WIN a WinBook! See page 128NA 8

TECHNICAL ANALYSIS: WINDOWS 95

BYTE

THE MAGAZINE OF TECHNOLOGY INTEGRATION

AUGUST 1995

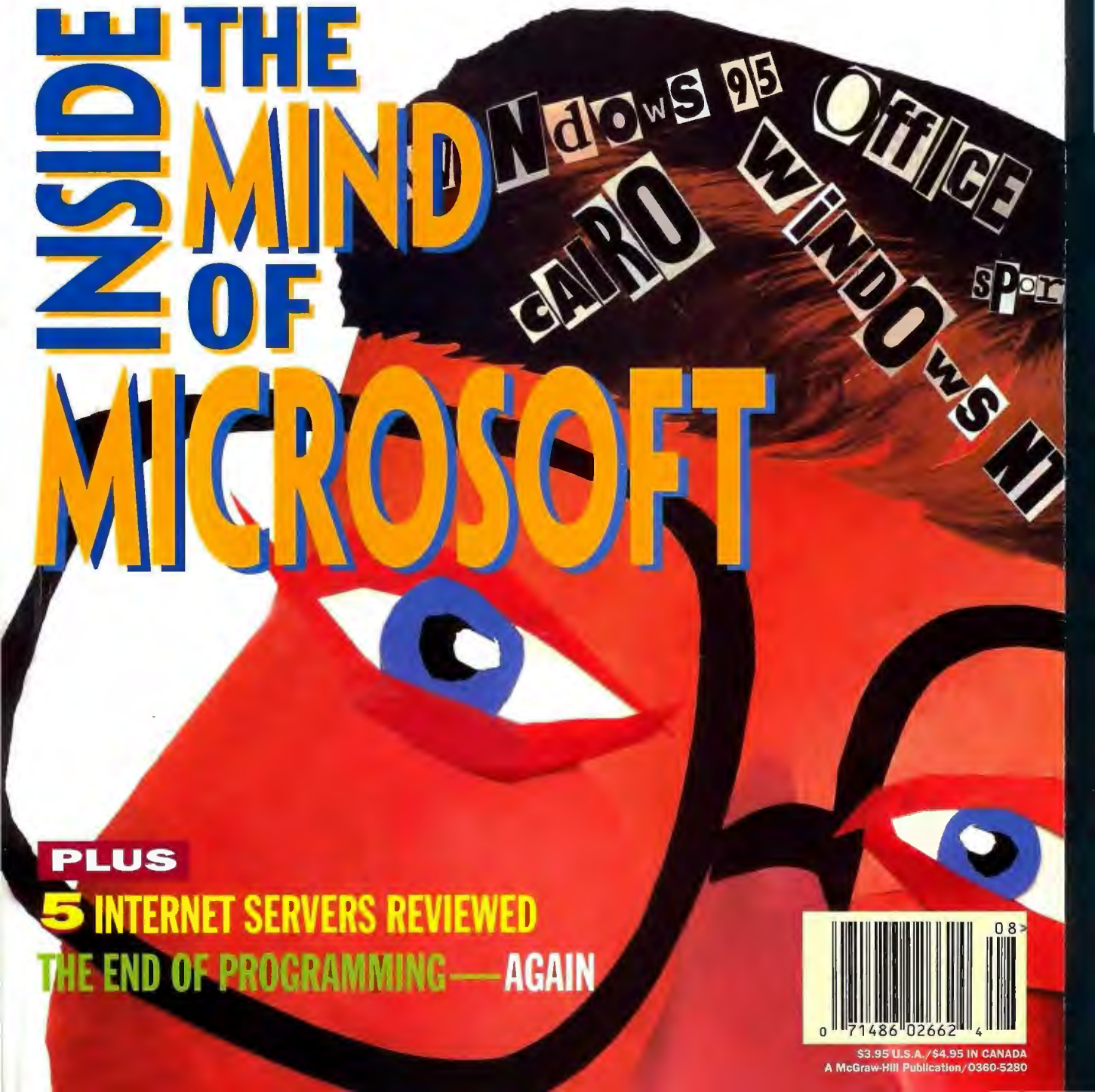
20 Years 1975-1995

Do the First Mac Clones Stack Up?

Lotus Notes—The Ultimate Groupware Building Block

Mission-Critical Objects PAGE 74

INSIDE THE MIND OF MICROSOFT



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PC MAGAZINE EDITORS' CHOICE — May 30, 1995 P120 MILLENNIA

PC MAGAZINE EDITORS' CHOICE — June 28, 1994 P90PCI POWERSTATION

PC MAGAZINE EDITORS' CHOICE — April 26, 1994 MAGNUM

PC MAGAZINE EDITORS' CHOICE — May 16, 1995 P90 HOME MPC

PC WORLD — February 1995 P90 HOME MPC

PC WORLD — October 1994 P90PCI POWERSTATION

intel inside pentium

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May 16, 1995
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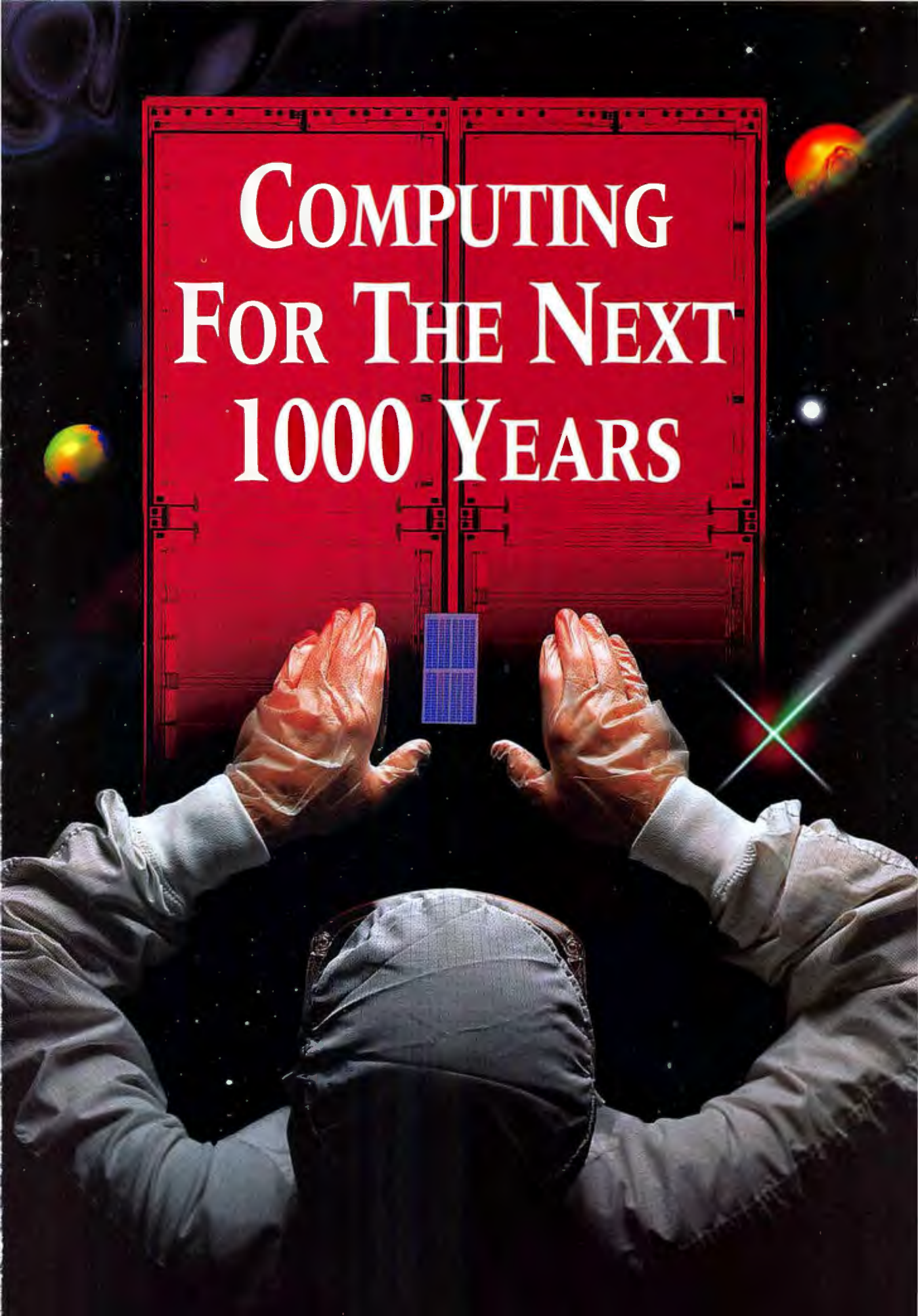
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"Buyers looking for the fastest system money can buy will find it in the Micron Millennia."

PC Week, May, 1995

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"The Millennia is nothing short of the best all-around PC available on the Market today."

PC Magazine, April 25, 1995

PC MAGAZINE EDITORS' CHOICE
May 30, 1995
P120 MILLENNIA

According to PC Magazine's most recent Windows based tests, the Micron P120 Millennia is a "star performer." The Millennia garnered the highest Graphics WinMark score ever seen, in addition to a top-notch Winstone score.

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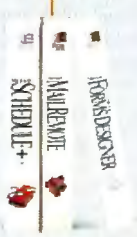


Microsoft

WHERE DO YOU WANT TO GO TODAY?®

BYTE
AUGUST 1995 VOL.20, NO.8

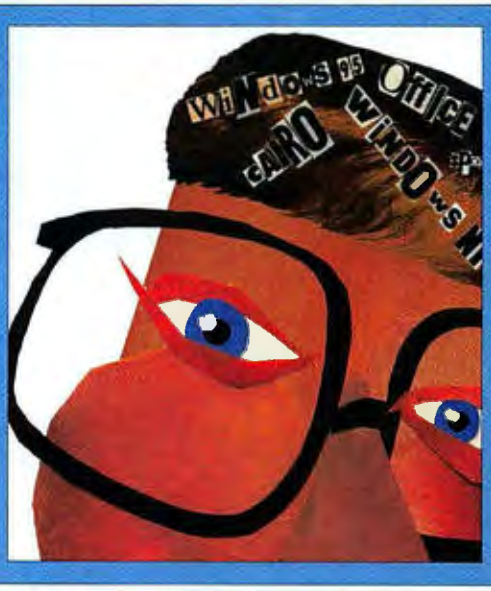
Cover Story

OPERATING SYSTEMS

Inside the Mind of Microsoft 48

BY TOM R. HALFHILL

Microsoft's OS strategy involves your desktop—and beyond.



The Elegant Kludge 54

BY RANDALL C. KENNEDY

Windows 95 has tons of new features—as well as architectural anachronisms from Windows 3.1.

News & Views

Features

THE BYTE NETWORK PROJECT:

Live Wire 103

BY JON UDELL

BYTE's new 56-Kbps link to the Internet sparks concern over public versus private IP addressing.

State of the Art

Reviews

SYSTEMS

Send in the Clones 111

BY TOM THOMPSON Finally — Power Mac clones! We take a look at one of the first, from Power Computing, to see how it stacks up against Apple's.

MULTIFUNCTION HARDWARE

Five-in-One Peripherals 113

BY G. ARMOUR VAN HORN They fax. They scan. They print. They copy. And they cost less than a grand. These do-it-all devices from Brother, Canon, HP, and Lexmark save space and money.

DATABASES

Foxy Move to Client/Server 117

BY DAVID S. LINTHICUM FoxPro developers looking to upsize to client/server will find Microsoft's Visual FoxPro 3.0 a worthy vehicle.

GRAPHICS ACCELERATORS

The Matrox Triple Threat 121

BY GREG LOVERIA Matrox's new Millennium combines a GUI, 3-D graphics, and video-playback acceleration on one card for only $379.

OPERATING SYSTEMS

Unix with No Excuses 123

BY MARC PAWLIGER IBM's AIX 4.1 embraces historical strengths, emerging standards, and technical innovations. They can't say AIX stands for "Ain't Unix" anymore.

SCHEDULING SOFTWARE

Software Roundup: Work-Free Workgroup Schedulers 128NA 2

BY DAVID SEACHRIST Picking the right scheduling program is almost as tough as scheduling a meeting.

DATA STORAGE

Portable-Data Stars 129

BY STAN MIASTKOWSKI New removable-media drives from Iomega and SyQuest forge a new niche in data storage.

SyQuest Takes On Zip—130

Sony's Mini-MO—132

INTERNET HARDWARE

Lab Report: Five Internet Servers Go Head-to-Head 134

On-line business is Big Business. We stress-test four RISC-based systems and a Gateway P5-120XL, all configured as in-house Internet file servers.

Best for the Net—136

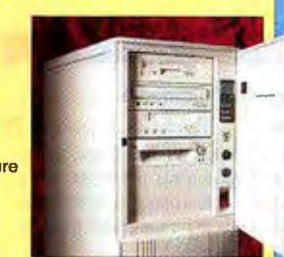
How the WWW Is Put Together—138

A Recommended WWW Server Configuration—141

Support a Safe Internet: Secure Your Site—143

Honorable Mentions—143

Dubious Achievements—143



Opinions

READER SERVICE

BUYER'S GUIDE 200

Mail Order

Hardware/Software Showcase

Buyer's Mart

PROGRAM LISTINGS

From BIX: Join "listings/frombyte95" and select the appropriate subarea (i.e., "aug95").

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

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

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State of the Art

Under Construction 93

BY KELLY TRAMMELL Have pity on groupware developers. They've got some serious problems to deal with.

Doin' the LN:DI—98

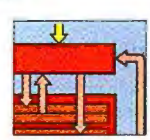
Telephony's Wake-Up Call—100

Core Technologies

CPUS

Building the Better Virtual CPU.....149

BY TOM THOMPSON How Apple revved up its 680x0 emulator.



OPERATING SYSTEMS

Novell Builds a NEST 151

BY SALVATORE SALAMONE Novell's vision of pervasive computing requires NetWare to move beyond traditional networked computers. The Novell Embedded Systems Technology brings NetWare to the broader market for controllers and embedded devices.

PROGRAMMING

PostScript Sins 153

BY KEVIN THOMPSON Errors in PostScript files are becoming painfully plentiful. Here are some of the most common ones.

NETWORKS

Merging ATM and Ethernet 155

BY SALVATORE SALAMONE Combining ATM switches with Ethernet switching hubs economically increases network bandwidth.

COVER IMAGE: STEPHEN KRONINGER © 1995

BYTE Contents by Platform

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

DOS/WINDOWS

OS/2

MACINTOSH

UNIX

NETWORKS

Index

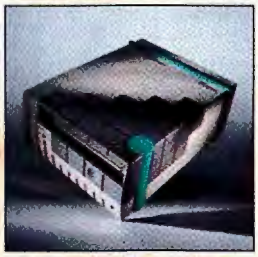
See The Future Of Storage.

Pinnacle Micro. The optical storage leader.

TAHOE 230

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

SIERRA 1.3 GB



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

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ORRAY 5.2 GB

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Another world's fastest chip

H-P claims its PA-8000 will outperform others

It's a title that seems to shift on a monthly basis, but Hewlett-Packard Co. announced a chip design Monday that it says deserves the title of the world's fastest microprocessor.

Th[e] PA-8000 chip will be part of H-P's line

instruction-set computing. H-P's workstations have bec[ome] [lead]er, controlling 32.7 per- cent of th[e] systems [in] analyst A[rthur] [Ro]sys[enberg] [ad]ers The [new] h[igh]-

Shortages hit 486 suppliers

A worldwide shortage of 486 chips is starting to make life difficult for system vendors as Intel shifts semiconductor production in favor of Pentium ch[ips]. Advanced Micro Devic[es] [can't] meet demand f[or]

HP lifts curtain on 64-bit chip, keeps mum on Intel project

Determined not to lose mind share in the processor game, Hewlett-Packard Co. last week provided a glimpse of its 64-bit PA-RISC 8000 architecture, which is still a year from delivery.

At the same time, officials at HP and Intel Corp. all but denied a wire service news report that said the results of the two companies' collaborative micro- processor development would re[sult] in 1997 as In[tel] That report was based on co[mments] Barrett, who [said]

IN TUNE WITH

In showing [off] that the 64-b[it] UltraSPARC ar[chitecture] betting that 64-[bit]

"By the end o[f] Larry Inman, HP's don't see the valu[e]

IBM accelerates revamp of OS/400 PowerPC version due later this yea

As IBM ships the last of its promised OS/400 Release 3.1 components this week, it is paving the way for deliv- ery of a completely redesigned, PowerPC-based OS/400 [due] later

their respective server platfor[ms]

The stakes are high. IB[M] claimed an installed base of 300,[000] AS/400s at the end of 1994, w[ith] sales growing by 50,000 units [per] [quar]ter. [Ap]plicati[ons] [pro]gram, 3, [Client]/ser[ver] [Ex]als said

IBM big iron revamps bode well for 95; Client/server OS, 64-bit architecture await AS/400

IBM has spent the past few years try- ing to answer questions about the [fu]ce in a client/server world. In will start to find out whether [IBM's] giant got it right.

[Cli]erver-oriented rewrite of the [op]ting system is supposed to be [de]February, following a

eagerly awaiting the coming makeover.

Mo[re] Forward

IBM reiterates PowerPC commi

IBM is expected to ship its long-awaited PowerPC systems in June, but with a beta version of OS/2 for Lee Reiswig, general manager of the Personal Soft Products division, said at an analyst conference in Fla., last

HP set to launch PA-8000 ch systems not expected until 19

[Hewlett-Pac]kard Co. plans to announce its next [Pre]cision Architecture microproces- [sor] on March 6.

[It] is expected to achieve a rating [of] SPECint92 and greater than 550 [on] those performance numbers are [met] as the processor nears produc- [tion] with the product said. [A] clock speed greater than 200 [MHz]

Sun Microsystems Inc's Sparc Technol[ogy] Business and MIPS Technology Inc. have announced the architecture of their next ge[n] processors a year before they will appear i[n] products.

"It's sort of a liar's race," said Andrew [Al]editor of Inside the New Computer Indust[ry] "The stakes keep going up."

The RISC chip makers are trying to pu[t] have processors advanced enough to not o[nly] [com]pete against each other but to also co[me] [clo]the gap i[n] [pro]cessors a[nd] [the] editor

IBM, Motorola To Announce 64-bit PowerPC

64-bit PowerPC [chip]r, which IBM and [Mo]will announce [Mo]th, promises dra- [matic] provements in [per]multiprocessing [ca]s over the 601, [60]04 chips, sources

to come [out] —twice [the] 604's ca[pacity]

The [new] other [PowerPC] apart [from] Power[PC]

IBM, Motorola show off PowerPC 620 prototype; volume shipment expected in '95

IBM and Motorola are announcing the PowerPC 620 this week, the most advanced implementation of the PowerPC architecture to date.

As part of the announcement, the two companies introduced the first 620 prototype, with sample shipments to follow in the second quarter of 1995.

Volume production [is] the second half

Sun announces untested 64-bit chip

[Sun] Microsystems Inc.'s SparcTechnology [Business] and the [MIPS] [Technology] the [next] be [applications] [have] [announced] the performance gap but

compared to Digital's Alpha AXP 21164, which has a SPECint92 rating of 330.

HP, Sun's biggest rival, is shipping a PA-7150 processor that has a SPECint rating of 135 and next month will introduce the PA-7200, which is expected to have a SPECint92 rating of about 150.

1997 date set for delivery of HP/Intel P7

Intel Corp. acknowledged last week that the P7 will be the first chip to come out of the alliance [to be] formed with

per second (see "Pentium now, VLIW later," Jan. 30, page1).

The basic concept of the VLIW is to have the com[piler]

PowerPC Much hype, little

PC Week via First!: Hannover, Germany -- IBM, Ap[ple] Inc., and Motorola Inc. showed little restraint in hyping [the] AIM here last week, but in private, officials from t[he] [com]pany admitted their standard isn't ready for prime time.

[A] range of PowerPC processors in the pipe[line] [will] on price/performance, lagging system and [software] continues to keep the PowerPC from brea[king] [into] niche and winning converts in the PC mains[tream]

[It's] going to take two to three years for us to really c[ompete] Jill Hester, general manager of IBM's Systems a[nd] Division, in Austin, Texas. "I don't have illusions that t[his] overnight disc[overy]

INTEL-HEWLETT-PACKARD ALLIANCE SEEN RALLYING A 64-BIT MICROPROCESSOR STANDARDS EFFORT

There are scant details of how Hewlett-Packard Co. plans to introduce technology developed under its [alliance with Intel]

[The] traffic. [Additional] massive 64KB Level cache. most previous [chips] have had 32KB or

IT'S NICE TO SEE IBM AND HP FIGHTING OVER WHO WILL BE NUMBER 2.

In fact, it's downright heartwarming. Digital, of course, beat both of them to 64-bit computing long ago. And while neither one has a 64-bit machine to sell you, we're now on our second generation of 64-bit Alpha-based workstations and servers. Machines that offer price/performance leadership at every level. For example, our new AlphaStation™ 250 system is half the price of the comparably performing HP workstation.[1] While our new AlphaServer™ 8200 and 8400 systems are the first and only servers capable of running the newest 64-bit database products —letting your application directly address up to 14GB of data in main memory, and giving you performance gains of up to one hundred times over 32-bit enterprise systems. Alpha-based systems run thousands of applications—including the ones you need most. And, thanks to the enormous capacity and scalability of 64-bit architecture, they'll work with your present equipment, and grow almost limitlessly as your business grows. Sure, it's possible that HP or IBM really will have 64-bit machines, eventually. But even when they start offering real-world 64-bit products, it'll still be years before they'll have been as thoroughly tested and evolved as ours are right now. So why wait? Whatever your business, whatever your budget, you can do what thousands of companies all over the world have done—and what IBM and HP have been unable to do—have a 64-bit computer you can call your own. For more information, contact your Digital business partner. Or call 1-800-DIGITAL. Or reach us via our Internet address: moreinfo@digital.com.

Digital's lucky chip

...sales of systems based on the Alpha chip have taken off, jumping 66% in the past year, and now exceed VAX sales. The chip excels at handling thousands of concurrent users–which is why regional phone companies

Digital Ships Its 100,000th Alpha System

Digital Equipment Corp. reports it shipped its 100,000th 64-bit Alpha system. The milestone is significant, in our opinion, in that competitors IBM, Sun, and Hewlett-Packard have yet to ship their first 64-bit product.

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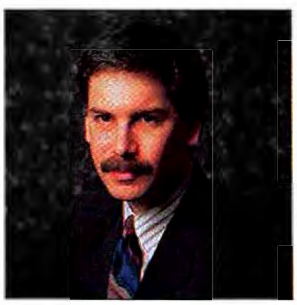
[1] As of 8/8/95.

AAL

Why I Love/Hate Microsoft



To discuss Microsoft is to dance in a narrow minefield rimmed by opposing camps of zealots. But so what?

Writing about Microsoft is like talking about politics. Unless you're sure of the precise nature of your audience, it's best to avoid the topic entirely. Say anything positive, and you're likely to get flamed for being seen as supportive of the Evil Beast. Say something negative, and you're almost sure to get swamped by hordes of aggressive Microsoft spin doctors. This is a shame, because Microsoft provides such wonderful fodder for debate about technology, standards, the needs of users, the essence of capitalism, and the free market—all manner of juicy cocktail-party conversation.

So we at BYTE, which is no stranger to controversy, this month analyze Microsoft's core business: its operating systems. Ace technology analyst Tom R. Halfhill delves into the current and future strategies that make up Microsoft's OS initiatives in "Inside the Mind of Microsoft" on page 48, and Randall C. Kennedy examines the inner workings of Windows 95 in "The Elegant Kludge" on page 54. These are important stories, because whether you love Microsoft or hate it, if you don't *understand* it, you're at an astounding disadvantage when it comes time to make your technology plans.

The Good, the Bad

I have to admit that in some respects I agree with the Microsoft-bashers. But in a lot of arenas Microsoft has simply done the right thing: It has developed good products and marketed them well. And for that the company deserves credit.

For example, Microsoft makes great desktop applications. Word for Windows does almost everything you could possibly imagine a word processor doing. The Excel spreadsheet defines its market. PowerPoint, once an also-ran in the presentation-graphics market, is now competitive. And it's these applications, more than the Windows OS itself, that have made Microsoft so powerful; without these market-leading applications, no one would ever have taken Windows seriously.

I don't really know if Bill Gates planned Microsoft's desktop OS and application-suite hegemony all along. When I interviewed Gates a few weeks ago (the interview will be published next month), he said he knew from the start the general attributes of the ultimate personal computer application platform but that he never really expected that Windows and Office would succeed to the extent they have today.

Of course, Microsoft has been immensely aided by another of its corporate attributes: its relentlessness in implementing a vision. Microsoft has never wavered from its plan to bring graphical applications to the desktop computer user. Other companies, meanwhile, have—just a slip here, a momentary rest on hard-earned laurels there. When these micro-opportunities pop up, Microsoft tends to gain just a little more market share or technology leadership. The company builds not just on its own vision but on the compounding errors of other vendors.

After 14 years in the IBM-compatible market, these little wins add up. We may not like it, but I for one respect the discipline that Microsoft has shown. It's won the company an entire market.

But enough praise. All of Microsoft's success has bred a corporate arrogance the likes of which you don't see in other computer companies (with the possible exception of IBM). Microsoft has had enormous success in the market defined by the desktop PC, but it's wrong for the company to assume that it can simply move this success into the consumer (i.e., TV) or corporate (data center) markets. These are fundamentally different channels, and they demand different products.

For example, they both demand something that desktop PCs don't deliver, the lack of which we've all grown to accept: absolute, unflinching reliability. The versions of Windows that have evolved from DOS don't have it, and probably never will. But Home Box Office simply doesn't crash, and you don't Ctrl-Alt-Del AT&T's central phone-switch mainframes.

Understanding Microsoft is critical to your success as a computer-technology expert. To appreciate Microsoft, and to appropriately use (or eschew) the products it releases, you need to spend a little time working through your own technology plans and comparing how they mesh—or conflict—with the Microsoft vision. It will be time well spent. ■

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

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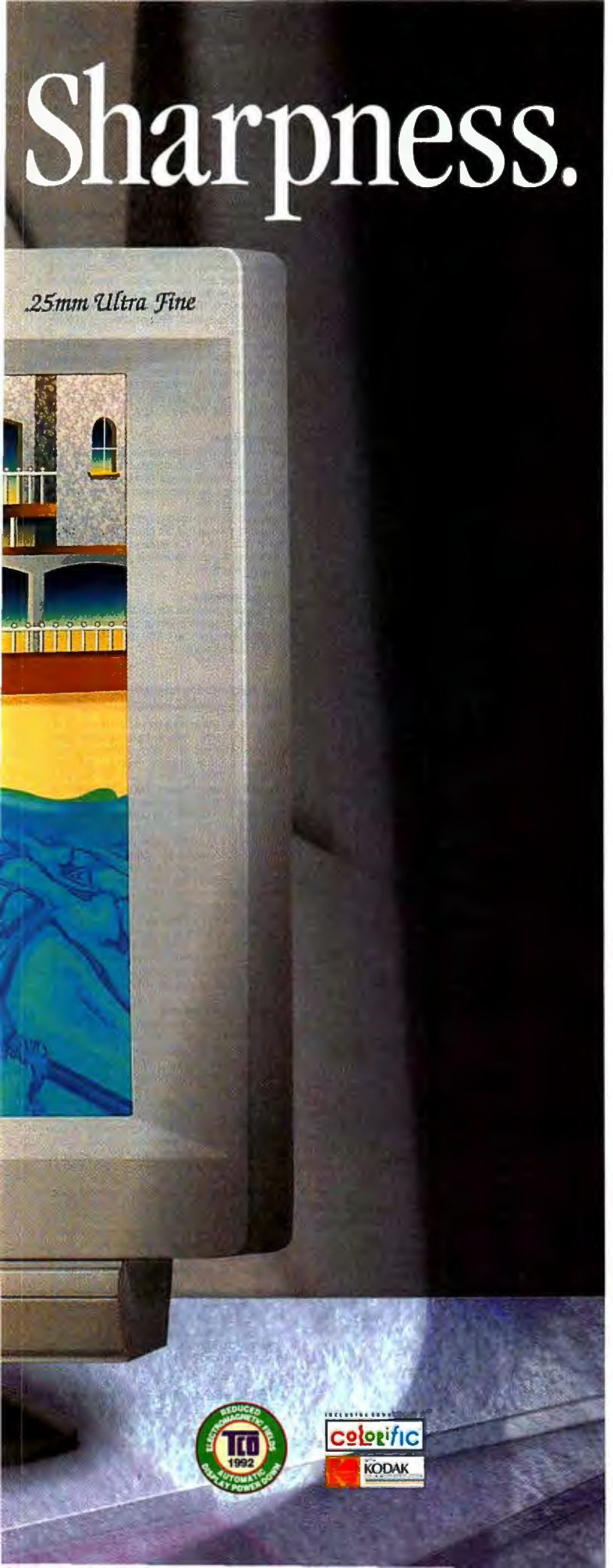

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No other sound card ever made this kind of uproar.

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Home Office Computing / January 1995

"No ordinary sound card, the Sound Blaster AWE32 adds QSound to widen and enhance the stereo effects of sounds."

"The Sound Blaster AWE32 has Creative Labs' suite of sound playback and editing software that does the job with admirable simplicity—and the addition of sequencer Cakewalk Apprentice and the presentation program HSC Interactive SE rounds out the bundle nicely. And of course, the Sound Blaster AWE32 is compatible with software written for older Sound Blasters, so it will work on anything from Windows to Doom."

"I heartily recommend the Sound Blaster AWE32. The 100% sound-effects compatibility and impressive music capabilities, make AWE32 an excellent all-round performer."

"To me, using a computer without sound and music is like driving a Lamborghini without the roar of its V12 engine. The AWE32 is completely compatible with the whole range of Sound Blasters. The MIDI side of the AWE32 has been enhanced to provide it with the kind of sound you would expect from a professional synthesizer."

"...if sound quality and performance is important, you can't go wrong."

CD-ROM Multi Media Magazine November / December 1994

B E S T B U Y S

"For flexibility necessary for business-related audio, turn to the Creative Labs Sound Blaster AWE32, which stands out with decent sound quality and excellent software that includes 3D sound and text-to-speech and speech recognition capabilities. Its lavish documentation is another welcome feature. The AWE32 gave us the smoothest rides and the best sound in the games we tested."

174 PC WORLD • DECEMBER 1994

PC Computing/December '94

Sound Cards

"Creative Labs has long been the leader in this market, with its Sound Blaster series setting the standard for PC sound. The $399 AWE32 is the most advanced card in the Creative Labs lineup. It has everything you'd want in a general-purpose audio board."

Multimedia World/December '94

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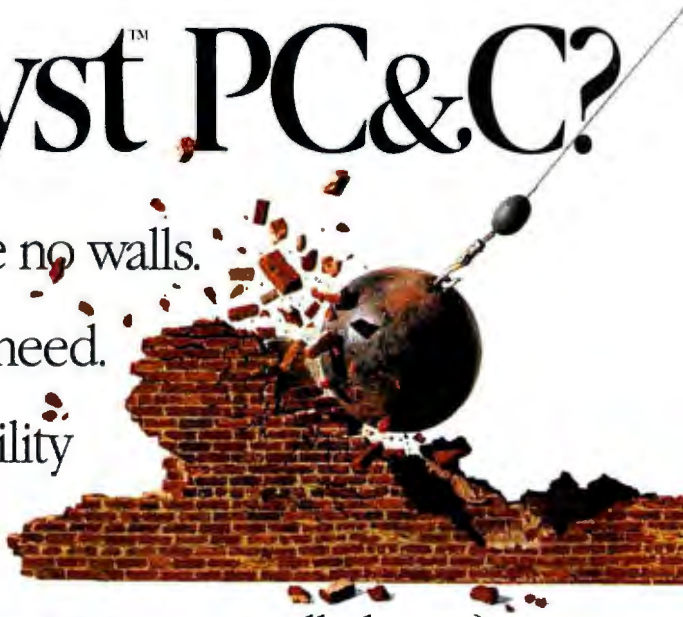

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Letters

A Benchmark Peeve

As a scientist, I'm always irritated when numbers are given to an unnecessary and meaningless degree of accuracy. In your June issue, for instance, the BYTE Benchmarks are quoted to six figures of accuracy (1 part in a million). The difference between an Integer index of 0.933050 and an index of 0.933051 would be just 1 second after running continuously for 12 days! Few physical quantities can be meaningfully measured to this accuracy. The weight of a computer, for instance, is usually quoted as something like 6.6 pounds, rather than as, say, 6.60123 pounds.

Bill Appelbe
Associate professor
College of Computing
Georgia Tech
bill@cc.gatech.edu

Appelbe is correct. Future versions of the benchmarks will be reporting to three figures of accuracy.—Rick Grehan

Thanks from a Southpaw

This is just a quick note to thank Jerry Pournelle for his sensitivity to left-handed-design issues in his recent laptop evaluation ("Privacy and Liberty," June). Since he's not left-handed himself, this point of view is unusual and especially welcome. Whenever I complain about hardware design I get accused of whining, but BYTE's position in the industry might cause designers to sit up and take notice.

Considering the high percentage of lefties in the industry, it just plain makes sense to consider us when designing this type of hardware. A design that ignores a significant portion of the customer base is foolish. I sincerely hope that Pournelle and the hardware reviewers at BYTE will continue to point out where designs are ergonomically flawed for left-handers.

Barry D. Benowitz
FAQ maintainer for alt.lefthanders
b.benowitz@telesciences.com

Conflict of Interest?

Your June "Books & CD-ROMs" section takes a look at four books relating to the information superhighway. The most highly rated title is one written by Nicholas Baran, who also happens to appear on your masthead. I haven't read any of the four books and thus cannot comment on the accuracy of the review. However, don't you think it might be ethical to list, in the book review, Baran's editorial and fiscal relationship with BYTE?

Art Grater
Pebble Beach, CA
agrater@netcom.com

In no way was our review slanted in favor of one of our consulting editors. But yes, the review should have acknowledged Baran's relationship to BYTE. —Eds.

The Technology's the Thing

After seeing John Astreides' letter titled "BYTE: Real Food for Real People" in your June Letters section, I would just like to say that the one reason why I purchase BYTE instead of the other magazines is, to borrow Astreides' words, the "articles with meat that explain the technology." It is refreshing to find a magazine that's not afraid to use big words and weird terms to describe what really goes on in the world of computers.

Don't ever change that.

Aaron Platt
aaron@platt.demon.co.uk

Comments from Treat

As a mathematician, operations researcher, and computer programmer, I feel I have to respond to Raphael Needleman's March editorial ("Mutant Chips") that warns against depending on heuristic methods, because they may work, but "we don't know why."

Neural networks are used for absolutely everything that humans do, and deterministic algorithms cannot duplicate human performance in many cases. This isn't a temporary situation. Chaos theory and Godel's incompleteness theorem both guarantee that we won't be able to solve every problem in a deterministic way.

Artificial intelligence—like real intelligence—depends on heuristic methods, and computers won't be doing anything really interesting for us until heuristics are built into chips.

I also have to make a comment about the "How To Bruise an Integer" text box in Tom R. Halfhill's article "The Truth Behind the Pentium Bug" (March). A number like 4.1 or 1.1 or 0.1 cannot be exactly represented in binary floating-point values. The binary equivalent of 0.1 (decimal) is 0.0001100110011... (binary), where the "0011" sequence repeats infinitely. That is, the fraction 1/10 has a repeating binary representation, in the same way that 1/3 has a repeating decimal representation.

When we use Calculator to do arithmetic, we forget that we are doing things approximately, through binary floating-point notation. That leads to disconcerting results. This is not because we have "bruised an integer," but because we have truncated a floating-point number without realizing it. We are disconcerted because we forget the approximations, not because we use them.

It isn't particularly difficult to do such computations accurately. If I wrote Calculator in Smalltalk, with its Fraction class used to represent every number entered in the display, there would be no such errors in ordinary arithmetic. The problem isn't bruised integers; the problem is a poor substitute for arithmetic.

Dr. Bobby R. Treat
Arlington, VA
Bobby.Treat@dp.hq.af.mil

Give or Take a Megahertz

Reader Karl Richards asked in your June Letters section whether a 100-MHz Pentium actually runs at 99 MHz. That assumes the main bus runs at 33 MHz, but I have seen hundreds of so-called 33-MHz 486 CPUs and system boards marked as 33.3 or 33.33 MHz.

William Tsui
Destiny Software Productions, Inc.

Kudos for Coverage

I'd like to thank you for supplying computer users with intelligent, broad-based coverage of the computer industry. As a

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Circle 75 on Inquiry Card (RESELLERS: 76).

Mac user, I am frequently disgusted by the blatant misrepresentation of technologies in the media to make the masses believe that Bill Gates is some kind of Thomas Edison. If Bill Gates really had my interests at heart, then he would stand for competition and invention in the name of progress and would revel in the challenges.

Kevin Banff
Banff@eworld.com

The Bell Curve Controversy

Jerry Pournelle's suggestion in his February column that we can all test Murray's and Herrnstein's conclusions in *The Bell Curve* on our home computers makes about as much sense as testing the conclusions of *Mein Kampf* with a spelling checker: You would just be proofreading without thinking about the assumptions. You can't obscure the biased tone with matrix inversion and regression analysis. Accepting a single value as a meaningful measure of someone's intelligence may be enjoyable parlor discussion, but to suggest that social policy be based on it is ludicrous.

Nick Didkovsky
New York, NY
72250.3313@compuserve.com

While no one disputes the existence of special skills and talents, there is a consensus that a general factor is more important for predicting most behaviors. The theory of prediction by multiple-regression equations, along with the factor analysis that refines those predictions, isn't difficult to understand. But doing much with it takes a lot of computation. Prior to the availability of powerful desktop computers, there was little chance of the average educated person being able to examine the "general factor" hypothesis. Now anyone with a computer and a year or so of college math can try to falsify that hypothesis or try to find a better one.

I am not aware that Mein Kampf *contains any testable hypotheses at all.*

—Jerry Pournelle

Observations of the Trip

I would just like to let you know how entertaining I found Rafe Needleman's article "Tales from the Trip" in your June *Special Report on Mobile Computing*. I don't travel very frequently with a laptop machine, but quite a few of my colleagues do. I shall certainly be recommending your article to them.

Huw Evans
Glasgow, U.K.
huw@dcs.gla.ac.uk

My group recently purchased a Dell Latitude XP laptop, which we plan to take with us when visiting customers and branch offices in the U.S. and Europe. Could you give me more information on the type of cable that your associate picked up from the Hotel Latzen?

Bryan Guthrie
bjguthri@cca.rockwell.com

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—Rafe Needleman

As the CEO of a non-profit who works away from my office a significant amount of time, I readily identify with your trials and tribulations on the road. The big problem with international travel is the presence of government-owned phone services which use proprietary connections in order to discourage competition from other equipment suppliers. Most European PTTs still maintain a list of "approved modems" which may be connected to their systems; they tend to be slow and very expensive. But a few well-chosen adapters can be a big help!

William Saal
73417.3242@compuserve.com

In your articles "Let's Put on a Show" (May, page 12) and "Tales From the Trip" (June, page 162) you make comments such as "...we had only one reliable phone line back to the States." and "...doesn't seem to recognize American touch-tone signals." and "I'm only getting 2400 bps on the German guest house phones." Americans tend to think that whatever they do and have is good and everything else is bad or strange. Our phone lines are as reliable as yours.

Martin Burtscher
mburtsch@iiic.ethz.ch

While at the CeBit trade show, and a few hotels I visited, I had no problems connecting at high speeds (14.4 Kbps). I think telephone service in Germany is at least as good as in the U.S. Unfortunately, it was not as good in the guest house where we stayed. *—Rafe Needleman*

Fixes

In the June State of the Art section on new memory chips, the 3D RAM graphics memory chip from Mitsubishi Electronic Device Group was incorrectly identified in two places as being developed by Matsushita.

For readers who received the BYTE *Extra Unix Edition* in the June issue, there was an error in the pricing for Novell's UnixWare 2.0. The correct price is $1695. ■

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DESKTOP VIDEOCONFERENCING

Videoconferencing's Achilles' Heels

For many users, desktop videoconferencing remains an elusive goal, due to incompatibilities and inconsistent ISDN availability. The barriers are coming down, but slowly. Here's why.

BY SALVATORE SALAMONE

If you thought videoconferencing was going to drastically reduce your traveling, don't toss out your frequent flyer membership cards just yet. Despite much promise and promotion, most corporations still aren't communicating via videoconference. And they most likely won't be unless more vendors support interoperability standards, and ISDN becomes more widely available and used.

DVC (desktop videoconferencing) is at a crucial juncture. Currently, the market is small (by most computer industry standards). For example, only 30,000 desktop videoconferencing systems shipped last year, according to the consultancy Personal Technology Research (Waltham, MA), during which time over 18 million PCs were shipped within the U.S. However, several industry analysts see desktop videoconferencing exploding over the next two years and predict that up to 1 million DVC systems may be shipped by 1998.

The reason for such optimistic projections? The marketplace is starting to remedy the lack of interoperability and unavailability of ISDN, two of DVC's biggest stumbling blocks.

On the standards front, progress was made earlier this year when the PCWG (Personal Conferencing Work Group), which is dominated by Intel, finally agreed to support H.320, the ITU-T's standard for videoconferencing. PCWG says the next version of its conferencing software, based on Intel's PCS (Personal Conferencing Specification), will initiate videoconferencing calls using the H.320 call setup procedure. If the DVC system on the receiving end of the call uses PCS, the call will switch and use the PCS video compression algorithm (Intel's Indeo). Otherwise, H.320 compression algorithms will be used for the duration of the call. Such compliance with international standards will assure users that products from different vendors will have a basic level of interoperability.

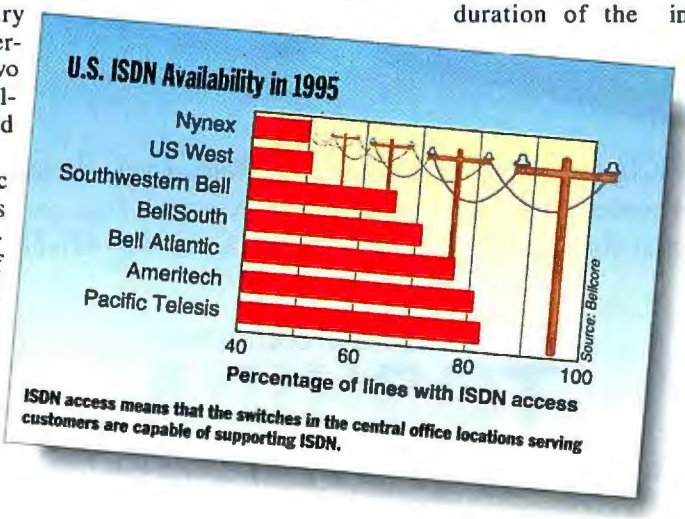
However, interoperability won't matter much if ISDN service isn't available in your area. For many DVC users, ISDN offers a good combination of price and performance and seems to be the minimum for decent-quality motion video.

For example, such products as Vistium Personal Video System from AT&T, Communique from InSoft, and Simplicity from Paradise Software all claim 30 frames per second refresh rates when running over ISDN. That's in contrast to the analog-only DVC systems that deliver 15 fps at best (but, more typically, half that rate) when using V.34 modems.

Getting ISDN service is still a problem that varies greatly from region to region. Some regional Bell Operating Companies have been fairly aggressive both in the deployment and pricing of their ISDN services. For example, in the Pacific Telesis region, Pacific Bell is offering residential ISDN service for about $25 per month plus three cents for the first minute of a local call and one cent for each additional minute during prime-time hours.

The Pacific Telesis region has the greatest penetration of ISDN availability—82.6 percent of the telephone lines in this region will have ISDN access this year, according to Bellcore. (ISDN access means that the switches in the central office locations serving customers are capable of supporting ISDN.) That's in contrast to the northeastern U.S., which Nynex serves, where only 49.8 percent of the lines are projected to have ISDN access this year (see "U.S. ISDN Availability in 1995" at left).

The lack of ubiquitous ISDN service is creating an opportunity for analog DVC systems. Users are sometimes willing to trade video quality for plain old telephone service's availability and ease of use.



ISDN access means that the switches in the central office locations serving customers are capable of supporting ISDN.

Most analog videoconferencing products are collaborative work programs that include a video window on screen. This includes such programs as ShareVision from Creative Labs and Mega-Conference from Alpha Systems Lab that give users videoconferencing capabilities as well as providing file transfer capabilities, an electronic whiteboard for discussions, and the ability to annotate a shared document.

An FCC ruling that took effect earlier this year might impact ISDN pricing. The thrust of the ruling—which is still being debated in Washington, D.C.—is that ISDN subscriber line charges be billed not by line but by each ISDN channel. That means a BRI (Basic Rate Interface) ISDN circuit, instead of being billed as one line, is billed as three circuits. A PRI (Primary Rate Interface) line would be billed as if the customer had 24 circuits. The charges are $6 per month for a business customer's ISDN channel and $3.50 per month for a residential channel. Such charges could increase monthly ISDN charges by as much as 14 percent for a BRI user and 50 percent for a PRI user, according to Pacific Bell. It's too early to tell how the new billing scheme will influence the deployment of ISDN.

On-Line Services/Internet Comparison

Users have a variety of options for accessing the Internet's World Wide Web. Internet access costs from on-line services tend to be higher than those of Internet providers. But using a direct connection also requires you to use Unix shell commands or assemble and configure a collection of programs to handle E-mail and Web browsing. You might also need to pay an X.25 network, like SprintNet, to access an on-line service if you want optimum performance. —Steven J. Vaughan-Nichols

	AOL	CIS	DELPHI	DIGITAL EXPRESS	EWORLD	PRODIGY
Basic Monthly Fee	$8.95	$9.95	$20.00	$25.00	$8.95	$9.95
Hourly Rate	$2.00	$2.50	$1.00	none	$2.95	$2.95
Highest Common Speed Supported	28,800 bps	28,800 bps	14,400 bps	28,800 bps	14,400 bps	14,400 bps
Internet Accessible	X	X	X	X	X	X
Internet E-Mail	X	X*	X	X	X	X*
Usenet Newsgroups	X	X	X	X	X	X
Telnet/FTP	X	X	X	X	X	X
Gopher	X	X	X	X		X
Wais	X			X		
Web	X	X	X	X		X

*Additional charge in some circumstances
All services have several price plans. This chart shows the standard pricing plan.

MULTIMEDIA PROCESSORS

Hot Chips, Tough Choices

Rich color, realistic 3-D, multichannel audio, and full-motion video are just some of the benefits that chip vendors are touting for a new wave of multimedia accelerator processors. However, these chips' market success will rest heavily with the silicon vendors' software partners. And in some cases, those developing the next wave of games to benefit from these processors have discovered that the path to multimedia nirvana can be a steep learning curve.

Nvidia (Sunnyvale, CA) recently announced the NV1, an integrated multimedia chip that combines GUI acceleration, 3-D rendering, video acceleration, and audio processing. SGS-Tomson Microelectronics will also sell the Nvidia chip as the STG 2000. Nvidia says that peripheral-card vendors like Diamond Multimedia Systems (Sunnyvale, CA), a company that has already announced it will use the chip in a PC board to be released later this summer, will be able to sell NV1-based add-in cards for about $200. Diamond and Taipei, Taiwan-based LeadTek showed preliminary NVI-based boards at the Computex show held last June in Taiwan. LeadTek says a 1-MB DRAM–equipped version of its board will sell for under $250.

However, Dean McCarron, an analyst specializing in chips and controllers at Mercury Research (Tempe, AZ), points out that the technology that gives Nvidia its edge is also a potential drawback. "Games developers have told me that, while worth the effort, the NV1 will be difficult to program to," McCarron says.

Part of the NV1's advantage is that it takes a radical approach to 3-D imaging. Instead of building 3-D objects from a multitude of flat polygons, the NV1 creates them using a much smaller number of "curved surface" polygons. As a result, less processing power is required for the kind of high-quality, real-time 3-D graphics that can make a PC game look very impressive.

Nvidia says the chip will accelerate applications written to other APIs like RenderWare, 3-D DDI, and 3-DR. But to get the highest level of performance, you have to develop directly to Nvidia's hardware API. "The NV1 intrigues us because it's inexpensive and it's well designed in terms of performance and throughput," says David Kaemmer, chief technology officer at Papyrus Design Group (Somerville, MA). However, he adds, "To take full advantage of the NV1 would take quite a bit of work."

Kaemmer says that Papyrus expects to release what is essentially a custom version of its NASCAR car racing game for Windows 3.1 in September. Kaemmer says the NV1's approach works well for NASCAR, because it lets developers render the curves in the road and racing car with fewer vertices. But he also says that Nvidia's degree of market success will help determine how much effort his company devotes to rewriting its programs.

Another company placing a heavy reliance on software technology for its multimedia accelerator is Netherlands-based Philips and its TriMedia programmable DSP (digital signal processor), at the core of which is a VLIW (Very Long Instruction Word) architecture capable of executing up to five operations in a single cycle. Although VLIW specifies parallelism, unlike CISC or RISC technologies that rely on the processor itself to discover parallelism, VLIW relies on software, specifically the compiler. And that means developers will have to rely on the quality of their compiler and diagnostic and analysis tools, which Philips will supply, when writing applications for the TriMedia, slated to ship in volume next year.

It will be interesting to see which of the approaches—that of Philips, Nvidia, or a more traditional, OpenGL API–based one that's expected from the 3Dlabs/Creative Technologies partnership—will succeed in the quest for multimedia success. Mercury's McCarron predicts successful companies will have a strong balance of hardware, software, and third-party developers.

—Dave Andrews

NEW POWER MACS

Apple's Multimedia Macs

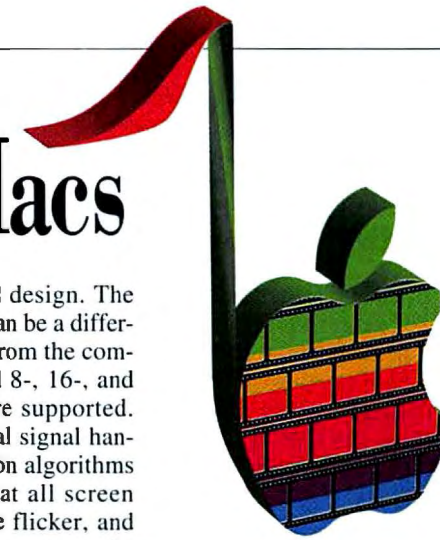
At Boston MacWorld Expo this August, Apple is expected to introduce a new line of Power Macs ranging from a high-end system for multimedia authors to inexpensive models.

The Power Mac 8500 targets multimedia authors by offering a fast 120-MHz PowerPC 604 processor and an impressive array of integrated AV (audio-video) features. A 100-MHz PowerPC 601 powers the Power Mac 7500, and its AV features make it useful for the small- and medium-size businesses and the home office. The SOHO (small office/home office) market gets power at a low price with the 601-based Power Mac 7200 series (available in 75-MHz and 90-MHz configurations), with prices starting around $1500.

All of these Macs offer three PCI slots, two Ethernet connectors (10Base-T and AUI), and quad-speed CD-ROM drives as standard. They use the same dynamic recompilation emulator and performance-tuned hardware architecture found in the Power Mac 9500 (see "Apple's Tsunami: PCI Power," July BYTE, page 26). The 8500 and 7500 use a plug-in processor board that allows upgrades to a faster 150-MHz PowerPC 604 chip.

The 8500 and 7500's built-in, second-generation AV capabilities are an improvement over the AV functions first introduced in the Quadra 840AV. They have 16-bit, CD-quality (44.1-kHz sample rate) stereo sound. Several ASICs enable the 8500 to capture and process live NTSC-, PAL-, and SECAM-formatted video at 8-, 16-, or 24-bit depths (the original design was limited to 8 or 16 bits). Thanks to the descriptor-based DMA, these systems can capture the video stream as a 320- by 240-pixel image at 30 frames per second, and 640- by 480-pixel image capture is supported at lower frame rates. For output, the 8500 and 7500 can display 8-, 16-, or 24-bit video in NTSC or PAL formats.

The original AV design used a split frame buffer that mixed the computer and captured video inside the DAC (D/A converter) display circuitry and thus limited the screen's output to the bit depth of the captured video (8 or 16 bits). In contrast, the 8500 and 7500 use a unified frame buffer in which the signals are combined digitally, eliminating many of the restrictions found in the old design. The captured video can be a different pixel depth from the computer video, and 8-, 16-, and 24-bit depths are supported. Due to the digital signal handling, convolution algorithms can be applied at all screen depths to reduce flicker, and the video stream can be directed toward a second monitor. A DAV (Digital Audio-Video) slot lets you plug in an MPEG or other card for hardware video compression or accelerated playback. These wouldn't be decent multimedia systems without plug-and-play setup, and to this end the computers have connectors for Super-VHS video in/out, composite video in/out, and stereo sound in/out.



A Power Mac 8500 with 16 MB of RAM, 1-GB hard drive, and quad-speed CD-ROM drive will sell for around $3999. A 7500 with 8 MB of RAM, 500-MB hard drive, and quad-speed CD-ROM will start around $2499. Prices for the 7200 series, with 8 MB of RAM, a 500-MB hard drive, and quad-speed CD-ROM drive will start at about $1499.

—Tom Thompson

STORAGE TECHNOLOGY

3.5 Will Get You 100

Even with compression, the 1.44-MB floppy drive is woefully inadequate for many of today's software applications that can quickly fill a 3.5-inch floppy disk. But at least three technologies that offer storage capacities of 100 MB or more are vying to become the next floppy standard.

One entrant is lead by three companies: PC and server vendor Compaq Computer (Houston, TX), disc supplier 3M (St. Paul, MN), and peripheral manufacturer Matsushita-Kotobuki Electronics (Takamatsu, Japan). The three say their formatted disks will each hold 120 MB of data, and their new drive, based on floptical technology, will be able to read and write to today's 1.44 MB—and the older 720-KB DOS-formatted—3.5-inch disks. Kevin Bohren, vice president of marketing in Compaq's desktop division, says the first PCs to have the new drives in them will likely appear in late 1995.

The 120-MB standard will compete with Roy, UT–based Iomega's 100-MB Zip drive, which uses Bernoulli technology and Winchester heads and is already shipping commercially (see "Portable Data Stars" page 129). The Zip drive holds 20 MB less than 3M's disc and is not backward compatible with current 3.5-inch floppies. But Cory Maloy, spokesman for Iomega, notes that almost every computer already has a floppy drive. "We don't see it [backward compatibility] as an issue now." However, he did say the company may release a drive that combines separate Zip and floppy discs in one bay. The company plans to release an internal version of the Zip drive in the third quarter of 1995.

Fremont, CA–based Syquest will release the third entrant, a 135-MB disk cartridge, this summer. Internal versions of Syquest's EZ-135 Disk Drive will sell for about $200, with media at about $19.95 (prices that are comparable to that of Iomega's Zip drive). Syquest says its drive, which uses removable Winchester media in a cartridge, will be twice as fast as a Zip drive.

Who will win the race? Data transfer speed will be a critical factor, but as of press time, only Iomega was shipping product. —DLA

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INTERNET ACCESS

BBSes to Provide Local Web Access

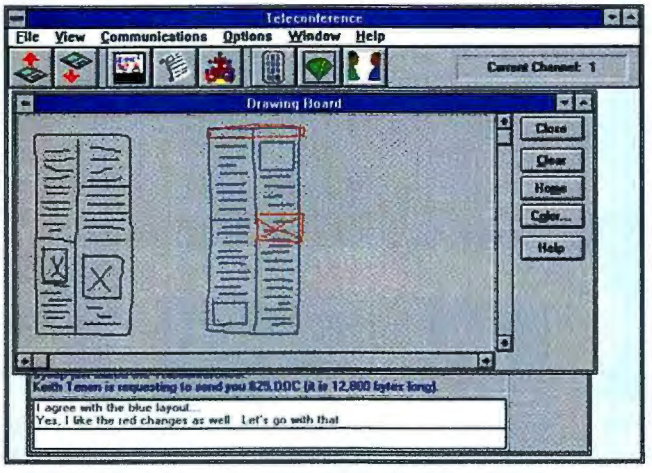
Someday soon, you'll be able to access the WWW (World Wide Web) from your local BBS. Following in the footsteps of Internet providers like NetCom and on-line services like America On-line, BBS software vendors are bringing internal Web browsers to their services' GUIs.

"Building Web access into BBS products is becoming a necessity," says Dennis Fowler, a journalist who follows BBSes. "With all the attention that the Web is getting, callers are eager for it, and sysops are pressing the BBS vendors to supply it." Fowler says some BBS system operators aren't waiting for their BBS vendor to supply WWW access solutions. Instead, they're creating their own Web gateways.

Adding Web browsers to BBS front-ends is the first step. But Fowler says Web access is a two-way street: BBS callers demand access to the Web, and Web surfers want access to BBSes. "I expect to see HTML [Hypertext Markup Language] links to BBS functions, so that file libraries, for example, can be accessed by Mosaic users," Fowler says.

Galacticomm's (Fort Lauderdale, FL, (800) 328-1128; (305) 583-5990). Worldgroup server with its ICO (Internet Connectivity Option) lets BBS system operators add Web server capabilities to their BBS. End users still can't access the WWW via their Galacticomm front end. But through the WorldGroup server, a WorldGroup client can telnet, FTP, and remotely log in to other Internet sites. A future version of ICO will support pass-through SLIP and PPP for browsing Web sites from your local BBS.

Another product, First Class, the E-mail/BBS package from SoftArc (Markem, Ontario (800) 763-8272; (905) 415-7000) can send and receive Internet E-mail through optional gateways. It also lets you log in from the Internet. A future version will let you broadcast data to the Web.



In addition to its Internet access capabilities, Galacticomm's WorldGroup adds interactivity, allowing two BBS users to collaborate in real-time on projects, such as reviewing a newsletter's layout.

Other BBS businesses will likely follow Galacticomm. While officials declined to comment, it appears that Mustang Software and Esoft are both exploring Web capacities to link with their communications software and their BBS programs, respectively.

For end users, such developments will result in yet another inexpensive entryway into the Web. Heretofore, users needed either a direct Internet connection or an on-line service to access the Web. This isn't a problem, provided you can access such services with a local phone call, but for many other users, getting on-line means making a toll call. Today, the ubiquitous BBSes are making it possible for almost anyone, anywhere, to get into the WWW.

—Steven J. Vaughan-Nichols

NETWORKS

WinSock 2 Enhances Connectivity

Running multiple TCP/IP applications from multiple vendors on a PC used to be a precarious proposition, due to differences in implementation among vendors. But in 1991, about 30 application, network, and OS vendors formed a group that created and promoted WinSock 1.1. It's an open Berkeley Unix-style Socket API that makes it possible to run any WinSock-compatible application with any WinSock-compliant TCP/IP stack. This revolutionized the Windows TCP/IP market and helped popularize the Internet.

Now, WinSock version 2 has appeared in its first draft form, and it promises to liberate other network applications from dependency on a single transport protocol. WinSock 2 will let software vendors create applications that work automatically and smoothly with a variety of network transports. This new API will specifically work with TCP/IP, IPX/SPX, DECnet and OSI, but its architecture will support additional transports that are plugged in through the service provider interface.

WinSock 2 will work with Windows 95 and Windows NT, but not Windows 3.1. It allows applications to exploit capabilities in ATM, ISDN, and wireless technologies.

The new WinSock will also include enhanced capabilities. Perhaps the most important of these is the ability to share sockets across multiple tasks, which allows one application or thread to share a data stream with another application or thread. Under WinSock 1, this was very difficult for a programmer to achieve.

"What WinSock 2 means for developers is it lets them build a single version of a program that will work with a multitude of popular networks," says Martin Hall, chairman of the WinSock group and chief technical officer of StarDust Technologies (Campbell, CA, (408) 879-8080 or martinh@stardust.com or http://www.stardust.com), a company that offers WinSock-based interoperability testing and consulting services. Hall predicts that users will see new WinSock 2–based applications in the first half of 1996.

—Steven J. Vaughan-Nichols

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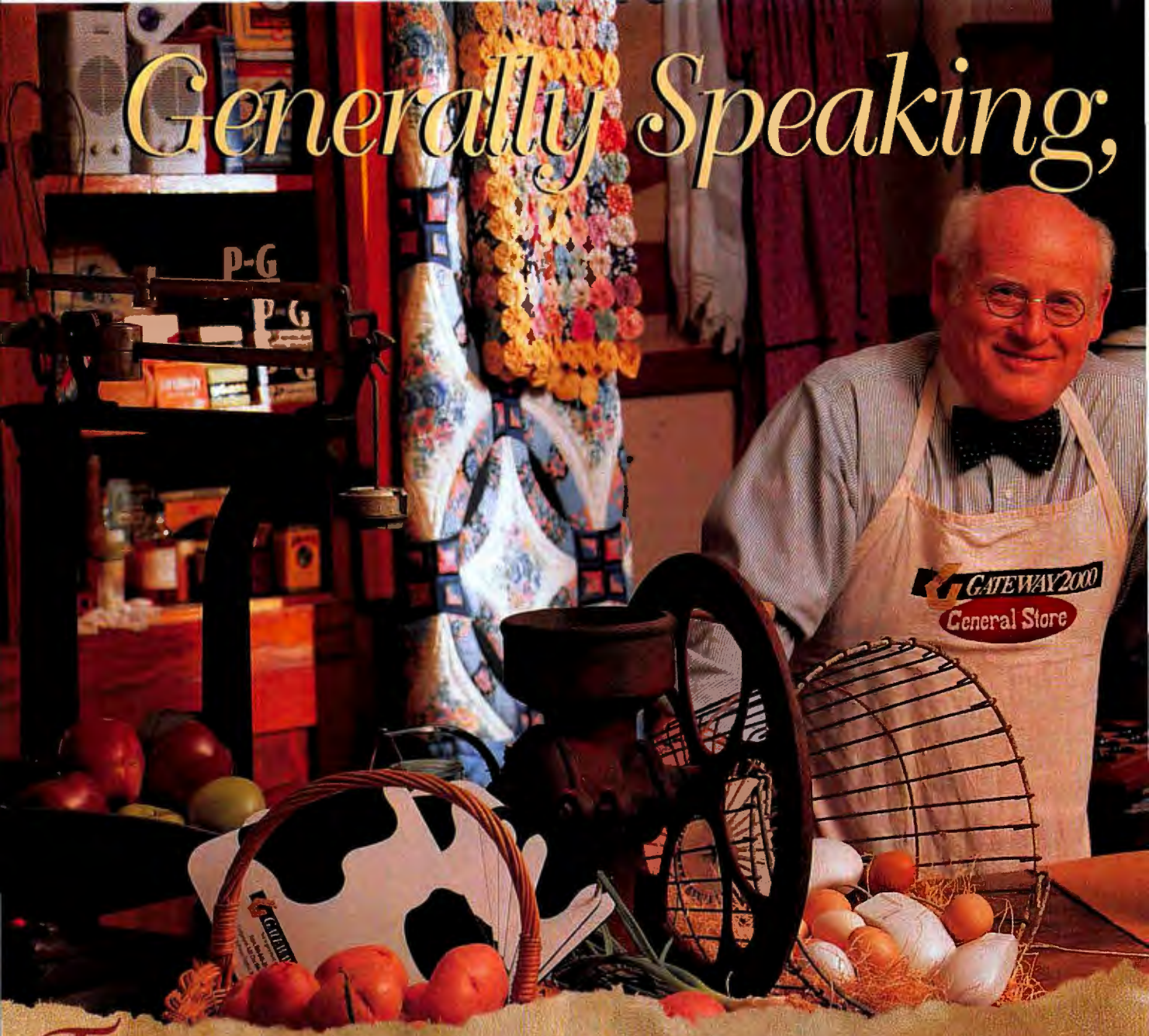

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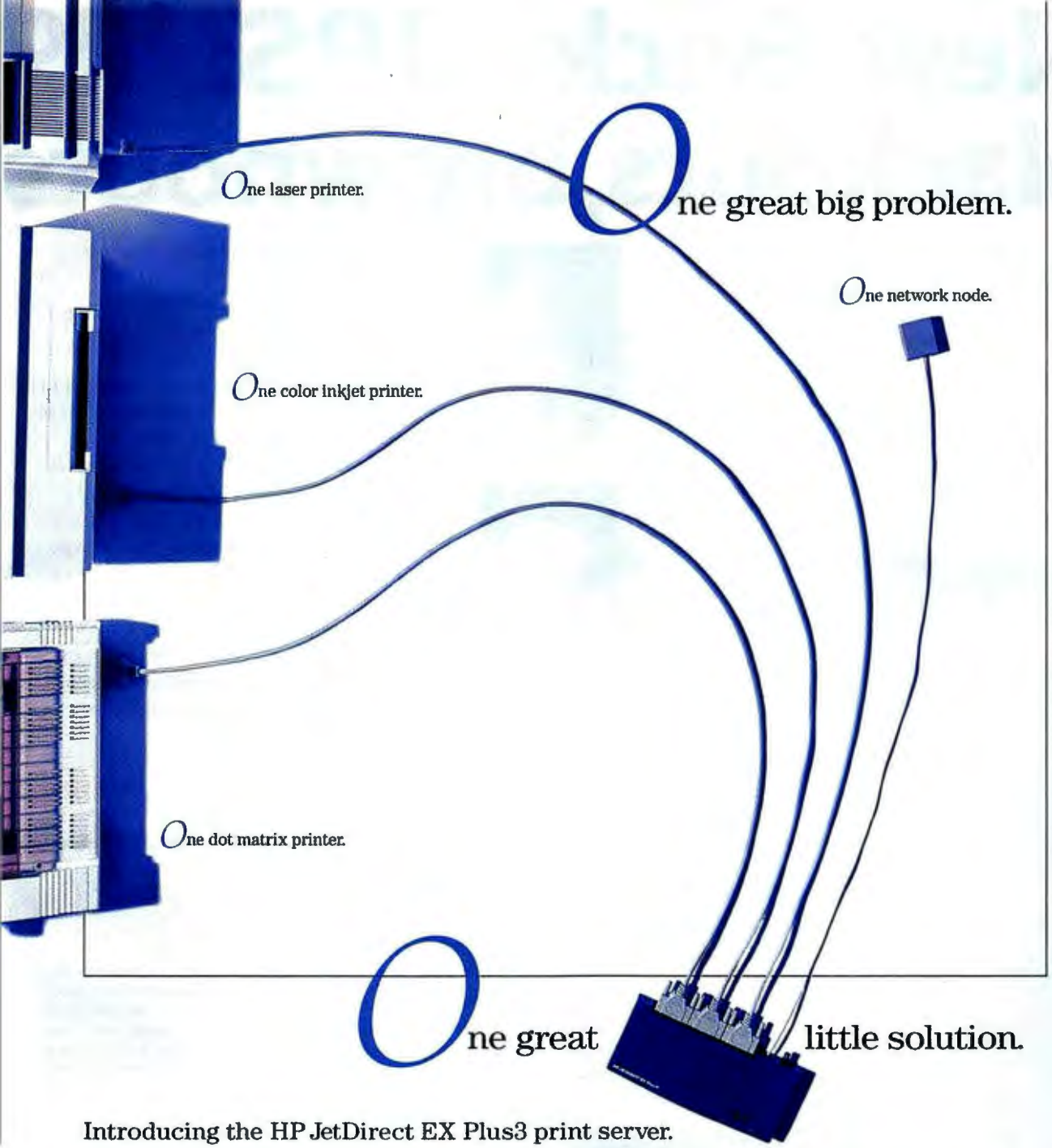

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NOS Compatibility: Novell NetWare; Microsoft® Windows™ 95, Windows NT, Windows for Workgroups, LAN Manager; IBM LAN Server; UNIX®: HP-UX, SunOS, Solaris, IBM AIX, SCO UNIX, lpd; Apple Ethertalk

Management Support: HP JetAdmin print management software enables consistent installation and management of any HP JetDirect connected printer on the network; supports SNMP-based network management software

- Flash memory for easy upgrades
- Multiple protocols with automatic switching
- Three high-performance IEEE 1284 ports
- 3-year return to HP warranty
- HP JetDirect EX and EX Plus3 print servers support all parallel printers
- HP JetDirect cards support HP printers with I/O slots

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Specifications for HP JetDirect EX Plus3. Award logos apply to HP JetDirect EX. *In Canada, call 1-800-387-3867, Dept. 239. Microsoft is a U.S. registered trademark and Windows is a U.S. trademark of Microsoft Corporation. UNIX is a registered trademark in the United States and other countries, licensed exclusively through X/Open Company Limited. RND016

New Back-UPS®: $119 blackouts, brownouts

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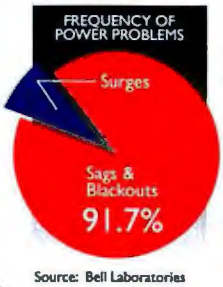
Just don't have the time for power problems on your PC? Don't worry. They'll always make the time for you. It's not if a power problem will occur, but when. Due to household appliances, poor wiring, bad weather or even other office equipment, power problems are as inevitable as death and taxes. You can't run, but you can hide, behind APC protection.

That's why we've just introduced new models in our award-winning Back-UPS line, now delivering reliable protection for just $119.

Source: Contingency Planning



Source: Bell Laboratories

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

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

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

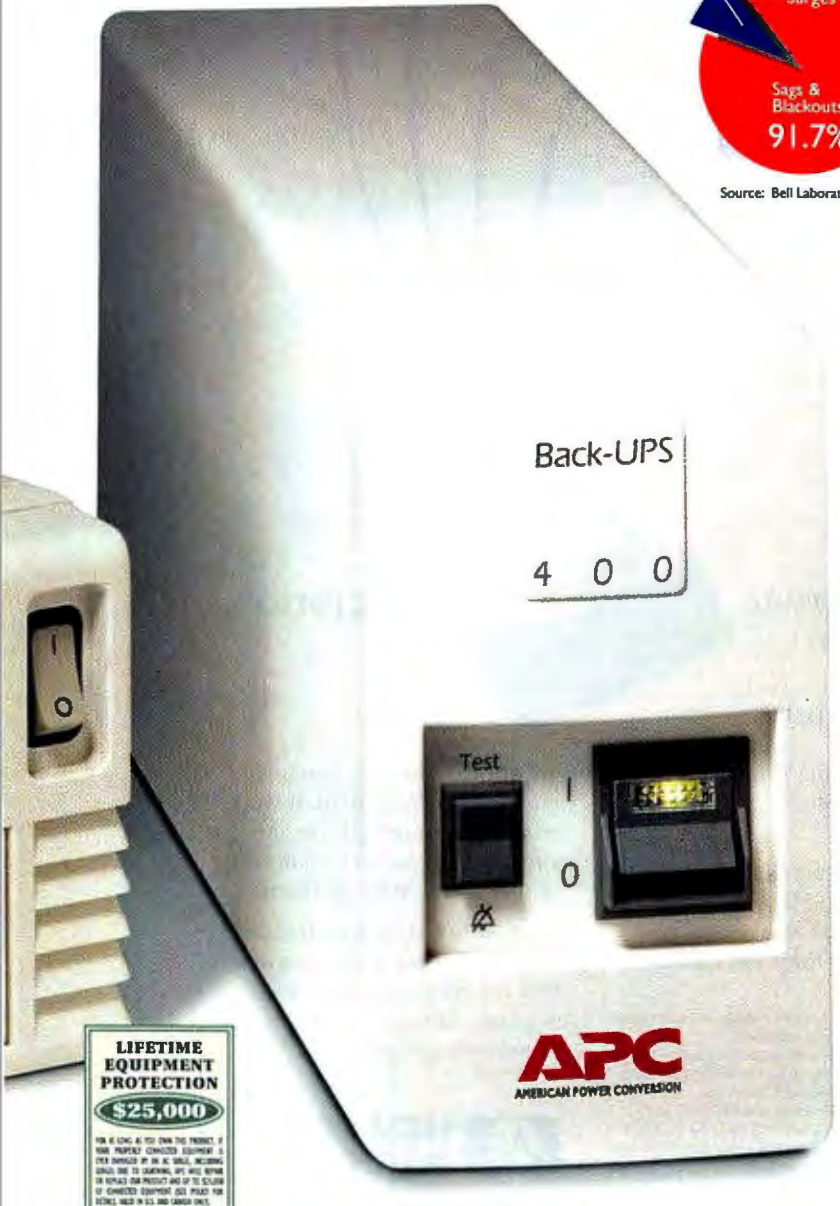
WHY A $119 APC UPS COSTS LESS THAN A $9.99 "SURGE PROTECTOR"...

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

For extended brownout protection for advanced PC workstations call about APC's New Back-UPS Pro!

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

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



PC World Top 20 Upgrade

"Don't take chances. Get the ultimate protection... from APC." --PCWorld

"★★★★ Back-UPS should be standard on every desktop... effective, affordable, designed to last..." --PC Computing

"A UPS can pay for itself the first time it saves your data." --MacUser

PC MAGAZINE UK

"The clear winner in price performance... it's unbeatable..." --PC Magazine UK

protection against and other trials by fire

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

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

Trial by Fire

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

Trial by Air

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

Trial by Earth

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

Trial by Water

Back-UPS Award Winning FEATURES

- Unmatched surge/lightning protection for maximum hardware safety
- Site diagnostics automatically spot missing ground and reversed polarity
- LAN signaling allows simple shutdown with interface kits for automatic data protection (400 and above)
- User replaceable, hot swappable batteries insure uptime safe disposal. Batteries will last 3-5 years under normal use.
- $25,000 lifetime Equipment Protection
- 10 minute runtime with specified applications. For longer runtimes choose next largest unit.

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

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

PROTECT YOURSELF OR KICK YOURSELF...

