mac client environments.

Thus, the University of Michigan developed LDAP as a streamlined way to access and update directory information in a client/server model. Using LDAP, for example, applications can add, delete, and modify objects and their attributes in a directory database. One or more LDAP servers contain the data comprising the directory tree, and LDAP clients connect to an LDAP server to query or modify the contents of the tree.

LDAP does not require an X.500-compliant directory; the protocol can communicate with any hierarchical, attribute-based directory. For interoperability, LDAP assumes support for the X.500 naming model. For example, object classes include country and organization, and generally follow the hierarchy defined by X.500. The new LDAP specification defines a syntax that supports the attributes of X.500 directory objects.

For reasons of security, LDAP supports authentication. Version 2 uses simple authentication (an encrypted password passing "on the wire") and Kerberos (the network security and authentication system that provides secure log-ins and authentication services using the Data Encryption Standard). LDAP 3 will take advantage of X.509 strong authentication, which uses public-key security certificates. However, LDAP does not provide for standard access-control mechanisms.

Besides the on-the-wire protocol itself, the term *LDAP* often refers to an LDAP API that offers a simple, low-level interface for applications to make a connection to a server and access the directory.

Multiple Uses

Commercial developers and corporate programmers can use LDAP in three ways. First, it can be a protocol for anonymous browsing. With LDAP, Internet surfers can browse directories and access publicly available information. Netscape

and Microsoft both say that their Web browsers will support LDAP.

Second, LDAP's authentication services mean you can use it to give users authenticated access to sensitive information.

The third and final application of LDAP is server-to-server communications, including replication capabilities and client referrals to other servers in a directory search.

The standard does not explicitly specify the use of LDAP as a replication protocol. However, the basic operations LDAP enables—such as reading, comparing, writing, modifying, and deleting data—are those required for the creation and maintenance of replicas.

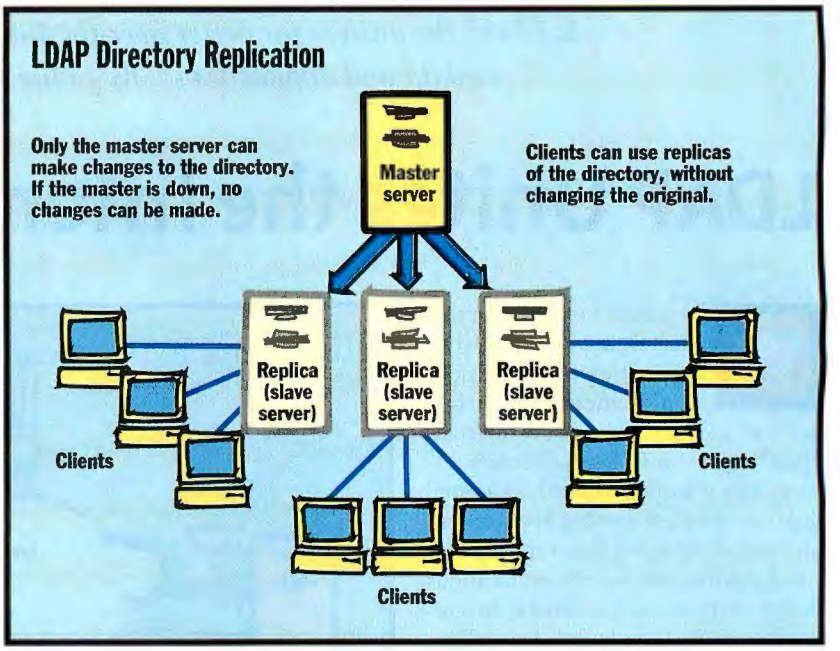
Netscape says it will use LDAP for replication in its Netscape Directory Server. This use of LDAP for replication has its roots in the first implementation at the University of Michigan, which uses a single-master replication topology. One server is the master of the database, and only it can make changes in the directory. Multiple "slave" servers provide replicas of the entire directory database, which balances the load of search and access operations across multiple servers (see the figure on this page). While reads usually far outnumber writes, this single-master model creates a single point of failure: If the master is down, no changes can go into the directory.

Existing directories such as NetWare Directory Service (NDS) and StreetTalk use a multimaster design that can make updates to any read/write replica. This allows high availability in both read and write operations.

To handle failed queries, LDAP 3 will let an LDAP server refer a query to another server if a particular server cannot satisfy a search request. The LDAP server can refer the requesting client to a server that may be able to satisfy the request. The referral capability also sends all write operations to the master server. As the figure "LDAP Referral" on page 121 illustrates, the referring server passes the name of the second server to the LDAP client. The client then connects to the server to which it has been referred.

But LDAP does not let multiple trees—in other words, multiple master servers—learn about each other and their contents automatically. Referrals are static, based on entries for other servers manually made in the directory database.

The University of Michigan is working on extensions to LDAP that would let master servers create indexes of their contents and pass them to other master servers. These so-called forwarding indexes would allow for dynamic referrals based on the nature of the client query and knowledge of the content of other trees. Until intelligent referral capabilities are added, an LDAP referral could in theory lead you on a wild-goose chase across the Internet, with each server referring you to yet another server, with no end in sight.



Netscape will use LDAP's single-master model for replication in Netscape Directory Server.

Who's Doing What?

Initially, most vendors said they would use LDAP only as an anonymous browsing protocol to make directory information available over the Internet. Novell, for example, announced LDAP support for publishing the information available to a guest log-in to NDS via LDAP. Netscape was the only vendor to go on record stating that it would use LDAP in all three ways mentioned earlier.

But as LDAP's momentum grew, the other vendors fell in line. Novell has said that it will use LDAP in all three ways. Microsoft says it will use LDAP as "its core directory protocol" in a subsequent version of Windows NT. Microsoft had originally planned to use the Object File System (OFS) as the directory repository in future NT releases. Microsoft now says it will use some of the technology from the directory in Microsoft Exchange Server.

While Microsoft will provide OFS capabilities through extensions to the NT File System (NTFS), the company is using the Exchange directory database and replication engine, expanding them for use with the new NT directory. For example, the basic schema of the Exchange directory will expand to reflect the needs of a general-purpose directory, and the replication model will extend to support full multimaster replication.

The resulting directory will increase the functionality of the domain-based naming system found in NT Server today. Rather than serving as the basic component for organizing the directory, for example, the domain will become a security and replication boundary in the directory tree. The directory will also extend to support a deeper hierarchy, including organizational units in domains. The directory will also let administrators delegate authority over groups and organizational units, without giving the delegates control over the entire domain or tree.

To accommodate Internet connectivity, future NT Server directories will work with the Internet's Domain Naming System (DNS) name space and support names based on DNS and Internet domain names. DNS names (e.g., acme.com) will

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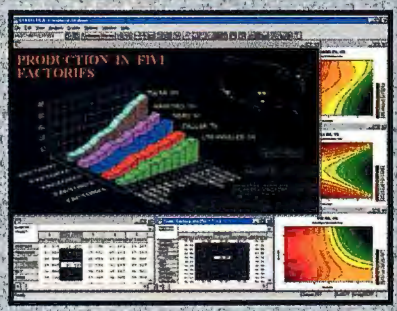
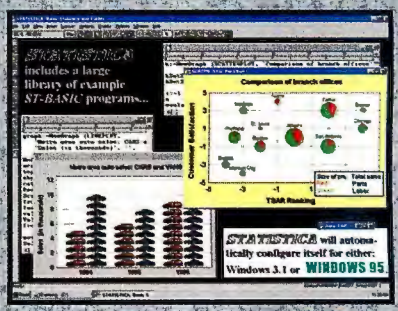
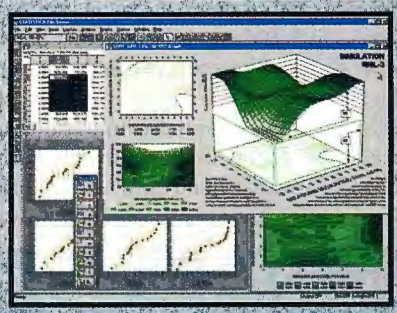
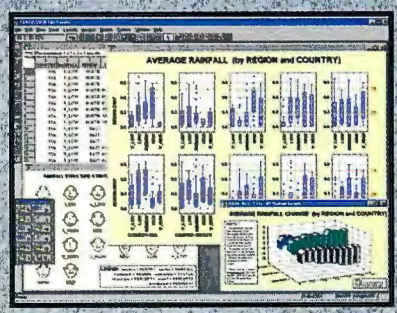
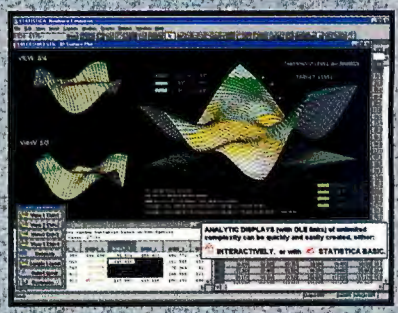
Windows 3.1 and WINDOWS 95/NT

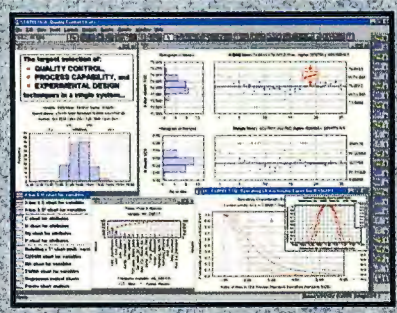


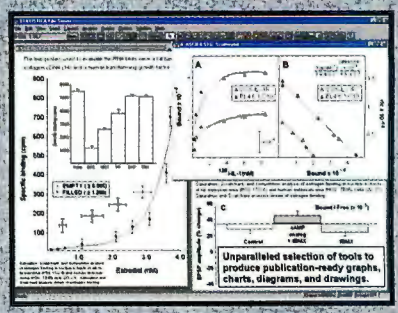


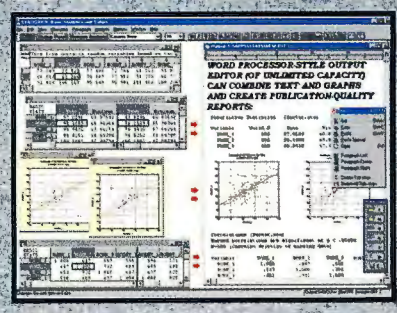


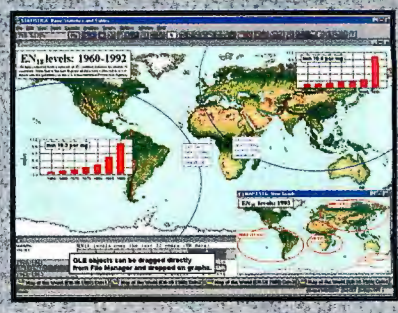












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be names of directory trees in future versions of NT. Applications and services will perform DNS lookups to find directory servers both on intranets and over the Internet. Having found a directory via DNS, applications will be able to use LDAP to access the information in those directories. Applications will also be able to use OLE DB and OLE DS, which are interfaces that are based on Microsoft's Common Object Model (COM) and ActiveX technologies.

Microsoft says it will integrate the content of the separate file-system and directory repositories in future versions of NT. For example, index and query services will let you search both the NT directory and the OFS provided by extensions to NTFS. Microsoft says that when this integration happens, you will be able to search for objects based not only on conventional attributes, such as filename, date, and owner, but on content as well.

As a result, LDAP may indeed inadvertently accomplish what X.500 never was able to: directory interoperability among different vendor implementations. Netscape Directory Server is already in beta testing and is due to ship this year. Novell, too, says it will ship anonymous LDAP support this year, with authenticated client/server access and replication support coming next year. Finally, Microsoft says it will ship the NT directory sometime in 1997. LDAP everywhere?

So What's the Catch?

As always, there is a downside to this. LDAP 2 does not include strong authentication and multimaster replication. In addition, the search model has limits, and the need for more intelligent referral capabilities and access-control mechanisms is clear. Also, like any standard, many product implementation details—such as the specific directory database to use and how to replicate it—are left up to the vendor.

Because of these limitations and the need to build competitive products, vendors will extend LDAP with features specific to their implementation. Novell continues to tout the multimaster replication capabilities of NDS, for example, and Microsoft says it will add similar capabilities to the NT directory. While Netscape is basing much of its work on LDAP 2, it's also making extensions that go beyond the current draft of version 3. Netscape is adding access-control capabilities, for example, that aren't in any current draft of the standard.

One of the biggest questions with LDAP is what level of interoperability will vendors achieve, given the various extensions that have been made to the standard? Today, Microsoft, Netscape, and Novell agree that the version 2 functions will be the interoperability baseline. However, interoperability will also depend on the degree to which Netscape publishes its extensions and the degree to which Microsoft, Novell, and other vendors support version 3 and track Netscape's extensions to it.

Although none of the vendors have explicitly stated their support for version 3 and Netscape's extensions, Netscape's

How LDAP and X.500 Compare

Feature	LDAP	X.500
Objective	Simplicity.	Global directory services.
Transport mechanism	TCP/IP.	OSI protocols, ACSE/ROS on session and transport layers.
Data model	X.500 as a baseline. Use standardized attributes where applicable. Publish standards to allow easy interoperability.	Rigid hierarchical data model that scales for a worldwide directory. Emphasis on generality. Many specifics are undefined.
Worldwide directory	Directories can grow from bottom up (the "Internet way"). Vendors can solve directory problems in many ways with interoperability. LDAP offers the freedom to mix rigorous X.500 DITs and Internet-style randomness.	Rigorous hierarchy of naming contexts and Directory Server Agents (DSAs) for worldwide directory. Assumes top-down model for name resolution. Tough to get everything to fit exactly right on a worldwide basis.
Security	Does not specify an encryption mechanism. Netscape will use LDAP over SSL. Kerberos is available (not in Netscape). Will improve in future.	Defines X.509 authentication framework, but an encryption algorithm is not specified (RSA is the de facto standard).
Server protocol	Client referrals to navigate multiple servers. Servers can talk to each other (for replication or creating server hierarchy).	Another protocol, the Directory System Protocol (DSP) to talk between servers.
Replication	Use LDAP for replication.	Use DISP/DOP to address replication (only in 1993 X.500).
Referrals	Already does this. Chaining is supported based on server implementations.	X.500 supports referrals over DAP/DSP as well as chaining.
API	Simple C API defined in RFC 1823.	Complex, object-oriented API such as XDS API from X/OPEN.
Multicasting	Implementation dependent, not protocol specified. Client may query multiple servers simultaneously.	X.500 supports multicasting over DAP/DSP.
Encoding	Many as strings. All elements ultimately in lightweight Basic Encoding Rules (BER).	Use full ASN.1 and full BER. Harder to parse and compose.
Bulk import/export	LDIF standard to interchange LDAP information in text files.	X.500 does not address bulk transfer.

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market clout will create pressure to do this. Netscape has also made it clear that it intends to publish its extensions and that it will work to enable most of them through the Internet standards process.

LDAP Brands

Other characteristics will also differentiate LDAP implementations. For example, Microsoft will tightly integrate its directory with NT. Microsoft insists that tight integration with the OS is the only way to yield the performance and features developers need. Netscape, on the other hand, is building a set of services designed to run on multiple platforms, insisting that cross-platform capabilities are essential to interoperability.

Netscape and Microsoft are also taking different approaches to the kind of directory products that they're going to ship. Netscape is choosing to forgo the more sophisticated—and more complex—features (e.g., multimaster replication), choosing instead to get something out the door fast. Microsoft is building support for those additional features into its product, which will take longer to reach the market.

WHERE TO FIND

LDAP 3
http://www.ietf.cnri.reston.va.us/html.charters/asid-charter.html

Given that we need to learn to walk before we run with directories—and that most users have yet to crawl—Netscape's approach is valid. By getting its product out the door fast—and before Microsoft—Netscape will continue to put pressure on Microsoft in the intranet-server market. But don't count out Microsoft: Its ability to integrate the BackOffice products with a unified directory will be attractive to many users.

What Should You Do?

As the Internet and LDAP drive directory development, you'll have a number of decisions to make. Which directory is right for you depends on your current needs. For example, both the OS-specific and OS-independent approaches have merit. If you're using NT, the integration of the Cairo directory with NT and the BackOffice applications may be attractive. If you have a heterogeneous network, the cross-platform products from Netscape may provide the multivendor integration you need.

For most companies, e-mail systems and the intranet are the logical places to start with directories. As you choose the electronic-messaging, Web-server, and other infrastructure services that will comprise your intranet, making sure that you integrate them in a unified directory model will make administration much simpler. It will also give you the foundation for the intranet/Internet applications that will be the future of your network.

Understanding features is also important. For example, a lack of multimaster replication could be a problem in large networks if you can't centrally deploy and maintain the directory. If departments or divisions independently deploy multiple Netscape Directory Server masters, you will have to do a lot of customizing if you want those master servers to communicate, making implementation more difficult than it would be under a multimaster design.

In comparison, NDS already provides multimaster replication today, allowing changes to occur at many servers, which will accommodate distributed organizations more effectively. Microsoft also plans to support multimaster replication in its directory.

Also expect the advent of so-called meta-directory services, which could integrate multiple directories in applications and OSes. For typical organizations, beginning the long transition to directory-enabled computing won't be practical until they integrate the directories they already have and manage them in a more holistic fashion. Meta-directory products from such companies as Zoomit and WorldTalk will let you integrate multiple application-specific and NOS-based (network OS) directories, and manage them as a whole, logical enterprise directory.

In any case, basic levels of interoperability will be guaranteed because LDAP will be the common denominator. The emergence of LDAP as the Internet standard protocol for directory services is a watershed event. It will enable interoperability between clients and servers, and between servers, on the Internet. In addition, it will be the catalyst for directory interoperability between the Internet, intranet products based on Internet technologies, and existing NOS-based and application-specific directories used in today's organizations. And that's a major step forward in directory services, the prime technology surprise. B

Jamie Lewis is president and a principal analyst of The Burton Group, where he specializes in NOSes, messaging systems, directory services, security systems, and network management products. You can contact him on the Internet via **editors@bix.com**.

Directory Services Today

What directory services do: They help you name, describe, find, and protect resources over far-flung networks. Instead of a network of distinct physical entities, directories help us create logical networks that we can use as a functional whole.

Problem: Each network OS (NOS), messaging system, and client/server application uses its own directory. If you use multiple networks, you will log in to different services many times each day. Even worse, network administrators must manage a sea of accounts. As applications become more distributed, locating applications and resources becomes almost impossible.

Solution: General-purpose directory services promise to serve multiple applications and OSes, give administrators a centralized administration tool, and offer end users a single place to log in and search for the resources they need. To be effective, general-purpose directories must be interoperable and let us transparently access multiple directories.

Directory Services Tomorrow

As applications become more network-centric, directory services will become a central component of evolving network-centric applications. For example, workflow application users may rely on directories to find the right people to review a purchase order in an approval cycle. In addition, directories may replace hard-coded uniform resource locators (URLs)—which are difficult to manage as they change—as the primary mechanism to find, access, and manage Java applets and ActiveX controls in Internet and intranet applications.

Secure IP fuels the drive for secure transactions and communications over the Internet. ***By William Stallings***

Internet Armor

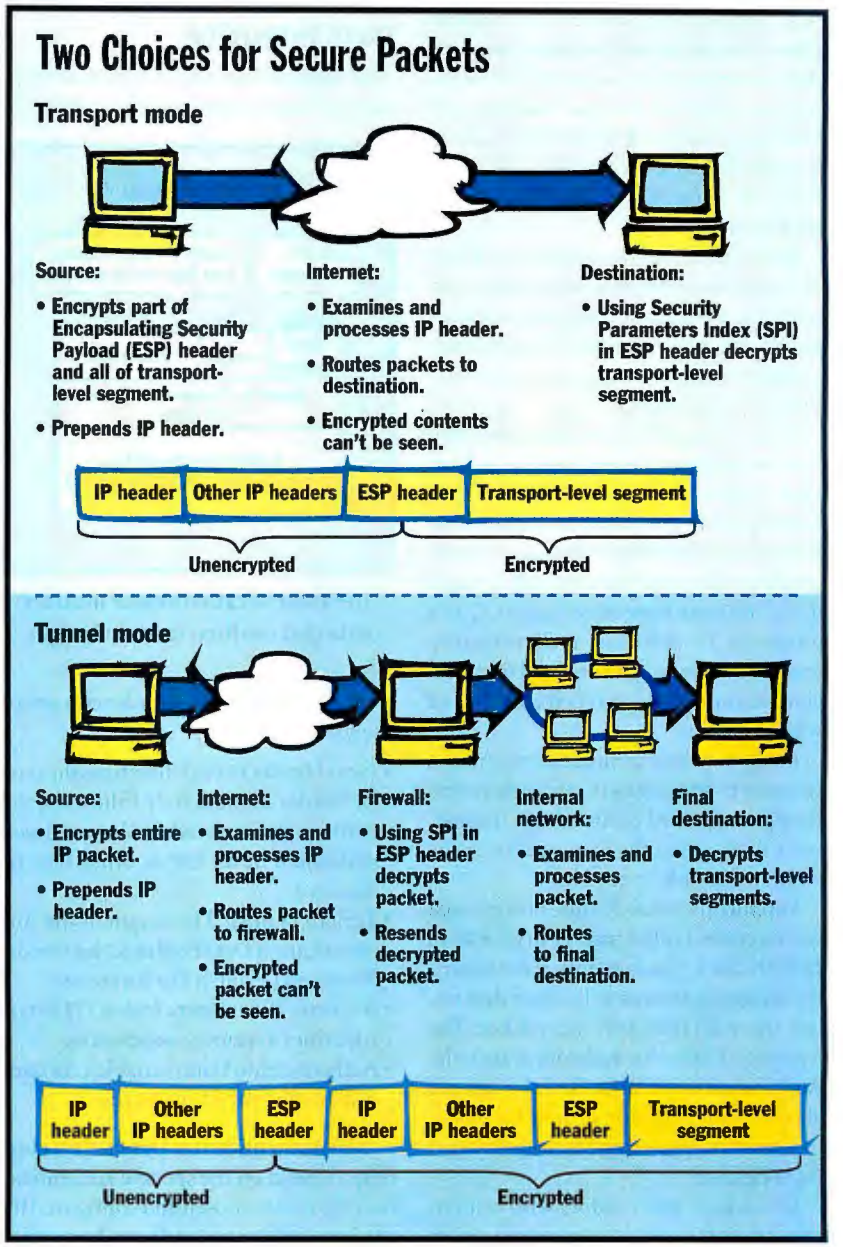
The Internet's a scary place. With packets whizzing to everywhere, from everywhere, and through anywhere, who knows who might be intercepting messages, listening in on communications, or stealing data? Any business trying to persuade the mythical on-line shopper to enter his or her Visa number faces an uphill battle. Even if your company wants all workers' e-mail messages to be confidential, how can you guarantee that? Lay your own cable from office to scattered office?

Don't fret; secure IP is coming. The Internet Activities Board (IAB), in response to the above issues, has included authentication and encryption as necessary security features in the next-generation Internet Protocol, called IPv6 (see "The New and Improved Internet Protocol," September BYTE). Even better, these security capabilities are usable with both the existing IP and the future IPv6. This means that developers and vendors can begin writing applications using these features today. And users can start taking advantage of them now, too.

What's the Problem?

The latest annual report from the Computer Emergency Response Team (CERT) lists nearly 2500 reported security incidents, affecting over 12,000 sites, in 1995. The most serious types of attacks reported include *IP spoofing* (by which intruders create packets with fake IP addresses and exploit applications that use authentication based only on IP), eavesdropping, and *packet sniffing* (in which attackers can directly read transmitted information, including confidential log-on information and database contents).

In 1994, the IAB issued a report titled "Security in the Internet Architecture." The report stated that the Internet needs more and better security, and it also identified key areas for security mechanisms. Among these were the need to protect a network's infrastructure from unauthorized monitoring and control of network traffic, and the need to defend end-user-to-end-user traffic using authentication and encryption mechanisms.



Both modes encrypt part of the packet, but tunnel-mode packets contain an inner packet that's used to cross an Internet firewall.

Clearly, no one wants to take on the task of rebuilding the Internet from the ground up as a secure network. The problem, then, is ensuring secure transmis-

sions over the nonsecure system that's already in place. Secure IP is one answer.

