COMPUTING'S GRAND CHALLENGES

FEBRUARY 1995

BYTE

THE MAGAZINE OF TECHNOLOGY INTEGRATION

20 Years 1975-1995

Scalable RAID

I see you: software to recognize faces PAGE 85

40 new true-color graphics cards for PCs and Macs PAGE 136

THE NEW WORLD OF

NOVELL

Beyond the horizon of NetWare! From AppWare to UnixWare to SuperNOS, we chart your journey across the stormy seas of the new Novell.

REVIEWS:

- Sony's Magic Link
- Esperant: Bulletproof SQL Queries

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WE JUST GOT HONEYMOON

Who says the desert's a dry, heartless place? We just came back from COMDEX, and to us it was a love-in.

We showed our wares to throngs of receptive computer fans, including the editors of BYTE magazine, who award the coveted "Shellys" for excellence and who aren't exactly a bunch of pushovers.

Three different Digital products were recognized (more than any other COMDEX exhibitor), each in an area of universal importance:

Most Significant Technology went to Digital's Clusters for Windows NT™ software. What Clusters does is allow multiple servers (both Intel and RISC-based) to work as one. This is *Most Significant* because it will give your business all the pluses of client/server computing but with serious improvements in reliability, simplicity and economy.

For example, clustering makes it easy to grow without replacing existing hardware and software. You've probably heard this promised before, but Clusters for Windows NT is different. It really works.

Best System went to Multia,™ a new Digital product that's been called the computer equivalent of the impossible dream: a desktop device that lets you run software on several different operating

BACK FROM A

IN VEGAS.

systems simultaneously. Multia can easily run PC, UNIX® and host applications (Digital's, IBM's, anybody's) side by side and share data among them. In a poof, barriers that have constrained businesses for years just evaporated.

And finalist for *Best System* was Digital's AlphaServer™ 2100 4/275. You decide why. Was it for being fastest in its class? Was it for costing 40% less than slower servers from our competition? Was it for having a 3-year warranty with 1-day service (as opposed to their 1-year warranties with up to 3-day service)? Or all of the above?

Anyway, thanks to the editors of BYTE and everyone else who came to see us at COMDEX. We like you, too.

We also like the folks at AIM Technology. They give out UNIX EXPO's Hot Iron Awards, which are based strictly on unbiased performance tests. This fall, Digital workstations and servers earned an unheard-of 10 out of 16.

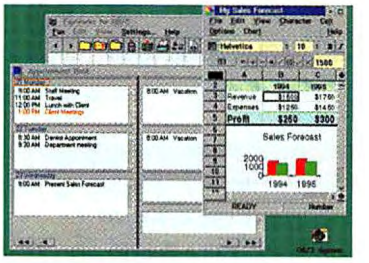
Maybe all these experts are trying to tell you something. For more information, call your local Digital sales office or reach us via our Internet address: moreinfo@digital.com.

digital™


MAZDA'S I.S. CHIEF
CAN'T WAIT TO
GET WARPED.

OS/2 is in its third rev, so it's solid, stable, and mature.

Mike Anzis is the I.S. man behind the wheel of Mazda's computers. And OS/2® Warp is about to make his life easier.



The BonusPak gives mobile users the applications they need.

From a basic 4MB laptop to a client/server system, the OS/2 family now scales an even wider variety of PC platforms.

As Mike puts it: "We use OS/2 on our headquarters' client/server systems. It's also installed in our 900 dealerships. But until now, we haven't been able to get OS/2 everywhere we need it – on laptops in the field. OS/2 Warp changes all that." OS/2 Warp is the 32-bit, multitasking, Windows™-friendly way to run a computer. With simple installation and proven reliability, OS/2 Warp is a total computing solution that performs ruggedly at every level.

IT'S ONE MODEL THEY REALLY NEED ON THE ROAD.

And OS/2 Warp is a real communicator. With fax, Internet e-mail, and desktop conferencing, there isn't an easier way to keep those out on the road in the loop.

OS/2 Warp also offers Mike Anzis rock-solid reliability. "I know from years of experience with OS/2, I can trust it to keep performing. Now I can enjoy this peace of mind at every level."

OS/2 Warp is available for under $90. To get warped, stop by your local software dealer, or call 1 800 3 IBM-OS2. Ask for a free demo disk.

A toolbar gets users into their applications quickly and easily.

The new 32-bit, multitasking, multimedia, Internet-accessed, crash-protected, Windows-friendly, totally cool way to run your computer. **OS/2® WARP**

IBM®

OS/2 Warp is available from your software dealer. It's also available from IBM for $89 by calling 1 800 3 IBM-OS2.

Circle 236 on Inquiry Card.

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FEBRUARY 1995 VOL.20, NO.2

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Phase change promised much as a rewritable medium, but high costs have kept it out of the mainstream. Matsushita hopes to change that.

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A new device from the Brooktrout Networks Group could save you a lot of money on intracompany fax phone calls.

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NETWORKING

Novell's Campaign 42
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Novell is embarking on a grand strategy to get 1 billion users and devices connected to NetWare by the year 2000.

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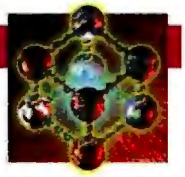

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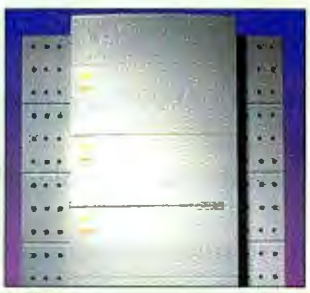
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State of the Art

PATTERN RECOGNITION

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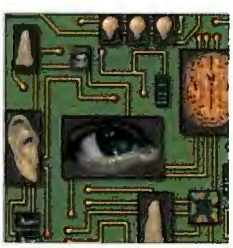
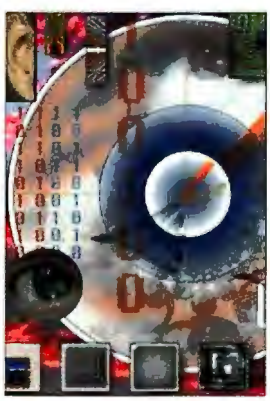
Finding and understanding patterns in data are key to creating mainstream applications for speech- and handwriting-recognition or machine-vision systems.

Face Value 85
BY EDMUND X. DEJESUS
New facial-recognition research is yielding fast, accurate, and commercially viable algorithms for a variety of applications.



Eyes, Ears, & Brains on a Chip 91
BY MARK CLARKSON
Economical pattern-recognition horsepower comes to the desktop thanks to the latest generations of DSPs (digital signal processors) and dedicated processors. Here's how systems developers are using this power in commercial products.



Opinions

PROGRAM LISTINGS

From BIX: Join "listings/frombyte95" and select the appropriate subarea (i.e., "feb95").

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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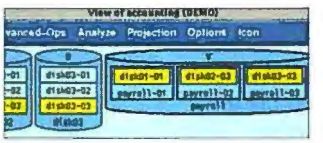

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BYTE Contents by Platform

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

DOS/WINDOWS

OS/2

MACINTOSH

UNIX

NETWORKS

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XXXXL STORAGE

Pinnacle Sierra 1.3GB™ Optical Hard Drive • 4500 RPM Rotational Speed • 19 msec Effective Access Time • 2.0MB/sec Data Throughput

It seems impossible to find a hard drive that's large enough to fit your storage needs today. That XL hard drive you just bought is now full.

Introducing a solution that's large enough to solve any storage problem... the Sierra 1.3 Gigabyte rewritable magneto-optical hard drive. It has the speed of a hard drive with an infinite capacity. So every time you fill up an optical disk, just add another one.

You can store online data, secondary data or even backup your files on your Sierra optical drive. It will never let you down. Optical is the most reliable storage device available. You can erase and write over four million times on optical media that has a shelf life of over 30 years. Save XL amounts of money over magnetic media which costs about $1.50 per megabyte, as compared to optical which costs only 15¢ per megabyte. Perfect for applications that demand XL amounts of data such as graphics, prepress, imaging, networking, digital audio and video, multimedia, and any other data intensive applications.

So the next time you're shopping for that XL hard drive... just keep the one you have and buy something that you will never outgrow... the Sierra 1.3GB™. To order or for a local reseller call: **800-553-7070**

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THE OPTICAL STORAGE COMPANY®

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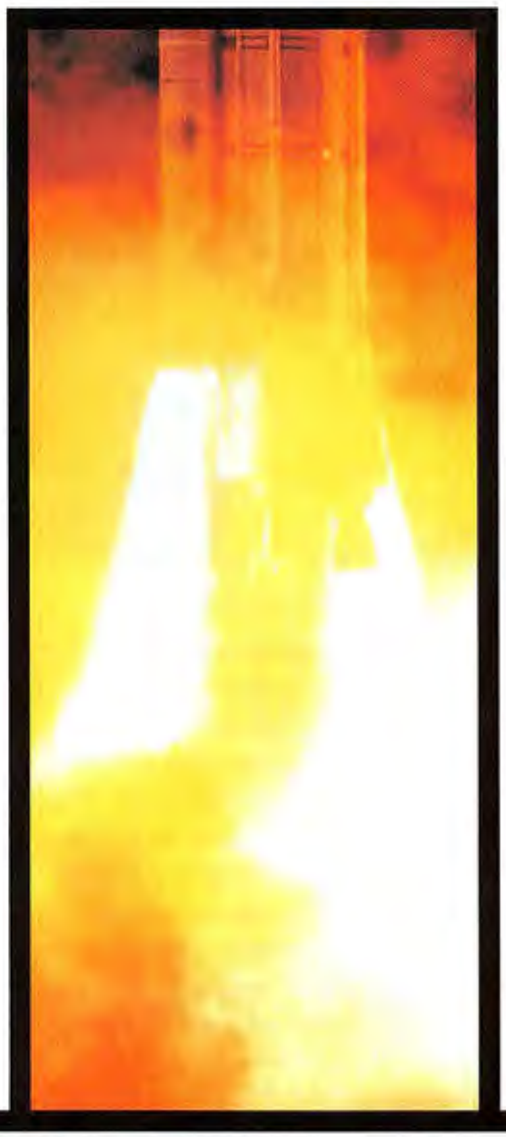
Hey, Windows NT.

Prepare *to* meet your server.



THE NEW ALPHASERVER FAMILY. THE ULTIMATE LAUNCHPAD FOR WINDOWS NT 3.5.

Microsoft® Windows NT,™ the most powerful, easy-to-use client server software, now has the hardware it deserves: Introducing the AlphaServer™ family, the most powerful, easy-to-own client server hardware.

Each AlphaServer is powered by Alpha, the world's fastest, most advanced microprocessor, designed to deliver incredible performance for Windows NT.

Only an AlphaServer can offer you on-line access to the huge chunks of data required for the latest applications. So when you run Windows NT on an AlphaServer, you can handle more users, more applications (over 1,700 committed), and more work with less hardware.

You'll pay less, too, because the AlphaServer family is priced so low—and backed by a three-year warranty, which you won't find anywhere else in the category. If this sounds like a perfect match for your organization, call your authorized Digital reseller or 1-800-DIGITAL.

ALPHA GENERATION

	AlphaServer 1000 4/200	AlphaServer 2000 4/200	AlphaServer 2100 4/275
Processors (SMP)	1	1-2	1-4
TPS	Up to 285	Up to 400	Up to 850
SPECint92	135.8	131.8	200.1
Max SPECrate_int92	3,136	6,178	15,470
I/O slots	2 PCI, 7 EISA, 1 both	3 PCI, 7 EISA	3 PCI, 8 EISA
Max I/O Bandwidth	132MB/s	132MB/s	132MB/s
Max Memory	512MB	640MB	2GB
Max Int. Storage	14GB	16GB	32GB

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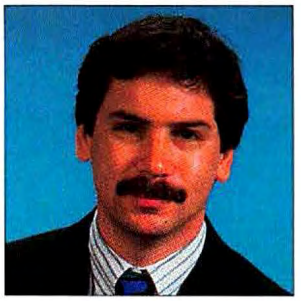
Information Underload



We have the capability to process a lot more data than we're getting now—it's all a matter of presentation

Information overload is a myth. We don't get anywhere near the data it takes to overload our neurons. According to some estimates, our mind is capable of processing and analyzing many gigabits of data per second—a lot more data than any of today's supercomputers can process and act on in real time.

So why do we feel overloaded by the quantity of information we receive? Because we're getting it unfiltered. Anyone who has ever tried to follow more than a few Internet newsgroups is aware of the high signal-to-noise ratio in unmoderated groups. It's the same with TV, newspapers, and—dare I say it—magazines. You and I can process information in ways that AI researchers haven't dreamed about, but a lot of our bandwidth is consumed with the boring act of filtering out the junk.

A few things make information more digestible. As the new kid on the block here, I'm making an early pledge to ensure that BYTE continues to explore the most modern ways to present information. And as readers of this magazine, as the people who decide how to implement technology, I'm going to suggest that you continue to pay close attention to how your products present information. Because getting the data across the gap from screen to mind is what it's all about.

Most important, let's get the data into a form we understand; let's turn it into valuable information. Of the part of the human mind that processes incoming signals, 90 percent is devoted to input from our stereoscopic visual system. Presented correctly, we can understand data in multidimensional form extremely well.

Perhaps you're tired of poring over stock tables and can't find the patterns in a typical price/earnings chart. Some new programs take the sea of stock market data and shape it into a visual, moving, morphable picture that's much better suited to our analog pattern-matching machinery. That's the best way to leverage high-tech horsepower: Use it to turn data into shapes that make sense to us.

In the case of the interface to BYTE, expect to see more hard data expressed in new and compelling ways. Today I can't give you a time-lapse view of the workings of a complex technology like OCR in the pages of BYTE. But I wish I could, and I'll do everything I can to do the next best thing—even if I have to resort to flip-books in the corners of the magazine's pages.

I'm also a proponent of using all available technology to disseminate information. Luddites cry "so much for the face-to-face meeting" every time a new communications technology comes along. But a quick hop across the country in a crowded airliner quickly reminds you that people are still rushing to meetings around the globe.

Look at the communications channels in front of you. Some are based on new technology (e.g., E-mail, pagers, and voice mail), but some are relatively old (e.g., the telephone and postal mail). The one thing they share in common is that when they were introduced, just about all of them were decried as culture killers of the worst degree.

But the interesting thing is, almost all media are still being used, and we're better off for each of them. As each new method of transmitting information has come to be, we have come to understand which communications niche it fits best—even if it is a new niche. Every time we dash off a letter or pick up the phone, we make an information-routing decision based on the nature of the information we have to transmit, the feedback we want, and cost. Most of the time we make the right decision, and mostly we make it automatically—cellular phones for urgent conversations, E-mail for reasoned discussion, and pagers for immediate one-way short notes.

I say, give me more. Give me videoconferencing, give me wireless access to the Web, give me a (safe) implanted cellular phone. I'll still go out with friends on Friday nights, and I'll always know where the off switch is when I want privacy.

I love magazines—their portability, information density, and character—but we all know that the paper magazine isn't the best way to get every kind of information across. So stay tuned for initiatives that use the latest media to expand the bandwidth of the BYTE information flow. And write to me—paper, fax, or E-mail—and tell me what you'd like to see in BYTE. ■

RAPHAEL NEEDLEMAN, EDITOR IN CHIEF
(rafe@mcimail.com)
fax: (603) 924-2550

Color is color, unless you have delicate skintones.

Introducing the Phaser™540 color laser printer, the first desktop laser to print with photographic quality. It uses our continuous tone technology to produce prints unequaled by any half-tone color laser—that is, by *any* other desktop color laser. Imagine how polished your business charts will be at 600 dpi! And how easily they will print at nearly 4 pages per minute in full color. Naturally the Phaser 540 prints on your letterhead in elegant color or precision black. And features Adobe™PostScript™Level 2 and Pantone's certified color. It networks to support any computers you choose. And it's from Tektronix, a Fortune 500 leader, where quality in workgroup color lasers passes the skin test with flying colors.

Tektronix

Free output sample, call 800-835-6100, Ext. 1053.

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Realtime technology...

Why do so many realtime developers like working with QNX?

POSIX Outside, **Performance** Inside

If you know the UNIX® OS, you know the API and utilities of QNX or any POSIX OS. But when it comes to performance, you can't judge a POSIX OS by its cover – they're all *supposed to* look alike. Check out QNX's numbers (e.g. 5 µsec per context switch on an 80486).

Scale it Down, Up, Out

QNX's modular architecture lets you scale down the OS to fit on a tiny ROM-based platform. Or scale it up to drive a resource-rich workstation equipped with X and TCP/IP.

Or scale it out to build a vast network running hundreds of CPUs. You can even "hot-swap" OS modules (filesystems, device drivers, system processes) *on the fly at run time!*

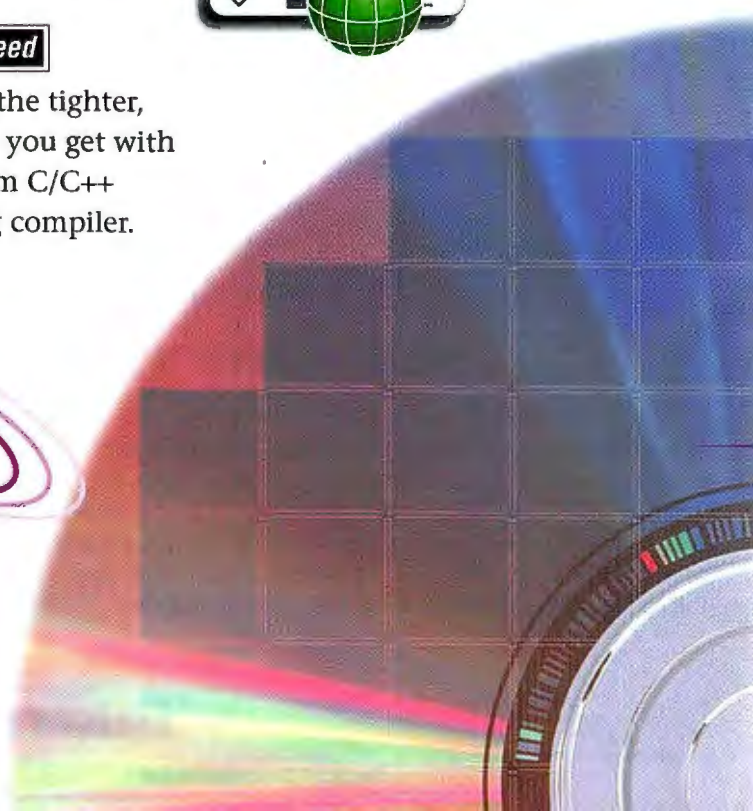
Tools for **Speed**

You'll like the tighter, faster code you get with the Watcom C/C++ optimizing compiler.

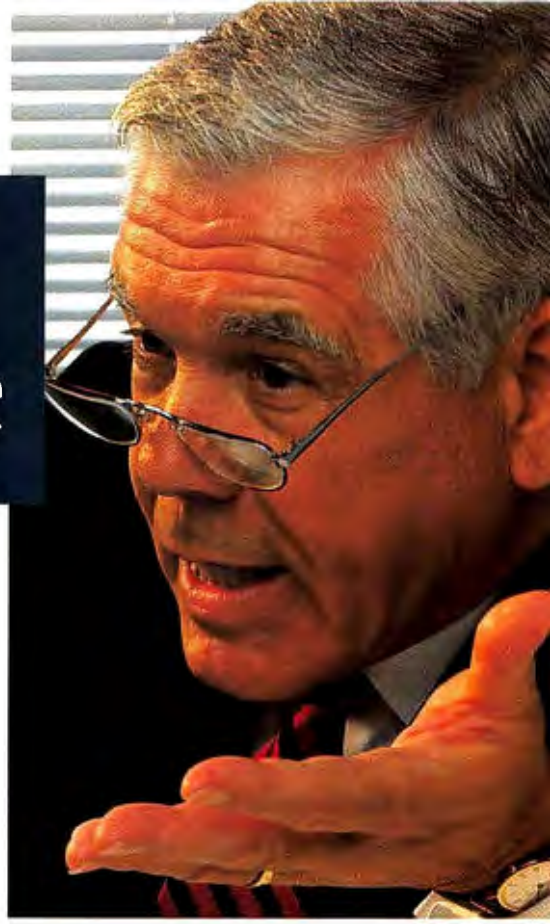
You'll also like our distributed debugger, profiler, trace analysis tools, code-generating GUI builder – they're all engineered to save you time.

Let's Talk **Technology**

If your realtime apps call for a proven, high-performance OS, call us. And ask all the detailed technical questions you can think of. After all, QNX is made by programmers for programmers.



...for the bottom line



Why do so many corporations succeed with QNX?

One OS *Fits All*

From cash registers to instrumentation, PDAs to robotic controllers, QNX is the only realtime OS that can be scaled to fit the platform. So your programmers won't waste time learning a new OS for every project. And you won't have to make another OS buying decision. Naturally, a single modular OS will cut the cost of your runtime systems, because you pay for only the OS modules you use.

Tools for *Productivity*

Runtime performance is critical, but so is beating your competitors to market. With QNX's rich development environment, your programmers will have the tools they need to produce better software sooner.

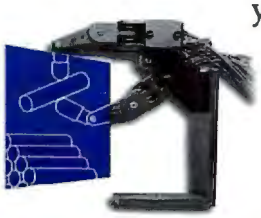
POSIX for *Open Systems*

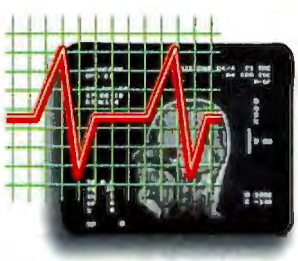
As a certified POSIX OS, QNX lets you port applications quickly and easily across platforms. And programmers who know UNIX or any POSIX OS will be productive with QNX immediately.

Let's Talk *Business*

Why is QNX the leader in realtime OS technology? Proven 14-year track record, satisfied Fortune 500 customers, no-nonsense licensing policy, Gold support plan...

The bottom line? QNX can give your realtime applications a real advantage.





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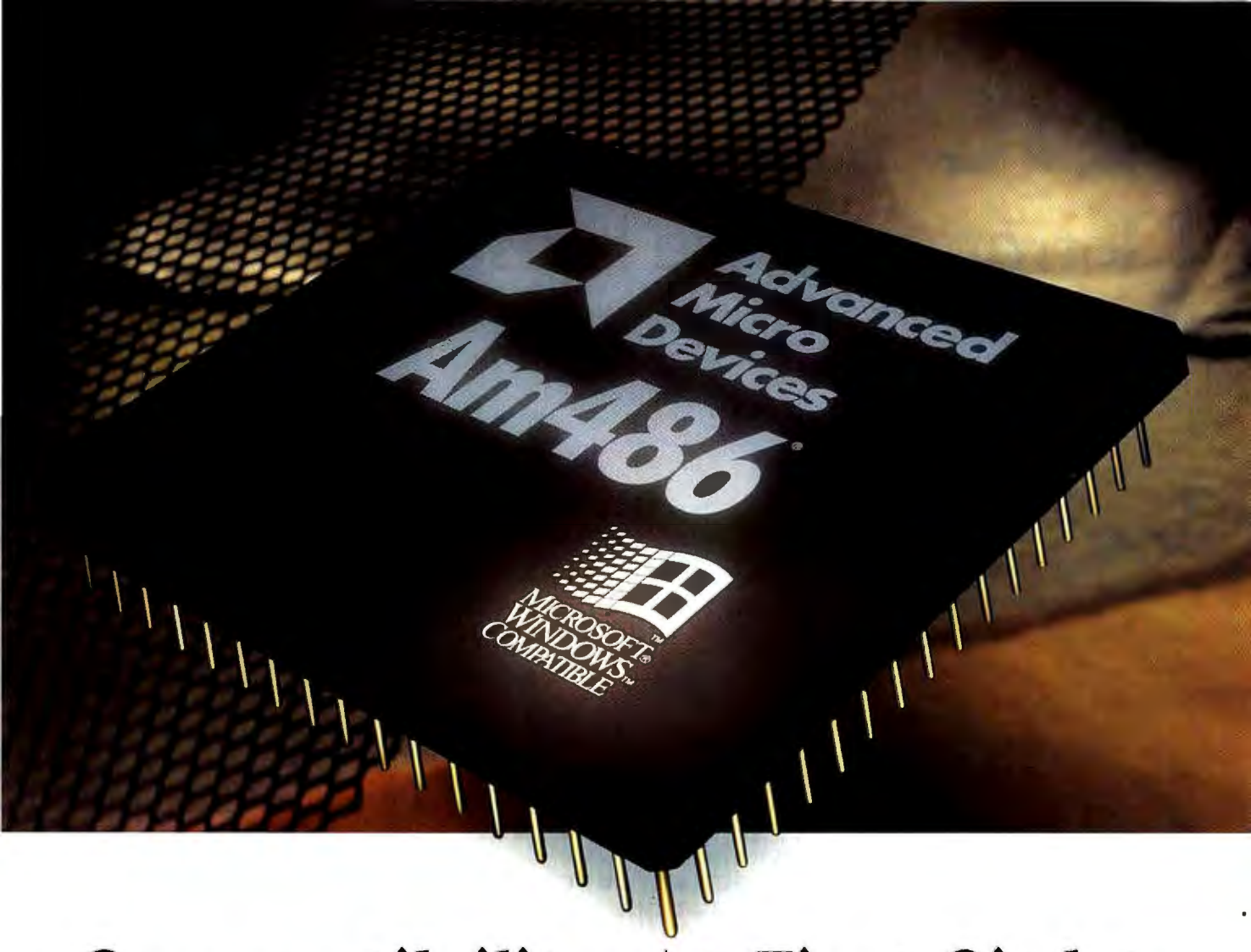

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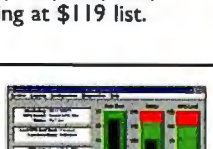

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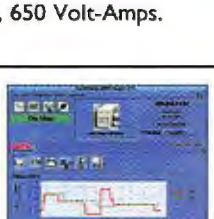

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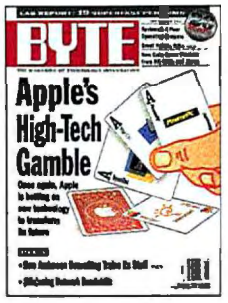
Letters

On the Fence

I read your fascinating cover story "Apple's High-Tech Gamble" (December 1994). You'll hate this one: I bought the magazine and read the article because I am a long-time Amiga guy whose wife is forcing him to give up the ghost and get a multimedia setup for the kids. I'm trying to figure out what to buy—a Mac or a PC? Although I loved your piece, I'm as confused as ever and can't get off the fence.