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

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Circle 63 on Inquiry Card.

OPTICAL TECHNOLOGY

Blue Laser, Bright Future

Recent breakthroughs in the development of blue-laser diodes and blue LEDs portend higher-capacity CD-ROM discs, brighter projection displays, and replacements for today's short-lived light bulbs. Although you probably won't find blue lasers in commercial products for another three or four years, researchers say they are confident that blue lasers will replace less efficient red lasers by the end of the decade.

Blue lasers will deliver increased CD-ROM storage capacity because of the shorter wavelength of the blue light compared to that of the red lasers used in today's CD-ROM drives (see "Blue Laser Capacity Improvement" at right). Shorter wavelength means the "pits" formed in the CD-ROM can be smaller, permitting higher pit densities and more data storage. Currently, the blue lasers in existence aren't light and compact enough for consumer electronics. Researchers are now developing semiconductor laser diodes and LEDs that offer a better cost/performance/size solution.

LEDs are less complex than lasers. They have a wider distribution of colors in their output spectrum, emit into a broader output cone, and emit dimmer light than lasers. Unfortunately, you can't simply increase the current on an LED and expect it to lase. Lasers require a more sophisticated device architecture than LEDs to generate their concentrated light.

But historically, high-quality LEDs have been precursors for laser-diode development. "It's kind of like learning to walk before you run," says a spokesman for Durham, NC–based Cree Research. "You need to understand how to build an LED before you build a laser diode." That is why researchers see advancements in LED commercialization as a harbinger of future laser availability.

For several years, Cree has actually been selling rather dim blue LEDs made from silicone carbide (SiC). But recently the company announced the prototype development of a superbright blue LED made from a combination of materials: a gallium nitride (GaN) layer grown on top of an SiC wafer. These LEDs are over 20 times brighter than Cree's previous SiC LEDs. Neal Hunter, president of Cree, says that by the end of 1995, the company should be producing up to 5 million of the new LEDs per month. "These blue LEDs emit about 0.5 milliwatts of power at 435 nanometers and have passed our accelerated life test, so they are quite robust," Hunter says. "Half a mW is sufficient power to enable 90 percent of the applications envisioned for blue LEDs. A little more power—perhaps 1 mW to 1.5 mW—is needed for outdoor signs, and improvements beyond that make applications brighter and more power efficient."

Blue Laser Capacity Improvement

LASER WAVELENGTH	NUMBER OF MUSIC ALBUMS ON CD-ROM (due to wavelength changes only)	NUMBER OF MUSIC ALBUMS ON CD-ROM (due to all factors including compression and improved tracking)
860 nm (near infrared)	1	7
635 nm (red)	2	14
430 nm (blue)	4	28
350 nm (ultraviolet)	9	63

Cree joins Japan-based Nichia Chemical Industries as a blue LED supplier. Nichia, which also has an office in Lancaster, PA, startled the industry about two years ago by demonstrating a blue LED based upon the GaN-sapphire combination. Nichia said its LEDs have a lifetime of over 10,000 hours (about 42 days continuous operation), stable enough for commercial applications.

Nichia's breakthrough shifted much development work to GaN, a material that others had previously tried but rejected as too inefficient. Paul Maruska, considered by many to be the "father of GaN," demonstrated light emission from the material while working at RCA in 1968. "Nichia uses the same basic process that we developed at RCA, but they improved the device efficiency by adding a heat-treatment step," Maruska says. "RCA gave up too soon. With a little more work, we could have done this 20 years ago."

Maruska is now working with a new start-up company called NZ Applied Technologies (Woburn, MA) to develop its own blue LEDs. Blue LEDs, when used in conjunction with red and green LEDs, could be used in displays ranging from small message signs to large outdoor displays. A more intriguing use of blue LEDs is to illuminate rooms: A blue LED combined with a green-yellow LED in a single package emits white light that is similar to normal light. Such devices could replace short-lived incandescent bulbs with stable, inexpensive LED pairs.

As for blue lasers, many organizations are researching these devices, including Sony, Philips, 3M, Panasonic, APA Optics, and numerous universities. Officials at Cree believe they can develop blue lasers from the GaN-SiC materials the company is commercializing. Cree has partnered with Philips Laboratories (Briarcliff Manor, NY) in a contract from the Advanced Research Projects Agency to deliver a 3- to 5-mW, room-temperature blue-laser diode in two years.

A critical goal in blue-laser diode development is to reduce the number of defects in fabrication materials. Cree's Hunter believes his company is close to getting the defect densities low enough for laser development.

—Chris Chinnock

Blue Laser and Blue LED Applications

Blue Laser Applications
- Higher density optical storage (audio/video/data)
- Spectrography and sensing
- Materials processing
- Optical communications
- Brighter, more efficient projection displays
- Higher resolution printing

Blue LED Applications
- Direct view displays (laptop backlighting)
- Laptop screen backlighting
- Room illumination
- Indicator lamps

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Circle 68 on Inquiry Card.

SECURITY

Corporations Eye Private Security Schemes

Over two years ago, the U.S. Government raised the passions of many computer users when it offered encryption chips named "Clipper" that left a back door open for surveillance. Any law enforcement employee with a warrant could tap into a central database of "escrowed" keys and decrypt the data encrypted with this chip. The Clipper chip never found much of a market beyond the U.S. Government, because of its cost and its aura of Big Brother, but the notion of escrowing keys with a third party lives on. Several influential companies are investigating providing private backups of keys to corporations and users.

The distinction between giving the government copies of the keys and storing them with a private data backup agency may seem small to individuals, but it can make a crucial difference for corporations. Many businesses face the problem of recovering encrypted files when employees with the keys leave the company, retire, go on vacation, call in sick, or disappear.

Several companies both large and small are testing the market for providing software that escrows keys automatically for businesses. Trusted Information Systems (Glenwood, MD), a security software company that first started investigating software-based escrow systems over a year ago, is one such company (see "Software-Key Escrow Emerges," October 1994 BYTE). They're also currently working with National Semiconductor, which is exploring providing special smartcards. Motorola recently announced plans to build escrowing features into its encryption products. RSA Data Security (Redwood City, CA), one of the pioneers in the field, offers an intriguing feature in its software for the Windows PC and the Macintosh. The escrow back door can be turned off easily.

The escrow systems encrypt files by using standard algorithms, but they finish by appending a copy of the encryption key that can be used to read the hidden data. This key is encrypted with a different key, which is usually the escrow service's public key. Now, only people with the corresponding secret key that matches the public key can unlock the appended key and get at the contents of the main file.

Someone within the company, such as the general counsel or the MIS manager, may hold the secret key. Another option is to have an external service bureau hold a copy of the key. Many software companies may vie for this job, but they may have some unexpected competitors. Bankers Trust will likely enter the market and trade on the corporate culture of privacy and security that it developed in the banking business.

It is not clear how external service bureaus will guarantee their work. Stewart Baker, a former general counsel of the National Security Agency (Ft. Meade, MD), predicts that escrow companies may offer bonds in the same way that locksmiths guarantee their fidelity. One of the biggest problems may be estimating the value of the keys, because information can have such a protean nature. —Peter Wayner

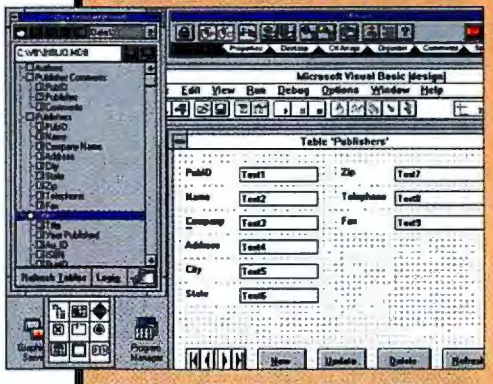
CODE TALK

RICK GREHAN

Jeeves Comes to Visual Basic

It's the small things that count. VBAssist 3.5 ($179) from Sheridan Software (Melville, NY, (516) 753-0985; fax, (516) 723-3661) does small things. But it does so many small things, and it does them so well, that the resulting sum is greater than the parts.

In operation, VBAssist appears as a floating, tabbed toolbar. It executes concurrently with Visual Basic's IDE and adds capabilities primarily, but not exclusively, to VB's form designer. Here's an example: You're busy building a form, and you've placed a column of buttons along the right-hand side of the form window. You want it to look tidy, right? You want all the buttons to be the same size; you want them aligned precisely. You can do this in VB, but you'll probably have to dip into each button's properties box to verify width, height, and so on. You're toiling when you'd rather be programming.



VBAssist provides a number of useful utilities for Visual Basic programmers.

With VBAssist on the job, you simply size the topmost button the way you want it, select the remaining buttons of the group, and click on VBAssist's resize toolbar button. Voila, all buttons are now the same size. To align, select the button group and click on VBAssist's vertical alignment button. Done. VBAssist even provides a data entry field that lets you control spacing between buttons when you align them.

Such is the nature of VBAssist. When you find yourself wrestling with one of those tedious but necessary chores of VB application design, VBAssist steps in to smooth out the ride. Want to quickly arrange the tab order of entry fields? VBAssist lets you do it by simply clicking on the fields in the order you want.

I was particularly impressed with VBAssist's librarian-type functions. For example, say your organization has standardized the appearance of dialog boxes in which controls should have a particular color or a caption should be in a particular font. VBAssist lets you gather those properties into a template and save the template into a library. Building a new application that adheres to your company's standards then becomes a snap: You pull the templates out of the library as you're constructing your forms, and your consistent user interface is assured.

A similar VBAssist function lets you place arbitrary pieces of frequently used source code into a code repository. Code "pieces" can be anything from an oft-used snippet to a full-blown routine, and VBAssist lets you attach up to four keywords to each element of the library. Finding your favorite sort routine is just a quick keyword search away.

VBAssist's data assistant tool lets you wire connections between a database table's fields and a form's data entry fields with drag-and-drop ease. With the help of VBAssist's form wizard, the data assistant will even whip up a prototype data browser form, code and all. Just tell it the table and the form, and it does the rest. You can extend the resulting form and code to create more elaborate data management screens.

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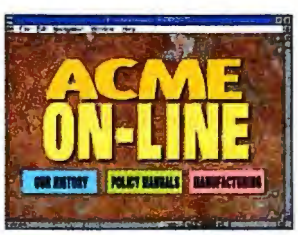
A YEAR IN THE LIFE OF A FRAMEMAKER DOCUMENT.

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

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

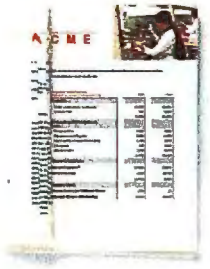


JUL 1 *Oh, the joys of red tape. Leave it to the government to issue a whole slew of new safety regulations right before Acme's publication deadline. Sound like a nightmare? Not with FrameMaker. The document jockeys at Acme appended the document with a regulation directory in standard government format,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

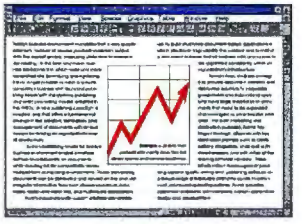
AUG 21 *The buyout of a competitor, Maxco, meant suddenly the two rivals had to find a way to work together. But since FrameMaker supports industry standards in mixed environments, compatibility was not an issue. A selection of filters made converting Maxco's documentation into FrameMaker format a breeze.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

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

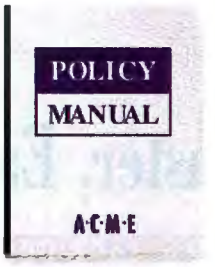
OCT 18 *"The original drawings? Uh, my dog ate them," said the architect. He wasn't kidding either. But the people assembling Acme's latest manual showing their new facility were in luck. FrameMaker not only supports popular graphics file formats, but also creates live links between other applications.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



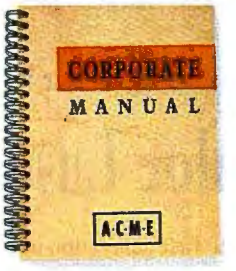
MAR 28 *This year there wasn't quite enough green stuff to go around at Acme. Which meant several marketing programs were cut from the budget and the marketing plan. No problem. FrameMaker instantly updated the table of contents and index accordingly. And WYSIWYG table editing ensured all the tables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



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



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



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

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

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

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Circle 77 on Inquiry Card.

COLOR PRINTERS

Color Lasers: Faster, Easier, Cheaper

The first generation of color laser printers were pricey, difficult to maintain, and expensive to operate in color. A second generation of products due to ship this summer addresses these issues, although prices remain relatively high (at least $5000).

One second-generation offering comes from Xerox (Rochester, NY, (800) 349-3769) and its XPrint line. With three machines (the 1200 by 300 dots-per-inch model 4915 [$6895] and the 600 by 600 dpi models 4920 and 4925 [$7995 and $9495, respectively]), Xerox claims it is cutting black-and-white page costs to about 2.5 cents a page, which is comparable to that of a monochrome laser printer. Color prints will cost about 20 cents a page, a price that's competitive with other laser printers but slightly more than the Tektronix Phaser 340 phase-change printer's estimated 11 cents per color page. All three Xerox printers print at up to 12 pages per minute in black-and-white and up to three ppm in color.

With its Intelligent Color technologies that make it easier to generate high-quality images, Xerox hopes to make color printing less daunting. However, although Xerox's new printers will ship with consumables like toner installed, they still require separate developer and toner cartridges, making them more difficult to maintain.

Apple's (Cupertino, CA, (408) 996-1010) new Color LaserWriter 12/600PS doesn't require separate developer and toner cartridges and thus reduces the number of consumables a user must confront. In this respect, the 12/600PS joins Tektronix's (Wilsonville, OR, (800) 835-6100) new Phaser 540 Plus ($8995), a modest upgrade of the Phaser 540. The Phaser 540 already combined toner and developer.

Apple's color laser printer (prices start at $6400) prints at up to 12 ppm in black and 3 ppm in color at 600 dpi. The 12/600PS's rotating carousel for the four color-toner cartridges makes it easy to replace spent toner.

Another handy feature is the 12/600PS's automatic color calibration and PhotoGrade technology, which delivers close to photorealistic color. And although the printer ships with just 12 MB of RAM (the Xerox printers come with 16 MB to 24 MB depending on the model), the 12/600PS can print at 600 dpi in black and white or color, thanks to its compression/decompression ASIC. Apple says its Contone compression lets a page that would require 120 MB of RAM print with just 8 MB.

Despite the performance and usability advances, analysts say color laser printers are still too expensive for the mainstream, especially when quality monochrome laser printers sell for $400 to $1500. However, increased competition should continue to drive improvements. HP, QMS, and even NEC will also likely introduce new color laser printers this year. With competition from phase-change printers like Tektronix's Phaser 340 (see "Color Encroaches on the Desktop," June 1995 BYTE, page 28) and from startling new color ink jets (see the text box "HP's Fast Color Ink-Jet Printer" this page), the prognosis for end users is a new palette of cost-effective and high-performance color output options.

—Jon Pepper

HP'S FAST COLOR INK-JET PRINTER

Color ink-jet printers are not just for the small- or home-office user. New high-end color ink-jet printers like the Color Jetprinter 4079 Plus ($3199) from Lexmark (Greenwich, CT, (800) 358-5835) target graphics artists and CAD/CAM users with its PostScript Level 2 support, color matching, and 11- by 17-inch printing capability. But color ink-jet printers generally suffer from slow output performance (one ppm for monochrome output is typical).

However, HP's (Santa Clara, CA, (800) 752-0900) DeskJet 1600C, which was announced earlier this year in Europe and more recently in the U.S., prints at 600 by 600 dpi resolution at up to 9 ppm. Color pages are produced at 300 by 300 dpi at up to 4 ppm. At estimated street prices of $1400, the 1600C will tempt buyers who can't afford a color laser printer. A Mac version, the 1600CM, includes PostScript and should sell for $1999. You can expect Canon and Lexmark to provide products with similar speed in the coming months as well. —Jon Pepper

Whatever Happened to . . .

The Polar Chip Set?
(See "Intel, AT&T, and AMD Continue the Chase," December 1993 BYTE, page 28.)

In 1993 the computer industry had high hopes for the PDA (personal digital assistant) market, and several companies sought to establish its chip platform as the industry standard, including San Jose, CA–based VLSI Technology. In a joint venture with Intel, VLSI designed the Polar chip set. But the PDA market never blossomed, and, like other PDA casualties Eo, PenPoint, and AT&T's Hobbit chip set, the Polar project was dropped. "We dissolved the agreement with Intel last summer because the PDA market had not taken off," says Linda Prosser, VLSI's vice president of communications.

Because Microsoft didn't deliver its Winpad software (the software engine for the Polar chip set), customers who had planned to produce Polar-based devices were unable to bring those devices to market. However, VLSI is still active in the PDA market, producing the ARM processor that's used in Apple's Newton and in Motorola's Marco PDAs.

—Nick Baran

Comparing Color Ink-Jet and Laser Printers

	HP COLOR LASERJET	XEROX XPRINT 4920	APPLE COLOR LASERWRITER 12/600PS	HP DESKJET 1600 C[1]	LEXMARK COLOR JETPRINTER 4079 PLUS
Print resolution (dpi)	300 x 300	600 x 600	600 x 600	600 x 600; 300 x 300 (color)	360 x 360
B&W print speed	Up to 10 ppm	Up to 12 ppm	Up to 12 ppm	Up to 9 ppm	1.7 ppm
Color print speed	Up to 2 ppm	Up to 3 ppm	Up to 3 ppm	Up to 4 ppm	Up to 1 ppm
Emulations	PCL 5E	PS Level 2[2]	PS Level 2	PCL 5E	PS Level 2
Paper capacity	250 sheets	250 sheets	250 sheets	180 sheets	100 sheets
Price	$7295	$7995	$6400	$1699	$3199
Print method	Color laser	Color laser	Color laser	Color ink-jet	Color ink-jet

[1] Also comes in a Mac version with PostScript option
[2] Optional PCL 5E

Blasts from the Past

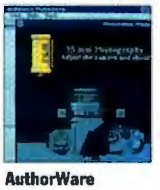
DENNIS BARKER

386SX Showdown Even though we'd criticized the 386jr architecture, SX machines were now selling for as little as 286s were. We tested 24 of them, with prices starting at $2000. Our favorites came from Zeos, Hewlett-Packard, AT&T, and Micro Express.

End-user programming was the focus in State of the Art. We looked at database query languages, scripting languages, and multimedia authoring systems. Things had come full circle: Just as in the old days, if you really wanted to get the most out of your computer, you had to know how to program, even though it was a different kind of programming.

Windows 3.0 applications were multiplying like bunnies now that the OS itself was out. We looked at IBM's Current PIM; Vellum, a CAD crossover from the Mac; Ventura Publisher; VisionWare's XVision, which turned a PC into an X Window System server; and Authorware's eponymous Professional authoring system.

Ventura Publisher


AuthorWare

ZoomText

Computers are still inaccessible to many people. But a few companies had tried to fix that. "Opening Doors for the Disabled" looked at adaptive technology that made PCs useful for people with sensory or physical disabilities: speech-synthesis systems, text magnifiers (e.g., ZoomText), head-controlled mice, braille I/O devices, and a talking pocket computer called Braille 'n Speak.

OS/90 was a tiny OS that developer GeoWorks said had all the windowing and graphics capabilities of OS/2 and Windows. Here's the kicker: It ran adequately on an 8088, and its kernel used less than 100 KB.

What do you call a machine that has zippy color graphics, custom chips for animation and stereo sound, text-to-speech routines, a video coprocessor, a multitasking OS, a GUI, and a price lower than a Mac's? You call it an **Amiga**. We got a special preview at Commodore headquarters. Even though the ROM code and OS weren't yet frozen, our editors were wowed.

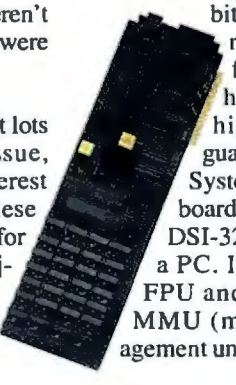
> "We think this machine will be a great success . . . the Amiga will probably have a great effect on other personal computer companies and the industry in general."

Declarative languages got lots of coverage in this issue, sparked by growing interest in Prolog (which Japanese computerists had picked for the Fifth Generation project). Besides Prolog, we examined John Backus's FP, Lisp, and Hope, one of the "new generation of functional languages."

The Tandy 1000 hit the market that month. Having a price of $1746 (with a monochrome monitor), it was a good alternative to the IBM PC. Performance-wise, it was slower. The most infuriating thing was the size of the box: It was too small for most IBM-compatible expansion cards.

Intel's 386 meant 32-bit computing was coming as a standard engine for PCs. The chip would have a 12- or 16-MHz clock, and Intel estimated it would be two to three times faster than the 286. But all you could get then were technical papers. Production wasn't scheduled to start until mid-1986.

If you didn't want to wait for Intel, you could get National Semiconductor's **NS32032 chip**—one of the first commercially available 32-bit CPUs. The chip had eight 32-bit-wide general registers and five modes to help support high-level languages. Definicon Systems had built a board around it. The DSI-32 plugged into a PC. It also had an FPU and an optional MMU (memory management unit).



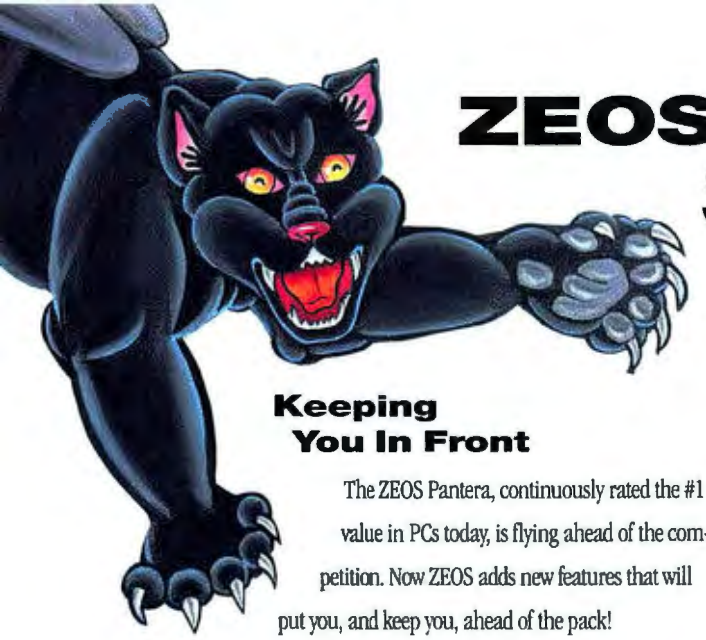
Go Forth and spread the word about the control freak of programming languages. Besides an article by Charles Moore himself on the language he invented, this issue offered a tutorial and reported on uses for this versatile language, such as controlling cameras to film spaceship sequences for *Battle Beyond the Stars*.

Using such high-tech components as rubber cement and pipe insulation, Steve Ciarcia explained how to build your own modem for less than $50.

"High-performance, high-quality, and large-capacity hard-disk drives are now a low-cost reality for your personal-computer system." This described a 5-MB Winchester drive that was available for $1500.

The Last Blasts Quiz

In honor of the last Blasts column, a tiny trivia test: What was the name of Intel's first 32-bit chip? What was it optimized to run? Send your answers to dbarker@bix.com. The first correct respondent will receive a BYTE T-shirt.



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PC WORLD — 486DX2-66 January 1994, February 1994, March 1994, June 1994, December 1994, January 1995, February 1995, March 1995, April 1995; DX4-100 October 1994, November 1994, December 1994; Pentium-60 December 1994, January 1995, February 1995, April 1995; Pentium-66 June 1994, July 1994, August 1994, September 1994; Pentium-90 August 1994, September 1994, October 1994, November 1994, January 1995, February 1995

PC Best — Pentium-66 May 1994; Pentium-90 February 1995

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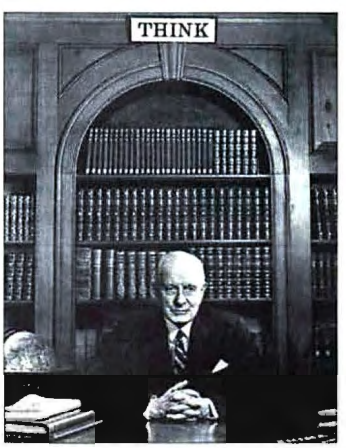
Big Blue: An Insider's View

ROWLAND AERTKER

Emerson W. Pugh is an insider. He served IBM for 35 years as a research scientist and executive. Since his retirement, he has been granted unrestricted access to the company's archives, putting him in the best possible position to tell this tale. This is not Pugh's first foray into Big Blue's history. He authored or coauthored three other volumes—*Memories That Shaped an Industry: Decisions Leading to IBM System 360* (1984), *IBM's Early Computers* (1986), and *IBM's 360 and Early 370 Systems* (1991).

Those books focused on the development of the technologies that defined mainframe computing in the period from 1950 to 1980. *Building IBM, Shaping an Industry and Its Technology*, clearly intended as a business history, sacrifices technical detail to achieve a broad view of the 100-year evolution of an industry.

Pugh begins his account two decades before the merger that created the Computing-Tabulating-Recording Co., rechristened International Business Machines in 1924. He starts with the punched-card machines Herman Hollerith developed to win a contract to tabulate the U.S. census in 1890. This is no accident. Of the three companies that merged to form C-T-R in 1911, only the punched-card business was still a part of IBM at the end of the 1950s. Even more telling is the fact that 60 years after Hollerith won the census contract, punched cards were still used only for recording data. They were not used for programming until 1949.



Yousuf Karsh's famous 1948 photo of Thomas J. Watson.

Building IBM testifies to the dizzying acceleration of technological change since World War II. Pugh traces the development of the early electronic computers. He also chronicles the role of the battle for government contracts, especially during the cold war years, as a goad to technical advances.

It is also a history of the personalities that shaped IBM: executives and managers such as Vincent Learson, John Opel, and Fred Brooks; FORTRAN developer John Backus and RISC architect John Cocke; defectors such as Alan Shugart and Gene Amdahl; and even non-IBMers, such as Seymour Cray.

Of course, the Watsons, senior and junior, are the most prominent players. Anecdotes abound. Pugh finds the origins of policies that defined the IBM image in the elder Watson's personal history. The prohibition of alcohol at IBM functions grew out of the consequences of a youthful drinking bout that got him fired from a job selling sewing machines. The straight-arrow demeanor required of IBM employees was the result of a stint running NCR's secondhand cash-register business that found him and 29 other officers under indictment for antitrust violations.

Pugh describes the grooming of Tom Watson Jr. to succeed his father and the turbulent years that followed. But this tumultuous period ushered in important advances, including the first all-semiconductor main memory and the first high-speed cache. It also gave birth to Future System, IBM's most expensive failed development effort.

It is obvious that Pugh has combed through mountains of material. There are copious notes for every chapter. He even finds a candidate for the origin of the IBM PC in a 1970 memo. Perhaps the best measure of this book's achievement is the degree to which it stimulates the reader to return to Pugh's earlier volumes for more of the technical detail behind IBM's successes. ■

BUILDING IBM, SHAPING AN INDUSTRY AND ITS TECHNOLOGY

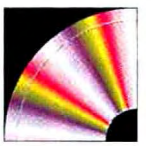
Emerson W. Pugh

MIT Press

ISBN 0-262-16147-8

$29.95

Rowland Aertker is senior researcher at BYTE. You can contact him on the Internet or BIX at raertker@BIX.com.



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Fortune 500 companies pay thousands of dollars annually to subscribe to just one of the Meta Group's seven IT (information technology) consulting services. The Meta Solution offers 1994's monthly IT reports, drawn from Meta's consulting services. For example, Enterprise Data Center Strategies treats client/server and mainframe strategies and other enterprise-wide architectural issues. Workgroup Computing Strategies addresses client and network OSes, as well as mail, workgroup, and decision support applications.

The CD-ROM includes "flash" notices of important events or announcements, "fax" summaries of weekly all-service research meetings, and analytical reports from each service. The Windows interface supports Boolean and intuitive searches and offers a browse mode, all via a button bar or pull-down menus. Intuitive searches can be based on text you compose or select in a document.

Search results can be reported in reverse chronological order or by relevance, which is based on the number of hits in a document. You can search all services and document types simultaneously or limit your search to one or a combination of services or document classes. You can print or export entire documents or selected text.

The search engine is still evolving. Masking more words, such as *a*, for instance, will help. For now, don't be surprised if an intuitive search based on a few lines of text retrieves hundreds of records. Remember, too, who Meta's clients are. If your IT needs intersect with those of the corporate giants, this CD-ROM will be most useful to you.

A Mac version is in the works. Ingram-Micro plans to make the same data available to resellers via its InfoWare IT on-line service this summer.

—Rowland Aertker

WHEN IT COMES TO CD-ROM.. WE WROTE THE BOOK

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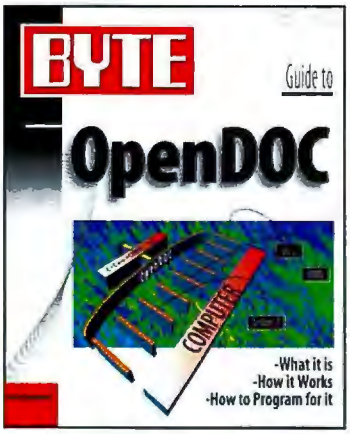

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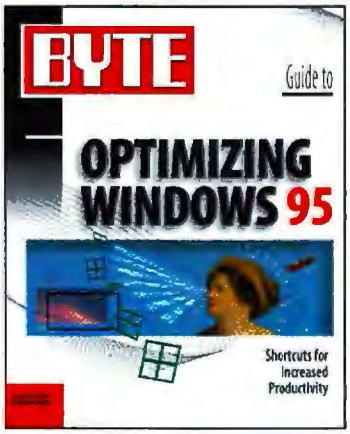

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Inside the Mind of Microsoft

Coherent. Consistent. Relentless. These are the words that describe Microsoft's OS strategy. Any questions?

TOM R. HALFHILL

If you were to put Microsoft on an analyst's couch, here's what you might hear: "I had a bad childhood." (The analyst scribbles: DOS.) "But my adulthood is looking up." (The analyst scribbles: Windows NT.) "But I'm having

trouble controlling my inner child." (The analyst scribbles: Vestiges of DOS in Windows 95.)

Diagnosis: perfectly normal behavior. So normal, in fact, you might think it's all going according to some divine plan.

The plan is Microsoft's strategy for OS dominance—the desktop today, servers tomorrow, and eventually anything that runs an OS, including PDAs (personal digital assistants), office equipment, consumer appliances, TV set-top boxes, and video servers. (See the text box "Tigers and Icebergs: Microsoft On-Line" on page 50.)

This strategy is working. Its foundation, the Win32 API, is becoming a standard platform for third-party software—even for non-Microsoft OSes. Its plumbing, OLE 2.0, provides seamless software integration and is supported by a steadily growing number of applications. Another key building block is Visual Basic, Microsoft's tool for building custom solutions; more than a million copies have been sold. Finally, there's Microsoft Office, the applications suite that is capturing nearly 90 percent of the market.

Windows 95 = MS-DOS 5.0

Windows 95—the newest addition—is ironically the most antiquated part of this structure. But it serves two purposes: It will move developers to the Win32 API and will ease the transition for users whose hardware isn't yet ready to handle the demands of Windows NT.

Microsoft, when pressed, agrees: "If you're in a corporate environment and you're thinking long-term, and hardware isn't a limitation, you should be looking at Windows NT," says Jim Allchin, senior vice president of Microsoft's business systems division. He continues: "If you've got only 4- to 8-MB systems, there's no question that Windows 95 is the choice."

In a lot of ways, Windows 95 is reminiscent of MS-DOS 5.0. It is the next-to-last major release of an OS that has transformed the computer industry but is nearing the end of its useful life. Windows 95 will be followed by a minor release (code-named Nashville) in a year or two and then capped off by what will almost certainly be the last major upgrade (Memphis) about a year after that.

About then (1997 or 1998), the version of Windows NT now known as Cairo will be released. Its object-oriented architecture and Network OLE (formerly called Distributed OLE) plumbing will enable the advanced features that Windows 95 hints at but won't be able to fully deliver.

Microsoft has made this strategy very clear. "Microsoft put a stake in the ground four years ago: Win32, WOSA [Windows Open Services Architecture], and OLE," says Jamie Lewis, president of The Burton Group (Salt Lake City, UT), a research-consulting firm. "Sure, there have been some deviations and hiccups along the way. But overall, Microsoft's migration path has been clearly defined."

That message seems to have gotten through to corporate users, too. Paul Dunton, director of computer solutions and services at Pacific Gas and Electric (San Francisco, CA), says he's deploying NT on applications servers and is very much aware that Cairo is coming in a few years. Almost all the new systems PG&E is purchasing are 32-MB Pentiums, which will comfortably run NT. When asked if he comprehends Microsoft's long-term strategy, Dunton jokes, "You mean besides world domination?"

Then he gets more serious. For now, he says, the vast majority of his users will upgrade from Windows 3.x to Windows 95, not NT, which is reserved for advanced users. "At this point, we're not promoting NT as an end-user OS. It's probably overkill for most of our 20,000 users to have that environment."

Stiff hardware requirements and higher licensing fees are also slowing the adoption of NT. According to estimates from International Data Corp. (Framingham, MA), Microsoft shipped only 400,000 units of NT in the first full year of availability, compared to 2.4 million units of OS/2 in the same period. But Microsoft is undeterred. Nearly five years elapsed between the 1985 debut of Windows 1.0 and the 1990 release of Windows 3.0, the first truly successful version of Windows. Microsoft plays for the long haul.

To NT Through Win32

Microsoft really wants to support only one desktop OS, but that isn't possible today because NT won't run on most PCs, and Windows 95 can't absorb all the advanced features of NT. Also, it will be a few years before most users realize they need those advanced features.

In the meantime, Microsoft is confronted with the problem of getting from Windows 95 to Windows NT. Win32 is the path of convergence. The core OS code will not actually merge, but the application code will. Windows 95's core code is irrevocably tied to the x86, and it will never be completely rewritten. Microsoft spent five years and $150 million to write the 6 million lines of code in NT and has no reason to repeat that ordeal.

Microsoft would like to see all the 16-bit software that currently runs on Windows and DOS ported to the Win32 API. (Win32 is the API underlying every application written for Windows NT and, eventually, all applications written for Windows 95.) Windows 95 is a crucial way station to that end. Ideally, from Microsoft's point of view, everybody would already be migrating to NT, which is much more solid and 32-bit from the ground up. But NT requires at least 12 MB of RAM (16 MB on RISC) to run—and 20 MB to run well. It's also sluggish on anything less than a swift 486, and there are still a lot of 386s out there.

So, because scaling NT down to run on older hardware simply isn't practical, Microsoft is using Windows 95 to carry the bulk of the market to Win32. Windows 95 has borrowed several key features from NT—such as preemptive multitasking and memory protection—but Win32 is the most important one.

Even though Windows 95 will run DOS and Win16 programs, Win32 programs run better and will also run without modification on NT. In fact, NT compatibility is a requirement for displaying the Windows 95 logo on software packaging. True, there are some differences between the NT version of Win32 and the Windows 95 version, which is sometimes called Win32c. But those differences are relatively minor and won't impede the general movement toward Win32.

Win32 is thus gaining strength despite the slow adoption rate of NT, the primary platform to use it. In May, even IBM acknowledged Win32's importance by unveiling the Developer API Extensions for OS/2—a Win32 subset that will let programmers write software that can be recompiled for either OS/2 or Windows. And Digital Equipment (Hudson, MA) recently announced that OpenVMS will support the Win32 API via Wind/U, a Unix-based Win32 layer from Bristol Technology (Ridgefield, CT). By writing to Win32 and the Microsoft Foundation Class Library, developers can recompile their applications to run on OpenVMS or Digital Unix.

The Office Strategy

APIs such as Win32 are visible only to programmers; users interact with the OS and applications. Microsoft is blending

Tigers and Icebergs: Microsoft On-Line

Today desktops, tomorrow the world. That sums up Microsoft's global OS strategy. Microsoft is preparing for a future where computing devices of all types are ubiquitous, networked, and part of our daily routine.

For a while, it looked as if PDAs (personal digital assistants) were the next big thing. But judging from Apple's struggles with the Newton, it will be a while before PDA technology catches up to expectations. That's a fortunate reprieve for Microsoft, which is having trouble scaling Windows to fit on today's palmtops.

The next battlefront could be TV set-top boxes for interactive broadband networks. Someone has to provide the software for the head-end video servers, the network switching equipment, and the millions of TV set-top boxes. Why not Microsoft?

Microsoft's data superhighway project runs under two code names: Tiger and Iceberg. Tiger, now dubbed MMS (Microsoft Media Server), is the video server that can spool independent streams of TV and video programming to thousands of home and business subscribers. Iceberg is the distributed OS that will run Tiger. Both technologies are undergoing small-scale trials.

The official name for Iceberg is MITV (Microsoft Interactive Television). Essentially, it's a distributed OS for the world's widest WAN. The foundations of MITV are familiar: Windows NT, Win32, OLE, and COM (Component Object Model). But like a real iceberg, the bulk of this mass is submerged. A simple user interface keeps people from realizing they're channel-surfing with Windows. New security features in MITV protect the integrity of back-channel communications, so users can pay bills, manipulate bank accounts, and order merchandise right off the screen.

Published APIs will let third-party developers write applications for the set-top boxes, just as they do now for PCs. They'll use familiar tools: enhanced versions of Microsoft's Visual Basic and Visual C++. Most of the OS and all the applications software will be automatically downloaded over the network into the set-top box when users switch on their TVs. Only a small amount of boot code will reside in the box's ROM; this reduces costs and makes field upgrades transparent.

A related piece of this strategy is the Microsoft Network, the new on-line service that's integrated with Windows 95. It, too, will be a pathway for remote banking, home shopping, and content delivery. The two main differences are that the Microsoft Network is targeted at PCs instead of TVs, and it's designed to work over the relatively low-bandwidth network of the telephone system.

Because mouse potatoes are more open to new technology, the Microsoft Network will be a good test market for new services that may later be offered to couch potatoes. It guarantees that no matter which pathway into the home emerges as the most important—PCs or TVs—Microsoft will have all bases covered.

those layers together so users won't perceive abrupt boundaries between different applications or even between the applications and the OS.

Naturally, Microsoft wants that applications layer to be Microsoft Office, a suite of business programs that includes Word, Excel, PowerPoint, Mail client license, and, in Office Professional, Access. Microsoft has expended considerable effort to make the applications work together, so that switching from one program to another barely causes a blip on the menu bar.

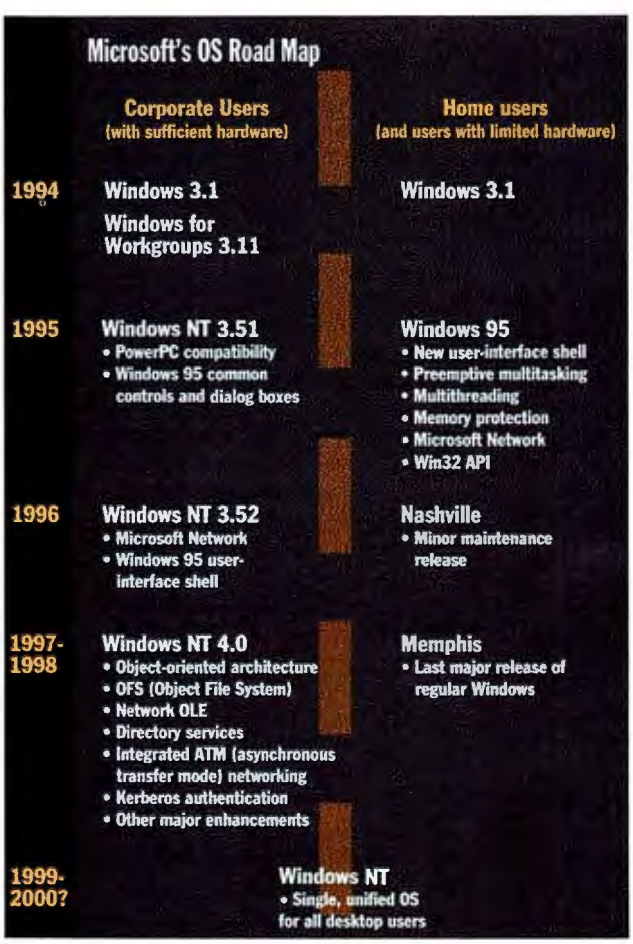
As a corollary to this strategy, Microsoft expects that advanced users and consultants will build custom solutions by using Visual Basic to further integrate the Office applications. And the plumbing that enables all this integration is OLE.

"An excellent example is the use of Microsoft Office Compatible products and OLE to create custom applications," says a Microsoft document. "Users stay within a single, familiar Office environment, yet they have the benefits of solutions that are very closely tailored to their needs."

Notice Microsoft's description of Office as an "environment" in which users do all their work, and the reference to "Office Compatible products." It's clear that Microsoft already considers Office an integral (if not integrated) part of Windows, and that third-party developers will be relegated to the role of making Office-compatible components, not Office-competitive applications. In fact, there's a new term for this emerging market niche: *fourth-party software*.

And market research proves it's already happening. Dataquest reports that Office captured an overwhelming 86 percent of the worldwide market for suites in 1994, far outpacing Lotus SmartSuite and Novell PerfectOffice. For business users, the dominant desktop OS isn't just Windows; it's Microsoft Office.

Microsoft hopes for a repeat of its Office success with BackOffice—a bundle of Windows NT Server, Mail Server, SQL Server, SNA Server, and the Systems Management Server. By bundling the OS and these packages together for a competitive price, making them work together well, and



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making them easy to use, Microsoft wants to woo sites that currently depend on anything from NetWare running on a PC to MVS running on an ES/9000.

The OLE Connection

In effect, both Office and BackOffice are another layer of software atop the OS. It's a very rich layer that provides almost all the capabilities needed by business users and also enables the construction of custom solutions. Through OLE integration, the Office and BackOffice applications expose hundreds of their features as methods that can be called by other OLE-capable programs and tools.

OLE stands for Object Linking and Embedding, but even Microsoft rarely spells it out anymore because the original definition is a small part of OLE 2.0. Indeed, OLE has become an umbrella-like brand name that covers nearly all of Microsoft's technology for software integration, client/server solutions, and components.

Microsoft's preferred tools for exploiting this top-layer "API" are the stand-alone versions of Visual Basic or VBA (Visual Basic for Applications), which is integrated with some of the Office products. VBXes (Visual Basic custom controls) complete this picture by providing prepackaged components that add even more functionality to the custom solutions.

Today, OLE allows compound documents with in-place editing and the smooth integration that helps make Office so popular. OCXes (OLE custom controls), the 32-bit replacements for 16-bit VBXes, are revolutionizing RAD (rapid application development). Right now, they're used mainly as design-time parts in tools such as Visual Basic, but a growing number of applications will let you embed OCXes as run-time components, too.

OLE automation servers are paving the way for tomorrow's Network OLE. Currently, automation servers expose their methods to programs in the same memory space, like DLLs. A growing number of automation servers can run in any process, even on another networked system. Network OLE will allow these objects to be distributed across networks while maintaining security and transaction integrity.

OLE DB, the newest member of the OLE family, interfaces OLE to multiple databases. Among them is Microsoft's future object-oriented file system for Windows NT (see the text box "A Peek at OFS" above). Ultimately, we could be looking at a distributed file system based on this technology.

Almost all this technology is expected to converge in Cairo. By then, 16- or 24-MB systems will be the baseline, so hardware shouldn't be a limitation. Cairo will inherit desirable features from Windows 95 and Memphis, until finally the day arrives when Microsoft can offer a single OS to all desktop users. If everything goes according to plan, NT and BackOffice will be running on the network server, too. Add it all up, and it's a coherent plan that bets heavily on market momentum and synergy, not stealth or even superior technology.

Clearing the Confusion

Because Windows 95 is based on Win32 and has acquired some of NT's features, some people are confused over which Windows to use. But Microsoft's delineation is quite clear: Windows 95 is for anyone who doesn't have the hardware to comfortably run NT and also for home users who play games. (After years of denial, the computer industry has finally recognized entertainment software as a critical category. Windows 95's WinG and WinToon extensions are designed for better games.)

According to Microsoft, NT is for everyone else—especially business users who can appreciate its robust security, superior crash protection, symmetric multitasking, and CPU portability. Ultimately, however, Microsoft would love it if its software were running on all hardware, everywhere. ■

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A Peek at OFS

There is a crisis in disks today. The FAT (file allocation table), which is the file system used on all DOS PCs, doesn't use all the space on them. Because the FAT has a fixed number of sectors, it must increase their size as disks get larger.

Cairo will introduce an improved file system that can address logical mass-storage devices as large as 408 million TB. That's about 418 billion GB or 427 trillion MB.

But the real challenge for future file systems is to make it easier for users to manage their mass storage. Already, people are losing track of files on 200-MB hard drives. It's obvious that the current model of organizing files into more deeply nested thickets of directories and subdirectories simply won't keep up.

Files aren't just files anymore. With compound documents, files may contain embedded objects in diverse formats that are linked to the applications that created them. For example, a Microsoft Word document might contain tables linked to Excel and pictures linked to Paintbrush. If you want to view all the Excel tables you created over the past six months, today's file systems are inadequate because the smallest items they catalog and retrieve are files, not objects. Users need a finer-grained file system that lets them find, retrieve, and manipulate objects independently of the file structure.

Microsoft's answers to these problems are OLE structured storage and OFS (Object File System), an extension to NTFS (NT File System). OLE structured storage is like a file system within a file. The compound file is subdivided into a tree structure of subfiles called stream objects and sub-subdirectories called storage objects. Your data is stored in the streams; storage objects may contain streams or other storage objects.

This might appear to complicate matters even further, because it adds yet another tree to the file hierarchy. That's where OFS comes in. Microsoft recently announced OLE DB, an interface layer that connects OLE to back-end databases. That database can be a flat-file database, a relational database, or a file system organized like a database. In effect, OFS will be a relational database that can be searched and sorted using tried-and-true query methods.

OFS is extensible, so you (or a program) could add new fields. Today's DOS FAT has only a few fields for such attributes as time/date stamps, file size, and read/write flags. But OFS could have fields that store the name of the person who created the file or object, the formats of the objects, or just about anything else that would help you manage your information.

Some elements of this technology are found in Unix, OpenVMS, System 7.5, the Newton OS, and OpenDoc's Bento-format compound files. Indeed, even some current Windows applications (e.g., Word) let you tag a file with additional attributes. But for most PC users, OFS will be the biggest leap forward in file management since the introduction of subdirectories in DOS 2.0. And the implications for corporate data systems are even more remarkable by enabling the tracking and searching of data in compound documents.

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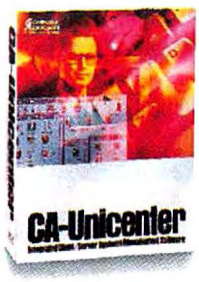

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The Elegant Kludge

Windows 95 may push the Windows 3.1 architecture as far as it can go

RANDALL C. KENNEDY

Windows 95 is a remarkable evolution of the Windows architecture. Its new interface is easy to customize and navigate. It runs 16- and 32-bit applications better than ever. It also has such advanced features as Plug and Play and built-in networking. There is no doubt that it will make the lives of millions of PC users better.

Yet despite the advances that Windows 95 represents, there are still Windows 3.1-isms. For most users, these architectural anachronisms may mean nothing more than an occasional unexpected crash. But they also lend tremendous weight to Microsoft's assertion that Windows NT and not Windows 95 is the preferred solution for advanced business users, who need security and superior crash protection.

View from 10,000 Feet

Microsoft has done an impressive job flushing out the features list for Windows 95. It has probably the best support for mobile computing of any OS, the built-in communications features are extremely impressive, and it offers a fix to the long-standing complaint that Windows will run only a few applications before stating that it doesn't have enough memory.

Portable computer users will love the much-vaunted Plug and Play technology. Although it sometimes has problems dealing with legacy hardware in ISA-bus PCs, Plug and Play works wonderfully on notebooks with PCMCIA slots. Plug in your card, and the built-in 32-bit card and socket services recognize it and automatically load drivers for it (prompting you for disks if it needs new drivers). Unplug your card, and the drivers unload.

Similarly, Windows 95 tracks whether your notebook is docked or undocked and loads appropriate drivers. So, for example, when you go into the office and dock your machine, Windows 95 knows that you're connected to an external monitor and runs at a higher resolution. Undock, and it knows that it should be running at a lower resolution.

Users on the go will also like the Briefcase, a file-synchronization tool built into Windows 95. When you leave your office, you can pack the Briefcase with the files you need and load it onto a notebook. When you return, simply load the Briefcase back onto your desktop and synchronize the contents. Windows 95 examines the individual files for changes and automatically updates your originals to reflect work done outside the office.

Windows 95 is also a great communicator. If you're on a LAN, you'll find that Windows 95 not only supports all the common network protocols and adapters, it makes them easy to manage through a simple control panel applet.

For telephone-based communications, you have Microsoft Exchange. The bundled Exchange client, which includes fax, E-mail, and Microsoft Network subsystems, provides many features that you had to purchase separately under previous Windows versions. For example, the Microsoft Network client will enable on-line software distribution and technical support.

Finally, a redesign of Windows 3.1's 64-KB resource heaps enables you to run more applications before you encounter out-of-memory error messages. For example, with Windows 3.1, you could generally run three to five applications at once. With Windows 95, you can generally run a mixture of six to 12 DOS, 16-bit Windows, or 32-bit Windows applications.

Fixing Problems

Windows 95's stability, networking support, and user interface are unquestionably improved compared to DOS and Windows 3.1. But they aren't all at the level that users of OSes such as OpenVMS, Unix, and even Windows NT expect.

One of the problems in Windows 3.1 is that a single application can crash the entire operating environment, forcing a reboot. Similarly, Windows 95 bares much of the OS's core to running applications. For example, the critical USER and much of the GDI (Graphical Device Interface) code—which provides window management and graphics services to applications—is still 16-bit and runs in the same address space as 16-bit applications. A buggy 16-bit program can potentially hang the virtual machine in which USER and GDI run or, worse still, stomp all over USER and GDI themselves, bringing the system to a halt.

continued

Windows 95: Head-to-Head

	Windows 95	Windows NT 3.51	OS/2 Warp Connect
Preemptive multitasking of 32-bit applications	Yes	Yes	Yes
Preemptive multitasking of 16-bit applications	No	Yes	Yes
Multithreading	Yes	Yes	Yes
Protected subsystems	No*	Yes	Yes
Fully reentrant design	No	Yes	Yes
Multiple DOS virtual machine configurations	No	Yes	Yes
Object-oriented interface	Yes	No	Yes
Dynamic object tracking	No	No	Yes
Long filename support	Yes	Yes	Yes
Cross-process OLE (32-bit)	Yes	Yes	No
Support for Win32s applications	Yes	Yes	Yes**
Support for Win32 applications	Yes***	Yes	No

* Windows 95 doesn't protect most of the system's address space from 32-bit applications.
** Up to Win32 version 1.15 (version 1.20 includes 32-bit OLE support so it doesn't work under OS/2)
*** Provided they don't use any NT-specific security APIs.

Even 32-bit applications can bring the system down. Much of the lower 1 MB of the Windows 95 system code's address space (i.e., the System VM) is wide open to operations by Win32 applications.

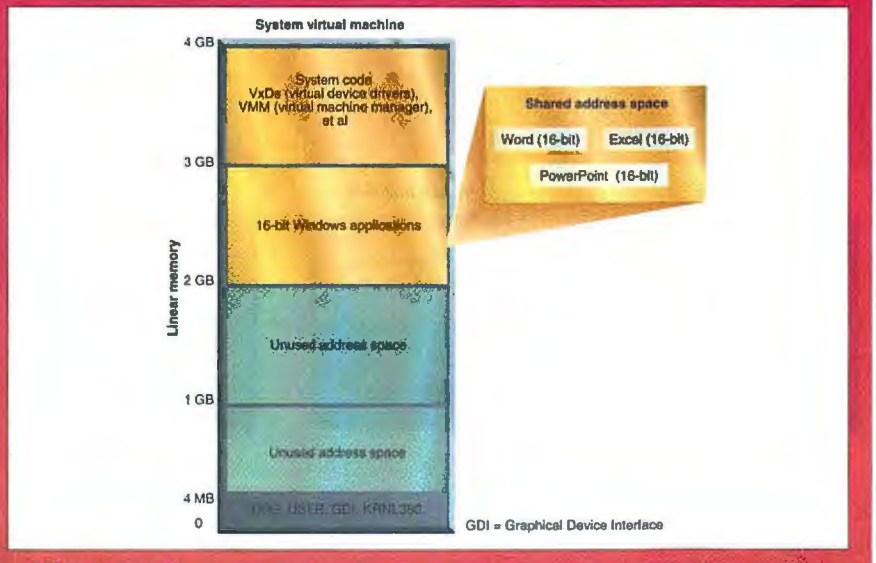
Multitasking is another potential sore spot. Windows 95 routes all USER API calls through the 16-bit System VM, which is also where 16-bit applications execute. If a 16-bit program hangs the System VM by refusing to process messages (the most common type of failure among existing Windows applications), all other processing eventually comes to a standstill. Until you clear the errant 16-bit program (Windows 95 has a good facility for killing it) and thus free the System VM, other running programs—even 32-bit ones—are blocked from executing.

Finally, there's Windows 95's new GUI, which is different. Most users think it's an improvement. But if you're in charge of IS, even if you ignore the retraining costs associated with a wholesale change in the GUI, there are holes in the Windows 95 object-oriented implementation that can be annoying. The lack of a SOM (System Object Model), such as the one in OS/2, is a good example. With no centralized object manager to track object interdependencies, links between visual elements and the underlying file system are fragile. Thus, if you move a file to another volume, all shortcuts to it are broken. Similarly, if you rename a DOS executable file from a DOS prompt, you'll get the same result.

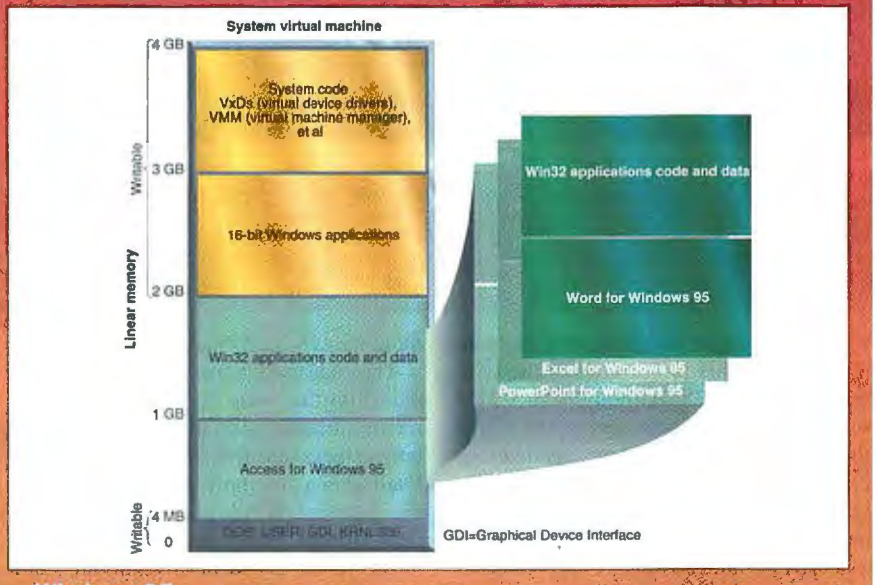
Comparative Architecture

Comparing the designs of Windows 3.1, Windows 95, OS/2 Warp Connect, and Windows NT 3.51

All four OSes run 16-bit Windows applications. All four can run 32-bit applications (albeit not necessarily the same ones). But they each have different ways to ensure that the applications run. The Windows 3.1 architecture is probably the easiest to crash; Windows NT's architecture is probably the most secure. Here's why.



Windows 3.1 Under Windows 3.1, there is one System VM. When you look at the memory map, you can see what that means: All applications run in the same address space. In addition, the DLLs that provide OS services run in this same memory space. With this architecture, if one application crashes, it's likely that all of Windows will crash.



Windows 95 Windows 95 modifies the Windows 3.1 model a little. Much of the OS's code still runs in the same space as your applications, but Win32 applications are run within private address spaces, which decreases the likelihood of one bad application crashing all of Windows 95. Notice that DOS is still in the bottom 4 MB of memory, along with USER, GDI, and KRNL386. Not that much seems to have changed.

Ghost in the Virtual Machine

Under Windows 3.1, a simple, protected-mode, 32-bit VMM (virtual machine manager) runs the show. You probably know this as WIN386.EXE, that large executable file sitting in the SYSTEM subdirectory of any Windows 3.x installation. WIN-386's job is to juggle the various Windows VMs—the System VM and any VDMs (virtual DOS machines)—to make Windows 3.1 work.

The key component the VMM manages is the System VM. It's essentially an extended VDM. The System VM provides DPMI-based (DOS Protected Mode Interface) extended memory to all running Windows applications. Windows applications execute in the System VM, in a shared address space stretching in linear memory from 2 to 4 GB. This shared VM also houses the window management (USER) and graphics (GDI) subsystems, as well as any VxDs. In essence, Windows 3.1 operates in one chunk of memory.

This model still applies under Windows 95—with some modifications. Like Windows 3.1, all 16-bit Windows applications execute in a shared address space in the upper 2 GB of linear memory. However, to provide support for 32-bit Win32 applications, Windows 95 modifies the original VMM in two ways.

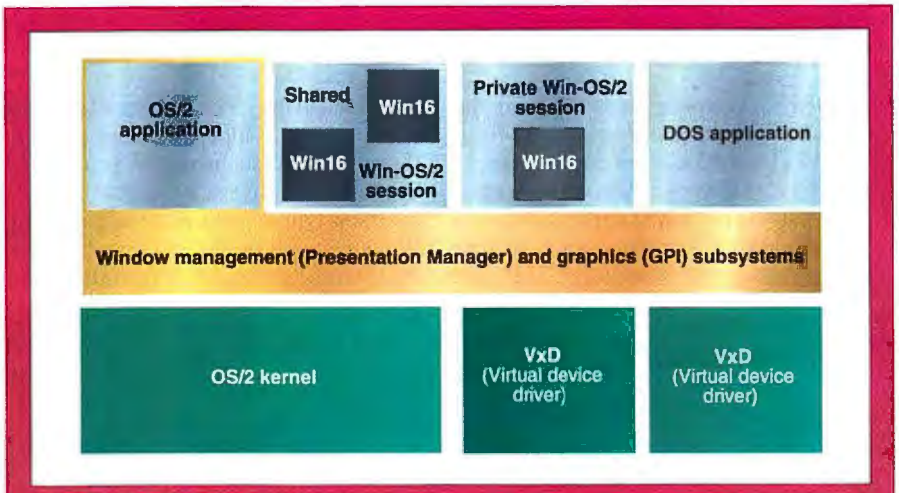
First, Windows 95 revises the linear-memory map of the OS. It exploits the region from the lower 1-GB range (just above 4 MB) up to 2 GB to provide an address space for Win32 processes. Win32 applications are mapped into this region

at run time and make their API calls to subsystems and VxDs located in the upper 2 GB. The result is a 4-GB address space for the Win32 application—the lower 2 GB for the program's own code and data, the upper 2 GB for the OS. This configuration is similar enough to Windows NT that Win32 applications will execute on either platform (with a few exceptions, most notably applications that rely on NT security APIs).

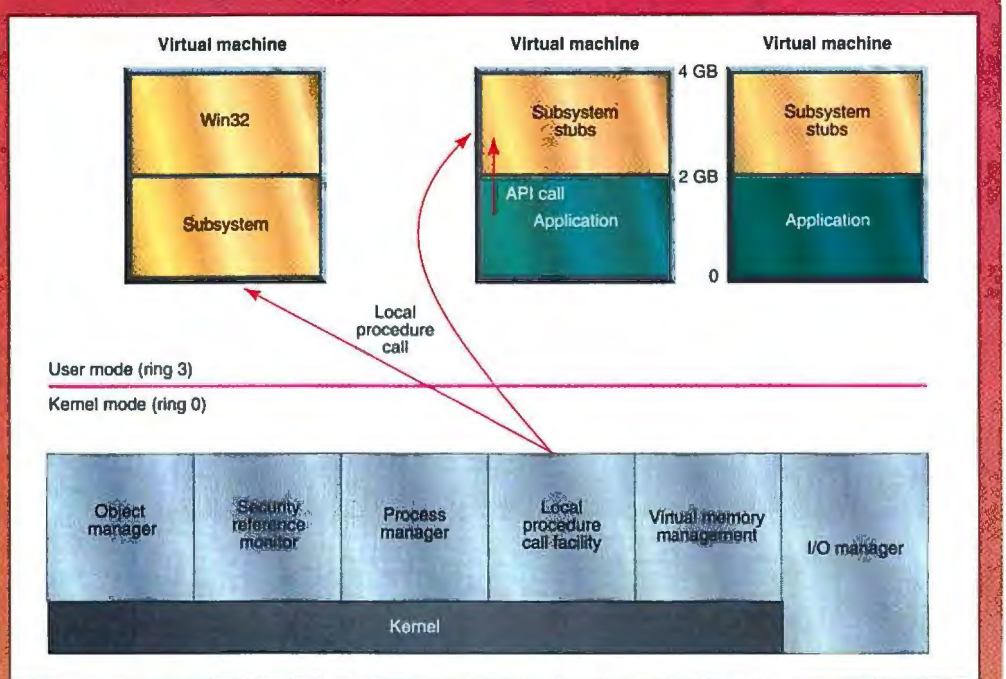
But applications compatibility is where these similarities end. Under Windows NT, each process is isolated in its own private 4-GB VM. API calls are intercepted by subsystem "stubs" located in the upper 2 GB of the address space and sent through a special message-passing mechanism in the Windows NT Executive (the local procedure call facility). They are then processed by the real subsystems that reside safely in their own isolated VMs. This protection model is remarkably secure, which makes NT extremely hard to crash.

Windows 95, on the other hand, loads each Win32 program into the System VM. As a Win32 program executes, its address space is also the address space of the System VM. Here's what goes on there. The upper 2 GB contains most of the Windows 95 subsystems, including the system and network cache, while the lower 1 MB contains the real-mode DOS image from boot time as well as parts of the 16-bit Windows subsystems (i.e., USER, GDI, and KRNL386).

This model enhances performance because all the code is running in the same VM, eliminating costly local procedure calls. But it also increases the risk of a debilitating crash because the Win32 program can write to almost all of the upper 2-GB and lower 1-MB regions.



OS/2 Warp Connect OS/2 does things differently. For example, 32- and 16-bit applications run in separate VMs, so it's difficult for them to step on each other. You also have the choice of running Win16 applications in either the same or separate memory spaces, making it difficult for them to step on each other. Of course, the OS's core services are largely protected from bad applications.



Windows NT 3.51 NT uses a client/server architecture unique among these OSes. Hardware calls and other low-level manipulations are virtually impossible with this setup. Applications must instead invoke services via local procedure calls. While extremely secure, this configuration slows some performance, particularly in games, which like to write directly to hardware. Like OS/2, Win32 and Win16 applications run in separate memory spaces, and you can choose whether Win16 applications will run in the same or separate memory spaces.

The second way in which Microsoft modifies the Windows 95 VMM is by adding support for threads within Win32 applications. A multithreaded application appears more responsive to the user by breaking itself up into small pieces, each of which can be scheduled independently by the OS's scheduler.

Multithreaded applications assume a preemptive multitasking model. In other words, the OS should be able to schedule when applications will have the CPU's attention. But this is not always the case with Windows 95. Although the VMM scheduling is itself preemptive, it's still at the mercy of 16-bit Windows applications because the OS relies on 16-bit code in key areas. To retain a high degree of compatibility, Microsoft kept some of USER and GDI 16-bit. Existing 16-bit Windows applications interact with these modules directly, as they do under Windows 3.1. API calls from Win32 applications first go through a thunking layer that translates them into 16-bit format.

The code used in these 16-bit modules is based on the same single-tasking, nonreentrant code found in Windows 3.1. To protect these sensitive structures from overloading in a preemptive environment, the designers of Windows 95 serialized access to them. Only one task can execute in the 16-bit USER or GDI modules at a given time—all other processes are blocked until the program either finishes with the code or is preempted by the Windows 95 scheduler.

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When dealing with Win32 applications, Windows 95 indeed behaves like a preemptive multitasking OS. But, because 16-bit Windows applications weren't designed to be preempted—and most break when you interrupt them improperly—Microsoft kept Windows 3.1's cooperative multitasking model when executing 16-bit applications under Windows 95.

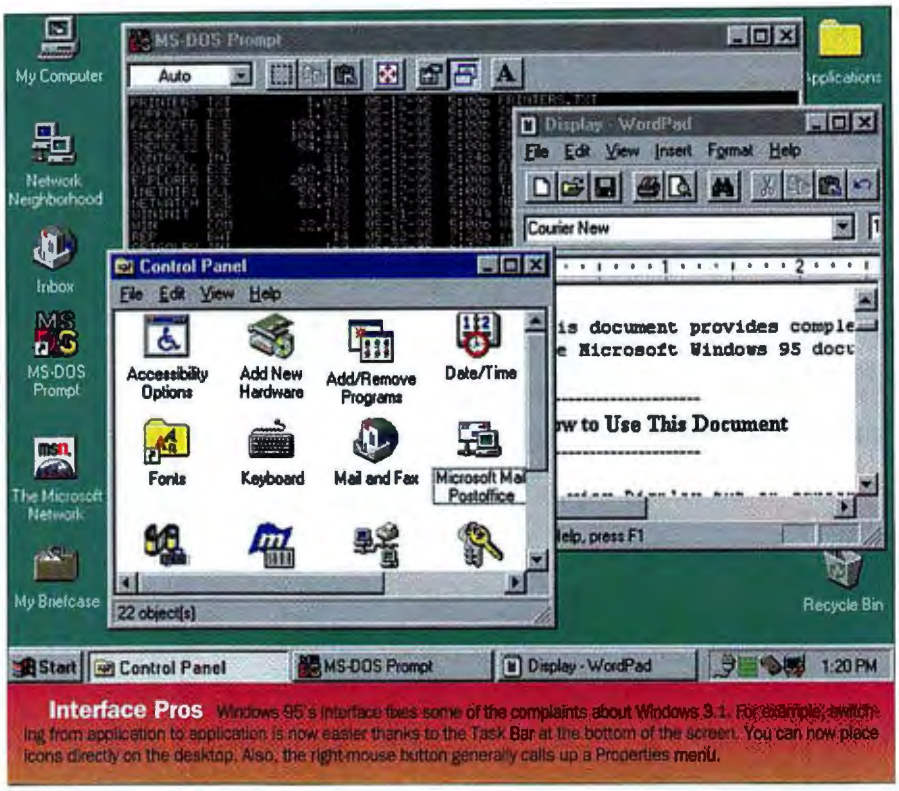
In a nutshell, when a 16-bit program executes, all other programs are blocked from running until the 16-bit program "yields" (slang for making one of the known API calls that let the Windows cooperative scheduler switch tasks). This is true even of Win32 programs. Although they are preemptively scheduled and exist in their own address spaces, they must still make API calls to the 16-bit USER and GDI heaps. As long as a 16-bit program is executing, access to USER and GDI is blocked. If a 16-bit program hangs, all processing will eventually halt as thread after thread blocks on the unavailable USER and GDI.

In addition to the changes to the VMM, one of Windows 95's most highly touted features is support for a 32-bit file system called VFAT (Virtual File Allocation Table). It is based on the FAT (file allocation table) file system that DOS has used for years. Windows 95 moves the code into protected mode, implements it in 32 bits, and, through a clever use of extra, hidden directory entries, adds support for long filenames.

The first two points affect performance—VFAT, like 32-bit File Access in Windows for Workgroups 3.11, screams. The last point, long filenames, benefits the broadest range of users. No longer do you have to truncate document descriptions to fit the eight-dot-three straitjacket of DOS's FAT implementation. Windows 95's long filename support is compatible with Windows NT. You can dual-boot the same system and gain access to long filenames in both environments.

In terms of the big picture, VFAT is the first product of Microsoft's efforts to modularize Windows. Under Windows 3.1, disk I/O was handled by DOS (with a little help from the BLOCKDEV and INT13 VxDs). While effective, this model was monolithic and tied to FAT devices. Under Windows for Workgroups 3.11, Microsoft laid the foundation for VFAT by changing to an IFS (installable file system) model. File system drivers plug into the IFS Manager, letting you add new file systems at will and making the environment more extensible. In a way, WFW's IFS was a kind of dry run for Windows 95's VFAT.

In theory, you should be able to plug just about any file system into the Windows 95 IFS model. In practice, this isn't as easy as it sounds. Advanced file systems often include security or other platform-specific functions that would be difficult or impossible to support under Windows 95. IFS's most compelling use will likely be as a method to get nonstandard storage media—and in some cases, network transports such as NFS—to work better under Windows 95.



Inside the Whale

It's the people who will see the innards of Windows 95 the most (mostly programmers writing VxDs) who will have the clearest picture of the differences between Windows 95 and Windows NT. That's where you see how the OS protects sensitive memory areas.

When you look at the world from the vantage point of an Intel CPU, you see it as a series of programs running at different privilege levels—or protection rings—within the scope of the memory management scheme. At the very heart of the environment is the kernel, which is the first program to take control of the CPU.

Under Windows 95 and Windows 3.1, the VMM is the kernel. The core OS services (the VxDs) execute beside it in ring 0, while applications (DOS, Win16, and Win32) run in ring 3. In Windows NT, the kernel is part of the Executive, a set of core OS services that run at ring 0—the most privileged level of the CPU's memory and execution scheme. As with Windows 95, Windows NT (Win32) applications run in ring 3.

Because they run in ring 3, applications aren't as privileged as the kernel or other core OS services. For example, the VMM can deny them access to certain hardware resources or force them to go through VxDs. Consequently, it's harder for them to crash the entire OS than it was under Windows 3.1.

Windows NT doesn't allow anything into ring 0 except the OS. But Windows 95 runs VxDs there. In addition, to maintain compatibility with Win16 and DOS applications, Windows 95 fails to exploit all the CPU's available protection mechanisms. For example, Windows 95 lets DOS programs directly control interrupts, improving performance but also potentially hanging the entire system if a DOS application goes south.

Win32 applications can also cause problems. To maintain compatibility with Win32 programs written for Windows NT, Windows 95 maps them all into the same address range in linear memory—0 to 4 GB. Although parts of this memory are protected (the lower 64-KB region), other parts aren't (e.g., the upper 1-GB region).

This means that a Win32 application has complete read/write access to VxDs such as the IFSMgr (installable file system manager) or VCACHE (the protected mode disk and network cache). In a perfect world, Windows 95 could conceivably

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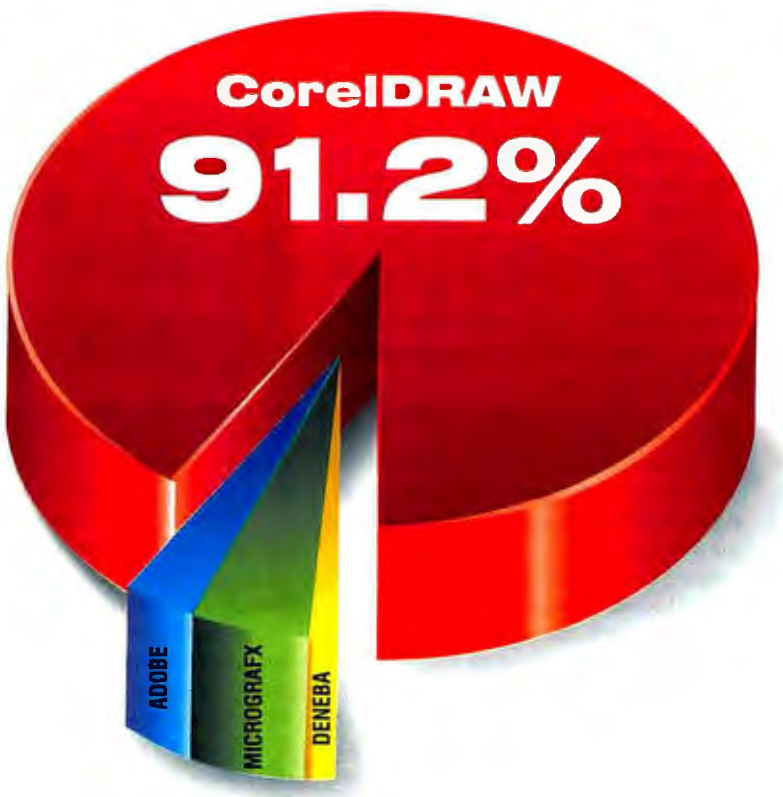

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protect this sensitive upper 1 GB by making all its pages read only, but this in turn would break any 16-bit Windows applications that directly manipulate VxD data (a common occurrence).