Security at the IP Level

The Internet community has already developed application-specific security mechanisms in several application areas, including e-mail (e.g., Privacy Enhanced Mail and PGP), network management (e.g., SNMPv2 security), and Web access (e.g., Secure HTTP and Secure Sockets Layer). But users have security concerns that cut across protocol layers. For example, an enterprise can run a secure, private TCP/IP network by disallowing links to untrusted sites, encrypting packets that leave the premises and authenticating packets that arrive.

By implementing security at the IP level, an organization can ensure secure networking, even for security-ignorant applications. For example, all corporate e-mail can be run among corporate sites over secure IP pipes.

IP-level security encompasses two functional areas: authentication and privacy. *Authentication* ensures that a received packet was in fact transmitted by the source identified in the packet header; the packet you just received actually did come from trusted colleague X, as it purports. In addition, authentication ensures that nothing has altered the packet in transit; what you received is indeed what was sent.

Privacy enables communicating nodes to encrypt messages to prevent eavesdropping by third parties. Even if somebody intercepted the message, he or she wouldn't be able to read it.

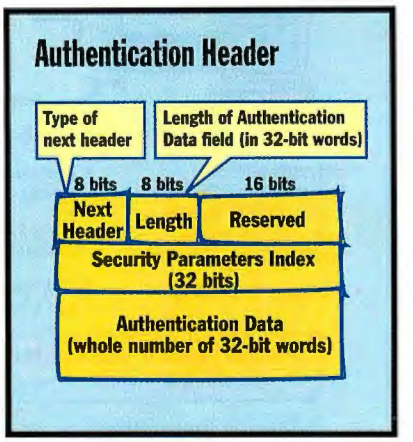
Support for these features is optional for the current IP but mandatory for IPv6. In both cases, you implement the security features as extension headers that follow the main IP header in a packet. The extension header for authentication is the Authentication header (see the sample above). The extension header for privacy is the Encapsulating Security Payload (ESP) header.

Developers and vendors who want to take advantage of these authentication and privacy features must make their applications aware of these extension headers. When an application encounters such a header, it must know what to do with the remainder of the packet, which primarily involves decryption and possible resending. (More on this later.)

There's a clear need for APIs of some sort for an application to invoke security. Alternatively, a network manager can configure certain applications—or all of them—to use secure IP. In the former case, an application would need to have a feature for invoking security. These configuration and implementation details all fall outside the scope of the standard, thus providing a golden opportunity for vendors to exploit this product niche.

Data Integrity

The Authentication header provides support for data integrity and the authentication of IP packets. This header consists of the following fields:



The authentication header includes data that confirms its stated origin.

- Next Header (8 bits): Identifies the type of header immediately following the Authentication header. (As you'll see, this might be an ESP or other type of header.)
- Length (8 bits): The length of the Authentication Data field in 32-bit words.
- Reserved (16 bits): For future use.
- Security Parameters Index (32 bits): Identifies a security association.
- Authentication Data (variable): An integral number of 32-bit words.

The Authentication Data field's contents depend on the specific authentication algorithm chosen and configured by the network manager. It can be configured so that secure IP is used for all offsite TCP/IP traffic.

Configuration can be in every host, or a firewall system can invoke security features. These features might involve APIs at some point, but few vendors have announced products. The network manager typically distributes encryption keys, so it's unlikely that a third-party source would be trusted.

In any case, the Authentication Data is calculated over the entire IP packet, excluding any fields that might change in transit. (Such fields are set to zero for purposes of calculation at the source and the destination.) The authentication calculation happens before fragmentation at the source and after reassembly at the destination. Hence, fragmentation-related fields are included in the calculation.

There are many ways to use the IP authentication service. For example, you can provide authentication directly between a server and its client workstations. Each workstation can be either on the same network as the server or on an external network. So long as the workstation and the server share a protected secret key, the authentication process is secure.

Another application for the service is to allow a remote workstation to authenticate itself to a corporate firewall (see the figure "Two Choices for Secure Packets" on page 127). This can get the workstation access to the entire internal network. Also, the requested server might not support the authentication feature.

Using the Encapsulating Security Payload provides support for privacy and data integrity for IP packets. Depending on the user's requirements, this mechanism can encrypt either a transport-layer segment (e.g., TCP, UDP, and ICMP), known as *transport-mode ESP*, or an entire IP packet, known as *tunnel-mode ESP*. Transport mode supports all applications automatically and is reasonably efficient, making it the most likely choice, except for the cases outlined below.

The ESP header begins with a 32-bit Security Parameters Index (SPI), which identifies a security association. The remainder of the header, if any, might contain parameters that are dependent on the particular encryption algorithm being used. In general, the first part of the header, including the SPI and possibly some of the parameters, is transmitted in unencrypted (i.e., plaintext) form, while the remainder, if any, is transmitted in encrypted (i.e., ciphertext) form.

Transport Mode

You use transport-mode ESP to encrypt the data carried by IP. Typically, this data is a transport-layer segment, such as a TCP or UDP segment, which in turn contains application-level data. For example, you

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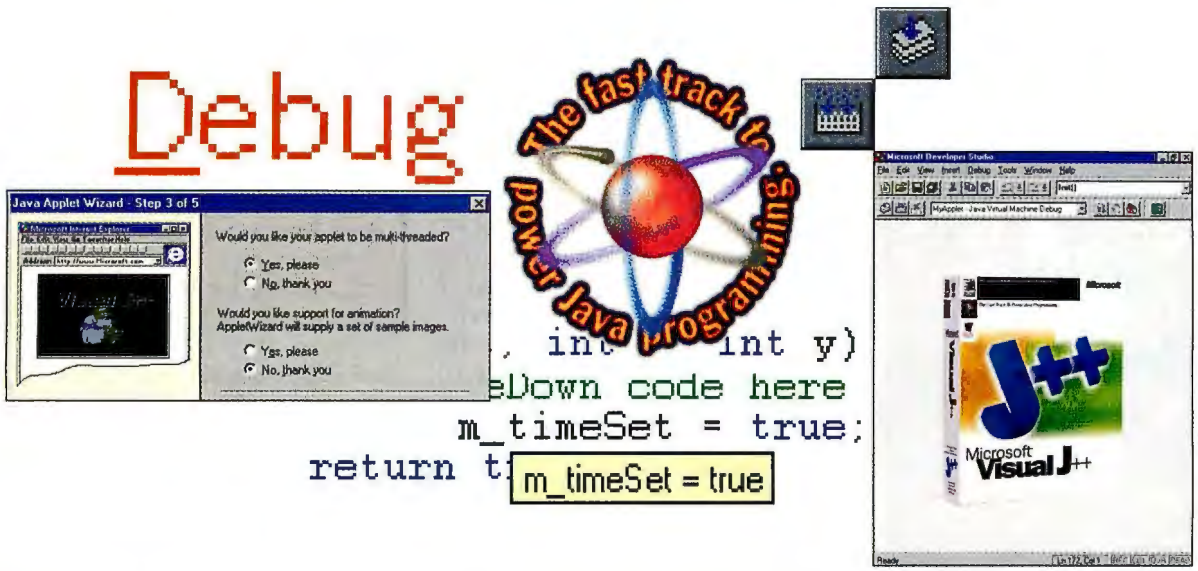

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might encrypt confidential e-mail messages or database data using transport-mode ESP. For this mode, the ESP header goes into the IP packet immediately before the transport-layer header (e.g., TCP, UDP, and ICMP).

Transport-mode operation works as follows. At the source, you encrypt a block of data, consisting of a trailing portion of the ESP header plus the entire transport-layer segment. You replace the original plaintext of this block with its ciphertext to form the IP packet for transmission (see the figure "Two Choices for Secure Packets").

This packet is then routed to the destination as usual. Each intermediate router needs to examine and process the IP header plus any plaintext IP extension headers, but it doesn't have to examine the ciphertext.

The destination node examines and processes the IP header plus any plaintext IP extension headers. Then, using the SPI in the ESP header, the destination node decrypts the rest of the packet to recover the plaintext transport-layer segment.

Transport-mode operation provides privacy for any application that uses it, thus avoiding the need to implement privacy in each application. This mode is also reasonably efficient, adding little to the total length of the IP packet.

One drawback to this mode is that it's possible to do traffic analysis on the transmitted packets. (Basically, if destination addresses and source addresses are in the clear, an unscrupulous person can build up a traffic profile on you or your company. There are some possible scenarios—lots of e-mail between a company and a stock-brokerage house before the company goes public, for example—in which you might want to prevent outsiders from knowing the amount of traffic flowing between various endpoints.)

Tunnel Mode

Tunnel-mode ESP encrypts an entire IP packet (including its own header). For this mode, you prefix the ESP to the packet and then encrypt the trailing portion of the ESP header plus the packet. You prefix the IP header (and any other headers) to the ESP header. You can use this method to counter traffic analysis.

Why all this rigmarole? Because the original IP header contains the destination address (and possibly source-routing directives and hop-by-hop option information), it's impossible to simply transmit the encrypted IP packet prefixed by the ESP header alone. Intermediate routes would be unable to process such a packet. Thus, it's necessary to encapsulate the entire block (ESP header plus encrypted IP packet) with a new IP header that contains sufficient information for routing but not for traffic analysis.

Whereas transport mode is suitable for protecting connections between hosts that support the ESP feature, tunnel mode is useful in a configuration that includes a firewall or other security gateway that protects a trusted network from external networks. In such a case, encryption occurs only between an external host and the security gateway or between two security gateways. This relieves hosts on the internal network of the burden of encryption and also simplifies the key-distribution task by reducing the number of needed keys. Further, it thwarts traffic analysis based on ultimate destination.

Why You Need Secure IP

- To send confidential e-mail
- For protection from IP spoofing
- To secure transactions over the Internet
- For remote access to corporate databases over the Internet
- To avoid traffic analysis

You can use tunnel-mode operation to set up a virtual private network. Here, an organization has two internal private networks that interconnect across the Internet. Hosts on the internal networks use the Internet for data transport but don't interact with other Internet-based hosts. By terminating the "tunnels" at the firewall or security gateway to each internal network, the configuration allows the hosts to avoid implementing the security capability.

Consider a case in which an external host wishes to communicate with a host on an internal network protected by a firewall and in which the external host and the firewalls implement ESP. The following steps must occur for transfer of a transport-layer segment from the external host to the internal host.

First, the source prepares an inner IP packet with a destination address within the target internal host. An ESP header

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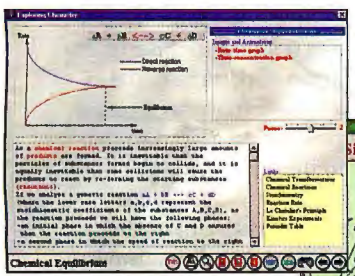

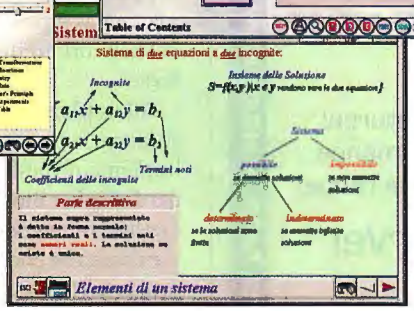

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prefixes this packet. Then the packet and a portion of the ESP header are encrypted. The resulting ciphertext block is prefixed with a new IP header (consisting of a base header plus optional extensions, such as routing and hop-by-hop options) whose destination address is the firewall; this forms the outer IP packet (see the figure "Two Choices for Secure Packets").

Next, the outer packet is routed to the destination firewall. Each intermediate router needs to examine and process the outer IP header plus any outer IP extension headers, but it doesn't need to examine the ciphertext.

Third, the destination firewall examines and processes the outer IP header plus any outer IP extension headers. Then, using the SPI in the ESP header, the destination node decrypts the remainder of the packet to recover the plaintext inner IP packet. It then retransmits this packet on the internal network. Finally, the inner packet may or may not pass through a router as it travels by way of the internal network to the ultimate destination host.

All implementations that are said to conform with the ESP specification must implement the Data Encryption Standard–Cipher Block Chaining (DES-CBC) method of encryption. In this method, the data to be encrypted—plaintext—is processed as a sequence of 64-bit blocks. The input to the encryption algorithm is the XOR of the current plaintext block and the preceding ciphertext block; the same key is used for each block. In effect, this chains together the processing of the sequence of plaintext blocks.

The input to the encryption function for each plaintext block bears no fixed relationship to the plaintext block. Thus, repeating patterns of 64 bits are not exposed. To produce the first block of ciphertext, an initialization vector (IV) is XORed with the first block of plaintext. On decryption, the IV is XORed with the output of the decryption algorithm to recover the first block of plaintext.

Security and Privacy

You can combine the IP security mechanisms to transmit an IP packet that has both privacy and authentication. There are two ways to do this, based on the order in which you apply the two services.

The top portion of the figure "Privacy Plus Authentication" on page 134 illustrates the use of encryption before au-

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thentication. In this approach, the user first applies ESP to the data to be protected and then prepends the authentication header and the plaintext IP header(s). In this case, the entire transmitted IP packet is authenticated, including encrypted and unencrypted parts.

As mentioned earlier, there are actually two types of authentication:

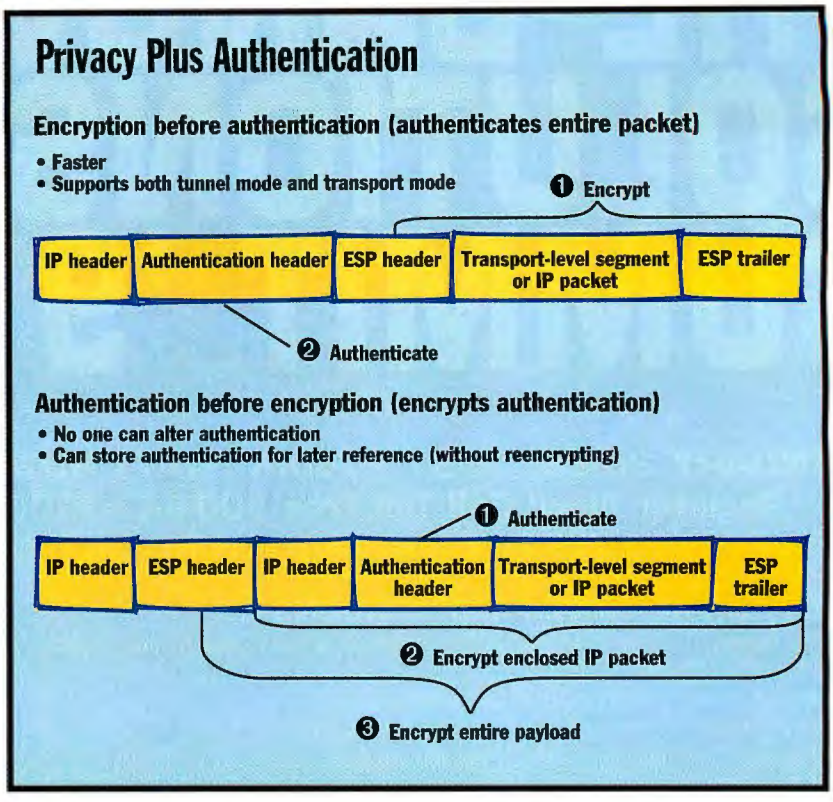
Transport-mode ESP: Authentication applies to the entire IP packet delivered to the ultimate destination, but only the transport-layer segment is protected by the privacy mechanism (i.e., encrypted).

Tunnel-mode ESP: Authentication applies to the entire IP packet delivered to the outer IP destination address (e.g., a firewall), and authentication is performed at that destination. But an entire inner IP packet, rather than just a transport-layer segment, is protected by the privacy mechanism for delivery to the inner IP destination.

The bottom part of the figure "Privacy Plus Authentication" illustrates the use of authentication before encryption. In this approach, which is appropriate only for tunnel-mode ESP, the authentication header is inside the inner IP packet. This inner packet is authenticated and protected by the privacy mechanism.

Thus, you can apply the functions of authentication and encryption in either order for tunnel-mode ESP. The use of authentication before encryption might be preferable for several reasons. First, since the Authentication header is protected by ESP, it's impossible for anyone to intercept the message and alter this header without detection.

Second, it may be desirable to store the authentication information with the message and the destination for later reference. It's more convenient to do this if the authentication information applies to the unencrypted message; otherwise, the message must be reencrypted to verify the authentication information.



You can encrypt and authenticate in either order; encrypting last protects authentication information.

Whither IP Security?

The driving force behind the acceptance and deployment of secure IP is the need to connect private WAN/LAN infrastructures to the Internet for access to Internet services and to use the Internet as a component of the WAN transport system. Users need to isolate their networks and, at the same time, send and receive traffic over the Internet. The authentication and privacy mechanisms of secure IP provide the basis for a sound security strategy.

Because the definition of these IP security mechanisms is independent of their use with either the current IP or IPv6, their deployment does not depend on the deployment of IPv6. Indeed, we are likely to see widespread use of secure IP features long before IPv6 becomes popular.

One practical issue hindering the deployment of secure IP is the export restrictions imposed by the U.S. and some other countries. These restrictions do not affect the IP authentication mechanism, because it only provides authentication and integrity; it does not provide message encryption. But the ESP mechanism is most definitely subject to such limitations. The IAB recently issued a "Statement of Cryptographic Technology and the Internet," urging the removal of such restrictions, thus adding its voice to that of many other groups and individuals seeking this relief.

One recently announced product is Secure WAN (S/WAN), codeveloped by RSA Data Security and TimeStep. S/WAN operates at the IP level and incorporates the IAB-secure IP standards. Its intent is to enable corporate customers to secure connections between their private networks and the Internet.

We can expect to see many IP-level security products announced throughout 1997. Because of the export-restriction problem, it's likely that authentication mechanisms will be more widely marketed and deployed. Nevertheless, both authentication and privacy at the IP level seem destined to proliferate over the next several years, making the Internet a less scary place. B

WHERE TO FIND

RSA Data Security, Inc. Redwood City, CA (415) 595-8782 fax: (415) 595-1873 http://www.rsa.com/	TimeStep Corp. Kanata, Ontario, Canada (613) 599-3610 fax: (613) 599-3617 http://www.timestep.com

William Stallings is a consultant, lecturer, and author of numerous books on data communications and computer topics. This article is based on material from his just-published book, Data and Computer Communications *(Prentice-Hall, 1996). You can reach him at* **ws@shore.net** *or at* **http://www.shore.net/~ws.**

IMAP promises better message management—for those who can cope with its complexity. ***By Dave Kosiur***

E-Mail Grows Up

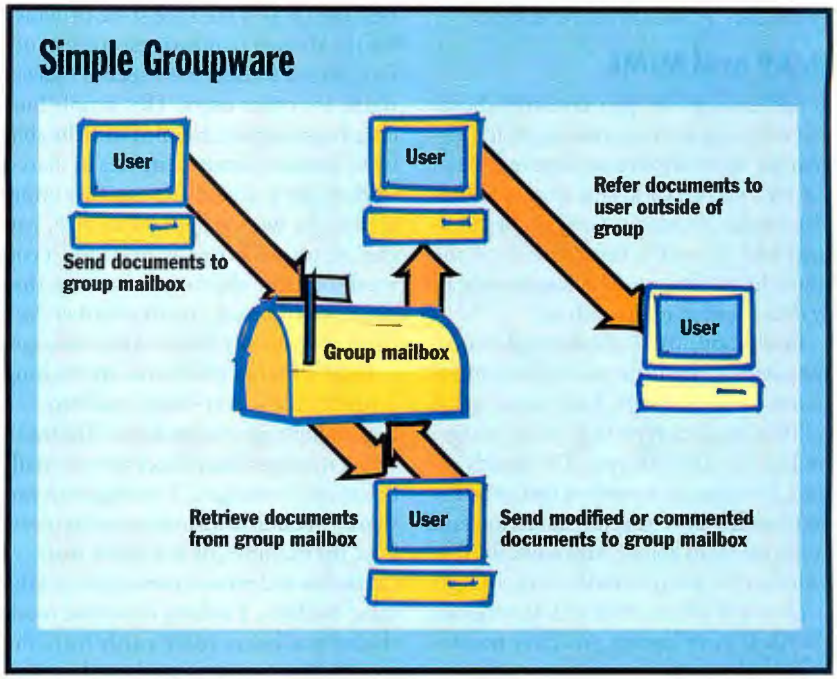
Hang around an airport long enough, and you will see an ironic sight: Mobile workers frozen in their tracks, standing at the pay phones. After originally planning to pause just long enough to grab an important e-mail message, they now have one eye on a notebook screen and one eye on the clock as a behemoth message attachment crawls over the telephone line. Only a final boarding call can get these warriors moving again.

Part of the problem is POP, the Post Office Protocol that we've relied on for many years to retrieve e-mail messages. It's simple and pervasive, and before e-mail became ubiquitous, it was efficient. But people who communicate via TCP/IP networks—most notably the Internet—now need a protocol that offers more.

For example, if you have 20 inbox messages, you want to be able to choose messages to download. When you're on the road, you may not want all of them. If a message comes with a 2-MB graphic-file attachment, you want the option of downloading the short text message and keeping the attachment on the mail server until you're back in the office. POP just can't deliver these capabilities.

But the Internet Message Access Protocol (IMAP) can. This newer protocol offers selective retrieval of messages and message parts from a server, server-based message processing, and shared mailboxes. This last feature can make IMAP the foundation for simple groupware applications (see the figure above).

Unfortunately, there's a catch. IMAP makes the process of launching e-mail applications more complex, and its resource requirements can strain your mail server. In time, IMAP might help you communicate more efficiently. But before it enters your world, you must learn how to cope with its demands.



IMAP lets you set up group mailboxes to provide the basis for groupware applications on the Internet.

POP vs. IMAP

Both POP and IMAP define methods for e-mail clients to retrieve messages from a server. They both also depend on a third protocol, SMTP, for sending mail. (The Internet Engineering Task Force [IETF] guided the definition of all three.) In client/server terms, you use POP and IMAP to design clients, while SMTP works for message transfers between client and server (as well as between servers).

One difference between POP and IMAP is the way that each lets client programs retrieve messages. With POP, your messages reside on a message store (usually a server), and all pending messages are transferred from the message store to your local system when you connect the two. Once you download a message, you can read, delete, or process it without any further interaction with the server. In fact, with this off-line mode, the server has no further knowledge of the state of the messages delivered to the POP client.

IMAP, on the other hand, lets you query a message store for pending messages in a multistep process. First, you can request only the message headers in a given mailbox on the server. You can then retrieve entire messages or message parts, leaving the remaining messages and parts in the server mailbox. Message deletion on the message store is a separate action, so copies of messages that you download remain on the server until you manually delete them. This is helpful for archiving or sharing messages.

IMAP clients can operate in either on-line or disconnected mode (see the figure "Three Access Modes" on page 136). In on-line mode, you manipulate your mail, but it all remains on the server. In disconnected mode, some of the mail is located on the server, and some is on the local client.

In disconnected mode, the state of messages on your local system and those on the server will likely be different when you reconnect later; some type of syn-

chronization must take place. IMAP assigns each message in a mailbox with a unique identifier. Unlike message-sequence numbers, as used in POP, these unique identifiers persist across sessions, making it easier for you to synchronize messages from a previous session with the message store. But the details of this synchronization process have not been fully spelled out in the IMAP4 protocol specs; they're still being worked on.

IMAP and MIME

If you're using POP, you have little choice but to accept an entire message if it's formatted in Multipurpose Internet Mail Extensions (MIME). This system identifies the data format in the body of a message and relays the information to the mail-client software, which automatically decides what to do with it.

In addition, MIME allows single e-mail messages to include multiple components, or *attachments*. Each piece can be a different data type (e.g., text, image, and audio) and subtype. The disadvantage, however, comes when you're on the road with a slow-speed connection and someone sends you a 2-MB movie file that you don't want to handle until you get back to the office. POP still downloads the file to your laptop; you have no other choice.

On the other hand, IMAP integrates well with MIME. You can use your IMAP client to check the sizes and types of each MIME attachment before downloading so that you can, say, copy the text of a message to your laptop but leave the attached 2-MB multimedia presentation on the server until you're ready to download the file.