J. Romaner
73241.204@compuserve.com



The standard argument is there's more software available for PCs than for Macs, and that includes multimedia software as well. However, as an Amiga user, you'd probably be happier with a Mac. I am biased, though: I formerly owned an Amiga and now own a Mac.—Tom Halfhill

Real Programmers and Sine Waves

Thanks for reminding your readers that there are still some "real" programmers in the world. Although the intent of "Programming in Tight Spaces" (December 1994) was not to present Chip Gracey's sine-wave generator for its own sake, it would have been nice if you had published it without errors. After all, it's only six instructions. The first two lines of the loop should have read:

```
loop mov w,-velo
     snb sine.7
```

Also, the listing caption on page 217 should have mentioned that the program's six steps actually consume seven instruction cycles. At 20 MHz, those seven cycles will take 1.4 microseconds, not the 1 microsecond quoted.

Finally, Rick Grehan should have noticed that the program doesn't actually produce a sine wave at all. Its output is a series of parabolas, generated by the well-known "double-the-difference" algorithm.

Andy Warren
FastForward Engineering
Vista, CA

*Thanks for the catches in the program listings. I feel particularly guilty about the sine-wave generating program itself. Chip Gracey presented it to me as an approximating function, suitable only for low-overhead waveform production in those cases where space is more important than accuracy. Obviously, I failed in passing on that intention in the article—*mea culpa.*—Rick Grehan*

The Pickiest Readers

Just to prove that BYTE readers can really sweat the details, in Dean Abramson's "Globalization of Windows" (November 1994), his explanation of the grouping of characters into scripts in Unicode contains a flaw. Abramson writes, "...a *B* in Russian...shares the same glyph as the Latin *B* but belongs to the Cyrillic script." But the Cyrillic letter for *V*, not *B*, is shaped like a Latin *B*. Abramson could have selected the letters *A*, *E*, *K*, *M*, *O*, or *T* to make his point.

Doug Ewell
Placentia, CA
74273,1010@compuserve.com

Ouch! I studied Russian for two years and really do know the difference between the glyphs for the letters B *and* V. *Too bad I didn't remember them when I was editing the article!—Russell Kay*

You Didn't Gush Enough

In the article "Starting with a Clean Sheet" (November 1994), Dick Pountain is not doing justice to modern APL when he says, "it is tempting to describe CleanSheet as a visual APL for the 1990s." That's like saying, "Counting is likely to be a good mathematics for the twenty-first century." Because of its nature, APL is not only one of the oldest computing languages but also one of the most promising of the next century. Ignoring APL is like sticking by writing the word *plus* rather than the symbol +. APL is the only language that can describe a problem and then execute it on a computer in the same code—and because that code is interpreted, at the speed of thought. "APL as a Tool of Thought" is not just a phrase.

Jan Karman
Almer, The Netherlands

Leading the Witness?

After I finished reading the article "Exploring Chicago and Daytona" (November 1994), I wondered about BYTE's motives to create such useless drivel. Maybe, 1) you forgot about integrity and jumped on the Microsoft bandwagon; or 2) BYTE editors had too much time on their hands; or 3) space aliens invaded BYTE.

If you ask, "Do you agree...," then you should allow the reader to respond, "No." You have assumed that Chicago and Daytona are the greatest operating systems and have completely ignored the possibility that some people may not want to upgrade to another Microsoft operating system.

Grant Likely
Calgary, Alberta

A Compelling Compiler Request

As a professional programmer, I am delighted at the turn toward more in-depth and technical reports on trends, alliances, hardware, software, and standards. However, I was disappointed that you only allotted one page to the differences between Microsoft Visual C++ 2.0 and Borland C++ 4.5 (News & Views, November 1994), especially since it affects so many programmers. I'm looking forward to a feature soon on the lowdown between all the compilers.

Ted Gaunt
Dearborn, MI
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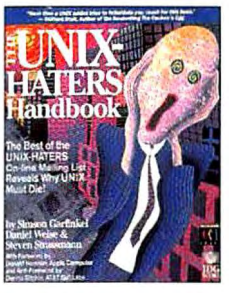

The Problem's in the Premise

Ben Smith's review of *The Unix Hater's Handbook* (Books & CD-ROM, December 1994) is really offbase. I picked up the book for the company library, and it has passed from hand to hand ever since. I've heard nothing but favorable comments from Unix and VMS programmers alike. Not only is the book humorous, it's also rather accurate technically. It may not be a literary work of

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art, but it is fun reading and doesn't deserve to be trashed. Read the book. Then fire the reviewer.

Mike Parker
CEO of Rincon Research
Tucson, AZ

Why Systems Fail

In Scott Wallace's article "Experts in the Field" (October 1994), he states, "Given that TestBench [a model-based expert system] focuses on failures and their causes, model-based reasoning tends to have limited applicability for most prospective users." This could not be further from the truth.

Model-based systems are much more applicable in the field of maintenance, because it is much easier to design a test to determine how a system is functioning correctly than to design one for how it might fail. A correctly designed model-based system can detect problems that have never occurred, where a rule-based system cannot; the rule to take you down that branch of the diagnostic tree would not yet exist.

Leonard J. Sparks
Silverthorne, CO

RISC Registers

I read "AMD vs. Superman" (November 1994) and was wondering how the registers are selected for the r-ops (RISC operations). Are they predefined? If so, how do they interact with the compiler-generated ones? Wouldn't you need to introduce some additional registers to hold the temporary results?

Nader Bagherzadeh
nader@ece.uci.edu

AMD's K5 has twice as many physical GPRs (general-purpose registers) as a conventional x86 processor, and it dynamically renames those 16 GPRs to represent the architectural set of eight logical GPRs. Temporary/intermediate results are held in a physical register until validated, and then the physical register is renamed as a logical register. This is becoming a common technique in modern processors. It's also used in the Cyrix M1 and the Mips T5 (R10000). Basically, it's just a way of getting around the limited register files of existing CPU architectures.

—Tom Halfhill

Plug and Play and Warp

The article "PCMCIA: Past, Present, and Promise" (November 1994) contains a glaring error. OS/2 2.1 does indeed support PCMCIA on third-party platforms (e.g., Toshiba laptops). IBM's OS/2 Warp includes PCMCIA Plug and Play already. Unfortunately, that fact destroys the author's thesis: that Windows 95 is the first Plug and Play OS.

Mike Potter
Atlanta, GA
mpotter@lanierwsm.atl.ga.us

BYTE Could Be an Addiction!

Thanks for a great magazine. I have been an avid reader since 1987 or thereabouts. Reading BYTE has enabled me to earn my Electrical Engineering degree and stay ahead of the pack. A number of times I've considered giving up my subscription only to have someone at work ask me a question that just happened to be covered in BYTE the month before. If you keep this up, I'll never be able to cancel my subscription.

Alan Ibbet
Rosemedow, N.S.W., Australia

Byte: The Word

I would like to get the following on record: The word *byte* was coined around 1956 to 1957 at MIT Lincoln Laboratories within a project called SAGE (the North American Air Defense System), which was jointly developed by Rand, Lincoln Labs, and IBM. In that era, computer memory structure was already defined in terms of word size. A word consisted of *x* number of bits; a bit represented a binary notational position in a word. Operations typically operated on all the bits in the full word.

We coined the word *byte* to refer to a logical set of bits less than a full word size. At that time, it was not defined specifically as *x* bits but typically referred to as a set of 4 bits, as that was the size of most of our coded data items. Shortly afterward, I went on to other responsibilities that removed me from SAGE. After having spent many years in Asia, I returned to the U.S. and was bemused to find out that the word *byte* was being used in the new microcomputer technology to refer to the basic addressable memory unit.

Louis G. Dooley
Ocala, FL

Fixes

Headquarters Software (What's New, December 1994, page 242) has changed its name to Zantel and is located in Pleasant Hill, California.

In the "Don't Write Off the Internet" text box (October 1994, page 52), Enterprise Integration Technologies, or EIT (Menlo Park, CA), was incorrectly referred to as Electronic Information Technologies.

In "These Maps Lead to the Desktop" (December 1994, page 38), ArcView 2.0, mentioned in the map caption, is developed and marketed by ESRI (Environmental Systems Research Institute). First St., a separate product developed on top of ArcView, is marketed solely by Wessex. ■

In the cockpit of every Delta Air Lines jet you'll find something absolutely critical to safe, legal, and efficient air travel: a FrameMaker® document. It's called a Minimum Equipment list, and it's also available on-line, for access via radio from dispatchers on the ground. It's one of many operational, technical, and administrative manuals that Delta writes and publishes in FrameMaker. Because FrameMaker gives Delta the functionality and flexibility they need to create, update, and consolidate their extensive documentation. Particularly attractive were features like automatic indexing. Superior graphics handling. Multiplatform capabilities for file compatibility across PCs, Macintoshes, and UNIX systems. And of course, on-line document distribution, complete with automatic hypertext links, through FrameViewer.® So don't just settle for any old publisher — fly first class with FrameMaker 4. Call *1-800-U4-FRAME Ext. 618* today for our comprehensive Guide To Document Publishing. And watch your publishing projects really take off with FrameMaker 4.

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VISUAL PROGRAMMING

Visual Pascal with a Punch

Borland's Delphi program addresses client/server and general-purpose applications development needs

TOM R. HALFHILL

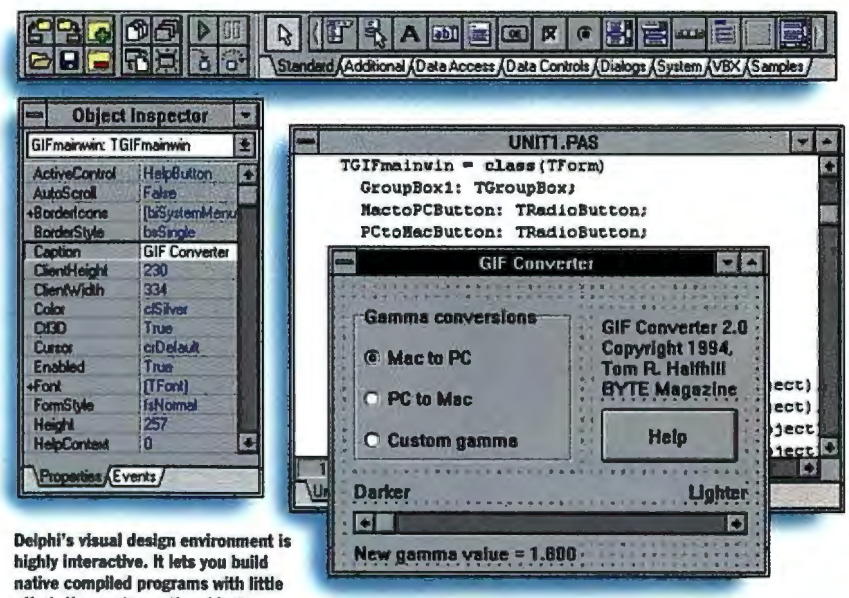
Programmers have been waiting since 1991 for Borland International (Scotts Valley, CA, (800) 891-2223) to offer an alternative to Microsoft's Visual Basic, the leading tool for rapid applications development on Windows. The wait is nearly over. Delphi, scheduled for release early this year, unites a VB-like visual design environment with the industrial strength of Borland's Pascal compiler and database-connectivity engines. Judging from an early beta version, Delphi is a well-integrated tool that will bring new versatility and performance to Windows development.

It's not that Windows developers are starved for tools. On the contrary, they're well served by such products as VB, Visual C++, PowerBuilder, SQL Windows, Clarion for Windows, Smalltalk, Borland's own C++ and Pascal compilers, Computer Associates' CA-Realizer, and many others. What's different is that Delphi bridges two important gaps. One is the conceptual gap between visual tools primarily intended for client/server solutions versus full-blown programming languages more suitable for general-purpose applications development. The other is the performance gap between interpretive or p-code languages versus true native compilers.

For desktop developers, Delphi has native connections for dBase and Paradox, as well as support for ODBC (Open Database Connectivity). Borland will bundle Delphi with Database Desktop, a tool for manipulating dBase and Paradox tables, and ReportSmith, a report generator. Borland says this version of Delphi will be priced competitively with the professional edition of VB, which sells for about $330 retail.

A high-end client/server version of Delphi will add ReportSmith SQL; Local InterBase Server, which is a utility for developing networked InterBase applications on single-user systems; SQL-Links, native drivers that let you connect to Sybase, InterBase, Informix, and Oracle; support for ODBC; and Visual Query Builder, from Coromandel Industries (Forest Hills, NY). Borland says this version of Delphi will be priced "very competitively" with PowerSoft's PowerBuilder Enterprise, which sells for about $3295.

But Delphi is much more than a client/server tool. It's also a full-featured OOP (object-oriented programming)



Delphi's visual design environment is highly interactive. It lets you build native compiled programs with little effort. Key parts are the object inspector (left), component toolbar (top), and form designer (right).

language capable of tackling almost any task, from casual freeware to commercial software. The underlying language is Object Pascal, a descendant of Turbo Pascal, which revolutionized DOS development in the 1980s and launched Borland. The compiler generates fast-running stand-alone executable files, as well as DLLs that are callable from C++, VB, dBase, Paradox, and other tools.

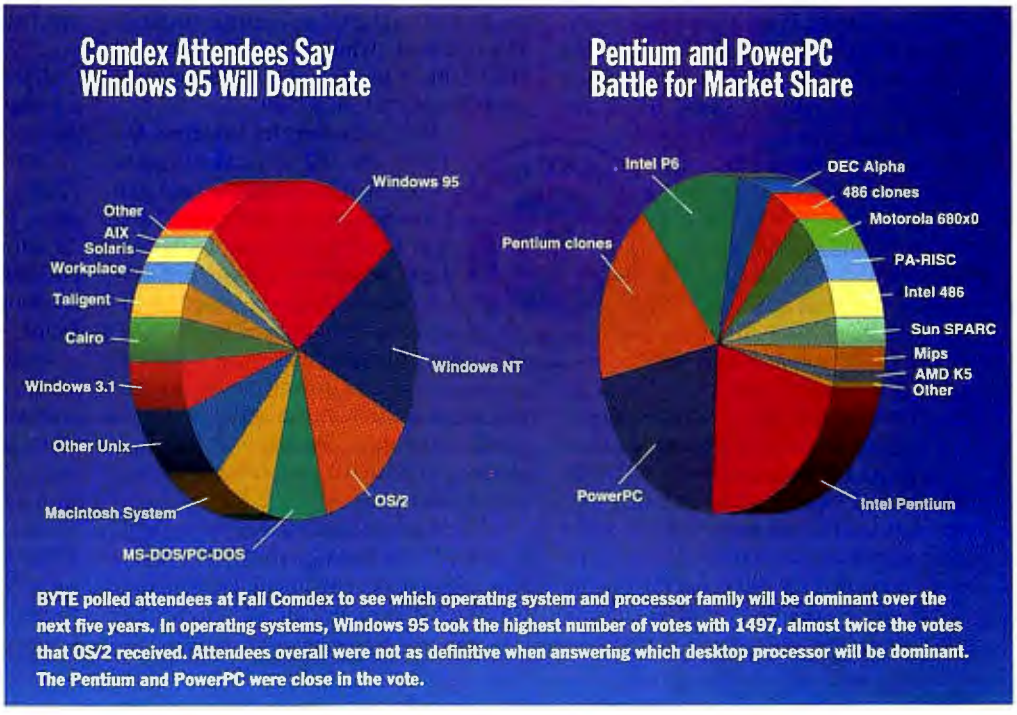
Delphi's front end is a visual interface that closely resembles VB. You create a user interface by drawing buttons, listboxes, text windows, menus, and other controls on a form. An object inspector lets you set the controls' properties and define the events they'll respond to. When you define an event, Delphi automatically creates a hollow procedure in a separate code window, ready for you to plug in your code.

Unlike the interface builders tacked onto some compilers, Delphi lets you move seamlessly back and forth between the design environment and code windows. As you make changes to your forms, Delphi automatically generates, modifies, or removes the appropriate code, and it does so without disturbing the code you've written manually.

While Delphi imposes an object-oriented structure on your program, it doesn't prevent you from reusing procedural legacy code. For example, I pasted large chunks of a DOS program that was written in Turbo Pascal into Delphi's code window. Within a remarkably short time, I had a spanking new Windows version of my program up and running.

You can also use VBXes (Visual Basic custom controls) and create your own reusable components. The components, however, are Delphi-specific. You can create VBXes with Delphi, but not until Microsoft releases Windows 95 will a subsequent version of Delphi allow you to build OCXes (OLE custom controls). A 32-bit version of Delphi will ship shortly after the release of Windows 95.

Is Delphi the long-rumored "VB killer"? Probably not. However, it is a powerful tool that no longer requires you to sacrifice performance or versatility in return for rapid development.



BYTE polled attendees at Fall Comdex to see which operating system and processor family will be dominant over the next five years. In operating systems, Windows 95 took the highest number of votes with 1497, almost twice the votes that OS/2 received. Attendees overall were not as definitive when answering which desktop processor will be dominant. The Pentium and PowerPC were close in the vote.

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How much resolution do you really need from your printer? That is the question that Lexmark ((800) 358-5835) is asking—and hoping to answer—with its Optra line of laser printers, which leapfrogs the Hewlett-Packard LaserJet standard by providing selectable resolutions of 300, 600, and 1200 dots per inch.

The Optra R, Lexmark's entry-level model, is an impressive product. For a list price of $1749 (or about the same price as an HP 600-dpi printer), you get a 12-page-per-minute print engine (8 ppm at 1200 dpi), PostScript Level 2 and PCL (Printer Control Language) 5, up to 129 shades of gray, automatic emulation and interface switching, 2 MB of RAM, and an easy setup. Options include a long-life (14,000-page) toner and duplexing. Print quality was outstanding.

But what does the average user gain from 1200-dpi printing? While it does produce four times the dots in a square inch (1200 by 1200 versus 600 by 600), the difference in text quality is probably not apparent to most observers. However, for reproducing photographic and other gray-scale images, the extra resolution makes a significant and clearly discernible difference. "For text only, 1200 dpi doesn't make a big difference, except with small [e.g., 5 point] text," says Charlie LeCompte, analyst for Lyra Research (Newton, MA), which tracks the printer industry. "But you don't have to be a visual scientist to see the difference in photographs. If printing out gray-scale images, you'll be able to see the difference pretty easily"

However, don't expect to see lots of other printer manufacturers jumping on the 1200-dpi bandwagon anytime soon. Cost is an issue, and 1200-dpi technology is too expensive for the burgeoning home-office and personal laser-printer market. Another drawback: Canon, the world's leading engine manufacturer, has no immediate plans for a 1200-dpi engine in the near term. "It isn't easy to build a true 1200-dpi by 1200-dpi engine," says Marco Boer, a printer analyst with International Data Corp. (Framingham, MA). He adds: "Memory overhead is costly, and even Lexmark recommends at least 8 MB of memory for 1200 printing, which would drive up the price."

What Boer and other analysts do expect to see is improved gray-scale printing from the competition. "For desktop publishing, the Lexmark is probably your best buy," Boer says. And for now, Lexmark has the market to itself.

—Jon Pepper

BEST OF COMDEX

Notebooks, NT Clusters Capture Awards

The 1994 Fall Comdex in Las Vegas featured scads of sleek new notebooks, numerous Internet-navigation programs, and the commercial debut of the 32-bit Windows NT Workstation 3.5 and OS/2 Warp operating systems. BYTE editors searched the convention halls for innovative new products that had been publicly announced within 30 days of the show and that would strongly influence business computing.

IBM's ThinkPad 755CD notebook PC ((800) 426-2968), winner of Best Portable System and Best of Show, features a 10.4-inch active-matrix screen (65,536 colors at 640- by 480-pixel resolution); speakers; a double-speed multisession Photo CD CD-ROM drive; video acceleration that supports full-screen, full-motion video; video capture and output; infrared ports; and much more. An IBM MWave DSP (digital signal processor) delivers CD-quality sound and Sound Blaster support. The ThinkPad also has a 14.4-Kbps data/fax modem and a digital answering machine. The notebook, which is based on an Intel DX4 100/33 processor, weighs about 7 pounds and starts at $7599.

DEC's Clusters for Windows NT ((800) 344-4825), a scalable set of servers that are addressed and managed as a single system, won as Most Significant Technology. Windows NT Server systems, which can be based on Intel 486, Pentium, and Alpha AXP PCs, offer redundancy of CPUs, storage, and communications hardware to minimize disruptions of the network due to server downtime. Backup systems in a cluster can be active, performing normal server functions.

DEC also won for Best System. Its Multia MultiClient Desktop ((800) 777-4343) Alpha-based system combines Windows NT Workstation 3.5, an X11.R6 server, and support for IPX/SPX, TCP/IP, DECnet, LAN Manager, NetBEUI, NetBIOS, and Pathworks. In another hardware category, Citizen America ((800) 477-4683) took the Best Printer award for its PN 60, a 2-page-per-minute, 360-dot-per-inch unit that weighs about a pound and costs $399.

Caere's PageKeeper 2.0 ((800) 535-7226), a program that automatically indexes your PC files and lets you retrieve the information you need, won as Best Application Software. Borland won the Best Development/System Software award for Delphi 95 (see page 22).

Avid Technology's ((508) 640-6789) Media Suite Pro for Windows, a 32-bit professional, nonlinear video-editing program, won as Best Multimedia Software. Video NT, a real-time MPEG compression card that sells for just $600 from France-based Vitec Multimedia (+33 1 47730606), won as Best Multimedia Hardware. The card supports a maximum of 15-frame-per-second, full-screen, real-time encoding.

ConnectSoft ((800) 234-9497) took honors for the Best Connectivity Software with its Internet Connection, which supports Internet E-mail, a WWW (World Wide Web) browser, a graphical `ftp` interface, and a gopher application. Xircom's ((800) 438-4526) CreditCard Ethernet+Modem II, which combines Ethernet, a 19.2-Kbps data/14.4-Kbps send/receive fax modem, and cellular modem connectivity on one PCMCIA card, took the Best Connectivity Hardware award.

The Best Peripheral award went to Panasonic's CD-ROM/Optical Disk System (see the related story in this section). The award for Fall Comdex 1994 Rookie went to BookLink Technologies ((800) 453-7873), developer of the Windows-based InternetWorks viewer/browser for the Internet. InternetWorks' multithreading, support for OLE 2, and customizability make it a worthy contender in the Internet surfing arena.

Best of Comdex Finalists

Portable System: Tadpole's ((800) 232-6656) 100-MHz Pentium-based P1000 notebook; Hewlett-Packard's backlit, 3.8-pound, 486-based OmniBook 600 ((800) 443-1254).

Technology: A 4-Mbps infrared-technology proposal from HP, IBM, and Sharp; Digital Simultaneous Voice and Data, which is being developed by a number of companies.

Printer: Tektronix's ((800) 835-6100) $8995 Phaser 540 color laser printer; the dual-function dye-sublimation, wax-thermal-transfer Pictura 310 Color Printer ($4995) from Fargo Electronics ((800) 327-4622).

System: DEC's Alpha Server 2100 4/275, which combines four 275-MHz Alpha CPUs; the Apple Power Mac 8100 running a PowerPC 601 chip at 110 MHz ((408) 996-1010).

Applications Software: Odyssey Development's ((303) 689-9998) Isys Information retrieval and management software for Windows; Quattro Pro 6.0 for Windows from WordPerfect, Novell's Application Group ((801) 429-7000).

Development Software: OCR Document Recognition Technology toolkit for Windows, which is being used by Delrina, WordPerfect, and other major software developers, by Xerox Desktop Document Systems ((800) 248-6550); MediaForge, a Windows multimedia authoring system from Strata ((800) 678-7282).

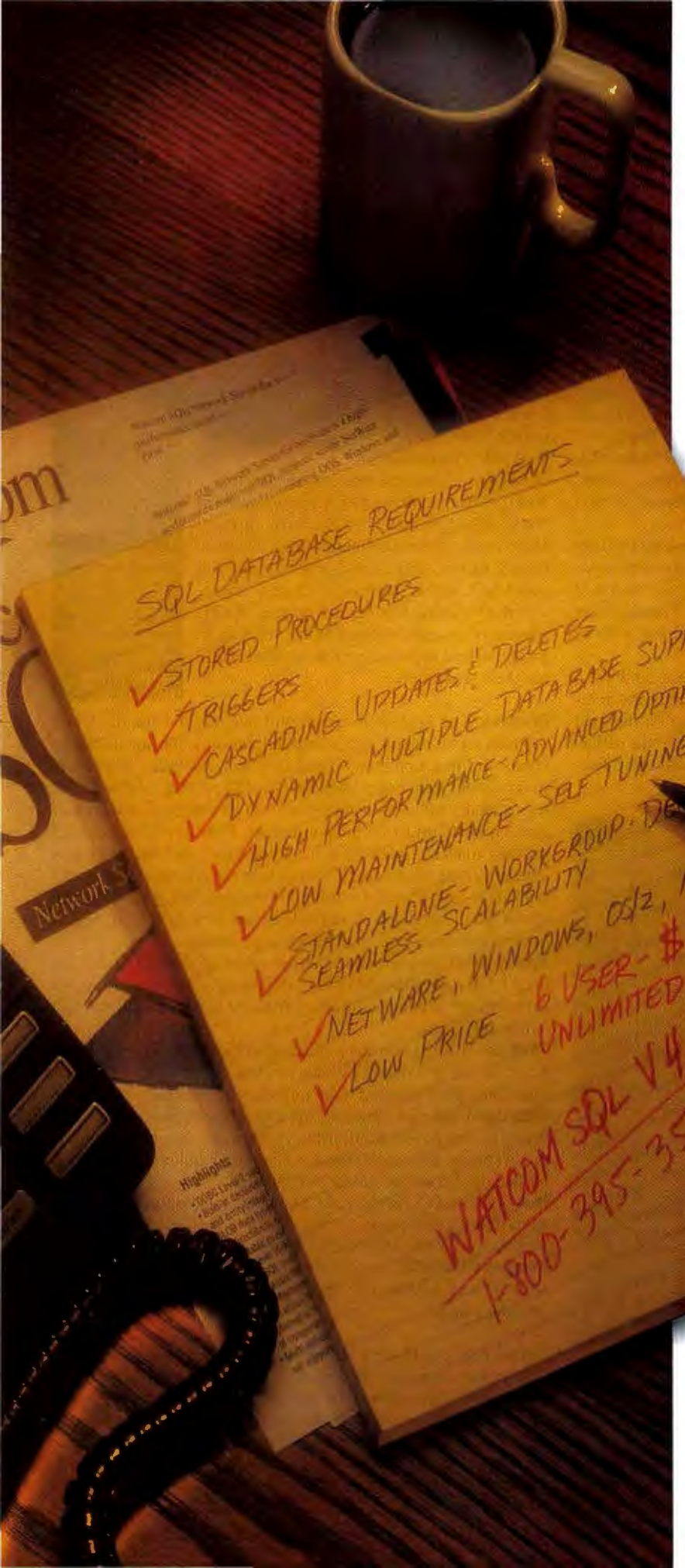
Multimedia Hardware: 3 Demon, a 3-D graphics accelerator from OmniComp Graphics ((713) 464-2990); Media-Tel, a telephony, fax/modem, and sound card for the PC from American Megatrends ((800) 828-9264).