Thunk

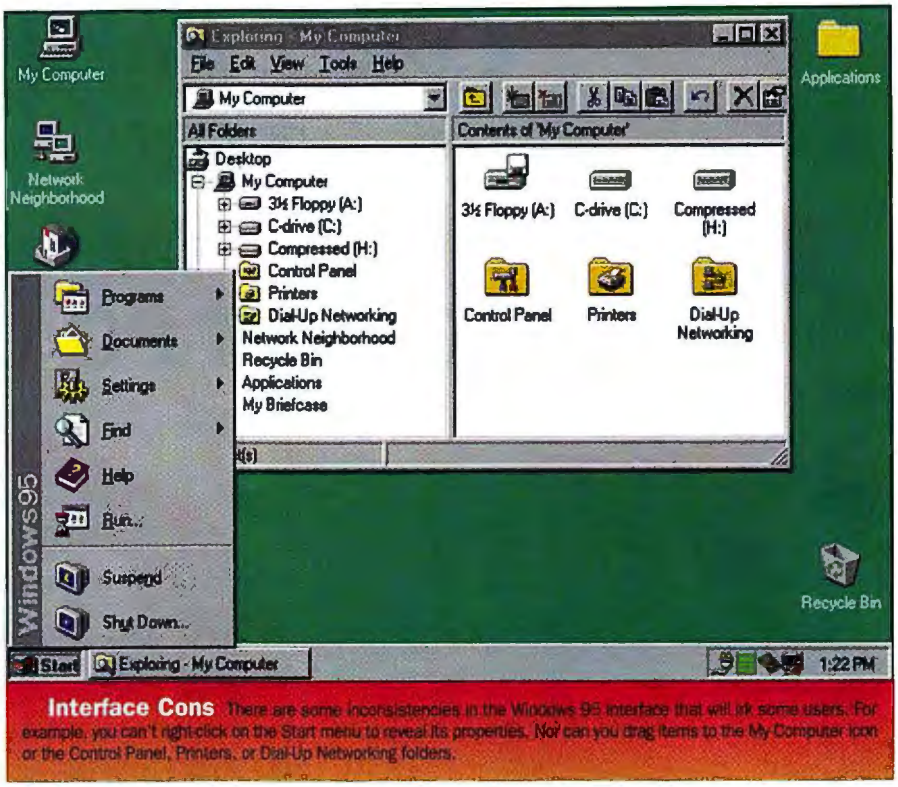
Thunking is the term used to describe how Windows 95 lets its newer, 32-bit components talk to its older, 16-bit components. Getting these two worlds to communicate is no trivial task. The 16- and 32-bit versions of the Intel protected mode are very different environments, and code written for one cannot simply call on code written for the other.

To begin with, the packaging of the API message parameters are different: 16-bit programs communicate using the 16-bit wParam and lParam variables, while 32-bit programs communicate using a 32-bit wParam. Similarly, the memory addresses specified in these message parameters must be reformatted to the scheme in use by the receiving program (32-bit for Win32 programs, 16-bit for Win16 programs and USER/GDI).

There must be a conversion mechanism, which is exactly what a thunk is: a mechanism for converting 32-bit API calls into 16-bit and vice versa. In Windows 95, thunks facilitate communication between the 16- and 32-bit sides of the OS. Each major 32-bit component in Windows 95 has a 16-bit counterpart. For example, USER32 works in conjunction with the 16-bit USER in the System VM (which is also the source of numerous bottlenecks). Similarly, GDI32 thunks down to the 16-bit GDI. Even KERNEL32 thunks down to the 16-bit KERNEL for many functions, such as managing current drive and directory information.

Beyond that, every single Win32 application has a corresponding data structure stored in real-mode DOS conventional memory. When a new program (Win16 or Win32) is launched under Windows 95, the Create Process API call—generated by KERNEL32.DLL—is thunked down to the 16-bit KERNEL, which in turn creates a new TDB (Task Database) entry for it in the 16-bit side of the environment.

The creation of TDBs under 16-bit Windows requires that KERNEL call all the way down to good old real-mode DOS, which then creates a corresponding PSP (Program Segment Prefix) entry in conventional memory. This sequence occurs for both 16- and 32-bit applications, with the only exception that the TDBs for Win32 programs are stored in extended memory (but their PSPs are still created and managed in conventional memory).



The practical ramifications of this design are twofold. First, because all running applications have a corresponding real-mode PSP, and because PSPs take up conventional memory, Windows 95's ability to run large numbers of applications is directly affected by the amount of available conventional memory your system has at boot time. (Sound familiar?) Second, with thunking going on, you have to wonder what the impact is on performance.

Windows 95 does a relatively good job of streamlining the thunking layer's performance. For most tasks, you shouldn't see any serious performance penalties. And because the only benchmark platform against which you can measure Windows 95's Win32 applications performance is Windows NT, and because Windows NT uses a more demanding client/server execution model, it's nearly impossible to determine just how well a Win32 program might execute in a fully 32-bit setting that isn't a client/server one.

You're most likely to see the real bottleneck under Windows 95 in the serialized 16-bit USER and GDI code and, to a lesser extent, KRNL386. While thunking probably won't hinder Windows 95 performance, these 16-bit bottlenecks might.

The Bottom Line

Despite any engineering compromises made by its tough requirements for backward compatibility, Windows 95 has some engineering feats. Dynamically loadable VxDs, Plug and Play support, and a new interface make it a compelling upgrade.

But many of Windows 95's other "new technologies" are merely adaptations from previous Windows incarnations. The ISF, most of the core VxDs, and even the VMM itself have their roots in Windows 386, a 1988 product. (We will be reviewing Windows 95 fully in an upcoming issue.)

Our verdict: If you play games, want a near guarantee of backward compatibility, or want incredibly complete driver support for your hardware, Windows 95 is the OS for you. If reliability or multitasking performance are more important to you than a slick interface and Plug and Play support, you should seriously consider Windows NT and whatever hardware purchases that upgrade would require. Microsoft is moving toward an all-Win32 world as fast as it can, so, unless you're a serious game player or have applications or hardware not supported by Windows NT, it might be better to bite the bullet now and switch to a fully 32-bit OS.

In any event, you should be running tests on Windows NT to determine what it does well for you and, if you're in charge of any number of computers, whose you should consider upgrading. ■

Randall C. Kennedy is coauthor of the forthcoming Windows 95 Bible *and author of* Migrating to Windows NT. *You can reach him at rck@dnai.com or editors@bix.com.*

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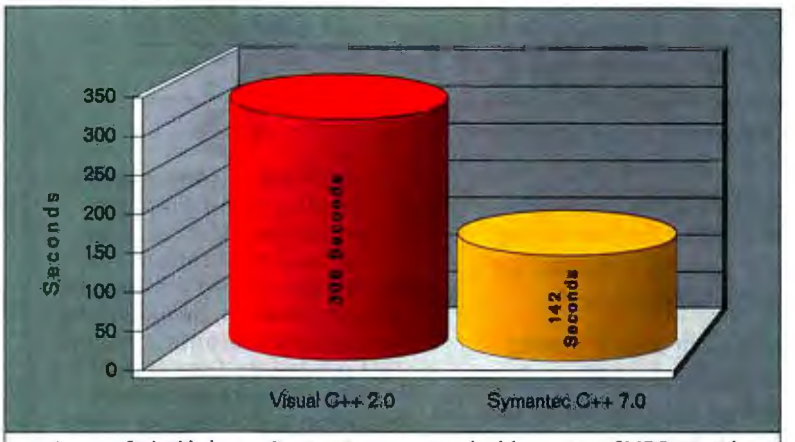

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Finding a Pattern

Databases rich with patterns are becoming common in all industries. Engineering firms now have good data on all parts of the engineering process and can use that data to produce better designs. Manufacturing companies need to be aware of sharp changes that might occur in any product (e.g., when another company introduces a significant competing product). Information suppliers can track the use of Web browsers to determine how people are reacting and can make choices about which information to choose next.

The most important stumbling block to using any of these algorithms is defining the logical structure of the problem so that the problem can, in essence, be explained to the computer. This means that large, vaguely defined problems, such as achieving peace in the Middle East, cannot be solved with pattern recognition. But more reasonable questions can be answered. For instance, is there a relationship between the disease that a set of patients has and their symptoms? If all the details are recorded, many machine-learning algorithms can identify the connections.

One of the groups successfully bridging the gap between abstract theory and applications is MLI (Machine Learning and Inference Center) at George Mason University in Fairfax, Virginia. The center, headed by Ryszard Michalski, produced a number of successful applications by working with well-defined problems, categorizing diseases, identifying objects in images, and combing databases for information.

Much of the work emerging from the MLI concentrates on finding the best logical rules for the data. Such learning programs strive to generate knowledge such as "Cars have four wheels, and bicycles have two." More statistically based learning algorithms might examine a set of bikes and cars and determine that the threshold that separates the two is three wheels. The difference is subtle. Learning algorithms aimed at finding rules shine on problems that have a fixed set of solutions. Statistical approaches do better where the dividing line is less obvious (e.g., the difference between tall people and short people). *continued*

Learning Systems

One of the better examples of the MLI approach to machine learning is the Inlen system. Inlen searches through large databases to find significant patterns. Supermarkets, for instance, encourage shoppers to join discount clubs so that they can generate profiles of their consumption. The IRS is widely believed to use pattern-recognition algorithms to identify suspicious tax returns. And federal law enforcement agencies are also believed to scan financial transactions to identify money laundering.

The Inlen system works with a relational database. Patterns are extracted from the database using a variety of different learning algorithms. The Inlen system is, in a sense, merely a CUI (common user interface) to some of these algorithms.

One of the algorithms used in the system is called Sparc (no relation to the chip). Sparc finds patterns in sequences of data and attempts to predict the next element. For instance, if the sequence were "circle, triangle, square, circle, triangle," then Sparc would predict that the next element was square.

The Sparc algorithm works by analyzing the sequence with three different submodules. One submodule looks for periodic patterns like the one in our "circle, triangle, square" pattern by trying all potential period lengths and looking for alignment.

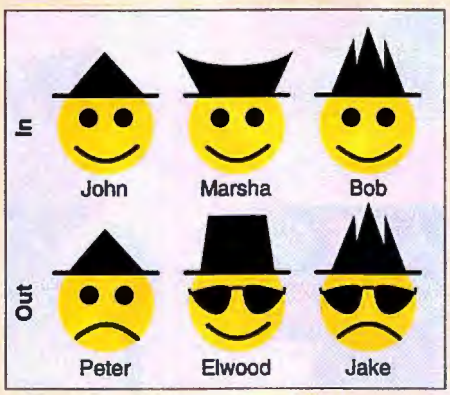
Another submodule searches for dependencies that may not be periodic. For instance, only squares come after triangles in the following sequence, "circle, circle, triangle, square, circle, square, circle, triangle, square, circle." The algorithm starts by generating hypothetical rules from single items in the series and then tries to see which rules hold generally. Normally, the algorithm will pick the shortest explanation possible.

Sparc's third submodule tries to combine several simple rules in what is called disjunctive normal form—that is, the submodule will look at a more complicated pattern and realize that one rule holds in some parts of the series and another rule holds in others. The submodule would combine the two rules with an OR and produce a rule that is general to the series.

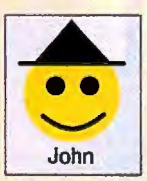
The Inlen system also includes many other modules. One called Cluster identifies groups of similar data. Another called Eventree generates decision tree rules built up of IF...THEN clauses.

MIX 'N' MATCH

Finding a method in the madness takes a bit of persistence.



Here we have a group of talking heads. Some of them are in a club, some don't get to be in the club. It's up to a machine-learning algorithm to figure out why some of the heads get in and why some don't. The algorithm takes a set of photos and figures out a rule it can use in the future. It uses concrete features, such as the shape of the eyes, hat, and mouth, and generates some rules.



Has a head
Has a hat
Has eyes
Has a smile
Has a round head
Has a triangular hat
Has round eyes

First, our algorithm creates some hypothetical rules from the first example it comes across. It doesn't know yet whether one of these rules is right or whether it's some combination—it has only one example to go on.

Has a head
Has a hat
Has eyes
Has a smile

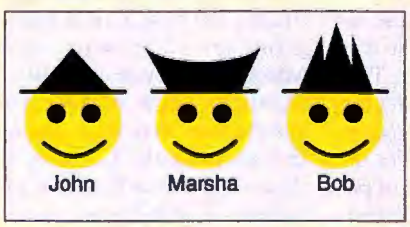
Has a round head
Has a triangular hat
Has round eyes

The algorithm runs its examples by the rest of the "in" crowd, ruling some out in the process. (In the example, it rules out only one, but in a real example, there would probably be more potential rules.)

Has a triangular hat
Has a head *and* Has a hat
Has a head *and* Has eyes
Has a head *and* Has a smile

Has a head *and*
Has a round head
.
.
.

Now it knows what it takes to get into the club, but it's a long list. So the algorithm looks at the heads that were excluded to see what they don't have in common with the members of the club. At this point, it starts to put the rules together with "and"s and "or"s, and the list gets long. We aren't showing all of it.



Has round eyes *and*
Has a smile

Finally, after analyzing the entire set of examples, the algorithm deduces the simplest rule. It might not be the only rule or even the *correct* rule for all cases, but it describes the set of data that it had to work with.

Joining Results

The process of combining the results from Inlen's modules can be complicated. Michalski's center is exploring several different methods for combining these rules. The classic method, deductive logic, forms new results by recognizing that if A implies B and B implies C, then A implies C. It's straightforward and easy to implement. But the Inlen system also includes processes for *generalizing*, *specializing*, *abstracting*, and *concretizing*, the knowledge built up by the modules. These are major components of Michalski's Inductive Theory of Learning.

Generalization, for instance, refers to an inference (e.g., if three students in the same class were assigned homework, then all students of this class were probably assigned homework). The system applies specific knowledge to a more general set. Complementary to generalization is specialization (e.g., if all students were assigned homework, then a specific student probably was).

Getting Answers

One of the big hurdles for all machine-learning algorithms is solving problems in an acceptable amount of time. Many of the problems fall into a class known as NP-complete, which means that there is no known efficient algorithm for finding the correct answer. This is because the number of potential answers can grow exponentially with the size and complexity of the answer.

The common solution in machine learning is to limit the size of potential answers, usually by creating hypothetical rules and ranking them. At each step in the recognition

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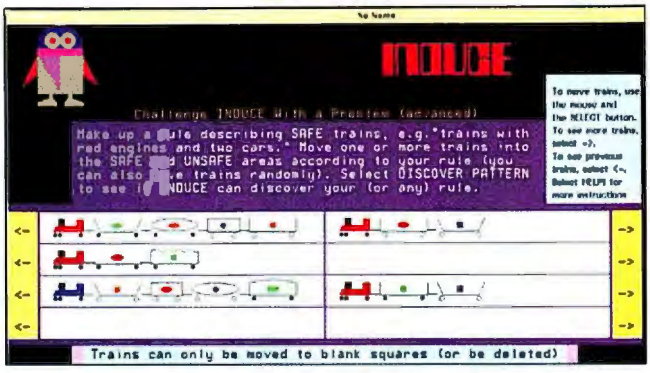
process, the number of potential new rules may grow significantly, so the algorithms rank new ones and eliminate the worst. Ultimately, this process may exclude the best final answer because preliminary versions of it don't make the cut along the way.

Evaluating the quality of machine-learning algorithms can be complicated by the fact that many algorithms are designed to perform well on particular types of problems. The rule-based systems emerging from the MLI are adept at picking up logically structured patterns (e.g., "a baseball player is a Yankee if the uniform has pinstripes"). More ambiguous relationships like the distinction between a tall and a short person are often hard to characterize with this more logical approach. In such cases, algorithms involving neural networks shine.

The machine-learning community recently held a competition to test learning algorithms. There were three different problems presented to the algorithms. The first was intended to be easy for symbolic systems—the solutions were generated from simple symbolic rules. The second test was tuned for neural networks; it required the algorithms to identify sets that might be described by a pattern. Here's an example: If a man satisfies two of these three attributes, then he's an acceptable date: tall, dark, and handsome. These problems can be difficult for symbolic learning algorithms to grasp because their description can grow exponentially complex. The third test involved a more symbolic approach with added noise.

The AQ17 program from the MLI was the only one to score 100 percent on all the tests. It succeeded on the more difficult second test because it is not a typical rule-generating algorithm. The winning AQ-17 algorithm used a feedback mechanism to generate synthetic attributes that could reduce the complexity (e.g., tall and dark). This synthetic approach really shines in cases where the number of different attributes in the set grows.



Bored? Challenge an AI to figure out your pattern. Here, a program called INDUCE takes some basic train types that you put together and figures out what makes a safe train "safe" by comparing it to a series of "unsafe" trains. Just click on the button, and it will figure it out.

On to Applications

The machine-learning algorithms are really just abstractions and are not tuned to any particular problem. The trouble is finding a domain that is structured enough to allow computer representation. The scientists at the MLI are experimenting with engineering problems—a domain rich in mathematical structure.

The MLI is investigating automotive design with Chrysler's Technology Center (Auburn Hills, MI). The team analyzed an automobile suspension system and tried to determine what features affected its manufacturability. The MLI reports that the initial results are promising.

Bridge design also presents another complicated, but well-structured, set of problems. Unfortunately, there are a limited number of training examples available to tune the system.

These applications for machine learning might not have the flash of the robots created by Hollywood scriptwriters, but they may grow to fill valuable niches. At this stage, they require a well-defined problem to operate, but this isn't a horrible limitation. The world is exploding with data, and even the simplest patterns could be quite valuable. Machine-learning algorithms can help find these patterns. ■

Peter Wayner is a BYTE consulting editor and the author of Agents Unleashed *(AP Professional, 1995). He can be reached at pcw@access.digex.net.*

PATTERNS IN THE CODE

There are two major approaches to machine intelligence and pattern recognition. The first tries to remake the world according to the mind of the computer by creating a clear, logical representation of the pattern. The second tries to fit the data with a statistical representation. Neither is good for both cases, but both have their successes.

Logical Matrix

Many patterns in the world make logical sense. Day follows night. Spring follows winter. Logical pattern-recognition algorithms are great at finding these patterns whether they are big or small.

There are two parts to these algorithms: a pattern generator and a pattern evaluator. The algorithms generate plausible patterns and test them against the data to see if they fit it well. The evaluator must choose the best pattern that is often the simplest.

Statistical Whims

But many corners of the world are not cut perfectly. How old is old? When is soon? Problems like these demand guesstimates that statistical algorithms generate well. These algorithms compare the sequences against each other and effectively render an opinion. Correlation matrices and covariance are important to making the final decision.

Combining the two algorithms often makes the most sense. A logic algorithm can define a pattern that comes close, and a statistical algorithm can refine the parameters.

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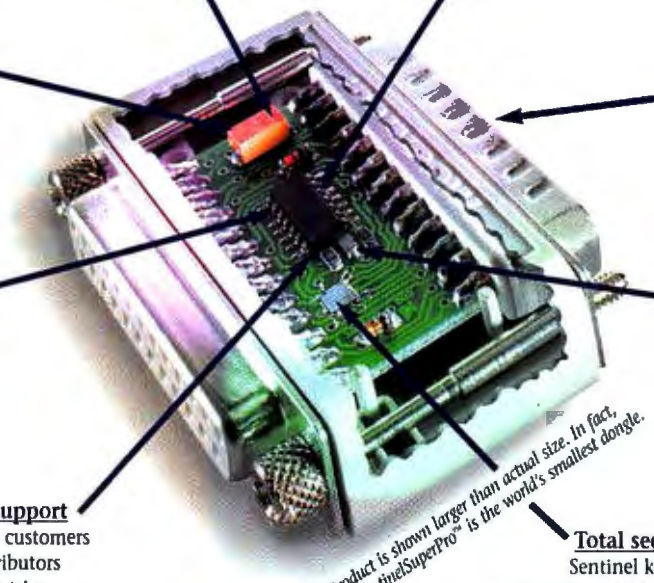

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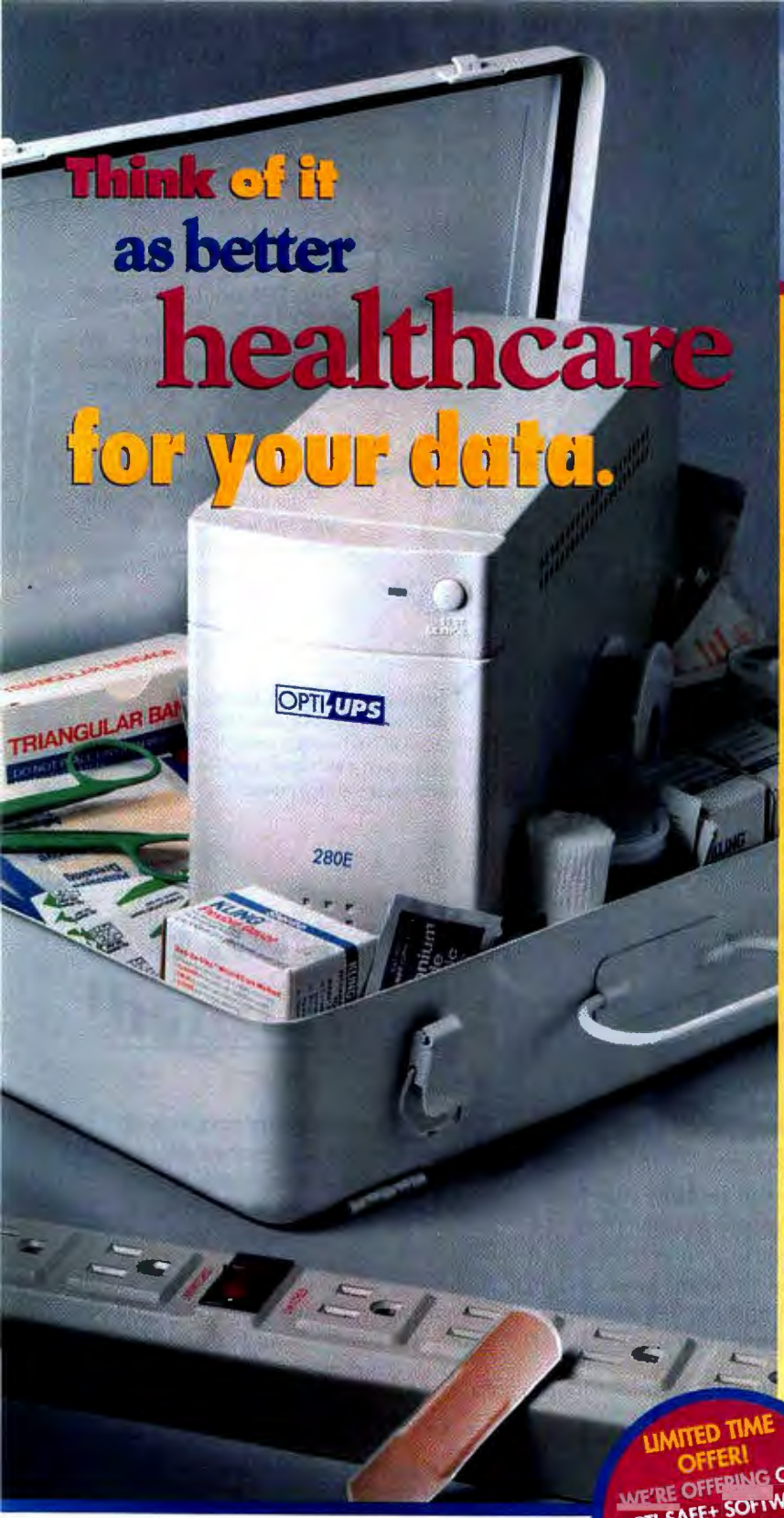

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The End of Programming

DAVID S. LINTHICUM

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RAD (rapid application development) tools are the microwave ovens of the programming world—they're new, they're fast, and they'll probably make a lot of people's lives easier. However, as anyone who has put aluminum foil into a microwave knows, you'll see benefits only if you use the tools properly.

When all the hype has settled, RAD tools promise two advantages over traditional programming. The first advantage is a shorter, more flexible development cycle, enabling you to leap directly from prototype to finished application. The second advantage is that a reasonably sophisticated end user can develop applications.

Sound too good to be true? Sometimes it is. RAD tools often require you to write code. But if you use them properly, you can reduce many programming tasks to drag-and-drop simplicity.

Rapid application development promises applications without programming. Does it deliver?

RAD's History

The roots of RAD lie in the prototyping tools of yore. With such tools, developers could quickly mock up an application so the end user could see and experience it before the design was finalized. Prototypes were the ultimate design tool, because they virtually eliminated misunderstandings about an application's look, feel, and capabilities. Once the developer and end user agreed on a prototype, the developer simply created an application that looked and acted like the prototype.

But these prototyping tools usually provided only "smoke and mirrors" for the developer. Prototypes rarely became final applications. After finishing a prototype, the developer might actually build the application in a language such as COBOL or C.

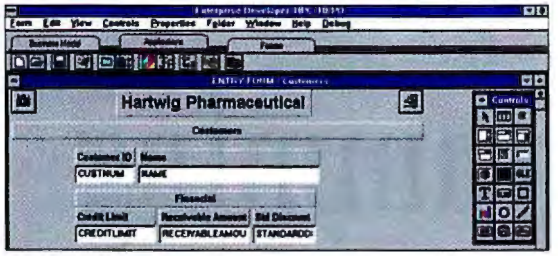
If this seems wasteful, that's because it is. Developers were building the application twice. To solve this problem, RAD tools extend the capabilities of prototyping tools by providing developers with everything they need to build a prototype as well as turn it into a fully functional application.

It's a fairly elegant solution. Developers build applications with RAD tools primarily by designing the interface. They assemble components such as buttons, menus, data windows, and combo boxes. Developers are more concerned with what the program does than they are with how it does it. They show the application to users, get feedback, and make modifications to the application. This process continues until the user is happy.

Speed Over Design

Some traditional systems developers criticize this type of *spiral development* as a process of getting it wrong many times before getting it right once. Forgoing the design stage may cost more in the long run, they say, arguing that poorly designed applications are difficult to maintain, upgrade, and port.

The "design-on-the-fly" method of development that RAD promotes does create applications quickly, but you then have to



Symantec's Enterprise Developer lets developers place business rules inside a special repository, thus saving programming time.

live with the application after deployment. Many RAD applications require a lot of fixing and redeployment cycles after delivery to get them right. This is known as the *prototyping death spiral*, and it could lead to user dissatisfaction, wasted money, and a short life span for the application.

From a design viewpoint, the key to good RAD development is to keep an eye on the big picture. When using RAD, organizations should not neglect the business objectives of the application. Developers need to design applications that take the greatest advantage of the object-oriented-like features that most tools provide, and that requires planning the application's implementation. Without careful planning, an application could fail to take advantage of reusable application components—worse, the application could become an unmaintainable mess.

Even if you save time when you're designing an application with a RAD tool, you may lose that time when you execute it or port it to another platform. RAD tools typically use interpreters and not compilers, and most interpreters execute about half as fast as compiled code. There can be a noticeable performance difference compared with a compiled language. Tools such as Borland's Delphi and Gupta's SQLWindows make strides by improving execution speed, but it will be some time before RAD matches the speed and performance of traditional compilers.

If you choose RAD, you could also be locking yourself into a platform. Most RAD tools don't provide much cross-platform portability. Delphi and Microsoft Visual Basic, for example, support only Windows. Some RAD tools support multiple platforms (e.g., Unify's Unify and Compuware's Uniface).

Get with the Programmer

Programming without programmers is the way some vendors sell RAD tools. The idea is that by using visual programming, anyone can assemble applications without writing a single line of code. And if you believe that...

Here's an example. IBM's VisualAge (a visual-programming tool that's based on Smalltalk) lets developers assemble an application from a palette of components—buttons, windows, menus, and so on. After placing all the necessary components on the application window, the developer links such nonvisual events as print commands to the components. When the user clicks on the print button, it invokes the connected nonvisual print event. But VisualAge, like other "no-code" visual-programming tools such as Powersoft's PowerBuilder and Visual Basic, does not let developers create all applications visually.

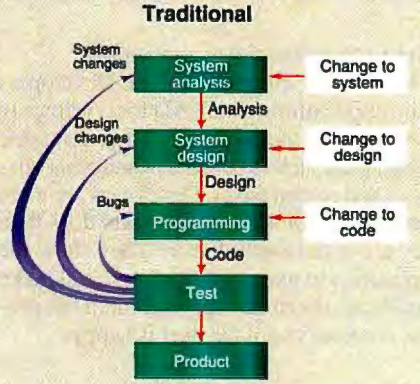
With the exception of the simplest applications (e.g., order-entry systems and client databases), most developers will probably have to learn to program using the underlying programming language. Applications that require low-level API calls or have special calculation or display requirements will often need good old-fashioned programming. For example, if an application uses real-time data or array processing, it will require extra code beyond the initial visual construction.

Still, the time gained from using a RAD tool can be immense. Most VisualAge programmers report the ability to create up to 80 percent of an application visually, with the last 20 percent consisting of specialized functions.

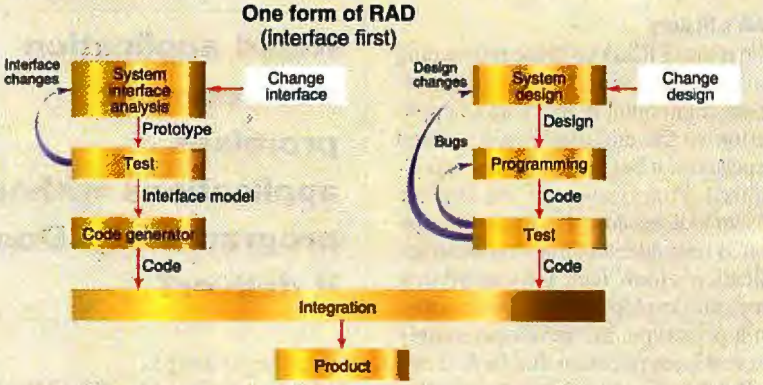
continued

TRADITIONAL vs. RAD

RAD isn't just a pretty face—there are some process differences between it and traditional programming. The main difference is that, as with object-oriented development techniques, the process is not entirely sequential. In other words, key parts of development occur simultaneously.



In traditional programming, you start at the top and work your way down sequentially, from system analysis through design and programming, to testing, finally winding up with a product. If you have any changes, you make them at the appropriate stage of the process. These changes have a ripple effect through the rest of the process: Change the design, and you have to change the code and retest.



With RAD (rapid application development), you design and prototype the interface separately from designing and programming the rest of the system. This enables you to have two groups of engineers working in parallel and mostly independently. If you change the interface (which in traditional programming would necessitate reprogramming—possibly severely), you can simply relink it with the back-end code. It may not even require any reworking of the systems design.

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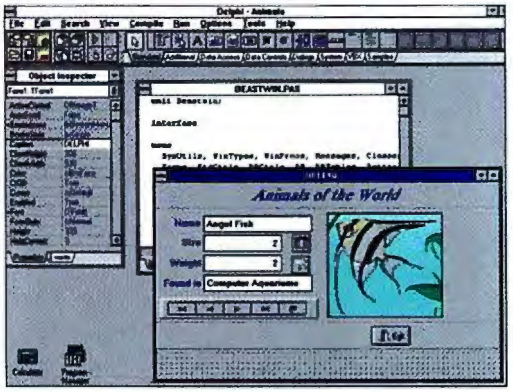

Borland's Delphi is an example of a sophisticated RAD tool allowing developers to assemble applications from prebuilt components. Delphi uses an object-oriented variant of Pascal for low-level development and provides links to most major database servers, including Oracle and Sybase.

RAD and Reuse

Most RAD tools provide facilities for component reuse, but fast development often means developers don't take time to design their applications to make reuse a reality. For instance, when creating an application using PowerBuilder, developers will probably select as many components as possible from a library. They can use the components as is or modify them using PowerBuilder's inheritance features. But that's only if they have the time to browse the libraries to find the prebuilt objects.

The trick to making the most of reuse in the RAD world is to construct from the generic to the specific. Build simple components first and reuse them throughout the application, making modifications as needed through inheritance. Good candidates for reuse include data windows, pop-up windows, and printer dialog boxes. Code reuse enables developers to modify an application in a single location and to have the changes propagate throughout the application, saving time in the process.

Many third parties have taken advantage of the reuse capabilities in RAD tools to build plug-in libraries. A developer can extend Visual Basic, for example, with VBXes (Visual Basic custom controls) and OCXes (OLE custom controls) from hundreds of vendors. These extensions add functions ranging from development project management to sophisticated database access, often at prices under $100. The power of VBXes and OCXes is so great that tools such as Delphi and Oracle's PowerObjects have designed in the capability to use them as well.

Reuse does not happen by accident. Developers need to put the time into the initial design and properly plan to set up the application to maximize reuse. The tragedy is that most RAD projects promote development speed, not reuse. Dozens of object-oriented analysis and design methodologies and CASE tools assist developers in this process. In most RAD projects, if you think through the application before you get lost in the RAD tool, you can create an application that maximizes the use of recycled code.

Applications development managers need to encourage reuse among RAD development teams. RAD tools should include mechanisms that let developers locate and use existing objects, such as shared object browsers that provide a searchable database of objects for RAD tools that are shareable among developers.

Avoiding Bad RAD

So, is it time to trade in our RAD tools for more traditional development tools, such as COBOL and C? Or is it time for programmers to find a new line of work as RAD takes over? The answer is a loud "neither." RAD has tremendous powers, but it is not without its limits. Although it is an important part of the enterprise applications development process, it doesn't eliminate the need for a good understanding of business requirements, a sound design, and skillful programming.

The process of building the application with the end user provides common ground, where the developer and the end user can reach an understanding as to how the application will appear and behave. But the developer is ultimately responsible for the long-term health of the application, and not just its rapid delivery. With RAD, developers can easily overlook critical issues during development, including structure, consistency, design, maintainability, and good use of reuse mechanisms. RAD-developed applications may appear healthy on the surface, but after a short time, developers and users begin to discover their shortcomings. After an application enters production, it's extremely difficult to correct problems that are normally corrected during development.

Most IS organizations will come in contact with RAD before the end of the century. Now is the time to look beyond the hype to see what it can do for you. More important, understand what RAD can't do. For all you programmers out there, your job is safe... for now. ■

David S. Linthicum is a technical manager with E.D.S. in Falls Church, Virginia. He's also the author of several books on software development and an associate professor of computer science at a local college. You can reach him on the Internet at 70742.3165@compuserve.com or on BIX c/o "editors."

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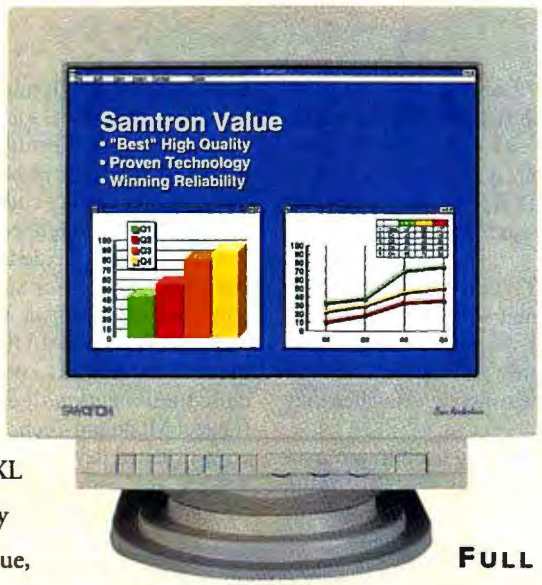

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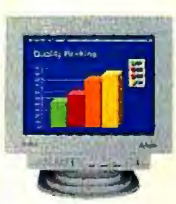

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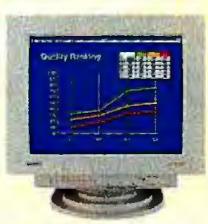

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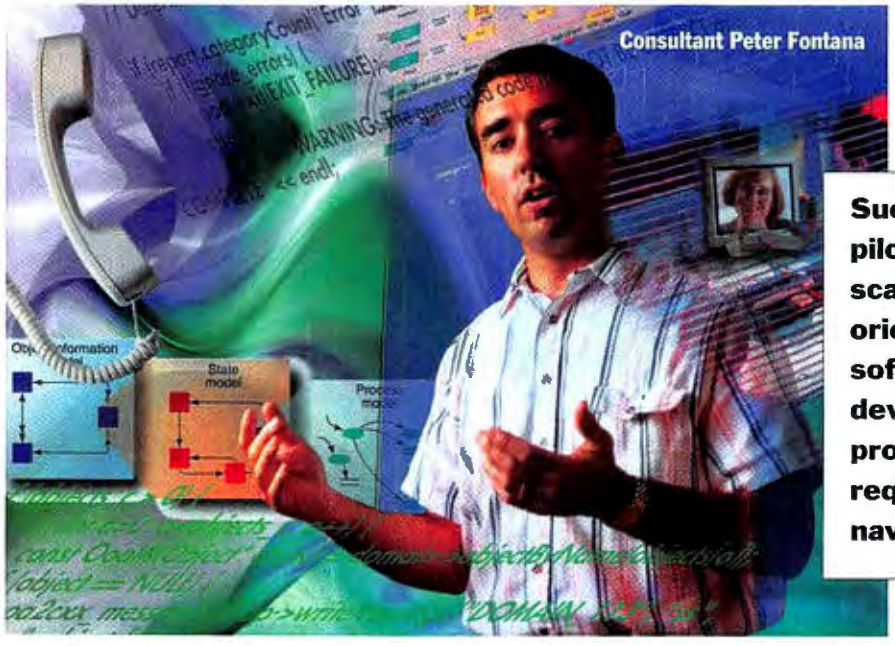
Big OOP, No Oops

EDMUND X. DEJESUS

Missed deadlines. Poor training. Lack of commitment. These are the signposts on the way to Failure City. Peter Fontana knows all about failure. More accurately, he knows how to avoid it. Fontana is a consultant helping GTE make a large-scale OO (object-oriented) development project succeed, despite a path strewn with pitfalls and potholes.

The project is astoundingly large: GTE Government Systems is completely rewriting the firmware and software for its new high-capacity ATM (asynchronous transfer mode) switch. This means that several dozen people have only 18 months to reengineer several hundreds of thousands of lines of code. And then they can start facing upgrades.

If it sounds impossible, it is—at least if you tried to use conventional engineering techniques. There's no way this group could do the project in the C and Ada code that the previous ATM switch used. GTE knows this. That's why, from the start, management chose to implement an OO approach over traditional methods. There's at least a fighting chance. Especially when version 2 rolls around in a few months.



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Successfully piloting large-scale object-oriented software development projects requires careful navigation

Inviting Disaster?

Wait! Doesn't OOP (object-oriented programming) take longer to learn? Doesn't it generate bloated, slow code? Isn't using a new technique just inviting disaster? Maybe—if you burst in expecting to churn out 10,000 lines of code a day. The OO mindset is radically different from the traditional.

OO development models the business problem instead of just throwing code at it. It might take more time and effort but, because it looks at the process as a whole, a successful model can solve both the original problem as well as related problems. The expected payoff is in better problem analysis, faster development, higher quality code, simpler subsequent development and maintenance, and reduced overall cost.

Once having decided to go OO, you may think that you just start coding in C++ or SmallTalk. Hardly. Writing code is a small part of any OO project. Choosing a method is actually step one.

There are several OO methods, each of which determines much of the process a project will follow. One broad category is called *elaborational*, and includes Booch, Rumbaugh OMT (Object Modeling Technique), and similar methods. Attractive to code-oriented developers, this approach iterates through analysis, design, and coding, capturing additional information on each pass, until the final iteration is at the code level. GTE felt that this style was too time-intensive, required many highly trained creative and experienced people, and was prone to error.

The *translational* style, which includes the Shlaer-Mellor method (see the figure "The Shlaer-Mellor Method" on page 76), automatically translates OOA (object-oriented analysis) models into code based on the CASE information. Partitioning the problem into independent domains, with implementation details separate from the application analysis model, allows concurrent development of the application analysis and the translation mechanism design. Also, software projects tend to fix problems in the code without making appropriate changes to the design, and difficult disjoints between design and code may complicate further development. But translational methods help calm the temptation to fix problem code, since fixing the model itself will translate into changed code, keeping design and code in sync. Tool sets can check semantic correctness, consistency, and completeness.

Starting from scratch on an OO project, as in this case, can be difficult, but Fontana feels that Shlaer-Mellor is a more complete method in such cases. So the GTE project adopted Shlaer-Mellor, supported by Cadre Technologies' ObjectTeam for Shlaer-Mellor running on Sun SparcStations.

Model Merits

"Without a method, OOP is just another way to hack code," says Fontana. You may find yourself tempted to grab a CASE tool and just start coding. It's happened often enough. But you won't get all the advantages of OO methods, such as reuse at the highest levels, concurrent development, and simplified upgrades. The high-level nature of the initial analysis forces developers to think about, and solve, the problem more completely up-front.

Fontana sees many benefits to Shlaer-Mellor. These include its concise notation, its ability to translate method to code automatically, its partitioning of the problem into logical domains, and its opportunities for code reuse at the domain level.

Why not another method? Fontana preferred Shlaer-Mellor's concise notation, especially because this was the first foray into OO development for many programmers. Though other methods proudly claim a "rich notation," watch out: That could be a synonym for "too many choices." It's fine to have many choices if your entire programming staff is the cream of the crop, but for the rest of us, Shlaer-Mellor's more concise notation is simpler to learn, easier to translate into code, and less confusing, especially for first-time OO developers. Since many of GTE's developers had never used OO methods, Fontana's choice makes sense.

The Reuse Grail

The main reason GTE chose OO development was code reuse. The ATM-switch software was slated for update every six months—an aggressive schedule, especially for adding new features. Reusing code would save time and development costs and simplify future development projects.

Developers aren't automatically reusers. They might require specific training or experience with the reuse system. Allocating or assigning a reuse librarian (a human being), or using a CASE tool like ObjectTeam, can help by building and managing searchable libraries of objects. Still, some programmers find it harder to use an existing component than to write one from scratch.

The benefits of reuse are especially realized for large-scale, long-term projects with expected upgrades or future related projects. The GTE project meets all of these criteria, and developers expect a large reuse bonus in terms of saved time, especially when related projects reuse entire domains.

Method Minuses

Life is not a bed of roses, even with Shlaer-Mellor OO methods. GTE found that it had to deal with training people in new methods, new programming languages, new support tools, and new platforms. And, possibly the greatest challenge, it had to overcome hesitancy from workers.

Multiple learning curves present the foremost problem. Some project team members required greater familiarity with new hardware (Sun SparcStations, instead of the Macintoshes most of the developers were familiar with), new OSes (SunOS and Solaris vs. MacOS), new tools (Cadre's ObjectTeam where before there

LARGE-SCALE OBJECT-ORIENTED DEVELOPMENT

The Problems

- Upgrading software and firmware for high-end ATM (asynchronous transfer mode) switch.
- Meeting demanding delivery schedules.
- Allowing for possible future expansion into a line of products.
- Dealing with multiple learning curves.

The Solutions

- OO (object-oriented) software development.
- Shlaer-Mellor method of OO development.
- Cadre Technologies' ObjectTeam for Shlaer-Mellor CASE tool.
- Consultants provide guidance for planning and scheduling.
- Training in C++ and Shlaer-Mellor method.

The Benefits

- On target to meet deadlines.
- Productivity meets or exceeds non-OO methods.
- Concurrent development of application analysis and implementation design saves time.
- Flexibility allows changes to hardware implementation without impacting analysis.
- Shlaer-Mellor OOA is reusable on future related projects.
- Nonexpert developers can get up to speed quickly.
- Management and developers gain experience for future projects.

Lessons Learned

- Choose an OO method appropriate to the project before choosing the tools and language.
- Management support is essential.
- Expect multiple learning curves when using new development technologies.
- Build support for OO methods with the most progressive workers.
- Use metrics appropriate to method.
- Consultants can offer valuable insights for planning and process.

was nothing), a new language (C++, instead of Ada and C), plus OO methods in general and Shlaer-Mellor in particular (rather than traditional functional decomposition). That's definitely a lot to absorb.

Fontana observes that traditional experience can run against you, especially if experience means, "I'm not learning some new method when the old method worked just fine." To facilitate change, start with five or six forward-thinking people on a six-to-nine-month pilot project: This builds support for new methods. By building support from your initial group outward, you don't have to forcibly convert people.

The key to success is to get going: Real pressures force organizations to face the changes and move forward. "To start the journey to get functionality to market, you have to step off the dock," Fontana says.

Take Hung Trinh, for example. He's a GTE software engineer who had programmed previous switches in assembler and had no prior experience with OO methods or C++. He found it hard to learn Shlaer-Mellor at first, but within about three months he felt comfortable. A course in C++, building on previous C knowledge, helped clarify how the OOA model translates into code. An added benefit: He believes his C++ and Shlaer-Mellor experience enhances his career.

Appropriate support tools simplify starting with a new OO method. For instance, ObjectTeam supports Shlaer-Mellor recursive design, diagrams, and notation. Automating the method's details can flatten a learning curve. By contrast, software architect Jim Connolly feels that current ObjectTeam tools don't adequately support configuration control and releases (especially for parallel configurations), requiring manual workarounds. While appreciating some features of ObjectTeam, Trinh thought the editor and other parts difficult to use.

Another possible pitfall for some companies is that metrics for OOA projects differ from conventional metrics. Some may insist on using the old "*x* percent lines of code done" milestones. Project-level management must vigorously defend the new metrics to upper management. Shlaer-Mellor is a consistent and straightforward method, with discrete steps and milestones, although not the traditional ones. GTE's management uses the new metrics and has changed its way of reading metrics.

Fontana has also seen upper management in other companies get antsy and say, "No code yet? Forget the pretty pictures, start coding." GTE's management has a more sophisticated view: They don't expect to see any code until they're about 60 percent of the way along. They then anticipate getting 50,000 to 100,000 lines of automatically translated code (bug-free, assuming that the architecture level and translator are correct) in a week. ObjectTeam for Shlaer-Mellor provides checking

TOOLS SUPPORTING SHLAER-MELLOR

Cadre's ObjectTeam for Shlaer-Mellor (pictured at right) shows windows including a State Transition Diagram and a State Event Matrix. Available for SunOS, Sun Solaris, HP-UX, Digital Unix, DEC OpenVMS, DEC Ultrix, IBM AIX, IBM OS/2, and SGI IRIX.

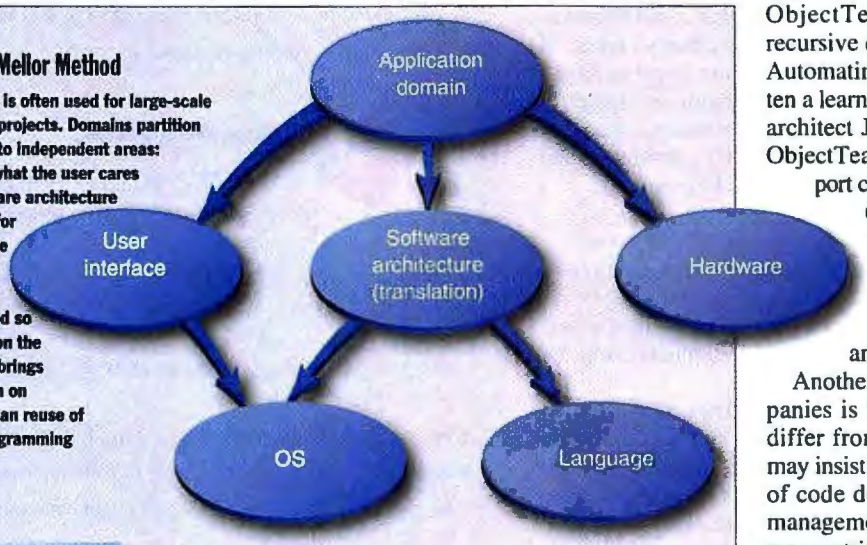
Objective Spectrum's BridgePoint 3.0 provides a user interface for easy navigation between model components. Available for SunOS, Sun Solaris, HP-UX, and SGI IRIX. (Objective Spectrum was recently acquired by Project Technology.)

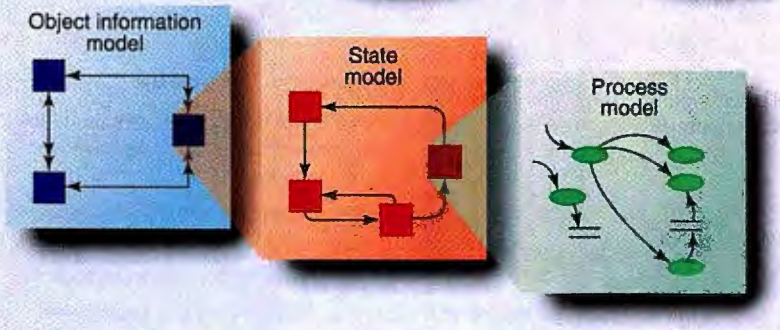
Kennedy Carter's Intelligent OOA (object-oriented analysis) application development environment propagates changes to the model automatically and provides debugging and regression-testing support. Available for Sun Solaris, IBM AIX, HP-UX, and DEC OSF/1.

SES's (Scientific and Engineering Software) Objectbench Consists of a graphical modeling tool for creating OOA models and an on-screen animated simulator for examining the dynamic behavior of OOA models. Available for SunOS, Sun Solaris, HP-UX, and IBM AIX.

The Shlaer-Mellor Method

Shlaer-Mellor is often used for large-scale and complex projects. Domains partition the system into independent areas: application (what the user cares about), software architecture (responsible for translating the OOA model to the computer language), and so forth. Reuse on the domain level brings greater return on investment than reuse of design or programming components.





Analyzing each domain produces an object information model that defines objects, their attributes, and relations to other objects.

Each object has a state model to describe its behavior and interactions with other objects.

Each state has a process model that details the processing needed in each state.

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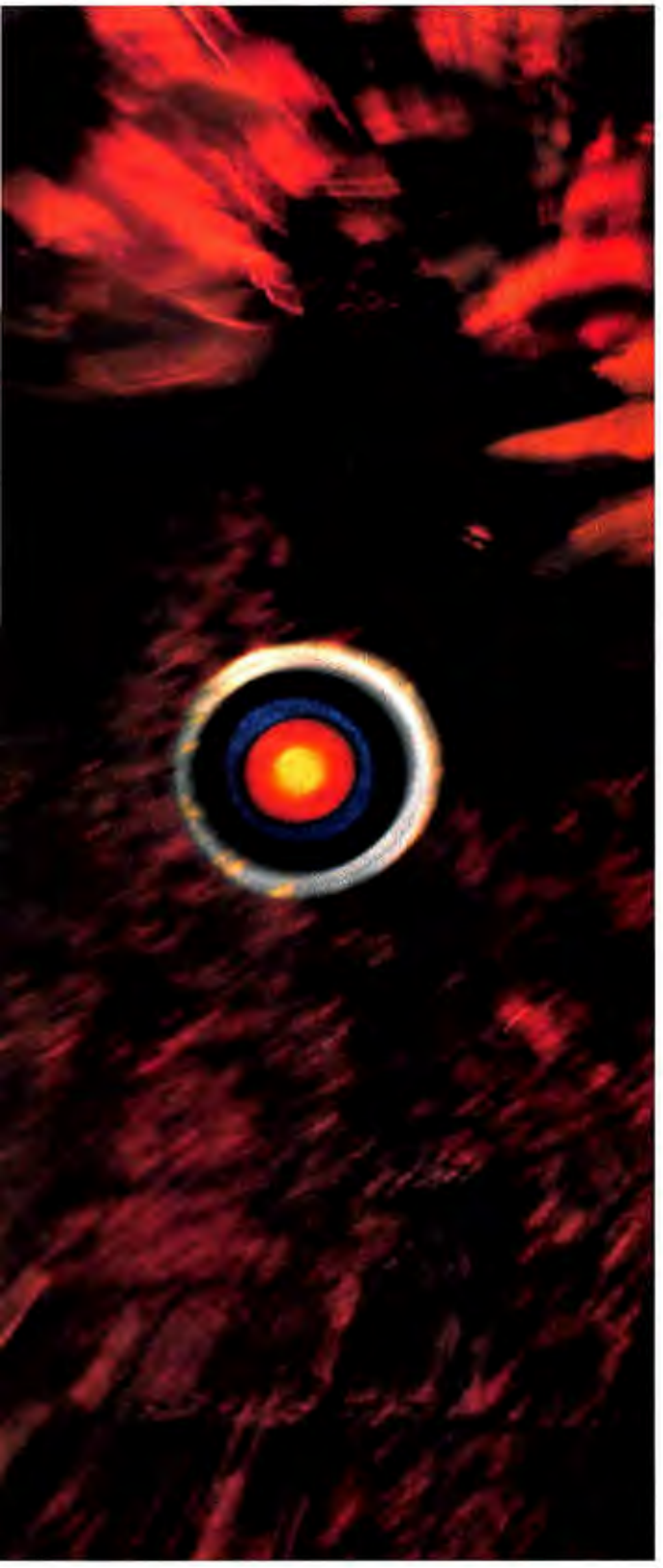

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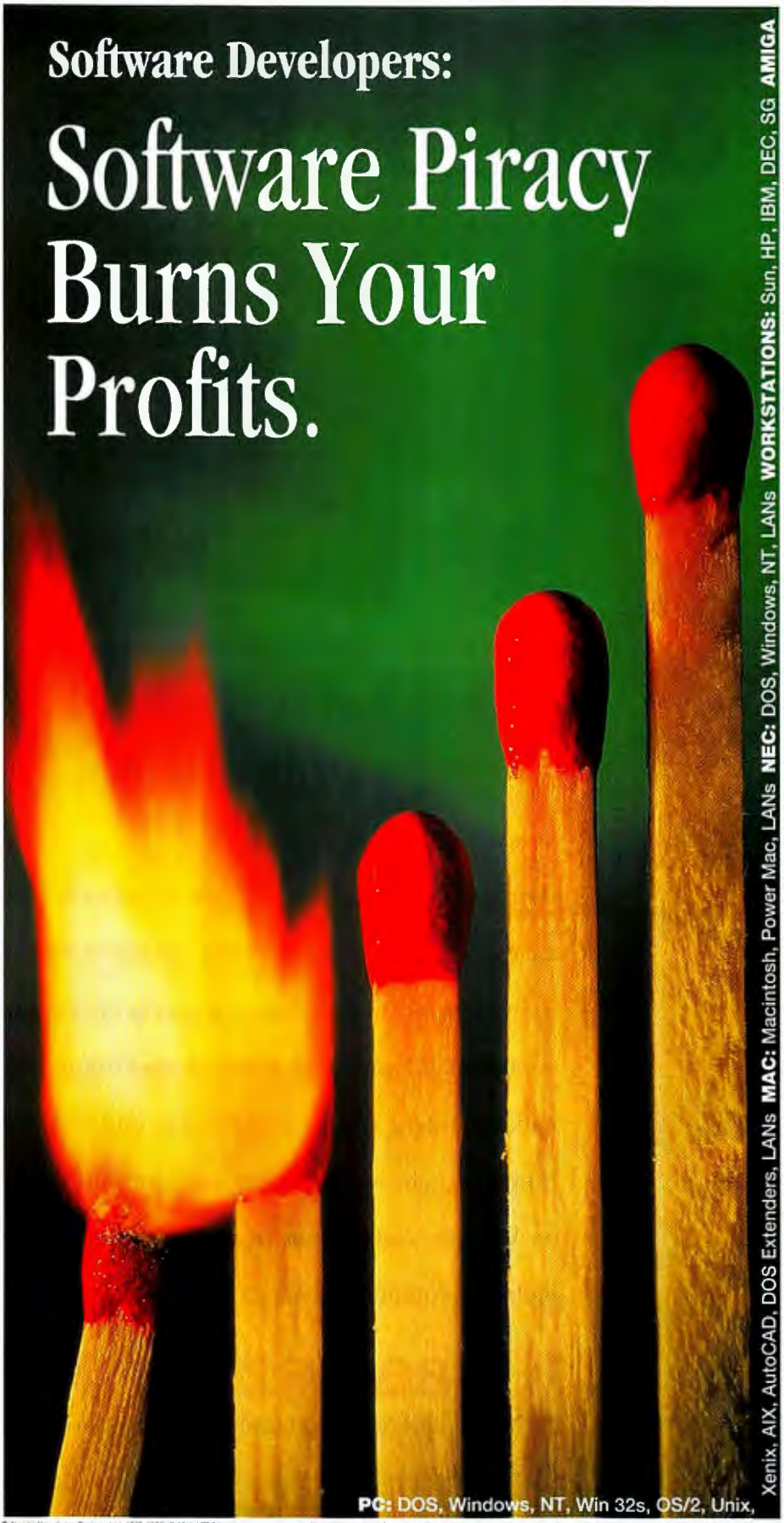

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HERD INSTINCTS

The difference between gagging on or grokking groupware comes down to overcoming technical hurdles

Remember the axiom about small-town lawyers? If there's one in town, the lawyer will starve; if there are two, they'll both make a fortune. Ironic as it seems, Lotus, the leading proponent of groupware, must have felt like the lone lawyer as it tried to sell the concepts of Notes in particular and workgroups in general.

The pioneering work in groupware is over, as IBM's bid for Lotus and the Notes crown jewel makes clear. The rush of other groupware applications coming to market proves Notes is worth fighting for. But companies offering you the groupware answer to all your problems may be holding something back. To launch a successful groupware installation, you'll first have to clear a host of technical hurdles. "Replication's Fast Track" discusses the problems of making sure everyone in an organization has access to current data, whether it's unstructured, as in Notes databases, or highly structured, as in relational databases. "Under Construction" outlines the problems developers face.

Notes administrators and developers have been grappling with these issues for years, and they'll be front-burner items for the newest competitors in the groupware market. One such faction includes IBM (with its Notes alternative), Microsoft, and Novell. They want to compete against Notes with fully formed groupware platforms. Before its Lotus offer, IBM introduced IBM WorkGroup, which is built on an OS/2 server and clients that can be either 32-bit OS/2 or Windows 3.1. The first components to ship were for fax, E-mail, calendaring/scheduling, and Addressbook functions. Also due out this year is Microsoft's Exchange, which will become the obvious choice for companies using Windows clients and NT servers.

The current version of Novell's GroupWise tightly integrates mail, calendaring/scheduling, and task management, but it falls short as an applications-development or work-flow platform. Novell is planning a major revision and name change (GroupWise XTD) for early next year. For a detailed competitive analysis of Notes, Exchange, and GroupWise, see the chart on page 84.

A second faction consists of companies releasing products that focus on individual pieces of the groupware puzzle. For example, Collabra Share, from Collabra Software, and Attachmate's OpenMind provide conferencing and interactive discussions over LANs and client/server implementations, respectively (for a head-to-head review, see "Workgroup Conferencing," March BYTE). Conference+, from The Mesa Group, provides a simple discussion platform that sits on top of Microsoft Mail.

All the articles here point to progress in overcoming groupware's technical problems. As programming tools mature and standards evolve, groupware is moving further from its pioneer roots. Soon it may become axiomatic to compare Notes and its competitors to legal dream teams rather than lone wolves. ■

—Alan Joch, Senior Editor

COMPETING PLATFORMS

DAVID MARSHAK

The Top Three Players

Lotus

	Current	Next Generation
Products	**Notes release 3.x** **cc:Mail** **Lotus Organizer** **Lotus Forms**	Notes release 4 (due during the second half of 1995)
Target Market	E-mail, groupware, work-flow, and interenterprise applications.	Same as **Current.**
Overriding Strength	Wide-scale customer and third-party-vendor support.	Same as **Current.**
Overriding Weakness	Notes' proprietary image, especially for its development environment.	Same as **Current.**
Unanswered Questions	N/A	Will release 4 provide the degree of scalability, availability, and manageability required for interenterprise applications? Can Notes succeed as an enterprise E-mail system?

Components Compared

E-Mail[1]	cc:Mail is the leading LAN E-mail program. Notes messaging is built into both the server and the client. Both products support VIM (Vendor-Independent Messaging).	Server provides client/server, enterprise-level E-mail for Notes and cc:Mail clients. Supports CMC (Common Messaging Calls), MAPI, SMTP, VIM, and X.400. Uses the same mail interface as cc:Mail.
Groupware[2]	The most advanced platform for document sharing and threaded discussions. Supports customized views and full-text indexing, as well as mobile users in workgroups. Organizer's group scheduling is loosely integrated with Notes.	Will offer an improved user interface for finding shared information.
Applications Development and Deployment	A forms- and formula-based development environment. Data replication allows immediate deployment of applications throughout an organization. Access to other data sources via ODBC (Open Database Connectivity) and other protocols. Strong third-party support (e.g., Visual Basic, PowerBuilder, and SQL Windows).	Enhanced development environment via LotusScript. Can create Navigator, a GUI for highly customized applications. Improved support for mobile users (including location management and field-level replication). OLE 2.0 support.
Work Flow[3]	Integrates messaging and database work flow. Replication supports distributed work flows, including mobile users. Work flow includes conditional routing, digital signatures, access to relational databases, and server-based agents. Most third-party work-flow products integrate with Notes. Lotus Forms provides simple, mail-based, routing work flows.	Action Bars provide a work-flow-oriented user interface. NotesFlow allows work flows to continue when you switch to other applications. A new agent builder simplifies work-flow development.
Interenterprise Applications	Popular in interenterprise applications, thanks to security, data replication, and applications development tools. Several public Notes services are available (e.g., AT&T Network Notes). InterNotes connects Notes networks with Internet WWW (World Wide Web) browsers and Usenet news groups.	Enhanced Notes reliability, availability, and scalability for "carrier-grade" services. More public services can use release 4. Release 4 will tightly integrate Notes and the Internet through the InterNotes Browser.

[1] Mail services and clients. [2] Information sharing, threaded discussions, and calendar/scheduling features.

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Microsoft		Novell	
Current	**Next Generation**	**Current**	**Next Generation**
Microsoft Mail 3.x **Schedule+** **Microsoft Electronic Forms**	Exchange (first release due during the second half of 1995)	**GroupWise 4.x** **SoftSolutions** **InForms** **MHS**	GroupWise XTD (due during the first half of 1996)
E-mail and groupware.	Same as **Current.**	E-mail and groupware.	Same as **Current.**
See **Components Compared.**	Potentially widespread customer and third-party-vendor support.	Tight mail, calendar, task, and document management integration with NDS (NetWare Directory Service).	Same as **Current.**
See **Components Compared.**	Not everyone is willing to commit to an NT-only server to run Exchange.	See **Components Compared.**	Tight NDS integration may be criticized as proprietary if GroupWise XTD runs only on NetWare.
N/A	What is Microsoft's long-term design philosophy? Are the program's current weaknesses endemic to the design? Can Exchange succeed as an enterprise E-mail system?	N/A	Can Novell successfully integrate GroupWise, InForms, MHS, and SoftSolutions? Can Novell add anything new to what Lotus and Microsoft already offer?
Microsoft Mail competes closely with cc:Mail in terms of market share and technology. Supports MAPI.	Server provides client/server, enterprise-level E-mail for Exchange and other MAPI clients. Supports CMC, MAPI, SMTP, X.400, and X.500. Integration with NT administration makes Exchange the obvious choice for E-mail with Windows clients and NT servers.	GroupWise provides file-sharing, post-office-based LAN E-mail with server-based rules. MHS (for file-sharing, post-office-based LAN E-mail transport) is used by a number of mail products.	A re-architected, MAPI-based, client/server messaging system based on GroupWise that will also support MHS.
Microsoft Mail provides limited support for sharing mail messages in shared folders. Schedule+ integrates with Mail.	Has public folders and threaded discussions for information sharing. Exchange scheduler is tightly integrated with mail.	Shared folders and tightly integrated mail, calendar/scheduling features, and task management. SoftSolutions offers advanced document management. Collabra Share can be integrated for threaded discussions.	The next generation is likely to tightly integrate Collabra Share and SoftSolutions (or similar technologies).
Currently, Microsoft Mail is not an applications platform.	Has public folders and a forms-based development environment for building mail and groupware applications. Public folders will replicate between servers; replication to remote and mobile users is promised for a later release. A forms registry can manage customized forms.	Currently, GroupWise is not an applications platform.	Applications-platform plans have not yet been announced.
The applications environment can be greatly extended with Visual Basic. Microsoft Mail can be used with the third-party WinRules product to create simple, client-based, mail-routing work flows. Microsoft Electronic Forms can build simple, mail-based, routing work flows.	Not positioned as a work-flow platform. Microsoft relies on third parties to integrate work-flow products with Exchange. Exchange will offer server-based rules to enable some work flows. The rules will run on new documents and won't be able to run on a scheduled basis.	Provides simple, rules-based routing. GroupWise rules can be client- or server-based. InForms can be used for simple mail-based routing of work flows.	Work-flow strategy is as yet unannounced. Expect future integration with FileNet's work-flow product.
Microsoft Mail is viewed as an internal corporate mail system only, with messaging gateways to other systems.	Server acts as an internal corporate mail system. Microsoft's interenterprise platform is likely to be based on Microsoft Network.	GroupWise is viewed as an internal corporate mail system only, with messaging gateways to other systems.	Interenterprise plans are as yet unannounced. Novell's NetWare Connect Services is being used by AT&T as part of Network Notes.

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Walk. Walk. Walk.
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REPLICATION'S FAST TRACK

Custom scheduling is the ticket to large-scale data distribution in groupware environments

DAVID YAVIN

PETER LACALAMITA © 1995

On the small scale for which it was originally designed, Notes replication works like magic. For instance, if you work for a small company and you're on the road, you might dial in to your office's Notes server to synchronize copies of a Notes database. In a matter of minutes, every change to the database since your last replication appears in the database copy on your laptop. Except for the occasional busy signal, the process works like a charm.

Large Notes operations don't always feel so charmed, however. The problems all lie in scale, and a typical large Notes installation may have several thousand active Notes databases distributed among hundreds of Notes servers worldwide. By design, any one of these databases can be updated by any of its users on any of the servers, from anywhere, and at any time.

In such a dynamic environment, keeping crucial information current is a daunting task. But it's not impossible. The secrets lie in proper scheduling and giving the responsibility of replication to the right people. It also means that there's no "one size fits all" solution. The right answers to the question of data replication in your organization are as unique as your fingerprints.

Small-Time Replication

When Lotus designed replication into Notes, it did so with the model of a small number of servers and a small geographical distribution in mind. Few people foresaw that within a decade, Notes replication worldwide would grow to the point where entire consulting companies would be dedicated to making it work better.

That's because many distributed organizations today choose to have local access to a *copy* of global information rather than global access to centrally stored information. Regardless of the distributed-data setting—and there are several—replication is the underlying process by which

Light at the End of the Tunnel, or an Oncoming Train?

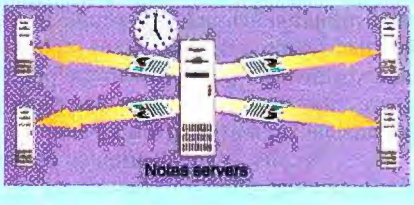
Release 4.0 of Notes will handle replication in new, but not necessarily predictable, ways

FIELD-LEVEL REPLICATION

In the current version of Notes, any change to a document in a database causes the entire document to be copied to replicas of the database during the next replication. R4 will offer more granularity, so only modified fields will be copied.

Look for: Faster replication than R3 for some databases. The best candidates for improvement are large-document databases in which most changes involve updates to small fields in existing documents. An example would be a training database in which each document has a video portion and a list that adds your name to it once you've viewed the document. Only the list of names will be copied during replication in R4.

Look out for: Increased overhead and longer replication times for other databases. R4 may take longer to replicate databases made up of documents that contain many small fields. For a server to determine which fields of a document need to be replicated, the bookkeeping of updates must be handled for each individual field rather than just for whole documents. Moreover, even after a server has identified modified fields, updating each of them individually would probably consume more time than simply overwriting the entire document.

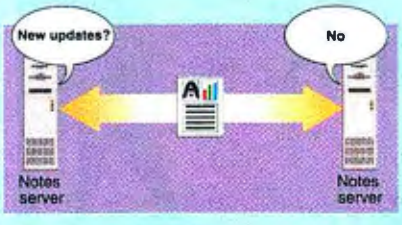


MULTITHREADED REPLICATORS

In the existing version of Notes, a server's replicator process can pull updates from only one other server at a time. R4 servers will be able to run several simultaneous replicators.

Look for: Less severe consequences of occasional extraordinarily long replications. In a hub-and-spoke replication topology, for example, the hub's replicator can often be the constraining bottleneck. Any unusually long pull (due to a slow connection or a large number of updates at the spoke) ties up the hub's replicator and causes delays in the initiation of subsequent replications by the hub. In severe cases, subsequent replications are simply missed. An R4 server will be able to spawn additional replicator processes as necessary and thereby perform simultaneous pulls.

Look out for: CPU overload, database-engine overload, and database corruption. The replicator is a CPU-intensive process. Several replicators running at once could seriously bog down the server. Several replicators simultaneously updating large numbers of documents could bog down the database engine, and serious problems could arise when several replicators try to simultaneously update the same database, or—worse yet—the same document.



UPDATE IDENTIFICATION

In R4, servers will apparently be able to identify much more rapidly those situations in which there are no new updates to be pulled.

Look for: Less overhead associated with initiation of replications. This improvement will make it less risky to schedule frequent replications. (It should help prevent problems of the type described in the article "Optimizing Notes Replication," September 1994 BYTE.)

Look out for: Nothing.

multiple copies of the same data are synchronized, creating the illusion that distributed users are all sharing one set of data. Replication clearly serves as a means of overcoming technological and geographical boundaries among distributed members of an organization or workgroup.

Ken Lownie, president of Connexus Consulting Group (Andover, MA), helps his clients find ways to put Notes to work in their organizations. "By mobilizing the data, you can cut down on the mobilization of the experts," he says, referring to the reduced travel costs and more efficient use of personnel. "This not only cuts the cost of large roll-up processes, such as an audit, but it improves the quality of the information as well." On the less tangible side, "Notes can help a decentralized organization appear to clients as a single, well-coordinated company," he says.

More a document repository than a database, Notes delights users with features not found in any other distributed-database product. But at the same time, Notes frustrates system managers and system administrators with unrivaled complexity and reliability problems. With Microsoft Exchange on the horizon, performance may become a key factor in the race to dominate the groupware market. But for now, the unique, document-based design of Notes propels it way ahead of the pack.

Another Notes advantage is its ability to give you a structured approach to unstructured data. Notes documents are flexible enough to be convenient to use, and they have just enough structure added to make them convenient to group, manage, sort, view, and distribute.

Mobile workers appreciate the support that Notes offers; the automation of a sales force is a popular example. The bidirectional exchange of information between a home office and a salesperson in the field can be reduced to pushing a button on the way out to dinner. While the salesperson dines, his or her laptop remains in the hotel room, diligently replicating data with the home-office server. When dinner's finished, the laptop has pulled all the latest information on product status, pricing, and availability, while the server has received fresh information concerning new opportunities and transactions of the day's sales.

200 Points of Complexity

When you scale up the model to match a large Notes installation, the numbers become awe-inspiring. For instance, just draw 200 points on a piece of paper and

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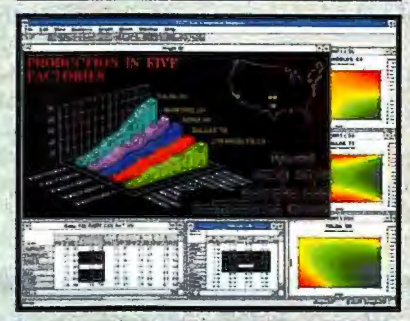

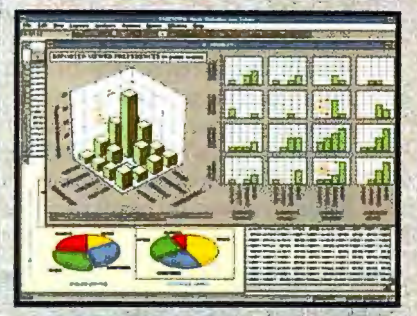

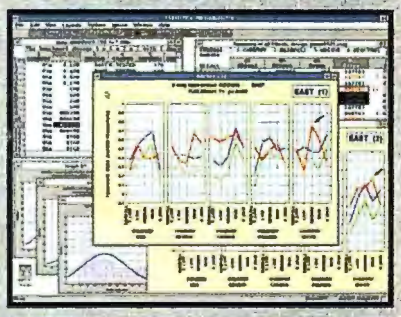

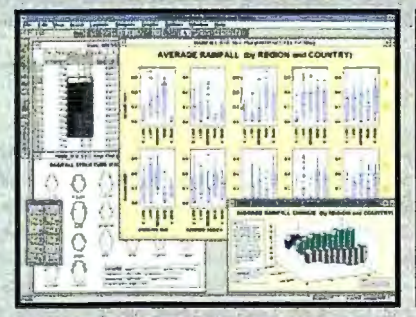

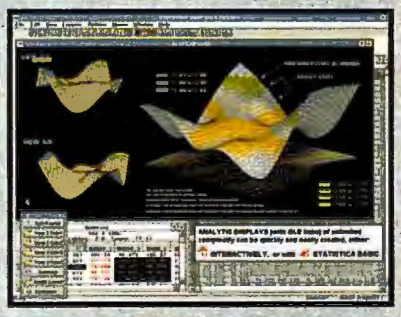

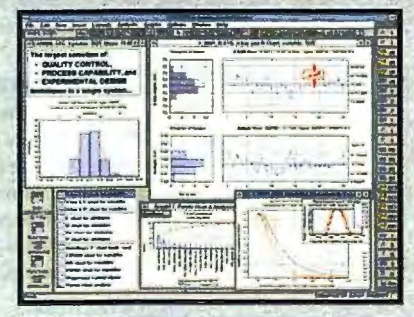

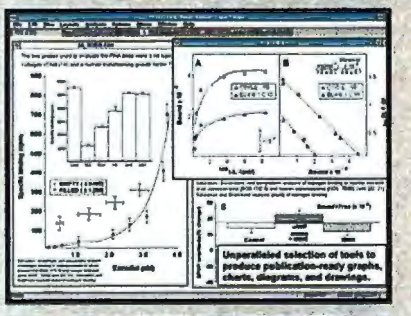

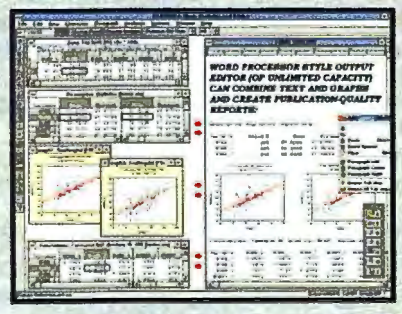

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Circle 109 on Inquiry Card.

consider how you might connect them. Then assign a time zone to each one and think about *when* you might connect them. Replications in a large organization are initiated according to a fixed schedule. The schedule determines the logical replication topology by stating which pairs of servers should replicate with each other. In this case, the schedule determines which of the two servers should initiate the replication and at what time. Both the complexity and importance of designing a reliable, "custom-fit" replication schedule are hard to overstate. Here are some of the main constraints that you'll face.