Simple Groupware

Because IMAP's message store provides for the sharing of messages, you can define shared folders with specific access rights for other users. This simple bulletin-board service, coupled with the ability to include Netnews articles in shared folders, lets you easily tie together information for workgroups. With POP, you can't share mailboxes or messages; if you want someone else to see a message that you have received, you must either "cc" them or manually forward the message.

IMAP's shared mailboxes are nothing more than a server-based mailbox file that multiple people can access. The IMAP server manages shared access to the mailboxes and messages. A workgroup can share a mailbox with minutes of its meetings, for example, or help-desk workers can access and process messages from the same mailbox. Looking down the road, shared mailboxes could easily form the foundation for message-based groupware via the Internet, particularly if you factor in server-based processing of IMAP mail and consider that messages might include Java applets.

IMAP also supports server-based message processing. You can, for example, search for a message without downloading all the messages from the server first.

IMAP Complexity

Unfortunately, IMAP's flexibility presents developers with several challenges. An IMAP-enabled application must support MIME and IMAP queries, as well as the bookkeeping of mail parts (since you might only request part of a message one time and another part the next).

You need to synchronize with the server, get an address book from it, and use SMTP for transport. You also need to get IMAP to refile or archive messages on the server. POP is simpler because once you retrieve a message, the server's job is done.

POP is popular because its simplicity makes it easy for developers to write both server and client software. There are lots of POP client packages available from a variety of companies, such as Claris, CommTouch, Frontier Technologies, FTP Software, Intercon, NetManage, and QualComm. These POP client packages are designed for a variety of platforms, including Unix, DOS, Windows, and the Macintosh.

Because of IMAP's complexity, commercial implementations have been slow in coming. But that's changing. Netscape plans to incorporate IMAP into its next generation of mail servers, which are due out this year. In addition, SunSoft offers an IMAP server and client. ICL's Embla is an IMAP client, and ICL/TeamWare offers the Internet Messaging Server, which supports both POP and IMAP. Others on the IMAP bandwagon include Control Data's Mail*Hub server, NetManage's Z-Mail Pro, and the upcoming messaging server from Software.com.

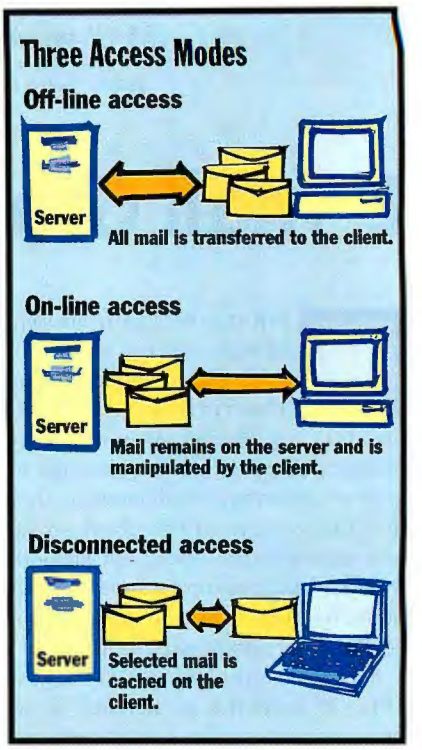
Which to Choose?

IMAP puts new demands on e-mail servers. If you're concerned about server disk resources, POP has the advantage over IMAP. Since you are downloading messages to the client machine with POP, there is no need to consign the server's disk capacity to storing old messages.

Because IMAP servers hold messages, storage might be strained if past messages

POP VS. IMAP

Feature	POP	IMAP
Off-line mail processing	✓	✓
On-line mail processing		✓
Server-based searches		✓
Shared mailboxes		✓
SMTP transport	✓	✓
Persistent message IDs	✓	✓
Simple to implement	✓	
Manipulate message-status flags		✓
Custom message flags		✓
Multiple mailboxes on server		✓
Archive messages on server		✓
Selective retrieval of message attachments		✓
Access to processed mail on server		✓
Minimum use of connect time	✓	
Minimum use of server resources	✓	



IMAP's access modes help manage messages on the client and mail server.

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aren't routinely deleted. Still, servers usually have more periodic and robust backup procedures; this guards against lost mail should the client machine crash. Plus, because IMAP offers more flexibility in picking which messages to copy to the client computer, sessions can be long while users look over their mail messages.

Even with its advantages over POP, IMAP alone isn't a complete messaging system for fixed and mobile users alike. Other protocols must provide universal access options and address-book information. After all, it wouldn't be convenient if you could leave your messages on a server for access from different client machines but still had to duplicate your preferences, address books, and news subscription lists for each client.

The Internet Message Support Protocol (IMSP), which is used in conjunction with IMAP, can perform these functions for you. A newer and potentially better alternative is the Application Configuration Access Protocol (ACAP). This protocol not only helps you create and store user options and address-book information, it also generalizes this procedure to handle other user-related items that might be shared, such as spelling checkers.

Thus, ACAP can support not only IMAP messaging systems but other applications, such as Web browsers. Furthermore, ACAP is flexible for users and applications alike: It allows clients to define data fields for the stored information.

ACAP doesn't compete with directory-services protocols, such as the Lightweight Directory Access Protocol (LDAP). Rather, they complement each other. Directories, such as those supported by LDAP, are designed to provide authoritative, enterprise-wide data about users and "top-down" definitions of groups of users, much like the phone book provided by your telephone company, corporation, or university does.

On the other hand, address books contain the user's view of, and the organization of, address information. This is more of a "bottom-up" approach, such as what you'd use in your "black book." ACAP lets you define address books, and it supports the sharing of user-defined address books. ACAP specs are circulating through the IETF community in draft form, but it might be a year or two before we see large-scale use of the protocol.

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Is IMAP for You?

IMAP has a lot going for it, especially if you're interested in supporting mobile clients and taking better advantage of MIME-compliant e-mail. Because it's relatively new and is more difficult to implement, there aren't as many commercial vendors of servers and clients as there are for POP. But that should change considerably over the next year.

If you're installing an IMAP-based e-mail system, pay attention to its integration with directory standards, such as LDAP, and check the progress of ACAP, so users will get a fully functional messaging system. Your mobile workers may catch more airplane flights with the messages they need in hand. B

Dave Kosiur is a networking consultant and freelance writer based in Reston, Virginia. You can reach him at **drkosiur@ix.netcom.com**.

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Jon Udell

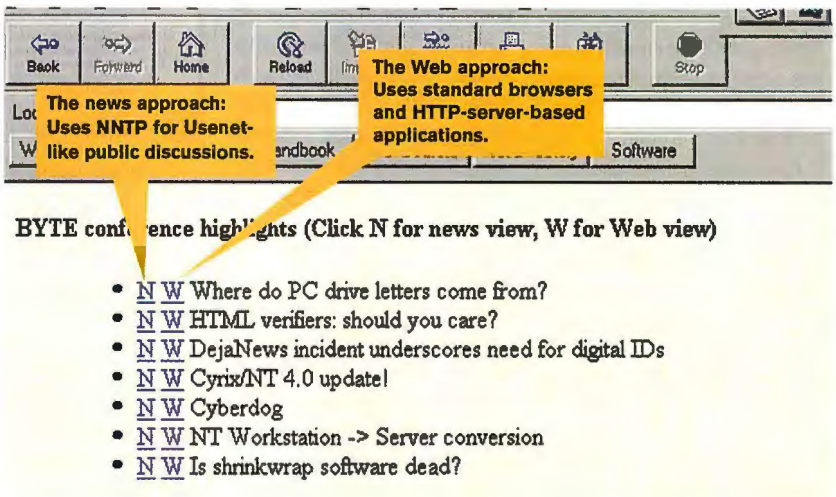
Web Project

Dual-Mode Conferencing

News-style conferencing has its advantages, and so does Web conferencing. Why not have both?

In a pair of columns last May and June I explored two approaches to text conferencing on the Internet. The news approach relies on the same Network News Transfer Protocol (NNTP) servers and clients that support public discussion on the Usenet. The Web approach uses Hypertext Transfer Protocol (HTTP) servers running applications that play in standard browsers. I like aspects of both so much that I've combined them into a single hybrid system (see screen at right).

I use both halves of this system myself because, while I prefer the news method, there's no NNTP gateway on our corporate firewall. So I use a newsreader from my home office and a Web browser while at work. Users, too, initially preferred their newsreaders, but I've noticed increasing traffic on the Web side of the system as I've beefed up its capabilities. The point is that with a choice of clients, a dual-mode conferencing system can appeal to a wider audience than a purely news-based or Web-based system can.



Because individual tastes and technologies determine conferencing preferences, dual-mode conferencing will appeal to a wider audience.

Key Components

BYTE's dual-mode conferencing system consists of four essential elements:

• Internet News Daemon (INND)—This foundation component controls the primary message database. Newsreaders talk directly to this database. Web browsers talk indirectly to this database by way of several Common Gateway Interface (CGI) applications. (I'm using INND 1.4, which comes with Caldera's Linux.) As I wrote last May, INND is a scary and complex beast, but if you focus on conferences that live only on your own site, you can ignore the thorny problem of replication with other news servers. Because this site-specific mode limits your feed to local postings, you may also be able to ignore the often-vexing process of message expiration (I do). These two simplifications make INND far more manageable than is normally the case.

• MHonArc—Earl Hood's Perl application transforms collections of RFC 822 messages into navigable Hypertext Markup Language (HTML) archives. It's typically used to make listserv archives visible on the Web, but since mail and news messages share the same RFC 822 headers, MHonArc also works on INND message databases. It creates index pages in a variety of formats, including the one I prefer: messages organized by conversational thread, with newest threads first. Because MHonArc can add or remove individual messages, and reprocess the index page accordingly, incremental updates to an MHonArc-generated archive are inexpensive. You can download MHonArc at http://www.oac.uci.edu/indiv/ehood/mhonarc.html.

• inews—This command-line tool comes with INND. Here's one way to post a message to a news server with inews:

```
cat > /usr/lib/news/bin/inews
Newsgroups: test

This is a test.
```

And here's how to reply to that message using inews:

```
cat > /usr/lib/news/bin/inews
Newsgroups: test
References: 012abc@host.com
This is a test.
```

The `References:` line in the header of the reply contains the message ID of the original message. How can you discover that? Here's one way: In the Netscape newsreader, do View->Headers->All. If

Frame Games

I prototyped a frame-enabled version of the BYTE on-line archive a while back, then shelved the project. Why? Mostly because the complexity of the four-pane system I envisioned, with links cascading across two levels of index pages, was daunting. The Web half of our dual-mode conferencing system presented a simpler challenge. Here the model was the classic two-pane arrangement you see in the Windows 95 Explorer and countless other applications: index pane on the left, linked to document pane on the right.

For the first naive implementation I tweaked my MHonArc postprocessor to crank out an extra version of the index page. Then I wrote a frameset page to define the layout and contents of the index and document panes. I placed a link to this frameset page on the main index page that said: "Frame view."

Qualified Success

This scheme worked; that is, it produced a two-pane browser whose index-pane links called the appropriate files into the document pane. But there were two problems with this. First, you missed the option to turn on frames if you jumped directly to a message, bypassing the index page. Second, if you clicked on nonlocal Web links in the document page (for example, the BYTE Site's home icon), the system would recurse. You could even create a "hall of mirrors" effect by successively launching two-pane browsers in an ever-diminishing series of document panes (see the screen at right).

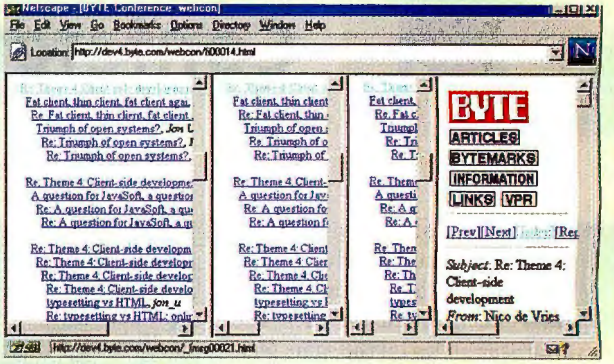
The solutions to both problems are related. To solve the first, I tweaked the postprocessor to add FrameOn and FrameOff links to the toolbar on every message page. The FrameOn link should, obviously, point to the same frameset page already pointed to from the main index page. But how to code the FrameOff link? Here's the solution: `<a href="threads.html" target="_top">`. FrameOff's Action, in other words, is to fetch the main index page and display it in the browser's top-level window. The same trick worked for the row of BYTE Site icons at the top of every message page.

More Problems

Having killed two birds with one stone, I spotted two more on the horizon. First, the FrameOn transition didn't preserve context. If you clicked it from message 57, you'd end up in frame view with message 0 in the document pane. The reverse FrameOff transition did preserve context because the postprocessor could generate unique-per-message links to match corresponding targets on the index page. But every FrameOn link pointed to the same frameset page, so they all reset your context to message 0.

The second problem was that the "_top" trick wasn't right for the Index link in frame view. Its effect in that case was the same as FrameOff—harmless, perhaps, but confusing.

The solutions to both these problems are, once again, related. Both solutions involve a strategy I'll call overgeneration. In the first case, the problem was that the single frameset page could not handle multiple contexts. Well, who said there could be only one frameset page? Another postprocessor tweak yielded one frameset page per message. The one for message 57, for example, sets the title of message 57 at the top of the index page and loads message 57 into the document pane. Then I tweaked the postprocessor to point each FrameOn link at the appropriate frameset page. Voilà! Now FrameOn was quickly transformed into a context-preserving action.



When using HTML frames, incorrectly coded links result in this dreaded "hall of mirrors" effect.

Overgeneration to the Rescue

Solving the second problem involved another kind of overgeneration. The reason there was no right way to code the Index link for frame view was that it didn't belong there at all. In frame view the index is by definition always visible, so an Index link makes no sense. But since the framed and frameless modes shared the same set of message pages, I was stuck.

Well, who said there could be only one set of message pages? Yet another postprocessor tweak doubled the set. This move enabled me to drop the unnecessary FrameOn link from frame view and vice versa. And most intriguingly, it allowed me to aim the Next and Prev links—in frame view—at the context-specific frameset pages I'd already generated to smooth the FrameOn transition. If you go to one of the BYTE Site conferences, click an index-pane title in frame view and the document pane reacts. That's the expected behavior with frames. Now click Next in the document pane. It reacts, as you'd expect, and so does the index pane! This two-way linkage is an effect I always prize, but seldom encounter, in multipane information displays. I didn't think it was possible to achieve this effect with HTML frames but, if you're willing to overgenerate, it is.

you type the message ID correctly when you post the reply with inews, newsreaders will display it indented below the original, and so will MHonArc's threaded index page.

• CGI scripts—The final component, and the only one I had to build myself, is a set of Perl scripts that extend MHonArc. The most important new feature they add is the ability to post and reply. The Web archive that MHonArc builds is read-only. My script adds Post and Reply links to each archive page. In the case of Reply, other scripts fetch the original message from the INND database, present it in a Web form, and transmit annotations back to INND by way of inews. I also added a frame view of the archive (see the sidebar "Frame Games" above).

MHonArc is freely available Perl code that anyone can modify, and that's just

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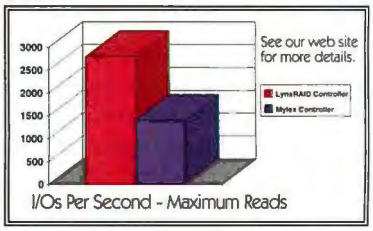

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what I planned to do at first. After a few false starts and a bit of reflection, I decided to take another tack. From one point of view, MHonArc is a moderately complex Perl program. Mastering it well enough to extend it is challenging; carrying those extensions forward to new versions of MHonArc would be equally challenging.

But wait! From another point of view, MHonArc is just a black box that consumes one set of well-structured text files and produces a different set of equally well-structured files. All I really had to do was run MHonArc on a set of news messages to create one kind of HTML archive, then filter that to create a new one. This reduced the problem to the sort of pattern-matching exercise at which Perl excels.

Hypertext Authoring

Anyone who participates in a news- or Web-based conference can be a hypertext author. You're probably familiar with automatic activation of Web URLs—type the string "http://www.byte.com/" in a message and, when it's posted, that string will become a link.

You can also create links to other conference messages. Unfortunately, the procedure isn't nearly so familiar, convenient, or standard.

Let's say you want to construct a reference to a message in another conference. On the news side, in Netscape, you can do this: Go to the target message, reveal its ID with View->Headers->All, then right-click the message ID and capture it as a URL by selecting Copy Link Location. Now, when composing a new message or a reply, you can paste in the URL to create a link to your target message.

Phew! Why is this so hard? Because on the Usenet, nonlocal references to messages are hardly worth the trouble. Odds are that a message will have expired by the time someone tries to follow a link to it. When you create stand-alone NNTP conferences like ours, though, there's a real incentive to layer and interweave the discussion using message URLs. Some BYTE conference participants are doing this now, despite the awkwardness of the procedure. As site-specific conferencing gains momentum, I hope the newsreaders will streamline that procedure.

On the Web side, it's reasonably straightforward to construct a message URL. Just go to that document, copy its URL, then paste it into a new message or reply. In a system like ours that stores messages as HTML files, the URL will simply name the file. In a system that keeps messages in a database, the URL will be a long string of CGI gobbledygook. Either way, automatic URL activation (if available) should yield an appropriately behaved link.

Message Pointers

Have you spotted what's wrong with this picture? Let's say you're reading a dual-mode conference using a newsreader. A message contains a news-style message URL constructed by another participant who is using a newsreader. You click it, and view the message in your newsreader. Now suppose that message contains a Web-style message URL. Click that link and you'll find yourself viewing the next message in your Web browser. This unpleasant contextual shift—which doesn't occur in the reverse case, by the way, since Web browsers can usually handle news:// and http:// URLs natively—leads to the notion of dual-mode message pointers. Why not have it both ways?

I've explored two versions of this idea. When I feature conference messages on our home page, I tuck the news URL behind a clickable letter *N* and the Web URL behind a clickable *W*. When the site e-mails conference updates to registered users, the summary of new messages includes both flavors of URL so that you can click through and see complete messages in the environment you prefer (if your mailer supports automatic URL recognition).

The next logical step would be to post-process both message databases and double up the message pointers. But I haven't taken that step yet, and I'm not sure I want to. It's doable, I'm sure (everything is), but it's more work than I want to invest in a system whose useful lifetime I guess might be six to 12 months. By then I expect the convergence of newsreaders and Web browsers will erode or eliminate the advantages that dual-mode conferencing offers today.

In the meantime, those advantages are real. Conferencing is a powerful and still largely underexploited tool. News-style conferencing appeals to many Usenet-literate folks and offers a variety of features—a rich, responsive user interface; multiple sorted views; unread message tracking; replication for off-line use—that you can't get easily (if at all) today in the Web realm. Web conferencing, meanwhile, appeals strongly to many in the Web generation who are not Usenet-literate. It's also handier when you need to conference across firewalls and when you want to brand your conferences with a distinctive look.

If you want to give dual-mode conferencing a try, and if you're willing to deploy INND, inews, and MHonArc as I've described, then you should check out my scripts at http://www.byte.com/art/download/dualmode.zip. Enjoy! B

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

Best of Both Worlds

News-Style Conferencing
- Offers a rich, responsive interface
- Presents multiple sorted views
- Tracks unread messages
- Provides replication for off-line reading

Web-Style Conferencing
- More intuitive for Usenet novices
- Crosses firewalls
- Lets you brand conferences with a distinctive look

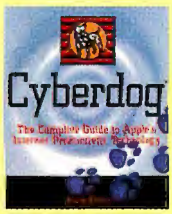
TOOLWATCH

GIF89a plug-in for Adobe Illustrator
Adobe
http://www.adobe.com/prodindex/illustrator/main.html#gif

BYTE's New Media production ace Joy-Lyn Blake now spends far less time retouching text when she makes illustrations Web-ready. The antialiasing in this free GIF exporter really works.

BOOKNOTE

Cyberdog:
The Complete Guide to Apple's Internet Productivity Technology
by Jesse Feiler
($34.95)
AP Professional
http://www.appnet.com/



What users and developers need to know about Apple's slick OpenDoc-based Internet component framework.

With dual Pentium Pros, accelerators, and NT, these machines make fast 3-D graphics cheaper than ever. **By Robert L. Hummel**

Affordable 3-D Workstations

Professional-quality real-time 3-D imaging has traditionally been the province of high-cost workstations with powerful graphics subsystems. Until recently, these Unix-based systems, costing $20,000 and up from companies like Digital, HP, IBM, and Silicon Graphics (SGI), have been the only feasible option for serious 3-D graphics design. RISC-based SGI workstations, for example, produced the awe-inspiring scenes in the movie *Jurassic Park*.

Demand for these increasingly powerful systems has remained high, but price has kept them out of reach for many professionals engaged in research, engineering, design, architecture, or animation. Within the last two years, however, a few workstation vendors, particularly Intergraph, have developed cost-effective and powerful 3-D graphics systems built around the latest Intel CPUs and running Microsoft Windows NT.

Another thing that's making gee-whiz imaging more affordable are fast, relatively low-cost graphics accelerator chips that encapsulate the 3-D functions required to implement the OpenGL 3-D API. Several vendors now ship PCI graphics cards based on 3Dlabs' Glint chips, for example. And Intergraph has transferred some of its proprietary graphics technology into its lower-cost Intense 3-D OpenGL card. Priced at around $2000, these new cards are not yet commodity items. But graphics workstations built around these cards, coupled with NT, bring economies of scale to both 3-D hardware and software.

We just finished testing four systems that represent the coming wave of affordable Intel-based 3-D graphics: Hewlett-Packard's Vectra XW, Intergraph Computer's TD-410, Tri-Star's StarStation SMP, and Netpower's Symetra. Because of their Intel chip sets, these Pentium Pro systems are remarkably similar. We requested comparable configurations: 128 MB of memory, dual 200-MHz Pentium Pro CPUs, a 4-GB SCSI hard drive, Fast Ethernet, a 17-inch display, and a 3-D graphics card with 16 MB of memory. The systems came with NT 3.51 because NT 4.0 drivers weren't available for the graphics cards at review time.

The differences we measured in 3-D graphics performance were due chiefly to the systems' graphics cards. The performance winner, the Intergraph TD-410, came with the company's Intense 3D; the other systems used cards based on 3Dlab's latest Glint 500TX/Delta chip duo. We tested the 3-D capabilities of these machines using Viewperf, an industry standard OpenGL benchmark. Although Viewperf does not take advantage of the multiprocessing capabilities of these workstations, there are 3-D applications such as Microsoft's Softimage 3D package that can. We found these systems very

HP VECTRA XW

RATINGS

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

TRI-STAR STARSTATION SMP

RATINGS

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

INTERGRAPH TD-410

RATINGS

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

NETPOWER SYMETRA

RATINGS

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

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

capable at manipulating fairly complex images. Experiments with animation rendering in Softimage 3D, however, showed that even with two processors, there is still a need for $100,000 workstations.

HP Vectra XW

ADVANTAGES:

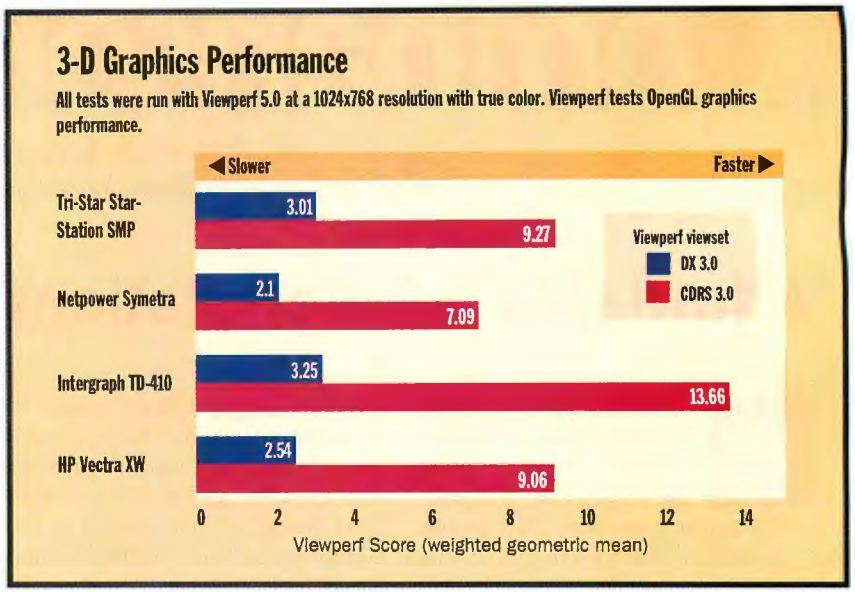
+ Quality engineering and rugged construction
+ Case opens easily

DISADVANTAGES:

– Pricey for the performance

Hewlett-Packard's Vectra XW illustrates the company's reputation for engineering. Housed in a wide mini-tower, the XW is built like a tank, with nearly every component manufactured for a custom fit. With its AccelGraphics' ProT2500 Glint-based graphics card, the Vectra XW provided solid but middle-of-the-road 3-D graphics performance, a bit behind the Tri-Star system, which uses a similar AccelGraphics card.