Multimedia Software: The Hotz Translator for Windows, a real-time computer-aided music performance and composition tool ((310) 474-0406); The Wall, A Living Memorial CD-ROM about the Vietnam Veterans Memorial, by Magnet Interactive Studios ((202) 625-1342 ext. 275).

Connectivity Software: The forthcoming Microsoft Network on-line service; LANtastic, a peer operating system for OS/2, by Artisoft ((800) 233-5564).

Connectivity Hardware: The Timex Data Link watch, which lets you transfer up to 70 PIM (personal information manager) entries from your PC into the watch ((800) 367-8463); the Cyberspace Internet Card, from ISDN*tek ($395, (415) 712-3000).

Peripheral: IBM Storage System Division's Ultrastor XP SSA hard drive ((800) 426-3333, Dept. * 30); the MBR-7 CD-ROM Changer, by Mountain (see page 30).



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MAC AND PC NOTEBOOKS

High-End Portables Take Off

High-end notebooks, which pack performance and multimedia capabilities in about a 7-pound package, are accounting for an increasing percentage of portable sales. This is due in part to a higher demand by businesses for desktop PC replacements. The increased demand for these diminutive powerhouses—along with the appearance of 3.3-V Pentium chips and greater availability of 9.5- and 10.4-inch active-matrix displays—has led to a wave of notebook introductions in recent months. Meanwhile, vendors are tracking advances in battery, screen, storage, processor, and bus technologies as they prepare the next versions of their products.

High-end notebooks that sell for $4000 or more jumped from about 10 percent in 1993 to 25 percent in 1994 of the total number of portable units shipped in the U.S., according to Bruce Stephen, an analyst at International Data Corp. (Framingham, MA). "We expect the premium products to hit and create a stir in Europe and Japan, too," Stephen says.

More and more companies are saying employees can have a desktop PC or a notebook PC, but not both. The high-end notebook lets mobile workers take their computing act on the road without sacrificing performance. When they return to the office, the notebook goes into a networked docking station with a full-size keyboard and display.

NEW HIGH-END NOTEBOOKS

IBM ThinkPad 755CD ((800) 426-2968); see page 24.

NEC Technologies Versa M Series ((800) 632-8377). High-resolution and true-color displays highlight NEC's Versa M family, available with a 75- or 100-MHz 486 processor and 9.5-inch active-matrix or dual-scan passive-matrix displays. True-color active-matrix models are capable of displaying 16 million colors at 640- by 480-pixel resolution, and high-resolution-color active-matrix models offer 800- by 600-pixel resolution with 256 colors.

Texas Instruments TravelMate 5000 ((800) 848-3927). TI's 75-MHz Pentium notebook features PCI-bus architecture, NTSC, PAL, and SuperVideo out; built-in sound and speakers; dual lithium-ion battery packs; and a 10.4-inch active-matrix screen.

Apple Computer PowerBook 540c and 520c ((800) 538-9696). Apple's 540c (active-matrix) and 520c (dual-scan passive-matrix) are now available with 500- and 320-MB hard drives, respectively. Apple says it will formally introduce its first PowerPC-based notebook this summer.

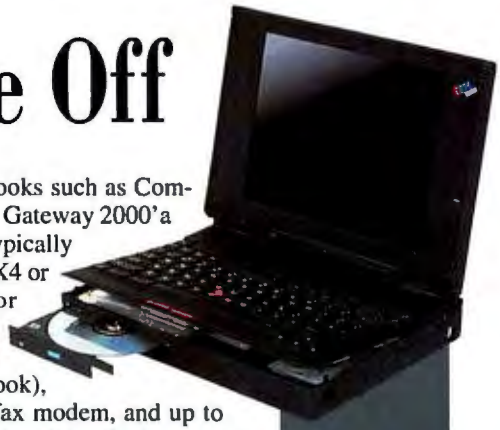
Hewlett-Packard OmniBook 4000 PC ((800) 752-0900). HP's first high-end notebook features either a 10.3-inch passive-matrix or 10.4-inch active-matrix screen.

Tadpole P1000 ((800) 232-6656). Tadpole now has a Pentium-based notebook with PCI-based graphics, built-in sound, SCSI, and PCMCIA.

Toshiba 4900CT ((714) 583-3000). The T4900CT, a 75-MHz Pentium-based notebook, ships with 8 to 40 MB of fast EDO RAM, which the company says eliminates the need for an L2 cache controller.

Epson ActionNote 800 series ((800) 374-7300 or (800) 289-3776). Epson's first multimedia-ready notebooks will include active- and passive-matrix models.

AST Research Ascentia 910N ((800) 876-4278). AST's 910N features an Intel 486DX4/75 processor and is the company's first notebook to use lithium-ion batteries.



The IBM ThinkPad 755CD's lift-up keyboard lets you remove the CD-ROM drive and install a removable disk drive or a PCMCIA cartridge to add an additional card slot.

High-end notebooks such as Compaq's LTE Elite or Gateway 2000'a new ColorBook² typically come with a 486DX4 or Pentium processor (or a 68040 processor if you own an Apple PowerBook), PCMCIA, a data/fax modem, and up to an 810-MB hard drive. Other features can include an integrated CD-ROM drive, infrared I/O, removable components (e.g., screens, floppy drives, and hard drives), sound and video I/O, and active-matrix or less expensive dual-scan passive-matrix screens. BYTE surveyed a number of notebook vendors to gauge where this category is headed. Here are their predictions:

Displays: The 10.4-inch screen will become the standard, and 9.4-inch active-matrix screens will migrate to value and midrange notebook lines. Look for 11-inch displays and wider availability of notebooks with better than 640- by 480-pixel resolution. NEC sells a model with 800- by 600-pixel SVGA resolution and another that supports up to 16 million colors. Bob Levin, director of product marketing for NEC Technologies' portable computer systems group (San Jose, CA), predicts the arrival of notebooks with 1024- by 768-pixel resolution sometime this year. The 800- by 600-pixel resolution should hold appeal for CAD/CAM, heavy-duty spreadsheet, and engineering applications.

Hard drives: Users can select hard drives of up to 810 MB, but 2½-inch 1-GB drives should be introduced early this year. Look for drives to get slimmer, migrating from 17 and 19 mm down to a height of 12 mm.

PCMCIA: This has become a standard I/O interface for notebooks. Look for the first notebooks that implement the 32-bit PCMCIA (aka Card Bus) standard to be introduced in the fall.

Batteries: High-end notebooks use either NiMH (nickel-metal-hydride) or the newer lithium-ion technology, but most vendors predict a migration to lithium-ion this year. It holds its charge better and delivers more power than NiMH.

PCI: Look for PCI (Peripheral Component Interconnect) to emerge as more Pentium-based notebooks come on-line. Apple should also unveil its first PCI notebook this year.

Integrated CD-ROM: Some units (e.g., the IBM ThinkPad 755CD) already have built-in CD-ROM drives, and other vendors will introduce them.

This year should see a continued series of balancing acts by engineers looking to add bigger screens while measuring the trade-off in battery life and weight. However, the compromises should be less obvious as notebooks are introduced throughout the year. This means you'll have more full-featured computers with about the same size and weight to choose from the next time you upgrade your "desktop" computer.

—Dave Andrews

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OPTICAL STORAGE

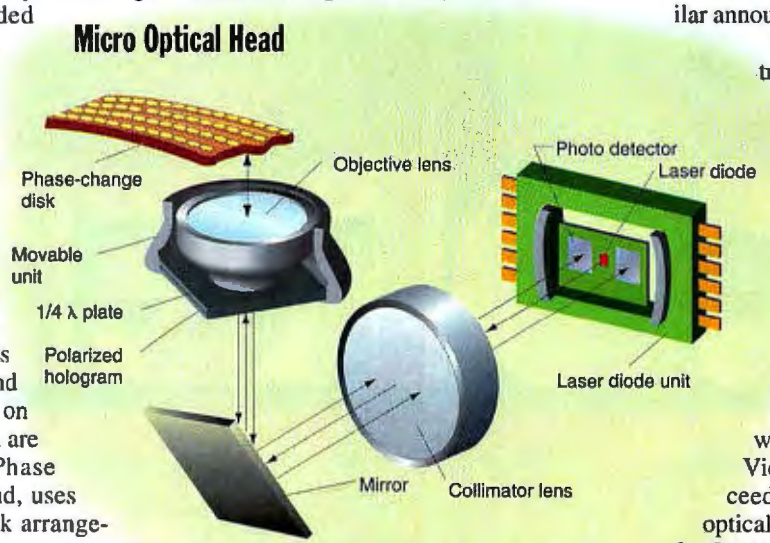
Rewritable Drive Integrates Two Optical Technologies

Optical phase change has promised the most as a rewritable medium, but high hardware and medium costs have kept it out of the mainstream. Matsushita hopes to change that. At Comdex, its Panasonic Communications and Systems Co. (Secaucus, NJ) showed a hybrid quad-speed CD-ROM reader/phase-change read-write device that it refers to as PD (phase-change dual). The half-height drive uses the same laser mechanism to read CD-ROMs and to read and write phase-change cartridges. The one-sided phase-change discs can hold up to 650 MB of uncompressed data, and a PD drive delivers a claimed average read rate for the phase-change disc of 870 Kbps.

The laser mechanism is surprisingly simple for a hybrid device (see the figure), especially when you consider the differences between phase-change and CD-ROM media. Tracks on a CD-ROM, for example, are arranged in a spiral. Phase change, on the other hand, uses the same concentric track arrangement as your hard drive.

The Matsushita device automatically senses which type of medium is in the unit and handles it accordingly. The loading mechanism had to be redesigned, because the phase-change medium is enclosed and the CD-ROM medium is not.

According to Rich Harada, Panasonic's national marketing manager for optical drive products, the most difficult part of the design process was to develop a more sensitive phase-change medium that was also cheaper. This allowed the use of a smaller, less powerful laser.However, the new medium is incompatible with all other current phase-change drives.



The PD laser mechanism is similar to that of a standard CD-ROM drive. A key difference is the use of a polarized hologram, which improves the efficiency of the laser while reading phase-change discs.

Panasonic expects a complete PD drive kit to retail for less than $1000 and appear sometime this quarter. Plasmon Data, which collaborated with Matsushita on developing the medium, says the price for the medium could go under $50 per disc in quantity. Plasmon has already announced a commercial PD drive that's called the PD2000e. NEC Technologies has said it will use PD drives in a line of multimedia PCs to be sold in Japan. Harada says that several U.S. manufacturers will make similar announcements early this year.

Will PD fly? Its pricing is attractive for a removable high-capacity storage device. The phase-change medium is faster and more durable than tape and much cheaper than removable hard drives. Both Panasonic and Plasmon say they will first target traditional users of removable storage, in areas such as prepress and imaging.

Bob Katzive, an analyst with Disk/Trend (Mountain View, CA), thinks PD may succeed in the mass market. "The optical industry in the past, except for CD-ROM, has shown the ability to shoot itself in the foot. [PD] may be the way to break out of this pattern."

—Michael Nadeau

SIGNIFICANT ENTERPRISE DATA-STORAGE-DEVICE DEVELOPMENTS

PRODUCT/COMPANY	DESCRIPTION/AVAILABILITY	SIGNIFICANCE
Low-cost CD-Recordable, multiple vendors	Drives for under $1000, this year	In-house publishing
Rewritable CD-ROM, JVC, Ricoh, Sony	Phase-change technology, this year or 1996	Rewritable, not multisession; challenges MO
MiniDisk, Sony, MO (magneto-optical)	2½-inch 140-MB, now	Potential CD-ROM replacement
3½-inch MO/high-density 3½-inch MO	120-, 240-MB now/650-MB this year or 1996	Low-cost optical storage
5¼-inch 4X MO, Sony, HP, Maxoptix	5.2-GB, faster access, 1996	Increased capacity, I/O
100-GB digital linear tape, DEC	Half-inch DLT cartridge, 1996	Increased 5¼-inch capacity
Tape mini loaders, HP, Conner, Rexon, Sony	4-mm DAT technology/robotics, now	Automated media handling, high capacity
New technology prototype tape, IBM	IBM 3490 half-inch cartridge, this year	10-GB, fills 3490 capacity gap
Nontracking tape, Sony, Datasonix	1.2-GB, now	Postage stamp–size cartridge
1.8-inch 1-GB/1-inch 1-GB hard drive	This year/1998	High-capacity storage/multiple-GB RAID on a card
2½-inch 1-GB hard drive	MR thin-film heads, alternate substrate, fluid-film motors, this year	Up to 5-GB multidrive internal storage per bay
Compact flash solid-state, SunDisk	32-Mb EEPROMs, up to 15 MB, this year	See January News&Views, page 30
Cached-actuator storage device, DEC, Zitel	Solid-state cache at actuator level of single hard drive; highly interactive algorithms, now	Higher I/O speed, better performance
Network storage applicances, multiple	Device with 16-MB RAM cache, 2-GB disk cache, and 60-GB optical jukebox, now	High-performance networked optical storage

(Source: Strategic Research Corp. (formerly Peripheral Strategies), Santa Barbara, CA)

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NETWORKING

It's Getting Easier to Integrate Multiple CDs

The integration of CD-ROM jukeboxes (i.e., changers) and towers on a network is becoming more seamless, thanks to new hardware and software products for LAN administrators. Companies often have multiple electronic reference libraries on CD-ROMs that users must have access to, according to Patty Chang, principal analyst in the computer systems and peripherals group at Dataquest (San Jose, CA). "Research groups frequently use many databases," says Chang. "Some of which the entire company might use, while other [discs] might be needed for only a handful of people."

One way to handle these different needs when it comes to accessing CDs is to swap discs in and out of a single drive. A more efficient approach is to use a CD-ROM drive that accommodates multiple CDs. However, integrating a CD changer onto a network is not always straightforward.

Products such as MacProducts USA's Magic CD 6 Quadraspin and Pioneer's DRM-602X offer a six-drive unit with a device driver that identifies multiple CDs in the unit's changer through different drive letters (see "Fast Access to Multiple CDs," September 1994 BYTE, page 182). But when you remove a specific library from one slot and place it in another, an application may not be able to find the CD. That's because the cartridge slots are mapped to separate network or user drives. When this happens, someone has to return the CDs to their correct slots or remap the drives to run a particular application. This exercise in CD-ROM swapping can annoy and frustrate users.

Both hardware and software vendors have devised solutions to this problem. Mountain Network Solutions' (Scotts Valley, CA, (408) 438-6650) double-speed CD7 Minichanger (it will sell on the street for about $499), which accommodates seven CDs, virtualizes all the CDs into one drive, thus eliminating the need to remap drives to specific applications. When you request a program or data on a CD, the drive looks for the CD with the particular application and loads it. The CD7 Minichanger lets you pop out a CD in the drive while still letting users access the remaining CDs. This makes accessing frequently used databases, as well as the occasionally needed CD, easier for most users.

Smart Storage (Andover, MA, (508) 623-3300) took a similar but more ambitious approach by providing single-drive-letter access to multiple CD-ROM drives and jukeboxes. Smart Storage already sells SmartCD, a program for PC networks or NFS (Network File System) clients that provides application- and device-independent access to CD-ROM drives, jukeboxes, and towers. The company plans to introduce two new programs in the first quarter: Smart CD Library for networks and Smart CD Manager for stand-alone PCs (the pricing of these programs was undetermined at press time). In addition to virtualizing CDs into one drive letter, both products will present users with a friendly DOS or Windows interface for selecting a CD-ROM application to run from a pool of CDs.

—Salvatore Salamone

CODE TALK

RICK GREHAN

Leadtools' Comprehensive Imaging Development Toolkit

In rare instances, I have the privilege of working with packages void of feature-bedecked user front ends that need a CD-ROM's worth of documentation to master. Such is the case with Leadtools, from Lead Technologies ((704) 332-5532; fax (704) 372-8161). Leadtools does one thing—image manipulation—and it does it right.

The whole package amounts to a floppy disk and a book. Leadtools Professional 4.0 (for both DOS and Windows) consists of a DLL and a library that lets you call the DLL. You'll need a Borland or Microsoft C compiler (or a compiler that is compatible enough to read standard .LIB files; I used Watcom C/C++ 10.0). The product is also available in versions for Windows NT and Clipper, Visual Basic, and FoxPro programmers.

The image of this airplane was enhanced using Leadtools' emboss function.

The Leadtools DLL provides routines that can read, write, and manipulate image files. It understands more file formats than I can list—some, I am embarrassed to say, I hadn't even heard of. Some of the familiar formats it understands are Targa, TIFF, PCX, GIF, EPS, Windows Metafiles, MacPaint, WordPerfect raster files, and the lowly BMP (i.e., bit-map) file. Leadtools does have access limitations on some formats. For example, it can read Kodak Photo CD files, but it can't write them due to licensing restrictions by Kodak.

Leadtools' manipulation functions are similarly diverse. You can sharpen, blur, rotate, flip, posterize, filter, and create mosaic (i.e., pixel-tiled) images. Every function I've ever seen in professional image-manipulation packages is here—and then some. Additionally, when you tell Leadtools to actually display an image, you can control the painting effect. It can "wipe" from left to right, right to left, top to bottom, or bottom to top. The image can "materialize" as random pixels are properly illuminated. You can even have the image spiral into existence.

The Leadtools disk is crawling with sample programs, each exercising a different class of functions from the DLL. If you need to see what an effect looks like (some are often hard to describe), the designers have thankfully provided several "exerciser" programs in executable form, along with sample images. You can load an image and try out the effect before adding it to your program.

Granted, the $795 price is steep, but it gets you DOS and Windows, plus royalty-free distribution rights to whatever applications you build. If I had to write my own personal version of Adobe Photoshop, Leadtools is where I'd start.

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INTRACOMPANY FAXING

Brooktrout Cuts the Cost of Internal Faxing

Faxing is popular to everyone except, perhaps, the person responsible for paying the phone bill to send all those faxes. Fortune 500 companies spend between $5.4 and $7.2 million annually (36 percent of their total telecommunications charges) for fax transmissions, according to a 1994 Gallup poll on fax usage conducted for Pitney Bowes. That figure is certain to grow, because the number of devices that let you send faxes is predicted to increase by more than 20 percent per year over the next four years, according to BIS Strategic Decisions (Norwell, MA).

Many companies have existing private networks to carry their voice and data traffic, but less than 20 percent of the Fortune 500 companies use those private networks to send faxes between sites. Instead, they use the public telephone network, incurring dial-up charges for each transmission. The Gallup poll found that 55 percent of the fax traffic is destined for a fax machine within the organization. Companies could save millions of dollars a year if they used their private networks for this traffic.

Until recently, there's been a good reason not to send faxes over those private networks. Because faxing is analog, it is treated as voice traffic. And most companies compress this traffic before letting it traverse their digital networks. This can play havoc with fax transmissions, causing fax machines at opposite ends of a connection to get out of sync and drop the link, requiring the fax to be retransmitted. Additionally, analog faxing takes 64 KB of bandwidth; few companies are willing to allocate that much bandwidth simply for faxing.

The Brooktrout Networks Group (Richardson, TX, (214) 907-0885) developed a novel approach that gets around these problems and lets you send faxes over existing time-division multiplexing and X.25 networks and other LAN/WAN technologies. The company's DAFS FaxRouter first digitizes the fax and then transmits it in a store-and-forward manner to another FaxRouter. The FaxRouter then converts the digital signal back to analog for delivery to a fax machine.

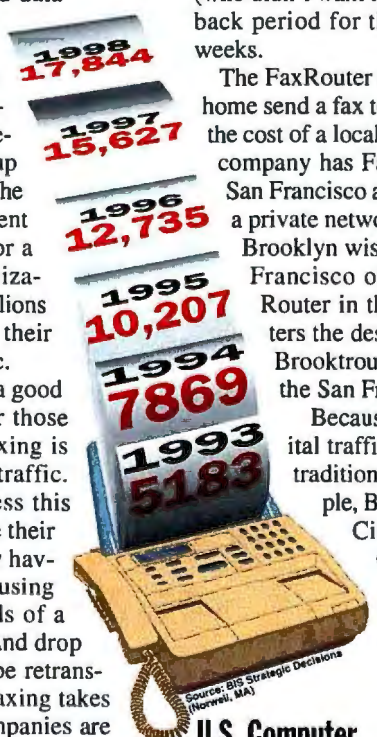
This lets a company allocate a low-speed channel (e.g., a 19.2-Kbps data channel in a multiplexer) to fax traffic. And transmissions can be sent at even lower rates, such as 1.2 Kbps, thanks to the store-and-forward capability.

The big advantage to using the FaxRouter is the cost savings when private networks are used to bypass the public telephone network. One user of the FaxRouter, a Fortune 500 manufacturer that has an international private network (who didn't want to be identified), says the payback period for the $2500 unit is about two weeks.

The FaxRouter also lets a person working at home send a fax to a long-distance location for the cost of a local call. For example, suppose a company has FaxRouters in New York and San Francisco and the sites are connected by a private network. A home-based worker in Brooklyn wishing to send a fax to the San Francisco office simply dials the FaxRouter in the New York office and enters the destination phone number. The Brooktrout unit will deliver the fax to the San Francisco office.

Because the fax is converted to digital traffic, it can also be carried over traditional data networks. For example, Brooktrout, in conjunction with Cisco Systems (Menlo Park, CA), has demonstrated that it can send digitized fax traffic over LAN internetworks. In the demonstration, fax data packets were sent over an Ethernet LAN to a Cisco 4000 router, which bridged the traffic over an internetwork. A second Cisco 4000 router received the fax data packets and forwarded them to a FaxRouter, which then converted the packets into G3 format and delivered them to a fax machine.

—S.S.



U.S. Computer Fax Shipments
(In thousands of units)

Fax transmissions are likely to continue to grow as more devices are installed to send faxes. The figure includes centralized systems, LAN fax servers, and fax modems.

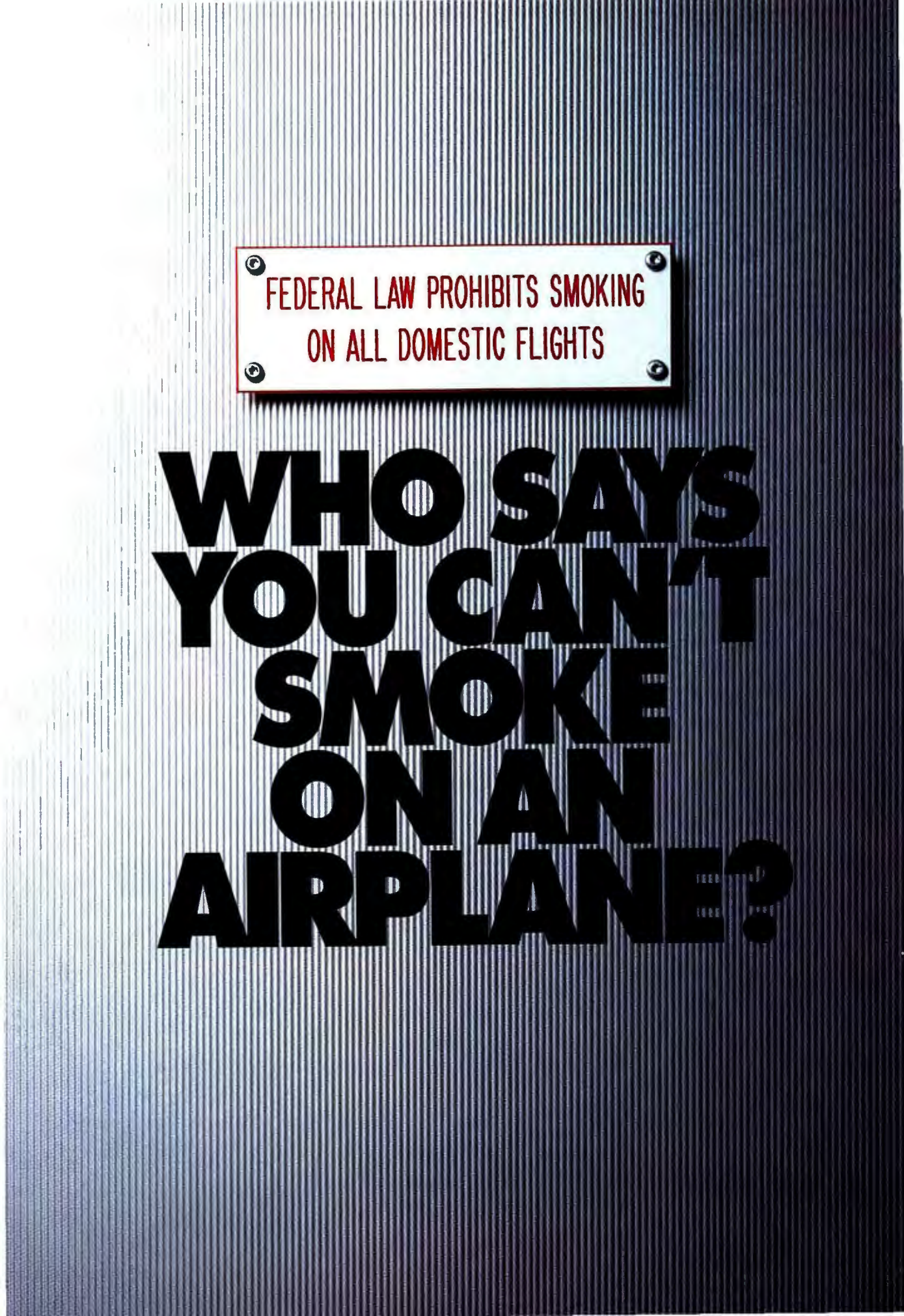
Whatever Happened to . . .