The duration of replications. Notes replication takes a long time: minutes or hours, not seconds or milliseconds. The overhead of executing the process often creates more of a bottleneck than the volume of data does. Moreover, the duration of replications can differ at both ends. A hub's replicator can remain idle and not initiate a scheduled replication if the telephone line is tied up while the partner/server from the last replication continues to pull its updates.

The single-threaded replicator. A server can pull updates from only one other server at a time. Whenever it is pulling, it cannot initiate additional replications and will not respond to replication requests sent by other servers.

Time-zone constraints. For international organizations, scheduling across time zones poses a major challenge. For example, the low-usage lunchtime hour might seem like a good time to schedule replications. However, the difference between 11:00 a.m. and noontime in New York is the difference between getting updates to European users before or after the end of their business day.

The Right Topology

In addition to devising the right replication schedules, there are two other factors to consider. First, ongoing monitoring and a periodic, systematic review of the entire replication system are of paramount importance. As Notes matures within an organization, usage and needs grow dramatically. Such growth often renders the existing topology and replication schedule obsolete. This is especially true in the transition from the pilot phase to the substantial rollout phase. On average, the entire replication strategy should be reviewed annually.

Second, every Notes system has its own unique personality and needs a personalized replication strategy. Too often, the numbers of servers and users in an organization serve as the main parameters that determine the organization's topology and replication-schedule requirements.

But each Notes implementation is unique in size, infrastructure, capabilities, and needs. Some companies use Notes to disseminate a small core of information that is generated in one central location. Others have massive, highly interactive applications in which documents are generated and modified by users scattered all around the globe. In some organizations, 24 to 48 hours for the propagation of updates is

STRAINED RELATIONS

Data replication is not unique to Notes. However, Notes replication is unique in that the data used in Notes is not relational. The fundamental object in Notes is a document, not a relational record. A lack of relational capabilities, and the delays inherent to Notes replication schedules, make it an inappropriate database for some types of work-flow applications. These factors also make Notes unsuitable for computation-intensive applications that use relational data.

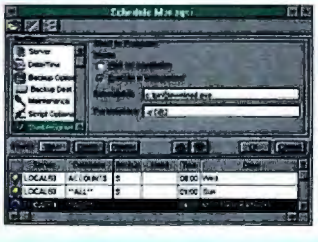
Jagdish Mirani, product marketing manager for Sybase's Replication Server, points to some of the advantages in the world of relational data. First, he says, unlike Notes, data in Sybase is modified by SQL transactions. Replication Server does not transmit the new data; it transmits the SQL transactions that modify the data. This requires far less network traffic, especially in cases where many records are modified by a single query. This approach also significantly reduces connection times and replicates transactions within seconds of their occurrence.

Second, Replication Server provides dynamic transaction routing. The decision to determine where a specific transaction should be replicated to can be postponed until after the transaction has been registered, and it can be based on the business logic at each stage. An order-processing application provides a good example. Whenever a new order is entered, a logical query can be run on the database to select which of several distributed warehouses located around the country (or around the world) should receive the order. The decision could be made by a calculation based on predetermined parameters, such as availability of the ordered product, the proximity of the warehouse to the shipping destination, and other factors. Within seconds, the order is replicated to the chosen warehouse and processed appropriately.

PATCHING THINGS UP

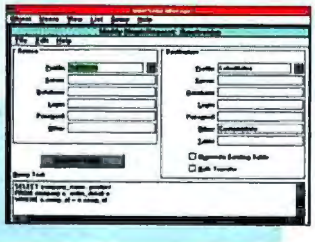
Here's what some companies are doing to integrate relational distributed-database products with Notes.

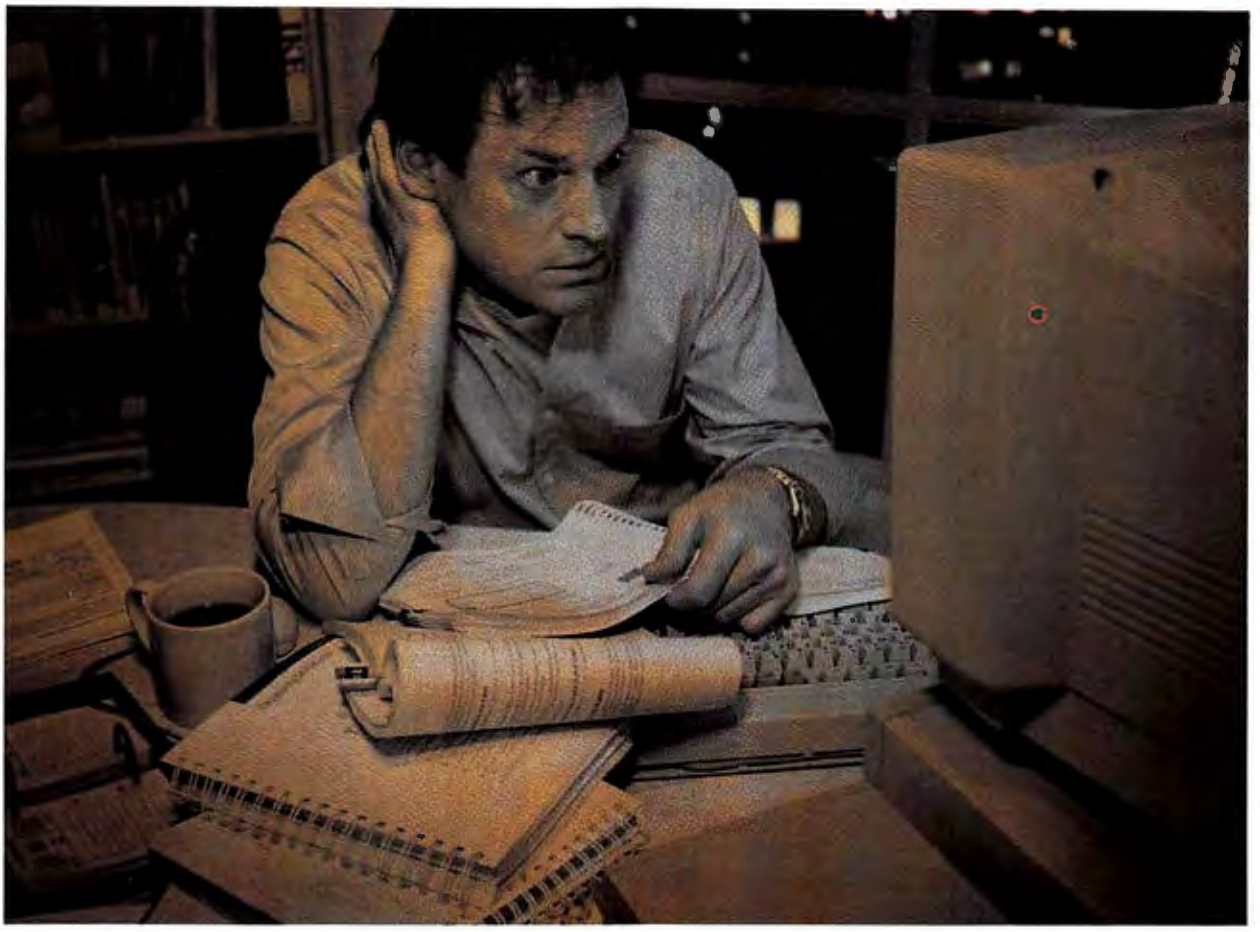
SYBASE'S REPLICATION SERVER now works with Sybase and DB2, and it should be Notes-enabled in the fourth quarter of this year. One Notes server will function as a Notes system's gateway to the relational world. A DLL process will capture any change to the gateway databases and create a relational transaction that describes the change to the data. A replication agent will send the transactions to Replication Server. Replication into Notes will rely on Sybase's custom ODBC (Open Database Connectivity) driver. Initially, the only data types supported will be numeric, text-string, and date/time.



GUPTA'S SQLBASE is geared for mobile users and assumes occasional connectivity to a server to replicate selected subsets of the relational data. SQLBase connects to Notes for data access. Replication with Notes, however, is only in the early development stages.

INFOPUMP FROM TRINZIC, while not a database product, provides data transfer capabilities and an interface to roughly 20 different database products, including Notes. It also provides replication capabilities to maintain the synchronization of data.





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How Exchange Handles Replication

Microsoft Exchange is due out by year's end. Last year it was also due out by year's end. Why the delay? If you asked Lotus, the company might say that Microsoft underestimated how difficult the replication process is until they tried to implement it.

With regard to replication, Exchange's most prominent deviation from Notes is that it works on a mail-based paradigm (see the figure "Exchange Replication" below). "Our philosophy is to define the messaging infrastructure first and then use this infrastructure to build groupware applications," says Exchange Server product manager Elaine Sharp.

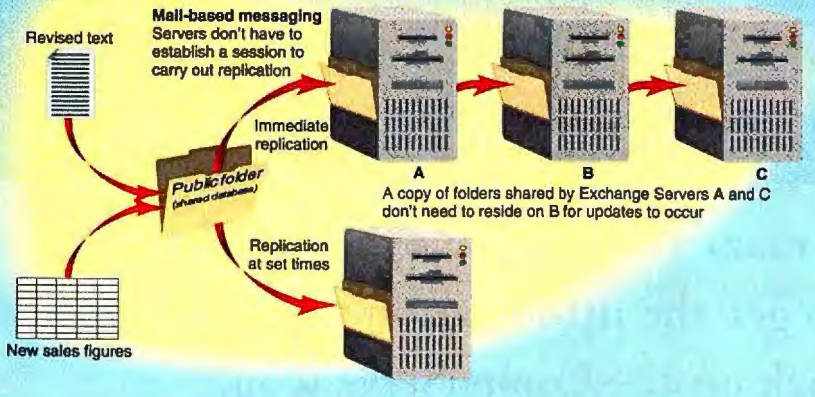
Since it's mail-based, replication in Exchange will not require that two servers establish a session with each other. Each "public folder"—the analog of a Notes database—will know which servers it is distributed to, while users will not. The internal distribution list helps determine what other servers the update should be routed to whenever a public folder is modified. Synchronization within Exchange could occur on a continuous basis or according to a schedule.

Folder distribution, according to Microsoft, should be decided dynamically, based on statistical usage patterns. If the level of requests to access a folder from a given site crosses a predetermined threshold, a copy of the folder can be put on a server at that site.

There's a significant difference in the ways Exchange and Notes handle message routing. In Exchange, if message routing from server A to server C passes through server B, a public folder shared by servers A and C need not reside on server B for updates to get through.

There is obvious appeal to this paradigm. The only question that remains is how well it will work. The industry's experience with Notes may well be why Microsoft appears to be taking performance seriously. Says Sharp: "We are planning to be very up-front with our customers about how important it is for them to plan and monitor the topology and schedule."

Exchange Replication



sufficient; others need several cycles per day. Some organizations commit substantial resources to monitoring performance, while others dedicate minimal resources.

Each replication strategy is unique as well. The objective is to strike a balance between simplicity and efficiency. Replication-schedule designs can provide efficient data propagation, but efficient schedules and the topologies that go with them might be complex in design and might require extensive time and effort to manage.

There are two major points to keep in mind. First, while hub-and-spoke is the simplest topology, it's also the least efficient. (For a discussion of its inefficiencies, see "Optimizing Notes Replication," September 1994 BYTE.) Second, no matter how decentralized an organization may be, its replication strategy must be centrally planned, or at least centrally coordinated. In planning a schedule, the entire system should be examined, not just individual, isolated pockets. For example, one remote-site manager's decision to save a few hundred dollars by using a slow modem can tie up a central hub's line for hours every day and throw an entire organization's schedule off track.

Who's in Charge?

Neither large-scale system diagnostics nor the planning of enterprise-wide replications are tasks for Notes administrators. If Notes were the construction industry, administrators would be charged with making sure everything is executed according to plan. Planning, inspecting, and ensuring performance would be the domain of architects and engineers. Too many organizations fail to realize this and thus settle for simple hub-and-spoke topologies and inefficient, often unreliable replication schedules.

On the small scale for which Notes was conceived, replication is a nonissue. The right replication schedule and administration can give large-scale operations a manageable feel once again. ■

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David Yavin holds a Ph.D. in mathematics from MIT in the fields of topology and combinatorics. He is president of DYS Analytics (Newton, MA) and works as a consultant for large Notes sites on issues of topology and replication scheduling. He can be contacted on the Internet at david@math.mit.edu or on BIX c/o "editors."

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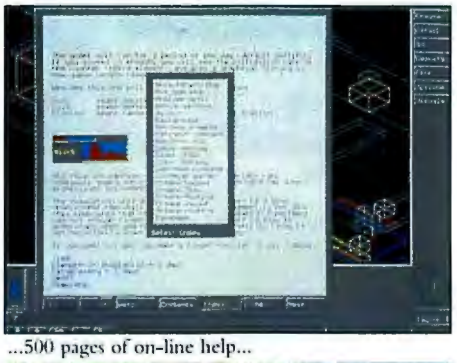

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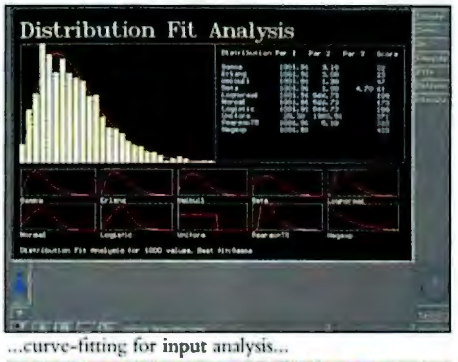

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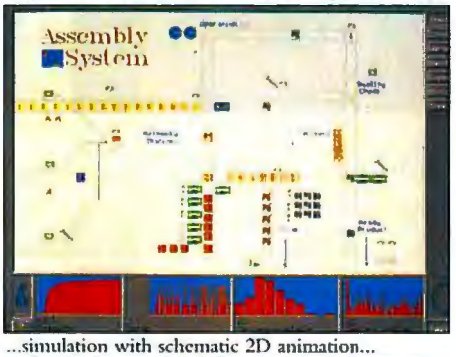

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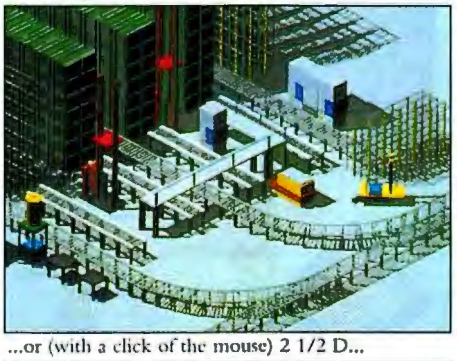

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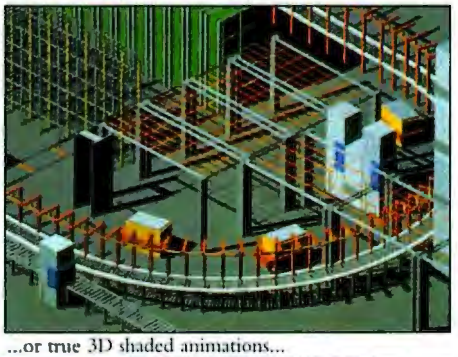

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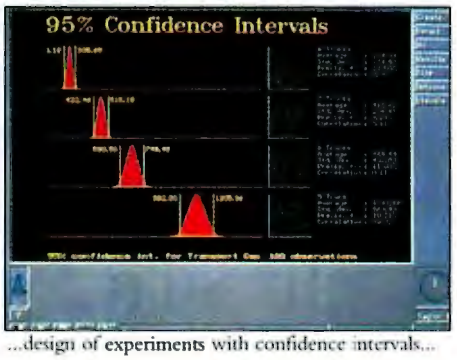

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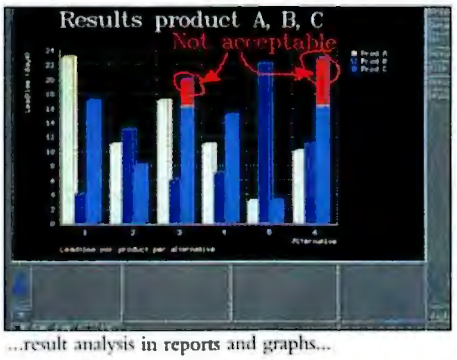

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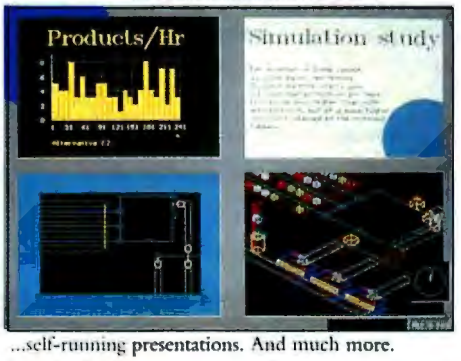

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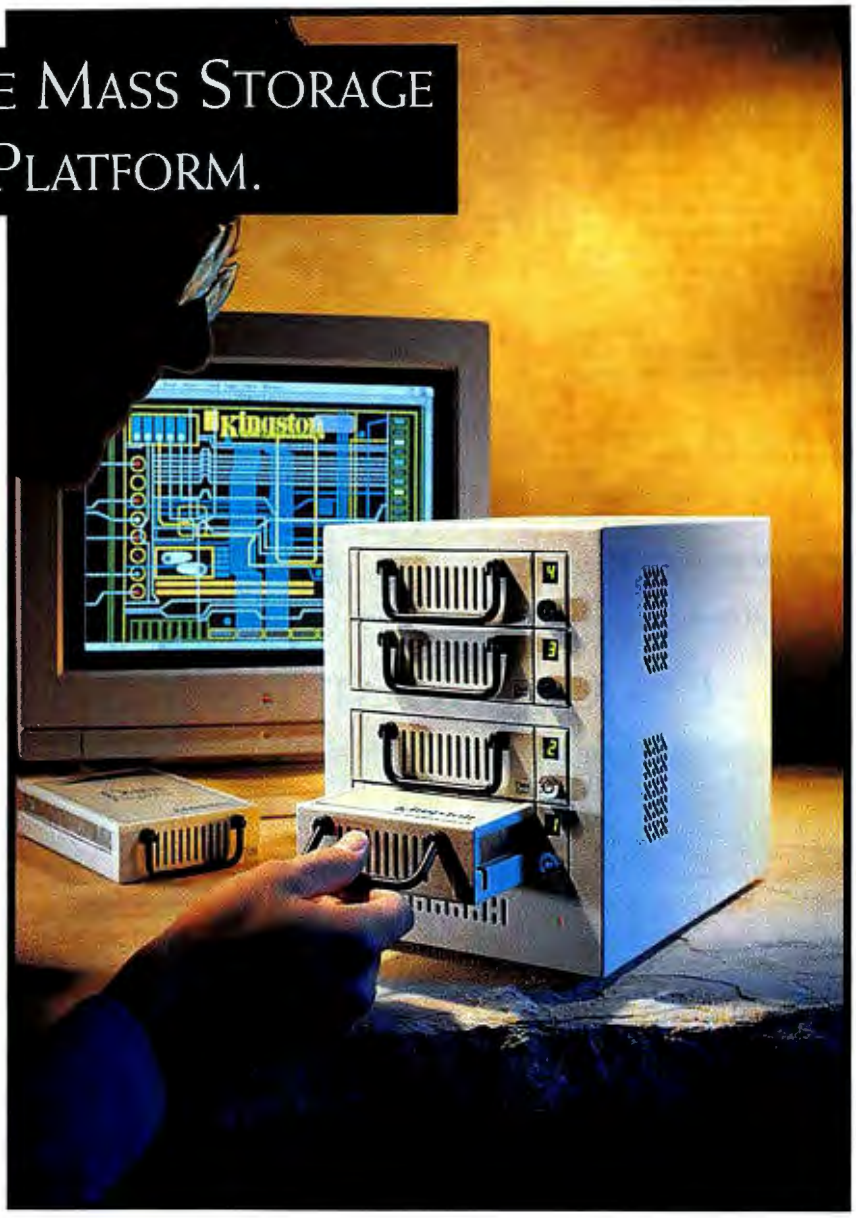

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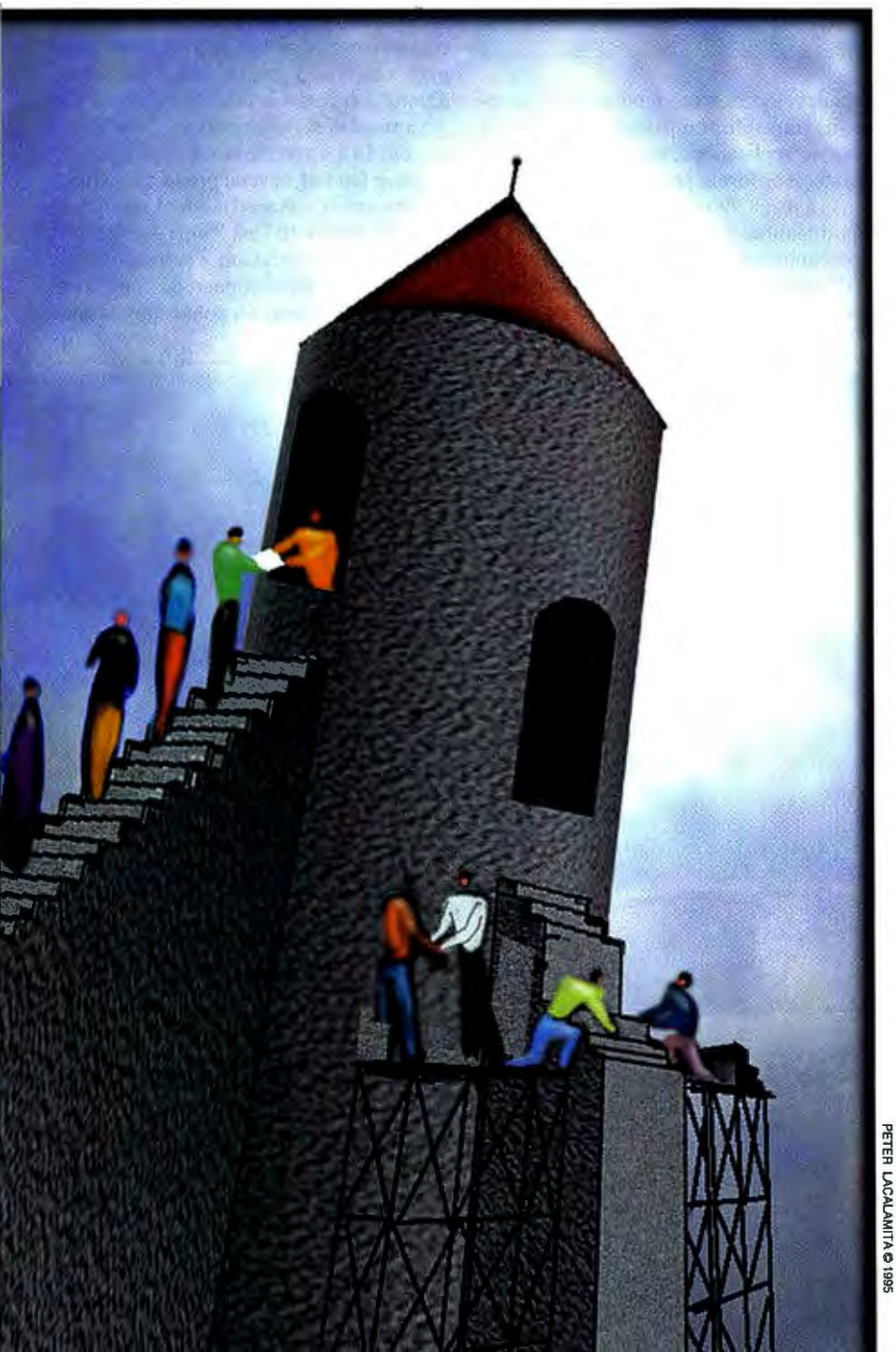
UNDER CONSTRUCTION

Groupware success comes when developers and end users alike understand the technical hurdles that confront the launching of applications

KELLY TRAMMELL



PETER LACALAMITA © 1995

Pity the poor groupware developer. It's easy for managers and end users to dream up enterprise-wide applications that foster collaboration and seamlessly tie an organization's talent into efficient workgroups. But dig deeper, as developers must, and reality bites. Issues such as immature programming tools, data-synchronization complexities, effectively handling middleware layers, sorting out mail interfaces, and accommodating a myriad of network protocols can quickly turn those dreams into multiheaded workgroup applications from hell.

Developers will grapple with most of these issues until everyone starts using the same OS, mail-transport platform, and network protocols. Because that's not likely to happen anytime soon, organizations need to understand the key technical hurdles that confront the building and implementation of groupware applications. This knowledge will give managers and end users more realistic ideas about what types of applications are possible and practical. At the same time, developers will be able to write more efficient applications, and they'll get them up and running faster.

Programming Limits

The first problem that groupware programmers face comes from development tools that often cater more to end users than to hard-core developers. For example, the Notes development environment is still loosely based on the Lotus 1-2-3 macro language from the early 1980s.

In this environment, the Notes *@commands* and *@functions* are the primary programming tools. These are macro commands that execute options from the Notes menus, call external programs, and run common algorithms and calculations. Any type of coding task that is not included as an @function (e.g., sequential number generation) becomes a long and complex macro-based script or requires a Notes API

PROGRAMMING TOOLS

PROBLEM	CHOICES	TRADE-OFFS
Standard programming tools don't always do the job. 	Use Notes @functions or @commands; rely on API calls for more sophisticated tasks.	Short development time and low costs yield modest, generic applications with limited capabilities.
	Write a custom C++ program with a proprietary mail interface, middleware layer, and data-synchronization code.	Tight development control and more robust applications but increased complexity and development time.

call. Both of them can be tedious to code and difficult to test and debug.

Unlike a procedural language, Notes cannot perform DO loops. Notes also lacks tools such as an integrated debugger, version control, and a report writer. As the rest of the development world moves toward class libraries and OOP (object-oriented programming) techniques, Notes offers developers more modest tools: common, reusable templates for building generic applications, such as a discussion database or forms-processing system.

As a result, developers face an interesting dilemma. They can use macro-based programming tools in Notes and rely on API calls to handle tasks that go beyond the capabilities of an @function. Or they can program the entire application in C++ and write a custom mail interface, multiplatform client, middleware layer, and data-synchronization code.

In the interests of time, budget, and user satisfaction, many programmers choose Notes. Most developers would rather give up control on the development side than write a complicated, specialized data-synchronization or replication routine.

Another important limitation of the Notes development environment is the way it restricts programmer and end-user interaction to forms for data input and views for displaying data. Items such as custom controls, ad hoc queries, event trapping, charts and graphs, and customized reports don't exist in this environment. To get around this, developers use low-level, custom DLLs and the Notes API.

Since last fall, several products, including Powersoft's PowerBuilder Library for Notes, Lotus's HiTest Tools for Visual Basic, and Revelation Technologies' OpenInsight, have appeared. They link event-oriented tools for connecting to and

manipulating Notes data. They give developers control over the application, user interface, and data store to help them work around Notes limitations. Developers can build simple or complex custom front ends to Notes and regain control over the user interface and application.

Some tools, such as the Lotus Notes ViP (Visual Programming) environment, give developers control over Notes data replication and messaging. These tools let developers build new types of Notes applications, such as executive information systems, query builders, and decision support systems that use charts and graphs.

The biggest enhancements to Notes from a developer's perspective will come when release 4.0 ships (see "Competing Platforms" on page 84). Of most interest to developers will be native support for both X.400 and SMTP mail protocols, which will make exchanging mail and documents with external mail systems easier.

Lotus Script, a visual development tool, will bring additional controls and procedural-language capabilities similar to those provided in Visual Basic. New OLE 2.0 support in Notes 4.0 will simplify interapplication integration. Finally, Notes 4.0 will support field-level data replication, to simplify data synchronization between remote clients and servers.

MULTIPLE DATA SOURCES

PROBLEM	CHOICES	TRADE-OFFS
Importing and exporting data from various sources.	Use bundled Notes tools.	Simple, but limited to structured or tabular text from spreadsheets and small databases.
	Write a custom C program that calls the Notes API to handle data import/export.	Good for solving specific problems versus code that can be reused in other situations.
	Use a third-party product.	Easy point-and-click mapping for source and target data versus costs that can run as high as $25,000 per server, depending on the product.

What to Do with Data

Workgroup applications often must receive data from multiple sources, perform some type of compiling or filtering process, and then replicate the processed information to distributed clients. Because

these tasks happen periodically, synchronization and integration are critical issues. Even with new tools, APIs, and utilities available to integrate traditional data sources with workgroup tools, data integration remains a significant implementation hurdle. (For details about data replication, see the article "Replication's Fast Track" on page 88A.)

One of the problems is that groupware platforms, including Notes, handle data differently than do traditional mainframe- or SQL-based DBMSes. Notes collects and stores data in an unstructured format that is good for group collaboration and coordination but problematic for transaction processing, querying, and reporting. Therefore, integration with these types of systems often becomes the linchpin in making a workgroup system work.

For developers, Notes provides some simple tools for importing and exporting data, but they are limited to transfers of structured or tabular text from spreadsheets and single-user databases. The next step up for developers is to write a C program that calls the Notes API to move data in and out of Notes databases. This is a good solution for solving specific problems, such as a one-time data migration or initial database load. However, this solution levies a high maintenance cost: You can rarely reuse these interfaces, and you must modify them whenever you change either side of the application or when the source of the data is different.

Another option is to use one of the new data-interchange tools that are available for Notes and SQL databases (see the text box "Strained Relations" on page 88D). These middleware products offer developers point-and-click mapping from source to target data and insulate the developer from having to work the underlying plumbing that is moving the data. These solutions work well as long as the source data you need is timely, stored in the correct format, and at the level of detail required by the target application.

Until recently, middleware products were server-based and expensive. They needed dedicated server hardware, were priced on a per-server basis, and required a great deal of custom programming. These products are generally limited to scheduled or batch migration and cannot support ad hoc queries or dynamic updates.

However, newer middleware tools such as Trinzic's InfoBroker provide dynamic access to foreign data sources, such as Oracle, SQL Server, or DB2. InfoBroker can run as an add-in task on the Notes server.

Better tools won't solve all your replication problems. Performance remains an overriding concern in any replication system you create. For example: A company wanted a Notes-based project management application to pull project expenditures from a mainframe general ledger daily and then replicate the information to project managers in the field.

However, the general ledger could not report actual expenditures by project, and the general-ledger information was updated only weekly. The solution came in bypassing the general ledger and writing a query routine on the mainframe to extract and sort the expenditure data by project

from a transaction file. The application then imported this extract file into the Notes database every night for distribution the next day to project managers throughout the company.

This worked because the amount of data being moved was way below 1 GB, which is technically the size limit for Notes 3.x databases. The practical limit from a performance standpoint is closer to 300 to 400 MB, depending on the number of users, the number of forms and views, and the complexity of the application. A query that pulls down 500 MB or more of data into a Notes database is like pointing a fire hose into a paper cup.

Mail Sort

Different E-mail systems and network protocols turn developers into systems integrators to build applications that work for everyone. Interoperability often requires developers to find lowest-common-denominator standards, which can limit an application's robustness and performance. It is common for organizations to have multiple, disconnected E-mail systems. Some companies may have 10 or more, although the long-term goal is to move to no more than three E-mail systems.

If you are writing an application that calls for mail integration, you must decide what level of integration is necessary. Mail integration can be as simple as converting mail messages to text and importing them into a common data store. Alternately, the integration approach taken can be as complex as initiating a work flow based on keyword triggers within the mail message.

A developer must figure out which mail standard and protocol to use. An alphabet soup of competing messaging standards and APIs exists, including MAPI, VIM (Vendor-Independent Messaging), MHS, X.400, and CMC (Common Mail Calls). Notes and cc:Mail support VIM. Using it, developers can write an application so that users forward cc:Mail messages to a Lotus

MAIL INTEGRATION

PROBLEM	CHOICES	TRADE-OFFS
Connecting multiple disconnected E-mail systems. 	Convert messages to text and import them into a common data store.	Simple to implement but effective for only a handful of different mail systems.
	Use multiple gateways for mail-message conversion.	Difficult to administer, but able to handle multiple mail systems at a relatively low cost.

Notes database, where the message text appends to a Notes form and initiates a work-flow process.

To perform the same tasks with other mail systems, such as MHS or MAPI, developers would run the message through a mail gateway for conversion to a workable format. Gateways are typically standalone processors that convert foreign addresses and message text to a common format for delivery by host mail systems.

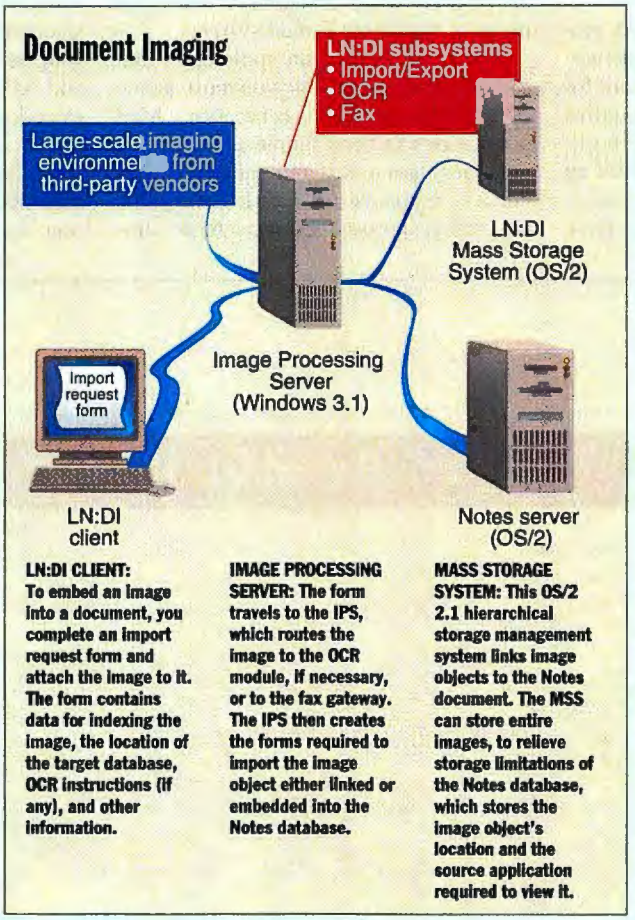
Like any other conversion, this process is an inexact science. Mail systems have unique features and functions that other systems may not support. Developers must determine what trade-offs are being made by the gateway and determine the impact on the application. *continued*

Doin' the LN:DI

JIM MCCORMACK

Lotus Notes Document Imaging (LN:DI, pronounced Lindy) lets developers build image-enabled applications within Notes. LN:DI is a logical choice for firms that have already deployed Notes. However, if your company doesn't use Notes, should you move to it and LN:DI just for imaging? It's not a clear-cut decision. Until recently, the answer was "look elsewhere for imaging," in part because LN:DI's architecture was limited and not scalable.

But updates to LN:DI beginning late last year and continuing with a revision that appeared at press time make it and Notes worth considering. The IPS (Image Processing Server) lets applications connect from LN:DI to a variety of front- and back-end imaging engines. It is also possible to store and retrieve large volumes of images to and from LN:DI.



Imaging Family

Lotus's IPS ($429) is a Windows 3.1–based server that directs the flow of images being processed by the LN:DI subsystems. The subsystems available from Lotus include an import/export module, for saving and retrieving images; OCR modules; and a fax module, for sending and receiving faxes via the Notes fax gateway. You make the IPS services available to Notes applications by setting up forms and profiles in the IPS databases.

IPS is the gateway into and out of the LN:DI environment. Third-party vendors can write applications that take advantage of the IPS interchange service to connect their systems to Notes. FileNet, ViewStar, IBM, and Wang have announced plans to link their large-scale imaging environments to Notes via the IPS APIs. Other vendors, such as Keyfile, PaperClip, and Watermark, use DDEs to populate a Notes environment.

Overcoming Size Limits

LN:DI client software ($89) uses the Windows 3.1 Notes interface for scanning and viewing images, and it is the only software needed to image-enable Notes. The client software supports TIFF, PCX, BMP, GIF, PCD, and JPEG graphics file formats. It will also support multipage TIFFs and color GIF and JPEG files. It uses OLE to store images in Notes documents. Using SmartIcons, you can scan and export an image into an RTF (Rich Text Format) field on a Notes document. You can embed image objects into a document and save the image as part of the document. For small-scale image applications, this is acceptable.

But databases in the current Notes release have a 1-GB size limit. To overcome this limitation for large-scale imaging applications, you'll need to spend an additional $4995 for MSS, LN:DI's Mass Storage System, which is an OS/2 2.1 hierarchical storage management system that lets you link the image object to the document and store only the image object's location and the source application required to view it.

The image object resides on MSS instead of in a Notes database. MSS migrates images from one medium to another according to the rules set up in a series of Notes forms. You have the option of running MSS on the same server as your OS/2 Notes server, but a second option, a dedicated computer for MSS, will deliver better performance.

Jim McCormack is branch manager for U.S. Technologies, a developer of Notes-based applications headquartered in Tampa, Florida. He has designed large-scale imaging applications for financial institutions. You can reach him on the Internet or BIX at editors@bix.com.

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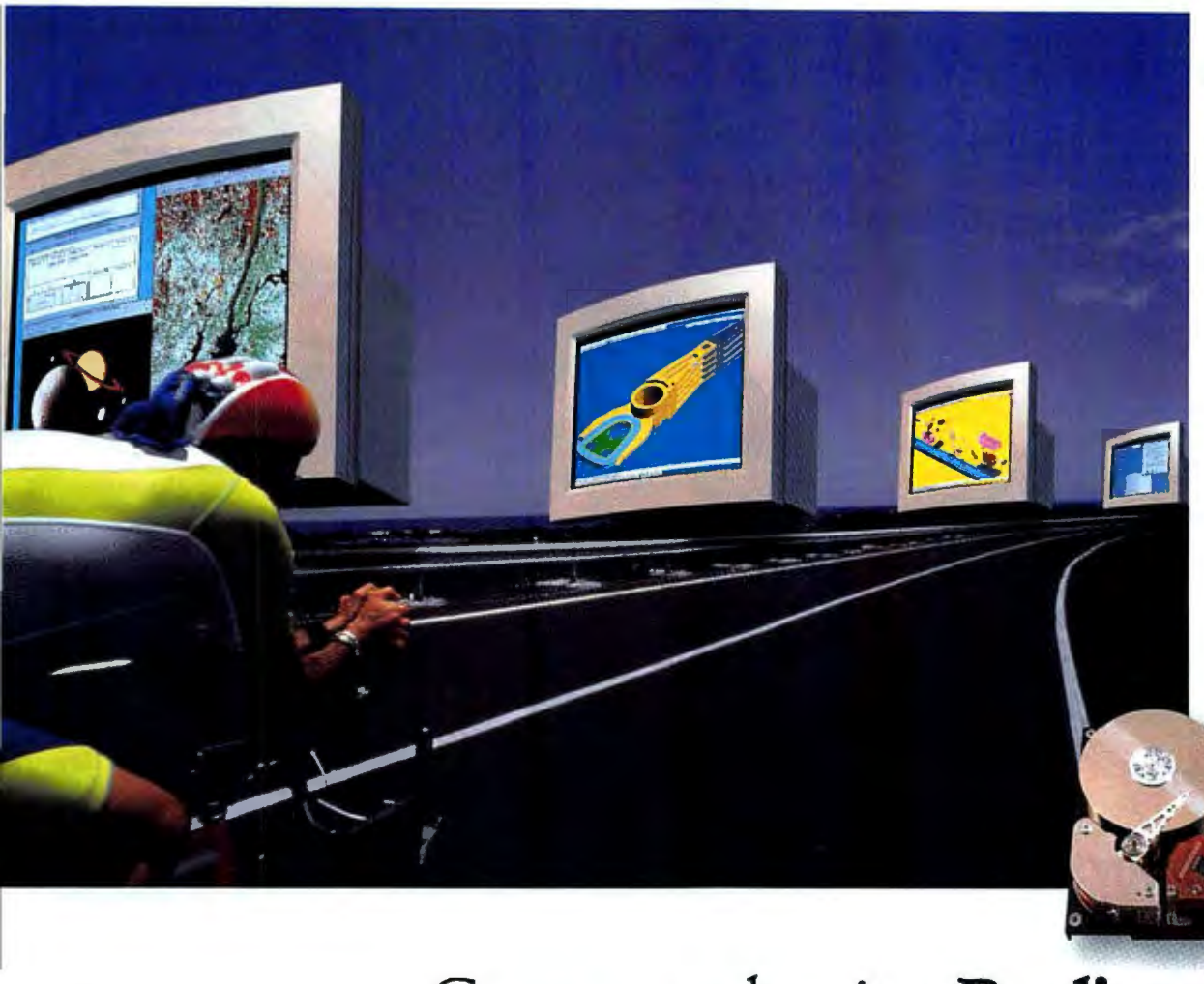

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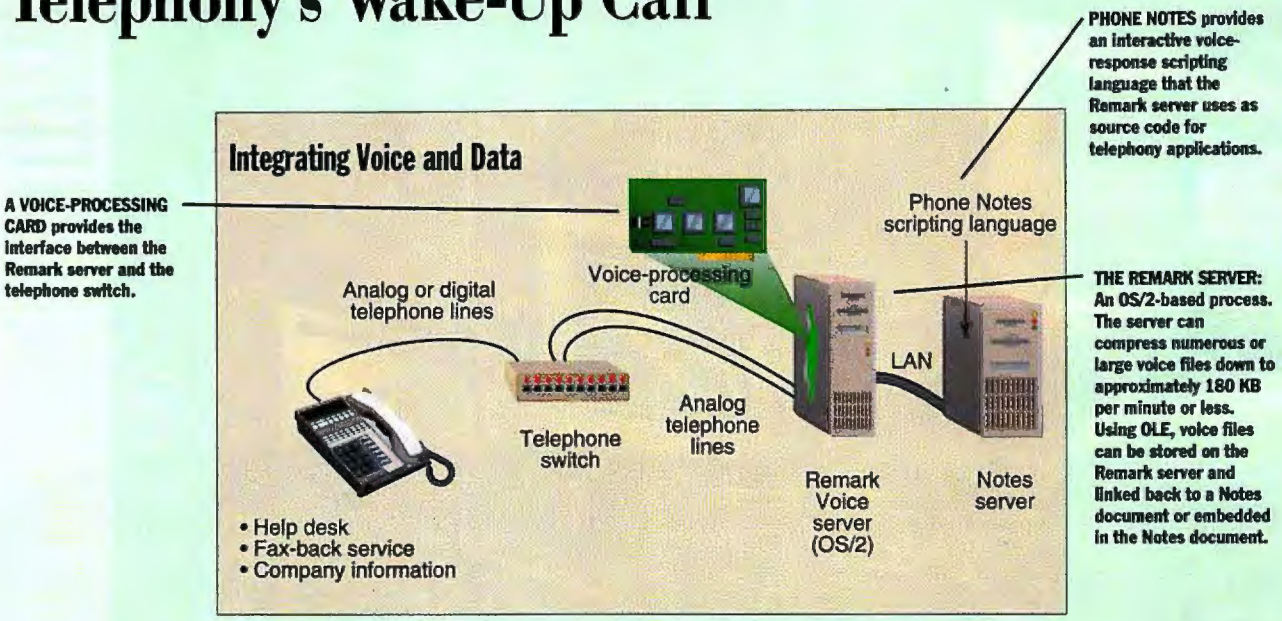
Telephony's Wake-Up Call



JEFF SMITH

Telephony used to be the domain of large service-oriented firms, such as those in the banking and insurance industries. Smaller companies generally could not justify the significant investment for proprietary systems that was required to implement telephony. However, that has recently changed.

Standards such as TAPI (telephony API) and TSAPI (telephony services API), and a growing number of third-party development products that support these standards, are helping to put Notes-based telephony within the reach of any organization that is large enough to justify a groupware installation. Some of the applications include help-desk support, fax-back services, "hot lines" for company information, and data-gathering systems. In the future, we may see telephony systems "reading" E-mail messages to business travelers or capturing and manipulating voice recordings as objects in a Notes document.

Speaking with One Voice

The combination of Phone Notes, from Lotus, and Remark, from Big Sky Technologies, is one example of how developers can integrate voice recordings and sound objects into Notes. Phone Notes provides an interactive voice-response scripting environment that the Remark server uses as source code for telephony applications. Remark PhoneClient lets end users access these applications from any telephone.

The Remark Voice server is an OS/2-based process that connects to an existing telephone switch via analog phone lines. Each phone line represents one concurrent recording or playback session. Therefore, the size of the Remark server and the number of lines required are directly proportional to the expected number of concurrent users of the application during peak periods. A 16-line system will support hundreds of calls during business hours.

A voice-processing card, purchased separately from such vendors as Natural Microsystems or Dialogic, acts as the interface between the Remark server and the telephone switch. The Remark server can compress voice files down to approximately 180 KB per minute. This can become particularly important in applications where conversations or messages are recorded and stored for future use. If you're willing to sacrifice some quality, you can choose to compress the recordings to 90 KB per minute.

Using OLE, voice files can be stored on the Remark server and linked back to a Notes document or embedded in the Notes document. This can be important if you store a large number of voice files or if they are lengthy. Storing files on the Remark server overcomes the Notes 1-GB file size limit. However, if these voice recordings need to be routed to users that do not have access to the initiating Remark server, embedding the files in Notes documents may be the only option.

Phone Notes applications require little Notes applications development expertise. To create a Phone Notes command, developers need only to understand the logical flow of the desired application, not a lot of

cryptic function calls. More difficult tasks are designing and developing the underlying Notes application that will be the repository or source of information for the telephony application.

Phone Notes has some limitations. Call management is one difficult area. Predictive dialing and load balancing work to some degree in small-volume applications, but Phone Notes falls short in these areas when you try to launch them on a large scale. The problem is that the Remark server's interface to the PBX is via analog lines only, and it cannot determine if an internal extension is busy without dialing it. Therefore, it cannot accurately determine when an extension is available for the next call.

In addition, any function that requires a high degree of integration with the telephone switch is difficult at best with Phone Notes. All communication between the user on the phone and the Remark server happens via Touch-Tones. This is effective when only one person is accessing the application. However, if two people are on a conference call, both parties hear the Touch-Tones, which quickly becomes annoying for the person who's not pushing the buttons, particularly if that person happens to be a customer.

Although some technical problems need to be ironed out, voice-based groupware applications are a reality today. As telephony standards evolve, audio as a data type may play an even more common and important role in how companies do business.

Jeff Smith is a product manager for workgroup applications at U.S. Technologies (Tampa, FL) and a designer of telephony systems. You can reach him on the Internet or BIX at editors@bix.com.

Some common problems with mail gateways include message text becoming truncated or address and subject fields getting garbled or lost. In an application where the subject field routes a product-request form to the proper department, the gateway conversion must be clean and reliable. Some organizations continue to operate proprietary mail systems for which no gateway exists. If the application requires a mail interface, the developer usually has to write the conversion code as part of a front end to the workgroup application. The worst-case solution is for the application to convert the data to ASCII, parse the data to figure out the addressing and message text information, and then import the data into the target database.

Remember the End User

A groupware application can't be successful unless it's easy to use and scalable. Part of the design work involves meeting with end users to determine how they will access the system. Some people may connect into a central server; others use a LAN connection or a remote-access server. Developers need to determine how the application will handle each access method.

Today, it is also common for workgroup applications (e.g., help desks and customer service) to support a myriad of requests or questions from E-mail, fax, telephone, and wireless devices. By comparison, COBOL programmers rarely have to worry about segmenting the user population by access method or the layout of the enterprise network.

Each access type has some issues associated with it—capacity and bandwidth, compatibility, and security—that have to be sorted out as part of the application's design task. For example, it certainly doesn't make sense for 15,000 salespeople to dial into one or two remote-access servers in an evening.

A similar problem with capacity exists when remote users or servers are replicating Notes documents that have large file attachments or embedded images. Moving documents that are 2 MB or larger over a dial-up connection can take up 8 hours.

Scalability becomes an issue when the infrastructure for a groupware application was initially built for small pilot groups. Few organizations prepare an enterprise architecture plan to support current and future applications requirements. As a result, enterprise architectures that are planned around 100 users in three major cities have a difficult time scaling to 1000 users on three continents. Because the application drives infrastructure requirements, the developer often carries out the task to plan and build the infrastructure, which is often a larger project than writing the application itself.

Another common implementation problem is that not everyone in the workgroup may have the technology needed to run the application. The first question to ask when you get a request for a multiuser, multilocation application is whether all participants are on some common system (e.g., Notes, mail, or forms). The usual answer is, "Not yet, but probably by the end of the year."

Faced with that response, do you roll out a groupware product such as Notes before you develop your applications? If you do, you risk early user rejection because of no immediate benefit. Or do you develop essential applications and then deploy Notes? The time delays minimize your application's return on investment and eats away at the shelf life of your solution.

An effective answer is to split resources into a development team and a Notes deployment team. You should allow the developers to stay one step ahead of the deployers so that applications requirements can be fed to the deployers on a just-in-time basis.

As groupware matures, the issues outlined above should diminish with new workgroup tools and standards for interoperability. Until then, workgroup computing will remain a challenging but fertile area for developers. ■

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Kelly Trammell is a partner with KPMG Peat Marwick's Strategic Services (Houston, TX), which focuses on workgroup computing and sales-force automation. You can reach him on the Internet or BIX at editors@bix.com.

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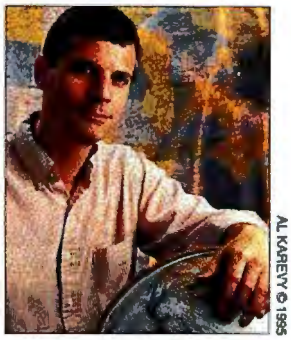


AL KAREVY © 1995

A new 56-Kbps link makes BYTE a full-time Internet citizen. But a big question looms: Which rules of citizenship should we abide by?

New England Telephone brought the 56-Kbps leased line this week: two pairs of copper wire that terminate in BYTE's ground-floor phone closet. At that point, the baton passed to Larry Graffam, our regular telephone-wiring contractor. Six years ago, Larry and I built BYTE's first twisted-pair LAN, and sometimes we still meet on the virtual border that lies somewhere between telephony and data networking. Today he's extending the new circuit to our third-floor computer room. "I don't know what a CSU/DSU is," he says. "Just tell me how to wire the jack." "Straight through on pins 1, 2, 7, and 8," I guess, trying to recall what worked when we connected the 56-Kbps X.25 link to BIX. The lights on the CSU/DSU (channel service unit/data service unit) flicker, but the link only sputters and won't catch.

We perform the ritual scratching of heads, wiggling of plugs, and swapping of wire pairs, all to no avail. A call to MV Communications, our service provider, reveals that our box can answer, but not call, its remote partner. Larry troops back downstairs and soon returns with the solution. The RJ-45 jacks he's used in the past for 10Base-T pin out differently than the RJ-48 that New England Telephone brought. Larry installs the RJ-48 jacks, the CSU/DSU lights up like a Christmas tree, and we have a live digital circuit.

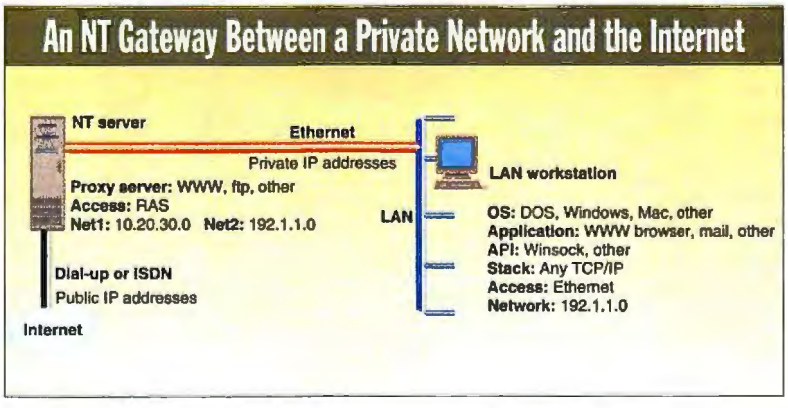
Along with the CSU/DSU that serves as our site's interface to a physical data network, we need a router. MV supplied a Livingston PortMaster, which I now fire up and connect via serial cable to the CSU/DSU. From an NT machine on a dial-up PPP link to the Internet, I ping the address that MV had configured into the router, and it responds. But does that address really correspond to our router? To find out, Ben Smith at MV's Peterborough POP (point of presence) verifies that the Internet protocol traffic that I'm sending maps to the data circuit between there and BYTE. The router is on a live IP link to the Internet, so MV can Telnet into and configure the Ethernet interface we'll use to access the link. From its pool of Class C addresses, MV fishes out one for us and assigns one of that network's 254 usable addresses to the router's Ethernet interface. We're up and running.

Two Schools of Thought

Now that we're operating a public Class C network, how should we use the remaining 253 IP addresses? Of course, we will use one for every machine that provides WWW (World Wide Web), FTP, or other externally visible services. At first, we'll most likely start with a single machine running as both www.byte.com and ftp.byte.com. Later, we might dedicate a machine to each of these services, and perhaps mirror services on additional machines. However, there are lots more LAN clients than servers, and the question is how to get them onto the Internet. There are two schools of thought in this area:

1) Public networking. This vision inspired the design of TCP/IP. Every node has its own globally unique IP address and can converse on equal terms with all other nodes. But to label IP nodes as "hosts" betrays assumptions that predate LANs and desktop computing. Hosts that run Internet services for users at terminals are nothing like Windows or Macintosh hosts that run their own TCP/IP stacks and applications. These desktop systems are personal Internet endpoints on which users can deploy their own Gopher, FTP, or WWW servers. Slick, but can you expect everyone on your LAN to use these rather sophisticated tools well? This crucial question leads to the second (and dominant) school of thought:

2) Private networking. With a private network, you set up gateways, firewalls, and routers that regulate the interaction of your LAN's clients with the outside world. Global peer-to-peer networking often isn't the right choice for corporate LANs. Companies provide Internet services, but most individuals don't really need those capabilities (at least not yet). This asymmetry dictates that corporate servers live either on or outside a defensive



NT's RAS (Remote Access Service) combined with a proxy WWW server is an innovative way for a small company to both export and import Internet services.

perimeter and that LAN clients live within the boundaries.

Public networking means that we dole out one of our 253 addresses to each IP device on our LAN, and we're small enough to do that comfortably. Private networking means that we can use unregistered IP addresses, or none at all—two options that I've been exploring for a while.

Instant Internet, No IP Addresses

Performance Technologies' Instant Internet (see "Short-Order Internet Access," July BYTE) is a network appliance: a box that attaches to the network, powers on, and solves a hard problem so quietly that you forget it's there. Instant Internet connects LAN clients to the Internet by decoupling a popular Internet API—Winsock—from its normal TCP/IP substrate and grafting it onto IPX. This setup is convenient because it does away with client IP addresses, and it's secure for the same reason: no exposure of IP addresses or on-LAN IP traffic.

In fact, the security angle is a bit subtler. Winsock is, after all, an implementation of the Berkeley sockets API, and its basic unit of connectivity is not the host but the port. For Winsock client applications to work, they have to create and attach sockets to ports on hosts. Instant Internet uses a tweaked version of WINSOCK.DLL to make this happen.

The converse is also possible: Inside servers could offer ports to which outside clients could attach sockets. For example, a LAN node's WWW server listening on port 80 would answer connection requests from outside WWW browsers that aim at that port on the Instant Internet box. To prevent this, Performance Technology blocks the inbound use of such well-known ports, except for the SMTP port that you'd need to deploy an Internet mail gateway on your LAN.

NT Gateway, Private IP Addresses

The figure "An NT Gateway Between a Private Network and the Internet" on page 103 shows the other solution that I've tried. A *multihomed* host (one with interfaces to two or more networks) routes IP traffic between the Internet and a private IP network. On the first try, I pinged a remote host from the LAN but got no reply. The NT box was the default gateway for TCP/IP clients on the LAN, so what was wrong? You guessed it: addressing. We've always used network address 192.1.1.0, the first Class C network, for internal IP tests.

Private use of this network number is an Internet folk tradition, and lots of these networks touch the official Internet. It's likely that the ICMP (Internet Control and Message Protocol) packets sent by my ping command reached the host, but to which 192.1.1.0 network should the host reply? When there are duplicate addresses, IP breaks.

The missing ingredient was a proxy server (an NT application) to relay messages between inside clients and outside servers. Process Software's Purveyor is one NT WWW server that offers this proxy capability. I installed it on a Digital Equipment Alpha machine running NT, pointed another machine's copy of Netscape at it (see the screen at left), and—Bingo!—the NT box instantly became a poor man's firewall.

Appliance vs. Gateway

I've tried both solutions for a few weeks on BYTE's LAN. The table above summarizes the pros and cons of each. Which is best? Sorry, but the jury is still out. We like Instant Internet because it gets results fast—after just 30 seconds, you're surfing the WWW. But a Windows-only solution ignores our Mac and Unix users. And the IPX substrate complicates the use of in-house WWW servers to manage private information. You can switch modes by swapping WINSOCK.DLLs on the fly; I do this, but I don't recommend it.

A traditional IP gateway, including our NT solution, requires a lot more up-front effort: TCP/IP stacks on every client, IP

WEIGHING THE ALTERNATIVES

INSTANT INTERNET

Pros
- Simple installation for NetWare (or Windows-over-IPX) users
- Secure—no IP on the LAN, inbound ports blocked
- Works with any 16-bit Winsock application
- Script support for dialer

Cons
- Non-Winsock TCP/IP applications break
- 32-bit Winsock applications (e.g., Netscape 1.1 for Win32) don't work
- No local (i.e., LAN) use of TCP/IP
- No non-Windows access
- Client service only; can't run servers

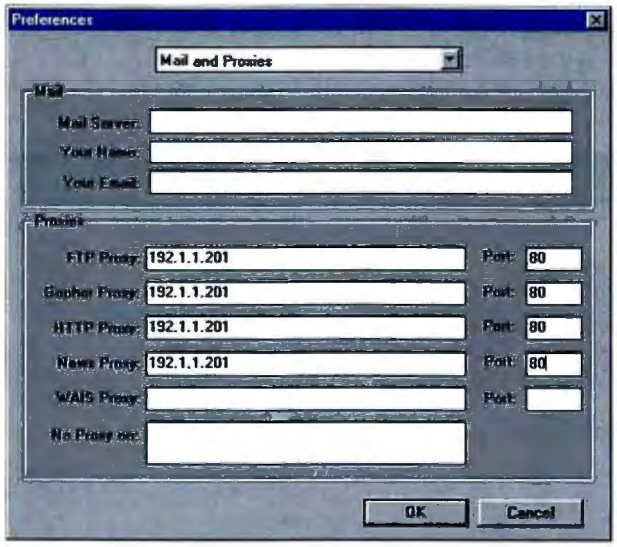
NT GATEWAY

Pros
- Less expensive if a Windows NT server is already in use
- Secure—no inside unregistered IP addresses are exposed to the outside
- Allows local (i.e., LAN) use of TCP/IP
- Non-Windows systems (e.g., Macs) can use the connection
- Can run servers (e.g., ftp and WWW)

Cons
- Requires a proxy server
- Applications limited to those supported by proxy server
- More complicated installation, even with DHCP to simplify addressing
- No script support in RAS (Remote Access Service)

Using a Proxy WWW Server

Point your browser at a proxy WWW server to get through a firewall or to hop from a private IP network to a public one. Be sure to refer all the client-side services that you care about to port 80 on the server. If you aim Netscape's FTP client at the FTP port (21) on the server—something I tried—it won't work. That's because a WWW server isn't an FTP server. The WWW proxy handles all the protocols, so all the action's on port 80.



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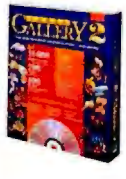

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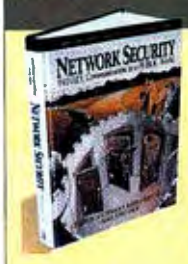

BOOKNOTE

Network Security: Private Communication In a Public World, $46
by Charlie Kaufman, Radia Perlman, and Mike Speciner
Prentice-Hall, 1995
ISBN 0-13-061466-1

Nuts-and-bolts explanations of all the important encryption and authentication regimes: what they are, why they work, and how they might not. Details on how NetWare, Notes, DCE (Distributed Computing Environment), and Microsoft networks implement security. All this, plus lots of laughs.

addresses all around, and applications configured to talk through proxies. But you can use Unix, OS/2, NT, or any capable OS on the multihomed host (if the necessary proxy has been ported to that platform), and options are equally bountiful on the client side. The gateway also doubles as an Internet server visible to the outside.

Traditional IP is truly powerful stuff. Of course, if we use it, we must decide whether clients get registered addresses or not. Is private networking an abuse of TCP/IP? The experts who hang out in BIX's Internet conference directed me to the RFCs (requests for comment) that frame this question. Details follow.

RFC 1597 vs. RFC 1627

RFC 1597, "Address Allocation for Private Internets," wants to reserve certain network addresses for duplicate use (see "Reserved Private Networks, per RFC 1597"). Primarily driven by the desire to conserve precious address space and ease the administrative burden of IP subnetting (see "Linking LANs," December 1993 BYTE), the authors also note that private addressing enhances security.

Not so fast, say the authors of RFC 1627, "Network 10 Considered Harmful." We should expand address space the right way, by means of IPng (see "Create More IP Addresses," April BYTE), not by violating the principle of unique addressing that's the foundation of the Internet. Maybe you don't need direct, network-layer connections to the outside today, but you might well need them tomorrow. Apple found out the hard way, the authors say, when it had to renumber 5000 hosts. Why bother? "Apple, IBM, and Motorola could not collaborate as easily as they have to [in order to] produce the PowerPC without uniquely assigned IP addresses."

The process used to assign IP numbers is the crux of the issue. RFC 1597 argues that with an automated method—such as the DHCP protocol, in which clients boot up without numbers and receive IP addresses on the fly—you can easily switch between public and private addressing or synchronize two private domains. RFC 1627, however, questions DHCP's maturity and effectiveness.

As an experiment, I had our DHCP server (an NT 3.5 service) move the block of addresses it manages. The NT clients caught on after a reboot, while Windows 3.11 and 95 didn't. I scanned the INI files and registries but couldn't flush out the old addresses. This was on a Friday, and the leases on those addresses weren't due to expire until Sunday. So I took the weekend off, and the problem fixed itself on Monday. I later learned that you can break Win 95's DHCP leases with `winipcfg`, and Win 3.11's leases using `ipconfig/release`.

Obviously, DHCP works for us, and private networking seems easy, useful,

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Handy Mac utilities, most notably Desktop Shortcut, a utility that makes the Mac File Open and File Save dialog boxes smarter. As we began cranking out images for the BYTE CD-ROM, these dialog boxes became a major bottleneck. Desktop Shortcut remembers recently used folders and last-known positions in lists. Why can't Finder and Win 95 track this crucial context?

and secure. But RFC 1627's argument is cogent. Business-to-business networking is on the way, and there's no point in throwing obstacles in its path. With that in mind, how should BYTE dole out its public Class C addresses? One for a gateway, or perhaps one for every LAN client? For now, we'll modify the first approach: just one address, and use a server connected *only* to the Internet. It'll be safe sex for a while, until I've studied the security issue more deeply.

I Outfox the Devil

The security tool named Satan probed our site in both the Instant Internet and NT gateway modes and gave it two thumbs

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Circle 122 on Inquiry Card (RESELLERS: 123).

up, for whatever that's worth. But you can't find what you're not looking for, and I doubt the Unix networking culture that spawned Satan understands the Windows networking conventions that Win 95 clients and NT servers follow.

Consider NetBIOS, the API and name service that enables file and printer sharing, NetDDE, and remote administration. One night I added some NetBIOS-name/IP-address pairs to Win 95's LMHOSTS file (see "Wide-Area Windows Networking," January 1994 BYTE) and dialed up the Internet using RAS (Remote Access Service). I found that I could NET USE drives on the Internet server back at the office and even remotely edit its registry.

You couldn't do that without my domain user name and password. But if you knew or guessed the name of the shared directory that I'd unintentionally left open to group Everyone, you could have plundered it. That's the kind of security hole that even Satan can't yet detect or climb through.

I'm pleased to report that the BYTE WWW site is coming along. We're currently putting images on the next BYTE CD-ROM, and you can try out part of the January issue on-line to get a feel for how it will eventually look. I've indexed the text archive using EMWAC's port of free-

Where to Find

EMWAC (European Microsoft Windows NT Academic Consortium) http://emwac.ed.ac.uk	**O'Reilly & Associates** Sebastopol, CA (800) 998-9938 (707) 829-0515 http://www.ora.com
Folio Corp. Provo, UT http://www.folio.com	**Process Software Corp.** Framingham, MA (800) 722-7770 (508) 879-6994 http://www.process.com
Lotus Development Corp. Cambridge, MA http://www.lotus.com	

WAIS (Wide Area Information Service); used Folio's Infobase WWW server to export a preexisting BYTE infobase to the WWW; and tried out the Lotus InterNotes Web Publisher. Also, I am finding the WWW site useful as a channel for private communications between our home office and its satellites.

Finally, BYTE's original PC Unix server, reconstituted under BSDI 2.0 (thanks to Ben Smith), will be coming on-line soon. That will allow Ben and me to scope out how NT and Unix stack up as engines that power Internet sites and as platforms for WWW development. ■

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

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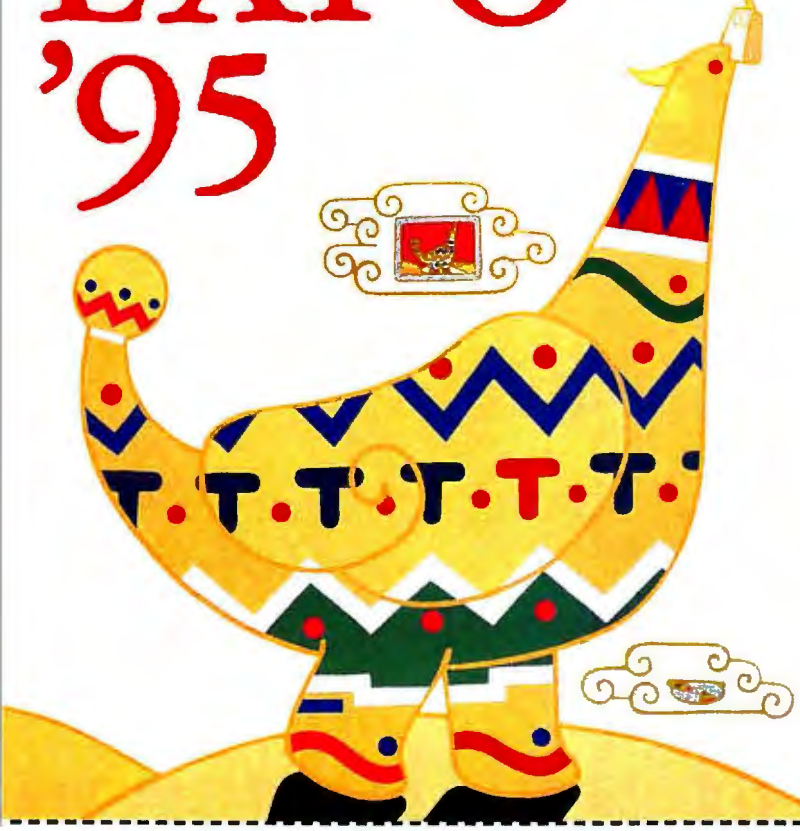

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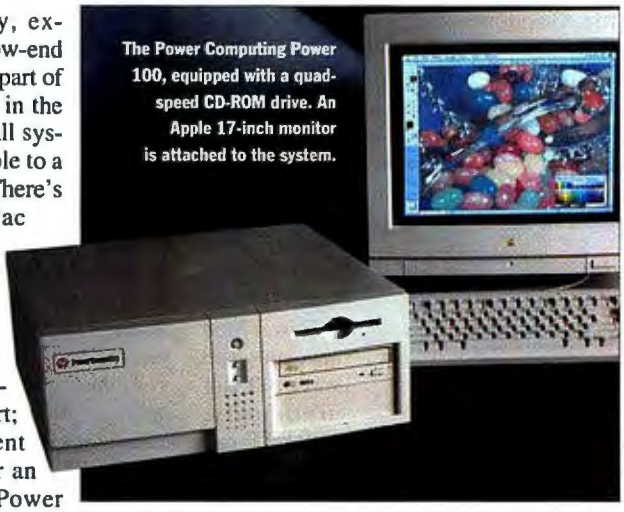
Send In the Clones

Power Computing's Mac-compatible system portends a good start for Apple's Mac OS licensing plans

TOM THOMPSON

Here's the verdict: Power Computing's Mac-compatible system is as fast as an equivalent Power Mac, it's less expensive, and it includes more goodies out of the box. Mac clones—finally—have arrived.

Thanks to its Power Mac line, Apple has become the largest vendor of RISC systems. It sold 1,400,000 of them in just 14 months. Equally as dramatic, Apple made an abrupt shift in its business strategy. It licensed the PowerPC version of the Mac OS—considered one of the company's crown jewels in terms of technology—to other vendors. Several companies signed licensing agreements late in 1994 or early this year. Power Computing began limited shipments of its Mac-compatible systems in May and will be in full production by the time you read this.



The Power Computing Power 100, equipped with a quad-speed CD-ROM drive. An Apple 17-inch monitor is attached to the system.

DAVID SHOPPER © 1995

Back to the Basics

Power Computing sells three models of Mac compatibles: the Power 80, Power 100, and Power 110. They use 80-, 100-, and 110-MHz PowerPC 601 processors, respectively. These computers closely match the hardware specifications of the Power Mac 7100 and 8100, with three NuBus slots, a 256-KB level 2 cache board, and a second display board with 2 MB of video memory, expandable to 4 MB. (A low-end design that's the counterpart of the Power Mac 6100 is in the works.) Base RAM in all systems is 8 MB, expandable to a maximum of 200 MB. There's the usual gaggle of Mac I/O ports: one ADB (Apple Desktop Bus) for the mouse and keyboard; two mini-DIN-9 Geoport connectors for modem, printer, and LocalTalk network support; and an AUI (attachment unit interface) port for an Ethernet connection. Power Computing will also tailor a system's hardware to meet your needs.

Because the Mac OS is intimately coupled to a number of Apple custom ASICs, we expected to see little difference between a Power Mac and a Power Computing system. We were thus mildly surprised when we opened the packing on the Power 100 system sent to us. Instead of the familiar mini-tower or pizza-box chassis the Power Macs sport, Power Computing uses a commodity baby AT form factor to house the system hardware.

Other cost-cutting measures are evident. There's no second plug connector on the system for powering a monitor, but because today's energy-saving monitors automatically shut themselves off, this isn't a big issue. The built-in video port doesn't use the kooky AV connector found on Apple Power Macs. Instead, it uses a standard DB-15 connector. This eliminates a lot of cabling headaches, but if you need to do voice recognition or sound input, you'll have to use a microphone and the sound-input jack, not an AV monitor. We had no problem connecting and switching an Apple 17-inch multiscan monitor to different resolutions on either video port.

In contrast to Apple's policy, you get an extended keyboard (the one with the function keys) with the computer. There's also software claimed to be worth $900: some Bitstream PostScript and TrueType fonts; Now Software's Now Utilities (system Extensions), Now Contact (a contact-list program), and Now Up-To-Date (a group scheduler); FWB's CD-ROM Toolkit and Hard Disk Toolkit; Claris's ClarisWorks; Intuit's Quicken; Apple's e•World on-line software; and Insignia Solutions' SoftWindows 1.0.

Test Run

To check out the computer, we simply uncabled one of BYTE's Power Macs and plopped the Power 100 into its place. We reatttached the cables, copied the Power Mac's contents to the Power 100 via File Sharing, and began working.

The usual applications worked flawlessly: Photoshop 3.0, Illustrator 5.5, MacWrite Pro 1.0v4, Excel 5.0, and cc:Mail 2.2. We were able to use all sorts of terminal software (e.g., America Online 2.5.1, AppleLink 6.1, and SITcomm 1.0.1) to maintain on-line contacts and successfully download and upload files. The Power 100 had no problems faxing manuscripts to authors using Global

Inside the Power 100

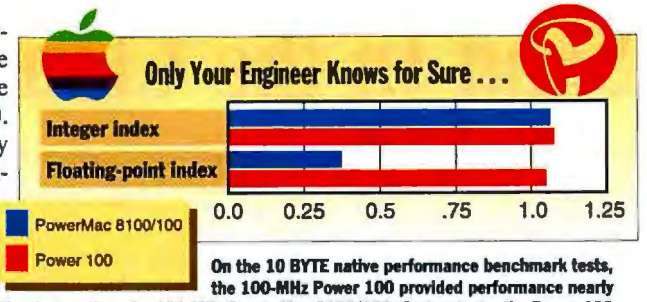
Wherever possible, the Power Computing design uses four-layer rather than six-layer circuit boards in the system. While four-layer boards require more real estate to construct a subsystem's circuits, the advantage is that they're less expensive to manufacture. (Just before the company went into production, the main logic board went from four to six layers to ease timing tolerances, which slowed the production schedule.)