The system board is able to accommodate up to 512 MB of system memory in eight standard SIMM slots. The system board also provides floppy, IDE, and 8-bit UltraSCSI interfaces (internal and external). Multimedia features include a Hitachi 8x IDE CD-ROM drive, integrated SoundBlaster 16 audio interface, a MIDI port, appropriate jacks, and a front-panel volume control.



With its Intense 3D card, Intergraph's TD-410 provides good OpenGL performance. The three slower systems use cards based on 3DLabs' Glint 500TX and Delta chips.

The case opens easily from the front; you lift two latches and slide it forward. An integral key lock on the rear can secure the cabinet. Of the system's three PCI slots, two are occupied by the network and 3-D graphics cards. There are also three ISA slots (one shared). The price for the roomy expansion area is cramped quarters around the drive interface connectors and memory slots. However, HP designed the power supply to release with thumb screws and slide out of the way without disconnecting. You need some patience to work inside the Vectra XW.

Intergraph TD-410

BYTE BEST

ADVANTAGES:

+ Top performance
+ Full multimedia integration
+ Solid, stylish chassis

DISADVANTAGES:

– Technical documentation optional

A slim-line desktop case and best-of-show performance make the Intergraph TD-410 an unbeatable value. Although it came in a TDZ-410 case, the system we tested is based on Intergraph's Intense 3D board with texture option, so it's actually a TD-410. Matched with Intergraph's nice 17-inch 17sd86 monitor, the TD-410's performance is complemented by its engineering and styling.

The quiet TD-410 employs large heat sinks with only two fans, mounted at the rear on the power supply. The system board can accommodate up to 512 MB in eight standard SIMM slots. It provides an UltraSCSI interface. The Intense 3D card takes up two of the machine's three PCI slots. The card's size, coupled with obstructions on the system board, may make it difficult to put anything but a short card in the adjacent slot.

If the machine's accompanying user manual is any indication, Intergraph must not think much of the technical expertise of its customers. All "detailed information," such as how to open the system unit, install expansion cards, and set jumpers,

TECH FOCUS | 3-D API

A More Open GL

Spun off from Silicon Graphics' proprietary GL graphics language, OpenGL is now an open API controlled by the multivendor Architectural Review Board. It provides an industry standard multiplatform library of graphics functions for 3-D drawing and rendering with wide vendor support, including Microsoft's (NT and Windows 95). OpenGL defines an extensive set of 3-D modeling and rendering primitives used to create and manipulate solid models and surfaces including:

- **Gouraud shading to show subtle color differences across an object's surface**
- **Texture mapping for realistic surfaces**
- **Double buffering for smooth animation**
- **Z-buffering for precise ordering of objects in the depth dimension**
- **Antialiasing for smoothing jagged edges**
- **Alpha blending for displaying transparency**
- **Calculations for application of lighting**
- **Calculations for transforming geometry, viewpoint, and perspective**

OpenGL functions can be performed by the host processor, but graphics display speed improves greatly when the OpenGL functions are off-loaded from the host processor to hardware 3-D graphics accelerators.

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1995 Computer Currents Readers Choice Award
1993 Shareware Industry Award
1992 Premiere Computing Magazine Award
1992 Dvorak/Zoom Award

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is only in the optional System Reference manual. The box also lacks an external reset button.

The complete multimedia support includes an 8x SCSI CD-ROM drive, Creative Labs Vibra 16C interface on the system board, and the ConcertMaster "multimedia keyboard" with built-in stereo speakers. The microphone, mute button, and volume control are located conveniently at your fingertips. Jacks for headphones, external microphone, and a powered subwoofer are also on the keyboard.

Netpower Symetra

ADVANTAGES:
+ Two 512-KB-cache Pentium Pro CPUs

DISADVANTAGES:
– Relatively high price
– Slowest performance
– Hard to access interior

The Symetra's 3-D capability is fueled by Netpower's TrueFX Pro card and coupled with a 17-inch Iiyama Vision Master 17 monitor. Developed with 3DLabs, and using the same 500TX and Delta chips as the other Glint cards, the 16-MB TrueFX Pro trailed in performance on the Viewperf tests. The Symetra was the only system to come with the 512-KB-cache version of the 200-MHz Pentium Pro. Buying the version with 256-KB cache will save you $2000 and cost you only a small drop in performance.

The Symetra is packaged in a wide minitower that's constructed of an odd array of panels, pins, latches, and tabs. The system board can accommodate up to 512 MB of memory in four 168-pin DIMM slots. Accessing the Symetra's interior can be a challenge. You must take off the cover, release two latches, and remove a side panel to access expansion card and memory slots. Adding a drive requires removing all four cover panels and possibly disassembling the drive bay assembly to reach the mounting screws.

Of the four PCI slots inside the Symetra, one of which is a shared PCI/ISA slot, two are used by the 3-D graphics card. An Adaptec SCSI PCI card takes a third and controls the 4-GB Fast-and-Wide SCSI hard drive. The integrated Wide UltraSCSI interface goes unused. An integrated SoundBlaster 16-compatible audio interface provides multimedia support, along with an 8x CD-ROM drive.

Tri-Star StarStation SMP

ADVANTAGES:
+ Lowest price
+ Second-best 3-D performance
+ Lots of expansion room

DISADVANTAGES:
– Lacks sound card

The Tri-Star StarStation SMP workstation comes with a version of the AccelGraphics Pro T2500 card and a 17-inch Iiyama Vision Master monitor. Coming in with the lowest system price ($8544), it provided the best performance of the three Glint-based systems. Housed in a large tower with lots of drive bays, the StarStation has the largest memory capacity of the four systems: up to 768 MB in six standard SIMM slots.

The system provides four PCI and three ISA slots (one shared), but three of the available PCI slots are occupied by the Adaptec SCSI card, 10/100Base-T network card, and the 3-D graphics card. In addition to two 3½-inch bays, the StarStation's tall case provides six 5¼-inch drive bays—all accessible from the front of the machine. Two bays in our evaluation unit were occupied by the hard drive and the Plextor 8x SCSI CD-ROM drive. No sound capabilities were provided with this unit.

PRODUCT INFORMATION

HP Vectra XW
$11,594 (estimated street price)
(two 200-MHz Pentium Pros, 128 MB of RAM, 4-GB hard drive, 17-inch display, 16-MB 3-D graphics card)
Hewlett-Packard
Palo Alto, CA
(800) 752-0900
(303) 635-1000
fax: (800) 333-1917
http://www.hp.com
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Intergraph TD-410
$11,231 (estimated street price)
(two 200-MHz Pentium Pros, 128 MB of RAM, 4-GB hard drive, 17-inch display, 16-MB 3-D graphics card)
Intergraph Computer Systems
Huntsville, AL
(205) 730-5441
http://www.intergraph.com/ics
Circle 1060 on Inquiry Card.

Netpower Symetra
$12,483 (estimated street price)
(two 200-MHz Pentium Pros (512-KB L2 cache), 128 MB of RAM, 4-GB hard drive, 17-inch display, 16-MB 3-D graphics card)
Netpower
Sunnyvale, CA
(800) 801-0900
(408) 522-5199
fax: (408) 720-8558
http://www.netpower.com
Circle 1061 on Inquiry Card.

Tri-Star StarStation SMP
$8544
(two 200-MHz Pentium Pros, 128 MB of RAM, 4-GB hard drive, 17-inch display, 16-MB 3-D graphics card)
Tri-Star Computer
Tempe, AZ
(800) 844-2959
(602) 731-4926
fax: (602) 731-9010
http://www.tri_cad.com
Circle 1062 on Inquiry Card.

Driving Performance

As is the case when evaluating any workstation component, comparing high-performance graphics cards requires both a philosophy of testing and a dependable benchmark. Vendors typically quote 3-D graphics performance as the number of primitives (such as triangles) the computer draws per second. But without additional information, such as the context, size, shading, color depth, and smoothing method used to draw those triangles, direct comparisons are meaningless.

To address this problem, the OpenGL Performance Characterization subcommittee has developed the Viewperf benchmark (available at http://www.specbench/org/). It's a portable benchmark and the current industry standard for evaluating OpenGL performance. Viewperf does not benchmark individual primitives—it measures the performance of actual application data sets called *viewsets*.

For benchmarking the systems in this evaluation, we chose two viewsets. The CDRS viewset is derived from Parametric Technology's modeling and rendering software for computer-aided industrial design. It is used to create concept models of automobiles, consumer electronics, and appliances. The test measures seven different operations on a model of a lawnmower. The DX viewset is based on IBM's Visualization Data Explorer, a general-purpose scientific data visualization and analysis package. The 10-test benchmark draws a set of particle traces through a vector flow field. Viewperf measures frames per second for each component test. The single result for each viewset is a weighted geometric mean.

Our benchmark tests show that the Intergraph TD-410's performance makes it the clear leader in this class of personal graphics workstations. Its price reflects the additional power of the Intense 3D board as much as it does the price of Intergraph's engineering and good customer support. If monetary constraints place the TD-410 out of your reach, the Tri-Star StarStation SMP offers somewhat more modest performance at a greatly reduced price. B

Robert L. Hummel is an electrical engineer, programmer, and consultant. You can reach him at **rhummel@monad.net.**

Now that 1-2-3 and Quattro Pro come in true Windows 95 flavors, can they shake Excel's dominance? By Richard Cranford

The Spreadsheet War, Revived

It's a three-way race again. With Lotus's long-delayed release of 1-2-3 97 (the first 32-bit version) this winter, market-leading Microsoft Excel finally has some serious competition. And by the time you read this, the latest version of

Microsoft's 32-bit spreadsheet, Excel 97, should be on its way to store shelves. Corel's (formerly Novell's, formerly Borland's) Quattro Pro 7 appeared last June.

All three products have notable new features, but equally notable is what's missing. The new version of 1-2-3 doesn't offer some of the goodies its users have clamored for, and Corel and Lotus have failed to adopt some of Excel's slicker features for their spreadsheets.

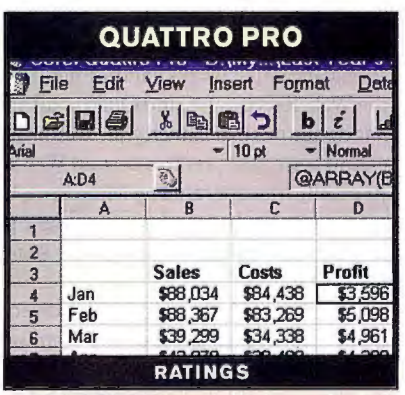
Productivity Tools

These spreadsheets are chock-full of functions that are accessible from the right mouse button. Behind these functions sit ad hoc menus of tasks related to a selected object. For example, right-clicking on a row number on the left side of a worksheet's frame pops up a menu that lets you delete that row.

All three programs let you fill in a range with a preset series of labels (e.g., the months of the year) or with ascending values. Excel and 1-2-3 let you do this by dragging; the trick is to the get the mouse pointer to the lower left corner of a starting cell (containing, say, the word *January*) before dragging either down or right. In Quattro, you can fill a range with labels, but only by selecting the range first and then right-clicking on the range and selecting from the pop-up menu.

You can create your own fill lists, such as the names of a company's locations, in all three spreadsheets. Lotus 1-2-3 has finally done away with a tedious system that required opening an INI file with a text editor and manually keying in a new sequence. You now add to 1-2-3's repertoire of fill lists by selecting File/User Setup/SmartFill Setup. Lotus 1-2-3's setup routine gathers up the lists in the INI file so that users don't have to reenter their custom lists.

Excel and Quattro both offer array formulas, which let you write one formula to populate a range of cells. Array formulas help preserve the integrity of a spreadsheet model by letting you create a block of formulas that perform a consistent function and by preventing changes to one member of a set. Lotus 1-2-3 has yet to add a comparable feature.



You can now group some of the worksheets in a 1-2-3 model without grouping all of them. When you group worksheets, the changes made in one sheet to column widths, numeric formats, and other attributes are passed along to all other sheets in the group. This has been an all-or-nothing proposition in 1-2-3 since the program went 3-D back in 1989. Many users have complained about it in forums on CompuServe and elsewhere. Now you can still create only one group, but you can decide which sheets it will include. You could use this feature, for example, to make a group out of sheets B through E in a nine-worksheet model.

Excel and Quattro have both been there and done that, and they also offer nice variations on the theme. Quattro lets you create groups for multiple sets of worksheets and even assign names to groups (e.g., sheets B through E can be one group, with the user-assigned name Sales, while sheets G and H might belong to a group called Op Costs). With Group mode turned on, changes made in the Sales group are passed to other sheets in that group, but not to the ungrouped sheets or to those in the Op Costs group.

Excel lets you select noncontiguous worksheets. Both Quattro and Excel

allow you to put an entry into the same cell of all worksheets in a group. That is, if you type a label in cell A1 of one worksheet in a group and press Ctrl-Enter instead of Enter, the label goes into all the cells A1 in the group. Lotus 1-2-3 can't do this as easily. In addition, Quattro and Excel let you move a worksheet from one position to another within its file just by dragging its tab. This is another feature wished for in the on-line forums, but it doesn't appear in the newest version of 1-2-3.

Lotus did, however, give its spreadsheet two operational features that are not found in its competitors. One is auto-totaling; 1-2-3 97 creates the @SUM formulas that sum up the columns or rows of a table when you enter the word *Total* below or to the right of the table. And its Info Box (see the screen on page 149) is a dialog box that offers one-stop shopping for numerical formats, text attributes, colors, borders, and other attributes. Since it's modeless, the Info Box instantly passes changes to the spreadsheet without your having to click OK.

Excel wins the prize for most interesting ease-of-use features. For one thing, it now allows natural-language formulas:

Lotus 1-2-3 97

ADVANTAGES

+ Auto-totaling
+ Modeless dialog boxes make changes instantly

DISADVANTAGES

– Requires Lotus Approach for database queries and PivotTables
– No array formulas

Excel 97

ADVANTAGES

+ Feature-rich
+ Supports Visual Basic for Applications

DISADVANTAGES

– Large file sizes
– Has fewest @ functions (234)

Quattro Pro 7

ADVANTAGES

+ Has the easiest-to-use programming language
+ Lowest-priced
+ Has the most @ functions (483)

DISADVANTAGES

– Not as easy to use as the others
– Outmoded print previewing

TECH FOCUS: OLE 2.0

Suite-Talking Spreadsheets

Microsoft, Lotus, and Corel all brag about how well the members of their respective software suites work together, but much of this is made possible by Windows' OLE protocol. The spreadsheets act as OLE 2.0 servers, so you can drag and drop worksheet ranges from one part of a sheet to another, to a different worksheet page within a file, to another open file, or out of the application window altogether and into a word processor, presentation program, or other document. You can drag from a worksheet application to a word processor from the same company (from Excel to Word, for example) or to a competing worksheet that can act as an OLE client (e.g., from Quattro Pro to Lotus's Word Pro).

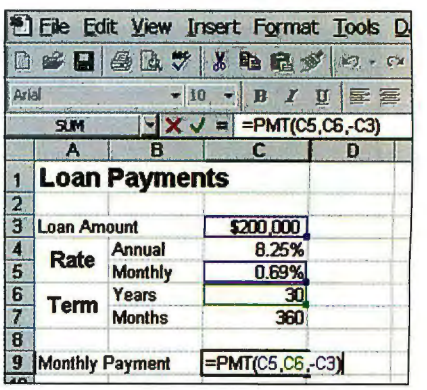
The range that's dropped into the word processor becomes a spreadsheet object. When you double-click on it, the document—the spreadsheet fragment itself and the text that surrounds it—remains in place, but the word processor's menu and toolbars are replaced by those of the host spreadsheet application. You modify the style or content of this table using the tools available in the worksheet, not those of the word processor. Clicking outside the spreadsheet object restores the word processor's normal menu.

After setting up a table with headings for the columns or rows, you can enter a formula using the headings without having to assign range names. In the screen on page 149, for example, you could complete the model by entering "=sales–costs" rather than "=B8–C8" in cell D9.

Also nice is the Range Finder, which shows the cells or ranges referenced by a formula when you edit that formula. In the screen at right, the formula in cell C9 indicates a (clearly wrong) monthly loan payment of $7400. Editing the formula instantly shows that it refers to the term in years, not in months. Dragging the green rectangle to cell C7 corrects the formula. The same screen illustrates a new alignment option in Excel called Merge Cells. Notice how the word *Rate* is centered vertically relative to the words *Annual* and *Monthly*. Merge cells let you turn cells A4 and A5 into a double-high cell and create this effect.

Much is made of the Web these days, so it comes as no surprise that the major spreadsheet makers all claim to have the spreadsheet that works hand-in-hand with the Web. Excel, 1-2-3, and Quattro all have handy buttons that launch your Web browser and transport you to a certain Web site (typically one operated by Microsoft, Lotus, or Corel). In 1-2-3, you can highlight a snippet of text and run a Yahoo search using that text.

Excel and 1-2-3 can open files directly from Internet ftp sites, or they can save worksheet files to ftp servers or Web sites via the normal File/Save menu. Quattro can open Hypertext Markup Language (HTML) files from the Web, from disk



Editing a formula in Excel 97 highlights cells and ranges the formula refers to.

drives, or from LAN directories, and it can save data in the HTML format for later uploading to the Web.

You can also enter formulas that refer to bits of information on the Web. The disadvantage of this is that you must wait to dial into a Web site (or sites) to get all the most up-to-date information whenever you recalculate the worksheet.

Get with the Program

Lotus 1-2-3's approach to programming hasn't changed much since 1986, and Quattro's language has been a close variation on 1-2-3's. Each product's language employs a set of commands spelled with braces (e.g., {GETNUMBER}) and entered in a range of worksheet cells.

Programs (i.e., macros) written in these languages have some serious limitations. For instance, to execute code conditionally, you must write one long label consisting of an {IF} command followed by the code to be executed when {IF}'s Bool-

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ean statement is true. You create IF...THEN routines rather than IF...THEN...ELSE routines.

Microsoft has included a version of its Visual Basic language in Excel for a few years now. The latest version, Visual Basic for Applications (VBA), is a full-featured language that allows for complex IF...THEN...ELSE and DO...WHILE routines and the like. With its latest release, 1-2-3 joins the club and allows for programming in Lotus Script, a language that's very much like VBA. And Quattro Pro offers PerfectScript, which is closer to the old macro language than to VBA, but which allows for more complex programming tasks. Both 1-2-3 and Quattro support their respective macro languages.

Live Previews

Quattro Pro 7 still uses a static print preview to show how a worksheet will look on paper. You can view the preview, or you can leave Preview mode to modify the worksheet, but never the twain shall meet.

By comparison, 1-2-3 and Excel provide concurrent previewing and editing. Excel's approach is a lot like invoking the full-page view available in the major Windows word processors. When you switch from Normal mode to Page Break Preview mode, the zoom factor is reduced and all margins and page breaks are visible, but all worksheet functions are still possible. While zoomed out, you can make changes such as applying shades or drawing boxes around ranges. If you need to edit individual cells, you can zoom in on the sheet without leaving Page Break Preview mode.

Lotus 1-2-3's approach is different, but still good. Its Dynamic Print Preview feature opens a print-preview window and tiles it with the current worksheet window. You apply changes in the worksheet and see them reflected in a full-page preview.

PRODUCT INFORMATION

Excel 97
(price undetermined at press time)
Microsoft Corp.
Redmond, WA
(800) 426-9400
(206) 882-8080
fax: (206) 936-7329
http://www.microsoft.com
Circle 977
on Inquiry Card.

Lotus 1-2-3 97
$329
Lotus Development Corp.
Cambridge, MA
(800) 343-5414
(617) 577-8500
http://www.lotus.com
Circle 976
on Inquiry Card.

Quattro Pro 7
$99
Corel Corp.
Ottawa, Ontario, Canada
(800) 836-3729
(613) 728-8200
fax: (613) 761-9176
http://www.corel.com
Circle 978
on Inquiry Card.

Feature Comparison

	1-2-3 97	Excel 97	Quattro Pro 7
Cells per sheet	2,097,152 (256 columns × 8192 rows)	16,777,216 (256 columns × 65,536 rows)	2,097,152 (256 columns × 8192 rows)
Maximum number of worksheets	256	Unlimited	Unlimited
Maps from worksheet data	✔	✔	✔
PivotTables	Requires Lotus Approach (included)	✔	Requires add-in (included)
Programming languages	1-2-3 macro language; Lotus Script (a BASIC-like language)	Visual Basic for Applications	1-2-3-like macro language; PerfectScript (a BASIC-like language)
Number of functions	280	421	483
Supports custom functions	✔	✔	
Array formulas		✔	✔
Create your own fill series	✔	✔	✔
Can act as OLE 2.0 server or client	✔	✔	✔
Internet support	Export data as HTML; open file from, or save file to, Web or ftp site	Export data as HTML; open file from Web or ftp site; save file to ftp site	Open HTML file; save files in HTML; save file to Web page

✔=yes.

The Artist Within

In any of these three spreadsheets, you can add simple drawn objects to a worksheet model. In 1-2-3 and Quattro Pro, these objects are limited to lines, arrows, ellipses, rectangles, and freehand shapes and doodles. Excel offers these and several others, inluding triangles, a pentagon, a heart, stars (with various numbers of points), the international "no" symbol, and flowchart symbols. Excel also offers many more ways to spruce up these shapes; you can apply textures such as marble, crumpled paper, and woodgrains, choose from several styles of gradient fills, and even give the objects depth and rotate them in 3-D space.

The drawing tools in all three programs support text blocks (as they've done for a few years now), and Excel lets you create WordArt objects as well. You can use WordArt to create an eye-catching worksheet title whose text is, for example, curved, tinted to simulate a metallic finish, or casting a shadow. Just click the WordArt button on Excel's Drawing Toolbar, pick a style from a gallery of suggestions, and supply some text.

The Race Is On

All three products provide the features we now take for granted in spreadsheets—a dizzying array of chart types, maps, version management, and programming tools—and add attractive extras.

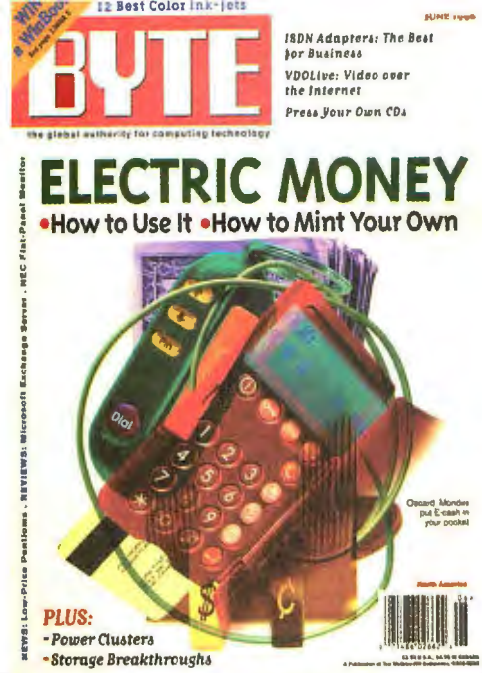
Excel offers the most robust set of ease-of-use features as well as a more venerable language for developers (although 1-2-3's new language compares favorably). Lotus 1-2-3's modeless Info Box is nicely conducive to fiddling with a worksheet to get its look just right. Quattro Pro seems a bit harder to work with, although it has a simpler programming language.