U.S. Memories?

In January 1990, a group of major U.S. semiconductor and computer firms, including Advanced Micro Devices, DEC, HP, IBM, Intel, LSI Logic, and National Semiconductor, announced plans to form a new independent company called U.S. Memories. The intention was to make the U.S. once again a major producer of DRAMs and to ensure a domestic supply of the memory chips. U.S. production of DRAMs had dwindled to under 10 percent, with Texas Instruments and Micron the only commercial suppliers. Headed by former IBM executive Sanford Kane, U.S. Memories was announced before it had the required funding to begin construction of a factory and to begin production of IBM-designed 4-Mb DRAMs.

The plan was to raise about $500 million from a variety of semiconductor and computer companies. Because many of the potential investors got cold feet, U.S. Memories never got off the ground. Other companies, such as Sun and Apple, declined to join the cooperative venture. Today, Micron and TI are still the only major producers of DRAMs in the U.S., although Motorola has begun commercial manufacture of DRAMs again. According to statistics from the market research firm Instat, U.S. production of DRAMs accounts for only 15 percent of the world market, with Japan and Korea holding the lion's share of the rest. This is some improvement over 1990 (largely due to the reentry of Motorola into the market), but it's a far cry from the ambitious goals of U.S. Memories.

—Nick Baran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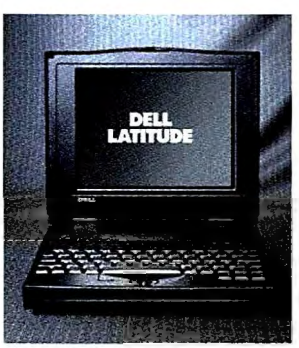

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Blasts from the Past

DENNIS BARKER

Zenith's new EISA PC, a 33-MHz 386 machine, was our cover story. It was one of the first EISA boxes, and it had a drive controller that "leaves others in the dust."

Three things that haven't changed. A Microbytes story quoted David Liddle, then chairman of Metaphor Computer Systems, as saying users have three big needs the industry isn't filling: the ability to access data, no matter where it is; tools that everyone can use; and tools that let even technology novices build applications.

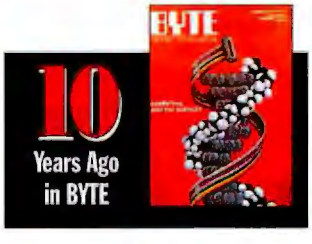
Department of It Sounded Like a Good Idea

We looked at some products that left the drawing board with grand hope and hype but tanked when they hit the market. These micro Edsels included the Apple III, the TI-99/4A, and the IBM PCjr.

Motorola had just released the 68040. Notable enhancements: an integrated FPU, two 4-KB caches, and separate MMUs (memory management units) for data and instructions. At approximately 20 MIPS and 3.5 MFLOPS, it would make the next generation of Macs run at the speeds of SparcStations.

Space Oddity An article called "Drowning in Data" proposed a serial memory system that involved bouncing data off the moon with a laser beam and using space as a recording medium. And did you know that digital tape has a bit-storage density that's about two orders of magnitude greater than the neuron density of the brain?

Ray tracing—a technique for rendering photo-realistic images—was a natural application for transputers. Author Owen F. Ransen showed how to use the Inmos chip's innate parallel processing power to whip up 3-D graphics.



Computers in the sciences. BYTE published articles that looked at using PCs for low-cost data acquisition, modeling kinetics, removing noise from data, interfacing with lab equipment, and viewing molecules—novel ideas back then.

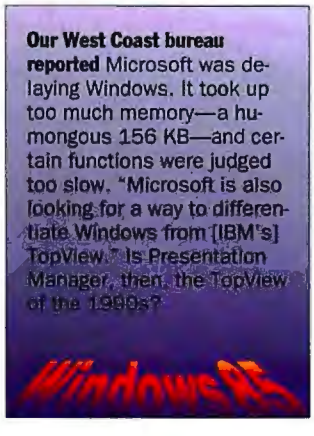
"It may be worth it someday when there's a lot of great software. But right now not many are going to pay a thousand bucks to hook up a $2000 computer to a network. . . because there isn't enough software that makes it worthwhile."

— Steve Jobs, in an interview with BYTE, on the lack of networked computers

Did you hear the one about the COBOL hacker who. . . Reader William Carlson wrote to suggest we add a "Jokes and Riddles" column and a comic strip or two. We haven't forgotten your suggestion, Mr. Carlson. We're just trying to figure out how to embed the sound of a rimshot in the pages of the magazine. (Ba-dum!)

Dick Pountain wrote from the U.K. about a system that almost attained his Platonic ideal of a computer. The MG-1 from Whitechapel Computer Works was powered by National Semiconductor's 32-bit 32016 processor. It was designed for speedy bit-mapped graphics. Fashion-wise, it was ahead of its time: It was housed in black.

Our West Coast bureau reported Microsoft was delaying Windows. It took up too much memory—a humongous 156 KB—and certain functions were judged too slow. "Microsoft is also looking for a way to differentiate Windows from [IBM's] TopView." Is Presentation Manager, then, the TopView of the 1990s?



Our first column on computers and the law looked at Lotus's lawsuits against businesses it accused of illegally copying 1-2-3 for internal use. Other software companies were also lining up their lawyers. A "vocal group of users" charged that the lawsuits were "nothing more than an attempt to intimidate users into paying inflated license fees."

Graph theory was the major story, explaining how graphing programs could figure such things as the shortest distance between two cities. The big challenge with these graphs was storage. "Space should not be wasted on 0s that represent nonexistent edges."

Retro tech Robert Newcomb described how he built a plotter out of an Etch-A-Sketch, two stepper motors, gears, a circuit board, and a Tiny BASIC program. He hooked the device up to a KIM-1 computer. The Etch-A-Sketch drew quite nice graphs and had two advantages: It didn't use any memory to put information on the screen, and it was nonvolatile—well, as long as you didn't shake it.

Steve Ciarcia's project was seasonal. It was something that BYTE's New Hampshire–based staff could really relate to: using a computer to control a wood stove.

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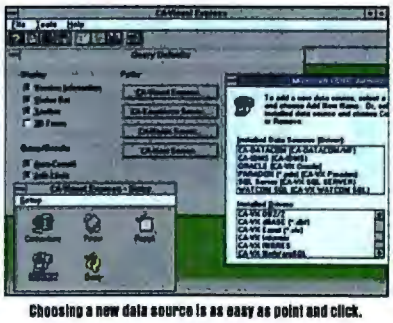

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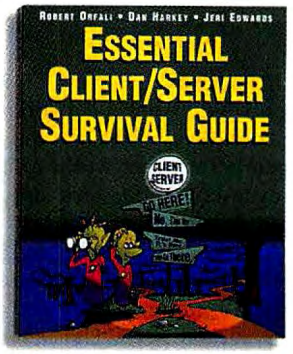


A Savvy Guide to Client/Server Computing

JON UDELL

These folks can sling acronyms like nobody's business. What's even more amazing is that they can make sense out of the alphabet soup. Two of the authors, Robert Orfali and Dan Harkey, have shown in previous (and more massive) tomes a remarkable grasp of the nuts and bolts of OS/2-based client/server software development. Those books are full of hands-on, code-rich tutorials on protocol stacks, RPCs (remote procedure calls) and messaging, SQL databases, TP (transaction processing) monitors, and more.

In *Essential Client/Server Survival Guide*, they emerge from the OS/2 programming trenches to deliver a sweeping survey of the entire client/server field. It's as savvy, informative, and entertaining as anything you are likely to read on the subject.

The problem, of course, is that client/server isn't one technology but many—remote SQL, TP, message-oriented groupware, distributed objects, and so on. Like the proverbial blind men feeling the elephant, most of us have a hard time seeing the whole picture. The authors succeed brilliantly in mapping the elephant. They build a taxonomy that neatly sorts out successive generations of technology.

For example, they classify stored procedures and triggers (Sybase and Oracle) as "TP lite," and load-balancing, distributed transaction systems (Encina and Tuxedo) as "TP heavy," a surprisingly useful way to clarify how these two sets of technologies are both similar and different. Later, in a masterful chapter on distributed objects, they build on the analogy by showing how a CORBA (Common Object Request Broker Architecture) object adapter is, in effect, the next wave of TP monitor.

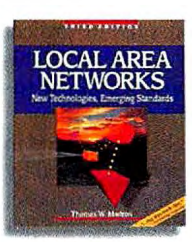
Database servers, transaction servers, and object servers are overlapping parts of client/server technology. Informed analysis of any one of these subjects is rare enough. When writers/practitioners can define the evolution, uses, and limits of all three—as Orfali, Harkey, and Edwards ably do—they can justly claim to have created an essential guide. ■

ESSENTIAL CLIENT/SERVER SURVIVAL GUIDE

Robert Orfali, Dan Harkey, and Jeri Edwards
Van Nostrand Reinhold
ISBN 0-442-01941-6

$24.95

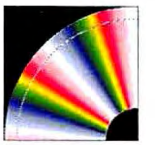
Jon Udell is a BYTE senior technical editor at large. You can reach him on the Internet or BIX at judell@bix.com.



AN EXCELLENT GUIDE TO LANS

LOCAL AREA NETWORKS: NEW TECHNOLOGIES, EMERGING STANDARDS, 3d ed., by Thomas W. Madron John Wiley & Sons, **ISBN 0-471-00959-8, $29.95**

If you are looking for a ground-floor introduction to LANs, this book is a good place for you to start. Obviously, no single book can cover every technical issue in networking, and this one thankfully avoids trying to do so. Instead, Thomas W. Madron focuses on the basic technologies that are needed to implement the first three layers of the OSI (Open Systems Interconnection)



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As I write this, the Programmer's Bundle from RoundBook Publishing Group is a set of three CD-ROMs that are being sold separately. However, RoundBook has learned that the public is buying the CDs together, so it has decided to release them as a package.

The three CDs—C/C++ Programming Reference volumes 1 and 2 and the Windows Programming Reference—hold 15 books, including all the associated tables, figures, and listings. The vehicle for accessing the titles is Microsoft's Multimedia Viewer.

Combined, the books give excellent coverage of C and C++, particularly if you are using a Microsoft or Borland product. One book does describe some features of version 9.01 of the Watcom compiler. The Windows CD contains books on OLE, ObjectWindows, serial communications, resources, and more.

My biggest gripe is with the operation of the Multimedia Viewer. Here's an example. You're reading one of the books and the text says: "See listing 2." The words *listing 2* are in green, so you can click on them to open a dialog box displaying listing 2. Do that, and all you can do is look at it—you can't cut it or copy its contents into the Clipboard. To get listings, you have to issue a separate series of commands that copy *all* listings onto your hard disk and then look for what you want.

Also, you can't search for a word or phrase from the table of contents screen. You have to click on a chapter and then on a topic. This gets you to actual text, and only then does the toolbar with the "search" button on it become available.

Still, this is a remarkable resource. Although the price for the bundle has not been set (the CDs retail for $79.95 each), I suspect it will be stunning when you consider what the books would cost separately.

—Rick Grehan

stack, with occasional forays higher up the stack.

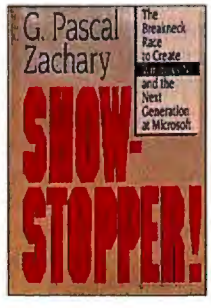
After a brief overview of why you would want a network (e.g., E-mail and print servers), the book dives right into the maze of standards that glues the open-networking world together. The discussion depicts the seven-layer OSI stack and lists the relevant standards at each layer. Madron also discusses how support for different physical media (i.e., twisted-pair and fiber-optic cable) is included in the standards. The chapter on NOSes (network operating systems) skillfully navigates you through an ocean of network acronyms, such as NetBEUI (NetBIOS Extended User Interface), SNA (Systems Network Architecture), and X.400. Coverage includes MAP (Manufacturing Automation Protocol) and NetWare, as well as a brief mention of additional NOS products, such as Banyan Vines and IBM LAN Server.

The following chapter is actually a continuation of the NOS chapter, but it's aimed at peer-to-peer networks. The author provides detailed discussions of the installation process for three of the biggest players in peer-to-peer networks: LANtastic, Personal NetWare, and Windows for Workgroups. He makes no attempt to provide an answer for which is best. Instead, he tries to leave you with the right questions to ask to find the solution for your particular needs.

The book also includes chapters on peer-to-peer versus client/server networks, bridging and using gateways to other networks, and security and implementation issues. Separate chapters are devoted to each of the main IEEE signaling schemes, for example, 802.3 (Ethernet), 802.4 (Token Bus), and 802.5 (Token Ring). For the network neophyte, this book covers a lot of ground in an easy-to-understand, readable way.

—Rex Baldazo

TOO MUCH OF AN INSIDE LOOK



SHOW-STOPPER!: THE BREAKNECK RACE TO CREATE WINDOWS NT AND THE NEXT GENERATION AT MICROSOFT by G. Pascal Zachary The Free Press, ISBN 0-02-935671-7, $22.95

I found this inside account of Windows NT's development less satisfying than its role model, *The Soul of a New Machine*. Sure, it's titillating to read about Dave Cutler's Bunyan-like exploits and sobering to be reminded how a major software project can devastate the families of the engineers, but we've heard all this before. What I wanted from this book was more technical sophistication and more balanced reporting than it delivered.

A computer, we're told, is like a wealthy English household in the 1890s, in which the upstairs crowd (applications) is served by the downstairs crew (the operating system). Well yes, I suppose, but upstairs/downstairs analogies don't begin to unravel the political and technical issues driving Microsoft in its war with IBM and the Unix community. The problem is that while G. Pascal Zachary interviewed dozens of Microsoft employees, he talked to virtually no one outside the company. A wider net might have landed a livelier and more important book. ■

—Jon Udell

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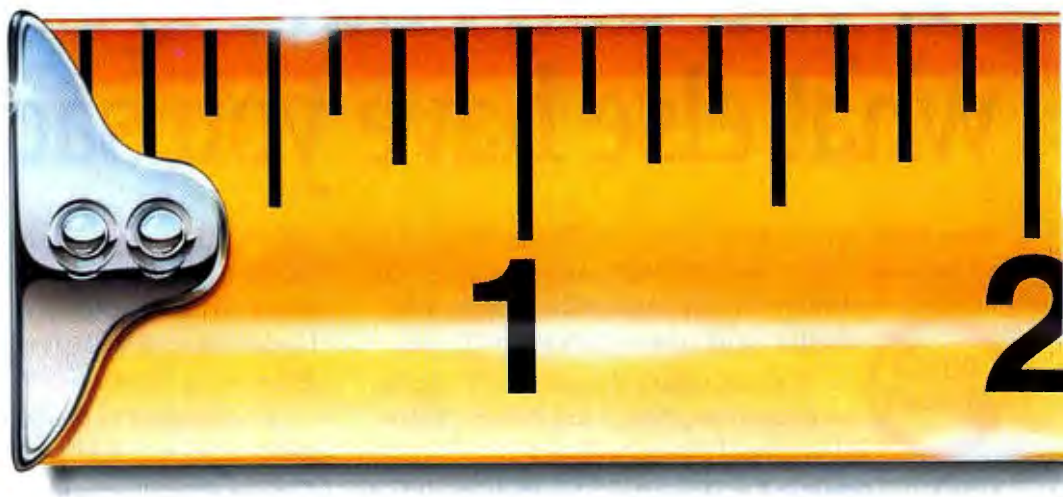

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Novell's

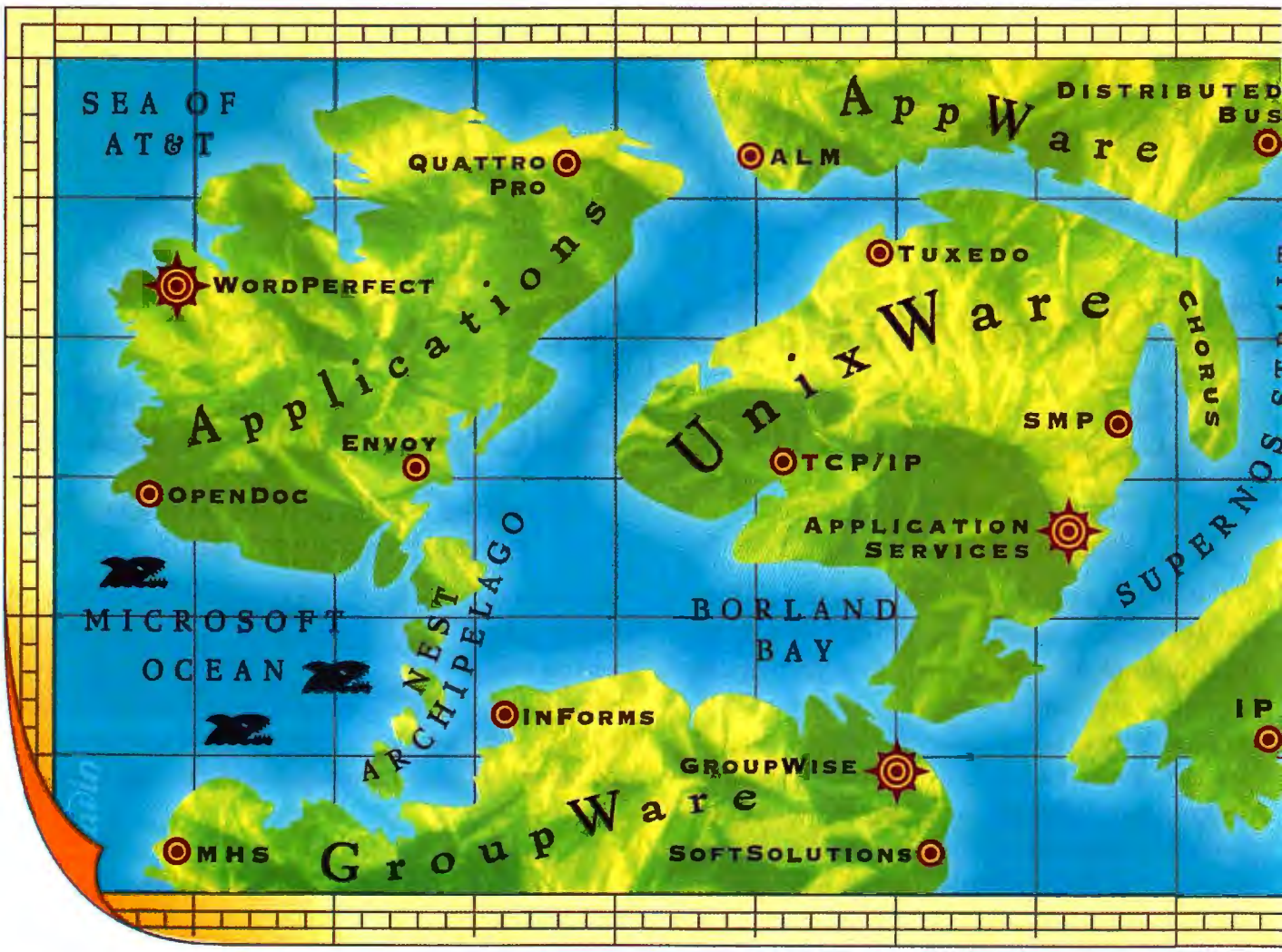
The Vision: a billion connected users and devices by the year 2000.

The Plan: reinvent its operating systems, protocols, and services.

JON UDELL

A few months ago, we pulled the plug on Guernsey, BYTE's original NetWare server. First powered up six years ago, Guernsey survived anachronistically into the mid-1990s alongside newer systems, because NetWare 2.15C kept flogging useful work out of the lowly 286 PC we ran it on. That says a lot about chief architect Drew Major's skill and about the quality of the special-purpose operating system he invented to run network services in the inaugural decade of the LAN.

Newer versions of NetWare still retain the legendary speed and reliability of its predecessors, but these qualities alone can no longer sustain the huge conglomerate that Novell has become. Last spring, at the 10th annual BrainShare '94 (Novell's devel-



Campaign

opers conference) in Salt Lake City, Utah, the message to 5000 attendees was that NetWare was but one of three pillars of the new Novell. In the future, AppWare and UnixWare would receive equal billing with NetWare.

The message continued: After digesting a series of acquisitions—including USL (Unix Systems Laboratories), Serius, Software Transformation, WordPerfect, and Borland International's spreadsheet division—Novell would redefine the second decade of PC networking just as it did the first. Directory, WAN, messaging, telephony, hierarchical storage, document, and other advanced network services would become as common as file and print services are today. Novell would field applications exploiting those services and provide the tools and components needed to create and manage networked applications.

That was a fine vision, but the unrelated NetWare, AppWare, and UnixWare families of products formed an unsteady tripod, and Novell's network services (beyond file and print) are a mixed bag. Six months after BrainShare '94, at Networld+Interop in Las Vegas, Novell's CEO Robert Frankenberg emerged with a plan to regain the tight focus that Novell's hectic expansion had blurred. Dubbed *pervasive computing*, the new strategy ceded the desktop operating-system war to Microsoft's Windows and reaffirmed Novell's mission to scale networks from the department to the enterprise and beyond.

Frankenberg said that Novell would unify NetWare and UnixWare into an all-purpose SuperNOS and raise the ante on an embedded-systems framework called NEST (Novell Embedded Systems Technology) (see "Smarter Copiers, Printers, and Fax Devices Are Coming," November 1994 BYTE). The client-side focus would shift to Corsair, a new graphical NetWare shell featuring a Mosaic-like network navigator called Ferret. Casualties included the AppWare leg of the tripod, which Frankenberg sawed off at the knee when he halted development of the AppWare Foundation, a toolkit that would have enabled applications and Novell's brand of software components (AppWare loadable modules, or ALMs) to port across client (and eventually server) platforms. Frankenberg told BYTE that while the idea of portable components was appealing, Windows software developers just weren't lining up to support it.

More of that kind of brutal pragmatism will likely be required to meet Frankenberg's daring challenge. He wants a billion users and devices connected to NetWare by the year 2000 (versus an estimated 40 million today). Sheer hype and fantasy? Maybe not. Voice networks are that pervasive today,

Novell understands that its domination of LAN file and print services won't carry the company into the next century. The new strategy, called *pervasive computing*, just might.

- **It starts with a hybrid NOS (network operating system), called SuperNOS, that will blend the pedal-to-the-metal power of NetWare with the robust applications server that is UnixWare and will support massive complexes of clustered servers.**
- **On this base it layers global directory, distributed management, advanced storage, and other services needed to scale networking from the department to the enterprise and beyond.**
- **Then it offers access technologies for vast numbers of never-before-connected LANs, devices, and users.**
- **Finally, it ices the cake with applications and services that live in the fabric of the network itself.**

Four-Layer Model for Pervasive Computing

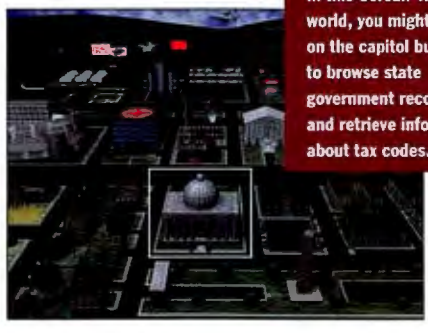
	Near-Term	Long-Term
Applications	WordPerfect, GroupWise, SoftSolutions, InForms, and Quattro Pro	More network-aware applications Consumer applications: finance, edutainment, and information
Access	Corsair/Ferret advanced client NEST AT&T NetWare Connect Services	Improved ease of use for home and business users Network-aware faxes, PBXes, and printers Business Internet
Services	File, print, global directory, messaging, distributed management, document, and telephony	Object-oriented file system Data migration/replication
Infrastructure	NetWare, UnixWare, IPX/SPX, TCP/IP, RIP, SAP, and NLSP	SuperNOS

data networks will be tomorrow. Bob Metcalfe, inventor of Ethernet, has recently noted that Ethernet LANs pump vastly more data than does the Internet; thus, they collectively form the true information superhighway. NetWare, of course, runs most of the world's Ethernet LANs. However, Microsoft wants those billion connections, too; it already owns the desktop and is encroaching on Novell's server stronghold. To meet this challenge, Novell will have to retool its operating systems, protocols, services, and tools. Here's how the current plan is shaping up.

The Crown Jewel

NetWare's modern era began in 1989 at the fifth BrainShare conference, when Novell rolled out NetWare 386 (also known as NetWare 3.0). Two demonstrations brought the crowd to its feet cheering. In the first, Novell showed how the NetWare kernel could install in minutes and then dynamically load (and unload) disk, network adapter, and network protocol drivers (NetWare 2.x, like most Unixes, had required a kernel rebuild to accomplish these tasks). That flexibility remains to this day an inspiring example. We can, for example, restart AppleShare or NFS (Network File System) services on one of BYTE's NetWare 3.1x servers without interrupting logged-on DOS users. OS/2, Windows NT, and Unix can't match NetWare's dynamism; it's a key asset Novell must carry forward to SuperNOS.