A glance at the main logic board reveals a smattering of Apple ASICs, the 601 processor, and locations for two additional NuBus slots. If demand warrants it, Power Computing can add the extra connectors and a different NuBus controller chip needed to support a five-slot computer. A four-layer video board occupies the 601 PDS (Processor Direct Slot) and sports both an Apple DB-15 and a PC VGA video connector. All the I/O subsystem controllers are crammed onto a board plugged into a proprietary I/O slot. This board handles the two SCSI buses (one fast internal, one standard external), the Ethernet and LocalTalk network connections, and the NuBus controller. If Power Computing wants to change or enhance an I/O subsystem, it requires only a modification to the I/O board.

Finally, the 72-pin DRAM sockets are readily accessible for RAM expansion. This isn't the case with the Power Mac 8100.

Village's OneWorld fax server. The usual army of Extensions worked perfectly (e.g., ATM 3.8 and Now Software's Super-Boomerang and WYSIWYG Menus).

We had a bad moment attempting to access image files from an Apple QuickTake 150 digital camera until we realized the problem was a missing codec Extension file. Developers will be pleased to know that Metrowerks CodeWarrior 1.2.2 (aka CW6) works on the Power 100, as well as Jasik Designs' low-level PowerPC debugger. For quality time, Bungie Software's Marathon—a game more complicated and tougher than Doom—ran without a hitch. In short, everything on an Apple Power Mac ran on the Power 100. Not surprisingly, the BYTE native and application benchmarks revealed few differences in performance between the Power 100 and the Power Mac 8100/100.



On the 10 BYTE native performance benchmark tests, the 100-MHz Power 100 provided performance nearly identical to that of a 100-MHz Power Mac 8100/100. On two tests, the Power 100 showed faster floating-point performance—due to the improved math library in System 7.5.1, not to system differences. Here we show just the integer and floating-point indexes derived from the 10 tests. Results are indexed; higher numbers indicate better performance, and a Dell 90-MHz Pentium = 1.

We can't state it any clearer: Power Computing has successfully replicated the Power Mac. This speaks well for the company's engineers and for the nascent Mac OS licensing market. We are concerned that Power Computing might not be able to make enough systems to meet demand or might compromise quality to ship systems. However, the company stands behind its work with a 30-day money-back guarantee and a one-year warranty.

At the time of this writing, Power Computing's prices were lower than those of equivalent Power Mac systems, ranging from a difference of $800 for a Power 100 versus a similarly equipped Power Mac 7100/80 to only a $236 difference between a Power 110 and a Power Mac 8100/110. If your computing needs are modest and your budget is tight, you might look at the Power Mac 6100/66, for which Power Computing has no counterpart. ■

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

Five-in-One Peripherals

New multifunction PC peripherals fax, scan, print, and copy, all for under $1000

G. ARMOUR VAN HORN

Four multifunction peripherals with street prices under $1000. Clockwise from upper left: Lexmark's Medley 4x, Brother's MFC-4500ML, Canon's MultiPASS 1000, and HP's OfficeJet LX.

DAVID SHOPPER © 1995

When Canon, Ricoh, Okidata, and Xerox released multifunction peripherals a few years back, they seemed like a great idea: Tuck your fax machine, copier, printer, and scanner into one tidy box. The new units were spiffy, sexy, expensive—and a complete marketing flop. In a turn of events, the MFP (Multifunction Peripheral) is back with a vengeance, fueled by the growing SOHO (Small Office/Home Office) market and by new product launches from major manufacturers.

This review examines four new MFP products aimed by both price and function at the SOHO market. Brother, Canon, Hewlett-Packard, and Lexmark each produce computer-controlled multifunction machines that offer five functions: plain-paper fax, PC fax, printer, copier, and scanner. These units and their software drivers rely on the PC's parallel printer port (a speed advantage), and Windows-based interface software. Each lists for between $1000 and $2000, but all carry estimated street prices below $1000.

Start with Plain Paper

As a rule, a multifunction device requires less space, power, and capital investment than individual components, which is why they make sense for a small office (or any office). A single device, smaller than most laser printers, an MFP connects to your PC usually with only a single cable, and replaces five pieces of office equipment in the process.

The current and defining generation of MFPs work by splicing your computer into the logical heart of a plain-paper facsimile unit. Through software, your computer controls each of the components—a fax machine, copier, scanner, printer, and fax modem—as individual peripherals.

Because they're derived from plain-paper fax products, the four MFPs presented here perform best as fax machines and printers. Scanning and copying capabilities are not yet up to snuff. Still missing from the equation is some form of ordinary data transmission capability in their modems, which remain fax-only items.

We found the four MFPs to be excellent stand-alone plain-paper fax machines with full feature sets (speed dialing, one-touch dialing, broadcasting, and auto redial, to name a few). Each one scans at a minimum of 200-by-200 dpi resolution. If you choose to print all incoming faxes, the computer can be turned off or disconnected without interfering with the MFP's operation. All four have memory to store incoming faxes when the computer is not ready to accept the files on disk or to queue up outgoing faxes.

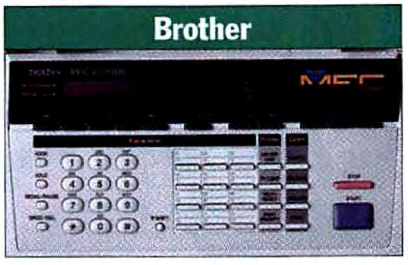
All the units have the option to print incoming faxes at 100-percent size on letter, legal, or A4 paper, and can also auto-reduce incoming faxes to fit on letter-size paper. This last option is necessary with a sheet-fed fax machine, since most faxes are sent on letter-size sheets. With the origin and time header adding about a half inch to the top of the received page, without an auto-reduce feature, the bottom half-inch of the fax would be lost.

Windows Preference

Anyone who has suffered the mind-numbing exercise of programming a standard fax machine from its front panel will welcome the opportunity to enter all of those settings from a well-designed Windows interface. MFPs also allow you to save the fax configuration to the unit with a single click of the mouse. As you may imagine, it's far easier to enter your company name (station ID) from the keyboard instead of picking one letter at a time from a tiny LCD menu. Although all four units are capable of this convenience, Canon's current software does not yet support it.

Real estate and law offices are examples of businesses that need to maintain a record of outgoing faxes, and all these

systems provide fax logs. Lexmark's MFP takes this process a step further with a 65 percent–reduced image on the first page of the transmission report. If you send faxes without cover sheets, this feature puts the first page of your correspondence directly on the delivery receipt.



These units are particularly adept at converting from print resolutions (300 or 360 dpi) to the common fax machine resolution (198 dpi). Not surprisingly, all four exhibited the occasional vertical artifact when accepting input from standard fax machines. Each of these machines also has enough built-in memory to scan in a page in one swift pass, and the image is easily transmitted from the MFP's memory to your computer.

For Your Convenience

Because much of their work consists of computer-generated documents, many small offices never bother with the expense, maintenance, and space requirements of a full-size copier. The copying capability of an MFP, though limited compared to a conventional copier, is a true convenience. Making a copy is simple: You slide the document in as if you would a fax, and hit the start button. These MFPs can use their memory for limited collation, too. The Lexmark Medley goes a step further and offers to send a copied page as a fax to one of your stored telephone numbers.

MFPs produce copies with roughly the same level of quality as a fax machine. When producing copies, none of these units can accept bound material. Pages must go through one at a time into the sheet-fed scanner. While they're not full-featured scanners, both the Brother and HP MFPs allow reduction, and the Brother also enlarges copies to 150 percent.

Scanning at a course 200 dpi lets these units perform fast scans at a convenience level of quality, and the Lexmark Medley scans at 300 dpi. Major OCR packages support 200-dpi scanning, and all four MFPs have the 20- to 30-page document feeders that lend themselves to this task. Each of these units can scan a stack of pages to your computer rather quickly.

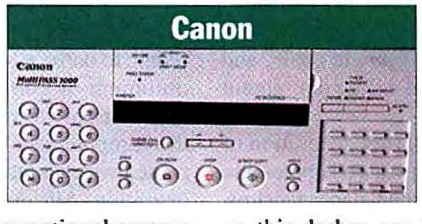
Brother MFC-4500ML

Unlike the other MFPs in this comparison, the Brother MFC-4500ML Multi-Function Center is based on laser rather than ink-jet technology. It shares the same engine as the Brother HL630—a 300-dpi, 6-ppm personal laser printer that carries a street price of roughly $400. As a result, the MFC-4500ML's output is slightly superior to the ink-jet MFPs, and operates much faster. However, the Brother's installation process might discourage some technically challenged customers.

With no coordinated installation documentation, you need to rely on a manual that describes four MFC models of various configurations, along with a second manual for an item called the Missing Link—an interface box with a cable and software that gives your PC control of the MFC-4500ML. While the Missing Link is included as standard equipment with the MFC-4500ML, it's an option for other members of the MFC line. However, confusing the issue, you must install it as an option. Also, the MFC-4500ML required more physical assembly than any of the other test units and at least double the set-up time.

Further compounding the installation process, the MFC-4500ML requires both a parallel and a serial connection to the host PC. The parallel port poses no problem, but it's not always easy to find a free serial port on a Windows system. You may end up needing to reassign serial port addresses and interrupts.

The dual-port design does offer advantages once you clear the installation hurdles. As you scan a document to disk through the serial port, a lengthy document can print to the laser printer through the parallel port. Another nice touch is the ability to print while faxing or copying. Also, because the MFC-4500ML uses the parallel port in a conventional manner for printing purposes, you won't encounter hardware conflicts with software that requires dongle-based copy protection.



Once installed, the Brother software was consistent and intuitive, and the print quality was slightly better and significantly quicker than its ink-jet competition. The scanning process, though simple, produces acceptable quality. Once it was properly installed and running, everything felt right on this attractive and sturdy system. It should be the first choice for an office that already has a color ink-jet printer.

Canon MultiPASS 1000

The MultiPASS 1000 is the newest and most complete member of Canon's multifunction peripheral family. Based on Canon's 360-dpi BubbleJet printer, the MultiPASS boasts six functions. However, the sixth function is just the telephone handset. (Among the four review units, only the HP doesn't provide a handset). Canon's software, however, offers some unique telephony functions, such as the ability to play a tune during hold mode.

We received a prerelease version of the Canon MultiPASS 1000 and several updates to its componentry throughout the testing process. The final release is scheduled for mid-June. Not surprisingly, we ran into some problems. The inability to cope with Traveling Software's drivers for LapLink was one software shortcoming. Another involved problematic TIFF files produced by the scanner—they opened in Photoshop 3.0, but not in version 2.5.1. They also opened in Paint Shop Pro 3.0, but not in Corel PhotoPaint 5. Hopefully, Canon has worked these problems out.

For some, the Canon MFP's lack of gray-scale printing or scanning will rule it out. The scans this unit produces were also more blocky in appearance than those from the other MFPs. Despite the 200-by-200 dpi rated scanning resolution, there was less detail in scanned type.

The bundled software, Desktop Manager for Windows, works as a printer and scanner driver. It also provides additional functions, such as inboxes (fax and scan), outboxes (fax and print), phone books, distribution lists, and a fax viewer.

The MultiPASS 1000 uses a paper cassette similar to those found on most laser printers, which seems to be a logical approach to handling blank paper. However, this dashes any hope of using a variety of paper sizes, since it only accommodates letter or legal-size paper.

While the Canon MultiPASS 1000 is well built, and designed around a print engine with a huge installed user base, we cannot yet recommend it until we test finalized software. Assuming all problems are corrected in the final product, Canon's latest MFP still offers little additional functionality over the HP OfficeJet LX.

Hewlett-Packard OfficeJet LX

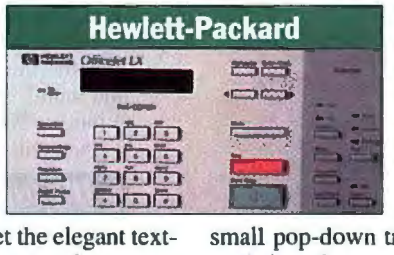
By adding a set of printer control buttons to a good fax interface, HP set a new standard for easy-to-use front panels with their original OfficeJet multifunction device. The new OfficeJet LX is the same hardware, but with new software that adds scanning and convenience copying abilities. Owners of the older OfficeJet can upgrade for $119.

The unit is based on the ink-jet print engine of HP's DeskJet 520 printer, which provides 600-by-300-dpi resolution plus image enhancement. Print quality matches that of a good ink-jet printer, but is not as good as the Brother MFC's laser output.

The ease of setting up HP's OfficeJet LX set the standard in our testing of the current group. Clear documentation helps install the various paper trays you must attach to the base unit, and mechanical setup was straightforward. Unlike the other MFPs, HP compiled the documentation in a single volume, which dramatically simplifies setup and installation.

The sole problem we encountered surfaced when the software seemed to detect the presence of a DLL used by Polaris' Packrat, which had been installed and subsequently removed. HP tech support helped us solve this problem, and it shouldn't affect many users.

Eclipse Fax SE software handles the PC-controlled faxing and scanning admirably. For example, if you set fax output as the default Windows printer, sending faxes and adding destinations to the phone book becomes an intuitive process. Despite a low 200-dpi scanning resolution, scanned text has nearly the same quality as that from the 300-dpi Lexmark Medley and should meet the criteria for OCR purposes.



HP's OfficeJet LX Manager utility provides two-way communication with the hardware, so that you get the elegant text- and graphics-based status and error reporting that's standard with new HP printers. The software checks the status of the unit at start-up and at frequent intervals from within Windows. It reports any problems it encounters, such as an unplugged printer cable.

Apart from what seem like flimsy paper trays, the OfficeJet XL lives up to the quality expected from its HP label. Thanks to HP's aggressive marketing, supplies for this unit should be bountiful for many years to come.

Consistent operation, universal availability of service, and impressive faxing and scanning capabilities make the OfficeJet XL a safe, if uninspired, choice in an MFP.

Lexmark Medley 4x

As the most stylish MFP of the group, it comes as no surprise that Lexmark's Medley is also the first multifunction machine that prints in color. It uses the same color ink-jet engine and 150-sheet paper tray as Lexmark's ExecJet IIc printer. It prints at an impressive 600-by-300 dpi resolution in monochrome mode, and at 300-by-300 dpi resolution in color. Other features that set it apart are a 300-dpi, 6-ppm scanner and a 14.4-Kbps fax modem. A nice touch is the small pop-down tray that feeds business cards into the scanner.

There are three models. We tested the 4x, which has the handset that the 4c doesn't, but comes without the battery backup feature and color ink cartridge that the 4sx has. Lexmark did supply color ink cartridges, however. The Medley produces color printing of reasonable quality, and is useful for producing both charts and basic graphics. Printing a 1024-by-768 screen capture image requires about two and a half minutes, and the results closely match the screen colors. Naturally, more complex images take longer.

The color-printing mode is strictly a printer function, and remains inactive when receiving faxes. Separate ink cartridges are used for monochrome and color printing, and Lexmark gave the Medley a clever socket, which conveniently stores whichever ink cartridge is not in use. Since you're likely to use this printer in monochrome mode for receiving faxes, and in color mode for printing, the storage socket keeps the unused cartridge from drying out.

Instructions are clear and setup was quick—less than 30 minutes, including software installation. Again, it would have been even easier if software and hardware were documented as a single item instead of two separate products.

Lexmark offers the only MFP software that does not require a place in your Windows Start-up group. The Medley's FaxSynergy software loads and remains in memory the first time you send a print job to the fax option. Similarly, Lexmark has its own print queue manager for spooling to the printer, much like Print Manager, except that it places no demands on your PC until

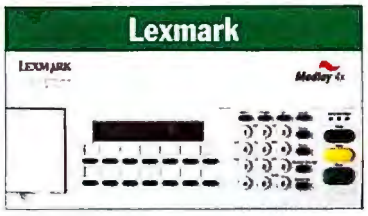
MULTIFUNCTION FEATURES

Unit	Brother MFC-4500ML	Canon MultiPASS 1000	Hewlett-Packard OfficeJet LX	Lexmark Medley 4x
Price (MSRP/street)	$1899/$999	$1480/$799	$959/$799	$999/$899
Ease of setup	Poor	Good	Excellent	Excellent
Fax from paper/PC	Y/Y	Y/Y	Y/Y	Y/Y
Fax to paper/disk	Y/Y	Y/Y	Y/Y	Y/Y
Fax memory (received fax pages)	20	70	24	60
TWAIN support	N *	Y	Y	Y
Modem speed (bps)	9600	9600	9600	14,400
Scanner dpi	200 x 200 **	200 x 200 **	200 x 200	300 x 300
Scan to disk	Y	Y	Y	Y
Monochrome printing	300 x 300 laser	360 x 360 ink-jet	600 x 300 ink-jet	600 x 300 ink-jet
Color printing	N	N	N	300 x 300 3-color ink-jet
Print engine speed (ppm)	6	2	3	3
Paper supply (sheets)	200	200	100	150
Document feeder (sheets)	30	30	20	20
Copy settings	50-150% (8 settings)	100% only	70-100% (6 settings)	100% only
PC interface type	parallel & serial	parallel	parallel	parallel
Handset	Y	Y	N	Y
Uninstaller	N	Y	N	N

* OCR software option available

** 200 x 400 dpi interpolate

you access one of its functions. Annoyingly, Lexmark's fax software simply cannot remember where it keeps the phone book files. Rather than navigate to the Medley directory for a phone book, it's almost always simpler and faster to type in the recipient's name and fax number.



Overall, the Medley is an impressive product. When visitors came through the office during the MFP evaluation process, the Lexmark Medley's design earned it the most compliments.

Real Benefits

Above all else, these multifunction units are plain-paper fax machines, and they handle that chore with the same speed and flexibility as stand-alone plain-paper fax units that currently sell for $500 to $600. While no single one matches the speed, quality, or paper handling capabilities of an office laser printer or dedicated office copier, they all handle small, simple jobs in both categories with relative aplomb.

The real benefit of MFP ownership is the flexibility that PC-based software adds to the computer-fax equation. Even in our well-equipped test environment—three laser printers, a stand-alone fax machine, two scanners, a fax/modem card in every computer, and a copying service across the hall (open during business hours)—each of these machines would add appreciable flexibility to our workday. In less generously equipped offices, any one of these units would quickly make a considerable contribution.

For an office already equipped with a color ink-jet printer, the choice is a toss-up between the Brother for its faster, high-quality laser printing, and the HP for its universal support, software, and lower price. For those who already own basic monochrome-printing equipment, the Lexmark is the clear choice for its color capability. ■

G. Arnour Van Horn works as a production artist and as a consultant and writer on electronic imaging and prepress. His studio is located on Whidbey Island, northwest of Seattle. You can reach him on the Internet or BIX at vanhorn@bix.com.

Product Information

MFC-4500ML Multi-Function Center
Brother International Corp.
Somerset, NJ
(800) 284-4357
(908) 356-8880 ext. 4506
fax: (908) 764-4493
Circle 1068 on the Inquiry Card.

MultiPASS 1000
Canon U.S.A, Inc.
Lake Success, NY
(800) 828-4040
Circle 1069 on the Inquiry Card.

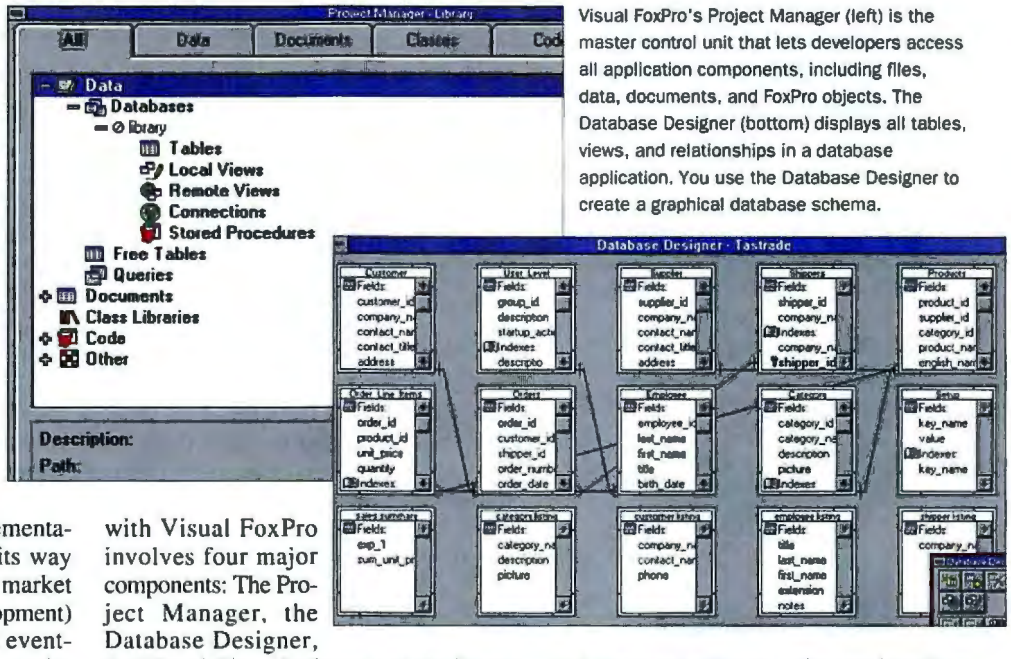
OfficeJet LX
Hewlett-Packard Co.
Santa Clara, CA
(800) 752-0900
(208) 323-2551
Circle 1070 on the Inquiry Card.

Medley 4x
Lexmark International, Inc.
Lexington, KY
(800) 358-5835
(606) 232-2000
fax: (606) 232-2380
Circle 1071 on the Inquiry Card.

Foxy Move to Client/Server

FoxPro may come to rule the desktop henhouse with new object-oriented client/server tools, but bigger predators await

DAVID S. LINTHICUM



Visual FoxPro's Project Manager (left) is the master control unit that lets developers access all application components, including files, data, documents, and FoxPro objects. The Database Designer (bottom) displays all tables, views, and relationships in a database application. You use the Database Designer to create a graphical database schema.

In the late 1980s, Xbase tools, such as dBase, FoxPro, and Clipper, ruled the desktop. They delivered an inexpensive solution for many small single-user and multiuser database applications. Then came the client/server model and mechanisms for separating the database and interface processes using object-oriented development tools. While sales of client/server tools flourished, legacy desktop DBMS tools fell behind in capabilities and popularity.

But Microsoft's Visual FoxPro 3.0, an upgrade of FoxPro for Windows (itself a Windows implementation of FoxPro for DOS), fights its way into the mainstream database tool market with RAD (rapid application development) capabilities, object-oriented and event-driven development, and integration with other technologies, such as OLE 2.0 and MAPI. As a bonus, Visual FoxPro's database server connections provide a scalable migration solution for existing FoxPro applications, and they make FoxPro a true client/server tool. The big questions: Can FoxPro meet the needs of existing FoxPro developers while adding enough features to attract new users? And can it thrive in the crowded database tool market?

Visual Features

If you're already a FoxPro programmer, you'll be happy to know that Visual FoxPro can now access most standard Windows-based events, and the FoxPro language is fully object-oriented. These new capabilities finally bring FoxPro into the world of true Windows applications development. We looked at the developer-oriented Professional Edition. Microsoft also sells a less-expensive Standard Edition that lacks development tools for things like browsing classes and creating executables. For existing FoxPro sites, Visual FoxPro can run existing FoxPro for DOS and FoxPro for Windows applications.

Building database applications with Visual FoxPro involves four major components: The Project Manager, the Database Designer, the Visual Class Designer, and the Forms Designer. Although the components themselves are straightforward, the way the components interact is not.

The Project Manager is the master control unit that lets you access all application components. In the world of Visual FoxPro, a project is a collection of files, data, documents, and FoxPro objects. From the Project Manager, you can access application components using an outline view that you can expand or collapse at will (see the screen above left).

Visual FoxPro's Database Designer displays all tables, views, and relationships for your database. You can create a graphical database schema using an interface that resembles a CASE tool. You add tables to the Database Designer and link the tables graphically by dragging and dropping one database attribute onto another (see the screen above right). With the 3.0 release, FoxPro can use more data types, including currency (where it rounds to four digits to eliminate rounding errors), SQL-style date and time, and binary characters.

Visual FoxPro uses a metadata repository called the Database Container that contains information about all related tables, local views, remote views, and connections. When you open the Database Container, all connections created for the database take effect, including local views, remote views, stored procedures, tables, and relationships. When you set relationships or other database properties inside the Database Container, they exist throughout the entire application.

Clicking on Tables Properties in the Database Designer opens a dialog box where you set table-level validation rules that will be invoked whenever you add a record. You may also specify triggers that execute during inserts, deletes, and updates. You can set indexes as primary, candidate (an attribute in a relation that may serve as a primary key), unique, or

VISUAL FOXPRO STRENGTHS

- Fully object-oriented development language
- 16- or 32-bit operation
- Upsizing Wizard converts databases to SQL Server
- Tools for upsizing to client/server

...AND WEAKNESSES

- Limited code-generation features
- No advanced data dictionary or integrity features
- Limited connectivity to third-party database servers

regular (legacy). Triggers and index expressions can access stored procedures in the database container. Moreover, Visual FoxPro is transaction-oriented; it lets you define the beginning and end of a transaction, as well as roll back to the beginning.

Visual FoxPro's Class Hierarchy

Visual FoxPro has two primary types of classes: containers and controls. Containers can contain other objects and allow access to objects contained within them. Control classes do not allow manipulation of their internal components. Manipulating objects requires identifying their place in the container hierarchy; a form control, for example, would first be referenced through the form set and then the form.

Objects by Design

The new Visual Forms Designer bundles the controls you'll need for a Windows application (e.g., entry fields, list boxes, and check boxes). You can align objects using a Layout toolbar, and easily bind objects and data using the graphical Data Environment Designer. You create forms by dragging and dropping fields and controls. The Visual Forms Designer works with Visual FoxPro objects, so you can save groups of objects created in forms as a class for use elsewhere.

The Visual Class Designer, a clone of the Visual Forms Designer, is where you define custom classes by creating properties and methods. Here is where you design generic application objects for reuse throughout the application. Visual FoxPro adds new controls to the Visual Class Designer, including the Grid Control, which lets you manipulate data as rows and columns, and the Page Frame Control, which defines global characteristics of the form page, such as border style and positioning. To create a visual class, you select New Class from the File menu and designate the built-in class as the base class.

Upsizing to Client/Server

Visual FoxPro will not disappoint those who are making the transition to client/server systems. It provides access to database servers with persistent application-level connections. You use these connections by creating remote views on the FoxPro database container, or by using transient connections created at run time. Visual FoxPro uses Microsoft's ODBC (Open Database Connectivity) exclusively. Fortunately, ODBC is new and improved with 32-bit OLE 2.0.

To create a customized connection to a server, you must use the Connection Designer. The resulting database server connection is really part of the database. It provides information to the application about how to access data that resides on a remote database server. For each connection, you can specify the data source, user ID, and password, as well as other information required for your particular server. With Visual FoxPro, you can also configure connections for asynchronous processes or batch processes, and you can specify how long it takes to time-out a database connection.

Tricks of a Sly Fox

Another feature of Visual FoxPro that you may find handy in these days of 32-bit OSes is its ability to run itself or its applications in 16- or 32-bit environments. Visual FoxPro is already set up to take full advantage of Windows 95 when it finally ships. This means that the current version will run on Windows 95, and that Microsoft will offer a Win32 version of Visual FoxPro, ensuring that Visual FoxPro can run in 32-bit mode under Windows 95. Visual FoxPro also works with Windows NT, Windows 3.1, and Windows for Workgroups 3.1.

In true Microsoft tradition, Visual FoxPro provides Wizards to help developers or novice users create tables, forms, reports, and queries, as well as interface with other Microsoft products like Word for Windows and Excel. For example, the Form Wizard helps you create a date-entry form for a single table.

The most helpful Wizard for the client/server transition is Visual FoxPro's Upsizing Wizard, which creates a Microsoft SQL Server version of a Visual FoxPro database, thus saving the hours it would take to do the migration by hand. However, it would have been nice to include other popular database servers such as Sybase System 10. *continued*

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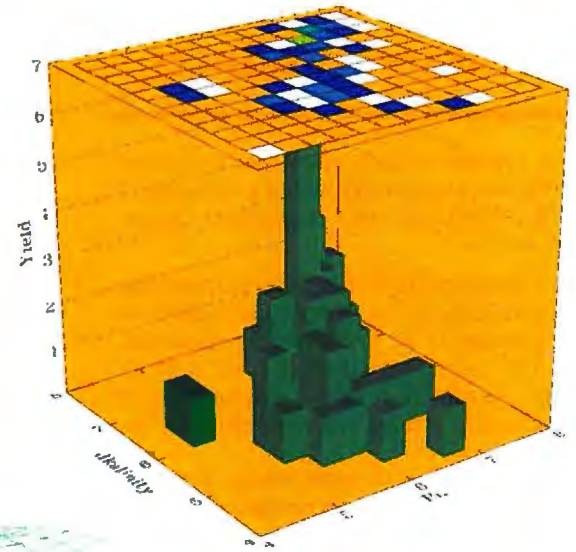

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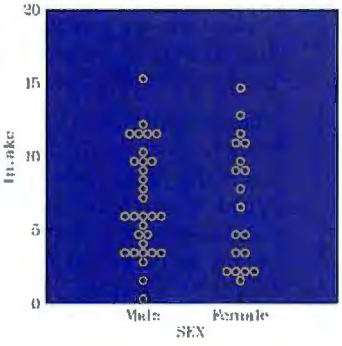

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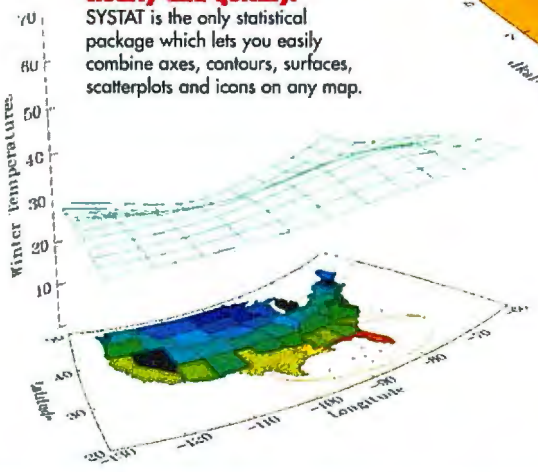

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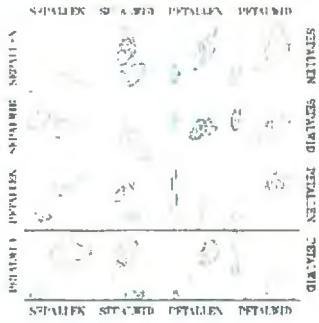

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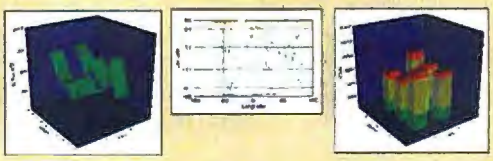

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Fox in the Henhouse

Clearly, Visual FoxPro will continue to provide a home for existing FoxPro applications, and most developers who followed FoxPro when Microsoft acquired it from Fox Software will continue on to Visual FoxPro. However, many may have to go to Microsoft University to completely understand how to take full advantage of the new features that Visual FoxPro provides. They're moving from a procedural to an event-driven programming model, and the new programming environment is complex.

The advanced, object-oriented event-driven approach to development is unique in the desktop database world, but it is par for the course for the existing client/server development tools against which Visual FoxPro is also competing. Microsoft also has a few kinks to work out of the software. When comparing Visual FoxPro to the current line of popular client/server development tools, you'll find that the database server connectivity is awkward (for example, it lacks native driver support). In addition, Visual FoxPro does not provide an advanced data dictionary or integrity features, and the code-generation facility is limiting. For instance, Visual FoxPro does not generate Xbase code for forms; this capability was sacrificed to achieve better performance, according to Microsoft.

If you look at where FoxPro has been, and where it's trying to go, Visual FoxPro is a move in the right direction. The programming model promotes and facilitates application object reuse, and Visual FoxPro greatly improves on its ability to communicate with database servers, which finally makes it a true client/server warrior.

Visual FoxPro provides a scalable environment that can be used to create simple, single-user applications as well as workgroup client/server applications that support critical business processes. If you're looking for a database that does it all, Visual FoxPro 3.0 should be on your list. ■

David S. Linthicum is a technical manager with EDS in Falls Church, Virginia. You can reach him at 70742.3165@compuserve.com or on BIX c/o "editors."

Product Information

Visual FoxPro 3.0
Standard Edition $199
Professional Edition. $495

Microsoft Corp.
Redmond, WA
(800) 426-9400
(206) 882-8080
fax: (206) 635-6100
Circle 1144 on Inquiry Card.

The Matrox Triple Threat

Matrox's Millennium PCI graphics card speeds up Windows displays, 3-D animations, video playback, and makes CAD applications fun again

GREG LOVERIA

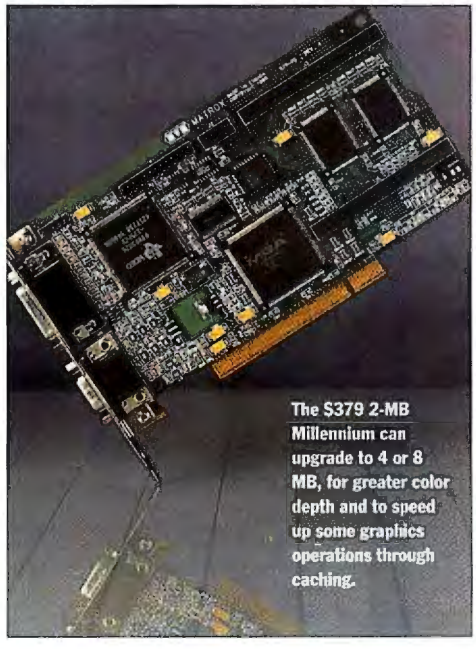
The Matrox MGA Millennium is a blisteringly fast, five-star Windows accelerator, even if you don't need its 3-D graphics and video playback acceleration. The $379 half-slot PCI (Peripheral Component Interconnect) card ships with 2 MB of Samsung's fast WRAM (Window RAM). WRAM is dual-ported like video memory for high graphics bandwidth, but it's faster—particularly with text and fill operations—and less expensive.

The 2-MB Millennium supports 24-bit color at 800- by 600-pixel resolution, 16-bit color at 1152- by 882-pixel resolution, and 8-bit color at 1024- by 768-pixel and 1600- by 1200-pixel resolutions. The 200-MHz TVP3026 RAMDAC supports vertical refresh rates of as high as 85 Hz at 1600- by 1200-pixel resolution. You can expand on-board WRAM to 4 or 8 MB with daughterboards ($219 for 2 MB, or $569 for 6 MB), increasing color depths to 24 bits at 1152- by 882-pixel and 1600- by 1200-pixel resolutions, respectively.

We tested a PC version; versions for PCI Power Macs and other PowerPC systems should be available soon. Matrox drivers support Windows 3.1, 3.11, NT, and 95; MicroStation 5.0; and DOS/Windows drivers for AutoCAD 12 and 13. OS/2 Warp drivers should be available by the time you read this.

Using Matrox's MGA-2064W graphics chip and WRAM, the Millennium is faster at 2-D and 3-D graphics acceleration than the MGA Impression Plus board it replaces. The 2064W also adds video acceleration to the mix. With hardware pixel scaling and color-space conversion, it smooths playback and color dithering of Microsoft/Intel DCI-compliant (Display Control Interface) video streams from Video for Windows 1.1, Indeo, and CinePak codecs as well as non-DCI QuickTime video.

Matrox's 2064W drivers interface directly to such 3-D APIs as Microsoft Reality Lab, Microsoft OpenGL, Intel 3DR, Criterion RenderWare, Ithaca Hoops, and Apple QuickDraw 3D. With trueSpace 2.0 from Caligari, a Windows-based 3-D modeling and animation application that incorporates both 3DR and RenderWare APIs, we found that the Millennium enables real-time model rendering.



The $379 2-MB Millennium can upgrade to 4 or 8 MB, for greater color depth and to speed up some graphics operations through caching.

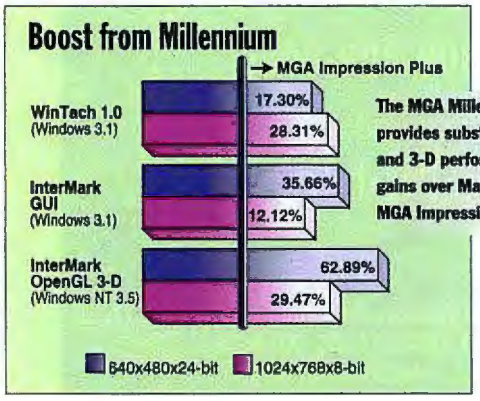
DAVID SHOPPER © 1995

Install and Test

Adapter and driver installation is easy. The Millennium has only two DIP switches. One disables on-board VGA circuitry for dual-display CAD environments; the second allows EPROM reprogramming for BIOS updates. Matrox's PowerDesk utilities let you change resolution and color depth on-the-fly under Windows 3.1 and enable the adapter's real-time hardware zoom features, which are great for pixel-level image editing. Under NT, you must change resolutions by installing new drivers and rebooting the system.

Matrox's DynaView 2D drivers for AutoCAD, however, work under both Windows 3.1 and NT to provide real-time spyglass and bird's-eye zoom functions, which are invaluable when you're working on large, detailed drawings. As tested with AutoCAD 12 and 13 for Windows, the DynaView 3D program allows fluid, real-time *x*, *y*, *z* axis rotations and walk-throughs of Gouraud-shaded 3-D models.

We compared the Millennium against its capable predecessor, the MGA Impression Plus, running 2-MB cards in the same Micron 120-MHz Pentium system (see the figure). To test 2-D graphics performance under Windows 3.1, we used the NSTL InterMark tests and Texas Instruments' WinTach 1.0, which mixes CAD vector draws, font caching, spreadsheet scrolls, and paint fills. The Millennium beat the Impression Plus handily (with similar results under Windows NT 3.5). Some individual operations sped up little; others sped up a great deal. InterMark's OpenGL tests also showed strong 3-D improvement for the Millennium. The Millennium hastens video playback, although it dropped occasional frames with CinePak at two-times resolution and 24-bit color.



Product Information

MGA Millennium...$379 (with 2 MB of WRAM)
Matrox Graphics, Inc.
Dorval, Quebec
Canada
(800) 361-1408
(514) 969-6320
fax: (514) 969-6363
Circle 1239 on Inquiry Card.

At $379, you can afford to improve your overall graphics performance, even if you're not into 3-D animation, digital video, or CAD applications. But if your needs run the gamut of those applications, the Millennium is a real bargain. ■

Greg Loveria writes and consults on animation, imaging, and 3-D graphics from Binghamton, New York. You can reach him on the Internet at gloveria@spectra.net.

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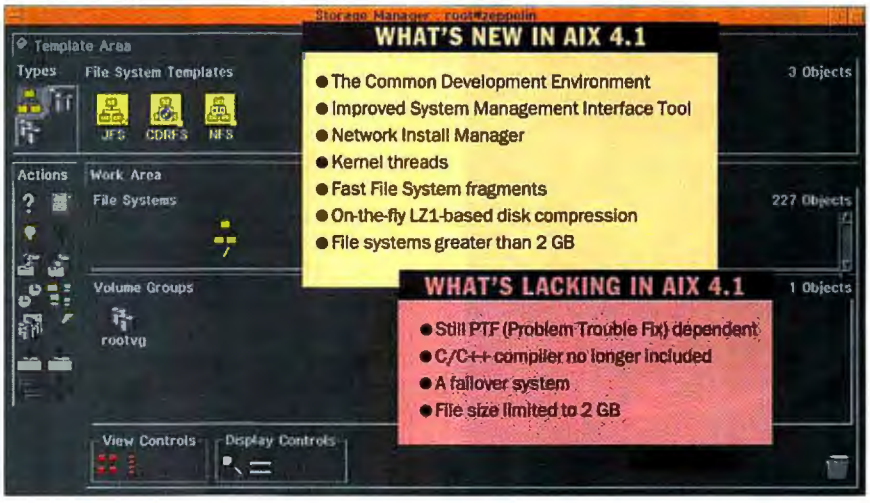
Unix with No Excuses

IBM's AIX 4.1 finally becomes a full-throttle Unix with CDE, kernel threads, fragments, and dynamic kernel extensions

MARC PAWLIGER

When IBM's version of Unix was first released in 1990, Unix purists claimed AIX stood for "Ain't Unix." Many "AIXisms" made AIX look quite different from other existing Unix releases. And in the Unix industry, "quite different" usually translates to "yet-another-thing-I-have-to-learn" for developers and administrators.

Over time, AIX in its evolutionary version 3.2 and newest version 4.1 has come to stand shoulder to shoulder with the other Unixes in market acceptance, embracing historical strengths, emerging standards, and technological innovations.



The VSM (Visual System Manager) is an extension of the CDE environment. VSM is a set of tools that lets you view installed products, hardware, and user accounts using an "object oriented" visual metaphor. The storage manager tool shown enables easy control of logical volumes, volume groups, and file systems.

Up Front

IBM made usability a priority for AIX 4.1, and it shows. The CDE (Common Desktop Environment, being jointly developed and supported by IBM, Sun, Novell, and HP) is now part of the AIX X Window System package. Familiar for some time to HP users in a slightly different form, the CDE makes Unix a whole lot easier to explore.

AIX expands the stock CDE environment with other tools such as the VSM (Visual System Manager) and the AIXWindows Customizing tool. VSM is a set of tools that lets you view installed products and hardware and user accounts from an object-oriented visual metaphor. The Customizing tool automates the difficult task of setting up and customizing GUI programs.

In the PC space, AIX utilities can read and write DOS-format floppy disks, and the optional Wabi (Windows Application Binary Interface; see "A Less Wobbly Wabi," July BYTE) environment runs Windows applications under AIX. SoftWindows, another third-party utility, can emulate an entire PC in software for additional support of PC applications. NetWare file services are also available.

AIX includes all the standard Unix tools: the Bourne, Korn, and C shells. AIX also ships the BSD versions of most tools when they differ from their System V Unix counterparts. Where possible, they merge the two together. For example, the `ps` command will act like the System V `ps` when given options preceded by a hyphen, while it will act like the BSD `ps` when given options without a hyphen, since, historically, that is how the two different commands were invoked on those systems.

The Secret of NIM

Version 4.1 introduces the NIM (Network Install Manager) for doing network installation as part of the server bundle. With it, you set up a NIM master machine that contains the filesets and bundles you want to install on NIM client machines. The master can install all the various kinds of AIX installations, including stand-alone and "diskless" installations that boot from remote servers. You can set up "canned" configurations for all the client machines, or a client machine can have its own specific configuration on the master.

Modern Unix systems typically require numerous patches to keep them up and running. Frequently, applying one patch causes another one to break, requiring yet another patch to fix the new problem. AIX 3.2 attempted to stem this tide by packaging each patch or PTF (Problem Trouble Fix) along with all the other patches on which the original patch depended. This was a disaster. While ensuring the integrity of the system, it wove a complex web of "corequisite and prerequisite" PTFs for each and every fix. AIX 4.1 limits the codependency of a PTF to a single release and fix level of a fileset, instead of to the presence of other PTFs.

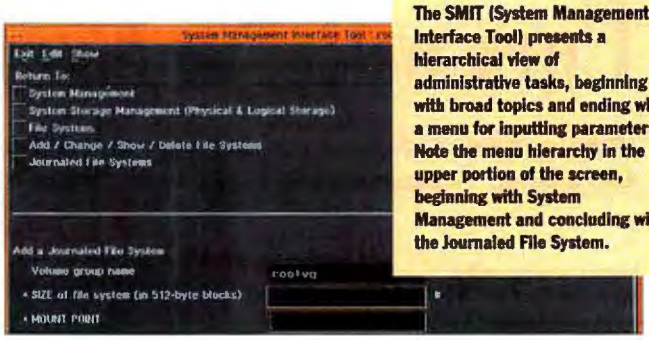
SMIT Happens

At the heart of AIX administration is the SMIT (System Management Interface Tool). It comes in GUI- and terminal-based versions, so you can run it remotely from an X machine or on a dumb terminal. SMIT presents a hierarchical view of administrative tasks, starting at the top with broad topics like Software Installation and Management, System Storage Management, and Communications Applications and Services.

SMIT calls one of about 100 different commands to do the work. It generates a commented log of the executed commands to use as a shell script or as an example of how to run the commands without SMIT's overhead.

AIX requires the same kinds of configuration necessary to get any Unix machine on the network. It supports automount, NIS+, NFS, and TCP/IP—all of which you can set up through SMIT—for straightforward network configuration. SMIT does not support more complex configurations such as automount maps and DNS (Domain Name Service), due to their free-form, more com-

plex nature. You configure these by editing the appropriate `rc` start-up files as on most systems.



The SMIT (System Management Interface Tool) presents a hierarchical view of administrative tasks, beginning with broad topics and ending with a menu for inputting parameters. Note the menu hierarchy in the upper portion of the screen, beginning with System Management and concluding with the Journaled File System.

The new PDT (Performance Diagnostic Tool) tracks device trends and resource usage and recommends ways to resolve conflicts. The `lockstat` tool determines whether locks are causing system slowdowns. The `trace` tool monitors the system activity of individual applications. Other tools like `filemon`, `fileplace`, and `svmon` show file and memory activity. The PTX Performance Toolbox combines the monitoring capabilities of many of these tools under a single umbrella application, complete with a configurable GUI performance console, and record and playback facilities. PTX also includes SNMP MIB (Management Information Base) support for monitoring remote machines.

Threads in AIX

The AIX kernel has many of the features you would expect in a third-generation operating system—scalability, Posix standard threads, logical volume management, frags, and on-the-fly disk compression. AIX 3.2 and earlier versions contained many features just now beginning to appear in other Unixes, such as a pageable and preemptive kernel, dynamic kernel extensions, and process threads (for more detail on the AIX kernel, see the text box "A Dynamic Kernel" on page 128).

Threading of processes lets the kernel make better use of the available hardware. AIX 3.2 added the ability to maintain threads within each process. At that time, IBM also adopted the DCE (Distributed Computing Environment) model of "user level threads" as the API. In this scheme, a single process maintained multiple threads. However, the kernel still viewed the main process and all its threads as a single entity and scheduled them as a unit. This would sometimes cause the scheduler to improperly prioritize processes that had both CPU and I/O intensive threads.

AIX 4.1 introduces kernel threads with an API defined in a draft Posix standard. Kernel threads differ from user threads in that the kernel recognizes them as individual units and can schedule and reschedule them properly.

The kernel threading model lets AIX allocate threads much more easily to idle processors to use hardware more efficiently. Until AIX 4.1, all generally available RS/6000 hardware was single processor, and the kernel, while preemptive, was not especially suited for multiple processors. To support SMP (symmetric multiprocessor) machines, AIX 4.1 breaks down the AIX version 3 concept of kernel-wide locks into nonrecursive spin locks (or simple locks) and more heavyweight recursive locks (or complex locks). With version 4.1, IBM has

A Surfer's Guide to AIX Resources

- **http://www.austin.ibm.com:** AIX news, technical papers, and a comprehensive and searchable database of AIX tips, Q&As, and links to other Internet AIX repositories.
- **http://www.ibm.com:** IBM's main WWW site, product announcements, and prices.
- **comp.unix.aix newsgroup:** home to a number of AIX gurus and newcomers alike, an excellent source of advice and conversation.
- **aixpdslib.seas.ucla.edu:** an anonymous FTP site with huge amounts of public domain tools and applications in both binary and source code form.
- The AIX FAQ (Frequently Asked Questions) file is available on the Internet at **ftp://rtfm.mit.edu:/pub/usenet/news.answers/aix-faq/part1 or http://www.cis.ohio-state.edu/hypertext/faq/usenet/aix-faq/top.html.**
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- IBM's ***/AIXtra:*** AIX for geeks.
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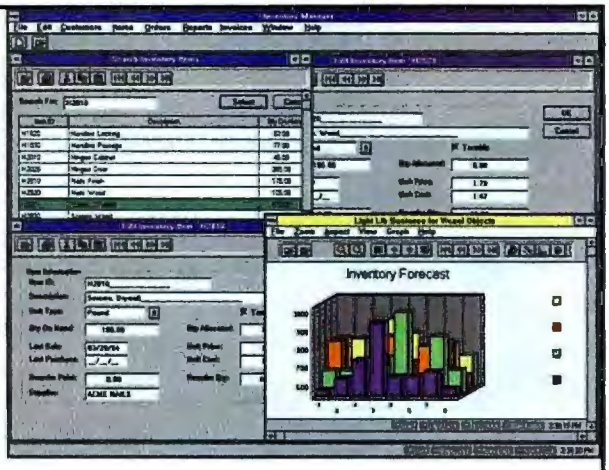

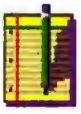

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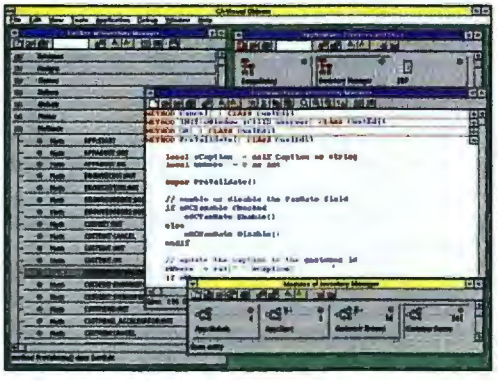

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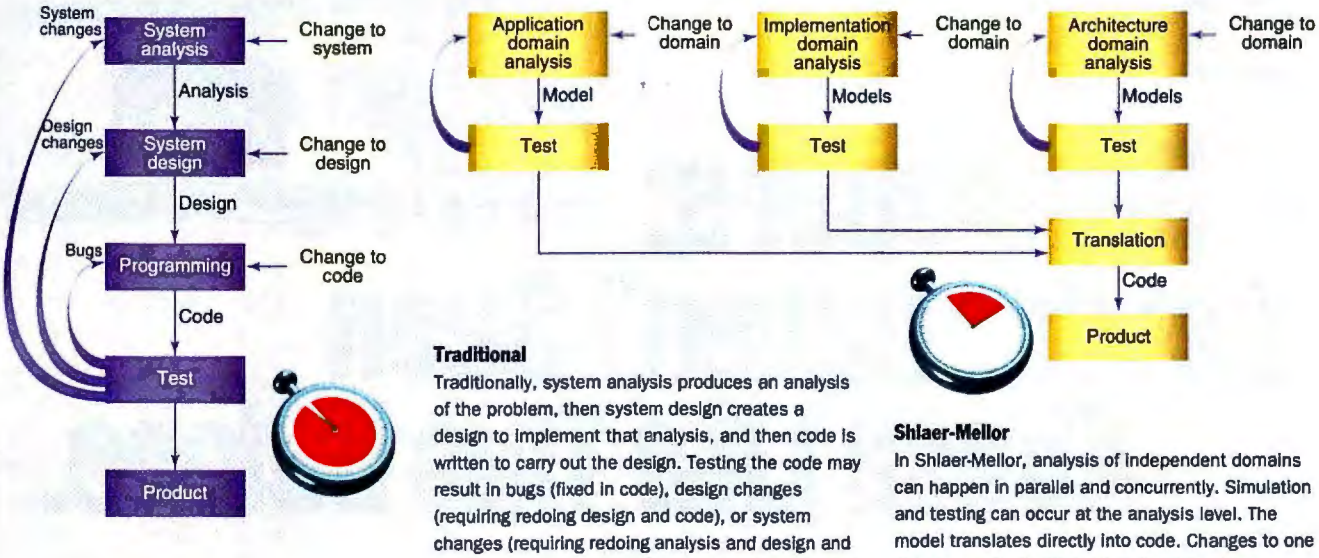
Handling Changes: Traditional vs. Shlaer-Mellor



Traditional
Traditionally, system analysis produces an analysis of the problem, then system design creates a design to implement that analysis, and then code is written to carry out the design. Testing the code may result in bugs (fixed in code), design changes (requiring redoing design and code), or system changes (requiring redoing analysis and design and code). Changes at any level require work and testing at all lower levels. Often, only the code is changed, and analysis and design are never updated.

Shlaer-Mellor
In Shlaer-Mellor, analysis of independent domains can happen in parallel and concurrently. Simulation and testing can occur at the analysis level. The model translates directly into code. Changes to one domain need not affect other domains. Since change at the analysis level translates directly into code, code and analysis stay in sync.

of milestones. Simulation and testing of the high-level analysis itself reduces the errors seen at the code level.

Defending against management panic usually includes pointing out the chosen method's historical success stories, gleaned from consultants, books, and published case histories. High-priced consultants can be very cost-effective if they can save an endangered multimillion-dollar project from the chopping block.

As if all this weren't enough, Connolly observed that scheduling and planning—requiring insights only available through experience—can be a nightmare for administrators unpracticed in OO methods. Consultants can help by estimating such factors as the number of objects based on specifications, how much time each phase should take, when to review, and analysis rules of thumb. Project Technology (founded by Sally Shlaer and Steven J. Mellor) provides consulting services, training, and books. Fontana has found that such knowledgeable and experienced consultants, like guides through the wilderness, can help you tell "the lettuce from the poison ivy." Connolly, too, felt that consultants and training services were almost essential in helping managers deal with schedules, plan team assignments, and select appropriate tools. Trinh found that Project Technology consultants offered helpful suggestions, especially with part of the analysis that seemed open to the risk of errors. The consultants did underestimate the time required for certain activities, probably because they did not fully appreciate the extreme complexity of the switch.

GTE declined to talk money, but one analyst experienced with OO development suggested a ballpark price tag of $5 million to $10 million for the initial 18 months of the project. In an OO project, you can estimate the number of objects required by the number of distinct entities—both tangible, like airplanes or invoices, and intangible, like roles or events—the project must address. These entities can range from a handful, for projects far smaller than GTE's, to several hundred or even several thousand for extremely complex problems. Information from Project Technology suggests you should allow one person/month (at about $9000) per object. Naturally, your mileage may vary, depending on the experience and pay-rate of the developers.

The Future Course

Despite encountering many cultural and technical problems, the GTE project is over half done and still on track, both Connolly and Fontana agree, with productivity at least as good as it would be using traditional methods. Based on projects by experienced colleagues, Fontana feels that, had there not been so many new technologies for developers to absorb, even higher productivity rates (and lower costs and faster deliveries) probably would have occurred. In this project, the payoff will be faster deliveries and simpler development for subsequent releases—a real bonus of successful OOP. ■

Edmund X. DeJesus is a BYTE senior editor. He has a Ph.D. in physics and has been a professional programmer for more than 15 years. You can reach him on the Internet at edejesus@bix.com.

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rearchitected many of the main kernel functions to both be more parallel and use the lighter weight locks when possible, making version 4.1 a robust SMP OS.

Turn the Page

AIX developers have done extensive work with paging and file I/O. AIX 4.1 combines aspects of read-ahead and write-behind, and fast memory I/O using file buffers. It implicitly maps memory files as they are used for its fast I/O implementation. Once a page of a file is read into RAM it can be accessed quickly.

To maintain efficient paging behavior, AIX maintains "file pages" and "computational (or data) pages" in RAM and treats them differently when deciding which pages to swap out. It keeps count of whether a page fault was on a new page, was a "repage" of the same page, or was a fault on a read-only page, such as program code. It uses these counts partially to determine which pages to swap in the case of a page fault.

The AIX VMM (Virtual Memory Manager) has a number of tunable parameters that determine at what level the system is excessively repaging, or thrashing. Once the VMM detects a thrash condition, it suspends some processes artificially and prevents the creation of new processes for a time to give existing processes enough continuous access to RAM pages to complete. The `vmtune` command and the `schedtune` command query and set the system thrashing thresholds. You can also use these commands to change how the scheduler acts in the presence of CPU or I/O intensive processes.

Volume Management

One highly praised new feature in AIX 4.1 is the LVM (Logical Volume Manager). Unlike most Unixes, AIX doesn't treat separate disks, or PVs (Physical Volumes), as separate entities but treats them in units called Volume Groups instead. You can create a file system, or LV (Logical Volume), which spans multiple disks. In addition, the LVM supports file system expansion on the fly, eliminating the need to back up, reformat, and restore a file system to enlarge it. On AIX the `chfs` command changes the file system size, even while it's in active use. The OSF/1 Unix system adopted parts of the LVM.

The AIX LVM breaks the disk into 2-MB or 4-MB chunks called Physical Partitions and assigns each one to an LV that the system can use as a file system or swap space. AIX 3.1 and 3.2 native file systems divide each Physical Partition into a block

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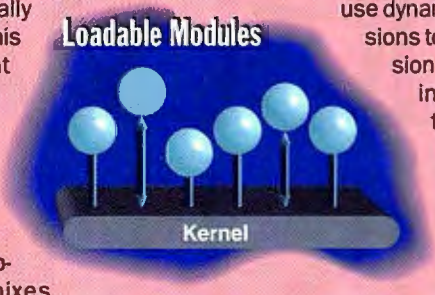
A Dynamic Kernel

The AIX kernel has many of the features you would expect in a third-generation operating system—scalability, Posix standard threads, logical volume management, frags, and on-the-fly disk compression. AIX 3.2 and earlier versions contained many features just now beginning to appear in other Unixes, such as a pageable and preemptive kernel, dynamic kernel extensions, and process threads.

Most Unix kernels run completely in RAM. This scheme avoids deadlocking the system in the event that the parts of the kernel responsible for swapping are themselves swapped out to disk. An entirely RAM-resident kernel has the disadvantage of consuming real memory for kernel tables that keep track of open files and devices, process states, and so forth.

For example, support of more simultaneous tasks ('processes' in Unix) than allowed by the default kernel configuration required you to edit a configuration file and recompile or regenerate the kernel. The system now supported more processes, but the kernel was always using the memory required for the bigger process table regardless of how many processes you were actually using. AIX makes all these tables very large in size to begin with (a process table is able to support 131,072 processes) but doesn't allocate the memory for them until it is needed, making the kernel's RAM footprint more in line with what it is actually being asked to do. This scalability is evident in many places throughout AIX. A pageable kernel is now a standard tool in the Unix kernel developer's arsenal and is also supported by other Unixes such as UnixWare and Solaris.



AIX makes adding new kernel functionality easier than most Unixes. Usually a developer who wants to extend kernel functionality has to regenerate the kernel, adding their own object code to the list of objects linked together to produce the new kernel. Since each version of Unix has its own API to add new functions, this is a time-consuming and arcane process. AIX eases this task by supporting dynamic kernel extensions. This mechanism provides a single API for developers to add or remove new object code to an already running kernel. AIX documents the structures and calls necessary for a developer to create a kernel extension, and it gives sample code for a number of different types of extensions.

AIX was one of the earliest Unixes to use dynamic kernel extensions to introduce a version of Plug and Play into the workstation world. While many Unixes will recognize a new device on the first boot-up after installation, AIX will go an extra step and configure the device for immediate use. AIX also keeps track of devices and their configuration in the ODM (object data manager). This makes it possible for AIX to issue a warning boot-up if it can't find a device it has previously seen. If you had removed the device, you can run the `diag` command to configure AIX to remove the device from the ODM. If the device was powered off or unplugged during boot, you can power on the device and run the `cfgmgr` command which will rediscover the device and add or recreate a /dev entry.

size of 4 KB. This makes it easy to implement the implicit file mapping scheme, since 4 KB is also the hardware's RAM page size. But this wastes an incredible amount of disk space since all files, no matter how small, take up at least 4 KB of disk. AIX 4.1 instead implements frags, or fragments, an idea first used in Unix by the FFS (Fast File System) on BSD Unix. Frags allow files to occupy partial disk blocks, resulting in much better disk space use at the cost of slightly less efficient file I/O and higher disk space overhead. AIX 4.1 lets you set the frag size at file-system creation time.

Since version 3.1, AIX has featured a JFS (Journaled File System), implemented as a way to combat corrupt Unix file systems caused by unexpected power outages or system crashes. A JFS file system uses a small companion LV called a JFS Log as a transaction record of disk operations on file system *metadata*, or disk space devoted to housekeeping and file system consistency. So the next time you mount the file system, any disk operations that were "in flight" but not completed will be backed out so the file system remains consistent. You may still lose data that was buffered but not written at the time of the crash, but JFS's purpose was to maintain disk consistency, not fault tolerance. Other products like HACMP (High Availability Cluster Multiprocessing) are available through third parties for applications that demand constant availability.

AIX fosters a real love-hate relationship with the Unix community. Many users love the hardware AIX runs on, but they don't like AIX. It's a burden they have to bear. Others look at AIX and see all the new improvements as a leap forward for IBM. In the end, the marketplace will make the decision, but it sure looks like the latest generation of AIX is a winner. ■

Product Information

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Marc Pawliger is an engineer on the Unix Photoshop team at Adobe Systems. From 1989 to 1993 he worked at IBM on the first release of InfoExplorer and on porting NextStep to AIX. You can reach him on the Internet at pawliger@ adobe.com or on BIX c/o "editors."

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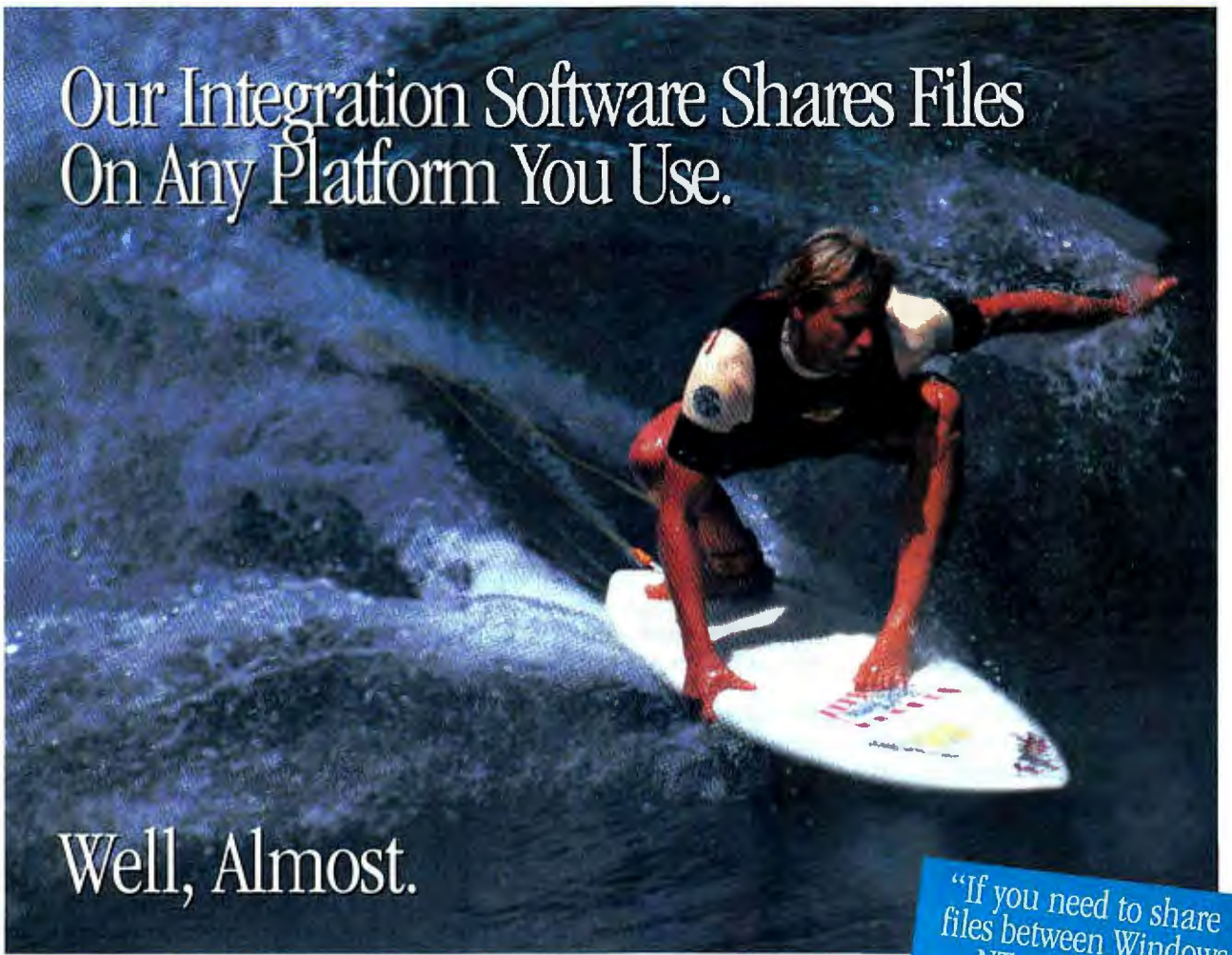

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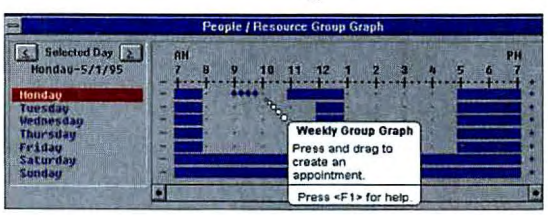
If you've never had to coordinate meeting schedules for a group of busy professionals, consider yourself blessed. Finding open time slots for a large group and shuffling schedules to make it all happen can frustrate even the most level-headed organizer. Group Schedulers automate the tedious task by sharing individual schedules, finding common open times, and securing commitments via E-mail confirmations.

NSTL evaluates seven of the most popular group schedulers for Windows. Dedicated tools for maintaining personal and shared calendars, these schedulers run on Novell Netware 4.1, and integrate meeting notifications and confirmations across a proprietary messaging system or through third-party E-mail architecture.



A rich feature set makes CaLANdar NSTL's top-rated group scheduler.

The Cream

Although most of the programs presented here handle group scheduling with relative aplomb, *Microsystems CaLANdar* earns NSTL's top ranking. It scored highest in both ease of learning and versatility, high in ease of use, near perfect in concurrency (a measure of how well a program avoids file-sharing violations during schedule updating), and above average in overall quality.

If your company plans to simultaneously deploy both an E-mail system and group scheduling, *GroupWise* is clearly the product of choice. Both its scheduling and E-mail capabilities are well integrated, and GroupWise takes good advantage of the Windows interface.

For existing cc:Mail or Lotus Notes installations, *Lotus Organizer* makes sense. With an intuitive interface that helps manage personal information, it caters to the scheduling needs of individuals. But it lacks a robust, integrated group module that would make it a better scheduler for large groups.

Do you have a large installed base of Macintoshes? *Meeting Maker XP* is the only group scheduler that runs both the client and server on a Macintosh.

Of E-Mail and Networks

All seven schedulers support Novell NetWare, Banyan Vines, LANtastic, IBM PC LAN, and Microsoft LAN Manager networks. CaLANdar, Meeting Maker XP, Microsoft Schedule+, and GroupWise also support AppleShare networks. All seven provide some WAN support, although they may require additional modules or special versions of the program in order to do so.

Both Futurus Team Combo and GroupWise bundle their own E-mail components, but gateway modules are available for transporting messages through a variety of other E-mail systems. For instance, GroupWise has nine E-mail gateways, while Team Combo offers only two.

OVERVIEW

KEY
▲ Good
■ Fair
▼ Unacceptable

	VERSION	PERFORMANCE	VERSATILITY	EASE OF LEARNING	EASE OF USE	REQUIRED MEMORY	PRICE
CaLANdar	3.0a	▲	▲	▲	■	8 MB	$495*
GroupWise	4.1	■	▲	▲	▲	4 MB	$695
Lotus Organizer	3.0	■	▲	■	■	4 MB	$495
Meeting Maker XP	4.1	■	▲	▲	▲	4 MB	$790*
OnTime	3.0	■	▲	■	■	4 MB	$828*
Microsoft Schedule+	4.1	■	▲	▲	▲	4 MB	$495
Futurus Team Combo	3.0	■	▲	■	■	4 MB	$649

*10-user price. All other prices are for 5 users.

Campbell Services OnTime, Version 1.54

OnTime's interface is not as slick as some of the other schedulers, but its screen design is logical, and its documentation well-designed. With its handy drag-and-drop and dialog box support, OnTime handles reschedulings intelligently. Every change you enter sends a new meeting notice; responding to the final notice accepts all earlier versions of the notice. While this technique has the potential to increase mailbox clutter, it also serves to minimize confusion, since the recipient does not need to respond to multiple meeting invitations for one meeting.

OnTime is the only program here that lacks a dedicated resource-handling option to schedule rooms and equipment. You can work around this limitation by setting up resources as separate user accounts. OnTime offers basic to-do list functions, but it doesn't address the management of group tasks very well. Along with cumbersome data exchange between the to-do list and calendar, the program does not support right-click access to shortcut menus.

OnTime comes equipped with a strong administration feature set, but its task management and querying features are weak. Network support is substandard in comparison to some of the other schedulers. While it's short of comprehensive utilities and group applets features, OnTime generates informative, well formatted reports.

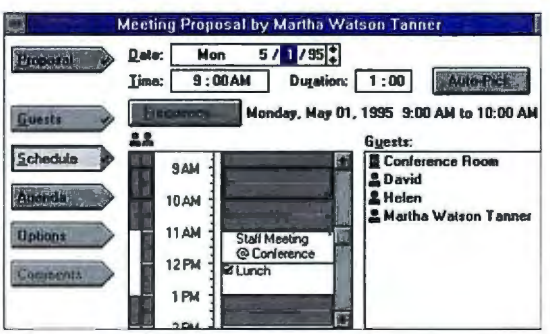
Futurus Team Combo, Version 3.52

Futurus Team Combo displays appointments, a monthly calendar, and a to-do list in separate movable windows. You can resize the to-do list, but not the appointment calendar window. Oddly, the monthly calendar occupies a disproportionately large area of the screen, and only resizes larger, not smaller. Team Combo provides program buttons

and context-sensitive menus activated by the right mouse button, but no drag-and-drop capabilities within the scheduler. It's also the only program here that uses spindial fields instead of a graphical time line, so we couldn't set time parameters by simply dragging the mouse.

Team Combo's interface attempts to tie various applications together but falls short. Accessing the application from within one another isn't as smooth as the other schedulers. NSTL testers experienced trouble trying to change an appointment. The manual suggests a cut-and-paste procedure, but it failed to work.

Team Combo provides good support for E-mail, security, utilities, and group applets (chat, group address book, in/out boards, phone message, and group notepad), but only average support for administration, remote, and network features. Because it offers no provisions for a group report with side-by-side user information (such as a report with free/busy times), presentation quality could only muster an average rating in most of Team Combo's reports. Weak data interchange is the product's greatest shortcoming.



Meeting Maker XP has strong remote features and is the best choice for Macintosh sites.

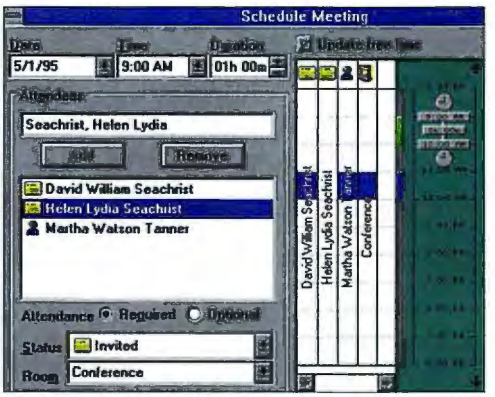
In spite of the many improvements that Futurus has made to Team Combo since NSTL last evaluated it, the scheduler still doesn't manage to stand up very well against the competition.

Lotus Organizer, Version 2.0

Lotus Organizer simplifies scheduling with a three-ring binder metaphor. Tabs provide access to different program modules (calendar, planner, to-do list, addresses, and so on).

To mark tasks complete, just click the box next to an item on the to-do list. Category and cost coding help tie tasks to projects. You can drag-and-drop tasks between to-do lists and the calendar, and a show-through option allows the to-do items to appear in the daily calendar.

Organizer also makes it easy to respond to meetings. You can set the program to automatically process certain types of events, either as a chairperson or as an attendee. To implement this functionality, Organizer requires either cc:Mail or Lotus Notes.



Lotus Organizer's intuitive interface simplifies scheduling.

Lotus Organizer produces stunning reports and delivers a full complement of report-enhancement options. The reports stand out for their informational content and presentation quality. The program's superior quality score would have been even higher, if it weren't for a couple of problems. It does not offer substantial group report capabilities, and you can't present side-by-side user information on a single page.

Shortcomings aside, Lotus Organizer is a solid scheduler, and it remains our first choice for personal scheduling.

Microsoft Schedule +, Version 1.0

Schedule+ easily schedules recurring personal meetings, but it is the only program presented here that does not allow the scheduling of recurring group meetings. With excellent tools for scheduling both groups and resources for meetings, Schedule+ also offers both drag-and-drop and dialog boxes for rescheduling. On the downside, drag-and-drop only works between different times, not between different days.

Schedule+ is easy to use for personal tasks, but group tasks require setting up a shared calendar, which is not as convenient as having the ability to send tasks. Although you can't drag-and-drop tasks between the to-do list and calendar, you can copy them. Right-mouse-button menus are also noticeably absent.

For remote access, Schedule+ relies on remote connection services provided by a network server, for example, Microsoft's RAS (Remote Access Services). Just like its rival, Meeting Maker XP, Schedule+ supports automatic synchronization of files.

Schedule+ produces excellent presentation quality in its daily, weekly, and monthly reports, but it is the only scheduler here that can't generate trifold reports. Nor does it create a group report with side-by-side user information. And it offers minimal font options.

Schedule+ shows its age in this evaluation. Microsoft hasn't offered a major upgrade in three years, but the new Windows 95 version is due out in the early fall.

Microsystems Software CaLANdar, Version 3

CaLANdar is NSTL's top choice overall. It scored well in all the test categories, and highest in both ease of learning and versatility. CaLANdar lays out its display in a logical manner, with the appointment calendar on the left, tasks in the upper right-hand corner, and two monthly calendars in the lower right-hand corner of the screen. Its screen design also assists in performing routine scheduling tasks. Although the program lacks the rule-based scheduling mechanism available in GroupWise and Organizer, testers performed all tasks in the usability scenario with ease.