On balance, Excel has the most complete and best-implemented feature set. If you're already an Excel shop, you're where you want to be.

If 1-2-3 is your standard spreadsheet, it may be time to switch, unless you have a major investment in 1-2-3-related skills. You won't go too far wrong by moving to 1-2-3's new 32-bit version, but you'll be getting a spreadsheet that still isn't as good as Excel. While Excel once was unwieldy for casual users, it now beats 1-2-3 in almost every area.

Quattro Pro has the best price and is a solid product. Stay with it if it's what you already use. But if you don't, consider it carefully, if for no other reason than that you'll be much in the minority. B

Richard Cranford is a freelance writer and consultant based in Cambridge, Massachusetts. He was formerly senior associate editor at Lotus *magazine. You can contact him at* **rcranford@aol.com.**



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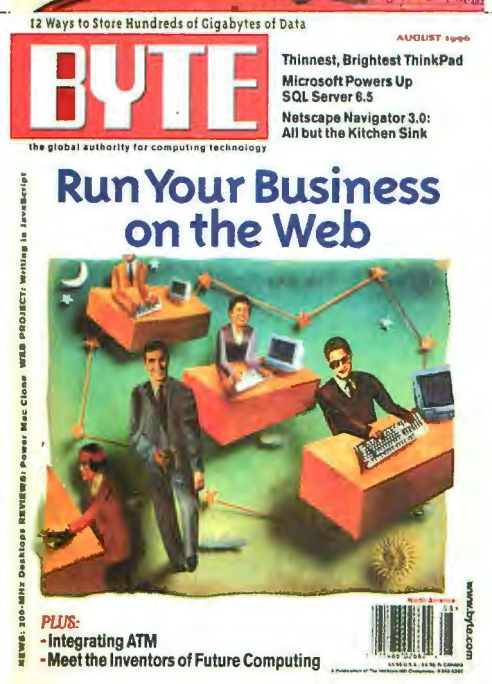

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24 ☐ Operating Systems
25 ☐ Large Systems (Mainframes/Minis)
26 ☐ Desktops (Micro's/Workstations)
27 ☐ Systems Software Products
28 ☐ Application Software Products
29 ☐ Peripheral Equipment
30 ☐ Telecommunications Services

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33 ☐	1,000-4,999	39 ☐
34 ☐	500-999	40 ☐
35 ☐	100-499	41 ☐
36 ☐	Under 100	42 ☐

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35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102
103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119
120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136
137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153
154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170
171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187
188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204
205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221
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290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306
307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323
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443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459
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967	968	969	970	971	972	973	974	975								

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Fax Boards/Machines	9
Input Devices	10
ISDN Hardware	61
Laptops & Notebooks	13
Mass Storage	23
Memory/Chips/Upgrades	15
Midrange/Mini Computers	62
Miscellaneous Hardware	16
Modems/Multiplexors	17
Monitors & Terminals	18
Multimedia/CD-ROM	19
Network Hubs/Switches	63
Networking	64
Optical Drives	65
PCMCIA	57
Printers/Plotters	20
Programmable Hardware	21
Scanners/OCR/Digitizers	22
SCSI/Peripheral Interfaces	59
Security	52
Servers	66
UPS/Power Management	24
Voice Technology	55
Workstations	67

Software

Business	25
CAD/CAM	26
Communications	27
Data Acquisition	28
Data Warehousing	68
Database	29
Educational	30
Engineering/Scientific	31
Entertainment	32
Graphics	33
Internet Services	69
Internet/Intranet	70
Macintosh	34
Mathematical/Statistical	36
Middleware	71
Miscellaneous Software	37
Net Management	72
Networking	73
On-Line Services	38
Operating Systems	39
Programming Languages/Tools	40
Security	41
Spreadsheets	44
UNIX	45
Utilities	46
Windows 95	47
Windows NT	74
Word Processing/DTP	48

General

Books/Publications	49
Recruitment	50
Mail Order	75
Miscellaneous	51

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Jerry Pournelle

Chaos Manor

A Hot Night at the Opera

A heat wave and disk errors plague Chaos Manor, causing Jerry to reach out for the Panic box.

The good news, at least for me, is that my new writing schedule is working just fine. In the last month, I've produced a thousand words a day on my novel *Starswarm*, and it's only three scenes from being done. The bad news is that I've had less time to play with computer stuff, meaning that it's short-shrift time at Chaos Manor.

One of the things I wanted to do was experiment with making CD-ROMs. We have two separate CD-ROM-making systems, one external, the other built into Joizy, Mrs. Pournelle's Gateway 2000 P-5 200XL. Joizy remains, with one exception, the fastest machine in the house. Roberta uses it heavily, and it works just fine. We'll get to the CD-ROM makers Real Soon Now.

The exception is interesting. The fastest machine in the house appears to be the Diamond Flower Doubleshot 133 dual-Pentium system running under Windows NT 4.0.

Of course, this business of what's fastest depends greatly on what you're doing with the machine. If you run a lot of DOS programs and make heavy use of network resources, dual-processor systems with NT 4.0 are a pretty clear win. If you're heavily into graphics, the speed you get depends as much on the video board as the CPU, but even so, a good dual-processor system will probably be a win. Certainly, the Intergraph TDZ-400 was, while we had it, by far the fastest system at Chaos Manor.

I haven't had any problems with NT 4.0, but I keep reading about incompatibilities. Apparently, Quicken users have to go through weird and arcane rituals to get America's favorite financial product to work with NT 4.0.

Meanwhile, just as I was about ready to write off OS/2 due to lack of IBM's support for it, friends inside IBM tell me that a symmetric-multiprocessing (SMP) version of OS/2 Warp Server has just been released. I also hear that SMP for Merlin is in alpha testing and could be released about the first of the year. There are some problems with applications I'll get to later, but support for multiple processors could put OS/2 back in the ball game: speed and stability in one package.

In many cases, however, it won't matter: the speed advantages are real, but you don't much care because you don't notice a saving of a couple of seconds. Under my new writing system, I write upstairs in what used to be Alex's room, using a standard Gateway 2000 486DX2/66 running Microsoft Word 6.0c.

Of course, this business of what's fastest depends greatly on what you're doing with the machine.

I have a bit over 200 pages—70,000 words—finished. Another 10 pages of notes are tacked on at the end, meaning that when I write, I'm pushing those words down to make room for new text. Every now and then, there's just enough drag that I notice it, but it's fast enough that I don't really care.

Although Word has a fast-save option, it's something I don't use. I have Word set to save the whole document and keep a backup copy every time I save (which I strongly advise you to do). Moreover, I began writing with computers back in CP/M days, and I developed the habit of saving early and often, generally at the end of every paragraph.

This means saving the entire 70,000 words of the manuscript every minute or so; and that works just fine, taking no more than a few seconds. In other words, fast enough is fast enough....

Things continue to happen at Chaos Manor. A few days ago, we went to the gala opening of the new Los Angeles Opera season. It was *I Pagliacci*, directed by Franco Zeffirelli and starring Placido Domingo. Wonderful: more like a modern musical than a grand opera.

While we were out, Alex came over, and he opened all the windows in my regular office. I've got air conditioning in the monkish cell where I now write, but when I came there in the afternoon, I didn't bother to button up and start the air conditioning, so it got pretty hot up there. Then on Sunday, the one day I don't work on my novel, I came up from breakfast to find a "blue screen" on Cyrus, the Cyrix 6x86-P166. This one announced that it had been unable to write to drive C. I'd seen that screen before and assumed that it probably was generated by System Agent or First Aid 95 Deluxe doing some kind of routine background check and getting hung up on the screen saver.

The screen said press any key to continue, and when I did, all seemed well.

One of the programs I scheduled for this month's column is DiskMapper, from Micro Logic, the company that publishes Info Select. DiskMapper gives you a visual picture of what's on your hard drive. It does this by calculating the size of each file, subdirectory, and directory, including "free space," which it shows as one big directory. Then it puts up a map in which each directory and subdirectory appears as a rectangle whose

area is proportional to the space it takes up on your drive. You can then click on those, and it will expand that area to a new level. The result is that you can see at a glance just what's eating your disk space.

DiskMapper works just fine with all kinds of hard drives, including removable drives. It also works with networked drives, but it is a bit slow with them. When DiskMapper is running on a Windows 95 (Win 95) drive and looks across the network at a large NT drive, it gets a little confused. It seems to map everything all right, but it reports the total drive size wrong.

A couple of my advisers had wondered about the airflow in Cyrus, and it was over 90° in the office.

I had DiskMapper installed on Pentafluge, a Pentium 60 system. Pentafluge has been my main machine for some time, but he's a bit out of date, and I'm contemplating changing systems. One candidate is Cyrus, and one step in the process is transferring Pentafluge's essential software, which includes utilities like DiskMapper.

Running DiskMapper showed that a game called Heroes of Might and Magic took up a humongous chunk of space on Cyrus. Heroes is one of those games I thought I'd like, but it didn't hold up. Some years ago, Chris Crawford said that good computer games need "the illusion of winnability": the game ought to be too hard for you, but you shouldn't know that. I presume he was thinking of arcade games like Space Invader, where no matter what you do, there's always another level that's even tougher. I prefer "the illusion of losability": I like to win, not be defeated.

Anyway, Heroes seems to follow Crawford's philosophy. Eventually, I went after it with a disk editor to give myself more money and larger armies. I discovered that while the game got tougher and tougher, it got no more interesting. Each new episode had the same features as the last, just arranged differently, with added silliness such as maze-like forests and hedgerows to make everything take three times as long. One day I just quit playing it. Now it was taking up a lot of disk space.

I never throw anything away. The simplest thing I could have done would have been to keep my highest-level save and throw the rest away, on the theory that I could always reinstall the game. Instead, I used Drag and File for Windows 95/NT (DF95/NT) to "move" the entire Heroes directory (and subdirectories) across the network to a Micropolis 4-GB hard drive running under Windows NT.

That was a big mistake.

DF95/NT has the neat feature that you can tell it to copy (or move) only updated files, so when you're copying an enormous directory, you don't have to copy anything that's already been copied. Moreover, you can install DF95/NT on a server and run it locally. It's a good utility for copying, but I don't recommend it for *moving* files. In fact, I don't recommend *moving* files at all. Copy them, and when you know you have a good copy, erase the originals. That takes a little longer, but it's a *lot* safer.

If you do move files, don't use DF95/NT because it doesn't recover gracefully from disk errors; and I got a disk error. About 90 percent through the move, I got the blue screen: Unable to Write to Drive C, Press Any Key to Continue. Alas, pressing any key didn't continue. Pressing any key got a partial restart of DF95/NT, but that program was completely confused. It trundled for a second, and then the system locked up completely. Ungood.

Ctrl-Alt-Del did nothing, nor did anything else, so I hit the reset button. This time a new message appeared: "No Operating System." Double ungood.

Turn it off and let it sit awhile, something I should have done in the first place. Sometimes reset doesn't erase all the cache memory. This time, Win 95 came up, but just as it was completing its start-ups, I got a new blue-screen error. Double plus ungood. I turned the system off before more damage was done.

Heat, I thought. A couple of my advisers had wondered about the airflow in Cyrus, and it was over 90° in the office, uncomfortable enough that I was about to turn on the air conditioning. I decided to put that off; I might as well finish this under the conditions I started with.

I have a box labeled Panic. It includes several flavors of DOS boot floppy disks. I fished out one and turned on the power. Cyrus came up just fine. I ran CHKDSK on C, and sure enough, there were a number of errors, which I did *not* let CHKDSK fix. Time for more potent magic.

One essential item in my Panic box is Norton Utilities for Windows 95 Emergency Disk (Bootable). I put it in the floppy drive, turned off the power, counted 10, and

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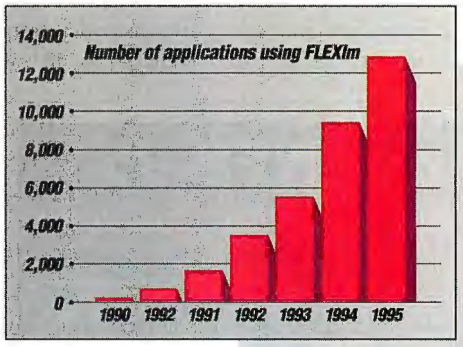

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fired up the system again. Norton Disk Doctor (NDD) appeared and found there was no file-allocation-table (FAT) entry for the subdirectory HEROES. Apparently, the "Unable to Write" error happened while DF95/NT was trying to update the FAT after deleting a file or subdirectory. NDD fixed the problem and scanned the disk for media surface errors. It found none.

Now Win 95 loaded correctly. The next step was to run Golden Bow's Vopt. It's not that I don't trust the Norton defrag program, but over the years, I have come to have full confidence in Golden Bow utilities. Moreover, although Vopt is a 32-bit program, it shuts down Win 95 and runs itself from DOS to assure complete control over disk writes. Sure enough, in the course of defragging the C drive, Vopt reported a write error. I told it to retry. Everything went well, but it sure seemed like there was a weak sector on that disk. Back in Win 95, I tried NDD complete with media scan, but it reported nothing.

Vopt used to come with a program called Vmarkbad. It found and marked bad sectors; alas, the newest version did not appear to have that. I later discovered it was still there but had been renamed Vscan. In any case, I had already moved on to the next step, which was to try Win 95's ScanDisk utility. I ran ScanDisk, and when I did, Lo!, it found a bad sector, which it marked. To be sure of that, I ran Vmap, which comes with Vopt, and sure enough, one sector now sported a little red bad-sector mark. If you don't have the Vopt utilities, they're worth having.

It was now hot enough that I figured to heck with tests, so I closed all the windows and started up the air conditioning. Then I ran all kinds of programs on Cyrus. I deleted the rest of the HEROES subdirectory. I ran Golden Bow's null file detector, discovering that both Microsoft Office and Corel Office Professional 7 create beaucoup empty files as well as directories. I killed off a lot of null files, did extensive disk operations, and let it run overnight. So far, all is well.

I still don't know if my "Unable to Write" blue-screen errors were caused by that soft sector on the disk, or by the hot weather, or whether the heat caused the disk error. I do know that once again NDD was a lifesaver, and it's worthwhile having the bootable Norton Utilities for Windows 95 Emergency Disk in my Panic box. On the other hand, NDD didn't find the bad sector, whereas ScanDisk did.

I didn't panic, because everything important had been backed up across the network.

A final note: I didn't panic, because everything important had been backed up across the network, with really important work copied in at least two places. A backup system is no good unless you'll use it. It's easy to get in the habit of copying to a networked drive.

Usually, I'm sure the Internet wasn't designed to drive me crazy, but there are times when I wonder.

One of the most useful utilities ever written was Norton Commander. It's a

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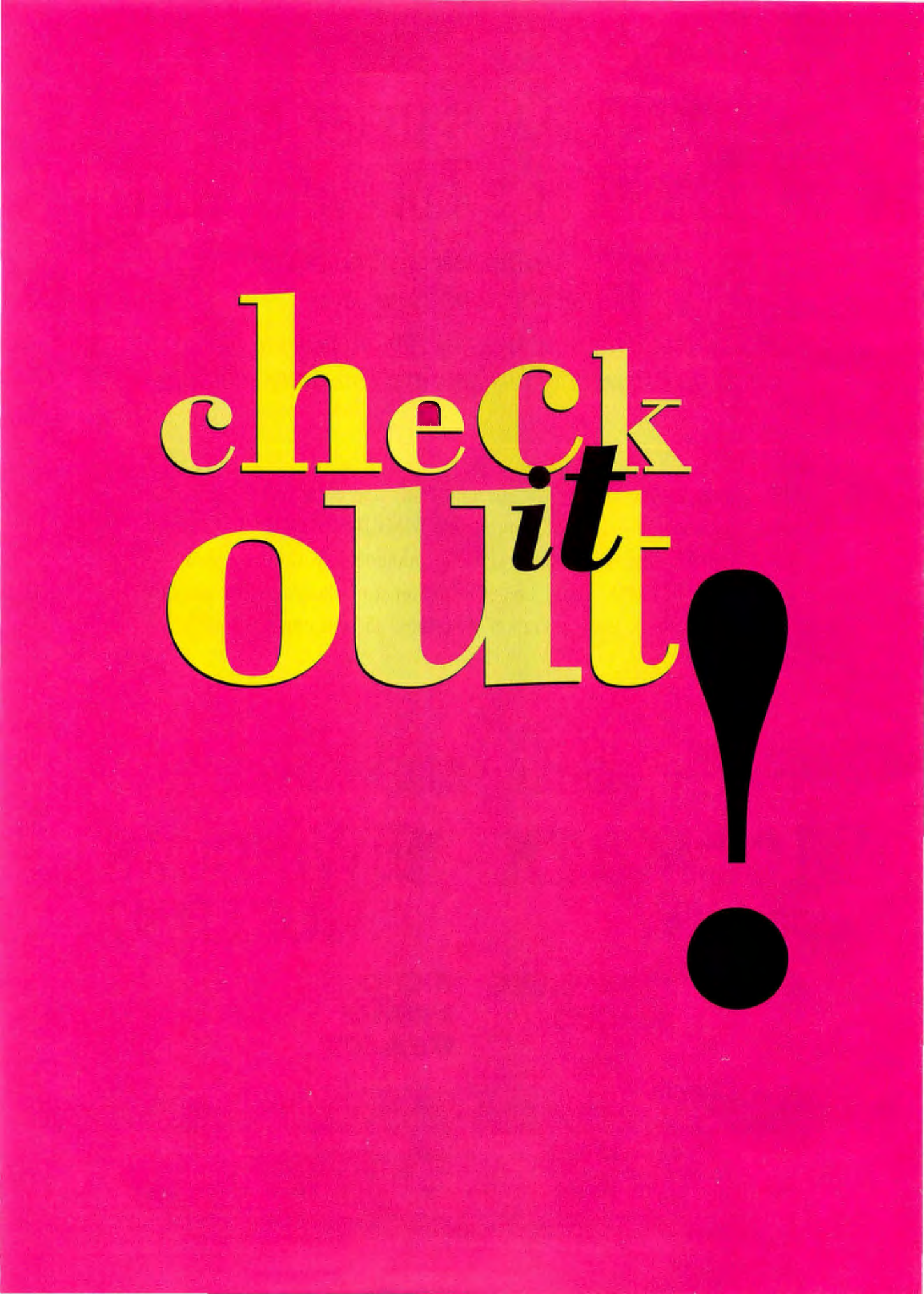
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DOS program that was useful from its first days and just kept getting better and better. For me, it became so indispensable that it was almost always the first thing I installed on a new computer.

Norton Commander is primarily a smart file manager. It also contains built-in viewers for a number of file formats, a utility editor that makes altering CONFIG.SYS and AUTOEXEC.BAT a snap, and a bunch of other stuff.

The final version even had a routine that would automatically call MCI and get your e-mail. That feature is obsolete now—it worked only at 2400 bps anyway—but I still use Norton Commander for nearly everything else. Alas, it has to run in a DOS window, and it doesn't understand long filenames.

The last time I wrote about Norton Commander, a number of readers advised me that there's a shareware program called Windows Commander, written by Christian Ghisler. It's similar to Norton Commander, and it understands long filenames.

This morning, I decided I'd look for Windows Commander. I first tried a search on "Commander" from EarthLink Network's home-page search system. I got 12,000 hits, and the first 20 all had to do with the game Wing Commander. Time to be a bit more selective. The AltaVista search engine accepts search strings in the form Windows +Commander, where the plus sign means that both words must be found. That still produced about 2000 hits, but the first 20 clearly referred to shareware programs that were called Windows Commander. Alas, they also contained lots of odd characters and numbers in place of text in their summaries.

My first thought was that all that garbage was due to unsupported fonts. It sure would be nice if AltaVista would add a feature that let you force searches in one language only.

Due to sloth, I have been using Netscape Navigator 2.0. Clearly, it was time to upgrade to version 3.0 and see if that would make a difference.

Netscape Navigator Gold 3.0 is a 6-MB self-extracting file. It takes a while to download. Alas, I hadn't turned off my screen saver when I began the download; about 2 MB into the process, the screen saver kicked in. When I got back in control, Navigator said "Document Done" at the bottom, and there was a 2.2-MB file in my TEMP subdirectory, with no indication that anything had gone wrong. If I hadn't known that the file was supposed to be larger than that, I would have thought all was well. Of course, I'd have found out when I tried to run it.

There was nothing for it but to start over. I got distracted and forgot to turn off the screen saver before I started, but this time I made sure to wiggle the mouse every few minutes. I wished mightily that Win 95 had the Don't Sleep feature from Berkeley's screen savers. I realize that Win 95 is multitasking, and I probably could have turned off the screen saver while downloading in the background. I guess deep down, however, I don't trust multitasking and Internet downloads, and it wasn't that hard to wiggle the mouse every few minutes. Anyway, it downloaded just fine. Now to install it.

Navigator wants you to shut down everything, including the Internet connection, while you install its upgrade, after which it wants to get back on the Internet to call home, report what you've done, and download some more parts. It also offers you all kinds of options for plug-ins and accessories. The process is pretty straightforward unless you want to pay for the upgrade; to do that, you have to fill out a screen form, and part of the form is off the bottom of the screen. The "CONTINUE" button is on the top of the screen, and there is absolutely no indication that you haven't filled everything out. I tried to pay three times before I figured out that I had to scroll the screen.

Eventually I had Netscape Navigator Gold 3.0 installed, and I have to say it's pretty snappy.

Next thing was to find Windows Commander. I remembered that one reader had given me site addresses, and I was able to find that e-mail in my archive. One site is http://www.shareware.com, and it's very much worth knowing about, being an enormous collection of Mac, DOS, and Windows 3.x, 95, and NT freeware and shareware. It includes Windows Commander, which is a 600-KB ZIP file.

Navigator Gold 3.0 comes with a bunch of plug-ins and links, and one of those connects to WinZip, a wonderful utility that essentially automates ZIP operations. Alas, when Navigator downloads a ZIP file, it invokes WinZip, which is a viewer. If it has any provision for just saving the blasted ZIP file, I can't find it. The result was that I saw a file called wcmd211.zip in my D:\TEMP directory. I knew it was there because I went out to Windows and looked to see that it was in the directory. Unfortunately, when I went looking for the file later, it wasn't there. Gone. Vanished. And I hadn't installed a thing.

Back to shareware.com. Download again. This time, when I saw wcmd211.zip appear in the directory, I used Norton Commander to copy it to another directory. I told WinZip to run the install.exe file that was included in the ZIP directory. The installation went smoothly.

Windows Commander works, and while it's not Norton Commander, it's pretty good. There are even some features the original didn't have. However, I still like the look and feel of Norton Commander. I keep hoping Symantec will upgrade it to Win 95, but until then, I plan to send in my shareware fee and keep Windows Commander.