The second demonstration showed how to write an NLM in C, pass it through the Watcom compiler, and then load and run it. The roar of approval that greeted the appearance of "Hello, world" on the NetWare console would have puzzled noninitiates. Only those familiar with the arcane hacking needed to create a NetWare 2.x VAP (value-added process) could fully appreciate how the new ability to write NLMs using standard C libraries and tools would advance the state of NetWare. The beauty of this, of course, was that now NetWare could natively support database, mail, and other advanced services. Unix and OS/2 developers could port to or directly target NetWare, gaining a performance edge and automatic integration with NetWare's huge installed base.



In this Corsair virtual world, you might click on the capitol building to browse state government records and retrieve information about tax codes.

C libraries and tools notwithstanding, NetWare 3.x was no more a general-purpose operating system than its predecessor had been. Running naked and fast at ring 0 on a 386, it made no use of the chip's ability to carve out separate, protected address spaces. (The newer NetWare 4's *domain* architecture now affords optional protection, but mostly for the convenience of developers; trusted production NLMs still run best in kernel address space at ring 0.) NetWare 3.x's new thread APIs were modeled after those of OS/2, but NetWare threads multitasked on a cooperative, not a preemptive, basis. Lacking real memory protection and preemptive scheduling, NetWare was—and remains—an eccentric platform for server applications.

The NLM Question

Advocates say the gain of porting to NLM is worth the considerable pain. It wasn't until late 1991, for example, that Gupta was able to convert SQLBase, its SQL server, into an NLM. "But we topped 100 TPC [Transaction Processing Performance Council] transactions per second with our NLM," says Matt Miller, Gupta's marketing manager. Once available, NLMs seem to not only perform well but also run stably.

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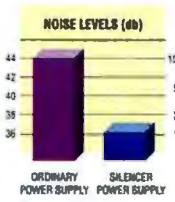

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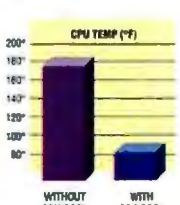

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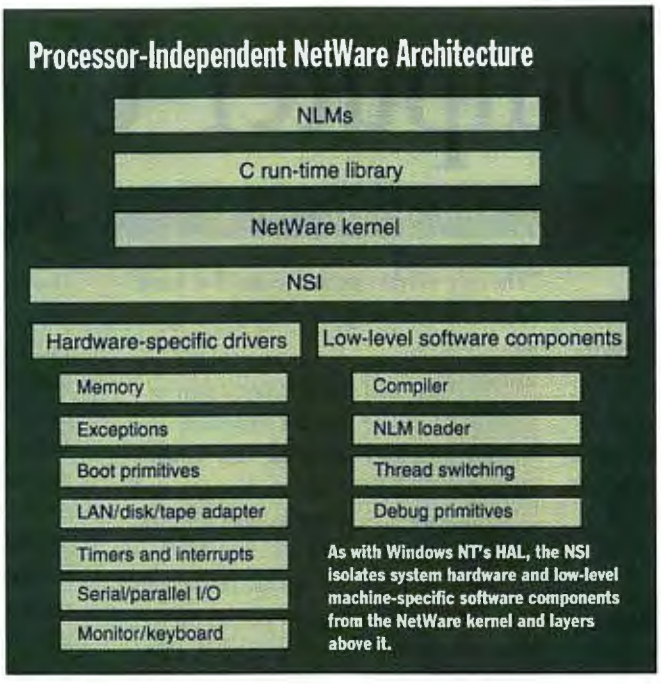
"My Oracle NLMs stay up for months on end," says Chris Cermak, lead systems analyst for Mettler-Toledo, a weighing and measuring equipment manufacturer in Worthington, Ohio. Phillip Ellis, project manager for MicroAge, a technology distributor based in Tempe, Arizona, reports similar success with the Lotus Notes NLM.

Critics say that these results are achieved in an extremely controlled environment. "Customers add a lot of memory, limit the number of users, and run just one application per server," charges Rich Finkelstein, president of Performance Computing, a Chicago-based client/server database consultancy. "Why? Because they don't want to learn Unix."



Indeed, Cermak and Ellis confirm that they run most NLMs on dedicated machines and that familiarity with NetWare—not performance—drove the decision to use NLMs. "At DBExpo, in an audience of 300 [developers], maybe a dozen showed interest in NLMs," says Finkelstein, "but two years ago, a third of the audience raised their hands." Finkelstein attributes the declining interest in NLMs to an increasing concern about NetWare's shields-down mode of operation. "You can make a Sherman tank go faster if you take off the armor," he says, "but that's not the point."

Finkelstein and others point out that Unix, NT, and OS/2 alternatives are getting easier to use and are scalable to RISC and multiprocessor hardware. Lisa Yi, senior product manager for Sybase SQL Server, notes that "some diehard NetWare users have begun to react favorably to NT." Attractive pricing, built-in IPX/SPX connectivity, and GUI-based administration lure these users into the Microsoft camp, says Yi.

NetWare for RISC

Although Novell's initiative to move NetWare to RISC has done little to clarify NetWare's role, its technology yield is crucial to SuperNOS. For the RISC effort, Novell rewrote NetWare in C and abstracted its hardware dependencies. Because Novell had previously used the name Portable NetWare to denote versions of NetWare hosted on VMS and Unix, this truly portable NetWare was called PIN (Processor Independent NetWare). It will run natively on PowerPC processors and support NLMs.

In his BrainShare '94 keynote address, Drew Major admitted that NetWare could have migrated to C years ago, with little impact on its performance, had he been comfortable programming in C back in the mid-1980s. "I'm still not always sure where the asterisks go," he joked. Atten-

Messaging and GroupWare

Novell's MHS is the Rodney Dangerfield of the store-and-forward world—it doesn't get any respect. Critics complain about the clumsy administrative interfaces to MHS and the newer server-based messaging engine, GMHS (Global MHS). Others point out that MHS and GMHS lack the client/server architecture of next-generation engines (e.g., Microsoft Exchange Server and Lotus Communications Server). Nonetheless, MHS traffic abounds on LANs, ranking third behind cc:Mail and Microsoft Mail.

MHS is pervasive because NetWare is, but also because it's exceptionally open to software developers. "Compared to VIM (Vendor-Independent Messaging) and MAPI, the MHS specs are so easy it's pathetic," says John Rizzi, vice president for sales and strategy with On Technology (Cambridge, MA), a software developer of group-scheduling applications. "Five lines of ASCII in a text file, placed in the right directory, goes anywhere in the world." You have to take MHS criticism with a grain of salt. Sure it's a hassle to administer, but so are cc:Mail and Microsoft Mail. Neither of these can yet seamlessly integrate with a NOS (network operating system), as MHS under NetWare 4.1 can (see the screen).

Client/server messaging, however, is clearly the way to go. "File-based technologies are hard to constrain," says David Knight, vice president of marketing for Isocor (Los Angeles, CA), a vendor of E-mail applications, services, and transports. He argues that a protocol-driven engine, such as the forthcoming Microsoft Exchange Server, can better secure messages because it doesn't leave readable text files lying around in public places. It can also more reliably track messages because only well-defined API calls can manipulate them. Such engines can also free themselves from dependence on the location of a message store or its underlying technology (e.g., file, database, and object), says Anik Ganguly, vice president for product development with Campbell Services (Southfield, MI), a network-scheduling vendor. Banyan's Intelligent Messaging service, he notes, offers these benefits now.

Of course, Novell now has two mail engines—Global MHS and the GroupWise engine that comes from WordPerfect. The latter, though also currently file-based, logically separates the mail client from the mail engine. "We have client/server messaging now," says A. J. Dennis, strategic planner for WordPerfect, the Novell Applications Group, "It just isn't protocol-based." That will happen in the second half of this year, says Stewart Nelson, vice president for R&D for Novell GroupWare. In addition to security and location independence, he notes, a client/server approach offers scalability. "Today we have 250-user post offices, because in file-sharing mode, you have limits," says Nelson. "In client/server mode, those limits go away."

A key GroupWise strength is its ability to track messages. Users know when messages are delivered, when they're opened, and when they're deleted. They can even withdraw unopened messages, a "save your job" feature for those who fire off hot-

dees laughed, but nervously. It was scary to think about NetWare's extreme dependence on a single mind. The merger of the PIN code base with that of NetWare 4.x, following the release of NetWare 4.1, will finally close a window of vulnerability that Novell left open far too long.

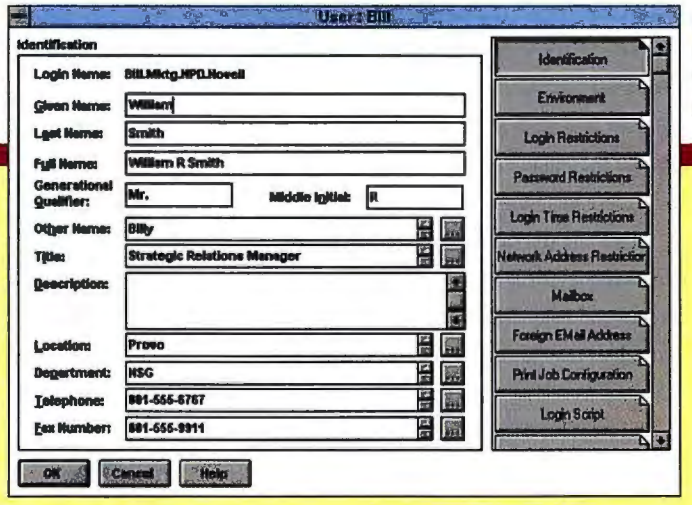
The PIN effort not only decouples NetWare from the x86 instruction set, it also isolates it from PC-style bus, memory, and interrupt architectures (see the figure "Processor-Independent NetWare Architecture"). This separation is defined by the NSI (NetWare Systems Interface), Novell's equivalent to the NT HAL (hardware abstraction layer). NSI's roots go way back, according to Carl Amdahl, CEO and chief technical officer of NetFrame Systems (Milpitas, CA), a company that has since 1989 adapted NetWare to run on superservers that are Intel-based but otherwise more like hardened mainframes than conventional PCs. "We licensed NetWare and stripped out all hard-coded references to the interrupt controller, to BIOS routines—everything around the Intel chip was up for grabs," says Amdahl. This work later found its way into NetWare 3.11, which isolates platform dependencies into the module that loads the NetWare kernel, and has now evolved into NSI.

"Novell did a good, clean job of abstracting the kernel from the hardware," says Russell Sonnenschein, NetWare NSI engineering manager for Apple. "It covers everything you need to get to the system prompt: video, keyboard, I/O, timers, interrupts." Working from Novell's specification, his team built an NSI layer for the Power Mac. "When we first integrated Novell's kernel with our NSI," says Sonnenschein, "we were up and running 5 hours after we loaded the NetWare image." He also verifies Novell's claim that ANSI C drivers that conform to NSI will recompile for and run on NetWare for the PowerPC. Note that PIN's benefits aren't confined solely to RISC. "People forget that Intel is a PIN partner, too," says Glenn Thompson, manager of NT and NetWare server marketing for DEC, citing Pentium-optimized NetWare 4.1 as a key benefit of PIN.

Who Needs PIN?

NetWare servers are classically I/O-bound, not CPU-bound; the 486s and Pentiums in these machines typically idle at a fraction of capacity. CPU-intensive NLMs that might soak up those extra cycles are still relatively scarce. So who needs PIN? That's a hard question for Novell, especially since its original PIN partner, Hewlett-Packard, pulled the plug on NetWare for PA-RISC and plans for NetWare for the Alpha have been shelved. One answer is that NetWare 4.x targets the enterprise, not just the workgroup, and RISC-powered NetWare 4.x superservers can consolidate file and print services. "But now we believe the Intel binary compatibility of our new converged architecture [the forthcoming x86/PA-RISC hybrid] will meet that need," says Ray Mausling, HP's marketing program manager for NetWare.

Customers' and resellers' familiarity with NetWare is one key reason to deliver it on RISC hardware, say Michael Tiemann, president of Cygnus Support (Mountain View, CA), and blazing performance is another. Cygnus is providing versions of the GNU tools used to build NetWare and NLMs for RISC platforms. "People criticize Unix and NT for their massive overhead," says Tiemann. "There's a wide-open opportunity for a lightweight, portable OS that won't suck the cycles on your super RISC machine."



In NetWare 4.1, at last, the administration of users and mailboxes happens on the same screen, reflecting the underlying integration of NDS and MHS.

UnixWare Revisited

When Novell first acquired USL and launched its own System V release 4.2 offering (UnixWare), it further clouded the NLM picture. Tailored to fit neatly into IPX/SPX networks, UnixWare was billed as Novell's robust, general-purpose applications server. Novell claimed you could now build network services for NetWare and applications for UnixWare. What's the difference between a service and an application? In view of Novell's ongoing push to attract NLM versions of top-tier products, such as Oracle and Notes, the distinction was fuzzy at best. "Anything that sells in high enough volume is no longer an application," jokes Nina Lytton, president of Open Systems Advisors (Boston, MA), "it's a network service."

Still, Unix is where most of the world's downsized applications run, and UnixWare's affinity for standard Intel-based boxes and NetWare LANs makes it a potent asset. A much-improved UnixWare 2.0 (which is due to ship in the first quarter of this year) exploits SMP (symmetric multiprocessing) hardware in a multithreaded fashion and rivals NT in its wealth of GUI-based system administration tools and in its ability to detect and configure for standard peripherals (see the screen "UnixWare 2.0's New Look").

With a single log-on to NetWare and UnixWare and the ability of each to use the other's print queues, the two systems

headed missives and later regret them. Message tracking, which GroupWise users take for granted, isn't available in most LAN E-mail packages. It's not only a major benefit for users but also an enabler of work-flow software. Lotus Notes, for example, must use third-party engines for centralized monitoring and control of message and document traffic. GroupWise's built-in tracking capability, coupled with its planned integration into NetWare's directory and distributed management services, should help Novell address the emerging work-flow market. In addition, Novell plans to add conferencing to the mix. Collabra Share for GroupWise, jointly developed by Novell and Collabra Software, is slated for mid-year.

Novell and WordPerfect engineers are still trying to figure out how to unite their separate technologies. "In Orem, you hear strong religious statements about the WordPerfect Office server, and in San Jose, they say the same things about Global MHS," says Isocor's Knight. "Eventually, you'll see Klingons working on the starship." They need to reach détente quickly, though. Novell networks right out of the box should provide interpersonal messaging services as complete, pervasive, and manageable as the basic file and print services, but today that's not the case.

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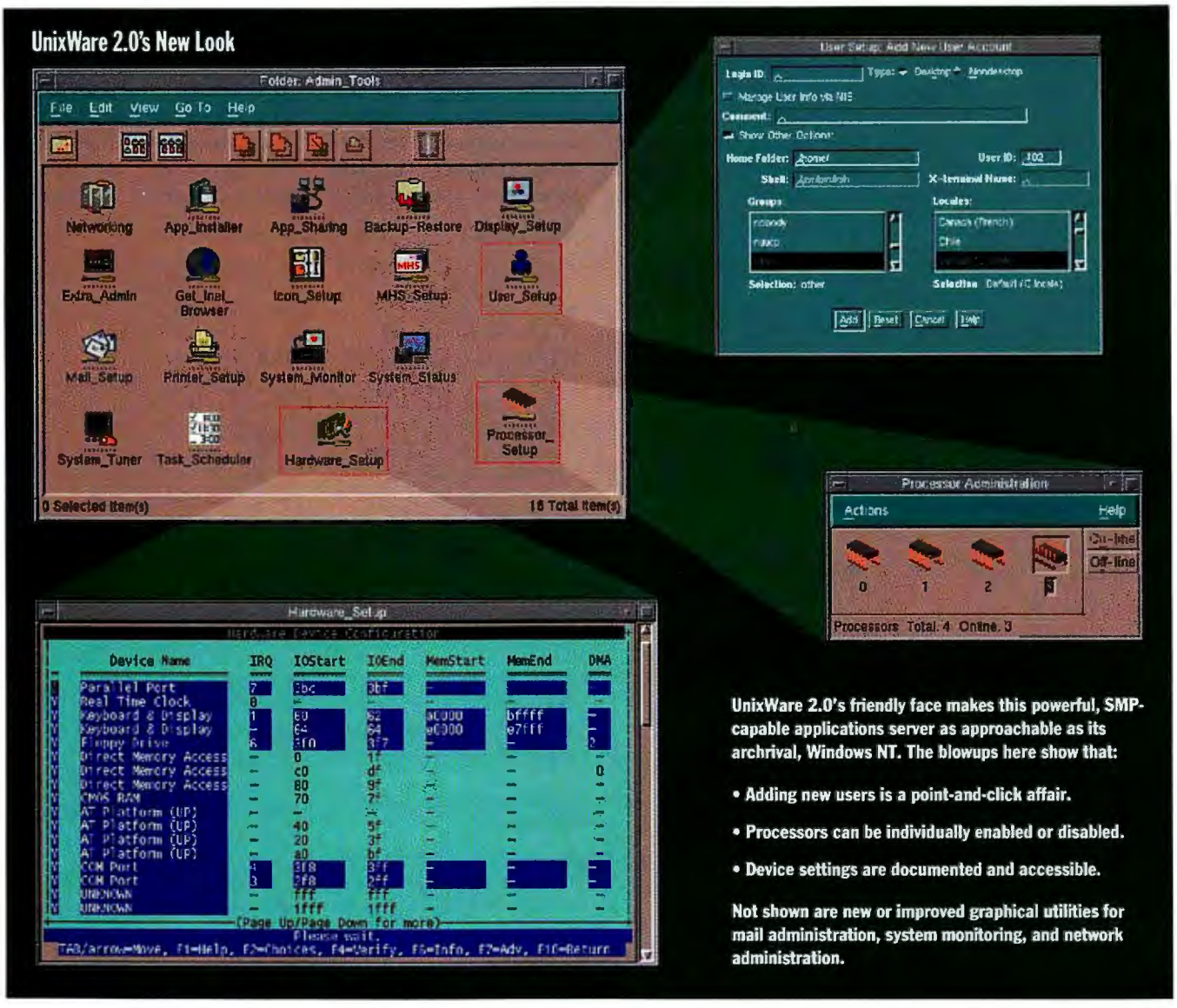

UnixWare 2.0's friendly face makes this powerful, SMP-capable applications server as approachable as its archrival, Windows NT. The blowups here show that:

- **Adding new users is a point-and-click affair.**
- **Processors can be individually enabled or disabled.**
- **Device settings are documented and accessible.**

Not shown are new or improved graphical utilities for mail administration, system monitoring, and network administration.

integrate better than ever before. But they still don't couple as tightly as Novell would like. UnixWare 2.0 still won't run NDS (NetWare Directory Services); that support is slated for version 2.1, which is due before the end of the year.

Are customers confused by Novell's failure to integrate NetWare and UnixWare fully or to clarify the role of NLMs versus Unix applications? Perhaps not as much as analysts like to think. Holiday Inn Worldwide (Atlanta, GA) is equipping its 450 international hotels with a combination of NetWare and UnixWare. The two are nicely complementary, says Don Lynch, director of worldwide hotel systems development. The front desks use NetWare's file, print, and Btrieve database services but talk through a UnixWare gateway to the mainframe-based reservation system. Because a Unix process buffers all transactions, there's protection against glitches on either the LAN or the WAN side of the gateway. Transactions can flow in both directions, because UnixWare can act as a client to a Btrieve database on a NetWare server.

Could NT fill UnixWare's shoes in this scenario? Perhaps, says Lynch, "but do you want to buy a car from somebody who's just built their first one or from somebody who's been building them for 20 years?" However, he notes that a one-box solution (which NT could provide) is more desirable than the current two-box arrangement—one for NetWare and one for UnixWare—and looks forward to a converged SuperNOS.

For Ameritech Library Services (Provo, UT), a leading vendor of public, private, and school library systems, UnixWare's connection to Novell opens doors in the K to 12 market. "When you come into a DOS environment with a Unix solution," says Bernadete G. Razevska, vice president and general manager of the company's school division, "you may have some hard selling to do." UnixWare helps overcome that resistance, she says, because it slides neatly into the NetWare LANs now found in many schools. UnixWare 2.0's scalability is a boon, Razevska adds, because it will ease districtwide consolidation of library systems.

These developers don't fret about NLMs. They know their applications need to run on a general-purpose operating system, and they think UnixWare is a good choice when those applications target users on NetWare LANs.

Multiprocessor NetWare

The ability of Unix, NT, and now OS/2 to exploit multiple processors has been another thorn in Novell's side, and at BrainShare '94, the company rolled out a three-phase multiprocessor road map delineating a strategy it calls *distributed parallel processing*, or DPP (see the figure "Novell's

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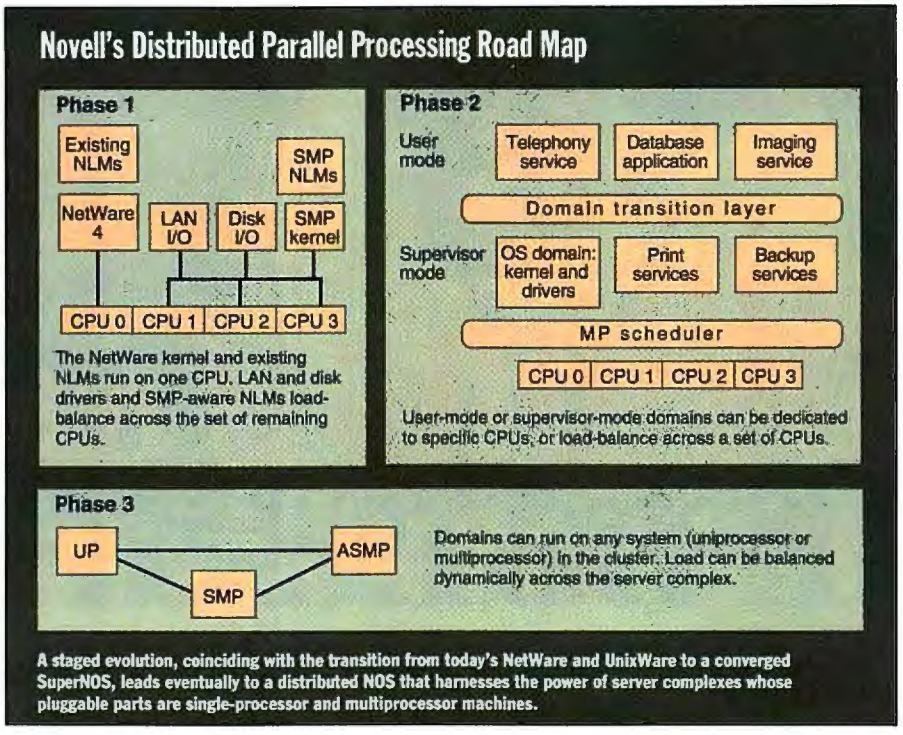

A staged evolution, coinciding with the transition from today's NetWare and UnixWare to a converged SuperNOS, leads eventually to a distributed NOS that harnesses the power of server complexes whose pluggable parts are single-processor and multiprocessor machines.

Distributed Parallel Processing Road Map"). In the first phase, NetWare will support SMP hardware. This implementation will be less symmetrical than the name implies, however. It entails only the minimal surgery required to spread NetWare's I/O processing (and specially adapted NLMs) across multiple CPUs (NetWare 4.1 and UnixWare 2.0 will share the same SMP APIs). A second phase will build on the NetWare 4 domain architecture and ASMP (asymmetric multiprocessing) to spread unmodified NLMs across CPUs in multiple protected domains. In the final phase, Novell wants to vault NetWare (by then converged with UnixWare to create SuperNOS) into the realm of clustered multiprocessing systems.

"You've always been able to scale NetWare by adding workstations," says Major. "We want you to be able to scale at the back end in the same way, by adding servers."

To coordinate such loosely coupled clusters of servers, Novell bought NetFrame's distributed lock manager, originally built for Oracle's Parallel Server. "It's a generic way to coordinate resource access and manipulation," says Amdahl. "The objects you register with the lock manager can represent not just files or records but resources of any arbitrary type."

Novell knows that PIN is a necessary short-term objective. The company has to gain control of the NetWare code, lay a foundation for hardware innovation, and allay concerns that arise when, as Tiemann notes, "people see Novell's NLM stalwarts fighting their real performance wars on RISC." The phased DPP initiative is, likewise, an impressive and ambitious long-term goal. Today's shared-memory SMP systems could ultimately become atoms bound together in much larger molecules enabled by DPP. As these strategies evolve, much will depend on when and how Novell unifies the APIs and, eventually, the guts of NetWare and UnixWare.

SuperNOS

Novell's grand vision crystallizes in SuperNOS. This new operating system will be built on a microkernel so that it can be portable, modular, and distributable. Novell's NetWare and UnixWare architects are hammering out just what that microkernel will be. An obvious choice is Chorus Systems' (Saint-Quentin-en-Yvelines, France) Chorus, which USL had selected as the base of its future Unix products prior to its acquisition by Novell (see "The Chorus Microkernel," January 1994 BYTE). It's particularly well suited because, unlike Mach and NT, Chorus blurs the boundary between kernel mode (privileged code in shared address space) and user mode (nonprivileged code in disjoint address spaces). In theory, that flexibility makes Chorus the ideal SuperNOS substrate, and Major says that a prototype of NetWare on Chorus is already up and running.

"We'll offer two execution environments—kernel and Spec1170 [X/Open's standard Unix API]," he says. A SuperNOS file server or router will use the kernel environment, where trusted NLMs can deliver maximum throughput and real-time response. A SuperNOS applications server would use the Spec1170 environment, where applications enjoy protection and standard APIs. When both environments coexist, the result will be a one-box NetWare and UnixWare solution.

At press time, however, Chorus had not yet been officially anointed as the Novell microkernel. "We'll take elements of it," says Major, "but we need a next generation of Chorus." That generation is at hand, counters Michel Gien, vice president of technology for Chorus Systems. He says the company is tuning the microkernel so that colocated server processes can use direct function calls, reserving the message-passing form of IPC (interprocess communications) for communication across address spaces. Gien also gently suggests that Major's team has not yet fully absorbed the Chorus technology transfer. "They are new at this," he says, "and have not had a lot of hands-on experience [with the microkernel]."

Novell hopes that from this bubbling cauldron of egos and technologies will emerge the scalable multipurpose operating system on which its future depends. There is understandable friction but also a profound sense of synergy.