Along with bubble help and excellent documentation, the wealth of features found in CaLANdar also set it apart. It earned

New Features of Schedule+ for Win95

Schedule+ for Windows 95 addresses many of the shortcomings of the current version, including:

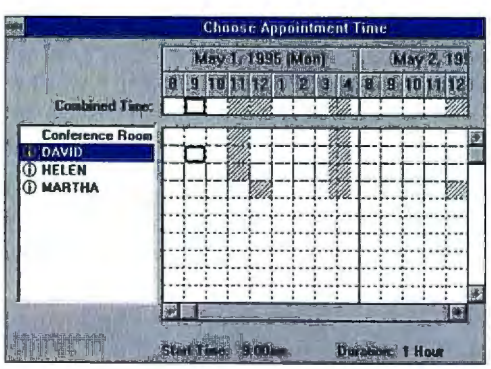
- **Right-mouse-click shortcut menus**
- **Tool bar, tool tips, and drag-and-drop capabilities between tasks and appointments**
- **Address module for tracking contact data**
- **Expanded print options, including trifold reports**
- **Direct integration with Timex Data Link watch for downloading appointments by holding the watch in front of your computer monitor**

SCHEDULING AND MESSAGING FEATURES

	CALANDAR	FUTURUS TEAM COMBO	LOTUS ORGANIZER	MEETING MAKER XP	MICROSOFT SCHEDULE+	GROUPWISE	ONTIME
SCHEDULE							
Sounds alarms	●	●	●	●	●	●	●
Alarms launch specified programs	●	●	●	○	○	●	●
Allows setting global lead time for alarms	●	●	○	●	●	●	○
Includes snooze delay	●	●	●	●	●	○	●
Allows attaching notes to appointments	●	●	●	●	●	●	●
CALENDARS							
Displays group busy times as time line bars	●	●	●	●	●	●	●
Views another user's calendar	●	●	●	●	●	●	●
Explicitly accounts for holidays	●	●	●	●	○	○	●
Lets administrator define workdays/hours	●	●	●	●	●	●	●
MEETINGS							
Finds first open time for all participants	●	●	●	●	●	●	●
Checks for conflicts	●	●	●	●	●	●	●
Requests confirmation of attendance	●	●	●	●	●	●	●
Alerts if response not received	○	○	○	○	○	●	○
Alerts if changes occur	●	●	●	●	●	●	●
Allows scheduling of resources	●	●	●	●	●	●	○
Supports groupwide scheduling of repetitive meetings	●	●	●	●	○	●	●
Restricts meeting searches by date range	●	○	●	○	○	●	○
QUERYING							
Supports appointment searching	●	●	●	●	●	●	●
Sorts appointments	○	○	○	●	○	●	○
Supports Boolean searches	○	○	●	○	○	●	○
Supports searching through notes							

● = yes; ○ = no Features not integral to the package are marked "no"

outstanding marks in task management, remote support, network support, security, and data interchange. The product's only weak spot is its querying features.



GroupWise delivers a consistent interface, a universal inbox, and an integrated E-mail system.

CaLANdar generates the best all-around group report, but limited font options lowered its output scores. Microsystems also offers remote software as an add-on module and a file-synchronization routine that you run manually.

GroupWise, Version 4.1

A solid integrated scheduler with excellent screen design, GroupWise provides a consistent interface and a universal inbox that receives E-mail, faxes, and meeting notices. It also offers convenient options that make it easy to change an appointment, manage to-do lists, and respond to group meetings.

GroupWise is the easiest to use when responding to meetings, letting you respond to notices from either the inbox or the calendar. The program also offers the most complete set of rules for the automatic processing of incoming messages. For example, you could decline all meeting invitations scheduled during your vacation. You also have the choice of responding to all instances or to just a single instance of recurring meetings.

GroupWise supports both drag-and-drop and dialog boxes for rescheduling appointments. During the rescheduling process, you can retract the original message to avoid a pile-up of notifications that concern the same meeting. GroupWise supports right-click shortcut menus and is the only program presented here that offers interactive help. Called Coaches, these items step you through procedures as you perform them.

GroupWise generates sharp, informative reports, with excellent presentation quality. However, options for enhancing output are limited in comparison to Organizer, Meeting Maker XP, and OnTime. Novell bundles a phone-message applet and group notepad with GroupWise.

The GroupWise client software supports a direct dial-up connection via a modem, but requires a dedicated message server and either GroupWise's Async or X.25 Gateway. You can choose which types of items are updated and deleted as part of a remote-session synchronization.

GroupWise performed strongest in the areas of group meetings and E-mail support features. It displays powerful task management, administration, network support, and data interchange. Query and reporting features are not GroupWise's strong suits.

On Technology Meeting Maker XP, Version 2.5

Meeting Maker XP's server software runs either as an NLM (NetWare Loadable Module) or on a Windows client. We didn't like Meeting Maker's default screen, but it was easy to position windows and to create a customized environment. The

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COMMUNICATION AND DATA INTERCHANGE FEATURES

	CALANDAR	FUTURUS TEAM COMBO	LOTUS ORGANIZER	MEETING MAKER XP	MICROSOFT SCHEDULE+	GROUPWISE	ONTIME
REMOTE SUPPORT							
Synchronizes remote and network calendars	●	●	●	●	●	●	●
Directly supports asynchronous remote operations	○	○	○	○	○	●	○
Allows remote viewing of free/busy time	●	○	○	●	●	○	●
Supports remote editing of appointments	●	●	○	●	●	●	●
NETWORK SUPPORT							
Novell NetWare	●	●	●	●	●	●	*
Banyan Vines	●	●	●	●	●	●	*
LANtastic	●	●	●	●	●	●	*
IBM PC LAN	●	●	●	●	●	●	*
Microsoft LAN Manager	●	●	●	●	●	●	*
AppleShare networks	●	○	○	●	●	●	○
Wide-area networks (WANs)	●	●	○	○	●	●	*
E-MAIL SYSTEMS							
Number of E-mail systems directly supported	8	1	2	3	3**	1	5
Number of E-mail gateways available	1	2	6	0	6	9	0
Number of standard messaging APIs supported	3	0	1	2	2	1	2
Direct support for Novell MHS	●	●	○	●	●	●	●
REPORTING							
Number of report templates	17	5	24	7	5	7	5
Supports custom reports	●	●	●	●	●	●	●
Print Rolodex-style information	●	●	●	●	●	●	●
DATA INTERCHANGE							
Supports OLE client and server	●	●	○	○	●	●	●
Network DDE links	●	●	●	○	●	●	●
Supports user-defined import/export formats	●	●	●	●	●	●	●
Supports personal digital assistants (PDAs)	●	●	○	●	●	●	●

● = yes; ○ = no * Novell NetWare and Banyan systems only **Supports any MAPI system

program lacks the handy context-sensitive menus activated through a right-mouse click, and provides only sparse drag-and-drop editing.

Meeting Maker XP shines with good support for group meetings, strong remote features, and average support for querying and task management. It lags behind in reporting features. By comparison, the other programs here presented more detailed information in their reports. For example, all the other programs print a miniature monthly calendar in their daily reports.

Meeting Maker's to-do list is a mixed bag of impressive features and a few shortcomings. The program notifies you when an assistant adds tasks to your to-do list, but it doesn't highlight overdue tasks. Meeting Maker intelligently processes appointment rescheduling, providing both drag-and-drop and dialog boxes for the task. The program only sends one meeting notice. Each additional change or reschedule entry updates the original notice, cutting down on mail clutter. Icons alongside the received message alert invitees of schedule changes.

Meeting Maker XP has the strongest support for Mac sites. With a native (as opposed to retrofitted) Macintosh interface, it's the only scheduler reviewed here that runs both the client and the server on a Mac. ■

Product Information

CaLANdar 3.00.06 . . . . . $495*
Microsystems Software Inc.
Framingham, MA
(508) 879-9000
Circle 1061 on Inquiry Card.

GroupWise 4.1 . . . . . $695
Novell Inc.
Orem, UT
(801) 226-6000
Circle 1062 on Inquiry Card.

Meeting Maker XP 2.5 . . . . . $790*
ON Technology Corp.
Cambridge, MA
(617) 374-1400
Circle 1063 on Inquiry Card.

OnTime 1.54 . . . . . $828*
Campbell Services Inc.
Southfield, MI
(810) 559-5955
Circle 1064 on Inquiry Card.

Lotus Organizer 2.0 . . . . . $495
Lotus Development Corp.
Cambridge, MA
(617) 577-8500
(800) 343-5414
Circle 1065 on Inquiry Card.

Microsoft Schedule+ 1.0 . . . . . $495
Microsoft Corp.
Redmond, WA
(206) 882-8080
Circle 1066 on Inquiry Card.

Team Combo 3.53 . . . . . $649
Futurus Corp.
Norcross, GA
(404) 242-7797
Circle 1067 on Inquiry Card.

*10-user price. All other prices are for 5 users.

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Portable: a notebook or subnotebook computer weighing 8.5 lbs. or less.

1 Do you plan to purchase a portable computer within the next 12 months? *(Choose one.)*

Definitely yes ..... ____1.
Maybe *(continue survey as if you plan to buy)* .... ____2.
No *(continue survey as if you plan to buy)* ..... ____3.
☐ Check here if you have purchased in the last six months

1A (If yes or maybe) Will this unit be paid for by yourself or by your employer?

Self (please go on to Question 2) ..... ____1.
Employer (please go to Question 1B) ..... ____2.

1B (If paid by employer) Approximately how many are employed by your company: *(Choose one.)*

1000 or more employees ..... ____1.
500-999 employees ..... ____2.
100-499 employees ..... ____3.
50-99 employees ..... ____4.
Fewer than 50 employees ..... ____5.
Uncertain ..... ____6.

2 Will you require CD-ROM with your next portable computer? *(Choose one.)*

Yes, internal CD-ROM, built into notebook ____1.
Yes, external CD-ROM, connected to port or docking station ..... ____2.
No ..... ____3.
Uncertain ..... ____4.

3 For the unit selected above in question 2, what weight would you be willing to accept? *(Choose one.)*

4.5 lbs. ..... ____1.
5.0 lbs. ..... ____2.
5.5 lbs. ..... ____3.
6.0 lbs ..... ____4.
6.5 lbs ..... ____5.
7.0 lbs. ..... ____6.
8 lbs. or more ..... ____7.

4 What type of processor will you require? *(Choose one.)*

Intel 486 SX/33 MHz ..... ____1.
Intel 486 DX2/50 MHz ..... ____2.
Cyrix DX2/50 MHz ..... ____3.
Cyrix DX2/66 MHz ..... ____4.
Cyrix DX2//80 MHz ..... ____5.
Intel 486 DX4/75MHz ..... ____6.
Intel 486 DX4/100 MHz ..... ____7.
486, unsure which version ..... ____8.
Intel Pentium 60 MHz ..... ____9.
Intel Pentium 75 MHz ..... ____10.
Intel Pentium 90 MHz ..... ____11.
Intel Pentium 100 MHz ..... ____12.
Intel Pentium 120 MHz ..... ____13.
Intel Pentium 150 MHz ..... ____14.
Intel Pentium, unsure which version ..... ____15.
AMD K5 ..... ____16.
Cyrix M1 ..... ____17.
Other ..... ____18.
Don't know ..... ____19.

4A What type of bus will you require?

PCI only ..... ____1.
ISA only ..... ____2.
Both PCI and ISA ..... ____3.
No preference ..... ____4.

5 Which screen will you require for your portable computer?

Screen type *(Choose one.)*
Monochrome ..... ____1.
Dual-scan color ..... ____2.
Active-matrix color ..... ____3.
Screen size *(Choose one.)*
8.4 diagonal ..... ____4.
9.4 inch diagonal ..... ____5.
10.4 inch diagonal ..... ____6.
11.4 inch diagonal ..... ____7.
12.4 inch diagonal ..... ____8.
Larger than 12.4 inch diagonal ..... ____9.

6 (If you require a color screen) What resolution will you require? *(Choose one.)*

640 x 480 x 256 colors ..... ____1.
800 x 600 x 256 colors ..... ____2.
1024 x 768 x 256 colors ..... ____3.
1280 x 1024 x 256 colors ..... ____4.
1024 x 768 true color ..... ____5.
Uncertain ..... ____6.

7 Will you require the following in your portable, docking station or both?

	Portable	Docking Station	Both	Neither
Speakers	1.	2.	3.	4.
Available CD-ROM	5.	6.	7.	8.
Available floppy drive	9.	10.	11.	12.
Parallel port	13.	14.	15.	16.
Serial port	17.	18.	19.	20.
Ethernet port	21.	22.	23.	24.
Infrared port	25.	26.	27.	28.
SCSI port	29.	30.	31.	32.
Tape back-up	33.	34.	35.	36.

8 (If paid by employer in 1A) Would your organization agree to purchase terms of net 45 days with 3% late fee stipulated? *(Choose one.)*

Yes ..... ____1.
No ..... ____2.
Uncertain ..... ____3.

9 What is the most important feature you look for in a notebook computer?

_____
_____
_____
_____
_____
_____
_____

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Portable-Data Stars

Small, removable-media drives build a better bridge over the gap between floppies and hard drives

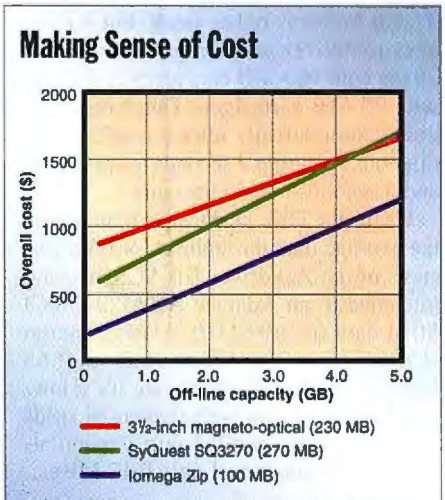
STAN MIASTKOWSKI

The 100-MB Iomega Zip (left) and the 270-MB SyQuest SQ3270 are both 3½-inch removable-media drives. The SCSI versions shown work on nearly all platforms.

Removable-media drives have sat on the mass-storage sidelines for years. For some applications, their combination of unlimited storage and hard drive–like performance has been indispensable. But in general, high drive and cartridge prices have hampered hopes of commodity stardom. Two brand-new 3½-inch drives reviewed here, from SyQuest and Iomega, could bring this storage category greater appreciation with new standards for price and convenience.

The three major technologies competing in the removable-media drive market have been MO (magneto-optical), SyQuest, and Iomega Bernoulli. MO drives and their ilk remain expensive, with drive prices starting at around $800 for 3½-inch internal 230-MB units, but they have enjoyed popularity in corporate environments, mainly for the long-term storage of essential data.

While MO technology promises greater storage life than purely magnetic technologies, its complexity keeps drive prices high and write times relatively slow. But on the plus side, the media is inexpensive, at under $30 per 230-MB cartridge, which often makes an MO drive less expensive in the long run (see the figure "Making Sense of Cost").



The cost of removable-media storage climbs as you buy more media. However, you must consider on-line capacity as well. Iomega's Zip looks good unless you want more than 100 MB on a cartridge. We compared the current pricing of external drive units with a SCSI adapter (not needed for Macs) and one cartridge. The cost of additional media is based on bulk packs (typically containing three or five cartridges).

Magnetic removable-media drives from Iomega and SyQuest use very different technologies. To the delight of users, the rivalry between these two companies has spurred higher capacities and lower prices. SyQuest places what's essentially a standard hard disk platter in its cartridges. Iomega's aptly named Bernoulli drives use the Bernoulli aerodynamic principle to control a flexible disk as it rapidly spins.

Besides letting you lock away sensitive data and quickly back up standard hard disks, removable-media drives have gained popularity for storing and transporting sizeable files, such as high-resolution graphics images. While Bernoulli drives are popular with PC users, SyQuest drives have long been an industry standard in the Macintosh-dominated publishing, advertising agency, and desktop publishing markets.

Both technologies have traditionally been burdened with high prices for both drives and cartridges and the inconvenient form factor of 5¼-inch media. But all that's changing fast. Both SyQuest and Iomega are now shipping 3½-inch removable media drives, and the Iomega Zip drive's pricing has fallen to commodity levels. New markets are open for removable media, and a combination of consumer demand and marketing factors is driving down the technology's price.

User-Focused Zip

Iomega's Zip drive underscores the dramatic swing toward a new consumer trend in removable media. Its consumer-driven design, pricing, marketing, and ease of use represent a radical new approach for the PC drive industry—and one that's being quickly emulated by others (see the text box "SyQuest Takes On Zip" on page 130).

Rather than use the old engineer-driven "build neat stuff and they will come" design philosophy, Iomega queried end-user focus groups, asking potential customers what they wanted most in a removable-media drive. According to Iomega, the three strongest desires were storage capacity of at least 100 MB, performance approaching that of a conventional hard drive, and a price tag no higher than $200. Surprisingly, Zip fulfills all those ideals.

Zip's designers started from scratch, dumping the proven Bernoulli technology in the process. While the Zip drive still uses air currents to stabilize flexible media at high spin rates, it doesn't rely on the Bernoulli effect to pull the media up to a stationary read/write head. Rather, a standard Winchester hard drive head in the Zip flies over the media surface. As with a Bernoulli design, the flexible disk makes the media light and shock-resistant. Both the drive and its media are portable.

The $199.95 Zip drive uses 25- and 100-

SyQuest Takes On Zip

SyQuest recently announced a drive that will compete head-on with Iomega's Zip, though with some crucial differences. The EZ135 wasn't available for review at press time, but the initial version—an internal IDE drive—is expected to ship by the time you read this.

Like other SyQuest drives, the 135-MB EZ135 cartridges use standard hard drive platters, but they're not compatible with other 3½-inch SyQuest drives. SyQuest expects cartridges to sell for the same price as Zip cartridges ($20) while providing roughly 35 percent more storage capacity.

With expected street prices of $200 for the internal IDE drive and $239 for the 2½-pound external SCSI drive (expected to appear in July), the pricing is also similar to that of the Zip drives. However, with an average seek time of 13.5 ms and an average throughput of nearly 2 MBps, SyQuest's EZ135 claims twice the performance of Iomega's Zip drive.

According to Rod Watkins, an analyst with the market research firm Dataquest (San Jose, CA), SyQuest was able to respond to the Zip drive quickly because the EZ135 is a scaled-down SQ3270 and shares many of the same components and media. SyQuest cut costs through economies of scale by reducing the internal buffer from 128 KB to 64 KB and by using industry-standard drive components.

Sold to computer dealers for integration into new PCs, the initial shipment of the internal IDE EZ135 is not aimed at consumers. But SyQuest is expected to mount an aggressive end-user campaign once the external SCSI version starts shipping. In addition, Microsoft will include an EZ135 driver in Windows 95. According to SyQuest sources, an external parallel-port version will be available in the fourth quarter of this year.

MB cartridges (with suggested retail prices of $9.95 and $19.95, respectively) and offers good performance. But what's most striking about the Zip drive is its stylish and functional design. Created by a leading industrial designer, the sleek blue case makes a big departure from the typical external drive box. Thankfully, ergonomics hasn't taken a back seat to design. For example, the indentation beneath the slot where you put the cartridge is deep enough to accommodate long fingernails, and a see-through window lets you read the label of an inserted cartridge.

Using off-the-shelf heads, servos, and drive electronics—instead of custom-made drive components, such as the still-available Bernoulli drives—helped Zip's designers keep development and manufacturing costs down without compromising performance or versatility. Another cost-saving feature is its unibody construction. The plastic case is an integral part of the drive, which carries with it the added benefit of increased shock resistance. The Zip is roughly the size of a paperback book, and it weighs just under a pound. Equipped with several sets of rubber feet, it can stably rest either flat or on its side.

The Zip comes in two interface versions, as either a SCSI or parallel unit. The SCSI version includes both PC and Mac software. (If your PC does not have a SCSI adapter, Iomega sells one for $149.95.) Easy-to-use switches on the back of the SCSI drive set SCSI ID and termination settings. For PC users, the parallel unit is a good portable choice for moving among different machines, with the help of unique software (see below). A pass-through parallel port lets you attach a printer.

Media Trails

A bit larger and thicker than a standard 3½-inch floppy disk, the Fuji-made Zip drive cartridge fits easily in a shirt pocket. According to Iomega, a "ski trail" test that continually reads and writes a single data track on the cartridge revealed an average of 2000 hours before errors start to occur. By comparison, although it spins at a much lower rate of rotation, a standard floppy disk starts to show errors after 100 hours.

The Zip's user-friendly focus extends to its installation and use. The SCSI version of the Zip drive comes with a large envelope containing two floppy disks (one for the PC, one for the Mac), an eight-page fold-out installation guide that covers both platforms, and an eight-page user's guide. Installation consists of plugging in an AC power brick, plugging the drive into the appropriate computer port (SCSI or parallel), turning on your system, and running the setup software from a floppy disk.

For both PC and Mac platforms, the installation process installs a group of handy utilities, including a Zip disk-copy utility, a complete hard disk–backup utility, and tools for formatting, ejecting, locking, and diagnosing Zip cartridges. Most intriguing among these is FindIt, an indexing utility that maintains a database of the files on all your Zip cartridges, which makes it easy to locate them with little fuss.

For the PC platform, the Zip drive does not use a conventional device-driver program invoked from your CONFIG.SYS file. Instead, a utility called Guest launches from AUTOEXEC.BAT. It looks for a Zip drive on either a SCSI or a parallel port and assigns it the next available drive letter. You can alternate between the SCSI and parallel versions of the Zip drive and have Guest recognize the drive and set it up for immediate use. This feature is obviously designed for sharing a Zip among a variety of systems. You can simply take a floppy along and run Guest as needed.

While the Zip's performance doesn't measure up to that of current hard drives, it's more than acceptable for the kind of applications you're likely to use it for. Its 32-KB buffer is rather small, but it manages to deliver an average seek time of 29 ms with 100-MB cartridges and 16 ms with 25-MB cartridges. The drive spins down automatically after a configurable time-out, requiring 3 seconds to spin down and 5 seconds to spin up again.

Using BYTE's Disktest, we measured the average data throughput for both versions of the Zip drive. The SCSI version (attached to an Adaptec AHA-2940 PCI SCSI card on a 90-MHz Alaris Pentium system) transferred data at about 0.65 MBps (comparable to the rate for a low-end IDE drive) for both sequential reads and writes. The parallel-port version attained data transfers of only 0.17 MBps.

SyQuest Breaks Loose

SyQuest's 270-MB SQ3270 drive represents a less radical design shift than the Zip drive. Nonetheless, its portable and convenient 3½-inch form factor still represents a fresh deviation from SyQuest's traditional product line of bulky but backward-compatible 5¼-inch drives and cartridges. As such, the 3½-inch drive repre-

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Circle 72 on Inquiry Card (RESELLERS: 73).

SONY'S MINI-MO

Derived from the 2½-inch MD (Mini Disc) technology that Sony introduced in 1993 for the consumer music and broadcast markets, Sony's MHD-10 MD Data drive is another contender in the ever-evolving removable media market. MD drives use MO (magneto-optical) technology with a proprietary compression scheme. The original consumer version stores 74 minutes of CD-quality audio; the computer-peripheral version stores 140 MB of data on the 2½-inch media.

Unlike typical MO drives, MD drives don't use laser modulation and a two-pass erase-to-zeros/write-the-ones process to write data. Because MD drives spin much slower than MO drives, they can use magnetic modulation to write data. In an efficient, single-pass process, the MD drive's laser heats each magnetic bit to its Curie temperature (365°F) while a magnetic head on the other side of the disc writes the data pattern.

The MD Data drive stands alone among removable media drives in offering different flavors of discs. Besides the standard read/write discs, read-only discs are designed for software distribution or CD-ROM-like applications. Furthermore, Sony also offers hybrid discs with both read-only and read/write sections. Designed primarily for applications such as interactive games, these discs let players save scores and character profiles. Sony MD Data drives can also play the Audio Mini-Discs found in larger music stores.

Announced in early 1994, the MD Data drive has suffered numerous delays, but Sony expects volume shipments by the time you read this. The delays have hurt Sony's attempts to forge alliances with hardware and software companies to make MD Data a new industry standard. Competitors (especially Iomega) have been able to get a leg up on the market by offering drives with lower prices and higher performance. MD Data drives have an access time of 500 ms and a data transfer rate of only 150 KBps, which places their performance closer to that of floppy drives than to that of hard drives.

Initially available only as an external SCSI unit, the drive is powered by batteries or an AC adapter. The $749.99 list price makes the MD Data drive a rather pricey alternative to the Iomega Zip and SyQuest EZ135 lines. While the Sony MD Data drives are certainly a unique and interesting technology, they may be too little, too late, and much too expensive.

sents more than just a shift in design : Although it's small and convenient, the new drive can't read SyQuest's 5¼-inch cartridges currently in use. For current SyQuest users, the 44-, 88-, and 200-MB 5¼-inch drives remain in production.

New for the PC platform, the SyQuest's 3½-inch design is actually over a year old in the Mac world. As with the larger 5¼-inch models, the 3½-inch SyQuest drive uses what are essentially standard hard disk platters in its 270-MB cartridges (which are also available in 105-MB format). SyQuest drives use a dual-sided technology with two Winchester-type read/write heads, which results in performance that's close to that of a standard hard disk drive.

With a street price starting at approximately $500, the 3½-inch 270-MB SyQuest SQ3270 drive is still aimed at the same professional market of graphics users and desktop publishers served by the larger SyQuest drives. Small office and consumer-level users are more likely to be attracted to the budget-minded Zip.

The SQ3270's standard box enclosure emphasizes its decidedly utilitarian nature. It comes in both internal and external versions equipped with an IDE, SCSI, or parallel interface. Street prices range from about $500 for the internal IDE versions to about $700 for an external SCSI (without an adapter) or parallel-port version. Single 270-MB cartridges cost around $70.

Installing an external SCSI SQ3270 was a straightforward process, though not as easy as installing Iomega's Zip drive. After we plugged in the external SCSI drive, the install program placed a device driver and ASPI manager into CONFIG.SYS. A separate installation utility installed a hard disk backup program along with a variety of straightforward programs for formatting and locking SyQuest cartridges.

Helped along by its 128-KB buffer, the SyQuest SQ3270 delivered performance comparable to that of a standard hard disk. Average seek time is 13.5 ms, and average access time is 22 ms. The drive offers four programmable power modes (sleep, standby, idle, and active) and takes 10 seconds to spin down and 8 seconds to spin up. Disktest revealed a respectable data transfer rate of 1.6 MBps with sequential reads for the SCSI version, but only 0.57 MBps with writes.

Sea Changes

While the SyQuest SQ3270 and Iomega Zip drives appeal to different needs and budgets, they both represent significant changes in removable disk storage. The SQ3270 exceeds both the capacity and the performance of SyQuest's larger drives while moving down to a convenient 3½-inch format. It's a strong entry into the PC market, where the departure from the SyQuest cartridge–compatibility chain won't be noticed.

The Zip drive is a harbinger of a new generation of peripherals that finally makes "user-friendly" drives a reality. It could also conceivably signal the end of the floppy drive as we know it. With a $200 price point, it's an unbeatable value that's already shaking up the industry. ■

Stan Miastkowski is a BYTE consulting editor who's been writing about computer technology for 17 years. He is the coauthor of the Windows for Workgroups Bible *(Addison-Wesley, 1993). You can contact him on the Internet or BIX at stanm@bix.com.*

Where to Find

MDH-10 MD Data drive $749.99
Sony Electronics, Inc.
San Jose, CA
(408) 432-0190
Circle 1032 on Inquiry Card.

SQ3270 ..... $500–$700
EZ135 ..... $200–$239
(estimated street prices, depending on interface)
SyQuest Technology, Inc.
Fremont, CA
(510) 226-4000
fax: (510) 226-4102
Circle 1033 on Inquiry Card.

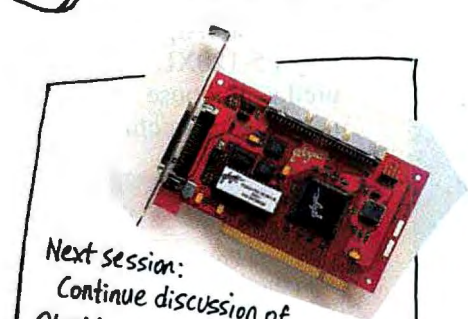
Zip drive $199.95
(SCSI or parallel interface)
PC SCSI adapter $149.95
Iomega Corp.
Roy, UT
(800) 697-8833
(801) 778-1000
fax: (801) 778-3190
Circle 1034 on Inquiry Card.

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

TOPIC	SYMPTOMS
PCI SCSI	Displays insatiable desire to pay excessive amounts for goods and services

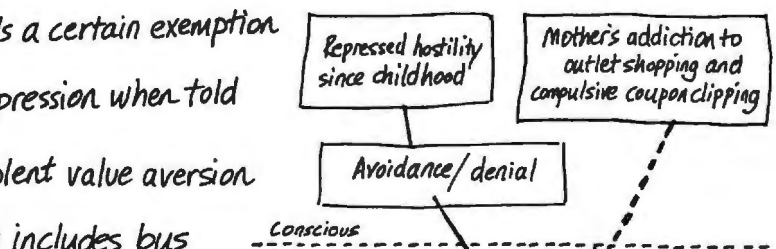
Patient, in his delusions of superiority, feels a certain exemption from rules of buying. Falls into deep depression when told about QLogic's Fast!scsi PCI Basic card. Violent value aversion surfaces after learning $134.95 price tag includes bus mastering. Patient sobs, shares happier moment of paying more than sticker price for his new car. Later, patient learns how Fast!scsi PCI Basic also includes comprehensive driver support and free CorelSCSI for CD-ROM and hard disk drives. Patient develops twitch in left eye when he hears about toll-free

Under hypnosis, patient reveals problem of overpaying for PCI SCSI cards, relates back to power struggle during toilet training.



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

technical support and five year warranty. Try reasoning with patient, explain that QLogic has over 20 million SCSI solutions in marketplace. And only QLogic offers so much for hardly any money. Suggest patient call 1-800-TOP-SCSI (867-7274) for further analysis



Patient again grabs tissue box. (Note: Go to ValueWorld for more tissues.)

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qlogic Nothing but the best - for considerably less

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5 INTERNET SERVERS GO HEAD-TO-HEAD

For a minimal initial investment, your company can set up its own in-house Internet server. We stress-tested high-end RISC- and Pentium-based systems.

STEPHEN PLATT AND ANTHONY J. LENNON

On-line business is Big Business. Corporations now envision the vast benefits of doing business on-line, and systems vendors are marketing new products to meet this rising demand. These same corporations are also exploring similar technologies for internal uses, such as publishing information for employees using Internet-style techniques. By setting up an in-house Internet server, you can reach a wide and diverse market with a relatively minimal initial investment.

For this report, we tested four RISC-based systems (with Alpha and Mips processors) and a Gateway P5-120XL (with a 120-MHz Pentium) configured as in-house Internet file servers. NSTL's Internet-server benchmarks stress the systems' CPU, disk-handling capabilities, and network compatibility and also let us compare systems that do not have the same basic OS or even comparable hardware. The benchmarks simulate heavy loads by sending constant WAIS (Wide Area Information Service), HTTP, and FTP requests to the server under TCP/IP.

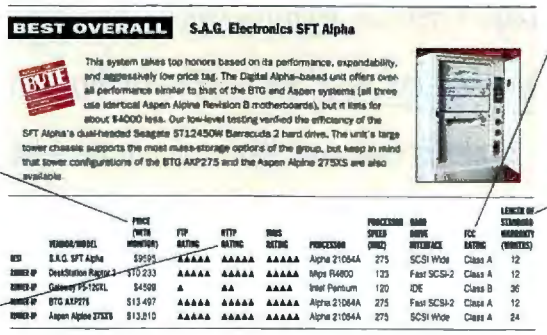
Our testing was open to all RISC systems; we included the Gateway P5-120XL as a cost-effective alternative to RISC technology. The systems we reviewed were configured with Windows NT Server 3.5. We installed publicly available versions of HTTP and WAIS servers on these units. IBM sent us its RS/6000 Model C10 PowerPC midrange server, which is based on the 80-MHz PowerPC 601 processor. But this speedy system, running its

How to use this guide

We ranked the file servers based on their performance in the NSTL Internet-server benchmarks and on their standard and optional features, usability, and test-configuration price.

See the Roll Call on pages 144 to 146 to see what features are included with the system at this price. Keep in mind that buying a 17- or 21-inch monitor and a high-end graphics card is overkill if the system is being used solely as an FTP, HTTP, and WAIS server.

Performance ratings use indexes calculated from the individual performance scores for the weighted transaction-based benchmarks. FTP tests included from two to 16 simultaneous Windows NT clients; HTTP and WAIS tests included from two to 32 simultaneous clients.



A Class A rating denotes that the product is for business use only; a Class B rating means that the system is suitable for home or business use. You might consider the Class B rating if you're setting up an Internet server at a home office.

Warranty and support policies are what frequently separate second-tier vendors from third-tier ones. Carefully consider the items listed in the Roll Call under this heading before purchasing a server.

Inside Internet Servers

AUGUST 1995 BYTE BEST INTERNET SERVERS

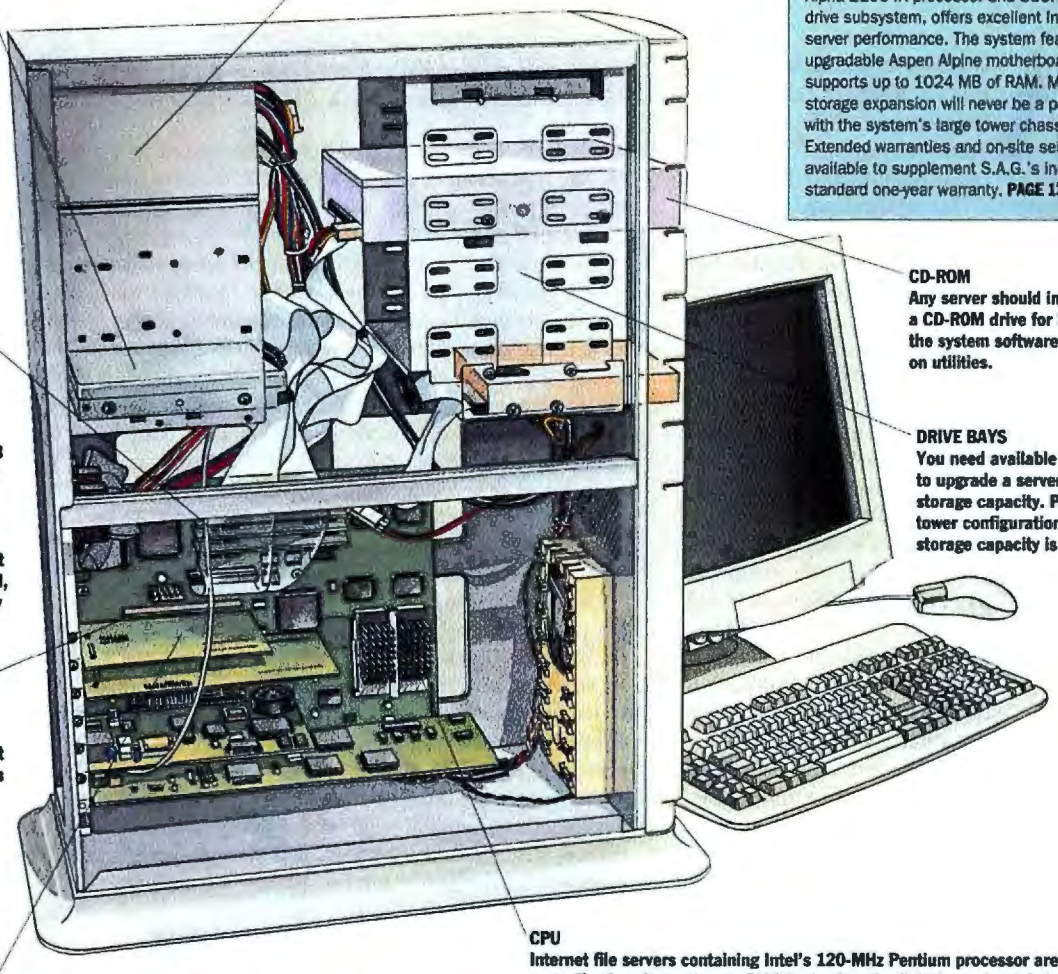
BEST

INTERNET SERVERS

BEST OVERALL

S.A.G. Electronics SFT Alpha

With a list price of under $10,000, S.A.G. Electronics' SFT Alpha represents a true value among the RISC class. The unit, with its Alpha 21064A processor and SCSI Wide hard drive subsystem, offers excellent Internet-server performance. The system features an upgradable Aspen Alpine motherboard that supports up to 1024 MB of RAM. Mass-storage expansion will never be a problem with the system's large tower chassis. Extended warranties and on-site service are available to supplement S.A.G.'s industry-standard one-year warranty. **PAGE 136**



HARD DRIVE STORAGE
It's almost always less expensive to buy a server with a higher-capacity hard drive than to add another hard drive in the future. Choose a hard drive with a fast controller and access times at or below 11 milliseconds. Local-bus drives usually offer the fastest data transfer rates.

POWER SUPPLY
Many of today's power supplies accept variable AC input from 90 to 240 V, a convenient feature for international use.

SIMM BANKS
Graphical 32-bit applications (e.g., Windows NT Server) are memory hogs. Internet file servers will function adequately with 32 MB of RAM, but additional memory will benefit certain network configurations. All the systems tested support up to 1024 MB of RAM, except for the Gateway P5-120XL, which expands to 128 MB.

CD-ROM
Any server should include a CD-ROM drive for loading the system software and add-on utilities.

DRIVE BAYS
You need available drive bays to upgrade a server's mass-storage capacity. Purchase a tower configuration if mass-storage capacity is a concern.

PCI SLOTS
At 33 MHz, a PCI (Peripheral Component Interconnect) local bus is more than 16 times faster than an ISA bus. PCI is also auto-configuring and processor-independent.

ETHERNET ADAPTER
ISA adapters operating at 10 MBps are adequate for most applications, but 100-MBps Ethernet adapters are now available. Adding a second network adapter boosts performance and reduces the network load in certain environments. If your only link to your clients is through a slower (e.g., T1) line, your Ethernet card won't affect overall performance very much.

CPU
Internet file servers containing Intel's 120-MHz Pentium processor are cost-effective alternatives to RISC technology for light to moderately heavy loads. High-traffic servers require workhorse RISC processors, such as Digital Equipment's Alpha 21064A or the Mips R4600. To upgrade the DeskStation Raptor 3 to a next-generation processor or to a new family of RISC processors, you can simply swap CPU modules.

proprietary AIX (Advanced Interactive Executive) OS, could not run all our benchmarks (see the text box "IBM C10 Reaches the Saturation Point" on page 136), so it wasn't included in the overall ratings.

Although many vendors are advertising RISC products designed for use as Internet file servers, only a few wanted their products to be included in a head-to-head comparison. We were surprised that some of the heavyweights in the RISC field—including Digital Equipment, Hewlett-Packard, NEC, and Sun Microsystems—declined to send us their products for review.

Other products, meanwhile, were simply not ready for testing. For instance, we tried to include the Integrix IGS 5 in this review. This slimline system features an 85-MHz Sun MicroSparc II processor and shipped to the NSTL lab configured with Solaris Unix 1.2 and OpenWindows. While running our FTP benchmarks, the unit repeatedly failed; even with the vendor's help, we were unable to solve the problem during our test cycle.

Finally, Apple did not want us to test its Workgroup Server 9150 because only beta Internet software was available at the time. The Workgroup Server 9150 features an 80-MHz PowerPC 601 processor and comes configured with System 7 software.

ILLUSTRATION: BRUCE SANDERS © 1995

ON-LINE SOLUTIONS

BEST FOR THE NET

Aspen System's Alpine 275XS, BTG's AXP275, and S.A.G. Electronics' SFT Alpha use identical Alpine Revision B motherboards manufactured by Aspen Systems. This motherboard contains a Digital 275-MHz Alpha 21064A processor featuring a 128-bit internal data bus, a 64-bit internal address bus, and separate two-way set-associative caches (16 KB each) for instructions and data. A 2-MB direct-mapped write-back secondary memory cache reduces, or eliminates, wait states on memory accesses.

A flexible system architecture lets you upgrade these machines with faster microprocessors as they become available. In addition to Windows NT, the Alpha 21064A processor supports Open VMS and OSF/1. System RAM expands to 1 GB via 128-MB SIMMs. SIMM sockets are relatively accessible on the Aspen and BTG units, but drive bays obstruct four of the eight SIMM slots on the S.A.G. SFT Alpha.

The SFT Alpha provides overall Internet-server performance that's nearly identical to that of the Aspen and BTG units (see the figure "Internet-Server Performance"). However, the Aspen and BTG systems, including their monitors, list for about $4000 more ($13,810 and $13,497, respectively) than the S.A.G. Alpha and its monitor.

DeskStation Raptor 3

The DeskStation Technology Raptor 3 NT workstation is targeted for graphics and 3-D animation, while DeskStation's UniFlex system, which is identical to the Raptor 3 except for its bezel, is intended to be a server. The Raptor 3 is processor independent; to upgrade it, you simply swap CPU modules.

Our test system was configured with the 633 processor module. This module contains a Mips R4600 processor that operates at 33 MHz externally

IBM C10 REACHES THE SATURATION POINT

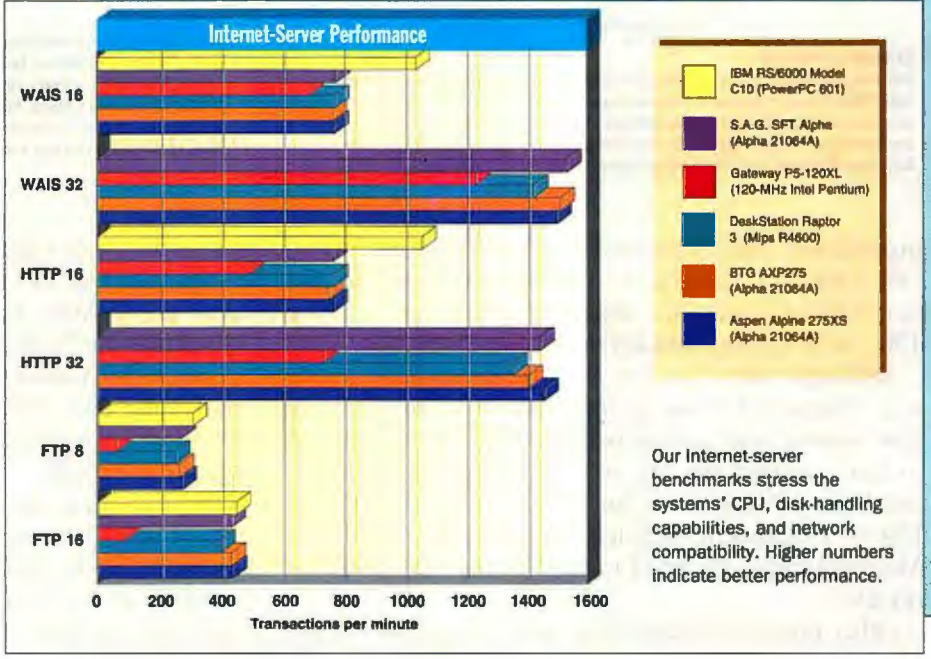
The IBM RS/6000 Model C10 PowerPC is based on the 80-MHz PowerPC 601 processor. The 601 features a 32-KB data/instruction Level 1 cache and a 64-bit bus. Although it functions nicely as an Internet file server, the Model C10 is marketed as a commercial server.

The Model C10's mini-tower chassis provides two bays for hard drives, two bays for CD-ROM or various tape devices, and four Micro Channel slots for communications and graphics devices. Our test system was configured with 64 MB of RAM and two 1-GB SCSI hard drives. The system accommodates up to 256 MB of RAM and 292 GB of hard drive storage using disk arrays and expansion units. An integrated SCSI-2 controller delivers a data transfer rate of up to 20 Mbps and accommodates up to four internal and two external SCSI devices. Additional standard features on the system include a CD-ROM drive and a Token Ring or Ethernet network adapter.

To enable us to test the Model C10 as an Internet server, IBM installed its proprietary AIX 4.1.1 OS on our evaluation unit (see "Unix with No Excuses" on page 123 for a review of AIX). IBM also provided HTTP server software, but we compiled a publicly available WAIS server.

The Model C10 performed impressively on NSTL's Internet-server benchmarks. For any particular number of attached clients, the Model C10 was capable of processing more transactions per minute than a comparable Alpha or Intel platform. Unfortunately, we could not fully review the Model C10 because it failed to run our HTTP and WAIS benchmarks when we moved from 16 to 32 simultaneous Windows NT test clients. The figure "Internet-Server Performance" shows the tpm results. Up to its saturation point, the Model C10 displays a high level of responsiveness.

We believe the Model C10's failures are due to the server becoming saturated. Technical personnel at IBM agreed that we reached a reasonable level of performance, but they suggested that, with finer resource tuning, higher levels of performance—and a higher saturation point—are attainable.



Our Internet-server benchmarks stress the systems' CPU, disk-handling capabilities, and network compatibility. Higher numbers indicate better performance.

and at 133 MHz internally, features an integrated FPU, and uses separate data and integer caches (16 KB each). A 512-KB (expandable to 1 MB) two-way set-associative write-through cache subsystem is integrated onto the processor module.

Our test unit performed competitively against its Alpha-based counterparts in NSTL's Internet-server benchmarks, and, with its ViewSonic 7E monitor, it costs nearly $3000 less than the Aspen and BTG units.

The Raptor 3 also supports Mips R4700 (150-MHz) and Alpha 21064A (275-MHz) CPU modules. In April, DeskStation Technology announced the availability of its Apocalypse module, which features Digital's new Alpha 21164 processor. The Alpha 21164, available in 266- and 300-MHz flavors, issues four simultaneous instructions with each clock cycle and supports a unique 96-KB, on-chip, three-way set-associative Level 2 cache. The Apocalypse module adds another 2-MB Level 3 cache. Prices start at just under $15,000 for a high-end Raptor 3 configuration with the Alpha 21164 processor.

The Raptor 3's proprietary BIOS provides a hardware-independent firmware layer to support certain OSes, such as Windows NT. The environment automatically boots to the appropriate NT installation by sensing which CPU module is installed. The Raptor 3's motherboard features four PCI (Peripheral Component Interconnect) slots, three ISA slots, and twin SCSI-2 ports.

Gateway 2000 P5-120XL

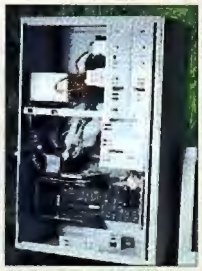
The Gateway 2000 P5-120XL, featuring Intel's recently introduced 120-MHz Pentium processor, represents a cost-effective alternative to RISC technology. Although the unit cannot match the performance of the high-revving RISC systems, it costs almost $5000 less in its test configuration than the least-expensive Alpha system, the S.A.G. SFT Alpha.

The P5-120XL features Intel's Triton chip set, which provides performance benefits over previous Pentium chip sets, including increased bandwidth from the PCI bus to system memory and support for newer memory technologies, such as pipelined burst and EDO (extended data out) memory. However, the Triton chip set doesn't support parity memory, which rules out using the P5-120XL as a mission-critical file or applications server. Our test model was configured with 32 MB of EDO memory (compared to 64 MB on the RISC units) and 256 KB of pipelined burst SRAM (static RAM). Through IDE PIO Mode 4 support, the Triton chip set increases the path between the system's 1.6-GB enhanced IDE hard drive and the processor, boosting data transfer rates and lowering access times.

Standard features of the P5-120XL include a quad-speed three-CD changer, an Ensoniq 16-bit sound card, Altec Lansing's ACS three-piece speaker system, a 17-inch Gateway Vivitron monitor, and an ATI Mach 64 video card with 2 MB of RAM. An integrated 14.4-Kbps fax modem with a telephone-answering device is also standard. Gateway's tower configuration has the ability to accommodate up to four 5¼-inch and five 3½-inch mass-storage devices. Four SIMM sockets are conveniently placed on the motherboard and accept a maximum of 128 MB.

BEST OVERALL — S.A.G. Electronics SFT Alpha

This system takes top honors based on its performance, expandability, and aggressively low price tag. The Digital Alpha–based unit offers overall performance similar to that of the BTG and Aspen systems (all three use identical Aspen Alpine Revision B motherboards), but it lists for about $4000 less. Our low-level testing verified the efficiency of the SFT Alpha's dual-headed Seagate ST12450W Barracuda 2 hard drive. The unit's large tower chassis supports the most mass-storage options of the group, but keep in mind that tower configurations of the BTG AXP275 and the Aspen Alpine 275XS are also available.



RUNNER-UP — DeskStation Raptor 3

You don't have to worry about the Raptor 3 becoming obsolete, thanks to its unique, 64-bit, PCI-like processor slot that lets you upgrade to a next-generation processor or to a new family of RISC processors by simply swapping processor boards. The Raptor 3's tower configuration supports eight 5¼-inch mass-storage devices, and you can install up to 1024 MB of memory using the motherboard's eight SIMM sockets. The Mips R4600–based unit performs a notch below the Alpha-based systems and, in its test configuration, costs about $640 more than the S.A.G. SFT Alpha.

RUNNER-UP — Gateway P5-120XL

The Gateway P5-120XL proves that systems based on Intel's new 120-MHz Pentium processor can work well as Internet servers for light to moderately heavy loads. Given Gateway's list price of $4599, including monitor, you can purchase two to three P5-120XL units for the price of a single RISC box. Remember, though, that our P5-120XL test unit was configured with only 32 MB of RAM and a 1.6-GB enhanced IDE hard drive. The system is limited to 128 MB of RAM, but you can add up to five 3½-inch and four 5¼-inch mass-storage devices. Gateway also offers the longest warranty (three years) of the vendors in this review, and its prices include one year of on-site service.

	VENDOR/MODEL	PRICE (WITH MONITOR)	FTP RATING	HTTP RATING	WAIS RATING	PROCESSOR	PROCESSOR SPEED (MHZ)	HARD DRIVE INTERFACE	FCC RATING	LENGTH OF STANDARD WARRANTY (MONTHS)
BEST	S.A.G. SFT Alpha	$9595	▲▲▲▲▲	▲▲▲▲▲	▲▲▲▲▲	Alpha 21064A	275	SCSI Wide	Class A	12
RUNNER-UP	DeskStation Raptor 3	$10,233	▲▲▲▲▲	▲▲▲▲▲	▲▲▲▲▲	Mips R4600	133	Fast SCSI-2	Class A	12
RUNNER-UP	Gateway P5-120XL	$4599	▲	▲▲	▲▲▲▲	Intel Pentium	120	IDE	Class B	36
RUNNER-UP	BTG AXP275	$13,497	▲▲▲▲▲	▲▲▲▲▲	▲▲▲▲▲	Alpha 21064A	275	Fast SCSI-2	Class A	12
RUNNER-UP	Aspen Alpine 275XS	$13,810	▲▲▲▲▲	▲▲▲▲▲	▲▲▲▲▲	Alpha 21064A	275	SCSI Wide	Class A	24

KEY

Ratings from 1 to 5: ▲ is the lowest; ▲▲▲▲▲ is the highest.

How the WWW Is Put Together

Today the WWW (World Wide Web) is the hottest example of distributed information and electronic publishing. It can be simultaneously global and local, complex and easily extensible, and corporate and personal. The basic tools and organization allow anything from a simple one-site setup to a link to the worldwide community.

The WWW is based on the concept of *hypertext*—documents with links to other documents, which lets you follow related ideas from one place to another. In some sense, it's an extension of linked help files. Instead of being bound to one file, documents can be spread across files, and even across computers. For example, if you're writing a document and want to create a link to something on a computer at some other site (even at another company, university, and so on), you just tag your hot spot with the name of the remote computer and the file. The figure "Linked Documents" at right shows how some hypertext-linked documents can be connected.

Even more powerful is the concept of the *form*, which is, in essence, a dialog box with check boxes, radio buttons, pull-down menus, and fields for editing. As an author, you design a form with the desired buttons, menus, and so on. You also write a program (in virtually any programming language), called a CGI (Common Gateway Interface) application, to handle the input—filling an order, adding a reader's name to a mailing list, looking up information, whatever you want.

At this point, you've created an interactive publication. A subscriber reads your pages and fills out your form. Your program then does something with the form's data, and you create a new page for the subscriber based on that data.

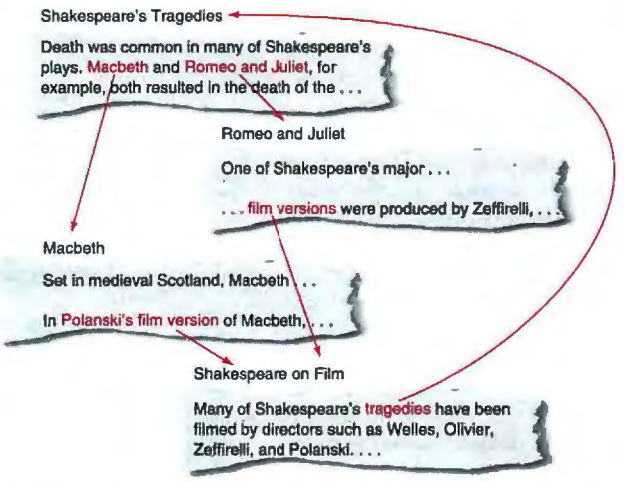
But how does it work? A fully functional WWW relies on three components to function together seamlessly: your computer (and its software), a set of network links, and one or more other computers acting as servers (see the figure "Components of a WWW Site" below).

A WWW setup functions similarly. On your computer, you use what's known as a *browser* to view published pages, regardless of where the pages are physically located. Each hot spot in a document knows the name of its associated file and on which computer (i.e., server) that file is stored. When you select the hot spot, the browser goes across the network to the server, asking the server for the file. The server responds with the file, and the browser proceeds to display the information.

The name of the computer and the file are combined into something called a *URL* (uniform resource locator). A typical URL might be something like http://s1/byte.html, which says to retrieve the file byte.html from the server s1 using a method called Hypertext Transport Protocol, or HTTP. URLs support several other transport protocols, including Gopher and FTP.

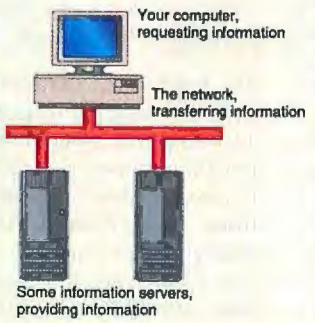
The four main tasks involved in completing the WWW publishing cycle are setting up a network, the server, and the browsers on the users' workstations, and, finally, creating the pages and forms-processing programs.

Linked Documents



Hypertext links let you navigate across documents (and WWW sites) by clicking on highlighted terms.

Components of a WWW Site



A fully functional WWW site requires a computer (with software), a set of network links, and servers.

INTERNET GLOSSARY

Archie
A software tool for finding files stored on anonymous FTP servers. FTP sites are regularly indexed by title and keyword, and Archie searches these indexes for files based on your search criteria.

Firewall
A security barrier, consisting of one or more routers capable of accepting, rejecting, or editing transmitted information, placed between an organization's internal network and a connection to the Internet.

FTP (file transfer protocol)
A protocol used to transfer files between Internet sites located across TCP/IP networks.

Gopher
A hierarchical text database that makes menus of material available over the Internet. Gopher is a client/server application that lets surfers drill down through a hierarchy of descriptions, narrowing the search until you find the document you need.

HTML (Hypertext Markup Language)
A coding language used to create hypertext documents for use on the WWW.

HTTP (Hypertext Transport Protocol)
A protocol for moving hypertext files across the Internet. Requires an HTTP client program on one end and an HTTP server program on the other. HTTP is the most important protocol used by the WWW.

S-HTTP (Secure Hypertext Transport Protocol)
A transaction protocol for the Internet that creates secure channels at the application layer.

SLIP (Serial Line Internet Protocol)
A standard for using a regular telephone line (a serial line) and a modem to connect a computer as an Internet site. SLIP is gradually being replaced by another standard protocol, called PPP (Point-to-Point Protocol), that encapsulates transport protocols in special packets.

URL (uniform resource locator)
A uniform method of specifying where different documents, network resources, and media reside on the Internet.

WAIS (Wide Area Information Service)
A document-database server that allows the indexing of huge quantities of information and then making those indexes searchable across networks, such as the Internet.

WWW (World Wide Web)
A network of servers that use HTTP to link documents across the Internet. The WWW connects Gopher, FTP, and WAIS servers, making them transparent to the end user.

"We recommend the Action AXP275 as an excellent all-around NT workstation."
BYTE Magazine, March 1995

"WHOOSH!"
Windows Magazine, March 1995

"AXP275 streaks from the gate, shatters records, the stopwatch"
Government Computer News, February 6, 1995

"Alpha cleans Pentium's clock"
Windows Sources, February 1995

"As good as it gets if you need speed"
PC World, February 1995

"The Action AXP275 runs NT at full throttle"
PC WEEK, November 7, 1994

"The AXP275 offers the fastest Win32 performance we've seen..."
Windows Sources, February 1995

"Every component of this computer is representative of the best technology available."
PC World, February, 1995

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How We Tested

We tested four RISC (Alpha and Mips) platforms, along with a system featuring Intel's top-of-the-line 120-MHz Pentium processor, to determine how well each functioned as an in-house Internet server. Configuring all the systems as Internet file servers lets us compare systems that do not have the same basic OS, or even comparable hardware.

This Internet-server methodology stresses the systems' CPU, disk-handling capability, and network compatibility; FPU and graphics performance is not a factor. Testing does not involve modem or serial transmission. We believe that a 28.8-Kbps phone line presents too much of a bottleneck to adequately stress these high-end systems.

TEST CONFIGURATION

We tested uniprocessor systems configured with a minimum of 64 MB of system RAM, at least 2 GB of SCSI disk storage, a single 10Base-T Ethernet port, and a CD-ROM drive. All test units met this specification except for the Gateway P5-120XL (which had 32 MB of RAM and a 1.6-GB hard drive).

As Internet service providers, the test systems were configured with an OS capable of functioning simultaneously as an FTP, WWW (World Wide Web), and WAIS (Wide Area Information Service) server. All the systems were configured with Windows NT Server 3.5.

Our test-bed included eight Dell Dimension/P75 systems, each equipped with a 75-MHz Pentium and configured with 24 MB of RAM and Intel 10-Mb Ethernet adapters. Windows NT Workstation 3.5 was installed on each client, which, in turn, was connected to the Internet server's 10Base-T port over twisted-pair cable. Each workstation was capable of running multiple NT sessions to simulate a much larger test-bed (up to 32 simultaneous clients).

INTERNET-SERVER TESTS

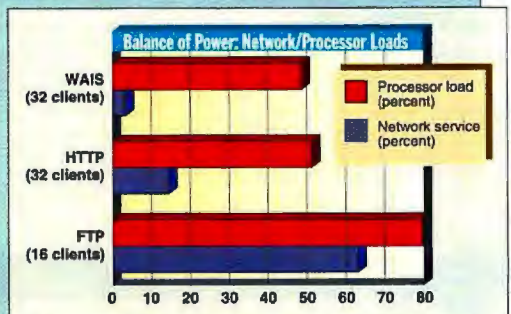
Our system benchmarks are based on real-world applications and stress the processor, disk, and video components. Servers are subject to different demands, placing more emphasis on the disk and network components. The processor and memory serve mainly to cache commonly used disk pages and shuffle requests between the network and disk systems.

Different network setups and different data organizations place different load patterns on a server. For example, HTML (Hypertext Markup Language) files tend to be small, averaging around 11 KB; typical GIF-image files are larger, averaging around 14 KB. Compressed files sent via FTP are significantly larger still, averaging around 120 KB.

File access patterns also differ. The topmost pages in a WWW tree, for instance, are accessed more frequently than the lower pages, since most ac-

A HEAVY LOAD TO CARRY

The NCSA (National Center for Supercomputing Applications) has determined that a WWW (World Wide Web) surfer waits an average of 5 minutes between page requests. During that time, many other things can be happening. If you're on a slow connection (e.g., a 14.4-Kbps modem), for instance, you might be transmitting the file. Or you might be reading the page or linking to pages on another site. More commonly, you're turning through cached pages that you've already seen. Even if we assume twice that access rate, a single real-world client requests a file every 2½ minutes, which translates into a processing rate of 0.4 transactions per minute.



Under heavy FTP activity, the server's work is balanced between network-servicing and processing chores. But as the server tends to HTTP and WAIS activity, the processor becomes the chief performance constraint.

A typical Alpha system can process many requests from many typical WWW users. But unless all your users are connected over a high-speed network (e.g., fast Ethernet or T3), your network connection becomes saturated long before your server does. An underloaded server is able to absorb new tasks without suffering a significant amount of decay in its transaction-processing rate. Such a server is able to, for example, transfer 100 files almost as quickly as it can transfer 50 files. On an unloaded server, the transaction-processing rate increases almost as quickly as the load does. When a server becomes saturated, however, doubling the load will double the amount of time it needs to perform its task. As the load gets larger, the server becomes supersaturated, and the transaction-processing rate drops sharply.

The figure "Balance of Power: Network/Processor Loads" above shows the effective network utilization and processor time of the S.A.G. SFT Alpha server on three of our tests. A heavy FTP load simultaneously stresses the CPU and the network link. The HTTP figures indicate a much lower network load, although the processor-utilization rate remains relatively high.

Another factor to consider is the rate at which clients request information; a high transaction rate (e.g., HTTP 32) indicates that clients will spend much time connecting and disconnecting for data transfer operations. A low transaction rate (e.g., FTP 16) indicates that the server will spend more time transferring data and less time opening and closing connections.

Under the FTP test, the processor and the network have a balanced load. In the HTTP test, the processor is loaded more heavily than the network, indicating that opening and closing connections represents a significant amount of the work.

The WAIS test represents an intermediate point. During times of almost no disk activity (e.g., when the WAIS database is cached), significant processor utilization, or low network use, the chief constraint is the processor, and its time is spent in WAIS searching and network-connection processing. So, for WAIS and HTTP activity, processing power becomes an important criterion when selecting an Internet server.

cesses involve a few central pages. In an FTP-based model, files can be evenly requested from any point in the directory tree. This is a reflection of the minimal amount of interdependence among files.

This means that servers that cache files and directories are affected differently by WWW and FTP loads. Top-level files and directories are more likely to be cached and rerequested under a WWW load than they are under an FTP load. An FTP-oriented server can manipulate larger files and will perform better if it can read and buffer large segments from the disk.

Unlike processing with WWW and FTP, WAIS processing places a significant load on the processor. Under WAIS testing, an on-line database of information is searched for records that match a keyword-based request. The index is fairly small and is easily cacheable.

We built a mixed set of files of differing sizes based on statistics from the NCSA (National Center for Supercomputing Applications, Urbana, IL). The data from the NCSA summarizes the usage patterns at its own WWW/FTP site, including average file sizes of various types, ranges of sizes, and ratios of binary data to text data.

To create the file sources, we constructed three separate directory trees on each server. The FTP tree held over 2100 files in 21 directories (for a total of 252 MB of data), the HTTP tree had 8700 files in 121 directories (112 MB of data), and the WAIS tree included over 6195 files in 30 directories (9 MB of data). The WAIS indexes were typically about 8 MB in size.

We specified three server-load patterns, each emphasizing a different form of server use. Our FTP load represented the kind of load a server might see when it's used primarily as an FTP server with limited WWW support. This type of load is typical of a file-archiving site. The HTTP load represented a server primarily involved in HTTP servicing, which is typical of electronic publishing. And our WAIS load consisted of 50 percent HTTP requests and 50 percent WAIS requests, which is typical of a system supplying WAIS through a WWW user interface.

We varied the number of active clients (FTP tests are repeated with 16, eight, four, and two active clients; we added a test with 32 clients for the HTTP and WAIS suites), increasing the client base until the server was saturated and could no longer respond to the client demand. When a client could no longer open a connection to the server to request or receive data, we declared the server to be saturated.

Contributors

Siva Kumar, Technical Analyst/NSTL, *specializes in hardware and NOS (network operating system) testing.*

Anthony J. Lennon, Project Manager/NSTL, *conducts reviews of systems, notebooks, and peripherals.*

Stephen Platt, Ph.D., Manager of Unix Development/NSTL, *directs testing of Unix hardware and software, Windows NT, graphical systems, and NOSes.*

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A RECOMMENDED WWW SERVER CONFIGURATION

A transaction-processing rate of 1000 pages per minute translates into an effective throughput of 1.4 million pages per day. However, the total number of requests is not the real issue when planning a server configuration. Instead, you should plan for dealing with the peak request load and the peak connection rate. Another consideration is how your network handles the data load. If your client stations are connected mostly through slower ports (e.g., 56-Kbps links or 14.4-Kbps modems), the outgoing ports will be a constraining factor, not how fast your disk and processor are.

How many users should you expect? A recently published paper from the NCSA (National Center for Supercomputing Applications) studied the load patterns on its own WWW servers, which are probably among the most heavily used servers on the Internet. They are subject to a "typical maximal" load of approximately 600 files per minute.

Unfortunately, this study does not describe what classes of links the client stations were using. Although the NCSA site has an internal FDDI (Fiber Distributed Data Interface) network and an external T3 link, slower clients cannot receive data as quickly as faster ones can, which then delays how quickly they can request subsequent pages. In effect, the ability to ship data quickly to a large number of slower links means that the site can support a greater number of concurrent users than if the clients were all connected on faster lines.

Another busy site of interest is www.playboy.com. *Playboy* estimates that it services 800,000 requests per day and turns away at least another 800,000.

Not many sites experience the kinds of loads placed on the NCSA and *Playboy* sites, however. Most sites providing services across the Internet can expect loads on the order of thousands of packets per day. An in-house site, even at a corporate headquarters supporting hundreds of people, should expect a significantly smaller load.

So, when you plan your server, consider the following four principal factors:

1. **The size of your network connection. Are your clients connected directly to multiple Ethernet ports? One Ethernet port? A T1 link? Something slower? You can provide service only as fast as the number of your network connections grows.**

2. **The surfing habits of your clients. Do they do a lot of indexing and server processing (stressful to the server's CPU)? FTP transfer (balanced between the disk and network, with the CPU used to transfer data)? Or WWW-style (World Wide Web) processing (more work for the CPU, but a lot of network-port servicing)?**

3. **The storage requirements of your data. This requirement affects your choice of disks (SCSI for many gigabytes, but you can probably get away with IDE if your data is measured in hundreds of megabytes and you don't plan to expand).**

4. **The access patterns of your clients. HTML (Hypertext Markup Language) and WAIS (Wide Area Information Service) users are helped by a lot of primary memory. Random FTP access doesn't employ a memory cache effectively.**

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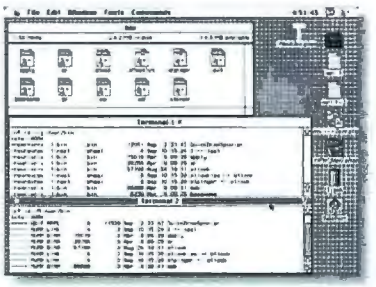
Mach[Ten]'s strength lies in the way it extends the Macintosh Operating System with UNIX networking and software development tools. The Macintosh/UNIX integration is so strong that you can even use Mac programs & utilities on UNIX data, and UNIX programs & utilities on Mac files.

And Mach[Ten]'s full internet protocol support lets you use your Mac as a domain name server, IP router, POP mail server, or Web server.

The UNIX software development system includes the GNU C and C++ compilers and libraries to let you create new applications or port existing ones. The Motif toolkit and suite of X clients and X client libraries make developing distributed applications a breeze.



Files and directories can be viewed on disk using the Macintosh Finder or the more versatile UNIX commands.

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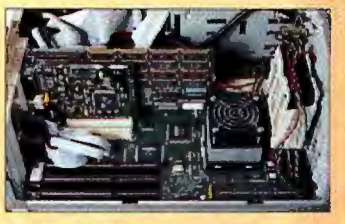
HONORABLE MENTIONS

The S.A.G. SFT Alpha, Aspen Alpine 275XS, and BTG AXP275 each have a remote diagnostics port that lets technicians perform component-level maintenance and diagnostics via modem. Thus, you can receive remote diagnostics on your system even in the event of a complete system shutdown.

The Gateway P5-120XL comes with a quad-speed CD changer that lets you load up to three CDs into the unit and switch among them without handling them. The CD changer supports multisession Kodak Photo CDs as well as XA (Extended Architecture) format and includes a headphone jack, volume control, play/pause controls, and a skip function. CD-ROMs are becoming a necessity on file servers for loading system software and utilities.

The SFT Alpha has a swinging door on the front of the chassis that prevents you from inadvertently turning off or resetting the system. It also includes a removable SCSI hard drive that's protected with a keylock. The large tower chassis is mounted on four rollers, enhancing the file server's mobility.

DUBIOUS ACHIEVEMENTS



The Aspen Alpine 275XS, BTG AXP275, and S.A.G. SFT Alpha each use identical Alpine Revision B motherboards manufactured by Aspen Systems. The board's processor, with its large heat sink and fan, extends nearly 2½ inches from the motherboard and potentially obstructs two of the motherboard's three PCI (Peripheral Component Interconnect) slots and one of its three 16-bit ISA slots, depending on the size of the adapter.

SUPPORT A SAFE INTERNET: SECURE YOUR SITE

Transmitting sensitive information, such as credit-card numbers or corporate financial data, across the Internet can be risky. By default, data that's sent across a TCP/IP network is transmitted as raw data. Thus, any clever thief can read the information as it's being sent, create fake data requests, and forge responses. With the prevalence of HTML (Hypertext Markup Language) forms and the development of publicly accessible Internet banking, Internet security has become a particularly sensitive issue.

Another equally vital consideration is the security of data on the client and server sites. Allowing external-site access to your server implies that people outside your site will have at least limited access to your file systems. Merely existing on a global network lets outsiders steal your data.

Finally, both user and provider must consider the problem of confirming that the other person is who he or she claims to be. Just as a server wants to confirm that persons ordering a service are who they claim to be, users need to confirm the sites to which they send sensitive information.

Three main techniques can secure server sites and data transmissions: firewalls, encrypted transmissions, and user/server authentication. When you install a *firewall*, you set up a single computer or a router to act as a filter that stands between all internal and external transmissions and allows only certain types of data to pass from one side to the other. An insecure site might allow almost anything to pass through; a more secure site can restrict transmissions to mail or nonanonymous FTP. Ports through a firewall can be either *absolute* (allowing everyone, or no one, to go through) or *user-secure* (allowing only select users with passwords to go through).

***Encrypted transmissions* encode data transmissions. S-HTTP and SSL have been proposed as alternative methods of encoding transmitted data. S-HTTP provides encryption services to WWW browsers, while SSL provides security and encryption services to any application at the socket, or intercomputer communications, level.**

Two common encryption techniques are public-key (e.g., RSA) and private-key (e.g., DES) encryption. Public-key encryption lets you broadcast an encoding key while maintaining a private decoding key. You can encrypt a message with the public key; however, without knowing the private key, the recipient can't effectively decrypt the message. "Signing" a message is also possible: If you encode the message with your private key, someone can decode it with the public key, which proves that it was you who actually sent the message.

With private-key techniques, on the other hand, the sender and the receiver must share key information. While a public-key system allows the transmission of public keys across unsecured paths, letting you secure a channel by passing the public key, it's slower than private-key encryption.

A combination of public- and private-key transmission is normally used to create secure channels. Public-key encryption is often used to sign and transmit private keys; the private keys are used for the bulk of the session to improve performance.

Finally, *authentication* confirms the identity of a user or a server. At a simple level, this can be done with the use of passwords and user IDs. More complex schemes allow you to store a digital signature that identifies the server site; the browser software must then request, compare, and verify the returned signature.