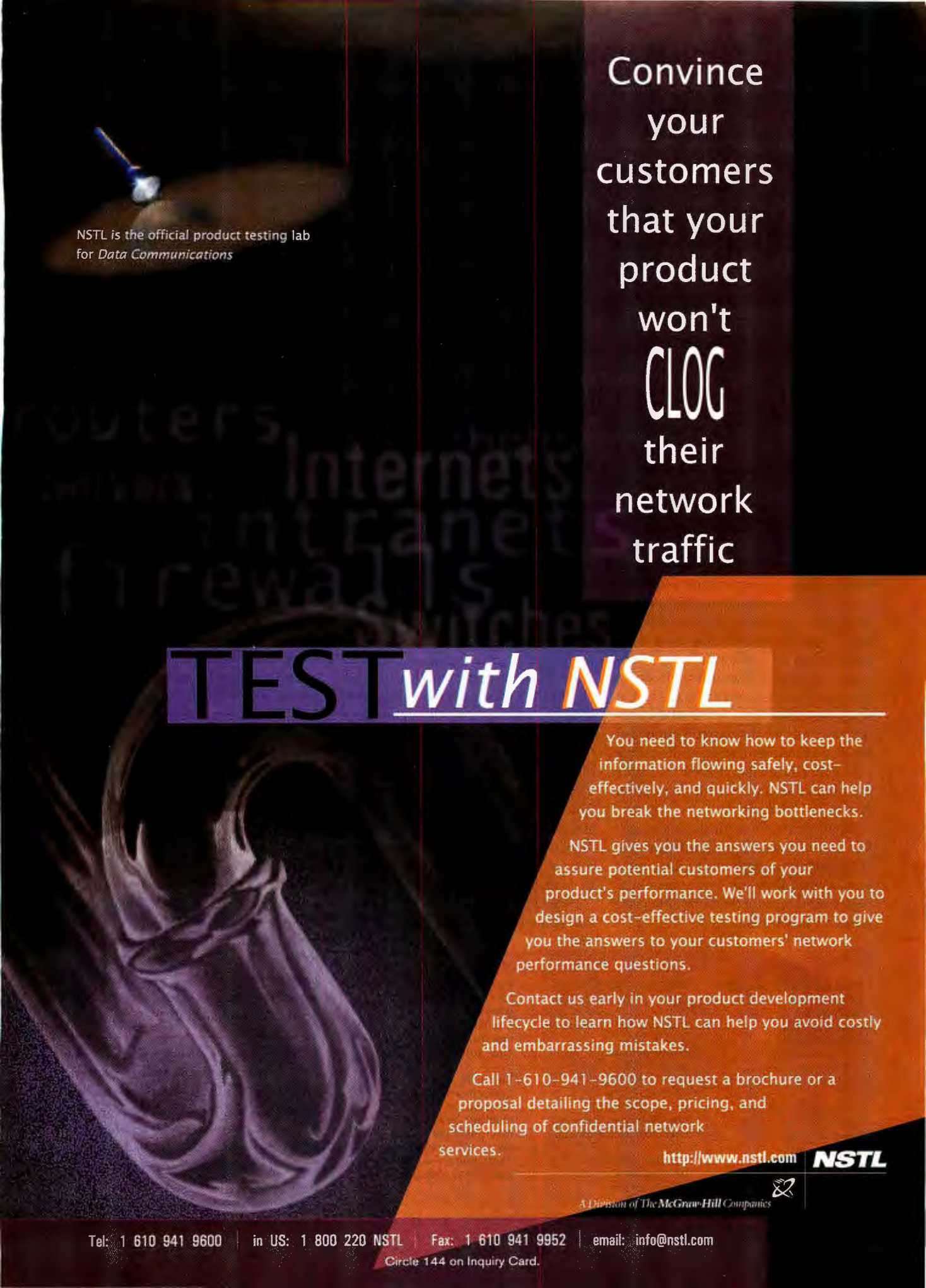
Don't we all love smart programs that know what you want better than you do?

Meanwhile, by gollies, although I had seen wcmd211.zip in my D:\TEMP directory, it isn't there now. On the other hand, the copy I made into another directory seems to be intact. On the gripping hand, I don't really need it since the installation program put the expanded files it contains into the appropriate places, and everything works.

I suppose there's some explanation of the interaction between Netscape Navigator Gold 3.0 and WinZip, but I can't find it. Be wary. Just because you think you downloaded a file and wanted to keep it doesn't mean it will stay around. Don't we all love smart programs that know what you want better than you do?

Meanwhile, if you spend a lot of time on the Net, you may find Starfish Internet Utilities a good investment. One feature, the InternetMeter, which keeps track of your on-line time and charges, is more useful to those who don't have flat-rate connect services; of course, nearly everyone has flat rate now. Still, it may be worthwhile knowing just how much time you're wasting.

The most useful feature is QuickMarks, which keeps track of your bookmarks regardless of which browser you're using, even if you frequently change from Netscape Navigator to Microsoft Internet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Explorer and back. QuickMarks allows you to organize and sort bookmarks so they're easier to find, and has a search feature in case you lose track of them. If you spend much time at all playing with the Internet, you'll accumulate a lot of bookmarks, and QuickMarks is the easiest way I know to organize them.

Granted, there are shareware versions of most features of Starfish Internet Utilities, but Starfish integrates them well, and the bookmark utility alone is well worth the program's price.

I said earlier that I'd get back to OS/2. I keep hoping IBM will do something with it, but I doubt they will. OS/2 has the potential to be a rival to both Win 95 and NT. IBM believes in solid code, understands servers very well, and used to understand marketing, particularly in corporate settings. They were never famous for mass marketing, but they sold a lot of IBM PCs and still sell ThinkPads as fast as they can make them.

Once upon a time, it was the in thing to bash Big Blue, and some people wanted to be admired as courageous for doing it, although I never quite understood why. I started with the opposite bias: back in the 1950s, IBM gave the University of Washington an IBM 650. They offered free programming lessons to any graduate student willing to go downtown to IBM headquarters and take the classes. I jumped at the chance, and for many years after, to me a computer meant IBM; I knew in a vague sort of way that IBM had rivals, but I doubt I could have named them.

They're still at the top in the server market, and they have server software for everything from desktops to the largest mainframes. They still have some of the best programmers in the world. They still have enormous resources.

What they don't seem to have is the ability to form strategic alliances with anyone but potential competitors.

Suppose they could do it. In particular, suppose they do whatever it takes to induce Corel to bring out the WordPerfect Suite for Merlin, it launches at the same time as Merlin SMP, and suddenly you can buy an OS, an applications suite, and great server software in one package, all integrated and simple to install in all IBM desktops and laptops. I think there would be quite a significant impact on the industry.

It's not even that hard to do. There won't be OS/2 support for Win 95 binary code, but IBM has written and published nearly all the APIs to let you recompile your source code. The only APIs that aren't out there deal with registry tweaking and security. Registry tweaking isn't nearly as good an idea as Microsoft thought it would be—I certainly would prefer editable ASCII INI files to registry arcana—and there's not a lot of security in Win 95 applications to begin with.

Alas, it's unlikely that IBM will go out and woo applications publishers, or learn how to market the result if they do, but it could happen, and it would be a very good thing for us all.

The CD-ROM of the month is DK Multimedia's Dinosaur Hunter. It's about what you'd expect, a trip through a virtual museum full of dinosaurs, and, of course, the CD-ROM can have a larger collection than any real museum.

Packaging CD-ROMs is a bit of a problem. The CD-ROM itself is small and thin and, like any CD, vulnerable to shoplifters in retail stores. On the other hand, if you put it into a bulky package, people expect more than just a CD for their money.

DK Multimedia's approach with Dinosaur Hunter is to give you a big heavy box with the Dinosaur Hunter CD-ROM, the EarthLink Total Access CD-ROM, a password to an Internet dinosaur information site, a pocket-size color handbook with at least as much information as there is on the CD-ROM, and a cardboard dinosaur-bones model that, if assembled, looks like it would be about 3 feet high.

Nothing really spectacular here, but if you know of a kid who likes dinosaurs, this ought to be just right for Christmas.

The book of the month is *Dave Barry in Cyberspace* (Crown, ISBN 0-517-59575-3). Fair warning: Dave is a Chaos Manor fan; see page 4. If you like his style of humor and you read BYTE, you will love this book. I'm not making this up.

The computer book of the month is by Robert Orfali et al, *The Essential Client/Server Survival Guide* (Wiley, ISBN 0-471-15325-7). This book has more than you wanted to know about client/server and presents it interestingly. NetBIOS, NetBEUI, pipes, stacks, databases, why you need to know about client/server; it's all here, and as intranets become more important, you'll find out you really did want to know all that and more, you just didn't know you needed to know it. Readable as well as being a good reference for a few more years.

The question I most often get both in person and by mail is "How do I get your job?" I've taken a stab at answering it, but it came out so long you'll have to look at http://www.byte.com to read it. While you're there, you can find some thoughts on "mushpad" pointing devices—my new Nimantics Orion 6× laptop has a mushpad, so I'm having to get used to it—and a few other things I didn't have room for in the column.

Meanwhile, in the pipeline is David Em's report (with my comments) on high-end graphics cards; text to speech; a nifty program for translation of documents to or from German, Spanish, and French; more on Partition Magic and System Commander; and the usual problems that crop up at Chaos Manor. B

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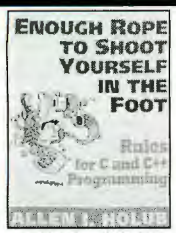

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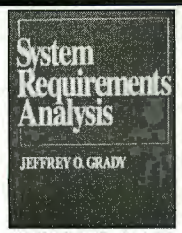

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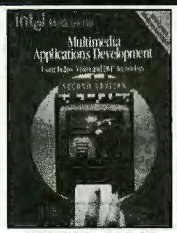

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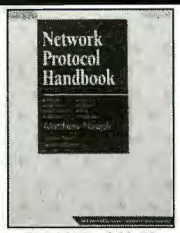

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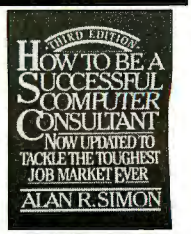

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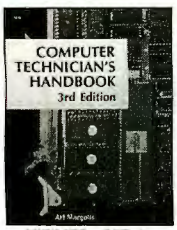

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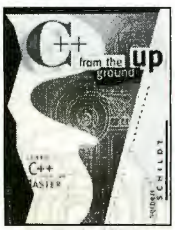

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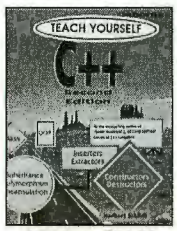

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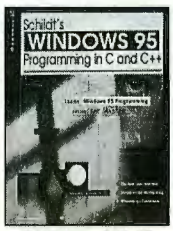

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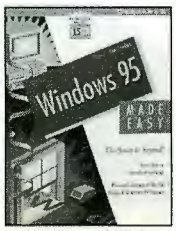

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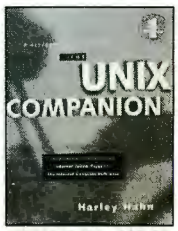

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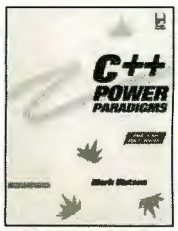

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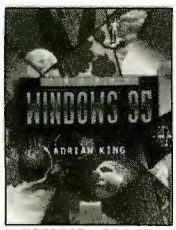

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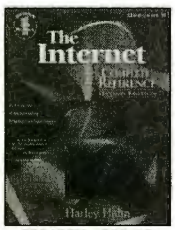

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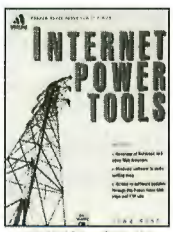

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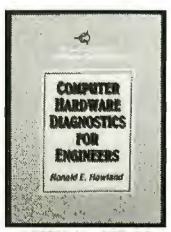

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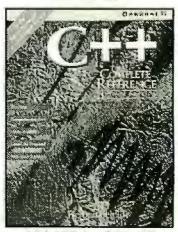

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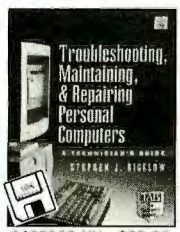

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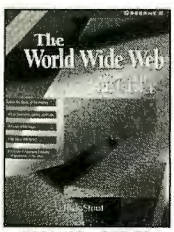

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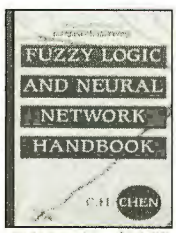

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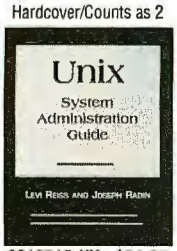

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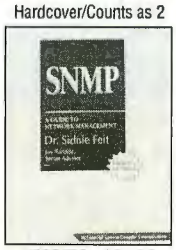

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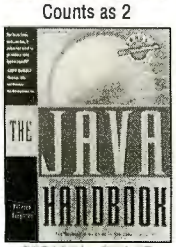

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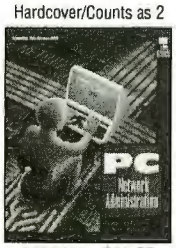

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Thinkpad 701, 701C	4Meg/8Meg/16Meg/32Meg	69/109/169/749
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Thinkpad 755C, CE, CD, CS	4Meg/8Meg/16Meg/32Meg	49/109/179/339
Thinkpad 760C, CD, L, LD	4Meg/8Meg/16Meg/32Meg	99/179/339
Thinkpad 760E, ED, EL, ELD	8Meg/16Meg/32Meg	109/189/539

COMPAQ MEMORY MODULES

Deskpro 486/25, 33L, 50L	2Meg/8Meg/32Meg	39/99/249
Deskpro 3/25i, 33i, 4/25iS, 66i	2Meg/4Meg/8Meg	39/69/89
Deskpro 386, 486 M Series	2Meg/4Meg/8Meg	39/69/69
Deskpro M Series Expansion Board	0K (no memory)	119.00
Deskpro 450, 4100, 575, 590, 5100, 5133	4Meg/8Meg/16Meg/32Meg	34/59/119/219
Deskpro 575, 5120, 5133, 5150, 5160 (EDO, pairs)	4Meg/8Meg/16Meg/32Meg	34/59/139/249
Deskpro 2000, 4000, 6000 Series (EDO, pairs)	4Meg/8Meg/16Meg/32Meg	34/59/139/249
Deskpro 5/60M, 5/66M, XE560 (quads)	2Meg/4Meg/8Meg/16Meg/32Meg	39/49/69/139/239
Deskpro XL (pairs)	4Meg/8Meg/16Meg/32Meg	39/49/69/139/239
Deskpro XL 6150, 6200 (ECC, pairs)	8Meg/16Meg/32Meg/64Meg, 128Meg	Call
Presario 510, 520, 524, 660, 720, 724, 860	4Meg/8Meg/16Meg/32Meg	34/59/109/219
Presario 920, 924, 954, 974, 978, 992	4Meg/8Meg/16Meg/32Meg	34/59/109/219
Presario 833, 850, 880, 866	4Meg/8Meg/16Meg/32Meg	39/64/119/239
Presario 5528, 7110, 7152	4Meg/8Meg/16Meg/32Meg	34/59/109/219
Presario 7170, 7180, 9536, 9546, 9548, 9564 (pairs)	4Meg/8Meg/16Meg/32Meg	34/59/109/219
Presario 9232, 9234, 9240, 9250, 9642, 9660 (pairs)	4Meg/8Meg/16Meg/32Meg	34/59/109/219
Proliant 1000 5/60, 2000, R, 4000, R (quads)	4Meg/8Meg/16Meg/32Meg	39/64/119/239
Proliant 1500, 1500R (pairs)	4Meg/8Meg/16Meg/32Meg	39/64/119/239
Proliant 4500, 4500R (quads)	4Meg/8Meg/16Meg/32Meg/64Meg	39/64/119/239/599
Proliant 5000, 5000R (pairs)	32Meg/64Meg/128Meg/256Meg	Call
Prolinea 4/25S, 4/33, 4/66	2Meg/4Meg/8Meg	39/49/69
Prolinea (enhanced), MT	4Meg/8Meg/16Meg/32Meg	49/69/129/229
Prolinea 575, 590, 5100, 5120, 5133 (pairs)	4Meg/8Meg/16Meg/32Meg	39/69/119/239
Prolinea 5100, 5120, 5133, 5150, 5166 (EDO pairs)	4Meg/8Meg/16Meg/32Meg	39/69/139/259
Prolinea 575E, 100E, 120E, 575MX (pairs)	4Meg/8Meg/16Meg/32Meg	39/69/119/239
Prolinea 590MX, 5120MX (pairs)	4Meg/8Meg/16Meg/32Meg	39/69/119/239
Prolinea 8150E, 6180E (pairs)	8Meg/16Meg/32Meg	69/119/239
Prosignia 300 5/75, 5/90, 5/120, 5/150 (pairs)	4Meg/8Meg/16Meg/32Meg	39/69/119/259
Prosignia 500 5/90, 5/120, 5/150 (pairs)	4Meg/8Meg/16Meg/32Meg	39/69/119/259

COMPAQ NOTEBOOK & LAPTOP MEMORY

Armada 1120, T	8Meg/16Meg/32Meg/64Meg	119/199/Call/Call
Armada 4100, 4110, 4120, 4130	8Meg/16Meg/32Meg Kit	Call
Concerto 4/25, 433	4Meg/8Meg/16Meg	79/99/169
Contura 4/25, C, CX	4Meg/8Meg/16Meg	79/99/169
Contura 400C, 400CX, 410C, 410CX	4Meg/8Meg/16Meg	79/99/169
Contura 420C, 420CX, 430C, 430CX	4Meg/8Meg/16Meg/24Meg	49/79/169/239
Contura Aero 4/25, 4/33	4Meg/8Meg/16Meg	69/99/169
LTE 5000, 5100, 5200, 5300	8Meg/10Meg/32Meg/64 Meg Kit	99/149/266/513
LTE Elite 4140C, CX, 4/75CX	4Meg/8Meg/16Meg/24Meg	49/89/179/249

LASER PRINTER MEMORY UPGRADES

AMOUNT UPGRADED	OK Bd	256k	1	2	3	3.5	4	5	6	8	16	32
Brother 630, 631, 641, 645	–	–	69	69	–	–	–	–	–	–	–	–
Canon LBP 430	–	–	39	–	–	–	49	–	–	–	–	–
Canon LBP 860, 1260	–	–	–	39	–	–	69	–	–	94	144	309
Canon LBP4, 4Lite, 4plus	–	–	129	179	–	–	–	–	–	–	–	–
Epson 6000, Action Laser	–	–	–	129	–	–	229	–	–	–	–	–
Epson Action Laser 1100, 1600	–	–	69	70	–	–	99	–	–	199	359	–
Epson Action Laser II	–	–	74	–	173	–	–	272	–	–	–	–
Epson 8000, 1800, 4000, 4100, 4300	–	–	89	–	173	–	–	272	–	–	–	–
Epson 1000, 1500, 5000, 5200	–	–	–	89	–	–	178	–	–	–	–	–
HP 2, 2D–	–	–	–	69	–	–	99	–	–	–	–	–
HP 3, 3D, 3P, 2P 2P+	–	–	–	*69*	–	–	*89*	–	–	–	–	–
HP 4, 4M, 4Si, 4SiMX	–	–	–	49	–	–	59	–	–	99	–	–
HP 4P, 4PLUS, 4MPm 1600, 1600CM	–	–	19	29	–	–	49	–	–	89	–	–
HP 4L	–	–	34	–	–	–	–	–	–	–	–	–
HP 3Si	–	–	39	–	–	–	69	–	–	99	–	–
HP 5L	–	–	49	74	–	–	89	–	–	199	–	–
HP 5P, 5MP, 4V, 4MV	–	–	19	39	–	–	49	–	–	89	124	–
HP Design Jet 600, 650, 200	–	–	–	39	–	–	49	–	–	89	139	239
HP Deskjet 500, 500C, 510, 550,560	–	*34*	–	–	–	–	–	–	–	–	–	–
HP Deskjet 1200C, 1200C/P	–	–	–	39	–	–	49	–	–	69	–	–
HP Paintjet XL300	54	–	–	–	–	–	69	–	–	144	299	–
IBM Laser 4019, 4019E	–	–	–	–	–	139	–	–	–	–	–	–
IBM Laser 4029, 4037	–	–	–	–	–	–	89	–	–	–	–	–
IBM Laser 4039, 4079	–	–	–	*69*	–	–	*89*	–	–	*189*	–	–
Konica LP-3110, 3115	–	–	119	189	239	–	–	–	–	–	–	–
Lexmark Medley 4C, 4x, 4SX	–	–	Call	Call	Call	–	–	–	–	–	–	–
Lexmark, Optra L, LX, R, RX	–	–	–	–	–	–	59	–	–	94	139	259
Lexmark Valuwriter 300,600	–	–	29	39	–	–	89	–	–	–	–	–
Lexmark Winwriter 200, 400, 600	–	–	29	39	–	–	89	–	–	–	–	–
NEC 90, 290	–	–	–	69	–	–	–	–	–	–	–	–
NEC 95, 97	–	–	–	79	–	–	–	–	–	–	–	–
Oki 400	–	–	–	79	–	–	–	–	–	–	–	–
Oki 400E, 400EX, 410E, 410EX	–	–	89	109	169	–	189	–	–	–	–	–
Oki 810E, EX, 600E, EX, 610E, EX	–	–	29	39	–	–	79	–	–	119	179	–
Oki 830, 840	–	–	–	89	–	–	–	–	–	–	–	–
Oki 2350, 2450	–	–	Call	Call	–	–	–	–	–	–	–	–
Packard Bell PB 9500	–	–	–	139	–	–	227	–	–	–	–	–
Packard Bell 9815	–	–	–	139	–	–	229	–	–	–	–	–
Panasonic 4420/4450i	–	–	–	99	–	–	169	–	–	–	–	–
Panasonic 4410/4430	–	–	–	*69*	–	–	*129*	–	–	–	–	–
Panasonic 4450	–	–	69	–	–	–	–	–	–	–	–	–
Panasonic 4400/5400	–	–	89	99	–	–	189	–	–	–	–	–
Panasonic 4440, 5410, 6500	–	–	79	99	–	–	159	–	–	–	–	–
Sharp 9400, 9460, 9600, 9700E	–	–	69	99	–	–	149	–	–	–	–	–
Sharp 9500, E, H, 9700, H	–	–	79	–	–	–	259	–	–	–	–	–
TI XL/PS17/PS35	–	–	49	–	–	–	–	–	–	–	–	–
TI Microlaser Pro E, Powerpro, Pro 600	–	–	89	129	–	–	189	–	–	329	–	–
TI Microwriter	–	–	79	119	–	–	–	–	–	–	–	–

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Compaq Contura 410, 420, 430 — $109.00
Epson ActionNote 800, 866C, 880C — $134.00
NEC Versa E, V — $119.00
NEC Versa S — $119.00
Toshiba 610 and 400 — Call
Toshiba 1900, 1910, 1950, 1960 — $119.00
Toshiba 2400, 4700, 4800, 4900 — $119.00
Toshiba 2100 Series — $121.00

TOSHIBA LAPTOP MEMORY

MODEL	AMT. UPGRADED	MANU. PART #	PRICE
Tecra 500/P650	*8Meg/16Meg/32Meg/48Meg/128Meg*		*119/239/459/Call/Call*
Tecra 700 (SDRAM)	*8Meg/16Meg/32Meg*		*119/259/429*
Tecra 710, 720	*8Meg/16Meg/32Meg/64Meg/128Meg*		*119/259/429/Call/Call*
T2000SXE/2200SX/T1800, 1850, C	8Meg	PC-PA2000U	94.00
T2100, 2105, 2150, 2155, 2110, 2115	4Meg/8Meg/16Meg/24 Meg		69/89/169/229
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	4Meg	PC-PA2012U	69.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	8Meg	PC-PA2013U	79.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	16Meg/32Meg	PC-PA2014U	159/279
T3400CT, T2400, T3600	4Meg/8Meg/16Meg/24Meg	PC-PA2019U	89/119/179/Call
T100, 105, 110, 115	*8Meg/16Meg/32Meg*		*119/189/319*
T400, 405, 410, 415, 420, 425	*8Meg/16Meg/32Meg*		*119/189/319*
T400CS, 400CDT, T100, 105 Edo	*8Meg/16Meg/32Meg*		*119/189/319*
T600, 610, CT Edo	8Meg/16Meg/32Meg		119/189/319