The Unix Systems Group, for example, has defined its own clustering initiative, SSI (single system image). "DPP and SSI are two sides of the same coin," says Major. The acronym doesn't matter, but the concept does. In today's client/server world, transaction-processing monitors handle load balancing and service replication for applications distributed across a few specialized servers. In tomorrow's intelligent networks, those servers will be numerous and standard, just as desktop systems are today, and the NOS will have to be able to recruit and reliably manage whole farms of them. Casting SuperNOS in that role is a vital initiative. Novell had better hurry, too. DEC, a pioneer in cluster computing, previewed an NT-based clustering technology at Fall '94 Comdex.

Rethinking IPX/SPX

NetWare takes a lot of heat for its favored transport protocol, IPX/SPX. Critics are right to point out that it scales ungracefully to WANs, but they are wrong to conclude that Novell should abandon it in favor of TCP/IP. "IPX has some great properties that IP bigots will never admit to," says

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Tim Gelinas, vice president of engineering for Spry (Seattle, WA). "You just kick-start a workstation and boom, you're on the network."

That's because IPX takes as its node address the unique number burned into every Ethernet or token-ring adapter. By contrast, administrators must dole out IP node addresses. While that tedious and error-prone chore can be automated using BOOTP or DHCP servers, such servers must be set up and cared for, and they can fail. With IPX, assigning node addresses is simply not an issue.

Another nice property of IPX is the generous size of its address space. An IPX address includes a 4-byte network number and a 6-byte node ID. IP, by contrast, crams the network number and the node ID into a 4-byte address. Apart from the administrative headaches caused by the sliding boundary between the network-number and node-ID parts of an IP address, there's real concern that the explosively growing Internet will exhaust the available supply of IP addresses. IPng (IP next generation), the Internet Engineering Task Force's proposed solution, will likely ease the crisis, but there's no guarantee that it will be painless for administrators.

Given the reach and simplicity of IPX, why do WAN experts always give NetWare such a bad rap? It's not IPX's fault. The real culprits are RIP (routing information protocol) and SAP (service advertisement protocol). RIP, which has been used in both IP and IPX networks (see the figure "The Family Tree of Routing Protocols"), is a *distance vector* routing protocol. A RIP-based router maintains a table of distances (hops) to other routers, as reported by its neighbors. In Novell's implementation of RIP, routers broadcast updates every 30 seconds, whether network topology has changed or not. Those updates suck up bandwidth on a WAN, and RIP routers react slowly when topology changes. Worse, if a link to a router fails, routers with multiple paths to the failed link can become confused and begin erroneously incrementing their hop counts, a syndrome known as the count-to-infinity problem. "Because this is engineering and not mathematics," jokes Novell senior consulting engineer Radia Perlman, "infinity turns out to be 15." In other words, the infamous 15-hop radius of an IPX internetwork is just an arbitrary limit.

Point	Counterpoint
NetWare isn't a general-purpose operating system.	That's right. It's a special-purpose operating system with its finger on the pulse of the hardware. NetWare's near-real-time characteristics mean that it can move a lot of data in a hurry.

Enter NLSP

A solution to the problems of RIP is at hand. NLSP (NetWare Link Services Protocol), like the OSPF routing protocol that is currently favored in the IP world, uses an alternative and more powerful *link-state* technology. Because a link-state router periodically sends out a complete map of its neighborhood and stores the maps it receives from other routers, it knows a lot more about the network than does a distance-vector router, can react more quickly to change, and can find alternate paths when a link fails. Because updates occur only in response to change (in Novell's implementation, every 2 hours if there is no change), there's a lot less broadcast overhead. Link-state routers see the big picture, not relying on immediate neighbors for topology reports, so

The AT&T Connection

Waiting in the wings is a development that could radically transform the significance of NetWare 4 and NDS (NetWare Directory Services). AT&T's forthcoming NetWare Connect Services marries these Novell technologies with its own InterSpan frame-relay network, and, eventually, ATM (asynchronous transfer mode) technology to create what will be, in effect, a business Internet. It's expected to debut in the fourth quarter of the year and will host, among other services, AT&T Network Notes, a smaller project based on Lotus Notes that is already in market trial. For NetWare Connect Services, AT&T will maintain the root of an NDS tree. Subscribers that attach their NetWare 4 LANs to the tree will enjoy intercompany and intracompany WANs through AT&T's public data network. To complement the InterSpan hookups, dial-up access will be available in 200 cities in the form of a 950 number that branch offices and individuals can use.

If this plan works well and is affordable, it will be a godsend for the many businesses that run LANs in multiple locations and are struggling with the endless hassles of private, do-it-yourself WANs. Because the NDS root will be public, subscribing businesses will eventually be able to browse and search networkwide for other businesses' users, services, and published information. However, although AT&T will own and operate the root, it won't be able to snoop. In NDS, organizations are self-governing worlds not beholden to the galactic empire.

It's hard to exaggerate the potential importance of such a business Internet. The TCP/IP Internet now being pressed into the service of business-to-business networking is a horse of an entirely different color. True, companies are eagerly creating their own WWW (World Wide Web) home pages and deploying Mosaic as a business application. However, the Internet lacks a coherent directory, and the so-called Internet discovery tools (e.g., `netfind`, `archie`, and `WebCrawler`), are, while ingenious, a poor substitute for a real directory. Companies that engage in network-based commerce will expect to be able to find each other on the network in the same way that they now find each other in the phone book. They'll expect to be able to contact each other whenever they want, not just when an intervening name server happens to cooperate. And they'll want to be able to bill for services rendered through the network. Clearly AT&T's infrastructure is tuned to satisfy just these kinds of expectations.

Can NetWare 4 and NDS meet the challenge? "We don't think there are inherent scalability limits," says John Friedmann, senior product manager for AT&T NetWare Connect Services, "but certainly there's no one who's done anything this big yet." The best large-scale test of NetWare 4 has been Novell's own. According to Jim Greene, product line manager for NetWare server products, the company saw early on that "we couldn't test NetWare 4 in the superlab, that's not real life." So Novell began using it on a production basis when the software was still in prebeta form. "Not all the IS guys will agree," says Greene, "but I think it was the best decision we ever made." Many of the 4.1 enhancements reflect Novell's own experience as a large-scale user.

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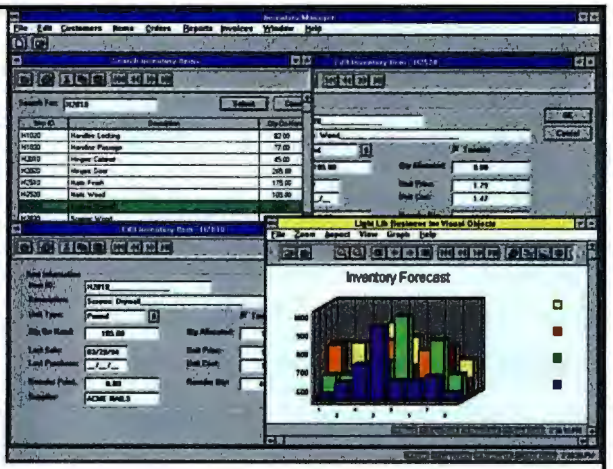

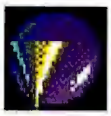

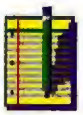

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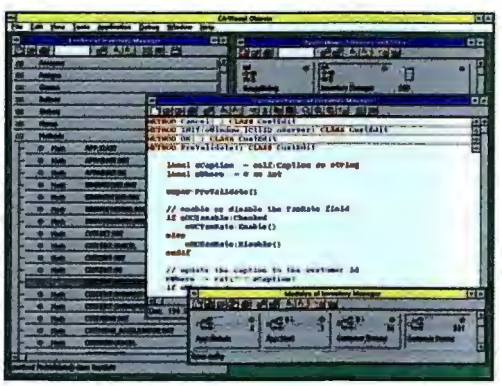

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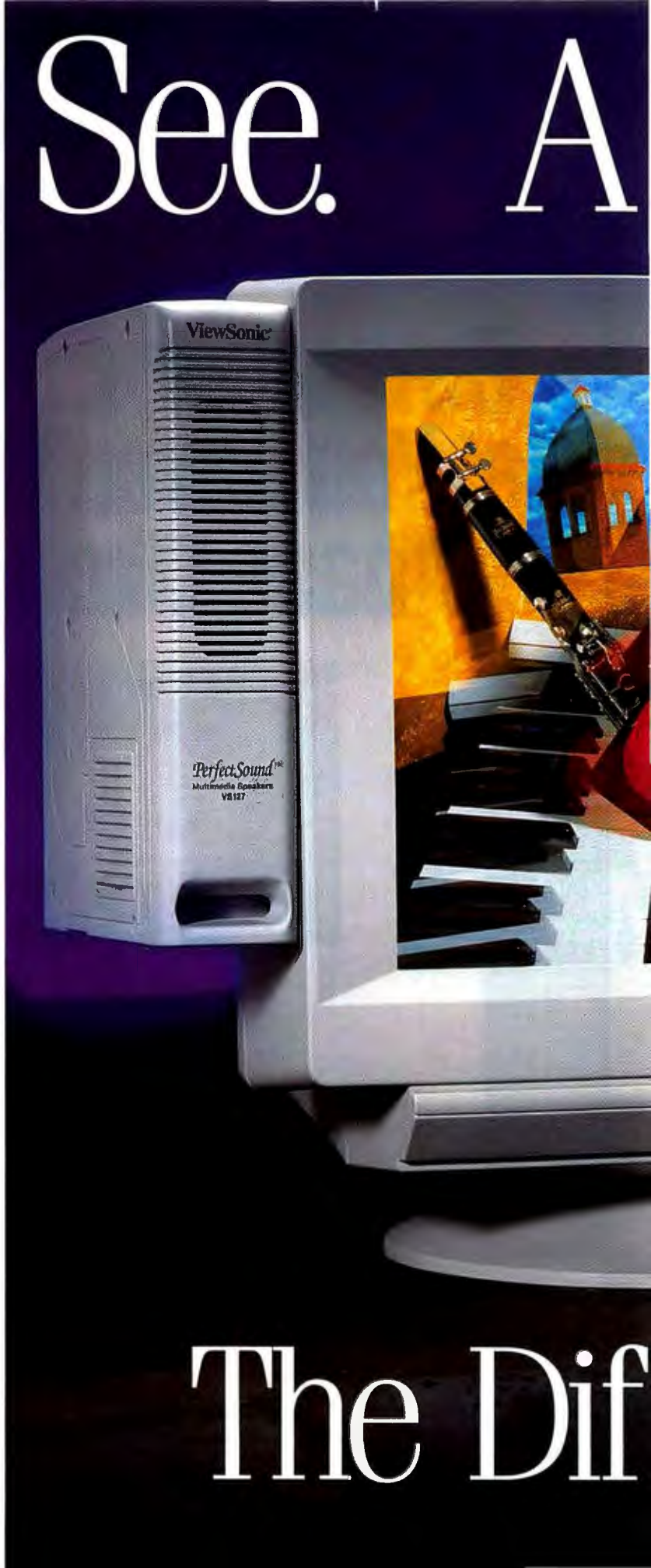

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no arbitrary count-to-infinity time-out restricts network diameter.

NLSP also cuts down on the once-per-minute SAP broadcasting that announces the availability of servers, printers, and all other advertised network services. Service advertisements propagate on the same bihourly schedule as do topology updates. Mark de la Vega, Novell's product line manager for Novell's NetWare infrastructure division, says that NLSP's elimination of RIP, its encapsulation of SAP, and its ability to compress SAP data—in concert with other optimizations, such as burst-mode IPX and large-packet IPX—can yield a 30-to-1 reduction in traffic on WAN links. Use of the NDS will improve matters still further, because you won't need to advertise services when you can simply look them up in a directory.

Point	Counterpoint
IPX/SPX doesn't work well on WANs.	Actually, the IP crowd should envy IPX/SPX's large address space and its administrative simplicity. The real problems are RIP and SAP, outmoded routing protocols that NetWare 4.1 replaces with the far more robust and efficient NLSP.

A Matter of Choice

Router vendors routinely include RIP and SAP filters that can control NetWare's appetite for WAN bandwidth. Now in NLSP, they have a much better tool for that job, and they're lining up to support it. "We'll have NLSP support in products in the first half of '95," says Dana Rasmussen, senior product manager for PC protocols at internetworking equipment vendor Bay Networks, formed by a merge between Wellfleet Communications (Billerica, MA) and SynOptics Communications (Santa Clara, CA). It is available now for Novell's servers and multiprotocol routers. Longtime critics of the IPX protocol suite may find to their surprise that it is about to become a quite credible substrate for networking on an enterprise or global scale. The remaining wrinkle is that Novell's implementation of NLSP lacks OSPF's ability to subdivide a large internetwork into smaller areas. Novell says that it or third parties can easily add this hierarchical routing capability on top of NLSP. "They've done the forward planning," agrees Wellfleet's Rasmussen, "and have proactively included router vendors to help define how NLSP goes beyond level one [flat, single-area] routing."

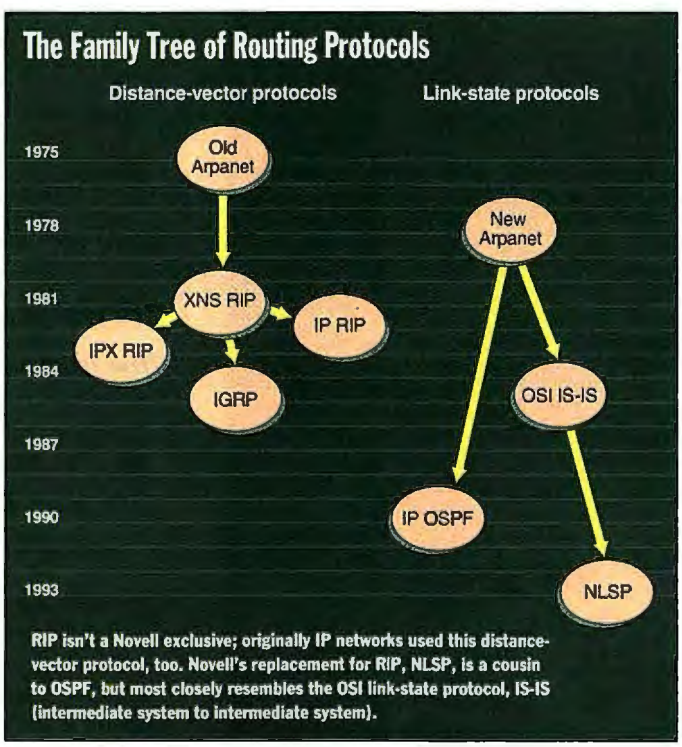
Enhancing IPX does not, of course, excuse Novell from catering to the IP bigots. Novell does offer NetWare/IP, which layers NCP (NetWare Core Protocol) on an IP substrate, but users and analysts say that it's neither cheap nor convenient. "We thought it would be our be-all and end-all," says Blaine Bauer, network analyst for Mobil, "but installing and maintaining the domain servers [replicable databases of SAP and RIP information] was a hassle, and performance was poor." Moreover, NetWare/IP doesn't yet automate the allocation of IP addresses. "NetWare needs to come out of the box ready to run IP or IPX, just as Windows now does," says Jamie Lewis, president of The Burton Group (Salt Lake City, UT). "Microsoft has done for transports what Novell did for network hardware—they've taken that issue off the table."

When it comes to network APIs, though, Novell does have a valuable, if underappreciated, asset in the form of TI-RPC (transport-independent remote procedure call). Windows Sockets, in its current version 1.1, expects a TCP/IP substrate. Microsoft has privately extended WinSock to work with SPX (on Windows 95 and NT), but transport independence won't be standard with all implementations until WinSock 2.0 arrives. TI-RPC, which is available on Sun systems and other Unix systems, as well as on all Novell-supported servers and clients, now offers transport independence. "You can build a TI-RPC server for either UnixWare or NetWare that can talk to both SPX and TCP clients at the same time," says Steve Lemmo, founder and chief technical officer of RPC tool vendor NobleNet (Southborough, MA), "and it'll be wire-compatible with a ton of Unix platforms."

The Global Directory

NetWare 4's headline attraction was NDS, an X.500-inspired global directory service designed to bring an organization's users, servers, and network services under a single umbrella. NDS represents a great leap forward that, to Novell's chagrin, not many users have yet been willing to make. The great success of NetWare's golden release, 3.11, created equally great inertia. "We did all the planning for directory services and thought it would take off," says Mobil's Bauer, "but users don't see a big incentive, and site administrators don't like having to switch over to VLM [the new NetWare 4 shell that loads a set of virtual loadable modules]." Indications are that Microsoft may face similar resistance moving users from its golden release of Windows, coincidentally—or not—also numbered 3.11, to Windows 95. The Windows 3/NetWare 3 matched set has become a deeply entrenched corporate standard.

To overcome the inertia, Novell and third parties will have to add a rich assortment of applications and services to NDS. In the 4.0 release of NetWare, not even Novell's own MHS mail directory could integrate with NDS. Many NLM-based services—including those from Oracle, Sybase, and Lotus—now do, and in NetWare 4.1, so does MHS. NetWare 4.1 also supplies tools to prune and graft parts of NDS; the absence of these in the initial release was a deterrent for some users. And NetWare 4.1 will provide APIs for synchronizing with NDS so that an existing human-resources application, for example, might



RIP isn't a Novell exclusive; originally IP networks used this distance-vector protocol, too. Novell's replacement for RIP, NLSP, is a cousin to OSPF, but most closely resembles the OSI link-state protocol, IS-IS (intermediate system to intermediate system).

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serve as the interface for adding new employees to NDS.

Despite its sluggish start, NetWare 4's ability to consolidate servers and other resources into a single system image has not gone entirely unappreciated. McGill University has already upgraded a few of its 120 NetWare servers and plans to complete the move to NetWare 4. "Directory services will be a great help," says McGill's senior network-systems analyst, Lisa Laing. "Users are logging in to servers all over campus looking for things; NDS will let us put our expensive new Xerox DocuTech printers where everyone can find them." And NetWare 4.1 will run at each of Holiday Inn Worldwide's 450 international locations, because, says Don Lynch, "I just want the latest and greatest."

The AppWare Saga

When Novell combined Software Transformation, Inc., and Serius to create the AppWare Systems Division, it placed itself smack in the middle of the component revolution that is transforming the software industry. AppWare's mission, Novell said, was to expose network services to developers in the form of easy-to-use components and to field those components on a wide range of client and server platforms. STI's Universal Component System, or UCS (also known as AppWare Foundation), would provide the portability, abstracting a superset of the GUI facilities available in Windows, Macintosh, Motif, and Presentation Manager and defining common APIs across these platforms for file I/O, memory management, and IPC. Serius Developer, now called Visual AppBuilder, would be the first of potentially many implementations of Novell's component framework. It's a visual programming tool for the Windows and Macintosh environments that's used to plug Novell's ALM components into an interconnection framework called the AppWare Bus. Novell planned to converge

Storage Management

NetWare has a universal file system; it supports DOS (FAT), Macintosh (HFS), Unix (NFS), and OS/2 (HPFS) name spaces. As the file system evolved with each version of NetWare, vendors of backup software had to scramble to catch up.

Novell's solution to this problem was SMS (Storage Management Services), which abstracts storage data structures and uses TSA (Target Service Agents) to export data. TSAs typically export file system data but can work against any kind of data store—NetWare 4.0, for example, included a TSA for the global directory.

To encourage broader uses of SMS, Novell in partnership with Palindrome (Naperville, IL), a vendor of storage management software, has undertaken to port SMS to non-NetWare platforms. Given a generic SMS framework, says Palindrome's vice president of technology, Jim Gast, database vendors can create TSAs that understand table and row locking, and E-mail vendors can create TSAs that work with names meaningful only within message stores. "When you back up a message store with native file system names," says Gast, "you have no clue how to restore just one person's E-mail, because objects don't have names that are natural to the user of the restore utility."

Along with improved SMS support, NetWare 4.0 offered an embryonic HSM (hierarchical storage management) capability. In its first incarnation that technology, which came from Imagery Software (Bedford, MA), a Kodak subsidiary, was specific to MO (magneto-optical) jukeboxes and the HCSS (High Capacity Storage System) designed for such devices. With HCSS, a vast quantity of image (or other) data can reside on a relatively small NetWare volume backed by an optical jukebox. Files not recently used migrate to optical storage; when requested, they migrate back. This application was the first to use NetWare's real-time data migration module; the next was CDISC, which caches NetWare-mounted CD-ROMs. It did not, however, use the SMS storage management data redirector, so SMS-enabled archival disk-grooming and HCCS-enabled file migration—though conceptually similar—remained two separate activities.

Imagery Software has developed an HCSS successor called MSS (Mass Storage Service). "HCSS was a jukebox manager," says John Hoye, marketing manager for Imagery Software, "but jukeboxes are just one place that MSS can migrate files to." The other place is the hard disk.

With MSS, files from a group of small departmental servers can spill over to a single superserver and from there to an optical jukebox. But there's still no connection between HSM and SMS. "I've always felt that HSM and SMS are solutions to the same problem," says Gast. "One set of data replication primitives should support all the different scenarios in which you move data from point A to point B—mail, directory synchronization, archiving, and HSM."

He's right. Novell today solves these problems using four different technologies that cry out for integration. Because NetWare lives close to the hardware, it can pump a lot of data in a hurry. That capability, packaged as a standard data-migration service, would make Novell networks more attractive to a large and growing number of applications.

As the data itself evolves from raw files to structured documents and objects that bundle code and data, the file system needs to follow suit. Here, too, there's more than one approach to the problem.

In the realm of document management, the latest versions of WordPerfect, GroupWise, and SoftSolutions support the ODMA (Open Document Management API) (see "Managing the New Document," August 1994 BYTE), which enable ODMA-aware clients to bypass the raw file system and place documents under the control of ODMA-compliant repositories. SoftSolutions support for DEN (Document Enabled Networking), a Novell/Xerox-companion effort that splits monolithic repositories into component services (e.g., storing, indexing, and converting), is also forthcoming, according to Alvin Tedjamulia, director of research and strategic planning for Novell GroupWare.

OpenDoc's Bento, another document storage technology, is tuned for single-user compound documents. If Novell succeeds with its OpenDoc for Windows effort, ODMA- and DEN-oriented document managers (e.g., SoftSolutions) will want to accommodate Bento-aware clients by directly implementing Bento structured storage and versioning or mapping Bento's APIs.

More generally, Novell aims to evolve NetWare's file system. "Apply NDS technology to a file map," says Joe Firmage, general manager of Novell's Network Development Tools division and vice president of strategic planning for the NetWare System's Group, "and you get an enterprise-wide attributed data store." Novell's Cairo? Exactly, says Firmage, "but we already have the network infrastructure today."

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these technology streams so that ALM components could build from a single source for all AppWare Foundation–supported platforms.

AppWare Foundation's demise came suddenly, and it left both Visual AppBuilder and Borland's OWL (Object Windows Library) for AppWare stranded. The latter, hosted on the AppWare Foundation and intended to enable OWL applications to recompile for non-Windows platforms, simply died. Embarrassingly, OWL for AppWare ads were in print when the announcement came. Visual AppBuilder, however, was merely wounded. The tool still supports ALMs on Windows and Mac systems, but developers must use platform-specific APIs to create those ALMs.

AppWare Foundation's API neutrality mattered most if your development plans were truly platform-neutral. In reality, the majority of developers heavily invested in the Windows API would have had to weigh the effort of porting to the AppWare Foundation against the free ride on MFC (Microsoft Foundation Classes) that Microsoft says can get Windows applications onto other platforms. In the end, Novell bowed out, electing not to buck the momentum of the Windows API. Will the AppWare Foundation survive? As we went to press, a small software tools company was courting venture capitalists and IBM for help in resurrecting it.

Point	Counterpoint
Novell has abandoned the desktop operating-system battle.	As well it should, because Windows owns the desktop. Novell resources that were being spent to make its DOS or Unix products compete with Windows can now be diverted to the unification of NetWare and UnixWare into SuperNOS, a NOS with global, not departmental, reach. The Novell/AT&T "business Internet," NetWare Connect Services, promises to revolutionize WANs while leveraging Novell's existing LAN stronghold.

Why would OpenDoc require the AppWare Foundation? As with ALMs, OpenDoc parts issue platform-specific API calls; a neutral API would enable a part to be written once for a number of platforms. Partial solutions are coming from Apple (Mac and Windows) and IBM (Presentation Manager, Windows, and Unix), but neither of these covers the gamut of clients. "We're a long way from a business relationship," says Cliff Reeves, IBM's director of object technology, "but we're vitally interested in any powerful tool that supports OpenDoc." The irony here is that Novell, the developer of OpenDoc libraries for Windows 3.1, 95, and NT, would benefit from the existence of a universal AppWare Foundation–based part framework.

Network Componentware

ALM wrappers for the NetWare directory, mail, and authentication APIs and for the Tuxedo transaction monitor, shipped with Visual AppBuilder 1.0. Wrappers for telephony, network management, and many other key NetWare services are slated to follow. Advocates say ALMs will do for network programmers what VBXes did for programmers of stand-alone Windows applications. "Controls are the right way to interact with NetWare," says Willie Neumann, president of Hyper Active (Columbus, OH), a middleware developer. "If you're building on NetWare services in C, you're spending man-years," says Steve Jones, vice president of ImPower, a Salt Lake City ALM developer. "The beauty of components is that I really can snap things together."

What about the loss of ALM portability? A pervasive computing strategy should reach all users, not just the 90 percent running Windows, particularly because Windows' dominance is almost never total. Joe Garnett, Chief of the Advanced Systems and Networks Element with the Pacific Air Force Computer Systems Squadron, says that the over 7000 clients attached to his 17 NetWare LANs scattered around the Pacific basin include an ineradicable minority of Mac, OS/2, and Unix clients. If the military can't mandate homogeneity, clearly businesses can't either. Yet the kinds of new applications likely to be enabled by network-aware components are precisely the ones that should reach all users. A desktop CTI (computer/telephone integration) application, for example, should have the same 100 percent penetration that phones do. (For more on Novell's CTI initiative, see "Computer Telephony," July 1994 BYTE.)