ROLL CALL OF SERVERS TESTED

FEATURES CONTINUE ON PAGE 146

MODEL	ASPEN SYSTEMS ALPINE 275XS	BTG AXP275	DESKSTATION TECHNOLOGY RAPTOR 3	GATEWAY 2000 P5-120XL	S.A.G. ELECTRONICS SFT ALPHA
Test-configuration price (without monitor)	$12,911	$11,497	$9674	$3960	$9199
Test-configuration price (with monitor)	$13,810	$13,497	$10,233	$4599	$9595
FTP rating	10.0	9.8	9.3	2.4	10.0
HTTP rating	10.0	9.8	9.8	6.5	9.9
WAIS rating	9.9	9.9	9.7	8.8	10.0
PROCESSOR					
Manufacturer	Digital Equipment	Digital Equipment	Mips	Intel	Digital Equipment
Model	Alpha 21064A	Alpha 21064A	R4600	Pentium	Alpha 21064A
Speed (MHz)	275	275	133	120	275
Cache-bus speed (MHz)	275	275	66	60	275
Memory-bus speed (MHz)	275	275	33	60	275
Internal data bus (bits)	128	128	64	64	128
Internal address bus (bits)	64	64	36	32	64
External data bus (bits)	32	32	64	64	32
External address bus (bits)	32	32	36	64	32
Instruction cache (KB)	16	16	16	8	16
Instruction-cache associativity	Two-way	Two-way	Two-way	Two-way	Two-way
Data cache (KB)	16	16	16	8	16
Data-cache associativity	Two-way	Two-way	Two-way	Two-way	Two-way
Voltage	3.3	3.3	5.0	3.3	3.3
SPECint92	189	189	94	N/A	170
SPECint92 estimated?	●	●	●	N/A	○
SPECfp92	290	264	73	N/A	290
SPECfp92 estimated?	●	●	●	N/A	○
Maximum number of processors	1	1	1	1	1
Number of processors in test system	1	1	1	1	1
SECONDARY PROCESSOR CACHE					
Standard (KB per processor)	2048	2048	512	256	2048
Maximum (KB per processor)	2048	2048	1024	256	2048
Total installed in test system (KB)	2048	2048	512	256	2048
Speed (ns)	17	17	17	15	17
Write policy	Write-back	Write-back	Write-through	Write-back	Write-back
Associativity	Direct-mapped	Direct-mapped	Two-way	Direct-mapped	Direct-mapped
SYSTEM RAM					
Standard amount (MB)	64	64	16	16	64
Amount in test system (MB)	64	64	64	32	64
Maximum amount (MB)	1024	1024	1024	128	1024
Speed (ns)	60	60	70	60	60
Built-in error-correction coding	●	●	○	●	●
Memory architecture	Interleaved	Interleaved	Interleaved	Paged	Interleaved
EXPANSION BUS					
Architecture	ISA	ISA	ISA	ISA	ISA
Local-bus architecture	PCI	PCI	PCI/proprietary	PCI	PCI
EXPANSION SLOTS					
16-bit ISA	3	3	3	3	3
32-bit local-bus PCI	3	3	4	4	3
32-bit local-bus VESA	0	0	0	0	0
AVAILABLE EXPANSION SLOTS					
16-bit ISA	2	2	1	1	2
32-bit local-bus PCI	1	2	3	2	1
I/O PORTS					
Serial	2	2	2	2	2
UART type	16550	16550	8250	16550	16550
Parallel	Bidirectional	Bidirectional	Standard/unidirectional	Enhanced	Standard/unidirectional
PS/2 mouse	● (with adapter)	● (with adapter)	○	●	● (with adapter)
Ethernet adapter model	3Com 3C509 (ISA)	3Com 3C509 (ISA)	3Com 3C509 (ISA)	SMC 8432BT (PCI)	3Com 3C509 (ISA)
Ethernet connectors	RJ-45, BNC, AUI	RJ-45, BNC, AUI	RJ-45, BNC, AUI	RJ-45, BNC	RJ-45, BNC, AUI
Fast SCSI-2 on motherboard	●	●	●	○	●
IDE	○	○	●	○	○
Enhanced IDE	○	○	○	●	○
SECURITY					
Power-on password	●	●	○	●	○
Setup-utility password	●	●	○	●	○
Keyboard lock	○	○	●	●	●

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HARD DRIVE					
Number of drives	1	1	2	1	1
Manufacturer	Seagate	Seagate	Conner	Western Digital	Seagate
Hard drive model	32550W	ST2400N	CFP 1080S	Caviar 31600	ST12450W Barracuda 2
Total hard drive storage capacity (GB)	2	2	2	1.6	2.1
Interface (IDE/SCSI)	SCSI Wide	Fast SCSI-2	Fast SCSI-2	IDE	SCSI Wide
Local-bus interface	●	○	●	●	●
Controller manufacturer	QLogic	NCR	AMD	Triton	QLogic
Controller location	PCI	Motherboard	Motherboard	Motherboard	PCI
Controller standard cache size (MB)	N/A	N/A	N/A	128 KB	N/A
Controller cache size in test system (MB)	N/A	N/A	N/A	128 KB	N/A
Controller maximum cache size (MB)	N/A	N/A	N/A	128 KB	N/A
AVAILABLE DRIVE BAYS					
Total 3½-inch drive bays	2	1	0	5	0
Total 5¼-inch drive bays	3	3	8	4	10
Number of 3½-inch drive bays with external access	0	0	0	1	0
Number of 5¼-inch drive bays with external access	3	3	4	4	6
Available 3½-inch drive bays	1	0	0	3	0
Available 5¼-inch drive bays	1	1	4	3	7
CD-ROM					
Drive manufacturer	Toshiba	Plextor	Chinon	Torturi Sanya	Sony
Drive model	XM-3501TA2564	PX-4XCH	535	CDR-31G	CDU55S
Disc loading	Cartridge	Cartridge	Cartridge	Cartridge	Drawer
Speed	x4	x4	x2	x4	x2
Average access time (ms)	150	235	280	250	220
Estimated maximum throughput (KBps)	684	600	300	600	300
Buffer size (KB)	256	256	256	256	256
Interface	SCSI	SCSI	SCSI	IDE	SCSI
POWER SUPPLY					
Power-supply output rating (W)	270	270	300	145	270
AC voltage	110–250	110–250	115–220	110–240	110–250
Switchable voltage	●	●	●	●	●
OTHER FEATURES					
Motherboard manufacturer	Aspen Systems	Aspen Systems	DeskStation Technology	Intel	Aspen Systems
Case type	Desktop	Desktop	Tower	Tower	Tower
FCC rating	Class A	Class A	Class A	Class B	Class A
DIMENSIONS					
Height (inches)	7.0	7.0	21.0	22.9	26.8
Width (inches)	16.0	16.0	8.0	9.5	8.7
Depth (inches)	15.0	15.0	22.0	17.1	17.9
Weight (pounds)	34.0	35.0	50.0	40.0	38.0
VIDEO					
Manufacturer	Number Nine	Number Nine	Number Nine	ATI	ATI
Model	GXE 64 Pro PCI	GXE 64 Pro PCI	GXE 64 Pro PCI	WinTurbo PCI	Graphics Ultra Pro
Chip-set model	S3 Vision 964	S3 Vision 964	S3 Vision 964	ATI Mach 64	ATI Mach 32
Circuitry bus	PCI	PCI	PCI	PCI	PCI
Highest noninterlaced display resolution (pixels)	1600 by 1200	1600 by 1200	1600 by 1200	1280 by 1024	1280 by 1024
Standard graphics memory size (MB)	4	4	4	2	2
Standard graphics memory size on test system (MB)	4	4	4	2	2
Maximum graphics memory size (MB)	4	4	4	2	4
MONITOR					
Manufacturer	CTX	Nokia	ViewSonic	Gateway	CTX
Model	1785GM	21-inch 44X Series	7E	Vivitron 17-Inch	1565GM
Dot pitch (mm)	0.26	0.25	0.28	0.26	0.28
Highest noninterlaced display resolution	1280 by 1024	1600 by 1200	1280 by 1024	1280 by 1024	1280 by 1024
Highest refresh rate at this resolution (Hz)	72	120	72	60	66
OTHER	Remote diagnostics port (DB9 external); user-switchable OS support for Windows NT, OpenVMS, and Digital Unix	Remote diagnostics port (DB9 external); user-switchable OS support for Windows NT, OpenVMS, and Digital Unix	64-bit, PCI-like CPU slot for processor independence and upgradability	x4, 3 CD-changer, and EDO memory	Remote diagnostics port (DB9 external); user-switchable OS support for Windows NT, OpenVMS, and Digital Unix
SALES AND SUPPORT					
Length of standard warranty (months)	24	12	12	36	12
Extended warranty available?	●	●	●	○	●
VENDOR INFORMATION					
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Toll-free phone	(800) 992-9242	(800) 449-4228	(800) 793-3375	(800) 846-2000	(800) 989-3475
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Building the Better Virtual CPU

Two different designs achieved the same goal: a faster 680x0 emulator for the Mac

TOM THOMPSON

In March, Apple released version 2.0 of MAE (Macintosh Application Environment), a program that hosts the Mac OS in a Unix window on Sun SparcStations or Hewlett-Packard's HP 9000 workstations. MAE 2.0 offers better Mac 680x0 application performance because it uses a faster 680x0 emulator. The Power Mac 9500, introduced this summer, also gets a performance assist from a new 680x0 emulator. What's interesting, and the focus of this column, is that both designs use the same technique—dynamic recompilation—to improve performance.

The Interpretive Emulator

To understand how these new emulators work, we must first explain how the original 68LC040 emulator operates. It consists of a lookup dispatch table and a PowerPC code library. The code library contains functions that implement each 680x0 instruction, and entries in the dispatch table point to these functions. The dispatch table also has entries for 680x0 processor A- and F-line exceptions (or traps). Apple uses the A-line trap as the entry point into its Mac Toolbox routines, and the F-line trap handles certain hardware-specific traps (e.g., address or bus errors). The emulator has a 580-KB footprint in ROM.

The emulator operates by fetching a 16-bit 680x0 instruction. (Instructions can be 32 bits or longer, but the first 16 bits define the instruction's function.) This value acts as an index to an entry in the dispatch table, and each table entry consists of two PowerPC instructions. For a simple 680x0 instruction, the first PowerPC instruction handles the operation in-line, and the second instruction returns execution back to the emulator. For some 680x0 instructions, the second native instruction is a PC-relative branch to a code library function. The function's native instructions complete the operation, and control returns to the emulator (see the figure "The Basic 68LC040 Emulator").

All this design does is interpret one 680x0 instruction at a time, all the time, and is thus known as an interpretive emulator. Interpretive emulation isn't efficient when sections of code are executed frequently (e.g., in tight loops). However, in Apple's case, it provided the best compatibility with existing 680x0 software.

Dynamic recompilation (or DR) offers better efficiencies during emulation by "recompiling" sections of frequently used 680x0 instructions into chunks of native code. Rather than laboriously interpret each 680x0 instruction inside, say, a loop, the DR emulator hops to a native-code block that performs the looping operation.

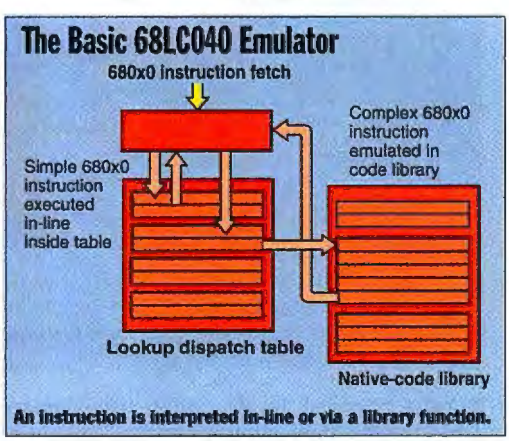
The MAE Implementation

The MAE DR emulator is actually an enhancement built onto the proven interpretive emulator. Because it's part of a program running on a workstation, the MAE DR emulator operates differently from the Power Mac DR emulator. The MAE emulator has to implement basic services normally provided through Apple hardware. However, it can also rely on certain low-level support, such as interrupt handling and disk I/O, from the workstation's OS.

The first task the DR emulator performs is to identify frequently used sequences of 680x0 instructions, or *hot blocks*. Marking a block's starting point is easy: It's the target of an emulated branch instruction. A block's end is determined by a change of program flow to a distant address, and resolving this properly gets tricky.

Several instances are used to discern these flow changes. The first one can be a return instruction, provided the return address isn't to a nearby location, for reasons we'll see. (This return instruction is an unconditional branch under RISC.) The second instance is a conditional branch instruction, but only if the target address is nonlocal.

One reason that there are no hard-and-fast rules for the first two instances is that high-level-language compilers frequently implement control statements as conditional branch instructions. These instructions test for conditions that, if satisfied, perform short jumps around a branch instruction that might exit a loop. This same situation also explains why an unconditional branch instruction (i.e., return) by itself doesn't guarantee the end of a block.



The third instance that marks a block end are certain complex 680x0 instructions. Recompiling them requires too much overhead and time. The easiest solution is to end the code block. For performance reasons, the MAE emulator tries to make the code blocks as large as possible.

With the potential hot blocks mapped out, the next step is to flag those blocks that are heavily used. This is done with little overhead by pushing the target addresses of 680x0 branch instructions onto the native stack. A frequency-of-use analysis is performed on the addresses, and those blocks that are executed more than 256 times per

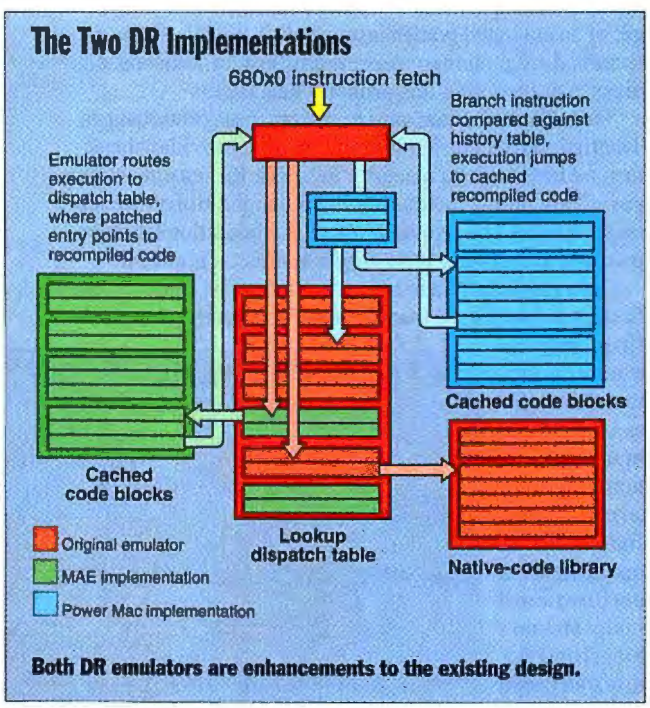
tick (i.e., 1/60 second) are recompiled.

Recompilation involves copying the PowerPC instructions out of the emulator's code library one at a time and performing postprocessing on the native representation of the hot block. Such postprocessing involves dead code removal and code optimizations (e.g., embedding data constants). The emulator does the postprocessing code generation rapidly by fetching and modifying data from 680x0 instruction templates. These templates were built in memory when the MAE process was launched.

Finally, the native-code blocks are placed in a cache buffer. This buffer's size is dynamic, usually hovering around 256 KB, but it can expand to 1 MB in an application-intensive environment.

The DR emulator performs sleight of hand so that the interpretive emulator uses the cached code blocks. Recall that a dispatch table routes execution to the appropriate native code. This table contains 2^{16} (65,536) entries for every possible 680x0 opcode variation, but 50,000 of them represent valid op codes.

The DR emulator updates some of the table's invalid entries with pointers to code blocks inside the cache buffer. It patches the 680x0 application's image in memory so that the start of each hot block contains an invalid op code. As 680x0 hot blocks are detected, recompiled, and the corresponding locations in the dispatch table and the application are revised, the interpretive emulator starts jumping to the recompiled code blocks (see the figure above, "The Two DR Implementations").



The Power Mac Implementation

The Power Mac DR emulator differs from the MAE design because it's responsible for running the OS. Like MAE, the Power Mac DR emulator is an add-on to the old emulator. The design was optimized for low overhead and a small footprint. It consists of 30 KB of hand-tuned PowerPC assembly language code.

The DR emulator sorts out frequently used 680x0 code blocks and recompiles them. As before, the start of a block is a branch instruction, while the criteria that determine the block's end differ from the MAE design. The instances that mark a block's end are an unconditional branch or jump instruction, an illegal instruction, and a complex instruction. Also, a block can be a fixed length of only 128 bytes, or 64 2-byte 680x0 instructions. The emulator maintains a small history table to flag hot blocks. For the Power Mac, the frequency-of-execution threshold value is small (typically less than 10) and was determined empirically.

The emulator uses a fast set of algorithms that recompiles a hot block. The 680x0 instruction value acts as an index into an array of functions, each of which translates an instruction type (e.g., an `ADD.W`, where the parameters are word values located in registers, memory, or a combination of both). The function first emits a general native `add` instruction. Next, it fills in the rest of the fields so that the PowerPC instruction specifies the location and size of its parameters, such as adding one 16-bit register value to another. An add to memory would generate the appropriate load/store instructions required to move the data to and from memory.

The recompiler stows the finished native instruction into the cache buffer, fetches another 680x0 instruction, and continues this process until the hot block's translation is complete. For blocks with short backward branches (indicating a loop), the recompiler also adds code that monitors hardware interrupts, because the emulator helps implement the Mac OS on a very low level.

The cache buffer is 256 KB in size. The caching algorithm is starkly efficient: When the buffer fills, it purges all the cached blocks and recompilation begins anew. More complex caching schemes added too much overhead to the design, and the high locality of typical code means that the buffer isn't purged often.

With the native block cached in the buffer, the DR emulator begins using it by monitoring the 680x0 instruction stream. When the emulator detects a 680x0 branch instruction, it compares the target address (i.e., the potential start of a hot block) with a hashed table of native program counter addresses. If there is a match, compiled code exists and execution hops to the address of the cached code block. If there isn't a match, the history table is updated, and the 680x0 emulator interprets the code.

Performance Wins

The DR emulators add a level of complexity to the original emulator. Also, caching the translated code produces some side effects that can affect compatibility. When code gets written to memory by a program, or the A5 jump table in a 680x0 Mac application's code segment zero gets modified, the cache buffer's contents can fall out of sync with memory. This causes a crash unless care is taken to notify the emulator of the change. The application must call one of several Toolbox routines that flush the cache, and the DR emulator honors cache-flushing instructions such as `CPUSH` and `CINV`. Any application whose code was redesigned for the 68040 should work reliably with these new emulators.

The performance gains outweigh the compatibility pitfalls, however. The MAE emulator boosts an application's performance by an average of 50 percent. Certain compute-intense operations, such as an Excel spreadsheet recalculation, see a 100 percent improvement or more. For the Power Mac emulator, native applications see a 10 percent to 15 percent improvement, while emulated applications run 20 percent to 30 percent faster. For some compute-intensive tasks, a speed boost of 200 percent has been observed. ■

Tom Thompson is a BYTE senior technical editor at large. You can reach him on AppleLink as T.THOMPSON or on the Internet or BIX at tom_thompson@bix.com.

Novell Builds a NEST

Novell Embedded Systems Technology makes NetWare portable and embeddable

SALVATORE SALAMONE

Novell has a vision called pervasive computing. It includes a goal of 1 billion devices connected to NetWare networks by the year 2000. This is an ambitious goal because there are only 40 million NetWare nodes (give or take a few million) currently deployed worldwide. To make it happen, Novell isn't talking about adding just PCs, Macs, and Unix workstations.

Instead, Novell is targeting devices that have not previously been connected to networks. It hopes that half of the billion nodes will come from embedded devices, things such as environmental controls, TV set-top boxes, and even vending machines.

The idea is to make such devices network-aware. They can then be connected directly to a network and take advantage of such NetWare services as directory and print services. At the same time, these devices would be able to share information with other devices on the network. And, if developers so desire, they may choose to make these devices intelligent enough to be managed through a common control or management system.

The way to make such devices network-aware is to embed NetWare into each device. To do this, Novell has developed NEST (Novell Embedded Systems Technology), which is essentially a portable version of NetWare.

NEST might be deployed, for example, in a building's temperature-control system. NEST-enabled sensors located throughout a building would pass temperature data back to a central location, where the data could be analyzed and actions taken based on the information. Rather than simply cranking up all the air conditioners in an office, a command could be sent only to the NEST-enabled air conditioner nearest a heat source or a device that is the most heat-sensitive (e.g., a minicomputer in an office).

Because many existing control systems use proprietary communications architectures, something as simple as selective cooling of an office is difficult to accomplish. Typically, the temperature sensors and the heating/cooling control system would not have the ability to be synchronized to the extent that a specific air conditioner could be instructed to operate independently from the others on a floor.

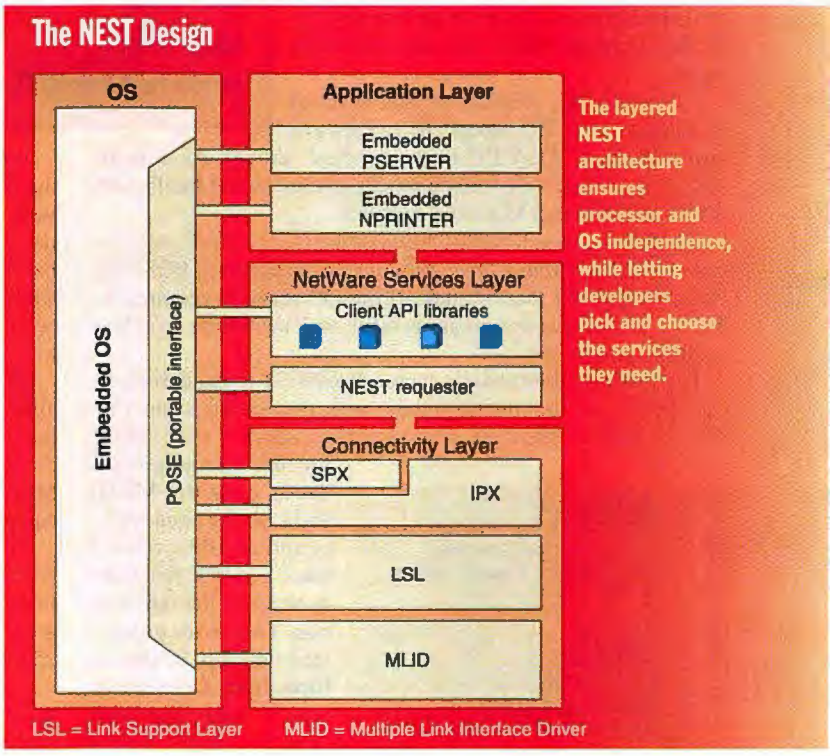
The Power of Flexibility

NEST has the potential to change things by offering a common communications architecture (NetWare) and a way to connect devices to that architecture. Novell designed NEST to be a flexible OS because of the large differences in the products on which it will run.

Novell found that between 70 percent and 80 percent of the OEMs interested in NEST use proprietary OSes in their devices. Any embedded NOS (network operating system) would have to be able to work with all these device OSes. Additionally, a wide variety of processors are used in the devices that are candidates for NEST. And the amount of memory available in many NEST candidates is typically low. Taking these factors into account, Novell developed NEST to be portable, modular, and device OS–independent.

To help deal with the variations in amounts of memory and the different types of functions that might be embedded into a device, NEST uses a modular, layered design (see the figure "The NEST Design"). It lets developers select the amount of connectivity and services they want.

The basic functional areas for NEST are the connectivity layer, the NetWare services layer, an application layer, and an OS interface. The connectivity layer provides data transport and low-level services based on Novell's ODI (Open Data-Link Interface). This layer includes several functional areas, including the MLID (Multiple Link



Interface Driver), which is the ODI layer that can receive packets destined for different protocol stacks within the device. The MLID can also let a single protocol stack simultaneously access multiple network topologies, such as Ethernet and FDDI (Fiber Distributed Data Interface).

Right above the MLID is the LSL (Link Support Layer), which handles communications between the MLID and the protocol stacks. IPX and SPX protocol stacks are also within the connectivity layer.

Next comes the NetWare services layer, which gives the device access to the services available from a NetWare server. These include connection, file, print, message, bindery, and authentication services, all of which can be made available to the device. Developers can choose the services they wish to use from client API libraries.

Also included in the NetWare services layer is the NEST requester, which is a module that builds protocol packets and provides send/receive support services. For example, these services might include packet-burst support, to more efficiently transfer bulk data, or auto-reconnect service, to automatically restore a dropped connection. The requester can be used to add packet signatures and RSA (Rivest-Shamir-Adleman) authentication services (if so desired for security).

Riding on top of the NetWare services layer is the application layer, which contains the programs that control the operation of the embedded system. The applications can be provided by an OEM, a third-party developer, and Novell. Two applications are included in the NEST SDK (Software Development Kit) 1.0. The first one is the Embedded PSERVER, a version of NetWare PSERVER NLM (NetWare loadable module), which lets a printer read and transfer files from a NetWare print queue for printing. The second one is the Embedded NPRINTER, a version of the NetWare remote printer program NPRINTER, which lets a printer establish connections to a NetWare server and transfer files from the PSERVER running on that server.

For portability, NEST is written in ANSI C, with OS and CPU dependencies kept to a minimum (see "OS/CPU Dependencies" above). As a result, NEST supports most common processors, including Intel's x86, AMD's 292xx, and Motorola's 680x0.

The last functional part of NEST is the OS interface, which is called POSE (Portable Operating System Extension). POSE is a Posix-based API that defines all the OS services required by NEST, such as memory management, task switching, synchronization, and timing.

The beauty of this modular approach to NEST is that developers can choose just the functions they need, thus saving system resources such as memory. For example, a device with simple broadcast requirements needs only the MLID and LSL for connectivity and an IPX protocol stack and IPX functions to transmit the information. To provide guaranteed delivery of the information, a developer simply adds the SPX protocol stack. (SPX provides a connection-oriented service between the device and the controller that guarantees packet delivery.)

Product Information

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OS/CPU DEPENDENCIES

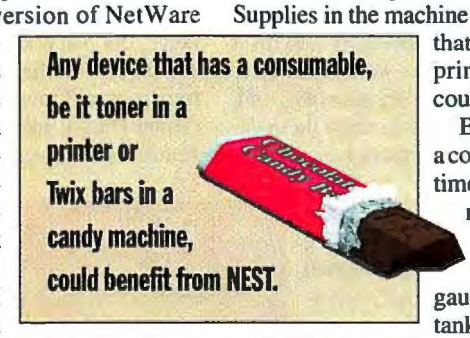
- CPU must be 16-, 32-, or 64-bit
- OS must be preemptive multitasking, with thread and semaphore support
- NEST reconciles byte order, data type size, and data alignment

First Implementations

While NEST must be adopted by equipment manufacturers whose devices have not traditionally been connected to networks, the first practical implementations are coming from a mix of networking hardware vendors and control-system vendors. Among those showing an interest in NEST are CD-ROM jukebox vendor Microtest (Phoenix, AZ) and building-automation product vendor Andover Controls Corp. (Andover, MA).

Several printer vendors have embraced NEST, including QMS (Mobile, AL), Lexmark International (Greenwich, CT), GCC Technologies (Bedford, MA), and Digital Products (Waltham, MA). All four vendors cite a similar reason for using NEST in their products—tighter integration with NetWare 4.x services (e.g., the directory and authentication services).

The ability of NEST-enabled devices to directly communicate with a central management system (network management or otherwise) has spawned talk of NEST-enabled vending machines. Supplies in the machine can be inventoried remotely. Any device that contains a consumable, be it toner in a printer or Twix bars in a candy machine, could benefit from NEST.



Besides knowing when to refill a machine, a company could identify buying trends in real time and make adjustments accordingly (i.e., remove a poorer selling product and add extra Twix bars). Or, utility companies could use NEST-enabled meters to read gauges in homes and send a truck to fill up oil tanks when they are getting low.

While there was interest from most of the developers attending the NEST track at Novell's Brainshare conference earlier this year, many said they will proceed cautiously. They've seen similar efforts in the past that have initially shown great promise but have then fizzled out. One example is Microsoft At Work, which offered a simplified way to connect office equipment such as computers, copiers, and printers (see "Whatever Happened to...?," July BYTE, page 30).

NEST may also face a challenge from another industry effort aimed at extending NOS features to devices that normally do not have them. In February, 15 companies (IBM and 14 Japanese companies, including Ricoh, Matsushita Electric Industrial, and Sharp) announced an initiative to develop a standard for office-equipment communications.

No matter how many vendors eventually support NEST, Novell has a long way to go to reach half a billion NEST nodes from embedded devices by the year 2000. To achieve this lofty goal, NEST devices must be added to networks at a rate of over 250,000 per day—every day—until the end of the century. ■

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

PostScript Sins

PostScript is now a common means of exchanging formatted documents. So why so many problems?

KEVIN THOMPSON

The first implementation of Adobe's PostScript page-description language raised the capabilities of laser printers to new heights and led to the growth of the desktop publishing market. Because the PostScript language was designed to be device-independent, many vendors created PostScript printers and imagesetters, and virtually all applications and GUI environments provided PostScript drivers to support these output devices.

The proliferation of PostScript drivers has created an interesting side effect. Because all applications can produce PostScript files and PostScript printers are reasonably common (although less so than PCL printers), PostScript files have become a de facto standard for the distribution of formatted documents. This usage is especially prominent on the Internet, where we recently counted more than 20,000 PostScript files available for public download, and it has driven the development of PostScript viewing and other post-processing applications.

Those of us who routinely download and print these files may be surprised to discover that most of them contain errors. These errors are typically invisible when the files are printed on laser printers, but become painfully visible when the pages in the files are viewed or printed out of sequence. This article identifies common PostScript sins and their perpetrators.

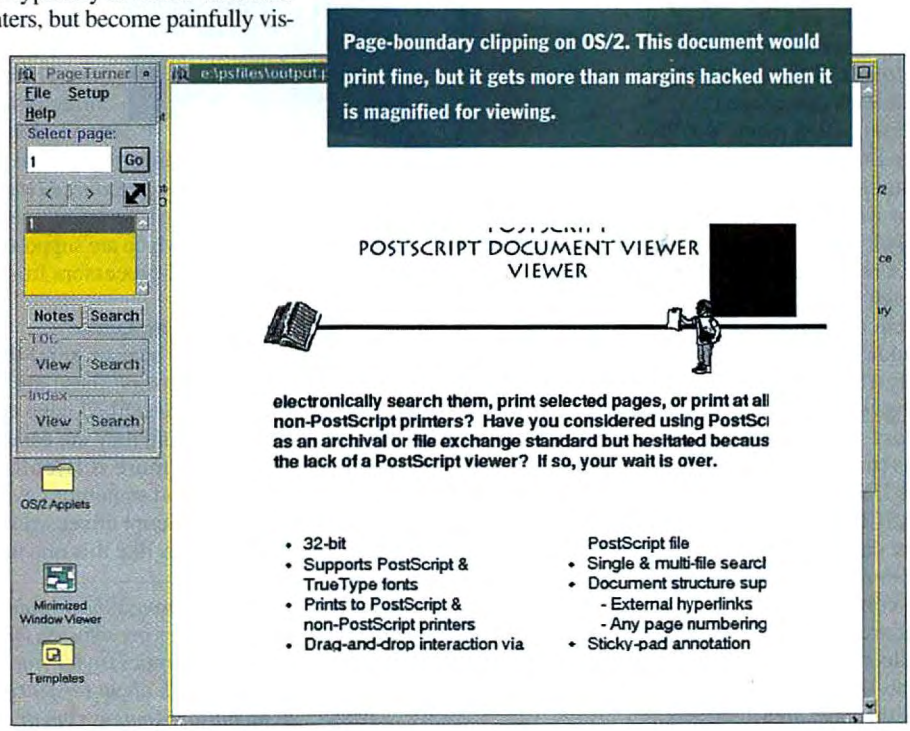
The Document Structure Conventions

The DSC (Document Structure Conventions) defined by Adobe for PostScript files are a set of conventions that are not enforced by the language but to which all drivers should adhere. The DSC divide a PostScript file into three main portions: the header (or prologue), the page area, and the trailer. The header consists of all code from the start of file (denoted by the `%!PS-Adobe` comment) up to but not including the first page. Each page begins with a `%%Page: <label> <ordinal>` comment, where *<label>* is a string containing the page number (e.g., ii or 2), and *<ordinal>* is the sequence number of the page (first page is page 1). The trailer follows the last page, beginning with the `%%Trailer` comment and ending with the `%%EOF` comment. (Note that a percent sign denotes a comment, and two percent signs denote a predefined DSC comment.)

Encapsulated PostScript files are intended to represent a single image to be pasted into a larger document. Their internal structure is therefore simpler, and they contain no `%%Page:` comments, because there are no pages. The header and trailer portions remain, but the page area of a standard PostScript file is replaced by the code that draws the single EPS image.

The principle purpose of the DSC is to provide page independence, which allows the pages to be rendered in any sequence. Thus the header should contain all setup information, and the trailer code restores the interpreter state to that which existed before the file was processed. Each page should contain the information required to render that page—meaning any text, graphics, or font data required by that page—which has not been defined in the header.

continued



Page-boundary clipping on OS/2. This document would print fine, but it gets more than margins hacked when it is magnified for viewing.

The following sections describe common errors and the environments that typically make them. Most of these errors correspond to DSC violations.

PostScript Coding Errors

Page-independence violation (Windows). These files contain font or procedure definitions on one page that are used on subsequent pages. If you render the pages out of sequence, the fonts or procedures are undefined and rendering fails. This is perhaps the most egregious violation, and the one with the least excuse, because relocating the definitions to the header where they belong is a simple matter.

Page commands in trailer (OS/2). These files put page commands in the header or trailer. The OS/2 driver puts the `showpage` command for the last page in the file trailer so that rendering the last page by itself yields no image at all. This is another trivial error for which there is no excuse.

Page-boundary clipping (OS/2). These files contain code that clips the image to the physical page size, less a small margin (see the screen). The pages print normally, but when magnified for on-screen viewing the enforced clipping chops off the top and right portions of the image. This clipping should simply be omitted, because it is unnecessary and troublesome. This is a case of going to a lot of effort to do the wrong thing.

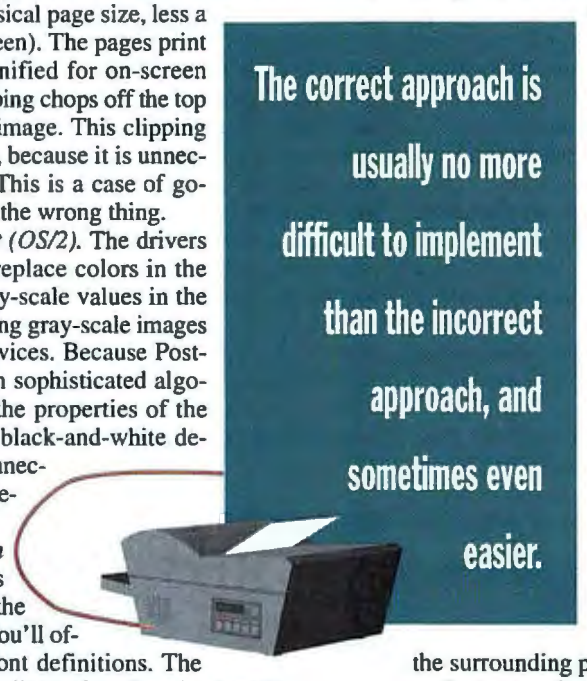
Color mapping on host (OS/2). The drivers that produce these files replace colors in the original document by gray-scale values in the PostScript file, guaranteeing gray-scale images even on color-capable devices. Because PostScript interpreters contain sophisticated algorithms to map colors to the properties of the output device (including black-and-white devices), host mapping is unnecessary and degrades the usefulness of the output.

Line-length violation (Windows). These files contain lines that exceed the DSC limit of 255 bytes. You'll often see this problem in font definitions. The font should be broken into lines of conforming length.

Zero-width lines (Windows, Tex). These files assume that visible results are produced by stroking or filling zero-width lines or filling a rectangle with a clipping region of zero width or height. Although the Adobe PostScript interpreter produces results in these circumstances, the documentation on PostScript painting rules indicates otherwise, and other interpreters may behave differently. (Similarly, you should avoid producing PostScript code that draws with single-pixel rectangles.)

Binary image data (Macintosh). These files contain bit-mapped images (usually photos) that are encoded in binary form, violating the DSC requirement that PostScript files contain only printable ASCII characters. Violating this requirement produces files that are damaged by E-mail or ASCII network transfers.

Header commands in page (Corel). These files put page-resizing commands such as `letter` in the page text. These commands are benign for printers, but cause the image bit map to be reallocated in a viewer, thus erasing the image immediately after it has been rendered. Page size commands belong in the header, not the page area.



Hexadecimal strings (Interleaf). These files use hexadecimal-encoded strings instead of literal strings. Although this usage is not strictly in error, it is undesirable, because the hexadecimal encoding requires twice the space of a literal string and impairs search operations.

PostScript Comment Errors

Although a PostScript interpreter ignores comments, other post-processing programs (e.g., file viewers) are dependent on the DSC comments and cannot function without them. Thus, DSC comments are important, and all drivers should provide them. The following comment errors are unfortunately common:

Omission of all comments (DOS applications). These files lack the `%%Page:`, `%%Trailer`, `%%EOF`, and other DSC comments. They cannot be viewed or otherwise post-processed.

Multipage EPS files (Windows). This is a user-interface issue in Windows. The Windows PostScript driver prominently displays an option to save to an EPS file, while not even documenting the obscure mechanism by which you produce a standard PostScript file. The result is that most Windows users select the EPS option to create multipage files. The driver then dumps all page images into the file without any `%%Page:` comments to denote their position. All post-processing programs, which rely on page-boundary markers, fail to locate the page data in these files.

The solution to this problem is to put the PostScript and EPS file options on equal footing in the user interface. Alternatively, having the driver put the `%%Page:` comments in the EPS files, although unnecessary for real EPS files, would at least solve the page-boundary problem.

Improper document nesting (Windows). These files lack the `%%BeginDocument: <name>` and `%%EndDocument` comments, which are supposed to denote embedded EPS files. The result is that post-processors may incorrectly identify the embedded file as a new, stand-alone PostScript file and fail to render the surrounding page or the rest of the document.

Omission of resource comments (OS/2). These files are lacking the `%%BeginResource: <fontname>` and the `%%EndResource` comments, which are supposed to denote font definitions, thus preventing post-processors from finding the fonts when needed.

Ignorance Is No Excuse

You should bear in mind that this is not an exhaustive list of PostScript errors; these are simply the most common. The errors we've described have two characteristics: They are due to ignorance, and they are easily rectified. The correct approach is usually no more difficult to implement than the incorrect approach, and sometimes even easier. Let's hope this article will inspire PostScript driver writers to improve their products and thus make articles like this one unnecessary. ■

Kevin Thompson is the president of Magus, a company that produces PostScript viewing software for OS/2 and Microsoft Windows. He has a Ph.D. in physics from Princeton University and never intended to learn so much about PostScript. You can reach him on the Internet at thompson@magus.com or on BIX c/o "editors."

Merging ATM and Ethernet

There's growing interest in building networks that unite ATM and Ethernet switching technologies

SALVATORE SALAMONE

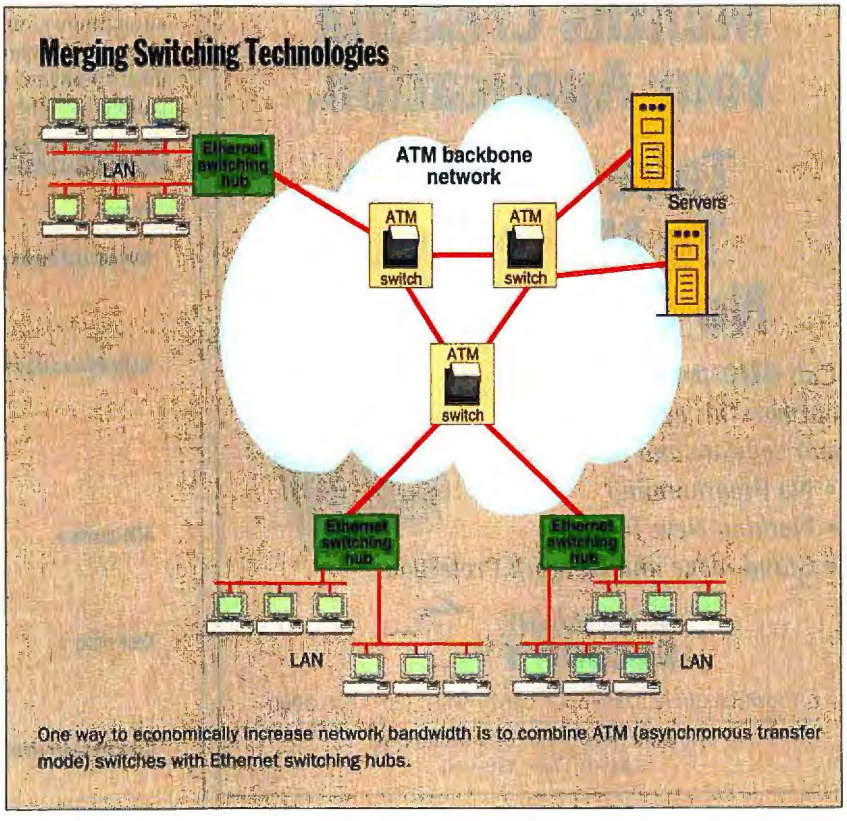
As corporate networks grow and as more network applications are deployed, companies find that they are often stressing the capacity of their networks. And with bandwidth-intensive applications (e.g., multimedia and desktop videoconferencing) on the horizon, many networks, in their current form, will not be able to handle the traffic loads. In the long term, bringing ATM (asynchronous transfer mode) to every desktop will ensure that there's enough bandwidth, but today it is far too expensive for most business networking applications.

One of the most promising and economic ways to satisfy the traffic patterns generated by newer client/server and multimedia applications is to combine two switching technologies—ATM and Ethernet switching—into one network. Such a combination gives departments more usable bandwidth, thanks to Ethernet switching and, by using an ATM backbone network, lets large amounts of data flow between workgroups (see the figure, "Merging Switching Technologies" at right). This combination of switching technologies can be used in a campus setting where buildings are linked through an ATM backbone, or in a single building where Ethernet switching hubs on each floor are connected through an ATM switch in the basement.

Whether used in a campus setting or within a single building, this merging of ATM and Ethernet switching technologies has many points in its favor. First, it leaves future networking options open. For example, a company could decide at a later date to push ATM to the desktop (when ATM adapter cards drop in price). It also puts a company in position to connect widely dispersed sites using high-speed, ATM WAN services that many of the telephone companies and independent service providers are gearing up to deliver.

Merging ATM and Ethernet switching technologies into one networking environment also preserves a company's current investment in its network adapter cards, cabling, and workgroup-level wiring hubs and concentrators. You can keep your existing equipment and still offer better bandwidth allocation to your departments. The cost savings of retaining the desktop are significant. For instance, an alternative to getting more bandwidth to each desktop would be to move everyone over to an FDDI (Fiber Distributed Data Interface) network. Even though prices have dropped, the least expensive FDDI adapter cards still cost several hundred dollars more than 10Base-T adapters. And such a change would also require you to replace your networking hubs.

It's not surprising then that many users are interested in merging ATM and Ethernet switching. Virtually all of the major router and enterprise hub vendors have been quick to announce that they will be players in this developing market. Some internetworking product vendors, including Cisco Systems (Menlo Park, CA) and 3Com (Santa Clara, CA), have beefed up their switching offerings through acquisitions. At the same time, hub vendors Alantec (San Jose, CA), Cabletron Systems (Rochester, NH), Chipcom (Southborough, MA), Digital Equipment (Maynard, MA), Lannet (Irvine, CA), Networth (Irving, TX), Optical Data Systems (Richardson, TX), Standard



One way to economically increase network bandwidth is to combine ATM (asynchronous transfer mode) switches with Ethernet switching hubs.

Microsystems (Hauppauge, NY), and Bay Networks (Santa Clara, CA) have been positioning their higher-end hubs and routers to enter this market.

Additionally, a handful of stand-alone Ethernet switching hub vendors have products that they've developed from the start to handle Ethernet on the workgroup side and ATM in the backbone (in the future). These products include the ANTswitch from Applied Network Technology (Westford, MA), the ATMizer 125 Relational Switch from Agile Networks (Concord, MA), the LANbooster Series from Onet Data Communication Technologies (Cambridge, MA), the MegaSwitch from NBase Switch Communications (Chatsworth, CA), and the QuikStack from XLNT Designs (San Diego, CA).

Different Approaches

There are several things to consider before selecting a device to perform Ethernet switching today with connectivity to ATM backbones in the future. First and foremost, decide which of the two fundamentally different types of product best fits your networking philosophy: An enterprise hub uses Ethernet switching and ATM modules that share an internal high-speed backplane (or ATM switching fabric within the hub), whereas a stand-alone workgroup hub performs Ethernet switching and has an interface to an ATM switch (which will be part of the ATM backbone).

The workgroup hub systems that Applied Network Technology, Agile, Onet, and NBase offer will typically be less expensive per port than will enterprise hubs. That's because, with these products, you're not paying for the features (i.e., redundant backplanes, power supplies, and cooling fans) that are required to operate in an enterprise setting. You're also not paying for the enterprise management system that is featured with enterprise hubs.

And that may be the second point to consider: How do you want to manage your network? If the workgroups are fairly autonomous, only needing connectivity to other groups, a stand-alone hub's management system will be fine. However, you will need to ensure that your hub vendor's ATM interface is compatible with the ATM switch manufacturer's product. (Yes, there

Key issues to consider before selecting products

Issue	Considerations
Network architecture	Must choose between a modular-based enterprise hub or a stand-alone workgroup hub with interface to an ATM switch
Integrated management system	Make sure management system offers full feature set for all devices (many vendors have acquired switching products to round out their product line and have not integrated the management systems)
ATM interface	Make sure stand-alone hub vendor has solid technical relationship with one or two of the major ATM switch vendors
Conversion	Look for vendors with ASIC technology that performs ATM cell to Ethernet frame conversion
Capacity under stress	Look for distributed processor architecture that is nonblocking

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are standards for such interfaces, but make sure your hub vendor has a solid technical relationship with one or two of the major ATM switch vendors.)

On the flip side, if you plan to connect users in different workgroups via enterprise-wide virtual LANs, you will need an enterprise management system. One note of caution: Even if you select equipment from an enterprise internetworking vendor, you may not get the enterprise management features you need. That's because there has been such an acquisition frenzy in this market. While all the products from one vendor can be managed through say, an SNMP (simple network management protocol) system, you may not have the ability from a central location to tap all the features in each system's proprietary management system.

Capacity a Key

There are nearly 40 vendors currently selling Ethernet switching hubs. But fewer than a dozen are poised to enter the ATM-to-Ethernet switching market, because of the complexity of merging the two technologies. In an ATM network, the Ethernet packets or frames must be converted to ATM cells (and vice versa). This packet-to-cell conversion technology is not widely available today. The conversion is done using an ASIC (application specific integrated circuit), which only a handful of Ethernet switch vendors have developed—notably, Nicecom (Lexington, MA), which was acquired by 3Com, and Onet.

Another key factor to consider is how the Ethernet switch operates under great loads. Depending on the networking environment into which the switch is placed, this can either be a major problem or no problem at all. For example, it's likely that companies taking advantage of merging ATM and Ethernet switching will connect multiple Ethernet LAN segments to high-performance servers. This setup, in which servers are put onto the high-speed backbone and the clients remain on Ethernet LANs, is commonly called a server farm.

While this seems like an ideal situation, you'll need to be concerned about blocking, which occurs when two clients on different LAN segments contend for the same server at the same time. If a client on one LAN segment is passing a large amount of data to a server and a second client tries to send data, a buffer in the Ethernet switch will hold the data from the second client until the server can accept it.

If a third client tries to have an exchange with another server while the second client's data is held in the buffer, most of the Ethernet switching hubs on the market will hold the third client's data in a queue behind the already buffered data. Some vendors, such as Onet, have circumvented this problem by developing nonblocking hubs that let the data destined for another server jump ahead of the buffered data in the queue, so that it may be passed to the free server.

Since most Ethernet switching hub vendors do not have ATM interfaces developed, it is not possible today to tell whether their products will suffer from blocking or not. However, users will soon be able to sort these issues out as more products make it to market. The hardware is becoming available and some of the management software is here. That bodes well for the merging of the two technologies, and it should help network managers provide the additional bandwidth they'll need for new applications without having to do a forklift overhaul to their networks. ■

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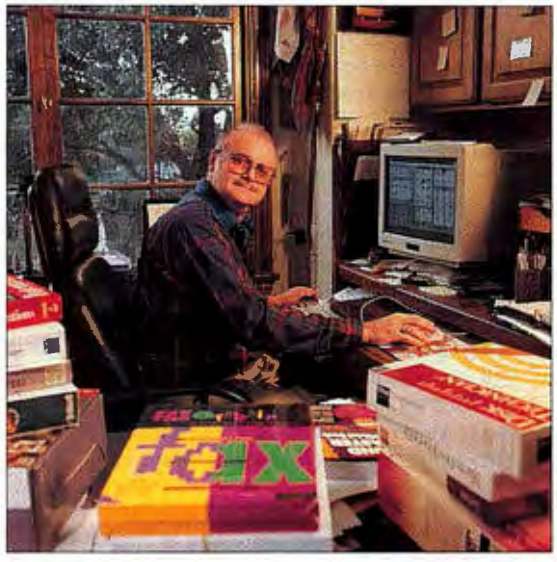
JERRY POURNELLE

Windows 95 Pastiche



AMY ETRA © 1995

Jerry divides his time between Windows 95 installations and the Electronic Entertainment Exposition

You probably know that BYTE editors choose the awards given at Comdex. This past spring, we gave the Best of Show award to Microsoft Windows 95.

To win Best of Show, a product must first win in its own category, which this year was "Best Operating System That Will Ship Someday." The nominees were Windows 95 (W95), Windows NT 3.51, and OS/2 Warp Connect. Because of eligibility requirements, this was the first time OS/2, W95, and NT have been head-to-head at one of these shows.

I find the awards discussion with the BYTE editors at Comdex the best educational experience I get all year. This year's debate was lively but not heated.

We all agreed that OS/2 Warp Connect had some technical advantages over W95, and, had it shipped a year ago, it would have made serious inroads into Microsoft's market share. OS/2 Warp Connect is neat, combining OS/2's generally solid 32-bit multitasking performance with real connectivity capabilities. It's not as versatile or secure as OS/2 plus OS/2 LAN Server, but it's a lot less expensive, and, as a peer-to-peer network, it beats Windows for Workgroups and, for that matter, W95.

W95 has pretty good connectivity and works well with Windows NT; but where it really shines is ease of installation. The clincher, though, was third-party applications. Spring Comdex was loaded with W95 applications ready to ship when the OS does. Some of those will be ported to OS/2 Warp. Some won't. But we didn't see any killer applications in development for OS/2 and OS/2 Warp. The developers are betting heavily on W95, and that makes it a cinch that it will have far more impact on the industry than OS/2. They haven't told me anything about it, but I presume IBM is planning a version of Warp to be compatible with W95.

That was a few weeks ago. Today I went down to the Electronic Entertainment Exposition (E3). The Los Angeles Convention Center was filled with every conceivable form of electronic game, from classic revivals—you can get the original Asteroids on a game cartridge—to highly complex games that come on multiple CD-ROMs and have live action with movie stars. It's a big show, with lots of hype and glitter, and lots of live entertainment. It's the sort of thing we used to expect from Hollywood, and, I have to confess, I'm glad to see some of the Hollywood glitter return.

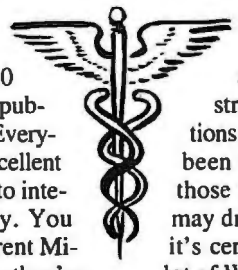
There was glitter enough for all—huge screens and giant speakers, live music in the corridors, parties galore, people in weird costumes, starlets and hunks as booth bait, and the best pressroom lunch I've seen in years. Although the biggest displays were for SEGA, Nintendo, and other dedicated games machines, there was plenty of software for "real computers" of both the PC and Mac persuasions. While most of the entertainment was bash 'em and shoot 'em games, there were also a lot of educational products. The show was big and exhausting, and I'm glad I went.

IBM was located right up front in the main hall, and there was quite a lot of IBM entertainment and educational software, including what looks

ILLUSTRATIONS: KATE MARION © 1995

to be an excellent hospital emergency room game. Some of this was under in-house development, but more was in cooperative development with third-party programming shops.

Microsoft was at the far end of the hall. They're aggressively going after the home market. As you'd expect from the outfit that released Bookshelf nearly 10 years ago, they've got a lot of published titles, with more coming. Everything from new entries in their excellent composer series to word games to integrations of science and history. You can't afford to be without a current Microsoft Home Products catalog—they're adding really good titles every few weeks.



Microsoft also had a display devoted to W95—and in addition to in-house titles, they gave display space to third-party companies writing W95 applications.

Meanwhile, back at the IBM booth, there was no OS/2 display and no OS/2 applications. All the software I saw was being developed for DOS or Windows and will be available on W95 before there's an OS/2 version. Think on that for a moment. Moreover, a couple of weeks ago, Microsoft, to great cheers from programmers, told a convention of games developers about new software tools that will allow them direct access to the video and sound hardware.

In a word: it's not just the third-party developers who think W95 will dominate the home and education markets. IBM's in-house software developers do, too; and if IBM has any corporate strategy for supporting applications development on OS/2, it hasn't been very successful even among those that IBM showed at E3. You may draw your own conclusions, but it's certain that you will be seeing a lot of W95 in the next few years.

I've been running W95 on Pentafluge, my main machine, for over a month, and although there are some minor annoyances, it's easier to use, and it works better than Windows. I like W95, and I'm installing it on most of the systems I use.

Alert readers will note that I said Pentafluge, not Big Cheetah, is now my main machine. It's a long story. The short form is that although Big Cheetah, with an Intel 66-MHz 486DX2 processor, and Windows 3.1 work together, that combination won't work with W95. The problem has to do with timing and the A20 line handler; I've written about this before, and I won't take up more time with it.

The bottom line is that Big Cheetah is temporarily out of service. When he returns, it will be as a W4WG workstation. Meanwhile, I've become sufficiently fond of W95 and the Pentium's speed that I'm keeping Pentafluge as my main machine. It's a real fire-breathing system (see my September 1994 column), and it has been stable for several months. I love it.

Part of my efforts to install W95 on Big Cheetah involved reformatting the hard drive. Shortly after that, Big Cheetah was simply out of service with hardware problems not due to W95, and I had no choice but to set up a new main system. Of course, the easy way to change main systems would have been to use the W4WG network to copy everything from Big Cheetah onto a couple of Maxoptix T3-1300 optical disks before I started mucking things up. Alas, I didn't do that. Instead, I relied on Palindrome's Network Archivist DAT (digital audiotape) system.

That would have worked fine if I had got the DAT drive working on Pentafluge.

continued

URGENT—YOUR INPUT NEEDED

On: Multimedia Development

Dear Reader:

To improve BYTE's coverage of technology in the State of the Art section, we'd like to get your feedback about what topics, areas, and products we should be considering, and in what ways. We're planning in the future to take a look at the state of multimedia development—the processes and systems that go into creating effective multimedia presentations, whether for corporate training, infotainment, educational systems, or self-help programs. We're thinking of covering some of the ins and outs of integrating and editing digital audio and music, video, and other animation and graphics, plus some of the programming approaches, techniques, and systems needed to make the final product work. We expect to look at some of the similarities and differences in designing and building multimedia for CD-ROM distribution as opposed to World Wide Web publication. But before we design our coverage, we'd like to hear what *you're* interested in, what you'd like to see us report on and analyze.

To let us know what you think, please use the following as a template to send us, via E-mail, an ASCII text file with your comments. Please be sure to include the <FIELDNAMES> with their angle brackets, followed by your information and comments. And thanks very much for your help.

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I could then install Network Archivist and let it go to work. Unfortunately, when I connected the external tape drive to the SCSI string, nothing happened. The rest of the SCSI system worked fine, but the tape drive was invisible. Worse, I had deadlines and needed files that existed only on Network Archivist tapes.

Pentafluge was connected to the network; W95 can talk to OS/2 Advanced Server, Windows NT Server, and W4WG with no trouble at all. I installed the Future Domain SCSI board that used to be in Big Cheetah into SuperCow, the Gateway 2000 486DX2/66 running W4WG. That worked, but what I couldn't do was make Network Archivist restore any files anywhere but to the logical drive it thought they came from. There's doubtless a way to accomplish this, but I sure couldn't manage it. Thus, I could write all my Q&A Write BYTE files to SuperCow's C drive, but not directly to Pentafluge's C drive, which SuperCow sees as the R drive.

I found myself transferring files from SuperCow to the Maxoptix optical disk to make room on SuperCow's C drive, restoring files from tape to that C drive, and then using the network to move those files over to Pentafluge's C drive. It was tedious, but it worked.

About then, Alex wanted to install Windows NT on Little Cheetah, the 50-MHz 486DX2 system. This time, we backed up all its files onto optical disks before he started.

Little Cheetah is an old system, and neither its hard drive controller nor its CD-ROM drive were recognized by Windows NT. We solved the CD-ROM problem by installing a new Creative Labs Sound Blaster AWE32 sound card with the Blaster CD 4X CD-ROM drive kit. The installation was simple, the CD-ROM drive is faster than blazes, and the sound is great. The whole process took under an hour. If you need sound and CD-ROM in a hurry, Creative Labs is the way to go. Nearly everything supports it, their instructions are well written, and things tend to go smoothly.

Changing controllers was nearly as simple with the AdvanSys PCI (Peripheral Component Interconnect) Bus Master Silver Kit. We put the AdvanSys SCSI controller in a VL-Bus slot, popped in the setup disk, and followed instructions. Since we didn't have to swap disk drives or do much fooling with hardware, the whole thing took under half an hour.

The AdvanSys SCSI controller is fast, the setup is easy, and the instructions are simple. It will run your SCSI CD-ROM drives and other SCSI peripherals. Like the Distributed Processing Technology controller, it has a 50-pin miniconnector on the back, so you can have internal and external SCSI devices. It also senses whether or not there's an external device and adjusts termination accordingly.

The AdvanSys software is well thought out. The company furnishes a boot floppy disk, which you use to check out the SCSI bus and devices; once that's done, you boot up normally. The instructions are clear, and, assuming your hardware works properly, you won't have any problems installing DOS/Windows, W95, or NT. I've been running the AdvanSys SCSI controller for two weeks with heavy use, and I've had no problems.

I haven't been running NT very long. I can say it's harder to install than W95. Among other things, NT wants you to know a lot about I/O port addresses, interrupts, and such, which W95 automatically goes out and finds. Indeed, one Microsoft techie told me that when he's got to install NT, he first gets W95 up and running and uses it

to investigate all the pertinent facts about the system. He records those and then installs NT and feeds it the information he learned from W95.

Once we had Little Cheetah running, I wanted to test the external drive port on the AdvanSys controller. We connected it up and had the same results we had with Big Cheetah: the SCSI bus worked fine, but the machine couldn't find the tape drive.

We know the tape drive works; but it normally works with one of those SCSI cables that has what looks like an RS-232 connector on one end and a big 50-pin SCSI connector on the other. Both the AdvanSys and Distributed Processing Technology controllers have small 50-pin connectors. I had only one small-50-pin-to-big-50-pin SCSI cable, so I used it in both places; it was brand new, but it sure looked like that cable was the problem.

There was one way to find out: I called Granite Digital and asked them to send me a small-50-to-big-50 SCSIVue Gold Diagnostic Cable. I presume you can find other reliable sources of SCSI cables, but I am darned sure about Granite Digital. Their cables work, and the diagnostic flashing lights will tell you what's going on with your SCSI system.

That took care of the problem. As soon as we connected the tape drive with the Granite Digital cable, the AdvanSys controller recognized it. When we used a Granite Digital SCSIVue Gold Diagnostic Cable to connect the unit to the Distributed Processing Technology controller in Big Cheetah, that worked, too.

The moral of this story is simple: if you have a SCSI problem, first check termination. The easy way to do that is with one of the little Granite Digital SCSIVue Diagnostic Terminators. If termination is all right, try a cable known to be good, preferably one of the SCSIVue Gold Diagnostic Cables. So far I haven't had to do anything else. *All* my SCSI problems have been either termination or cables.

If you work with SCSI much, keep a Granite Digital SCSIVue Diagnostic Terminator and a few of its diagnostic cables around. They'll sure save you time and trouble. Highly recommended.

Before we fired up NT on Little Cheetah, we installed the Intel Pentium OverDrive chip. Little Cheetah began life as a 486/25 and then was upgraded to a 486DX2/50; now it's a sort-of Pentium. Installation was utterly simple: remove old chip, insert new. The system fired up without problems, and there was no difficulty installing NT. They're not yet shipping a Pentium OverDrive chip for 486/33 systems, but if you have a 486/25, such as one of the old Tandy Sensation systems, you can give it new life with a Pentium OverDrive chip. Performance improvements are said to average about 90 percent over a 486DX2 and about 150 percent over a straight 486/25. While I haven't done extensive tests, that seems about right.

The only drawback we've found to the Pentium OverDrive chip is that it has a fan mounted on it. The fan is powered off the motherboard, so that's not a problem; but the chip plus fan are more than an inch thick, so if your motherboard has the CPU in the board-installation area—ours does—you'll have to arrange things so that the slot opposite the OverDrive chip is occupied by a short board.

Little Cheetah is noticeably speedier since we installed the Pentium OverDrive. The upgrade price is a bit steep, and I doubt I'd buy one for a system that already has a 486DX2/50, but the improvement over the standard 486/25 is dramatic. Recommended.

continued

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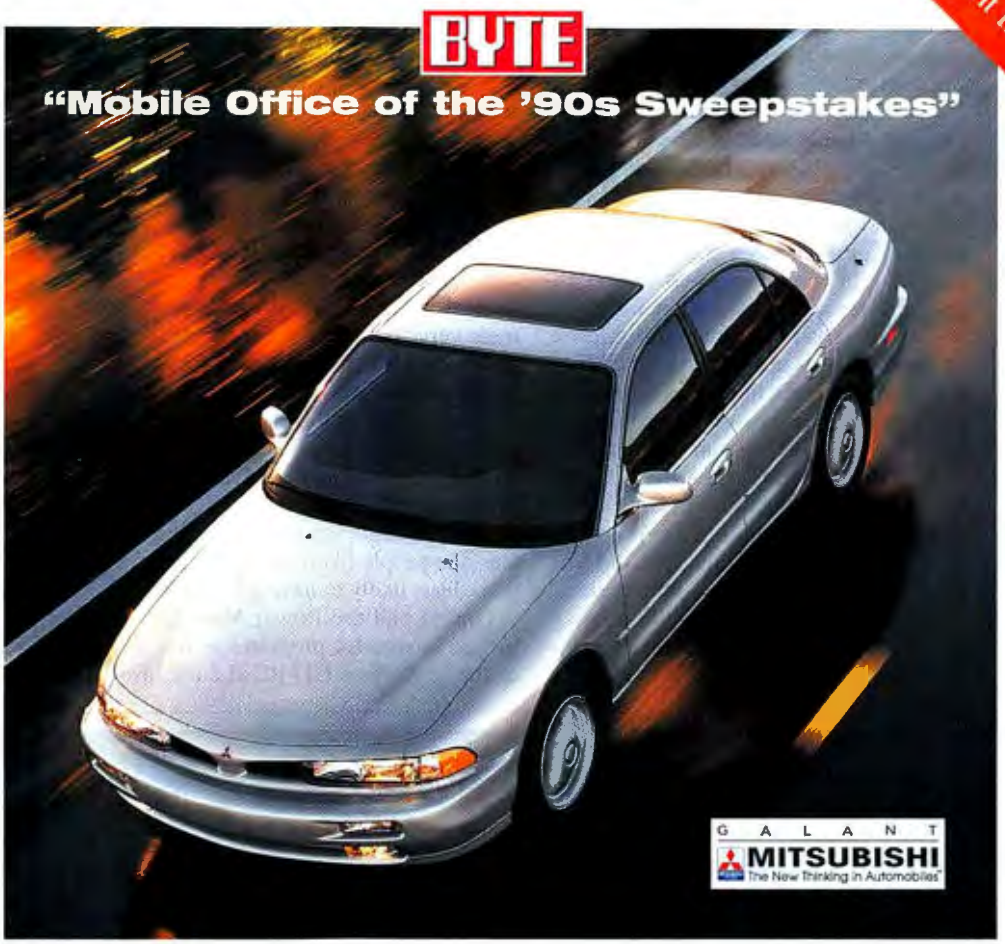

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SWEEPSTAKES RULES

The contest is open only to U.S. residents who are licensed drivers, 18 years of age or older. No purchase necessary. Entrants should fill out their daytime telephone number as indicated on the official entry form. You may obtain an entry form by sending a self-addressed envelope to BYTE Mobile Office of the '90s Sweepstakes, One Phoenix Mill Lane, Peterborough, NH 03458 by November 15, 1995 or fax to (603) 924-2535. Limit: one entry per person.

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

The winner shall be required to sign an affidavit of eligibility and a liability/publicity release which releases McGraw-Hill, Inc., from liability in connection with the winner's use of the prize, and permitting McGraw-Hill to use the winner's name and likeness to promote the contest where permitted by law.

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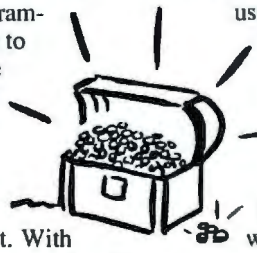
One prize to be awarded: a 1996 Mitsubishi Galant LS (approximate value: $23,088), plus various mobile computing tools described above; total prize value: $36,052. Vehicle specifications, including color, will be determined by Mitsubishi Motors. Standard manufacturer's vehicle warranty will be provided. Vehicle will be delivered to Mitsubishi dealer closest to winner's locale. Winner is responsible for registering, licensing, and insuring the vehicle. The prize is not redeemable for cash, nor is substitution of the prize by the winner allowed. The winner is responsible for any and all taxes associated with the acceptance of the prize. BYTE reserves the right to substitute a comparable prize upon unavailability. For the name of the winner, send a self-addressed, stamped envelope after November 16, 1995 to Marketing Dept., Mobile Office of the '90s Winners, BYTE Magazine, One Phoenix Mill Lane, Peterborough, NH 03458.

Apple had a fairly small booth at E3. That's a bit odd, because they had graphic games when S-100 computers were stuck with character-based games like Rogue; and the Mac pretty well introduced the modern era of computer games. Even more interesting, if you ask games programmers about the easiest system to write for, they'll say it's the Power Mac. David Joyner of Dreamer's Guild said, "Putting up Doom is an afternoon's work on a Power Mac," and while he's exaggerating a bit, he has a point. With the PowerPC processor, you can do all your calculations in floating-point math, and it will be as fast as integer arithmetic on Intel chips—and the PowerPC does floating-point math in parallel with other processes. Expect great things for Power Mac (and PowerPC systems in general).



We recently got a new Power Mac 8100/100 AV, but I haven't had much time to play with it. Like all Macs, it sets up easily. One of the first things we did was install all the new Mac speaking voices, including some we have from the product developer. I found some oddities. For instance, the keyboard says that the function of the Delete key depends on the OS and application, and that's sure true. In the Simple Text editor, that key, instead of deleting characters, inserts an invisible character that causes the voice to pause when it reads it. That capability can be useful, but if this feature is documented, I haven't found it.

The first application installed on the Power Mac was Roberta's reading-instruction program. The shipping version works like a charm, although some of the displays whizzed past a bit faster than we'd intended—the Power Mac really is fast. We're testing the development version that has the machine do the instruction; her currently shipping version needs someone who can read to serve as an instructor. The problem is that getting a good speaking voice that can read scripts takes a lot of memory and CPU power. If everyone had a Power Mac, it would be a simple job to get her program going, but, alas, the people likely to need it most are those least likely to have a Power Mac.

Once I had the Power Mac going, I looked around for programs to run. One of the first was a CD-ROM called Lost Treasures. Unfortunately, this is the kind of CD-ROM that makes you regret that CD-ROMs were ever invented. It has a wealth of information that you'd like to get at, but the interface makes you go around Red Robin's barn to find anything. It doesn't let you use a command line to look for something; instead, you have to work through endless screens.

When I was younger, I was quite a fan of lost treasures, partly because my great-grandfather MacKinnie was involved in recovering some of Laffite's gold in a Louisiana bayou. The story has been published a couple of times, but I'm dashed if I can find anything about it on this CD-ROM. It may be there, but that interface has defeated me.

When I was in high school, I recall reading about the Oak Island treasure (Oak Island is off the coast of Nova Scotia), so I looked for that, too, and found about a paragraph with less information than I can recall from a book I read 50 years ago.

I presume there's some useful information in the Lost Treasures CD-ROM, but you'll get more from good library books.

The last time I wrote about WizRule, I had the program but no clue as to how to buy a

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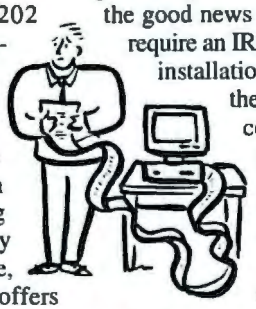
A120

copy. Now there's a new version for Windows from a company called WizSoft. WizRule will examine your databases—dBase, Clipper, Foxbase, or Paradox—and look for rules. An example of a rule might be, "If Customer is Franklin or Penn or Balboa, then City is Philadelphia; probability 0.98. The rule exists in 202 records." It will then list the exceptions.



Some of those exceptions may be database errors. WizRule is quite good at finding such things. Some rules will be trivial; but some of them may be extremely helpful in gaining insight into the way your company works. You may find, for example, that one salesperson consistently offers higher discounts than the others, or that one is far more productive in midweek than on Mondays or Fridays.

If you've got large databases, you probably have a wealth of information in there that you don't know about, and you need WizRule to get the most out of that data. It's pretty nifty.

David Mitchell describes Scanfx as something like a minivan: it doesn't do anything spectacularly well, but it does a lot of things more than adequately.

Scanfx is a combination color scanner, fax modem, and fax receiver. It connects to a phone line, and to both your computer and your printer, so that you can use it as a copier—just scan something and then print the copy; a plain-paper fax receiver; a normal fax machine; and a modem for sending faxes composed with a program such as WinFax. It comes with Calera's Optical Character Reader, meaning that it can translate typescript and some printed documents into machine-readable files.

Scanfx has the virtues and the limits of all sheet-feeder systems. It can feed itself a stack of paper, but you can't copy a book page or something oversize.Scanfx installs quite easily. You do have to install a board; the good news is that the board doesn't require an IRQ (interrupt request). The installation software is simple, and the system comes with a test color photograph; you can get it installed and tested in under 10 minutes. After that, it's pretty routine.

You wouldn't want to use Scanfx as the only copier in a busy office, but that's not its primary purpose. For copying an occasional page, it's pretty nifty; and, of course, you can use Optical Character Reader to scan the document into a machine-readable file and then reformat it in Word and print as many copies as you like.

If, like me, you hate curly faxes, but every time you look at the cost of a plain-paper fax you decide that curls aren't so bad after all, look into Scanfx. It may be just what you need.

The CD-ROM of the Month is Microsoft Encarta '95. Microsoft went to an awful lot of trouble to make this multimedia encyclopedia both informative and enjoyable, and that planning paid off. If you're planning on publishing a CD-ROM, look at this one to get some ideas on how it ought to be done.

The game of the month is Discworld from Psygnosis. For those who, like me, are addicted to English novelist Terry Pratchett's Discworld fantasies—set on a world that is, in fact, a disk carried by four elephants standing on the back of a giant turtle swimming through space, a world in which there can be intelligent if homicidal luggage, as well as wizards who study at the Unseen University—the Discworld game is a hoot. If you've never heard of Pratchett, and thus don't understand the rather obscure logic he uses, I suspect the game will drive you mad.

The book of the month is *The Death of Common Sense: How Law Is Suffocating America* by Philip K. Howard (Random House, 1994). If you suspect litigation and regulation have gotten out of hand, you'll be certain of it once you read this book. Some of the examples he gives are hilarious—until you realize it's all deadly serious, and people are fined, jailed, and driven out of business for transgressing absolutely senseless rules.

Next month, more on the Power Mac, including some educational software; a lot more on W95; and quite a lot of math and simulation software. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on the Internet or BIX at jerryp@bix.com.