NOTEBOOK, LAPTOP MEMORY

MODEL	AMT. UPGRADED	MANU. PART #	PRICE
ACERNote 730C, 735C, 760C, 760CX, 780CX	2Meg/4Meg/8Meg		49/69/99
ACERNote 763, 765, 782, 784, 786	4Meg/8Meg/16Meg		59/79/159
ACERNote Light 350, 352, 355	4Meg/8Meg/16Meg		69/99/169
ACERNote Light 356, 358, 359, 361 (pairs)	4Meg/8Meg/16Meg		69/99/169
ACERNote Pro 950, 954, 955, 957, 959 (pairs)	4Meg/8Meg/16Meg		79/109/189
Ambra N Series	*4Meg/8Meg/12Meg/16 Meg*		*89/109/139/189*
Ambra SN Series	4Meg/16 Meg		79/179
Ambra N-75, N-100	4Meg/8/16		49/89/169
AST Ascentia P30, P50	*8Meg/16Meg/32Meg*		*89/189/309*
AST Ascentia J10, J30, J50	*8Meg/16Meg/32Meg/40Meg Kit*		*99/189/Call/Call*
AST Ascentia 900N, 800N, 810, 910	8Meg/16Meg		99/189
AST Ascentia 950	8Meg/16Meg		99/189
AST Bravo & Explorer	*4Meg/16Meg*	*501255-001, -002*	*79/219*
AST Notebook Prem Exec 386SX/20/25/25L	4Meg	500814-003	69.00
AST Power Exec 3/25C, 425EL, 425SL	4Meg/16Meg	501166-001, -003	79/189
AST Power Exec 4/33SL	4Meg/16Meg	501318-001,002	79/189
AT&T Globalyst 130, 200, 250	4Meg/8Meg/16Meg		69/99/149
Austin DX4, DX2, SX2, SX Series	4Meg/16Meg		79/219
Austin Vista	*4Meg/8Meg/16Meg/20Meg*		*Call*
Canon Innova Book 150, 175	4Meg/16Meg		69/169
Canon Innova Book 200LS	4Meg/8Meg/16Meg/24Meg		69/99/219/349
Canon Innova Book 350CD, 360, 475	*8Meg/16Meg*		*89/169*
Canon Innova 486-10	4Meg/16Meg		79/219
CTX EZ Book 5x86 Pent. Series	*4Meg/8Meg/16Meg*		*Call*
DEC HiNote, Ultra HiNote	4Meg/8Meg/16Meg		69/109/189
DEC HiNote VP	*8Meg/16Meg/32Meg*		*89/189/299*
Dell Lattitude LM (pairs)	*4Meg/8Meg/16Meg*		*69/99/189*
Dell Lattitude 433, C, CX	4Meg/16Meg		79/199
Dell Lattitude LMP (pairs)	4Meg/8Meg/16Meg		79/119/199
Dell Lattitude LX, M	4Meg/8Meg/16Meg		79/119/199
Dell Latitude XP, XPi	4 Meg/8Meg/16 Meg		79/119/199
Epson ActionNote 650, 650c, 660c, 660cx	4Meg/8Meg/16Meg		69/109/189
Epson ActionNote 700, 700c, 700cx	4Meg/16Meg		79/189
Epson ActionNote 880, 866c, 890	4Meg/8Meg/16Meg/20Meg		59/89/159/199
Epson ActionNote 4LC/25, 4LC/33, 4SLC/2-50, 4000	6Meg		79.00
Everex Tempo LX, LX20, Carrier	2Meg	PCA 00053-0001	89.00
Fujitsu Monte Carlo	*8Meg/16Meg/32Meg*		*79/159/299*
Gateway 2000 Colorbook 4/33	4Meg/16Meg		69/179
Gateway 2000 Nomad 425 DXL/SXL	4Meg/16Meg		159/759
Gateway 2000 486 Handbook or Liberty	4Meg/16Meg		59/169
Gateway 2000 Solo Series	4Meg/8Meg/16Meg		79/109/199
Gateway 2100 Solo Series	8Meg/16Meg/32Meg		Call/Call/Call
Hitachi C-Series	*8Meg/16Meg/32Meg*		*99/189/369*
Hitachi M-Series	*8Meg/16Meg/32Meg*		*129/249/518*
HP Omnibook 300, 480, 425	2Meg/4Meg		83/129
HP Omnibook 530, 600	4Meg/8Meg/12Meg		69/89/149
HP Omnibook 4000	4Meg/8Meg/16Meg		69/89/169
HP Omnibook 5000	8Meg/16Meg/32Meg		89/169/319
Leading Edge Aviva 2000	4Meg/16Meg		69/179
Lexmark SE10	4Meg/8Meg		79/119
Magnavox Metalis	4Meg	286, 386SX	119.00
Micron Transport Pentium	8Meg/16Meg Kit		119/219
Midwest Micro Elite or Soundbook	4Meg/8Meg/16Meg		79/119/199
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NCR Safari 3180, 3181	4Meg/8Meg		79/119
NEC Ultralite Versa, E, V, MP	4 Meg/8Meg/16Meg/20Meg	OP4104	64/99/199/299
NEC Versa S, Versa 2000C & 2000D, 500	4Meg/8Meg/16Meg		59/99/169
NEC Versa 4000, 4050/4080	4/8/16/32Meg		69/99/169/299
NEC Versa 6000	*8/16/32Meg*		*169/299/539*
Olivetti Echos P75-P1335 (pairs)	4Meg/8Meg/16Meg		89/129/219
Packard Bell 386SX, 286	4Meg	286, 386SX	89.00
Packard Bell Statesman	2Meg/8Meg		49/99
Panasonic CF-V21P, CF-580	4Meg/16Meg		69/169
Panasonic CF-V41	4Meg/8Meg/16Meg/32Meg		79/119/219/369
Sager Midern, all models	*4Meg/8Meg/16Meg/32Meg*		*Call*
Samsung Sens 810	8Meg/16Meg		Call
Sanyo 17/18 NB	2Meg	MBC-NBMEM2	89.00
Sceptre Soundx, all models	*4Meg/8Meg/16Meg*		*89/129/239*
Sharp 3030, 3070	*8Meg/16Meg/32Meg*		*109/179/349*
Sharp 6781, 6881, 6785, 6700, 6800, 6741	2Meg/4Meg		79/129
Sharp 8150, 8650, 8660, 7700, 7760	4Meg/16Meg		69/189
Sharp 8700, 8800, 8900	4Meg/8Meg/16Meg		69/109/189
Sharp 3010, 3020, 3050, 3060	4Meg/8Meg/16Meg		69/109/189
Sharp 9000, 9030	8Meg/16Meg/32Meg		79/189/399
Sharp 9040, 9070 (pairs)	4Meg/8Meg/16Meg/32Meg		69/129/265/525
TI 4000, TI 4000E, TI 4000M	4Meg/16Meg		140/719
TI 5000, 5100, 5200, 5300	*8Meg/16Meg*		*99/199*
TI 6020, 6030	*8Meg/16Meg/32Meg*		*219/399/Call*
TI Extensa, 450, 450T, 455, 455T, 570	4Meg/8Meg/16Meg		59/99/169
TI Extensa, 550, 555, 560, 565 (pairs)	*4Meg/8Meg/16Meg*		*59/99/169*
Tandy 2820, 3820, 3830	2Meg/4Meg/6 Meg		65/99/135
Tulip, all models	*4Meg/8Meg/16Meg/32Meg/64Meg*		*Call*
Twinhead, Altima, Compudyne, 486SX, DX, Tandy 4860	4Meg/16Meg		79/189
Twinhead Slimnote 5	4Meg/8Meg/16Meg		79/99/189
Ultra 486 TS38	4Meg/8Meg/16Meg		79/99/189
Winbook XP	16Meg/32Meg		79/229/469
Zeos 386SX Notebook (not the + version)	2Meg		49.00
Zenith Master Sport SL, SLE, 600, 620, 625NL	2Meg	ZA-4-4	69.00
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Zenith Z-Note MX	4Meg/8Meg/16Meg		69/99/179
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Zenith Z-Star EX	*4Meg/8Meg/16Meg*		*59/109/169*

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14,400/14,400 Data/Fax Modem	59	*Audio Card*	*149*
Readwriter Card (ISA Slot)	149	Multimedia Combo, Sound/SCSI	499
Lan Ethernet (Coax), (10 Base T)	89	Type III 340 Mg Hard Drive	479
28.8 Comm. from Simple w/SimplJack	219	33.6 Data Combo Card 33.6/14.4 & Ethernet	399

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		1.6 GIG		239	1.6 GIG	AC31600	259
		2.0 GIG		276	2.1 GIG	$339 2.5 GIG	$389

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1.3 GIG	786	2.1 GIG	889	1.3 GIG	769
2.1 GIG	889	Versa 2000,4000 – 810mg	$499	2.1 GIG	849
THINKPAD 760 – 1.3 GIG	$768	1.3 GIG	768		
COMPAQ		**TOSHIBA**			
LTE 5000,5100–810m	$519	4700/4800 – 810mg	$499		
1.3 GIG	885	1.3 GIG	786		
2.1 GIG	910	Tecra T700 – 810mg	$749		
		1.3 GIG	829		

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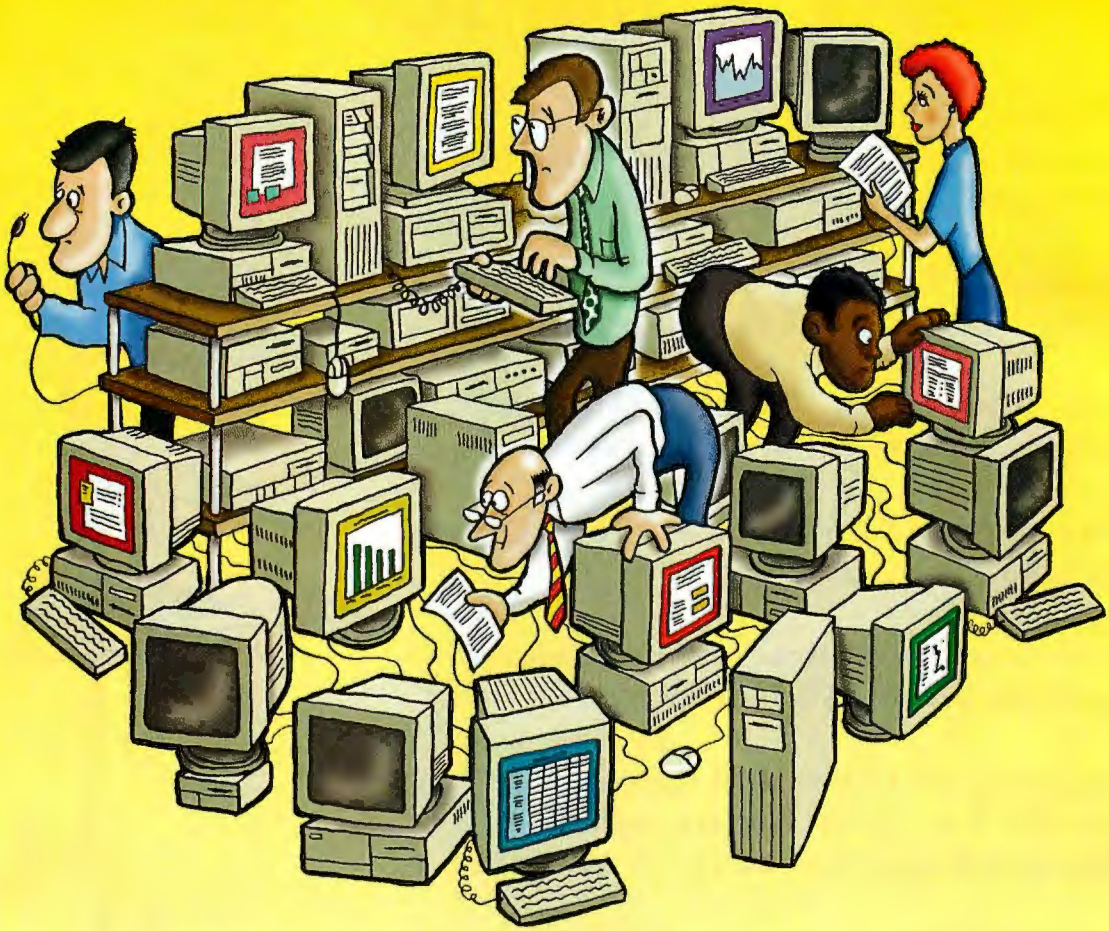

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ACPC-03	PC power adapter cable	2.29	2.06
ACPC-04	Monitor power ext. cable, 6 ft.	3.69	3.32
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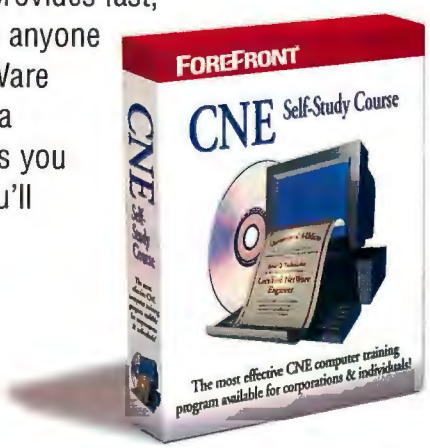

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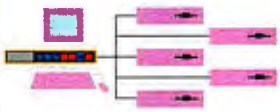

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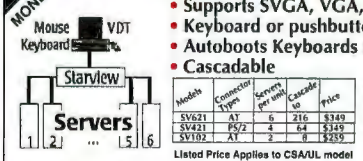

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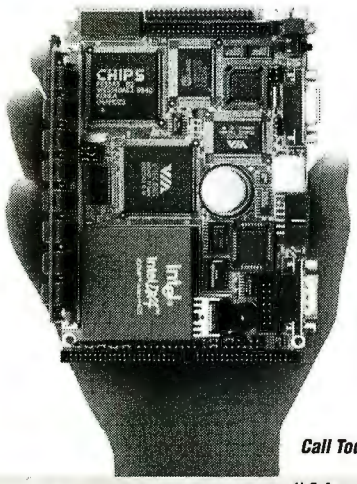

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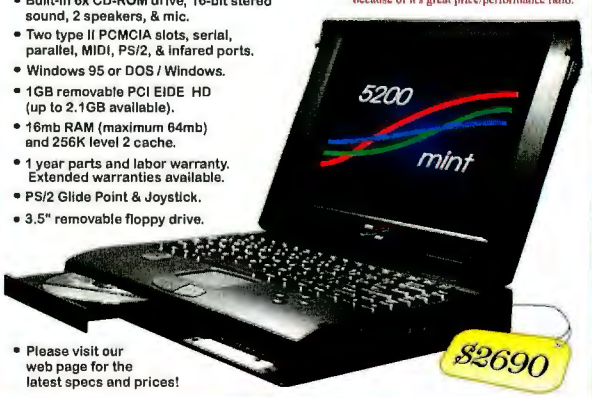

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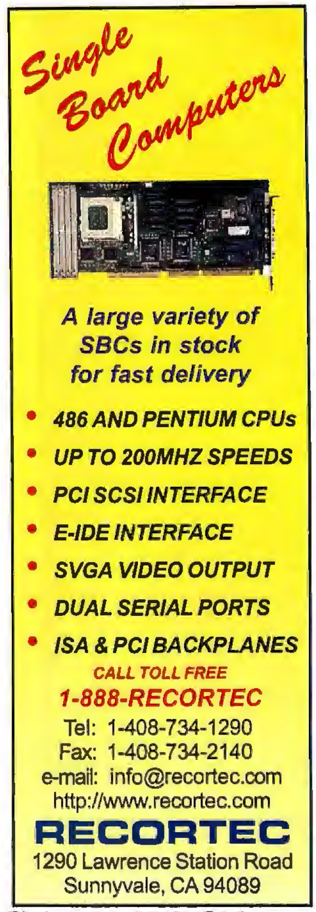

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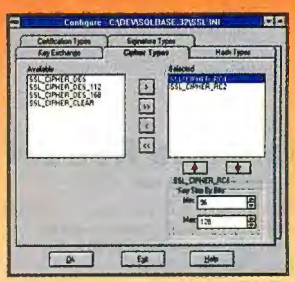

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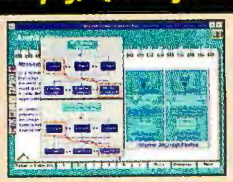

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	I		
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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102
103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119
120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136
137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153
154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170
171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187
188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204
205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221
222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238
239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255
256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272
273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289
290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306
307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323
324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340
341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357
358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374
375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391
392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408
409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425
426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442
443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459
460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476
477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493
494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510
511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527
528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544
545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561
562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578
579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595
596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612
613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629
630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646
647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663
664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680
681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697
698	699	700	851	852	853	854	855	856	857	858	859	860	861	862	863	864
865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881
882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898
899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915
916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932
933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949
950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966
967	968	969	970	971	972	973	974	975								

Editorial Inquiry Numbers

976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992
993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009
1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026
1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043
1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060
1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077
1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094
1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111
1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128
1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145
1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162
1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179
1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196
1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213
1214	1215	1216	1217	1218	1219	1220	1221	1222	1223	1224	1225	1226	1227	1228	1229	1230
1231	1232	1233	1234	1235	1236	1237	1238	1239	1240	1241	1242	1243	1244	1245	1246	1247
1248	1249	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260	1261	1262	1263	1264
1265	1266	1267	1268	1269	1270	1271	1272	1273	1274	1275	1276	1277	1278	1279	1280	1281

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Hardware

Accessories/Supplies	1
Add-in Boards	2
Communications	4
Computer Telephony	60
Data Acquisition	6
Desktops	5
Diagnostic Equipment	53
Disk Drives	7
Fax Boards/Machines	9
Input Devices	10
ISDN Hardware	61
Laptops & Notebooks	13
Mass Storage	23
Memory/Chips/Upgrades	15
Midrange/Mini Computers	62
Miscellaneous Hardware	16
Modems/Multiplexors	17
Monitors & Terminals	18
Multimedia/CD-ROM	19
Network Hubs/Switches	63
Networking	64
Optical Drives	65
PCMCIA	57
Printers/Plotters	20
Programmable Hardware	21
Scanners/OCR/Digitizers	22
SCSI/Peripheral Interfaces	59
Security	52
Servers	66
UPS/Power Management	24
Voice Technology	55
Workstations	67

Software

Business	25
CAD/CAM	26
Communications	27
Data Acquisition	28
Data Warehousing	68
Database	29
Educational	30
Engineering/Scientific	31
Entertainment	32
Graphics	33
Internet Services	69
Internet/Intranet	70
Macintosh	34
Mathematical/Statistical	36
Middleware	71
Miscellaneous Software	37
Net Management	72
Networking	73
On-Line Services	38
Operating Systems	39
Programming Languages/Tools	40
Security	41
Spreadsheets	44
UNIX	45
Utilities	46
Windows 95	47
Windows NT	74
Word Processing/DTP	48

General

Books/Publications	49
Recruitment	50
Mail Order	75
Miscellaneous	51

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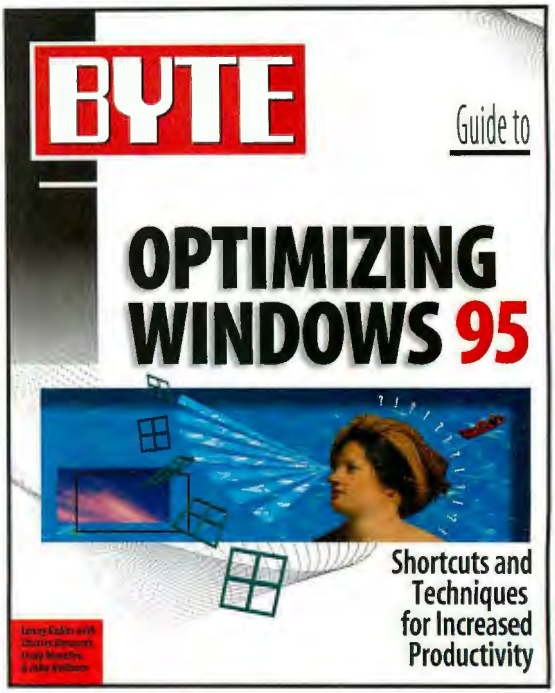

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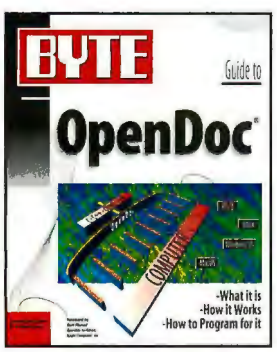

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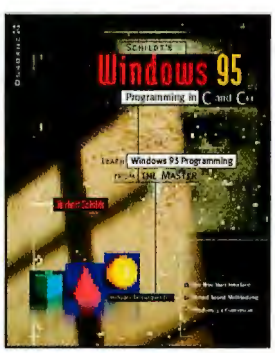

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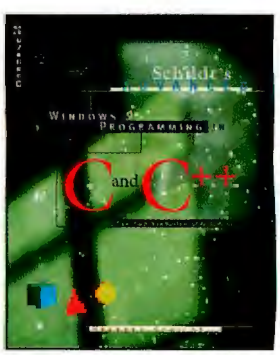

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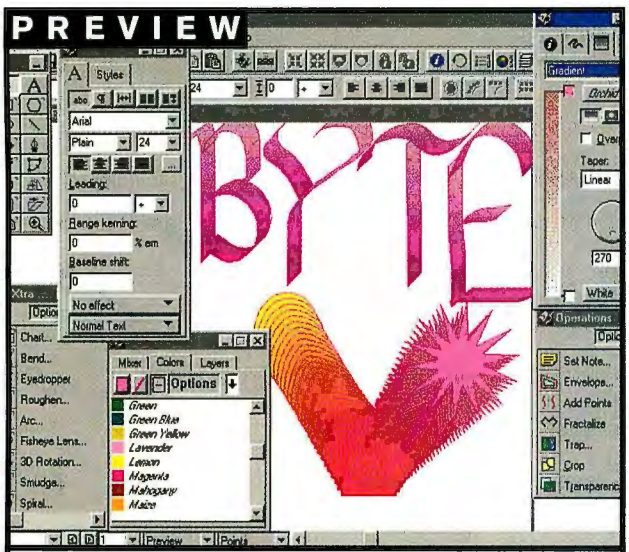

FreeHand Graphics Studio 7
about $449

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Graphics and Web-Page Production Suite

Macromedia's FreeHand Graphics Studio 7 includes four integrated cross-platform graphics programs: FreeHand 7, Macromedia xRes 3, Extreme 3D 2, and Fontographer 4.1. Together, they provide tools you can use for illustration and page design; image creation and editing; 3-D modeling, animation, and photo-realistic rendering; and font design. I tested the beta version of the suite on a Dell Optiplex XM 575 running Windows 95 and on a Power Mac 7100 running System 7.5.3.

The customizable palettes (drag-and-drop tabbed items to combine frequently accessed menus) and its docking feature (similar to "grouping" objects) ease work flow and save navigation time (see the screen). I found the ability to drag and drop from Adobe Photoshop, Adobe Illustrator, and Macromedia xRes—and between color palettes and objects or other menus—a highlight.

Built-in support for Shockwave lets you embed FreeHand graphics in Web pages. In addition, the suite provides cross-platform graphics export in GIF, JPEG, PNG, or PDF format. FreeHand easily handles QuarkXPress and Adobe PageMaker files, and includes AppleScript support. With behind-the-scenes file linking, FreeHand automatically updates changes to imported images without requiring you to reimport the edited file.

If you can tolerate the cumbersome nature of component switching, the trade-off with FreeHand Graphics Studio 7 is dynamite graphics production.

–Joy-Lyn Blake

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We look at Macromedia's FreeHand Graphics Studio 7, a graphics production package, and Psion's Siena pocket-size information manager.

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Contact: FacetCorp., Plano, TX, (214) 985-9901; http://www.facetcorp.com.
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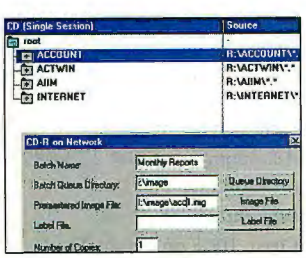

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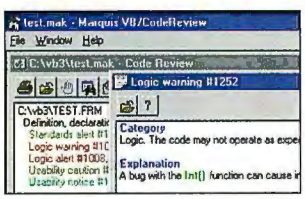

bugs; Visual Basic 3.0 and 4.0 bugs; DAO, Jet, and ODBC bugs; and Windows API bugs. The package includes code formatting and naming systems, as well as tools for developing code metrics such as function points and complexity.
Contact: Marquis Computing, Inc., Pomfret Center, CT, (800) 818-1611 or (860) 963-7065; http://www.marquistools.com.
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Contact: Renaissance Software, Inc., Dresher, PA, (215) 619-0130; rsisupport@aol.com.
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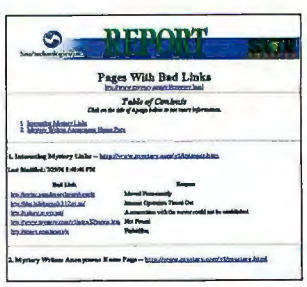
IF YOU ARE CONCERNED ABOUT TRANSMITTING e-mail, credit-card payments, and sensitive data over the Internet, Cloaking Device ($49.95) may interest you. The Windows 95 program features on-the-fly encryption and decryption; password protection; tamper resistance and virus protection; compression and decompression of batch files; and the ability for CompuServe users to send and receive binary files.
Contact: TommySoftware, San Francisco, CA, (800) 275-9406 or (415) 522-0612; http://www.tommysoftware.com.
Circle 988 on Inquiry Card.