For core NetWare services, that 100 percent reach will be assured if Novell keeps its promise to create ALMs for all supported client platforms. Third parties can follow suit if they choose. Hyper Active, for example, has ported its Oracle ALM from the Mac to Windows. Given the complex logic required for direct access to the database in the design-time environment, says Willie Neumann, the ALM port was a relatively small effort.

Once ALMs exist, corporate IS organizations can use Visual AppBuilder—which runs on Windows and the Mac—to deploy single-source applications across multiple platforms. Visual Basic, hosted only on Windows, doesn't offer that option. Visual AppBuilder's scope will further expand if, as is now planned, Novell brings it to UnixWare by mid-year. According to Joe Firmage, general manager of Novell's Network Development Tools division and vice president of strategic planning for the NetWare Systems Group, the tool will also support VBXes, OLE controls, and OpenDoc parts. "The AppWare environment operates at a high level of abstraction," says Firmage, "so it can consolidate these lower-level components."

Riding the Software Bus

Novell's ambitions for AppWare go beyond just showcasing NetWare services. It wants ALMs to ride on a (still experimental) AppWare Distributed Bus over multiple transports. At BrainShare '94, Firmage showed dramatically how Visual AppBuilder can divide an application into client and server parts that distribute transparently across a network. In addition, he showed how the network service thus created will replicate automatically to accept multiple clients. While that demonstration used Apple protocols—ADSP for transport and NBP for name service—Firmage says the AppWare Distributed Bus will also work with IPX/SPX and NDS; TCP/IP, an object request broker that complies with CORBA (Common Object Request Broker Architecture); and other substrates, possibly PeerLogic's Pipes.

One intriguing substrate is Novell's Tuxedo, an OLTP monitor that runs on a variety of Unix platforms and—thanks to a recent Microsoft/Unisys deal—NT as well. In a client/server system built with Tuxedo, clients don't simply ask servers for data, they ask them to perform autonomous transactions against data accessible directly to the servers. High-availability, high-performance systems demand this kind of technology, says Robert Coven, president of InterAccess (Totowa, NJ), a client/server consultancy. "I can replicate a Tuxedo service on two servers, then take down server A, transfer all users to server B, rewrite the application logic, then bring up the service again on A, and transfer users back to it. That's 100 percent

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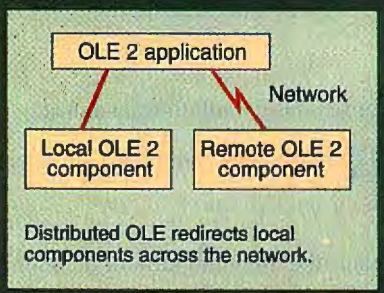
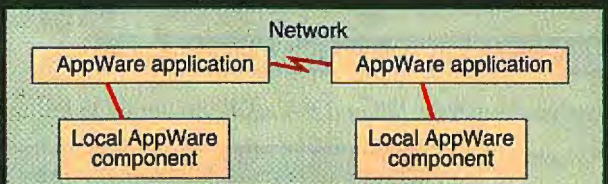
Distributed OLE vs. Distributed AppWare



Distributed OLE redirects local components across the network.



Distributed AppWare divides application logic into communicating partitions. For each partition, access to components is local.

In Novell's view, distributed software should cleave between application partitions rather than between applications and their components.

availability, and when I upgrade B and bring it back on-line, Tuxedo balances the load between the two servers."

The Tuxedo model of distributed computing dovetails neatly with that of the AppWare Distributed Bus. Both divide applications into coarsely granular partitions. The key point, says Firmage, is that while client or server partitions may both profitably use pluggable software components (for UI on the client side or data access on the server side), "the useful point of distribution is not between application logic and reusable components but between pieces of application logic" (see the figure "Distributed OLE vs. Distributed AppWare").

In other words, network services are not simply remote components. Their execution environment is the network. They need to be able to do things like replicate for reasons of redundancy and load-balancing. That's a compelling feature of Tuxedo that Novell wants AppWare to expose to a much larger population of programmers.

Making It Happen

Pervasive computing, in the current Novell blueprint, entails a four-layer infrastructure. The foundation is SuperNOS, offering two execution environments—NetWare's for core network services and transports and UnixWare's for layered applications. The technical and political challenges here are equally daunting. Can the hybrid SuperNOS retain NetWare's speed and flexibility while at the same time empower Novell to lead the Unix community and challenge NT in the applications server realm? No one knows, because SuperNOS is still—literally—on the drawing board. But the answers to these questions define the future of Novell and its products. Quite simply, these are bet-the-company issues.

Atop SuperNOS ride essential network services, including two on which Novell's growth critically depends—NDS and NDMS (NetWare Distributed Management Services). Reworked for NetWare 4.1 (and by year-end, for UnixWare 2.1), NDS is the fundamental enabler for pervasive computing. Given the slow uptake of NetWare 4.0x, the picture looks a bit gloomy. What could drive wider acceptance, though, is NetWare Connect Services, because 4.1 and NDS are the keys to the Novell/AT&T business Internet. How will companies manage these far-flung networks? That's the role of NDMS. But while NMS (NetWare Management System) 2.0 is a shipping product, with monitoring, analysis, software distribution, and licensing tools, NDMS is a strategic direction. Today, NMS monitoring is distributed, but NMS data is stored in local Btrieve databases. The NDMS strategy is to separate that data from the console and distribute it across SQL repositories accessible to non-Novell management platforms.

Point	Counterpoint
UnixWare and NetWare don't integrate well.	It's true that integration remains incomplete, but there's no question that UnixWare plugs into a NetWare environment more easily than any other version of Unix. With version 2.0, UnixWare's new SMP capability and ease of use make it an excellent choice for an applications server on a NetWare LAN.

That way, if a third party creates "the AI, 3-D GUI wonder-of-all-wonders management platform," says Michael Smith, director of West Coast operations for NetWorth, a hub vendor in Irving, Texas, "the NetWare administrator won't need a Ph.D." to use it. The data used by the local NetWare Hubcon utility, for example, will also be directly usable by the enterprise management system. Thus NDMS will generally enable, rather than specifically define, network management on the grand scale Novell envisions. However The Burton Group's Lewis cautions that "NDMS as a general statement of strategy is great, but they're a long way from delivering on it."

The third layer, which enables users and devices to access core services, includes NEST, Corsair, and AT&T NCS (NetWare Connect Services). NEST could enfold previously unconnected devices such as faxes, PBXes, and even (Frankenberg pointed out in his Comdex keynote speech) slot machines. Corsair, which Frankenberg demonstrated during that speech, presents a virtual-world interface intended to appeal not only to business users but to the vast and growing home market that Novell must reach to attain its billion connections. AT&T NCS aims to make the WAN as available as the LAN is today.

The icing on the cake is networked applications, including Novell's current and future groupware products, custom distributed applications enabled by Tuxedo and AppWare, and the distribution and sale of information and software through AT&T NCS to businesses and—increasingly—to consumers. That's the plan, but Novell's blueprint for building this layer is hardest to decipher. Last year's tools strategy, AppWare, has lost much of its momentum. Next year's strategy, the company says, is distributed objects, OpenDoc, and CORBA. But what about right now? Novell's brand of computing can't become pervasive unless networked applications pull millions of new users into the fold. Where these new applications come from is the $64,000 question. ■

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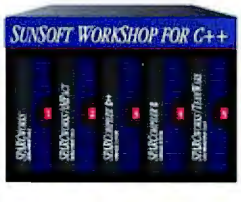

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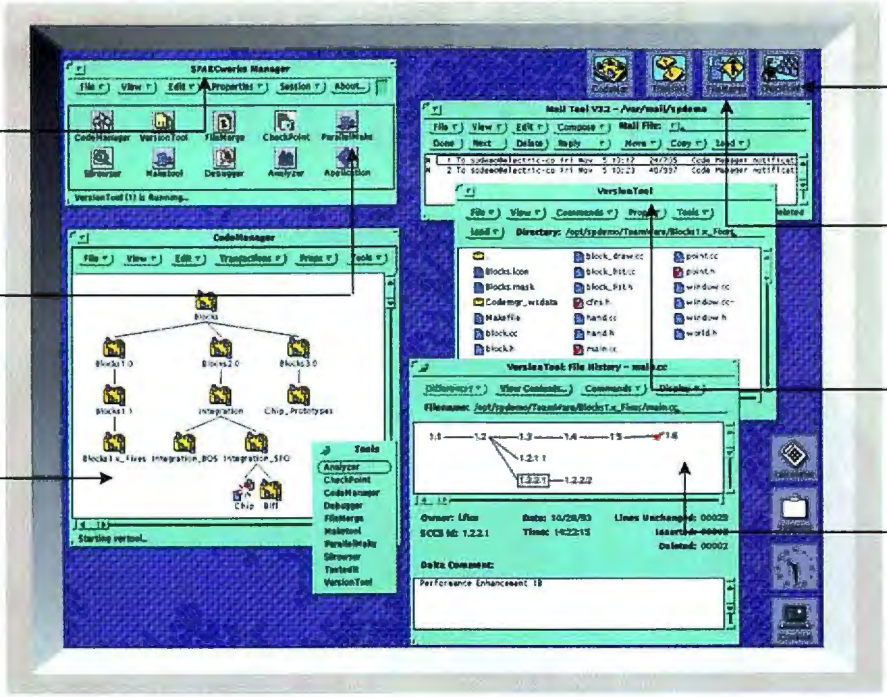

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The Grand Challenges

OLIVER SHARP

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Even using the biggest, most powerful computers available today, we still cannot reliably predict the weather for next week in any significant detail. And this is just one of a number of problems that we would like to solve using computers, but which are so complex that they are essentially beyond the abilities of current technology.

Recently, a group of scientists and sympathetic policy makers joined together and devised the High Performance Computing and Communication (HPCC) project. This is a large effort that involves many government agencies, including NASA, NSF (National Science Foundation), the Departments of Energy and Defense, and NIH (National Institutes of Health). At the core of the project is a set of hard-to-solve problems that require much more performance than supercomputers can currently muster. With a dash of marketing flair, HPCC project agencies call these problems the grand challenges.

Some big and difficult computing jobs need more power than today's supercomputers can muster

A *grand challenge* is an application that pushes well beyond the limits of today's fastest computers. Most of the problems that the HPCC group has identified require performance somewhere between 100 and a few thousand GFLOPS. The term *GFLOPS* denotes 1 billion floating-point computations per second, and *TFLOPS* denotes 1 trillion floating-point computations per second. The most powerful processors currently in use, such as those in the Cray C90, can deliver a sustained performance of somewhat less than 1 GFLOPS on highly tuned code.

In other words, computers that can run grand-challenge applications on a single processor need to be at least 100 times—and possibly several thousand times—faster than the best that can currently be achieved. Rather than waiting idly—for perhaps a decade or more—grand-challenge researchers are working with today's hardware to pursue the use of parallel architectures.

High-Performance Computing

To understand HPCC's importance, it's helpful to recall that the U.S. government has supported computer research since the machines were invented. During the 1950s and 1960s, for example, most computer design focused on applications used in business, such as handling accounting. But scientists needed quite another kind of machine. So, with the support of large, government-funded research labs, a number of companies sprang up to build machines that would perform floating-point operations faster than anything in existence. These machines came to be known as supercomputers.

When the Cold War was at its height, supercomputing was a high governmental priority. But the world has changed. With the end of the Cold War, widespread defense cutbacks, and a flourishing commercial computer industry, the warm relationship between government and high-performance computer makers is largely a thing of the past. Government paternalism is out of vogue, and hard-headed market economics is the new imperative.

But weaning supercomputing companies away from govern-

The Supercomputer Makers

Depending on how the term *supercomputer* is defined, there are between 10 and 20 supercomputer companies currently in existence. What follows is a rundown of some of the current crop of high-performance machines being offered by these companies.

Convex

Convex makes two lines of supercomputers, the SPP and the C4. The former is a parallel machine based on Hewlett-Packard's PA-RISC processors; the latter is a traditional vector supercomputer.

Cray Research

It's simply not possible to talk about the history of supercomputing without prominently featuring the name of Seymour Cray. For decades, the machines that he designed were the fastest in the world. In a field as volatile and competitive as the supercomputer field, he compiled an amazing record. He has since left Cray Research to form a new company, Cray Computer, that hasn't yet shipped any machines.


Cray T3D

Cray Research still makes one of the fastest vector supercomputers, the 16-processor Cray C90, which is discussed in more detail in the text box "A Closer Look at Two Supercomputers."

While massively parallel machines offer much-higher theoretical throughput, vector-based systems like the C90 are the workhorses of the supercomputer world. Getting peak performance from a vector machine is not easy, but scientific programmers have been working with these machines since the 1960s and are familiar with them.

In addition to offering its vector supercomputers, Cray has recently branched out into massively parallel architectures. Its T3D contains up to 256 DEC Alpha processors.

IBM

IBM recently announced the SP2, a parallel architecture based on Power2 RISC processors. The Power2 is a successor to the RS/6000 chip, and the SP2 can contain as many as 128 of them. The SP2 machines supplant IBM's older ES-9000 line of traditional vector supercomputers.

Intel

In addition to offering its well-known CPUs for personal computers, Intel has a supercomputer division that has been selling parallel computers for 10 years. The current offering, which is called the Paragon, is discussed in more detail in the text box "A Closer Look at Two Supercomputers."

Meiko

Meiko is not as well known outside the supercomputer community as the other companies that are listed here. It sells a massively parallel machine called the CS-2, which is based on SuperSparc chips optionally connected to a pair of high-performance vector units (Fujitsu µVP vector processors).

Silicon Graphics

Best known as a graphics company, Silicon Graphics, Inc., has long had a significant presence at most supercomputing sites. Its workstations have excellent graphics performance and are often used to visualize the results generated by big supercomputers. With its new Power Challenge system, SGI is trying to expand its market to include high-performance computation as well as graphics.

Japanese Companies

Although supercomputing has been dominated by U.S. companies, the Japanese have also been active in the field. Their machines have received somewhat less attention than they deserve, partly due to the reluctance of U.S. government agencies to purchase them.

The three major suppliers of Japanese supercomputers are Fujitsu, Hitachi, and NEC. All are household names in the U.S., but they are not widely known in the U.S. for their computers. According to some benchmarks, the Hitachi S-3800 contains the fastest single processor currently available. NEC's line of supercomputers is called the SX-3, and Fujitsu offers a line called the VP2000. All three use vector processing and are well represented in the upper ranks of floating-point benchmark results.

Recent Casualties

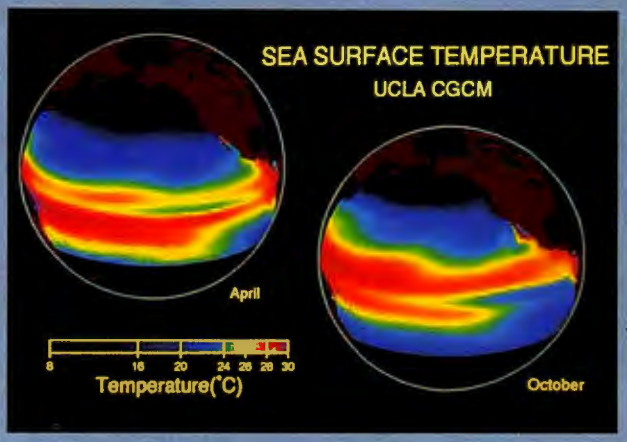
Trying to market a supercomputer is a dangerous business; the field is littered with the skeletons of dead companies that have failed in the attempt. It's extremely difficult to design and deliver a supercomputer; it's harder still to make money doing it. And even when a company manages to do both, few have been able to maintain a successful effort for an extended period of time.

For example, Kendall Square Research (Cambridge, MA) announced a massive layoff in September 1994 and stopped producing its line of supercomputers. The end was accompanied by a series of ugly revelations about financial shenanigans; corporate officers apparently tried to hide the shakiness of the company by manipulating sales and inventory figures.

Thinking Machines Corp. was once the golden child of supercomputing; it had the newest and most radical approach and was stocked with the best and brightest minds from MIT and other top universities. The company's first two machines supported only the data-parallel model, which demanded that programmers rewrite the computationally demanding parts of an existing application. Although scientific programmers were originally skeptical (and many stayed that way), many applications achieved impressive performance on the CM-1 and the CM-2.

However, the company ran into difficulties on its next generation, the CM-5. These were much more conventional machines than their predecessors, but TMC ran into serious problems in designing the vector processors that provided the machines' raw performance. The company also had difficulty building the compiler support to handle existing data-parallel applications efficiently and bringing in new users. In the high-performance-computing arena, companies don't generally get second chances.

Climate Modeling



Averaged sea-surface temperatures are shown for the months of April (left) and October (right), using data from a multiyear simulation on a Cray YMP using UCLA's coupled atmosphere/ocean model. The atmospheric component is the UCLA General Circulation Model, and the oceanic component is the NOAA/GFDL (Geophysical Fluid Dynamics Laboratory) Modular Ocean Model. (Photo courtesy of C.-C. Ma, C. R. Mechoso, and W. Weibel, of the UCLA Department of Atmospheric Sciences, and the NCO [National Coordination Office] for HPCC)

ment-sponsored projects and refocusing them toward the commercial market carries the risk that basic research might be lost in the shuffle. Research into the frontiers of computer modeling is an expensive proposition that often pays no quick dividends. Thus, HPCC ensures that basic research will continue and will pay dividends.

A Few Examples

Most of the grand-challenge applications now being pursued represent big science at its finest. They range from pure physics to biology, from chemistry to engineering, from seismology to fluid dynamics.

Scientists spend a lot of their time studying physical systems, generating theories about the rules that control them and shape their evolution. Computer models allow researchers to build a system that embodies these theories and then, if possible, to compare the model's behavior to data gathered through observation.

The scale of these models ranges from the subatomic particle interactions of quantum chromodynamics to galaxy formation and the evolution of the universe. The next few sections explain in detail some specific grand-challenge applications.

Earth Sciences

In the middle of the broad scale of scientific models are a number of grand challenges relating to the earth and its climate. The most ambitious one is the quest to build a 3-D model of this entire system to predict the changes that will occur decades or more into the future. Such models must incorporate both atmospheric and oceanic physics if they are to be at all realistic.

The atmosphere and the ocean require different modeling strategies, but they have an enormous influence on each other and cannot be accurately simulated in isolation. Global-climate models are the battleground of the global-warming controversy.

Scientists use coupled atmosphere/ocean models in their attempt to try and understand, and eventually predict, phenomena such as El Niño and the greenhouse effect and their global impact on climate. The development of improved representations of physical processes (e.g., cloud-radiation interaction) and the long-duration model simulations required for climate studies will demand a 100-fold to 1000-fold increase in computing, communications, and data management capabilities. Scalable parallel-computing systems and high-speed networks will help meet this demand.

Other earth-science projects are shorter-term or more restricted in scope, which allows greater accuracy. Environmental-impact projects try to predict the effects of various human activities and different environmental policies. For example, they might examine the air quality of a restricted area, such as the Los Angeles basin, or model acid-rain production.

Another long-standing goal is more-accurate weather forecasting. It's largely impossible to forecast too far into the future because of the way that weather evolves, but accurate short-term forecasting can save lives and prevent property damage as well.

Weather forecasting and global-climate modeling involve very different strategies. Current global-climate models may represent an area the size of California as a single point, but that wouldn't be satisfactory for weather prediction: The weather varies quite a bit between the top of Mount Whitney and the deepest point in Death Valley, a mere 140 miles away. A grid resolution of 5 kilometers would allow much more accurate weather prediction than current models, but it would also require orders of magnitude more computing power than is currently available.

Another focus of attention is *CFD* (computational fluid and plasma dynamics), the behavior of a body moving through a medium or vice versa. CFD can be used to design everything from high-pressure pipes to airplanes and automobiles. NASA has a large group of researchers who use CFD modeling for vehicles such as the space shuttles. Aerospace companies now employ computer models to supplement the traditional strategy of building a physical model and putting it into a wind tunnel.

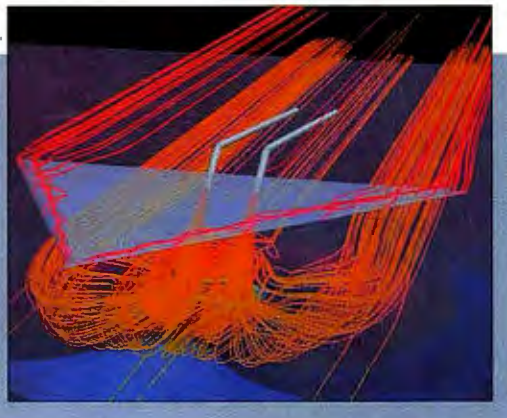
Computational Biology

Biology has not traditionally involved as much computer simulation as physics, but that's changing. Drug research relies on vast amounts of manual testing and is an expensive, hit-or-miss proposition.

Computer models could transform this process. Organic substances, such as proteins, contain many atoms that attract or repel each other, twisting the whole structure into a 3-D shape. The effects of a drug are partly determined by its shape. Using computer models, researchers hope to design drugs to target particular diseases.

continued

Aerodynamics



Scalable parallel computing enables flight-vehicle designers to use new simulation and optimization methods that combine several physical disciplines and integrate multiple vehicle components. This picture shows the airflow over and past the wing of a simulated high-performance aircraft that is using vectored thrust while descending to a few feet above the ground. (Photo courtesy of NASA and NCO HPCC)

Still another major goal is to use computers to map the sequence of genes that make up human genetic material. This would yield a much better understanding of inheritance and the process of mutation.

Imaging

Doctors have used x-ray images for decades, but one x-ray represents only one cross-section and may not reveal enough to support an accurate diagnosis. One solution is to take many x-rays from different angles and then piece the images together.

CT (computerized tomography) uses algorithms to take many readings and produce an image far more accurate than any single picture could be. While two-dimensional CT machines are in widespread use, researchers at institutions such as the Mayo Clinic are working on 3-D images.

To prepare for surgery on a brain tumor, for example, a surgeon could use imaging software to view and manipulate an image of the patient's head on a graphics workstation. The software could peel back layers and rotate the picture to show the exact location and dimensions of the tumor. But it requires a great deal of computation to turn hundreds or thousands of views into one detailed 3-D image.

CT is also being used outside the medical community. One new application involves finding cracks inside freeway supports caused by earthquake tremors, as well as erosion inside bridges caused by shifting sediment.

Industrial Applications

In addition to forming partnerships with laboratories and universities for carrying out basic scientific research, members of the HPCC group have sought partnerships with various industries that have computationally demanding problems. In health care, for example, there are projects that search large databases of previous cases to help doctors diagnose patients with unusual ailments. Architects and engineers are using stress-and-shear models to predict how structures will react to earthquakes and violent storms.

Financial companies use supercomputers to model securities markets. These companies are also interested in mining their large databases to discover rules that accurately predict whether customers are credit-worthy and will pay their bills.

Oil companies want to use models to avoid drilling test wells that don't produce anything; dry holes are expensive and damaging to the environment. Companies such as Shell work on supercomputing research.

Major Obstacles

Each grand challenge poses its own set of difficulties, but there are a number of common problems that are all related to one of three categories: the raw capability of the hardware, the algorithms used to solve the problems, and the tools that a programmer has available to build applications and analyze the results.

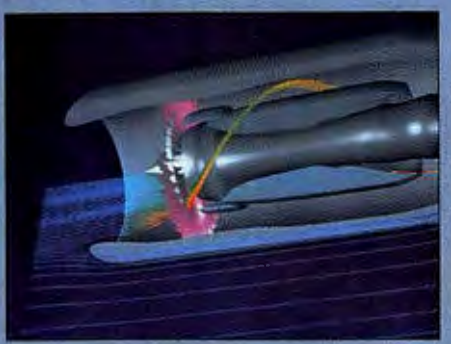
The most obvious necessity for running a grand-challenge application is extremely good floating-point performance. In theory, current parallel machines are a great deal faster than the best vector supercomputers. If exploited with maximum efficiency, many of them offer well over 100 GFLOPS. But it's much harder to exploit hundreds or thousands of processors than it is to rely on a single one. Grand-challenge researchers are among the most active users of parallel machines, and they have the scars to prove it.

While the most widely quoted performance figures almost always relate to the CPU, a supercomputer's I/O bandwidth is often just as important. This is a weakness of many parallel architectures: They offer a potentially large increase in CPU performance, but their I/O throughput does not scale accordingly; in fact, it is often much lower than that of high-end supercomputers.

Many grand-challenge applications require massive amounts of data to execute properly. Mapping the human genome, for example, is largely a database problem that uses search techniques on gigabytes—and eventually terabytes—of data. Most physical simulations require less initial data, but while running they generate enormous numbers of intermediate results.

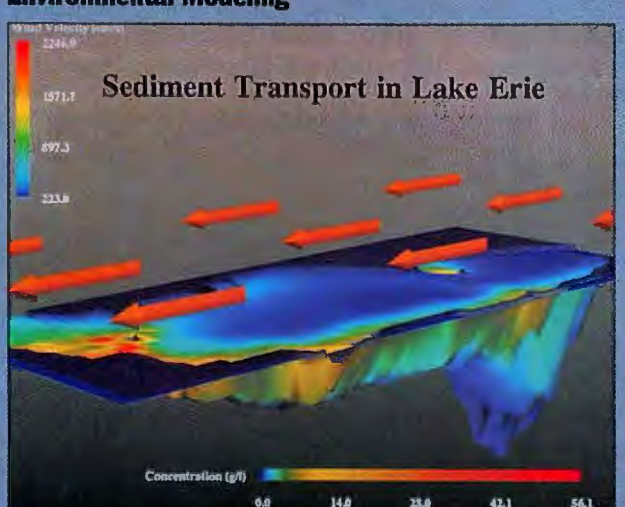
A climate model, for

Jet-Engine Simulation



Researchers at NASA's Lewis Research Center are developing a prototype numerical-propulsion-system simulator for dynamic numerical and visual simulation of jet-engine components. This multidisciplinary research, using scalable parallel-computing systems, will allow aircraft manufacturers to analyze options more rapidly and then design higher-performance propulsion systems at lower cost. Here, airflow through several components of a jet engine is simulated on a cluster of IBM RS/6000 workstations. (Photo courtesy of NASA and NCO HPCC)

Environmental Modeling



Contaminated bottom sediments and the associated decrease in water quality pose major problems in rivers, lakes, harbors, estuaries, and near-shore ocean areas. To study these problems, EPA-funded researchers at the University of California–Santa Barbara are developing computationally intensive, time-dependent, 3-D models of the hydrodynamics, particle transport, and sediment-bed dynamics, coupled with meteorology and significant biochemical reactions. The redistribution of toxic sediments in Lake Erie due to a large storm depends on wind direction, wind speed, and water depth; in the photo, sediment concentrations tend to be largest in shallow sections. Calculations were performed on a Cray YMP at the EPA's National Environmental Supercomputer Center. The visualization was done by the EPA's Scientific Visualization Center on an SGI workstation using Fast software. (Photo courtesy of EPA and NCO HPCC)

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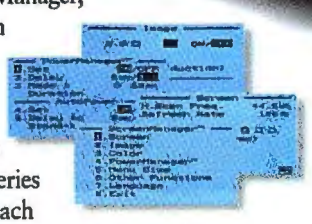

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A Closer Look at Two Supercomputers

Current supercomputers can be roughly divided into two categories: vector machines and massively parallel machines. The key distinction between the two is that almost all vector supercomputers can be purchased with multiple processors, but parallel supercomputers are dependent on using many processors at once to deal with a single problem.