For More Information

For those who, like me, are addicted to Terry Pratchett's Discworld fantasies, the **Discworld** ($39.99) game is a hoot. Contact **Psygnosis, Ltd.**, Cambridge, MA, (800) 438-7794 or (617) 497-5457; http://www.sony.com. **Circle 1240 on Inquiry Card.**

Microsoft went to a lot of trouble to make **Microsoft Encarta '95** ($99.95) both informative and enjoyable. Contact **Microsoft Corp.**, Redmond, WA, (800) 429-9400 or (206) 882-8080; http://www.microsoft.com. **Circle 1241.**

OS/2 Warp Connect (full-pack edition with Win-OS/2 code, $299) is neat, combining OS/2's mostly solid 32-bit multitasking performance with real connectivity capabilities. Contact **IBM Corp.**, Austin, TX, (800) 342-6672 or call your local IBM dealer; http://www.ibm.com. **Circle 1242.**

The **PCI Bus Master Silver Kit's** ($379) SCSI controller is fast, and the setup is easy. Contact **AdvanSys**, San Jose, CA, (800) 525-7443 or (408) 383-9400; http://www.advansys.com. **Circle 1243.**

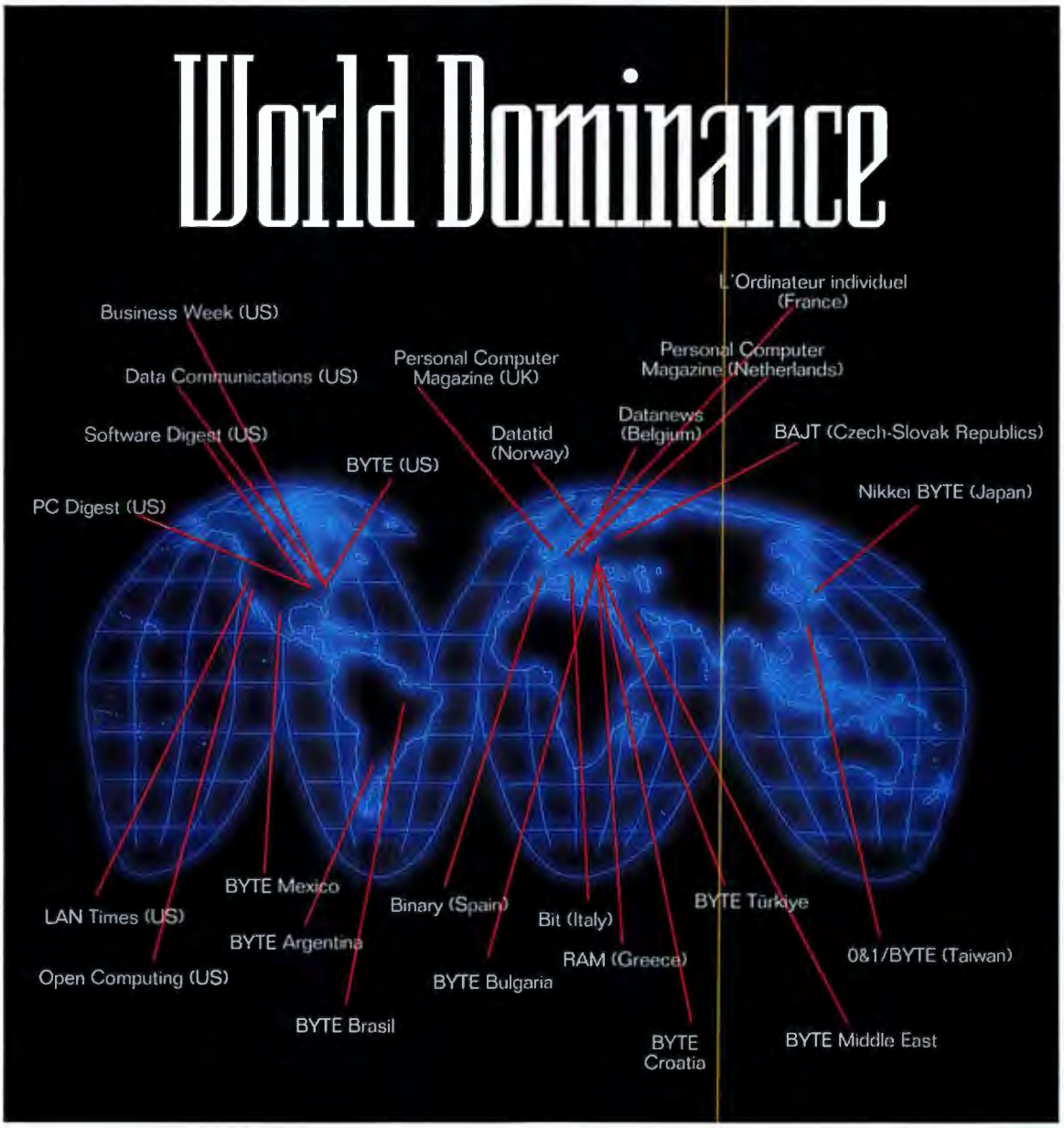
Little Cheetah is noticeably speedier since we installed the **Pentium OverDrive** chip ($449). Contact **Intel Corp.**, Santa Clara, CA, (800) 548-4725 or (408) 765-8080; http://www.intel.com. **Circle 1244.**

Scanfx ($599) is a combination color scanner, fax modem, and fax receiver. Contact **Plustek U.S.A., Inc.**, Sunnyvale, CA, (800) 685-8088 or (408) 745-7111. **Circle 1245.**

If you work with SCSI much, keep a **SCSIVue Active Diagnostic Terminator** (50-pin Centronics, $59) and a couple of **SCSIVue Gold Diagnostic Cables** ($39 to $169) around. Contact **Granite Digital**, Union City, CA, (510) 471-6442. **Circle 1246.**

If you need sound and CD-ROM in a hurry, the **Sound Blaster AWE32** sound card (street price about $299) and the **Blaster CD 4X** CD-ROM drive kit (street price about $219) are the way to go. Contact **Creative Labs, Inc.**, Milpitas, CA, (800) 998-1000 or (408) 428-6600; goblaster@compuserve.com. **Circle 1247.**

If you've got large databases, you probably have a wealth of information in there that you don't know about, and you need **WizRule** (single license, $495) to get the most out of that data. Contact **WizSoft, Inc.**, Framingham, MA, (508) 620-4554; http://www.wizsoft.com. **Circle 1248.**



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What's New Hardware

PREVIEW **HIGH-SPEED PENTIUM PCS**

Gateway's 133-MHz Pentium

Gateway 2000's P5-133XL packages Intel's new 133-MHz Pentium processor in a nine-bay tower PC with numerous multimedia and communications options. The P5-133XL unit we tested came with a three-disk, quad-speed CD-ROM drive; a 17-inch Vivitron monitor; an ATI Mach 64 graphics accelerator card with 2 MB of video memory; an Ensoniq 16-bit wave-table sound card; Altec ACS-31 speakers; a 3½-inch floppy drive; 16 MB of EDO memory, expandable to 64 MB; a 1.62-GB IDE hard drive; a 28.8-Kbps modem with a TelePath II telephone-answering device; a keyboard and mouse; and bundled Microsoft software.

Performance

	P5-120	P5-133XL
Integer index	1.32	1.46
Floating-Point index	1.29	1.64

(A 90-MHz Dell Pentium XPS/90 scores 1.00 on both tests.)

Running BYTE's Native Mode benchmarks, the P5-133XL showed improvements of 10 percent in integer performance and 27 percent in floating-point performance over Gateway's 120-MHz Pentium-based P5-120 (see the table above). In addition to its faster Pentium processor, the P5-133XL's host bus (the interface between the CPU, the memory, and the 256-KB cache) and PCI (Peripheral Component Interconnect) peripheral bus also run slightly faster—at 66 and 33 MHz, respectively, compared to 60 and 30 MHz in the P5-120.

Gateway 2000 P5-133XL
As reviewed, $4399
Gateway 2000
North Sioux City, SD
(800) 846-2000
(605) 232-2000
On CompuServe, go gateway
Circle 1035 on Inquiry Card.

The price of the Gateway 2000 P5-133XL is comparable to what its 120-MHz Pentium-based predecessor cost upon its introduction. The 133-MHz Pentium processor, combined with the three-disk CD-ROM drive option, makes the P5-133XL an excellent system for power users.

—Dave Andrews

THREE-IN-ONE VIDEO BOARD

The T230 Pro ($350) combines video acceleration, video capture and playback, and videoconferencing functions on one 32-bit graphics card designed for use with the PCI bus. The T230 Pro board comes with Tseng Labs' ET4000/W32P and Viper video accelerators, which maintain a steady 90-Hz refresh rate for flicker-free displays; 1 MB of DRAM ($310), upgradable to 2 MB ($350); and video capture and playback in NTSC and PAL formats. True-color modes extend to as many as 16.7 million colors with screen resolutions of up to 1280 by 1024 pixels. An internal 26-pin feature connector lets you add real-time video, and the board comes with an RCA connector for composite video input and an S-video connector for video recording and editing. The LeadPhone option supports two-way live-action color videoconferencing, transmitting video images from a desktop camera via a modem and an analog telephone line.
Contact: Leadtek Research, Fremont, CA, (510) 490-8076.
Circle 978 on Inquiry Card.

DIGITIZER SYSTEMS

Available in both 12- by 12-inch ($495) and 12- by 18-inch ($995) sizes, the Ultima II digitizers are compatible with most desktop publishing, CAD, graphic arts, and software applications for DOS, Windows, Sun Microsystems, and Unix systems. Cordless and corded pointing devices are available. The cordless pressure-sensitive stylus supports dynamic sensing capabilities, such as tilt, pressure (256 levels), and proximity. The tablet's surface menu includes 18 user-recordable macro blocks plus up to 16 additional user-recordable macro blocks from the pointing device.
Contact: GTCO, Columbia, MD, (800) 344-4723 or (410) 381-6688.
Circle 979 on Inquiry Card.

CELLULAR PCMCIA FAX MODEM

Incorporating MNP 10EC, the Smart ST1414C ($239) cellular PCMCIA fax modem supports 14.4-Kbps transmit and receive with fallback capability; MNP 2 to 5, V.42bis, and V.42, which allows a throughput of up to 57.6 Kbps; V.32bis, V.32, V.22bis, V.22, V.21, Bell 212 and 103 standards; and automatic line equalization for poor connections. You can print incoming faxes, schedule faxes to take advantage of lower phone rates, and send faxes to multiple destinations.
Contact: Smart Modular Technologies, Fremont, CA, (800) 536-1231 or (510) 623-1231; 74431.462@compuserve.com.
Circle 988 on Inquiry Card.

ALR'S PENTIUM SERVER

Supporting RAID levels 0, 1, and 5, the Revolution Q-SMP multiprocessor file server can handle up to four 90-MHz ($6495) or 100-MHz ($6795) Pentium processors. You get a choice of Level 2 cache: 256 KB, 512 KB, 1 MB, or 2 MB. The server also offers ALR's QuadFlex SMP architecture, FlashBIOS, and NetTune Server Management. Both machines come equipped with 16-MB EDC RAM, expandable to 1 GB; six EISA bus-mastering and four PCI bus-mastering expansion slots; 13 drive bays (18 with the optional Quick Hot Swap II kit); 1-MB PCI local-bus video; and a 1.44-MB floppy drive. Interfaces include two high-speed serial ports, one parallel port, one mouse port, and a keyboard port.
Contact: Advanced Logic Research, Irvine, CA, (800) 444-4257 or (714) 581-6770; http://www.alr.com.
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WIRELESS KEYBOARD ▼

Now you can use your PC as an integral part of your presentations taking place at distances of up to 30 feet away from your computer. The RF-50 Wireless Keyboard and Mouse Touchpad ($499.95) consists of a compact

83-key keyboard, a mouse touchpad pointing device, and an RF transmitter/receiver. The touchpad allows fast and accurate movement of the screen cursor as you simply glide your finger over its 2- by 3-inch surface.
Contact: Wireless Computing, Irving, TX, (214) 719-2515.
Circle 999 on Inquiry Card.

PARALLEL-PORT BUSINESS-CARD SCANNER ▲

CardScan Plus ($299), a dedicated parallel-port business-card scanner and Windows software, allows you to scan business cards without leaving your PIM. The software automatically recognizes names, titles, company names, addresses, phone numbers, fax numbers, and E-mail addresses and stores them in an electronic Rolodex-like format. You can instantly view scanned card images, add custom notes to records, send letters and faxes, and browse and search for information. In addition, you can find a contact and automatically dial his or her phone number.

Contact: Corex Technologies, Brookline, MA, (800) 942-6739 or (617) 277-5344.

Circle 987 on Inquiry Card.

486 AND PENTIUM PCs

Epson's ActionTower 8000 and 7000 Series PCs feature Pentium and 100-MHz 486DX4 processors, respectively. Both lines include multimedia capabilities; PCI local-bus architecture; a 16-bit, a 14.4-Kbps fax modem with such telephony features as a full-duplex speakerphone, VoiceView capability, and a phone-like user interface; a quad-speed CD-ROM drive; a stereo sound card; a microphone; a 1.44-MB floppy disk drive; and amplified stereo speakers. In addition, both systems come with Internet connectivity, Epson's FocalPoint user interface, and on-line documentation in English, French, and Spanish.

Based on a 75-MHz Pentium processor, the ActionTower 8200 ($1999) comes equipped with 8 MB of RAM; 256 KB of cache memory; 1 MB of video memory; and a 540-MB hard drive. The ActionTower 7500 ($1699) includes 8 MB of RAM, 1 MB of video memory, and a 540-MB hard drive.

Contact: Epson America, Torrance, CA, (800) 289-3776 ext. 3000 or (310) 782-0770; on CompuServe, go epson.

Circle 983 on Inquiry Card.

CONVERTIBLE NETWARE PRINT SERVER

A single-protocol print server, the PocketPrintServer ESI-2830A ($299) can change from NetWare to Unix or Windows NT, and it lets you connect a printer anywhere on a Novell Ethernet network.

Contact: Extended Systems, Boise, ID, (800) 235-7576 or (208) 322-7800; http://www.extendsys.com.

Circle 986 on Inquiry Card.

120-MHz PENTIUM TOWER SYSTEM

The Diamond P120 tower system offers a choice of 75-, 90-, 100-, or 120-MHz Pentium processors and comes with 16 MB of RAM, a quad-speed CD-ROM, a 1-GB hard drive, a 3½-inch 1.44-MB floppy drive, a 14.4-Kbps send/receive fax modem, and a 16-bit sound card. The Diamond P120 video lineup ($1889 to $3999) features a 64-bit PCI graphics accelerator and low-radiation color monitor. The top-of-the-line ADI 17-inch 26-mm dot-pitch monitor gives you a resolution of 1280 by 1024 pixels with 256 colors at 75 Hz.

Contact: DFI, Sacramento, CA, (800) 808-4334 or (916) 568-1234; info@dfiusa.com.

Circle 981 on Inquiry Card.

VIRTUAL OFFICE GEAR

With Virtual Office Gear, coworkers can collaborate efficiently without being in the same building. A TAPI-compliant ISA communications card, PhoneWorks provides voice mail, telephone control, caller ID, audio, 14.4-Kbps fax/data communications, and a speaker/microphone (single-line version, $399; dual-line version, $699). The Cruiser program ($199 per user) can track team members, their activities, and their communications. It includes MAPI-compliant E-mail, group scheduling, a calendar, messaging, and an address book. A PCMCIA communications card, PhoneWorks To Go ($229) includes voice mail, 14.4-Kbps fax/data communications, and telephone control. Designed to let you add music, voice, and sound effects to multimedia presentations, the SoundGear ($209) PCMCIA audio card includes a wave-table MIDI engine, speakers, a microphone, and the Windows Sound System. Finally, LANdingGear ($199) is a 10Base-T/10Base-2 PCMCIA Ethernet adapter that gives network access to a laptop PC.

Contact: ConnectWare, Harrisburg, PA, (214) 997-4439.

Circle 982 on Inquiry Card.

3-D VIDEO-INPUT DEVICE ▼

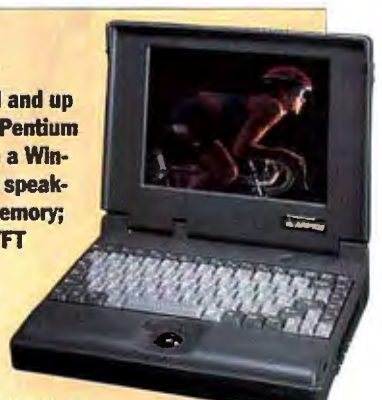
With CyberMouse ($99), you can move an on-screen cursor back and forth both vertically and horizontally, as well as through and around objects. The 3-inch-long band, which you simply wrap around your index finger, has two mouse-like buttons and beacons that transmit ultrasonic beams to sensors located on a 1-inch-wide plastic cradle that wraps around a side of your monitor.

Contact: IPC Peripherals, Fremont, CA, (510) 354-0800.

Circle 994 on Inquiry Card.

100-MHz PENTIUM NOTEBOOK

The Universa P-100 (from $2750) combines up to 40 MB of RAM and up to an 810-MB removable hard drive with a 75-, 90-, or 100-MHz Pentium processor. The notebook also comes with an enhanced BIOS with a Windows accelerator; 256 KB of secondary cache memory; a built-in speaker and microphone; a 1-inch (25-mm) trackball; 1 MB of video memory; a 10.3-inch dual-scan, passive color screen or 10.4-inch active TFT color screen; two PCMCIA Type II or one Type III slot; and hot-swappable batteries for more than 2 hours of mobile computing power. Built-in Microsoft Sound– or Sound Blaster–compatible digital audio lets you record, compress, store, and play back voice, sound, and music.



Contact: Aspen Computer, Buffalo, NY, (800) 472-3273 or (716) 626-0315.

Circle 976 on Inquiry Card.

What's New Hardware

Rugged 486 Pen-Based Hand-Held System

A pen-based hand-held computer, the wireless Badger GT-486P2 ($4495) offers the functionality of a full-size 486 PC and is rugged enough to withstand harsh environments and industrial field conditions. Embedded wireless options support cellular/CDPD, Ardis, and RAM radio modems. Features include a 25-MHz 3.3-V Cyrix 486SLC microprocessor, upgradable to 50 MHz; a 40-MB hard drive, upgradable to 340 MB; 4 MB of RAM, upgradable to 16 MB; a 6-inch backlit VGA (640 by 480 pixels) display; two PCMCIA Type II or one Type III slot; and I/O ports for serial, parallel, external keyboard, external VGA, and local-bus capability. An optional docking station for use inside vehicles includes interconnections for infrared, RS-232 with an external keyboard option, and one parallel port.

Contact: Badger Computers, Tampa, FL, (800) 322-3437 or (813) 972-6562; badger@grtk.com.

Circle 977 on Inquiry Card.

Simultaneous Voice and Data Modem

Now PC users can talk and share applications simultaneously over a single analog telephone line. The Sportster Vi 28.8 Faxmodem with DSDV card ($399) incorporates digital simultaneous voice and data communications. This new specification lets you exchange information such as voice, graphics, photographs, and video and offers scalability, advanced voice compression, and the ability to add new modem technology in the future. An external model is currently under development. The modem package includes Intel's ProShare Premier Edition Software, a personal data-conferencing application.

Contact: U.S. Robotics, Skokie, IL, (800) 342-5877 or (708) 676-7010; http://www.usr.com.

Circle 984 on Inquiry Card.

Ethernet Micro Hub

With five UTP ports, Hubby connects small workgroups to a 10Base-T Ethernet network. You can connect Hubby ($99) to workstations, laptops, and print servers or cascade it with other 10Base-T hubs using one of its UTP ports or a transceiver for connections to coaxial cabling. You can also use Hubby to set up temporary networks for projects or to connect small offices, remote sites, and home offices. LEDs indicate power, collision, link, and receive.

Contact: D-Link Systems, Irvine, CA, (800) 326-1688 or (714) 455-1688; sales@irvine.dlink.com.

Circle 985 on Inquiry Card.

Active-Matrix LCD Projection Panel ▼

Version 2.0 of the Ovation+ 920 ($10,995), a workstation-compatible, active-matrix LCD projection panel, can display 1280- by 1024-pixel images in 16.7 million colors. With a data rate of 135 MHz, the panel can pan freely around its 10.4-inch screen and expand a 640- by 480-pixel image to fill the screen. You get remote control of your software through Proxima's Cyclops cordless mouse and a LightBoard feature that enables you to highlight information on the projected image.

Contact: Proxima, San Diego, CA, (800) 447-7694 or (619) 457-5500.

Circle 992 on Inquiry Card.

Portable Laser Scanner

With 34 splash-resistant alphanumeric keys, including four programmable keys, TopGun lets you either key in or scan in data. Consisting of a Percon PT 2000 portable data-collection terminal and a TopGun laser module ($795), the package ($1590) provides an easy-to-read 4-row by 16-column LCD window that lets you scroll through and review up to 24 lines of data. A real-time clock and calendar let you time- and date-stamp any record. TopGun offers data-storage memory of 128 KB, which you can upgrade to 256 KB, 512 KB, or 1 MB. For additional applications, you can remove the TopGun module and attach a tethered input device, such as a 5-V laser, ID-badge scanner, wand, CCD, or single-track magnetic-stripe reader.

Contact: Percon, Eugene, OR, (800) 929-7899 or (503) 344-1189; info@percon.com.

Circle 989 on Inquiry Card.

Internal Tape Backup

Based on Travan technology, the HP Colorado T1000 ($235) is a QIC-80-compatible system that provides a 400-MB native capacity (800 MB using data compression) on a single Travan minicartridge. It interfaces through your PC's floppy drive controller. The internal drive includes Colorado Backup for DOS and for Windows, which provides unattended backup scheduling, an automated daily backup option, and support for popular networks. The HP Colorado T1000 can back up your data at up to 9.5 MB per minute and provides automated, scheduled, and customized backup flexibility.

Contact: Hewlett-Packard, Palo Alto, CA, (800) 810-0133 or call local Hewlett-Packard dealer; http://www.hp.com.

Circle 991 on Inquiry Card.

800-MB Tape Storage ▲

A QIC-80 minicartridge tape backup system, the Tape•Stor 800 uses 3M's Travan media to boost the compressed capacity from 250 MB to 800 MB. The tape drive writes data at up to 9.5 MB per minute and transfers data at 500 Kbps or 1 Mbps, depending on the floppy drive controller. The system's FastSense feature automatically senses the speed of the host system and uses the fastest available data transfer rate. The Tape•Stor 800 is available in internal floppy-interface ($235) and external parallel-port ($399) models.

Contact: Conner Tape Products Group, Costa Mesa, CA, (800) 626-6637 or (714) 641-1230.

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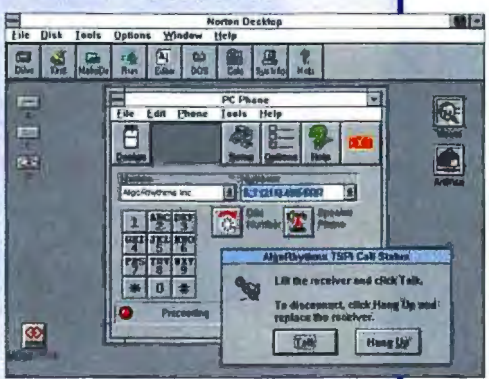
What's New Software

PREVIEW **ALGORHYTHMS' PHONEKITS**

Intelligence Comes to PC Phones

PhoneKits ($79.99) is communications-assistant software for Windows that turns your PC into a personal phone manager. It works with TAPI-compliant hardware, ranging from a simple modem to an integrated modem/telephone card.



The package consists of four tightly integrated modules: PC Phone, an on-screen phone with a construction kit that enables you to customize the features and look of the phone; Address Book, a PIM that enables you to enter contact names, addresses, multiple phone numbers, E-mail addresses, and notes, as well as print address lists, mailing labels, and envelopes; Answering Machine, which lets you set up voice-mail boxes and logs caller information from caller ID; and Call Log, which displays details for incoming and outgoing calls, including the time and duration of a call, who you called, and who called you (if caller ID is used). Call Log also uses caller ID to display your notes from previous conversations.

AlgoRhythms, Inc.
Dallas, TX
(800) 799-5487
(214) 490-5487
stanford@algorhythms.com
Circle 1002 on Inquiry Card.

In stand-alone mode, you can manually dial a number, or you can place calls from programmed speed-dial numbers or by looking up a number in the address book and then dialing it. A more powerful feature is PhoneKits' ability to dial from within Windows applications: You simply highlight a phone number and click on it. Similarly, when you highlight a person's name from within an application, PhoneKits searches the address book and pops up the number on your screen. To dial the number, you simply click on the mouse.

One of the great joys of using PhoneKits is its intelligence. For example, my office is in the 212 area code. Once I told it the area code from where I was dialing, the program took any phone number I'd entered with that area code and dialed it without my having to tell it not to dial the 212. Similarly, PhoneKits intelligently handles telephone extensions.

—Salvatore Salamone

SCALABLE SQL 4.0

With Scalable SQL 4.0, you can write one application that you can move from a palmtop PC to a large client/server configuration, on OSes ranging from DOS to OS/2 to Windows NT to NetWare, without modifying the application or the database. Version 4.0 of the software includes two-way replication; cost-based optimization; transaction-processing enhancements; programming extensions; standards enhancements; support for files up to 64 GB in size; date/time, unsigned, and currency data-type variables; and binary, large-object, data-type variables. Scalable SQL 4.0 (workstation engines, $149 per station; 10-user configuration, $995) also provides Visual Basic–compatible scripting, stored procedures, triggers, an ODBC driver, and IPX network protocol support.

Contact: Btrieve Technologies, Austin, TX, (512) 794-1719; on CompuServe, go btrieve.

Circle 1006 on Inquiry Card.

DAY-TIMER ADDRESS BOOK FOR WINDOWS

Day-Timer AddressBook lets you quickly and easily locate, sort, update, and print contact information. A contact file can contain multiple addresses; up to six phone numbers, E-mail addresses, and nicknames; and includes 12 customizable fields for other data. The program ($49.95) has an auto-dialer and phone log; a keyword-search function; and sorting by name, company, ZIP code, or follow-up date.

Contact: Day-Timer Technologies, San Mateo, CA, (800) 225-5005 or (415) 572-6260; sales@dtt.daytimer.com.

Circle 1007 on Inquiry Card.

SOFTWARE-ONLY VIDEO COMPRESSOR

A software-only technology, TrueMotion-S Compressor ($499) allows you to compress video onto your PC. The program provides video-editing and quality-control capabilities, reduces jerky or blocky motion to produce smooth images, and enables you to play video frames in forward or reverse. You can display your full-screen (640 by 480 pixels) smooth-motion video at more than 20 fps on 486/33-based PCs or Quadra 800 Macs.

Contact: Horizons Technology, San Diego, CA, (800) 828-3808 or (619) 292-8331; http://www.horizons.com.

Circle 1020 on Inquiry Card.

MAC COMPATIBILITY FOR THE LASERJET 5P

PowerPrint/5P offers Mac connectivity for the HP LaserJet 5P printer. The program provides such features as background printing, flexible scaling, 32-bit grayscale support, and cover pages. PowerPrint/5P (US$69) supports multiple paper paths, resolution enhancement, and TrueType and PostScript scalable fonts.

Contact: GDT Softworks, Burnaby, British Columbia, Canada, (800) 663-6222 or (604) 291-9121.

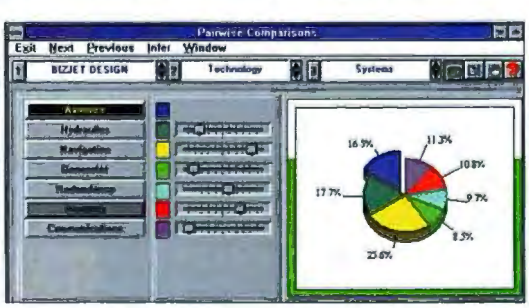
Circle 1009 on Inquiry Card.

DECISION-VALUATION SOFTWARE FOR WINDOWS ▼

Which & Why helps you analyze factual and emotional data to compare alternatives, rationalize conclusions, and reach the best possible decision. The program lets you quantify and rank each factor involved in a decision relative to every other factor to create a benchmark decision model. You can then use this benchmark to rate each alternative. Which & Why (US$349; DOS version, US$249) analyzes the input and then recommends the best alternative.

Contact: Arlington Software, Vancouver, British Columbia, Canada, (604) 844-7878; info@arlingsoft.com.

Circle 1015 on Inquiry Card.



SPEED UP WINDOWS ▲

Combining reporting and analysis features with speed-enhancement utilities, Hurricane ($79.95) speeds up both the Windows and Windows for Workgroups operating environments. The product consists of Discover for Windows, which analyzes Windows, DOS, and your PC and reports on such features as memory, video, resources, system usage, disk drives, and benchmarks; WinGauge, a real-time monitor that reports on problems and conflicts; and Hurricane Utilities, tools that solve speed, resource, and reliability problems. *Contact: Helix Software, Long Island City, NY, (800) 451-0551 or (718) 392-3100; on CompuServe, go helix.*

Circle 1011 on Inquiry Card.

SOLVE PCMCIA CONFIGURATION PROBLEMS

Now you can diagnose and solve your PCMCIA-card- and computer-system-configuration problems. CardWizard Pro ($69.95) lets you quickly troubleshoot card-configuration problems, resolve resource conflicts, view PCMCIA slot contents, receive notification of card activity, and launch applications upon card insertion. *Contact: SystemSoft, Natick, MA, (508) 870-0050.*

Circle 1019 on Inquiry Card.

GRAPHICAL FILE MANAGER FOR OS/2 WARP

FileStar/2 1.0 (single-user license, $99; 10-user license, $799) lets you view available disk drives, directory trees, and data files; move between directories to copy, move, rename, and delete files; and quickly locate files by filename or by text. The program conserves disk space by archiving files in ZIP format using the included InfoZIP products, and it lets you display the contents of archived files in a ZipView window and select them for browsing or decompression. *Contact: SofTouch Systems, Oklahoma City, OK, (800) 944-3028 or (405) 947-8080; 72274,3102@compuserve.com.*

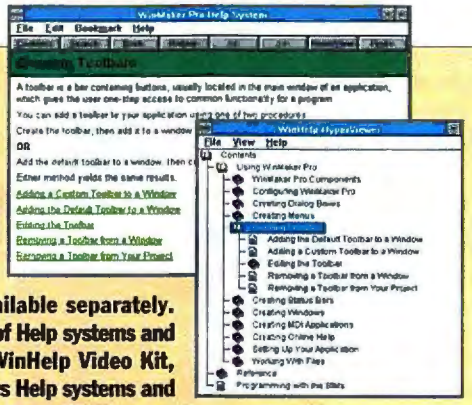
Circle 1012 on Inquiry Card.

ELECTRONIC DESIGN AUTOMATION FOR WINDOWS

MicroBench promises the ability to quickly convert product ideas into microcontroller-based products. You provide basic system parameters, such as the type of power, timing background, types of I/O, and memory. MicroBench then displays a block diagram reflecting your selections. Once the hardware elements are in place, you build your program from high-level keyword commands. Keywords are linked to modules of assembly code, which MicroBench ($695) stacks together to build the run-time program. The final result is a programmed 8-bit CPU and hard-copy documentation that includes a system block diagram, circuit schematics, a parts list, a program listing, and assembly-level object code. *Contact: MicroBench Software, Sunnyvale, CA, (408) 248-7776.*

Circle 1013 on Inquiry Card.

COMPLETE HELP-AUTHORING



WinHelp Office provides help authors with the tools they need for professional Windows Help development. The package ($599) includes RoboHelp, WinHelp Video Kit, WinHelp Tool Kit, WinHelp HyperViewer, Mastering WinHelp, and Moving to WinHelp 95. All the tools in WinHelp Office are also available separately. RoboHelp guides authors through the creation of Help systems and electronic hypertext documents. With the WinHelp Video Kit, you can integrate video and sound into Windows Help systems and create live-video product tutorials. WinHelp HyperViewer provides a fast way to search and explore Help systems. With the Mastering WinHelp video, new Help authors can quickly become productive and create professional Help systems in less than an hour, Blue Sky says.

Contact: Blue Sky Software, La Jolla, CA, (800) 677-4946 or (619) 459-6365; http://www.blue-sky.com.

Circle 1003 on Inquiry Card.

Software Update

Matrox Inspector 1.7, Windows imaging software for scientific and industrial applications, adds sophisticated scripting that lets you automate routines and develop applications without programming. You can extract precise measurements, vital statistics, and other information from images and develop proof-of-concept demonstrations. The Inspector Expression Builder lets you add built-in, user-definable, and external functions to a script. US$495.

Contact: Matrox Electronic Systems, Dorval, Quebec, Canada, (800) 361-4903 or (514) 969-6028.

Circle 1022 on Inquiry Card.

A development tool for building OSF/Motif GUIs for relational database applications, **TeleUse/DB 2.0** includes a database browser tool, a database template builder, open systems development facilities, automatic code generation, and advanced application-testing capabilities. $9000.

Contact: Thomson Software Products, San Diego, CA, (800) 833-0085 or (619) 457-2700; info@thomsoft.com.

Circle 1023 on Inquiry Card.

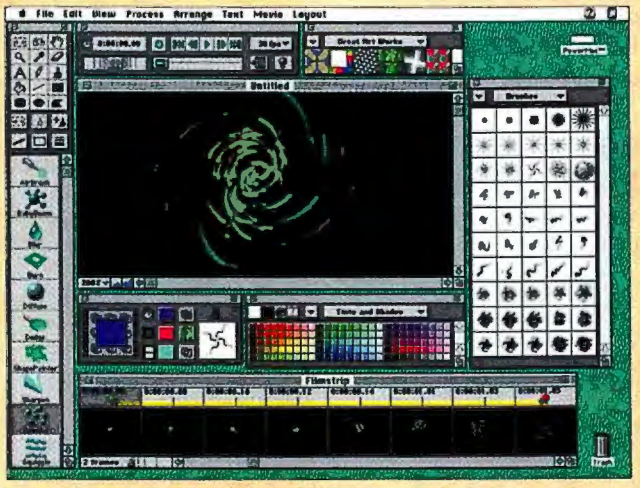
A software package that integrates IBM mainframe, AS/400, Digital VAX, and Unix connectivity, **Rumba Office 2.0** adds a common user interface, macros, and APIs across all hosts. It also provides client/server access to hosts, access to HP 3000 and 9000 host systems, a Windows VxD TCP/IP stack and applications, mail integration, support for Novell NetWare SAA 2.0, FTX file transfer compression, direct access to AS/400 data, AS/400 report writing, and support for AS/400 Shared Folders. $500.

Contact: Wall Data, Kirkland, WA, (800) 487-8622 or (206) 814-9255; http://www.walldata.com.

Circle 1025 on Inquiry Card.

What's New Software

VIDEO PAINTING



With MediaPaint ($695), you can paint onto QuickTime movies either frame-by-frame or while your movie is playing. You can paint onto a layer over the video without changing the underlying movie and paint one movie directly onto another. Built-in filters let you create special effects that you can customize by combining paint tools. In addition to being PowerPC-native, MediaPaint offers stencil paint, automatic copy, NTSC legal colors, live alpha, chroma-keying, onionskinning, plug-in filters, strokes and paths, plug-in tools, eraser paint, instant preview, step/record, animated painting tools, particle-system tools, filter tweening, and graphics tablet support.

Contact: Strata, St. George, UT, (800) 787-2823 or (801) 628-5218; http://www.strata3d.com.

Circle 1004 on Inquiry Card.

BUSINESS-CRITICAL SERVERS

OpenServer release 5, a Unix server OS, provides Host ($695 for five users) and Enterprise ($1295) server OS configuration for Intel processor–based platforms. Features include interoperability with PC LANs, WANs, legacy systems, and the Internet; integration of DOS and Windows PCs into client/server environments; and graphical system administration and software management facilities for managing local and remote systems. Release 5 provides built-in SMP support, up to 30 processors (Enterprise version only), multithreaded network subsystem and drivers (i.e., TCP/IP, Streams, and NFS), dynamic allocation of kernel tables, and memory-mapped files.

A single-user OS for business-critical computing, OpenServer Desktop System release 5 ($795) provides an integrated Unix system, networking services, and an X Window System–based GUI; advanced security, SMP scalability, and RAID add-ons; DOS and Windows support by means of SCO Merge and SCO Wabi add-ons; and a Mosaic World Wide Web browser, graphical news reader, and E-mail.

OpenServer Development System release 5 ($795) provides a multistandard C compilation system; a C++ compiler; an SCO Visual TCL scripting environment; DLL support; networking, graphics, and system APIs and protocols; an optimizing C compiler for Pentium and 486 processors; and debugging tools.

Contact: The Santa Cruz Operation, Santa Cruz, CA, (800) 726-8649 or (408) 425-7222; http://www.sco.com.

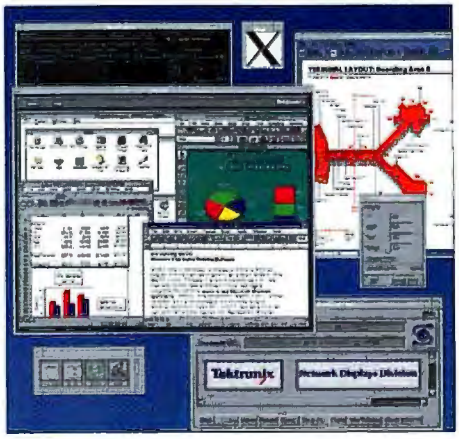
Circle 1014 on Inquiry Card.

WINDOWS ACCESS FOR IBM RS/6000 ▼

WinDD for Workstations provides Unix workstations and color X Window System 11–compatible devices with access to Windows applications running on PC applications servers. The WinDD server software allows a single 486- or Pentium-based PC to provide Windows applications for as many as 20 to 25 concurrent Unix users. Network configuration requires the WinDD server software for each PC applications server and the WinDD for Workstations display client for each user. Cost per seat is from $165 to $195; the WinDD applications server software on CD-ROM costs $3495 for a 10-user license.

Contact: Tektronix, Wilsonville, OR, (800) 547-8949 or (503) 682-7300; http://www.tek.com.

Circle 1016 on Inquiry Card.



Software Update

NetShield 2.2 for NetWare and **VirusScan 2.2 for DOS, Windows, and OS/2** include faster scanning performance, better integration between applications, Novell NetWare 4.1 support, enhanced notification options, a new Windows console, administrator-access controls, and increased scanning and detection performance. Call for prices.

Contact: McAfee, Santa Clara, CA, (408) 988-3832; http://www.mcafee.com.

Circle 1029 on Inquiry Card.

Chemical-structure-drawing software for Macs and Power Macs, **ChemDraw Pro 3.5** calculates formulas, mass, molecular weight, and elemental analysis; recognizes charged species and radicals; interprets functional group nicknames; generates isometric SMILES strings; and lets you cut and paste to Tripos's Unison, Unity, and Alchemy software. $795. **ChemDraw Std 3.5** adds hot keys, a syntax checker, unlimited undo and redo, AppleScript scripts, improved alignment tools, and drag and drop. $495.

Contact: CambridgeSoft, Cambridge, MA, (800) 315-7300 or (617) 491-2200; http://www.camsci.com.

Circle 1026 on Inquiry Card.

Visual Thought 1.1 for Solaris, an object-based drawing and graphics tool, lets you drag and drop objects from the library of application-specific, free-form, editable palettes or create your own palette; examine and edit objects; draw dataflow, process, circuit, and logic diagrams; create figures and diagrams as EPS files for import into document processors; and use the attachment mechanism to link arbitrary files and programs to objects. Floating license, $1295; node-locked license, $695.

Contact: Confluent, San Francisco, CA, (415) 586-8700; info@confluent.com.

Circle 1028 on Inquiry Card.

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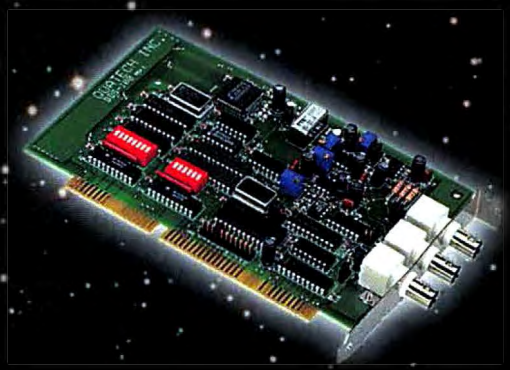

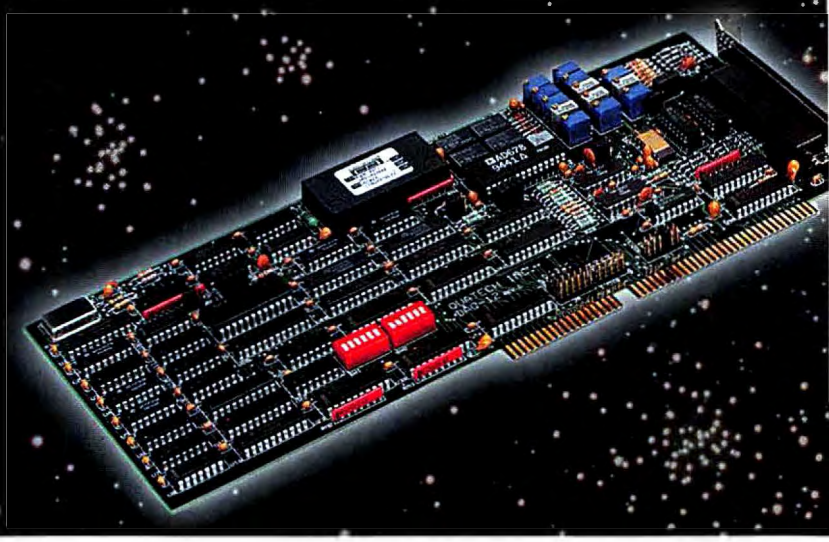

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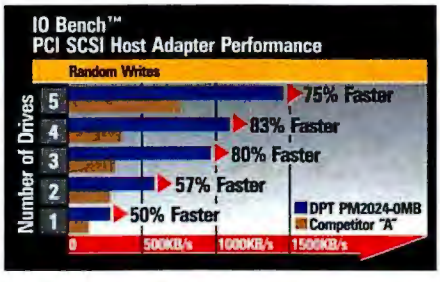

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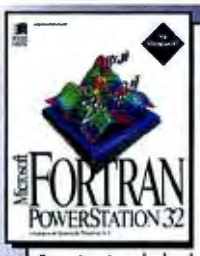

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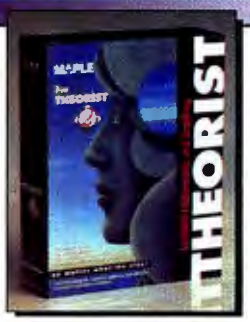

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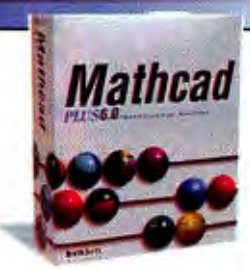

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Processor	Screen	HD	Price
486DX4/75	10.4" Dual Scan	320MB	$2199
4B6DX4/75	10.4" Dual Scan	500MB	2549
486DX4/75	10.4" Active	500MB	3069

Additional Toshiba Notebooks

T4900

Processor	Screen	HD	Price
T3600CT			
486DX2/50	8.4" Active	500MB	$3239
T4900CT			
Pentium 75	10.4" Active	772MB	$4799
T4850CT			
486DX4/75	10.4" Active	772MB	$3349
Satellite T2100			
486DX2/50	9.5" Mono	250MB	$1399
486DX2/50	10.4" Dual Scan	330MB	1999
486DX2/50	8.4" Active	330MB	2699

NEC

Versa M

- High Res. displays available - 800x600 res. on notebook
- True color displays available - 16.7 million colors on notebook
- Removable/Reversible display
- Replace floppy w/ 2nd battery for 6-10 hrs. battery life
- Replace floppy w/ Versa Bay - Add extra PCMCIA
- Built-in 16-bit sound, microphone & speaker
- Upgradable hard drive - easily add more storage

Processor	Screen	HD	Price
486DX4/75	9.5" Dual Scan	250MB	$2369
486DX4/75	9.5" Dual Scan	340MB	2459
486DX4/75	9.5" Active	340MB	2739
486DX4/75	9.5" Active	540MB	3029
486DX4/75	9.5" High Res.	540MB	3199
486DX4/100	9.5" Active	340MB	3399
486DX4/100	9.5" Active	810MB	4069
486DX4/100	9.5" High Res.	540MB	3879
486DX4/100	9.5" High Res.	810MB	4249

Versa P

Versa P

- 75MHz Pentium - for blazing performance
- High Res. displays available - 800x600 res. on notebook (10.4" on selected models)
- Removable/Reversible display
- Replace floppy w/ 2nd battery for 6-10 hrs. battery life
- Replace floppy w/ Versa Bay - Add extra PCMCIA
- Built-in 16-bit sound, microphone & speaker
- Upgradable hard drive - easily add more storage

Processor	Screen	HD	Price
Pentium 75	9.5" Active	340MB	$4069
Pentium 75	9.5" Active	540MB	4349
Pentium 75	9.5" Active	810MB	4729
Pentium 75	9.5" High Res.	540MB	4539
Pentium 75	9.5" High Res.	810MB	4899
Pentium 75	10.4" Active	540MB	4629
Pentium 75	10.4" Active	810MB	4999
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- 16-bit sound card
- Integrated pointing device
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Processor	Screen	HD	Price
486DX2/50	9.5" Dual Scan	340MB	$1949
486DX2/50	8.4" Active	455MB	2199
486DX4/75	9.5" Dual Scan	455MB	2199
486DX4/75	8.4" Active	340MB	2199
486DX4/75	8.4" Active	455MB	2459
486DX4/100	9.5" Active	525MB	3229

TravelMate 5000

- 75MHz Pentium with PCI Bus to optimize Pentium processor performance
- 10.4" Active Matrix display with 2MB Video RAM
- 10.5" Dual Scan display with 2MB Video RAM
- 65K colors on notebook display
- 16-bit Sound Card, Speaker, Microphone & MIDI
- Upgradable hard drive - easily add more storage
- Built-In Dual Lithium Ion Batteries
- Built-in infrared for no hassle printer connections

Processor	Screen	HD	Price
Pentium 75	10.4" Dual Scan	500MB	$3899
Pentium 75	10.4" Active	772MB	4599

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- Lithium Ion battery technology
- Built-in infrared for no hassle printer connections

Processor	Screen	HD	Price
Pentium 75	10.4" Dual Scan	500MB	$3439
Pentium 75	10.4" Dual Scan	800MB	3739
Pentium 75	10.4" Dual Scan	1.2GB	4229
Pentium 75	10.4" Active	800MB	4899
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Processor	Screen	HD	Price
486DX2/50	10.3" Dual Scan	340MB	$2559
486DX4/75	10.3" Dual Scan	510MB	2749
486DX4/75	10.3" Dual Scan	700MB	3049
486DX4/75	10.4" Active	510MB	3829
486DX4/75	10.4" Active	700MB	4129

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- Built-in infrared for no hassle printer connections
- 800 x600 resolution on notebook display (Pentium models only)
- Lithium Ion battery technology (Pentium models only)

Processor	Screen	HD	Price
486DX4/100	10.4" Dual Scan	340MB	$4099
486DX4/100	10.4" Dual Scan	540MB	4449
486DX4/100	10.4" Dual Scan	810MB	4899
486DX4/100	10.4" Active	340MB	4999
486DX4/100	10.4" Active	540MB	5349
486DX4/100	10.4" Active	810MB	5799
486DX4/100	10.4" Active	540MB	6349*
486DX4/100	10.4" Active	810MB	6799*
Pentium 75	10.4" Active	540MB	6549
Pentium 75	10.4" Active	810MB	6999

*Features built-in CD-ROM drive

Additional IBM® Notebooks

Processor	Screen	HD	Price
IBM ThinkPad® 701			
486DX2/50	10.4" Active	360MB	$4799
486DX2/50	10.4" Active	540MB	5149
486DX4/75	10.4" Dual Scan	360MB	4399
486DX4/75	10.4" Dual Scan	540MB	4749
486DX4/75	10.4" Active	360MB	5299
486DX4/75	10.4" Active	540MB	5649
IBM ThinkPad® 755CV			
486DX4/100	10.4" Active LCD	540MB	$6799

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LTE Elite

Contura 410

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Processor	Screen	HD	Price
486DX2/50	9.5" Dual Scan	350MB	$1989
486DX2/50	8.4" Active	350MB	2359

LTE Elite

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- Fast 486DX4/75 processor
- Built-in AC adapter - small, sleek design & reduced weight
- Upgradable hard drive - easily add more storage

Processor	Screen	HD	Price
486DX4/75	9.5" Dual Scan	340MB	$2739
486DX4/75	9.5" Dual Scan	510MB	3119
486DX4/75	10.4" Active	510MB	4159
486DX4/75	10.4" Active	810MB	4539

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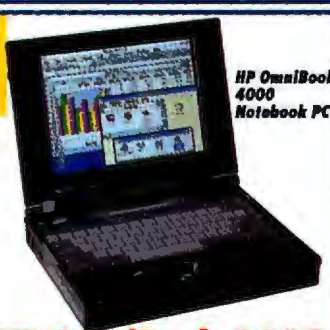

HP OmniBook 4000 Notebook PC

Additional Hewlett Packard Products

Processor	Screen	HD	Price
HP OmniBook 600 Notebook PC			
486DX2/50	8.5" Dual Scan	260MB	$2549
486DX4/75	8.5" Dual Scan	260MB	3049

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HP DeskJet 320 printer (portable)	$299.99
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HP DeskJet 660C printer	479.99
HP DeskJet 1200C printer	979.99
HP DeskJet 1200C/PS printer	1589.99

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HP LaserJet 5MP printer (IBM&MAC, 6ppm, 600dpi)	1039.99
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- Replace floppy w/ 2nd battery for 5-7 hrs. battery life
- Built-in infrared for no hassle printer connections

Processor	Screen	HD	Price
486DX4/75	10.4" Active	340MB	$2959
486DX4/75	10.4" Active	520MB	3149
486DX4/75	10.4" Active	810MB	3459
486DX4/100	10.3" Dual Scan	340MB	2999
486DX4/100	10.3" Dual Scan	520MB	3259
486DX4/100	10.3" Dual Scan	810MB	3569
486DX4/100	10.4" Active	340MB	3429
486DX4/100	10.4" Active	520MB	3619
486DX4/100	10.4" Active	810MB	3919
486DX4/100	10.4" Active	810MB	4489*

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7 17" .28 NI 1280x1024	569

CONTROLLER BOARDS

Promise DC5030 PCI, E-IDE Caching	$179
Promise DC4030VL-VLB, E-IDE Caching Controller	95
Promise 2300+	55
Adaptec 1542CK-ISA, SCSI Controller	199
Adaptec 2742T-EISA, SCSI Controller	289
Adaptec 2940 PCI/SCSI Controller	260
IDE/IO card, 2s/1p/1g	15
IDE/IO Enhanced ISA	45
IDE/IO-VLB, 2s/1p/1g	27
IDE/IO VLB Enhanced	35
IDE PCI Enhanced	45
Q Logic ISA SCSI	99
Q Logic VLB SCSI	159

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64Kx1	–	11.00	9.00	8.00
64Kx4	–	11.00	9.00	8.00
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1Megx4	–	49.00	39.00	38.00	–
1Megx4 (Zip Pk)	–	24.00	22.00	21.00	–
256x4 (Page Dip)	–	7.25	6.75	6.50	5.95
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256x4 (Page Zip)	–	9.25	9.00	8.85	–
256x4 (Video Zip)	–	–	12.95	11.85	8.85
256x8 (SOJ)	–	25.00	24.00	–	–
256 x1	–	3.25	2.95	2.75	2.25
64x4	–	–	–	3.75	–
64x1	–	–	–	–	2.00
256x16 SOJ	–	–	29.00	–	–
256x16 Video Zip	–	49.00	39.00	–	–

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8087	39.00
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8087-1	79.00
80287-XL	39.00
80387-16 DX	39.00
80387-20 DX	44.00
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Intel SX (Does All)	69.00
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	40NS	50NS	60NS	70NS	80NS	100NS
256 x 9	–	–	–	10.00	9.00	8.00
1Meg x 9 (3 chip)	–	48.00	45.00	42.00	40.00	–
1Meg x 9 (9 chip)	–	49.00	48.00	43.00	41.00	39.00
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256 x 36 1 mg	–	–	–	69.00	59.00	–
512 x 36 2 mg	–	–	–	89.00	79.00	–
1 meg x 36 4 mg	–	–	189.00	179.00	179.00	–
2 x 36 8 mg	–	–	379.00	364.00	364.00	–
4 x 36 16 mg	–	–	569.00	549.00	549.00	–
8 x 36 32 mg	–	–	1159.00	1149.00	1149.00	–
16 x 36 64 mg	–	–	2799.00	2745.00	2745.00	–
1 x 32 4 mg	–	–	169.00	164.00	164.00	–
2 x 32 8 mg	–	–	349.00	329.00	329.00	–
4 x 32 16 mg	–	–	499.00	479.00	479.00	–
1 x 32 4 mg EDO	–	–	–	189.00	–	–
2 x 32 8 mg EDO	–	–	–	389.00	–	–
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AST MEMORY

MODEL	AMT. UPGRADED	AST PART #	PRICE
Bravo LC Series, Bravo MT, Bravo MS, MS-L, Advantage Pro DX33, SX25	4Meg	500987-002	169.00
	8Meg	500987-003	338.00
	16Meg	500987-004	479.00
	32Meg	500987-005	958.00
Premmia LX P/60, MX4/66d, 4/100T, P/60	8 Meg	500987-003	338.00
	16 Meg	501340-002	479.00
	32 Meg	500987-005	958.00
	64 Meg	501589-001	Call
Premmia 4133, 4133S, 4/50d, 4/60d	8 Meg	501159-002	338.00
Premmia SE 4/33, 4/66d, P/60	16 Meg	501159-003	658.00
Premmia MTE 4/33, 4/66c, P/60	32 Meg	501159-004	1149.00
Manhattan G, V Series Server	64 Meg	501159-005	2298.00
Power Premium 3/33, 4/33, 4/33S, 4/50d, 4/66d	8Meg	500780-001 (72 pin)	378.00
Premium 486/25, 486/25E, 486/33, 486/33E			
Premium 386/33TE, 486/25TE, 486/33TE			
Prem. II 386/25, 386/33, 486/33, 486 SX/20			
Bravo 486/25, 486/33	2 Meg Kit	500780-005	118.00
Advantage 486/25, 486/33, 486/33P, 486 SX/20			
Premium SE 4/22	8Meg Kit	500780-001 (64 pin)	378.00
Premium SE 4/50, d, 66d, P/60	1 Meg	500780-003 (64 pin)	59.00
Prem. 386/33T, 386 SX16, Prem II 386SX 20, 386/25	4Meg	500780-004 (64 pin)	189.00
Premmia GX P/90, P/100	8Meg Kit/16Meg Kit	501565-001/501566-001	378/699
	32Meg Kit/64Meg Kit	501567-001/501568-001	1358/2699
AST Cupid Board	0-32 Meg	500818-001	179.00

AMBRA

Ambra Pentium-60	4/8/16 Meg	175.00/369.00/599.00
Ambra NC 425SL	2/4/8 Meg	109.00/209.00/366.00
Ambra N Series	4/8/12/16 Meg	189.00/349.00/569.00/619.00
Ambra SN Series	4/16 Meg	189.00/699.00
Ambra Sprinta SLC II	2/8 Meg	89.00/319.00
Ambra N-75, N-100	4/8/16	189.00/369.00/619.00

ZENITH MEMORY MODULES

MODEL	AMT. UPGRADED	MFG. PART #	PRICE
Z386/33, 25, 20, 33E	1Meg	ZA3800ME	59.00
Z386/33, 25, 20, 33E, 486/25E	4Meg	ZA3800MK	180.00
Z386SX	2Meg	Z-605-1 modules	119.00

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286/386SX-16, 386SX-20, 486SX-20 & 386-33 *all are 72PIN SIMM*:
1MEG – 59.00 4MEG – 180.00 8MEG – 349.00 16MEG – 659.00

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0Meg **$139.00** 2Meg **$238.00** 4Meg **$319.00** 8Meg **$486.00** 16Meg **$859.00**

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0-8Meg Extended and/or Expanded Memory for all IBM P/S2 Models 50, 50Z, 60, 55SX, 65SX, 16 Bit, 4.0 LIM Compat.
0K – **119.00** 2Meg – **199.00** 4Meg – **283.00** 8Meg – **449.00**

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BATTERIES

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IBM PS/1, PS/2 MEMORY MODULES

IBM PART NO.	WORKS WITH MODEL NO.	PRICE
30F5348 (512K)	30-286	37.00
30F5360 (2Meg)	30-286, 25-286, 60 MTHR BD.	104.00
6450375 (1Meg)	80-041	79.00
6450379 (2Meg)	80-111, 311-121, 321, 081, 181	84.00
6451060 (4Meg)	80-A21, A-61, 80-A31, 80-111, 80-311	189.00
6450604/92G7196 (2Meg)	70-081, 081, 121, 50Z, 55SX, 65SX, P-70, 58LS, 65LS, X-Station 120 & 130, 35SX, 35LS, 40SX	88.00
6450608 (2Meg)	70-A21, A-61, B-21, B-61, 35SX, 35LS, 40SX, Val Pt, 8281	90.00
78X8955 (128K)	25	35.00
34F2933 (4Meg)	35SX, 40SX, 55SX, 65SX, 55LS, 65LS	175.00
87F9977/92G7199 (4Meg)	55SX, 55LS, 65SX, 40SX, 35SX, 35LS	175.00
1057035 (512K)	P/S1-286	49.00
92F9935 (2Meg)	P/S1 & P/S1/386SX-2121	109.00
92F9934 (4Meg)	P/S1 & P/S1/386SX, Model-2121	189.00
92G7200 (4Meg)	PSI Expert, Consultant, Willow	175.00
92G7201, 73G3131 (4Meg)	Value Point Performance, PC Server 4/66	175.00
92G7539 (4Meg)	Aptiva 310, 330, 350, 510, 530, 710, 730	164.00
92G7541 (8Meg)	Aptiva 310, 330, 350, 510, 530, 710, 730	334.00
92G7543 (16Meg)	Aptiva 310, 330, 350, 510, 530, 710, 730	559.00
92G7545 (32Meg)	Aptiva 310, 330, 350, 510, 530, 710, 730	1149.00
73G3132/92G7203 (8Meg)	Value Point Performance, PC Server 4/66	339.00
80G1822/92G7204 (16Meg)	Value Point Performance, PC Server 4/66	609.00
92G7205 (32Meg)	Value Point Performance, PC Server 4/66	1239.00
6450902 (2Meg)	56, 57, 57SX, 90, 95, F-75, 57SLC, Value Point 77 486DX2, 486SX, SVR 85	90.00
6450128/92G7200 (4Meg)	57SX, 90, 95, P-75, 57SLC, 56, 56SLC, P/S1, 386SX, Mod-2123, 2133, 2155, Val Pt 77, 486DX2, 486SX, SVR85, Value Point 77 486DX2, 486SX, SVR 85	175.00
6450129/92G7429 (8Meg)	35SX, 40SX	339.00
6450130/92G7202 (8Meg)	56, 57, 57SX, 90, 95, P-75, 57SLC, Value Point 77 486DX2, 486SX, SVR 85	339.00
6451158/92G7208 (4Meg ecc)	466, 95XP, 95A (install in pairs)	199.00
6451159 (8Meg ecc)	466, 95XP, 95A (install in pairs)	399.00
92G7209/32G3720 (16Meg ecc)	9595 OPT	749.00

IBM NOTEBOOK & LAPTOP MEMORY

07G1415/07G1420 (4Meg)	Thinkpad 750, C, 700, C, 720, C, CL57SX	189.00
07G1416/07G1421 (8Meg)	Thinkpad 750, C, 700, C, 720, C, CL57SX	369.00
66G0095 (16Meg)	Thinkpad 750, C	968.00
66G0094 (4Meg)	Thinkpad 755, 360, 355, 340, 450	179.00
66G0094 (8Meg)	Thinkpad 755, 360, 355, 340, 450	339.00
66G0094 (16Meg)	Thinkpad 755, 360, 355, 340, 450	599.00
8189098 (4Meg)	Thinkpad 500, 510CS (3.3 volt)	199.00
8189099 (8Meg)	Thinkpad 500, 510CS (3.3 volt)	389.00
8189113 (16Meg)	Thinkpad 500, 510CS (3.3 volt)	759.00
79F0999 (2Meg)	LX40, N33SX, PS Note	103.00
79F1000 (4Meg)	LX40, N33SX, PS Note, Thpd 350, 350c, PS Note 425	189.00
79F1001 (8Meg)	LX40, N33SX, PS Note	349.00
Hard Drive (524Meg, 710 Meg)	Thinkpad 750, 755, 360, 355	949.00/1149.00
(4Meg/16Meg)	Thinkpad 755 Dimm Modules	209.00/699.00
(4Meg/16 Meg w/Adap	Thinkpad 755	289.00/749.00
60G0378 (8Meg)	Thinkpad 350, 350c, PS Note 425	338.00
60G0379 (16Meg)	Thinkpad 350, 350c, PS Note 425	589.00
92F0004 (2Meg)	N45SL	109.00
92G7259 (4Meg)	Thinkpad 701C, CS, Butterfly	Call
92G7261 (8Meg)	Thinkpad 701C, CS, Butterfly	Call
92G7263 (16Meg)	Thinkpad 701C, CS, Butterfly	Call

COMPAQ MEMORY MODULES

MODEL	AMT. UPGRADED	CMPQ PART #	PRICE
DeskPro 386/33, 386/33L, 486/25, 486/33L, 486/50L, System Pro	2Meg Module	115144-001	109.00
	8Meg Module	116561-001	369.00
	32Meg Module	116568-001	1399.00
DeskPro 386/33L, 486/33L	(Exp Bd)	116569-001	279.00
DeskPro 386/25, 386/20	1Meg Module	113131-001	79.00
	4Meg Module	113132-001	199.00
DeskPro 386S-16MHz	1Meg Exp Bd	113633-001	149.00
	4Meg Exp Bd	113634-001	279.00
	1Meg Module	113640-001	79.00
	4Meg Module	112534-001	199.00
DeskPro 386/20E	1Meg Exp Bd	113644-001	149.00
DeskPro 386/25E	4Meg Exp Bd	113645-001	279.00
	1Meg Module	113131-001	79.00
	4Meg Module	113132-001	199.00
DeskPro 286N, 386N, 386SX20, all "M" series, sytem LT series, all "I" series	1Meg Module	[illegible]	59.00
	2Meg Module	[illegible]	89.00
	4Meg Module	[illegible]	169.00
	8Meg Module	[illegible]	330.00
M Series Exp Bd	0-64Meg	129160-001	189.00
DeskPro 386/16	1Meg Kit	108071-001	99.00
	4Meg Kit	108072-001	399.00
	1-2Meg Exp Bd	108069-001	239.00
	4-8Meg Exp Bd	108070-001	437.00
DeskPro 286; DeskPro 5/60, 5/66M, 5/90M; Prosignia 5/60; Proliant 100 5/66; Proliant 2000 4/20, 5/66; Proliant 4000 4/50, 5/66 (ALL OF THESE MACHINES USE THESE MODULES)	512K Kit	113012-001	49.00
	8Meg Kit	146911-001	389.00
	16Meg Kit	146949-001	699.00
	32Meg Kit	146912-001	1356.00
	64Meg Kit	146913-001	2516.00
	128Meg Kit	146914-001	5799.00
Prolinea 386 3/25S, 3/25ZS	2Meg	141728-001	90.00
	8Meg	141742-001	318.00
Prolinea 486 4/25S, 4/33, 4/50, 4/66, CDS; Enhanced Prolinea, Prosarie series	2Meg	141683-001	95.00
	4Meg	141684-001	175.00
	8Meg	141685-001	339.00
Prosignia PC Server, 486/33, 486 DX2/66	8Meg	141685-001	339.00
	16Meg	149320-001	589.00
	32Meg	149147-001	1199.00

COMPAQ LAPTOPS & NOTEBOOKS

LTE/286	4Meg Bd	117081-003	179.00
LTE/386S/20	4Meg Module	121125-002	209.00
LTE LITE/20, 25, 25C	4Meg Module	129769-002	209.00
LTE LITE/20, 25, 25C	8Meg Module	129769-003	389.00
LTE LITE/20, 25, 25C	16Meg Module	129769-004	769.00
LTE LITE 425C/33C/25E/25L	4Meg Module	142337-002	189.00
LTE LITE 425C/33C/25E/25L	8Meg Module	142337-003	329.00
LTE LITE 425C/33C/25E/25L	16Meg Module	142337-004	619.00
SLT/286	4Meg Module	110237-001	199.00
SLT/386	2Meg Module	118304-001	109.00
SLT/386	4Meg Module	118305-001	219.00
Concerto, LTE Elite	4Meg	144790-001	189.00
	8Meg	144790-002	353.00
	16Meg	144790-003	699.00
Contura 320, 325	2Meg	139497-001	99.00
	4Meg	139498-001	189.00
	8Meg	139499-001	339.00
Contura 400, 410	4Meg/8Meg/16Meg		189/369/699
Contura 4/25, 4/25C, 4/25CX	4Meg	146520-001	189.00
	8Meg	146521-001	339.00
	16Meg	146531-001	699.00
Aero 4/25, 4/33L	4Meg	180532-001	184.00
	8Meg	180597-001	339.00

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TOSHIBA LAPTOP MEMORY

MODEL	AMT. UPGRADED	MANU. PART #	PRICE
T2000SX/2200SX/T1800, 1850, C	2Meg	PC-PA2000U	89.00
T2000SX/2200SX/T1800, 1850, C	4Meg	PC-PA2001U	189.00
T2000SX/2200SX/T1800, 1850, C	8Meg	PC-PA2002U	359.00
T2100, 2105, 2150	4Meg/8Meg		199/349
T2100, 2105, 2150	16Meg/24Meg		729/1249
T4400SX, SXC, T6400, T6600	4Meg	PC-PA2004U	189.00
T4400SX, SXC, T6400, T6600	8Meg	PC-PA2005U	359.00
T4400SX, SXC, T6400, T6600	16Meg	PC-PA2010U	669.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	4Meg	PC-PA2012U	189.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	8Meg	PC-PA2013U	349.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	16Meg	PC-PA2014U	694.00
T4700, 4800, 4850 (Hard Drive)	524Meg/710Meg		949/1149
T3400CT, T2400, T3600	4Meg	PC-PA2019U	194.00
T3400CT, T2400, T3600	8Meg	PC-PA2020U	359.00
T3400CT, T2400, T3600	16Meg	PC-PA2021U	699.00
T3400CT	32Meg		1549.00
T3100SX	2Meg	PC15-PA8308U	55.00
T3100SX	4Meg	PC15-PA8310U	189.00
T3200	3Meg	PC6-PA7137U	110.00
T3200SX	2Meg	PC12-PA8307U	55.00
T3200SX	4Meg	PC12-PA8309	199.00
T5200/T8500	2Meg	PC10-PA8304U	114.00
T5200/T8500	8Meg	PC10-PA8313U	419.00

NOTEBOOK, LAPTOP MEMORY

MODEL	AMT. UPGRADED	MANU. PART #	PRICE
ACER 730, 735C, 760, 780	2Meg/4Meg/8Meg		109/209/369
ACER 750	4Meg/8Meg/16Meg		199/459/799
ALR Venture	4Meg	12407980	249.00
Altima Virage	4 Meg/ 16 Meg		199/679
Altima Virage II	4Meg/8Meg/16Meg		199/389/679
AST Ascentia 900N, 800N	4Meg/8Meg/16Meg		199/379/679
AST Bravo & Explorer	4Meg/16Meg	501255-001, -002	189/679
AST Notebook Prem Exec 386SX/20/25/25L	4Meg	500814-003	189.00
AST Power Exec 3/25SL, 425SL, 4/33SL	4Meg/16Meg	501186-001, -003	109/659
AST Power Exec 4/33SL	4Meg/16Meg	501318-001, 002	194/769
AT&T Globalyst 200	4Meg/8Meg/16Meg		199/389/679
AT&T Safari NSX/20	4Meg	PEC 37051	259.00
Austin DX4, DX2, SX2, SX Series	4Meg/16Meg		199/699
[illegible]	2Meg	23080-00100	88.00
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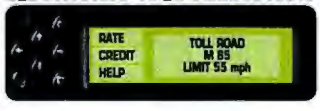

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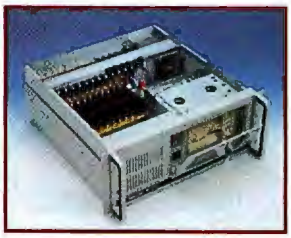

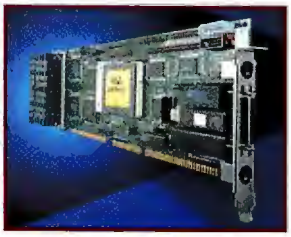

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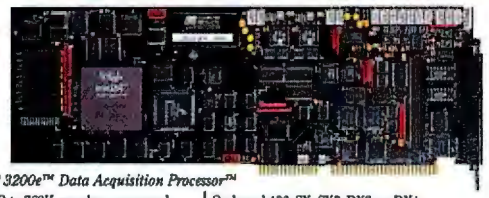

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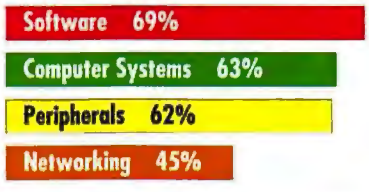

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•	MOTOROLA	96-97	
	N		
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	R		
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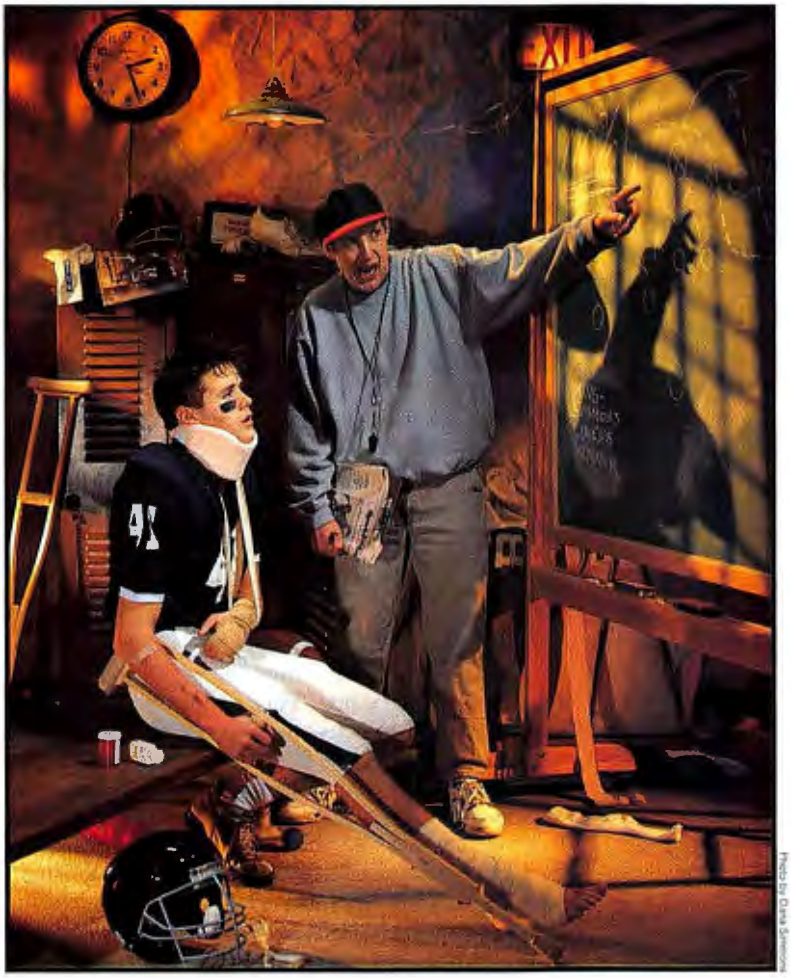

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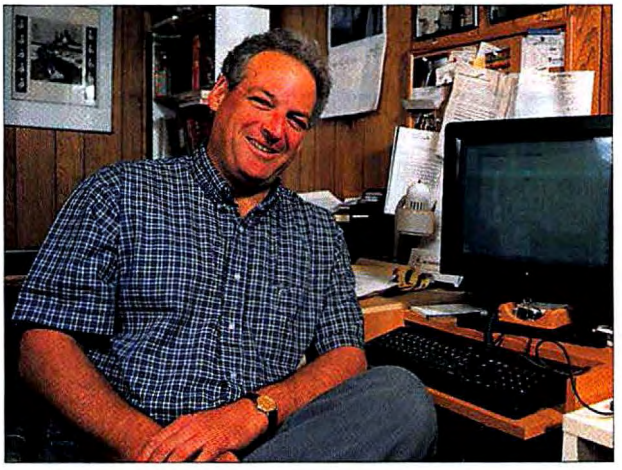
Stop, Look, and Listen!

Companies in the on-line business are rushing services to market. But do they really know what people want?



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The frenzied on-line market is heading in the same direction as pen-based computing—scurrying to offer something without finding out first if it's what people want. There's this blind faith that people are ready to live on-line. People might want E-mail, they might be fascinated by conferencing, and some can even endure chat sessions. But are they really interested in reading magazines and newspapers on their computer screens?

Omni magazine recently announced that it will offer its monthly issues electronically and supplement them with less-frequent paper issues. It seems like a risky move to me. Most people still prefer sitting in an easy chair, or on the train, or in the airport, thumbing through hard copy, particularly if the alternative is paying by the hour to read on-line.

As the telecomputing revolution sweeps through the land, its pioneers should bear in mind an obvious but often-overlooked credo: Listen to your customers. No matter how deep your pockets, no matter how great your previous successes, no matter how profound your vision, if you don't listen to your customers, you will fail.

If you need an example of what happens when industries ignore their customers, the pen-based computing market is a good one. Companies such as Momenta went bankrupt because they brought to market products that nobody wanted. These companies believed they could convince people that what they wanted was an expensive pen-input device with less-than-accurate handwriting recognition.

Another example: Time Warner recently installed new set-top boxes for its cable customers in four states and then raised the monthly rates, even for those customers who didn't want the box's new features. The media giant told customers they would lose their cable channels if they didn't upgrade to the new box. Amidst a howl of protest, Time Warner backed down and is now offering the new set-top box as an option. It could have avoided this problem by listening to its customers.

Or what about electronic shopping? When I talk to people in the on-line business, they dismiss the problem of transaction security as one that will be solved soon. They'd better realize that until security is completely solved and solid, people won't use on-line systems for doing business. It's similar to the makers of pen computers assuring everyone that perfect handwriting recognition is just around the corner.

Business transactions must be 100 percent reliable and secure. Security is not some minor side issue. It is the foundation on which electronic commerce must be built. We're still far away from truly secure electronic networks, and until we get there, electronic commerce will never take off. Developers of on-line services should be focusing on security technology at least as much as they are on getting Pamela Anderson to sit in on an on-line chat session.

Interactive entertainment. This is what the deal makers of Hollywood and Silicon Valley are cooking up for us. This is where they say multimedia is going. But is this something people want? There's little evidence that audiences yearn to be active participants in movies and do things such as choose the fate of Forrest Gump. Spielberg and Gates could end up spending billions of dollars developing products that nobody wants. As Time Warner found out the hard way, and as Hewlett-Packard found out by doing a customer survey, people are interested in interactive services—but they won't pay extra for them.

This lack of understanding about what people want is surprising considering all the market-research tools available. But in the high-tech world, where growth has been so phenomenal, companies become so convinced of their invincibility and so sure of the power of their technology "vision" that they ignore business fundamentals.

I don't mean to imply that there is no room for new and innovative technologies. But there is a need for new ways of thinking about how to market these technologies—how to make them affordable and accessible.

In France, the creators of Minitel had the market savvy to give everyone a free terminal and make money on the information piped into those terminals. Maybe the telecomputing companies should give the hardware away and make money selling the content. But first, they ought to ask people what they want—and then listen. ■

Nick Baran, a consulting editor for BYTE, is the author of Inside the Information Superhighway Revolution *(Coriolis Group Books, 1995). He can be reached on the Internet or BIX at nickbaran@bix.com.*

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