Maintain Multiple Web Servers

A WINDOWS 95/NT WEB-SITE MAINTENANCE tool, SiteSweeper 1.0 ($299) evaluates file types (text, image, audio, or video), their sizes, and dates of last modification; the number of images on a page; the total download size of the page; and the links to and from the page. You get a suite of reports that you can generate on demand or at scheduled times. SiteSweeper is based on an open-database architecture.
Contact: Site/technologies, Inc., Durham, NC, (800) 722-0607 or (919) 416-3113; http://www.sitetech.com.
Circle 989 on Inquiry Card.



Custom Mapping for Web Publishers

ETAK'S SUITE OF INTERNET MAPPING PRODucts (call for prices) includes E-Map View, which contains Etak's nation-

wide digital map database, a map server, customization control of the map's "look and feel," and a CGI for the Web interface; E-Map Route, which adds routing capability to E-Map View and allows you to dynamically generate directions between two points; and E-Map Locate, a geocoding server that assigns latitude and longitude coordinates to addresses, intersections, or cities.
Contact: Etak, Inc., Menlo Park, CA, (800) 765-0555 or (415) 328-3825; http://www.etak.com.
Circle 990 on Inquiry Card.

Video

Streaming Video and Audio

ALL-IN-ONE VIDEO-FILE PLAYBACK SOFTWARE for Windows 3.x, 95, and NT, Video Express Viewer 1.0 ($39.95) supports downloadable video-file formats and plays streaming-medium formats, such as ActiveMovie Streaming Format files. You can use the program to play Internet radio

broadcasts, multimedia slide shows, and Web TV shows.
Contact: ImageMind Software, Inc., Salt Lake City, UT, (800) 321-5933 or (801) 350-9461; http://www.imagemind.com.
Circle 992 on Inquiry Card.

Compress and Edit MPEG-1 Video

IF YOU WANT TO INCORPORATE MPEG video into your Web pages, the MPEG Toolbox CD-ROM ($125) lets

you convert and compress video sequences (AVI or WAV format) or series of images (BMP, TIFF, TGA, GIF, or PCX format) into an MPEG-1 sequence in audio, video, system, or Video CD format; edit MPEG-1 sequences, adding special effects, such as titles and fade-in and fade-out; and run MPEG-1 and Video CD files full-screen at a rate of between 25 and 30 images per second on a Pentium 90 machine.
Contact: Vitec-HTS, Sarasota, FL, (941) 351-9344; http://www.vitechts.com.
Circle 991 on Inquiry Card.

Software Updates

With **Project Scheduler 7 for Windows 95/NT**, you can customize the look of the interface; create and store an unlimited number of custom fields, formulas, and filters directly within the project database; and share project data with teams down the hall, across town, or around the world. $695.
Contact: Scitor Corp., Menlo Park, CA, (800) 533-9876 or (415) 462-4200; http://www.scitor.com.
Circle 995 on Inquiry Card.

Version 2 of the **C++ Component Series** consists of the following 10 libraries in the <ToolKit> series: Standards, Helper, Thread, Time, Streaming, Network, Pipe, File, Platform, and Web. They're all portable across popular hardware platforms, OSes, and compilers. Call for prices.
Contact: ObjectSpace, Inc., Dallas, TX, (800) 625-3281 or (214) 934-2496; http://www.objectspace.com.
Circle 996 on Inquiry Card.

Visual SQL 4.2 turns Microsoft Visual C++ Enterprise Edition and Visual C++ 4.x into C++ client/server development environments, extending Visual C++ with visual designers, intuitive wizards, and object-oriented data access. $1499.
Contact: Blue Sky Software, La Jolla, CA, (800) 457-4946 or (619) 459-6365; http://www.blue-sky.com.
Circle 997 on Inquiry Card.

HARDWARE

Accessories

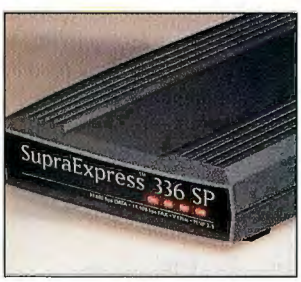
3-D Product Combinations

THREE MULTIMEDIA PACKAGES INCLUDE miroMedia 3D ($199), a standalone 2-D/3-D video graphics accelerator; miroMedia 3D with StereoGraphics' Simuleyes VR Stereo-Vision 3D Eyewear ($299); and miroMedia 3D with Simuleyes and miroMedia's Surround sound card ($399).
Contact: miro Computer Products, Inc., Palo Alto, CA, (800) 474-6476 or (415) 855-0955; http://www.miro.com.
Circle 999 on Inquiry Card.

Communications

Fax Modem to Share Voice and Data

INCORPORATING A SPEAKERPHONE, THE SupraExpress 336 Sp with ASVD (internal, $149; external, $169) delivers transmission speeds of 33.6 Kbps and V.80 video-phone functionality for synchronous exchange of audio and video. The package includes Thought Communications' FaxTalk Messenger software with remote-notification and fax-on-



demand capabilities, Databeam's FarSite application-sharing software, and VDONet's VDOPhone software for videoconferencing over ordinary phone lines.
Contact: Diamond Multimedia Systems, Inc., San Jose, CA, (800) 727-8772 or (360) 604-1400; http://www.supra.com.
Circle 1000 on Inquiry Card.

ISDN-to-PCI-Bus Connection

A PLUG AND PLAY COM PORT FOR CONNECTING to external ISDN terminal adapters, the LavaLink-PCI Dual-Port Communications Accelerator Board (US$149.99) supports data transfer rates of up to 460.8 Kbps. Each of the board's two COM ports incorporates a 32-byte FIFO buffer and an intelligent I/O processor, allowing Internet and remote-access applications to transfer data at the full bandwidth of the ISDN terminal adapter.
Contact: Lava Computer Manufacturing, Inc., Rexdale, Ontario, Canada, (800) 241-5282 or (416) 674-5942; http://www.lavalink.com.
Circle 1001 on Inquiry Card.

33.6-Kbps PC Card Data/Fax Modem

THE DATALINK PC CARD 33.6 MODEM ($239), which is available for PC and Mac portable computers, features power management that saves battery life and supports the V.34+ standard and landline and cellular communications.
Contact: ActionTec Electronics, Inc., Sunnyvale, CA, (408) 739-7000; http://www.actiontec.com.
Circle 1002 on Inquiry Card.

Networking

24-Floating-Port Ethernet Switch

THE FREEDOMSWITCH ($2199) DYNAMICALLY assigns its 24 ports to one of four internal 10Base-T segments based on current network traffic. If traffic flow changes, the switch automatically reassigns one or more ports to a different network segment to minimize collisions and maintain performance.
Contact: Compex, Inc., Anaheim, CA, (800) 279-8891 or (714) 630-7302; http://www.cpx.com.
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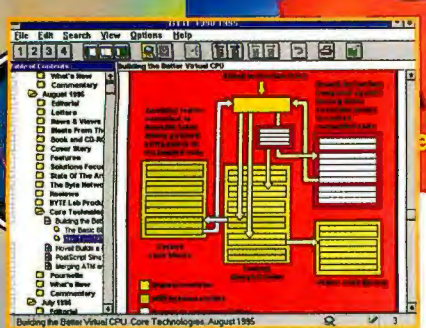

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Peripherals

540-MB Removable-Medium Drive

THE APS M540 USES 3½-INCH 540-MB data cartridges, which format to 515 MB in a Mac OS environment. The drive supports sustained data transfer rates of as high as 3.04 MBps with an average seek time of 10.7 ms and an average access time of 27 ms. The 4500-rpm APS M540 uses a 512-KB cache buffer and PRML technology for optimized data transfer rates.

Contact: APS Technologies, Kansas City, MO, (800) 235-2753 or (816) 483-6100; http://www.apstech.com/.
Circle 1007 on Inquiry Card.

Photo-Realistic Color Printer/Scanner

USING ALPS ELECTRIC'S PATENTED MICRO Dry inks, the MD-4000 (about $699) delivers 16.7 million colors at a resolution of 600 by 600 dpi or black-and-white text and graphics at 1200 by 600 dpi. The MD-4000 comes with an integrated 600-dpi, TWAIN-compatible, single-pass, 24-bit full-color scanner and a 100-page automatic sheet feeder that accommodates letter-, A4-, B5-, and legal-size paper.

Contact: Alps Electric (USA), Inc., San Jose, CA, (800) 825-2577 or (408) 432-6000; http://www.alpsusa.com.
Circle 1004 on Inquiry Card.

High-Capacity Hard Drives

THE 1.6-GB WNR-31601A ($268), 2.1-GB WNR-32100A ($342), and 2.4-GB WNR-32501A ($400) 3½-

inch hard drives feature a 16.6-MBps host transfer rate, PRML Read Channel technology, Fast ATA-2 performance via PIO mode 4 and multiword DMA mode 2, an 11-ms seek time, and a 5400-rpm rotational speed.
Contact: Samsung Electronics America, Inc., Ridgefield Park, NJ, (800) 933-4110 or (201) 229-4000; http://www.sosimple.com.
Circle 1005 on Inquiry Card.

Flat-Screen Color Monitors

THE CL15E, WITH A 15-INCH DIAGONAL screen ($379), and the CL17, with a 17-inch screen ($679), feature a

dot pitch of 0.28 mm, a maximum noninterlaced resolution of 1280 by 1024 pixels, horizontal frequencies of up to 69 kHz, a vertical refresh rate of up to 120 Hz, and on-screen display digital controls. The monitors come with antireflection and antistatic screens, and controls for color temperature and geographic screen adjustments.
Contact: Pacom Data, Inc., Fremont, CA, (888) 297-2266 or (510) 440-7200; http://www.pacomdata.com.
Circle 1006 on Inquiry Card.

Servers

Windows NT Servers

DESIGNED FOR DATA-INTENSIVE, MISSION-critical applications, the InterServe 650 and 660 servers (from $50,200) come with up to four 200-MHz Pentium Pro processors with a 512-KB L2 cache; up to 4 GB of memory; 12 PCI and three ISA expansion slots; 9-GB hard drives, for up to 1 TB of storage; Ultra-SCSI RAID controllers; eight hot-swappable drive bays; RAID subsystems that support RAID 0, 1, 3, 5, and 0+1; and remote management.
Contact: Intergraph Computer Systems, Huntsville, AL, (800) 763-0242 or (205) 730-5441; http://www.intergraph.com/ics.
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PREVIEW

Siena
512-KB version, $249;
1-MB version, $299

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Psion, Inc.
Concord, MA
(800) 997-7466
(508) 371-0310
http://www.psioninc.com

An Office in Your Pocket

With the Siena, Psion has created a hand-held information management device that you can carry without a second thought. It uses the same NEC V30 processor as its bigger, older cousin, the Psion Series 3A, but weighs just 6.7 ounces, including two AAA batteries, and is only 2¾ inches wide, making it an easy fit for just about any pocket. Despite its size, I found the keyboard, like the Series 3A's, acceptable for two-finger typing.

Like other vendors of hand-held devices, Psion is addressing PC connectivity. When you combine the Agenda Synchronizer with a serial link to the PC, it lets you automatically update with Microsoft Schedule+ 1 and 7, and Lotus Organizer 2.1. You can also use the program to back up Siena files. Siena also supports infrared data transfer to other Sienas. The preliminary unit I used didn't support printers or PCs, but Psion is working on that.

The Siena lacks slots for holding solid-state disks as found in the Series 3A. For an extra $79, however, you can buy an external solid-state disk expansion drive. The Siena doesn't support modem communications, and thus is positioned more as an information manager. However, lack of remote connectivity is about the only thing that might prevent you from carrying this unit on the road. Its size certainly won't.

–Dave Andrews

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Pentium Pro Server

THE ALR REVOLUTION MP PRO (FROM $3995) lets you start with one 200-MHz Pentium Pro processor and easily add a second processor. The

server comes with a 256- or 512-KB L2 cache; 32 MB of ECC RAM (expandable to 1 GB); eight expansion slots (four PCI, one EISA, and three shared PCI/EISA); one 3½-inch floppy drive bay; five 5¼-inch front-accessible and five internal 3½-inch drive bays; and support for up to four IDE devices. Other features include a 2-MB PCI graphics adapter; two 16550 UART serial ports; one ECP/EPP bidirectional parallel port; and ALR's InforManager, an array of integrated sensors that continuously monitor information such as system and processor temperatures, fan operations, and system voltages.

Contact: Advanced Logic Research, Inc., Irvine, CA, (800) 444-4257 or (714) 581-6770; http://www.alr.com.

Circle 1008 on Inquiry Card.

Systems

Multimedia Computer

THE ASPIRE ULTIMATE SOLUTION (FROM $2499) includes a 166- or 200-MHz Pentium processor with 256 KB of pipeline burst cache memory, 24 to

32 MB of EDO RAM, 10- and 12-speed CD-ROM drives, a 3.5-GB hard drive, 3-D 64-bit graphics acceleration with 2 MB of EDO video memory, hardware wavetable sound, hardware MPEG video playback, a 33.6-Kbps fax modem, and a 10-W subwoofer and joystick. You also get one-button direct Internet connection and Quick Start, which lets the PC accept incoming calls, faxes, e-mail, or Internet news 24 hours a day.

Contact: Acer America Corp., San Jose, CA, (800) 733-2237 or (408) 432-6200; http://www.acer.com/aac/aspire/.

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Tablet PC Has Wireless LAN Radio

A WINDOWS 95–COMPATIBLE TABLET PC, the Stylistic 1000 RF features Proxim's RangeLAN2 2.4-GHz wireless radio with 15 independent channels, a 1.6-Mbps data transfer rate,

and a 200- to 500-foot indoor wireless range to an Ethernet access point. The 3.6-pound system includes a 100-MHz 486 processor; 8 MB of DRAM, expandable to 40 MB; a 260- or 340-MB hard drive with a preloaded OS and LAN drivers; a lithium-ion battery pack, for 4 to 6 hours of operation; a metal-barrel stylus; serial, parallel, video, mouse, and keyboard connectors; a 72-pin port-replicator connector; and an IrDA infrared wireless port. Three 8-inch LCDs are available: DSTN color ($4830), transflective monochrome ($4340), and transmissive monochrome ($4185).

Contact: Fujitsu Personal Systems, Inc., Santa Clara, CA, (800) 831-3183 or (408) 982-9500; http://www.fpsi.fujitsu.com.

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3-D Rendering Workstation

THE 3D GRAPHIST (FROM $7000) COMES with dual 200-MHz Pentium processors with a 16-KB internal cache,

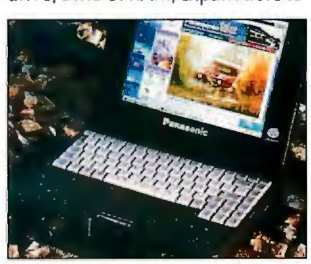
64 MB of EDO memory, a Plextor eight-speed SCSI CD-ROM drive, a Seagate Hawk 2.1-GB Ultra-Wide SCSI hard drive, a Teac 3½-inch 1.44-MB floppy drive, a Diamond Stealth 64 PCI video card, a Creative Labs Sound Blaster 16 card, Labtec LCS-600 speakers, and a 17-inch Samsung Syncmaster GLSI SVGA monitor.

Contact: Falcon Northwest Computer Systems, Inc., Coos Bay, OR, (888) 325-2661 or (541) 269-0775; http://www.falcon-nw.com.

Circle 1011 on Inquiry Card.

6.5-Pound Ruggedized Color Notebook

ENCASED IN LIGHTWEIGHT MAGNESIUM AND resistant to shock, vibration, water, and dust, the CF-25 notebook (about $3329 to $3869) is available with a 100- or 133-MHz Pentium CPU; an 840-MB or 1.35-GB hard drive; 8 MB of RAM, expandable to



72 MB; a 32-bit PCI-bus architecture; a Card Bus and ZV port; 16-bit stereo sound; a DayBrite 10.4-inch active-matrix color LCD screen; three stacked PC Card Type II slots; and an optional six-speed CD-ROM drive that swaps with the floppy drive.

Contact: Panasonic Personal Computer Co., Secaucus, NJ, (800) 662-3537 or (201) 271-3182; http://www.panasonic.com.

Circle 1013 on Inquiry Card.

Pentium Pro PC for Less Than $2000

AVAILABLE WITH A 150-, 180-, OR 200-MHz Intel Pentium Pro CPU, the Preferred 6200's (from $1950) desktop or tower configurations include five drive bays and seven drive bays, respectively; 256 to 512 KB of L2 pipelined burst cache memory; up to 768 MB of RAM; support for up to four IDE drives;

four PCI and three ISA expansion slots; two serial ports; one parallel port; and two USB ports.

Contact: CSS Laboratories, Inc., Irvine, CA, (714) 852-8161; http://www.csslabs.com.

Circle 1014 on Inquiry Card.

Video

PCI-Bus Digital Video Card

WITH THE WAKEBOARD MULTIMEDIA PRO (about $1000), you can capture and compress video as an AVI file for playback on a PC. Based on a programmable DSP, so it can perform real-time capture of video, the board comes with 2.5 MB of RAM (2 MB of DRAM and 512 KB of SRAM), S-Video and composite I/O, support for NTSC and PAL, and support for resolutions of from 160 by 120 pixels by 30 fps to 640 by 480 pixels by 15 fps.

Contact: Digital Video Arts, Ltd., Jenkintown, PA, (215) 576-7920; http://www.dval.com.

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Visual Programming for Science

New tools that go far beyond GUI construction.

By Rick Grehan

Until recently, if you had asked me to define what visual programming means, I would have pointed you to Visual Basic or Visual C++ and said, "That is visual programming incarnate." However, visual programming as exemplified by those two tools is not much more than building GUIs. Yes, you can construct a Visual Basic application using "nonvisual components" such as a database object. Those nonvisual components appear on the form as small bit maps that hint at the functionality lurking underneath, but do little more than act as reminders that a database is in the application.

I sometimes think another category of tools has a greater claim to the visual-programming title than the tools mentioned above. An excellent example from this other category is acroScience's Visual Science (VS). Prices start at $395, and discounts are available.

VS is similar to Oberon's Prospero (see "Prospero's Magic Application Integrator," February BYTE), but Prospero is primarily a data-manipulation tool. VS is a mathematical programming and simulation tool. Programming in either involves dragging "blocks" onto a workspace and wiring them together to form programs. In this scheme, the blocks represent execution objects. Wires represent data flow. Programming is therefore visual in the sense that the programming language itself is visual. With Visual Basic and Visual C++, the visual elements are part of the final application, not an aspect of the language.

The idea behind VS is not new. VisSim uses it (see "Travels and Travails," January 1994 BYTE), as does Prograph (see "Prograph CPX: Purely Visual," January 1995 BYTE). However, VS lets you encapsulate other external applications as building blocks.

Let's say you are building a VS application by populating a worksheet with blocks taken from a tool palette and wiring the blocks together. Functions a given block performs can range from primitive to complex. A good example of a primitive block is a decision block that works much as a simple multiplexer with two inputs and two outputs. One input acts as a selector; the other accepts arbitrary data. If the selector is set to zero, it routes the data input to the first output; if the selector is set to one, the data appears on the second output.

A complex block encapsulates more elaborate behavior and can be an entire program in the classic sense of the word. That is, the block can consist of a function written in a procedural language. VS includes its own language, MathCalc, which is a powerful mathematical language in its own right. MathCalc easily handles vector and matrix operations (matrix multiplication and division are built into the language). It includes over 100 math functions.

However (and this is important to note), a complex block could also be an entire MatLab program or an entire Interactive Data Language (IDL) program. (IDL is marketed by Research Systems of Boulder, Colorado.)

WHERE TO FIND

acroScience
(303) 541-0089
info@acroScience.com

VS links into MatLab through DDE. (Developers at acroScience hinted that a higher-throughput connection into MatLab would be available in the near future.) The connection to a MatLab block is as seamless as with any of VS's primitive blocks. Consequently, you can easily integrate arbitrarily large and powerful MatLab or IDL programs into a VS application. You identify which variables in the program act as inputs and which act as outputs. VS makes connections available so that you can wire the block into your VS application. This lets VS programs tap into capabilities beyond those available in a single application. Currently, acroScience is working to integrate other mathematics packages into VS; more should be supported by the time you read this.

PHOTOGRAPH: KELLIE WALSH © 1996

The ramifications of VS are interesting. If you have a problem you can't solve in MathCalc, you can call on MatLab for help. If MatLab doesn't include the feature mix you need to solve the problem, you can try another package.

I hope to see more of this trend, where visual languages act as large-scale macro languages for automating diverse applications. This allows you to work visually for the coarse-grained components of the application and then drop into traditional procedural code for the fine-grained elements. B

Rick Grehan is a senior technical editor for BYTE reviews and a coauthor of The Client/Server Toolkit. *You can reach him by sending e-mail to* **rick_g@bix.com**.

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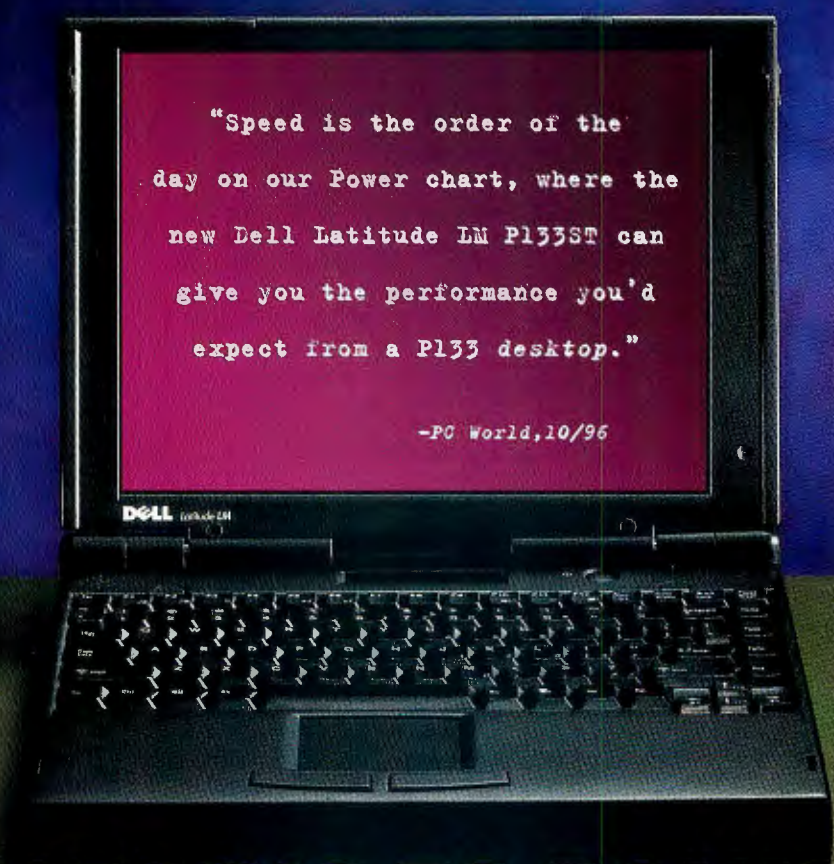

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The Dell Latitude LM P133ST. It looks like a notebook. Yet it performs like a desktop. Sounds like someone's going to have to start a new category! All thanks to *PC World* who started it when they gave us their Best Buy award and said, "the Dell Latitude LM P133ST is a hands-down Best Buy for users looking for a desktop replacement." A bold statement.

They also said things like it's the "fastest notebook we've ever tested." And "Pros: Large, crisp screen; terrifically fast. Cons: none." And to think they didn't even get to its 128-bit graphics accelerator which gives you amazing graphic abilities that your desktop-laden co-workers will envy.

We could go on and on. They certainly did. But we'll let you get to a phone first.

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