Parallel machines rarely provide enough performance to handle a grand-challenge application using only one processor at a time. Vector machines, on the other hand, are almost exclusively used as a group of independent processors that share resources. A very small percentage of the applications currently running on vector machines use more than one processor at once.

A Vector Supercomputer: The Cray C90

The C90 comprises a family of related machines, the most powerful of which, the C916, can have between eight and 16 processors. It has a clock cycle of 4.2 nanoseconds; the 15-ns memory is implemented on BiCMOS. A C916 system can have as much as 8 GB of memory.

During each clock cycle, two operands can be loaded from memory, and one can be stored for each pipeline. But due to the latency of the memory subsystem, memory operations must be scheduled properly to achieve maximum throughput. (For applications that require more memory, Cray offers an alternate line called the M90; these systems have lower floating-point performance but can support several times more memory.)

The maximum I/O bandwidth of the C90 is 13.6 GBps; it's handled by a variety of networks. The system can be connected to a solid-state disk (i.e., a large RAM drive) that stores up to 32 GB and supports access at the full I/O bandwidth. Physically, the machine takes up 48 square feet, and the Freon cooling unit requires another 50 square feet. The system can require more than 300 kilowatts of electrical power to run.

The core of the C90's floating-point performance, which peaks at about 1 GFLOPS per processor, comes from the vector processors. It's up to the programmer and the compiler to see that those processors are used effectively. Over the past few decades, scientific programmers have become used to programming for vector supercomputers and have learned how to write efficient code for them. Although it is rare to have code achieve a sustained throughput of anything close to 1 GFLOPS, a lot of real-world applications achieve hundreds of MFLOPS.


Cray C916

The C90's operating system is UNICOS, a Unix variant. The system comes with highly tuned compilers for various languages (including C and FORTRAN 77). Cray has also built a variety of tools for measuring the performance of an application and discovering inefficiencies or hot spots that need to be optimized.

A Parallel Supercomputer: Intel's Paragon

The Paragon is a descendant of earlier Intel machines. Intel began building parallel hypercube systems during the mid-1980s and then moved to a two-dimensional mesh with its Touchstone Delta.

The Paragon is similar in design to the Delta, but it uses faster, 50-MHz i860/XP processors with built-in support for network communications. Each processor can have up to 128 MB. Routing communications between processors through the mesh is handled by separate network chips; the bisection bandwidth ranges from less than 1 GBps all the way up to several GBps, depending on the machine's configuration.

I/O is performed through a HiPPI (High-Performance Parallel Interface) that supports up to 100 MBps. For comparison, the Cray C90 supplies not only a HiPPI but also a variety of other interfaces that can support as much as 1.8 GFLOPS per channel.

I/O performance is often an Achilles' heel for parallel machines. This is particularly true of a system like the Paragon, which can be configured to provide much higher theoretical CPU performance than even the biggest Cray vector machine.

For some applications, the Paragon attains extremely high performance. For instance, a 3680-processor Paragon achieves 143 GFLOPS on the LINPACK benchmark, as compared to just 13.7 GFLOPS for a 16-processor C90.

But achieving such performance on a massively parallel machine is difficult. At present, virtually every application that executes efficiently on massively parallel systems is hand-coded; the programmer directly specifies the data that is to be communicated between nodes using message-passing primitives. Intel provides libraries of tuned communications routines and tools to aid in performance monitoring and debugging on the Paragon, but the process is far from painless.

example, might have a time-step of 15 minutes. Arrays of values store the current state of the simulated climate; at each time-step, the program modifies those values to reflect the changes that occurred in 15 simulated minutes. To compute the earth's climate after 10 days, the model would iterate for 960 steps and dump the resulting values. If the run takes an hour, and the amount of data needed to describe the climate takes up only 1 GB, the I/O requirements are easily supported on a powerful system.

But suppose that the scientist working with this model is creating an animated view of the evolving climate that uses color to show temperature. The simplest strategy is to dump the current state of the simulated climate out to disk at every time-step. Suddenly, the I/O throughput goes from 1 GB per hour to 960 GB per hour. The programmer could reduce the I/O requirements by storing fewer temporary results, by storing them less often, or by being prepared to rerun the application.

But in spite of all these stratagems, grand-challenge applications generate a lot of data. Current supercomputers can transfer from 1 to 40 MBps of data to a hard disk. Larger, tertiary storage devices, such as tape drives, support much slower rates—between 0.5 and 5 MBps.

In the near future, grand-challenge applications will need to be able to transfer as

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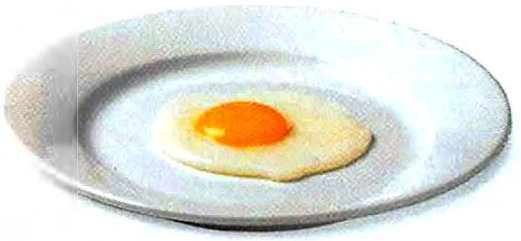

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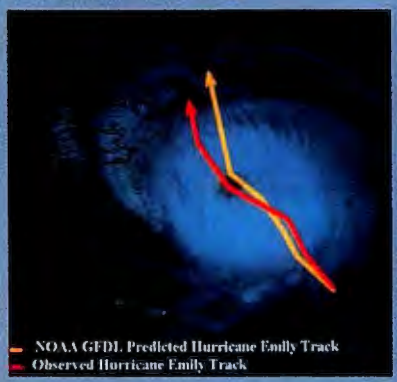

High-performance computing allows better modeling of the earth and its oceans and atmosphere. Better models result in improved guidance for weather forecasts and warnings that can save lives, as well as millions of dollars, through better targeting of evacuation efforts and protection of valuable property. Here, NOAA's predicted track for Hurricane Emily (yellow) is close to the actual track of the storm (orange), which did not make landfall. The forecast was made by the NOAA GFDL Hurricane Prediction Model using near-real-time observations. Calculations were performed on the GFDL's Cray YMP. (Photo courtesy of NOAA and NCO HPCC)

much as 1 GBps to disk and 100 MBps to tape. Major improvements to I/O design will be necessary for most supercomputing platforms before they can reach those speeds; that level of throughput to tertiary devices is a particularly distant goal.

Once a system can transfer data quickly enough to disk or tape, the next problem is deciding how to manage the huge piles of data that result. Many applications currently generate 1 GB of data or more per run. They will soon yield 10 GB, and as much as 100 GB in the not-so-distant future. The amount of data that must be put into archives will reach terabyte levels.

NASA's Ames Research Center (Moffett Field, CA) has faced this issue for years; it currently uses a large vault of backup tapes and a robot that zips around and plucks out the appropriate tape when old data is needed. The organization has continually upgraded its data-storage facility and is in the process of doing so again.

Algorithmic Issues

Many grand-challenge applications involve physical systems that are not well understood. To make progress, physicists need to improve their mathematical models and algorithms. For many of them, dreaming up new theories is the best part of their job; once the mathematics are hammered out, testing and implementing them correctly are subject to a myriad of pitfalls.

One of the most important decisions is which basic data structure to use for the model. When each grid point represents a parcel of space, the most straightforward data structure is a uniform 3-D grid. Uniform grids are easy to think about and implement, but they can also perform poorly.

For instance, when an airplane is moving through the air, the important behavior is concentrated in those few places where there are edges or corners and the flow of air is broken up into vortices. These areas determine whether the plane flies well and whether or not the wings will collapse.

With a uniform grid, this model either has a very low resolution that ignores key features of the flow or wastes a lot of CPU time on uninteresting parts of the scene. By using a nonuniform grid, the model can concentrate grid points where they are merited. Gridding techniques make up an active area of investigation.

Another set of problems emerges when two models need to work together, as with oceanic and atmospheric simulations. Interfacing them can be difficult from a practical standpoint because research groups often use different tools, languages, data models, and programming environments.

Beyond these issues lurk deeper algorithmic questions. Floating-point numbers represent approximations to actual values, while traditional mathematics deals with the abstraction of infinitely precise real numbers. Equations and algorithms can suffer terribly when they are translated to the approximate world of the computer.

The field of numerical analysis is devoted to reconciling this dichotomy, evaluating algorithms to see if they will be well behaved using a given floating-point representation. It's difficult to ensure that two completely different algorithms will not run into trouble if they exchange data in the middle of their computations.

Software Tools

One big stumbling block in building grand-challenge applications is the lack of software support. Many of the tools programmers need are simply unavailable, and the software that's in place isn't always stable. Using the latest and fastest machines often means being a guinea pig for buggy beta-release software.

At the most basic level, every programmer needs a reliable operating system and compilers that produce efficient, correct code. In the past, neither could be taken for granted on high-performance architectures. Working with unreliable system code, programmers were forced to tread warily in their search for performance. Fortunately, most of today's system software for sequential architectures is reasonably reliable.

Parallel systems, however, are much more problematic. The lack of standards in this area is particularly irksome; a program that is written for one machine generally requires a significant amount of work for it to be ported to another.

Some progress has been made in standardizing message-passing libraries that communicate between processors, but the rest of the picture is not encouraging. Debugging support is spotty, and robust performance-monitoring tools are largely nonexistent. So far, compilers that attempt to convert sequential programs into parallel form have not been very successful.

There has been more success in building visualization tools for looking at results. Examining raw numbers is generally not practical. Often, the most effective solution is some form of visualization, whether it's a simple line graph or an elaborate 3-D color animation. There are many projects around the U.S. that are building systems for visualizing large data sets.

What Lies Ahead

The HPCC group's goal is to push forward on the most difficult problems in scientific modeling. Despite cutbacks in defense spending, the government continues to support basic scientific exploration. Researchers are focusing on finding or building better tools, defining software standards, and incorporating more-ambitious theoretical models into their programs.

Hardware vendors are currently in a difficult stage of evolution. The traditional supercomputer vendors are adapting to a new environment in which government funding is more difficult to come by. Companies that sell parallel architectures have had the most trouble doing this, and many are not faring well in the marketplace.

In addition, supercomputer companies face a new threat: workstations, which can now provide fast floating-point throughput. Small machines are not yet a credible alternative for the most ambitious projects, for their I/O performance in particular is not even remotely adequate. It's up to the supercomputer designers to stay far enough ahead of their general-purpose competitors to remain economically viable. ■

Oliver Sharp, of Colusa Software in Berkeley, California, is a doctoral candidate at the University of California–Berkeley. You can contact him on the Internet at oliver@cs.berkeley.edu or on BIX c/o "editors."

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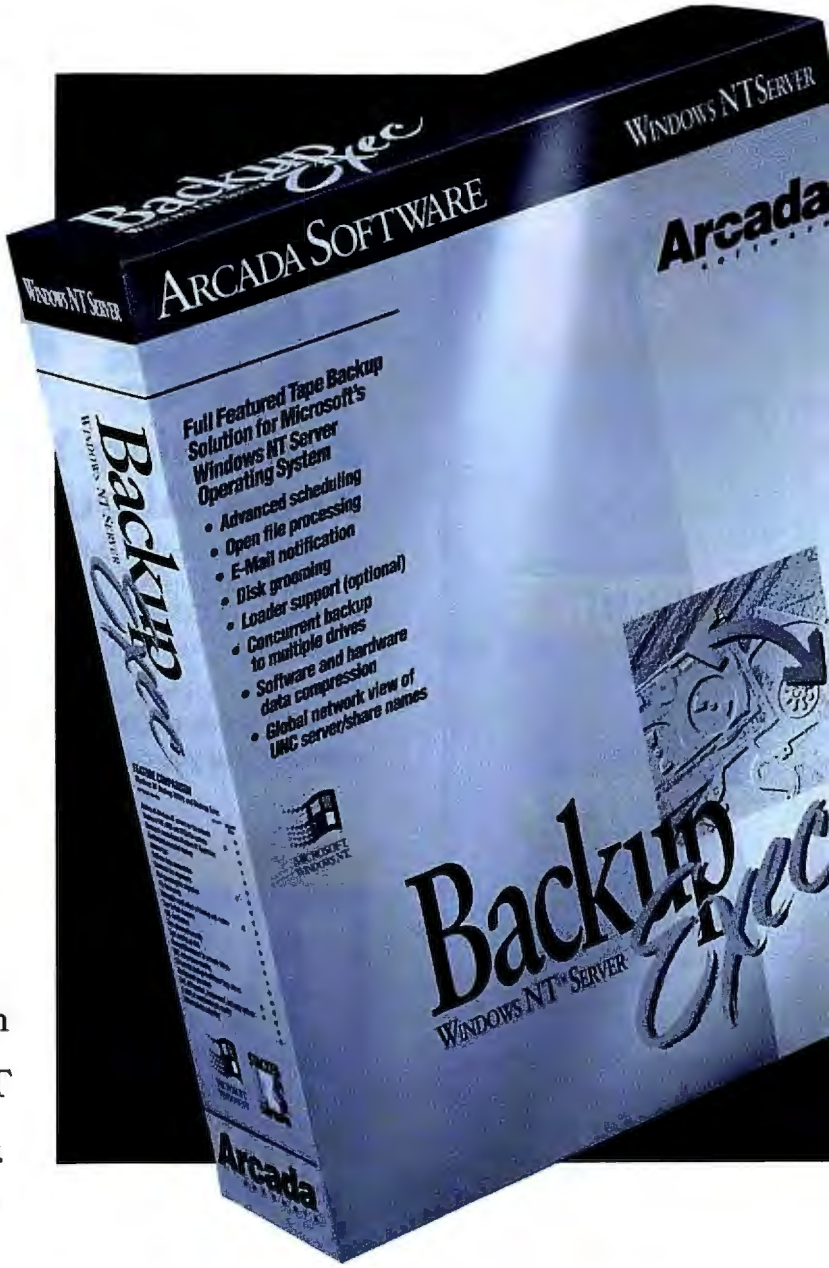

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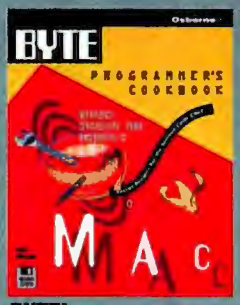

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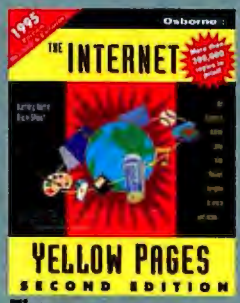

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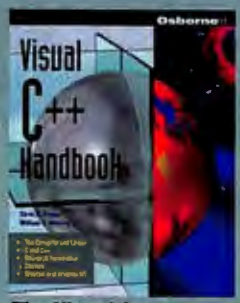

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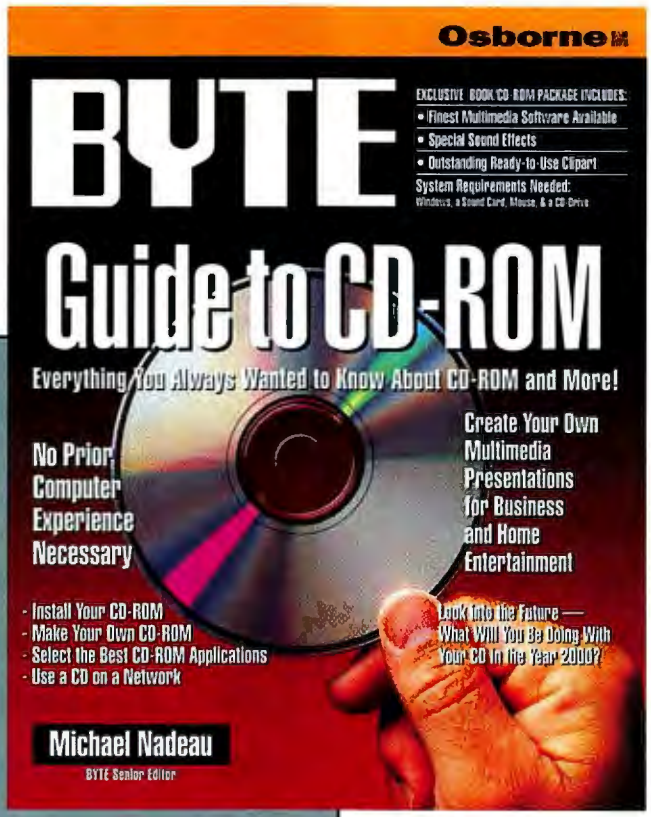

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Moody's Evolving Help Desk

MARK CLARKSON

It takes an expert and busy help desk to resolve the computer problems of the 1100 users at Moody's Investors Services, a bond-rating agency based in New York City that analyzes the credit risk associated with securities. Like any large organization today, Moody's has a lot of computers—everything from mainframes running proprietary analytical software to PCs running plain old Microsoft Word. To support this computer infrastructure and its users, Moody's technology department runs a help desk.

Computer users at Moody's call the help desk with problems ranging from the mechanical (e.g., "My PC won't boot" or "My monitor went out") to the mundane (e.g., "I can't get Harvard Graphics to print my charts"). If a help-desk representative can't resolve a problem over the phone, he or she writes up a ticket, and the user gets a visit from a TSA (technical-support analyst), who tries to solve the problem in person.

Using genetic algorithms, Moody's Investors Services schedules its help-desk troubleshooters and increases its efficiency

BARD MARTIN © 1995

Roger Stein, senior analyst at Moody's Quantitative Analytics Group

And therein lay Moody's help-desk problem—scheduling hundreds of jobs for dozens of staff troubleshooters.

The Trouble with Schedules

"The problem," says Roger Stein, senior analyst at Moody's Quantitative Analytics Group, "was how to efficiently schedule and route these requests for visitation [by a TSA] so that the right people end up with the right tasks, which are then executed in the right order. You don't want a TSA to spend a lot of time adjusting the colors on one person's monitor when somebody else's hard disk has crashed."

To schedule repairs efficiently, you must contend with the almost paradoxical arithmetic of organizational downtime. For instance, take two hardware problems of equal severity and priority—in both cases, the user is unable to do his or her work until the problem is fixed. One problem will take 5 minutes for a TSA to fix; the other will take 5 hours. Which one do you schedule first? From a time-expenditure standpoint, it doesn't matter. But from the standpoint of time lost to the organization, there is a big difference indeed.

Consider this: If you make the 5-minute repair first, both users wait 5 minutes, and then one user waits an additional 5 hours. Total time lost to the organization: 5 hours, 10 minutes. But if you make the 5-hour repair first, both users wait 5 hours, and one waits an additional 5 minutes; the total time lost swells to 10 hours, 5 minutes.

But what if the longer task has a far-higher priority? What if one of the users has already been waiting for three days? "Things get pretty complicated when you're talking about tasks of varying priority and varying durations," Stein says.

Genetic Algorithms

A quick glance out the window, or even at your own hands, should convince you that nature is the uncontested master of evolving solutions to complicated problems. All of nature's answers are phrased in the form of genes. In nature, genes express themselves as such things as people, slime molds, or oak trees. But back in the 1970s, scientist John Holland realized that, with a little cleverness, all sorts of things—from airplane propellers to mathematical proofs—could be described in genetic form. He called his approach the genetic algorithm, or GA.

To get a better propeller or proof using a GA, all you have to do is establish a colony of them and encourage them to breed. You periodically select the best individuals to use as the parents for a new generation. It's a lot like breeding livestock, except it's usually—but not always—conducted on a computer.

The almost magical thing about GAs is that they have no idea what they are doing. They are capable of finding elegant solutions to complicated problems, but there's no intelligence behind the way they formulate those solutions; it's pure, blind sex.

And that's just what Stein likes about them for Moody's prob-

lem: "If we were going to design a traditional expert system, we would spend hours and hours of very expensive time with help-desk personnel, figuring out the rules for scheduling the help desk," he says.

Instead, the help desk's new scheduling system, dubbed SOGA (Schedule Optimizing Genetic Algorithm), breeds efficient schedules using the GA. "The nice thing about genetic algorithms is that you don't have to tell them how to solve problems," he says. "You tell them what you want done and let them percolate away for a while, and they'll come up with some pretty-good solutions to your problem. They're totally unaware of how they did it, but that's irrelevant to finding a solution."

Stein usually applies his analytic skills to Moody's fiscal concerns and to intellectual exercises in mathematics. As one such exercise, Stein, along with friend and colleague Vasant Dhar of New York University, had already designed and built a prototype of SOGA. When the prototype was finished and they were writing up a paper outlining its performance, it occurred to Stein that SOGA might be useful for scheduling tickets for Moody's own help desk.

Because Stein and Dhar had already implemented a prototype system in DOS, the implementation went fairly quickly and was up and running in about two months. The production version of SOGA that runs on Moody's help desk is written in Microsoft's Visual C++ and runs under Windows. The majority of the code was written by one programmer. The system schedules tasks for the 12 TSAs and the approximately 20 second-line support personnel who assist Moody's more-than-1000 computer users.

A Close-Up on the Genes

In SOGA, schedules are represented by chromosomes made up of many genes. Each gene is a ticket—a problem received by the help desk, needing to be resolved. The system starts with a population of completely random schedules. As the GA runs and the schedules "breed," the genes are shuffled around from place to place, and eventually efficient schedules are produced.

SOGA uses a pair of GAs to produce its schedules. The first one breeds a master schedule made up of all the unassigned tickets. The second one then optimizes the schedules of individual TSAs.

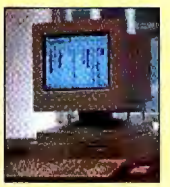
Here's how it works. When a problem call comes in, a help-desk representative creates a ticket entry in the help-desk database. This ticket contains information on the problem, including where the hardware is within the building and the general category of the failure (e.g., "PC fails with diagnostics" or "Modem at desk fails").

The trouble ticket doesn't usually have the name of any particular TSA on it. Whenever possible, SOGA is allowed to recommend a technician for the job. This is because the more latitude SOGA is allowed, the more efficiently it does its job.

Every 10 minutes or so, SOGA reaches into the help-desk database and pulls out copies of all unassigned tickets. Each of these tickets becomes one gene in the chromosomes that SOGA builds.

Suppose there are seven tasks to be completed: A, B, C, D, E, F, and G. SOGA begins by constructing a population of "chromosomes" (i.e., schedules) made up of these genes. Initially, the individual genes appear in a different, random order in each chromosome; for example, ACDFGEB, CGBDAEF, BGDAECF, and so forth. Next, the resulting chromosomes are broken apart again into their component tickets. *continued*

SCHEDULING: THINK OF IT AS EVOLUTION IN ACTION

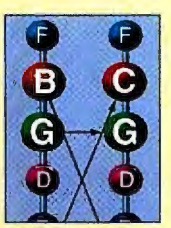


Moody's Help Desk

- It supports about 1000 PCs and 1000 computer users on 11 floors.
- Four people answer phones, 15 people are TSAs, and 40 to 50 people work as second-line support personnel.
- About 120 phone calls are received on an average day.
- About 40 problems are resolved over the phone each day.

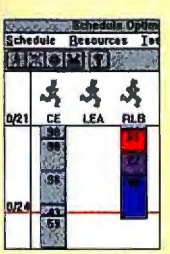
Supported Systems

- Unix boxes
- VAXes
- Mainframes
- IBM-compatible PCs
- Macintoshes
- All systems are networked together



SOGA System Highlights

- Genetic algorithms create and refine schedules for trouble tickets.
- Schedules are recomputed every 10 minutes.
- Unassigned tickets cannot drop out of sight.
- Fuzzy logic helps to model user satisfaction.
- Jobs are assigned according to individual TSA skills.
- A graphical interface quickly and concisely shows the current status of all tickets, whether they're scheduled or not.
- For each ticket represented on-screen, the size of its icon represents the average resolution time, and its border color indicates job priority.
- The longer a job sits unresolved, the more its priority rises.
- Schedules can be consulted from anywhere on the network.



Lessons Learned

- People resist being scheduled by a machine. Build in some flexibility and allow a certain amount of human selectivity.
- You don't need to create perfect schedules; "good enough" is good enough.
- Scheduling matters. Waiting unnecessary hours for a 5-minute fix wastes everyone's time.

All of Moody's many TSAs have different skill sets. Some specialize in software problems, for example, and others concentrate on hardware. On any given day, a particular TSA might be on vacation, out sick, or busy. The problem category on each ticket is matched against a database of TSAs and their skills, and tickets are assigned to a TSA who is qualified and available to handle the particular task. When every task in a chromosome has been assigned, it is converted into a potential schedule.

Each of these resulting schedules is then evaluated for fitness to determine how efficient it is and how happy it's likely to keep the computer users. The best few schedules are kept as "parents" for the next generation; the rest are discarded. The new parent schedules are used to produce the next generation. There is no question about which genes the offspring receive from their parents; the only variable in this system is the order in which the genes appear. The processes used to create a new schedule from two parents are shown in the figure "Genetics at Work in the GA."

Each of this new crop of schedules is submitted to the same fitness test, which yields a new set of parents, and the entire process is repeated until either a given number of generations has transpired or the solutions converge—that is, when additional breeding no longer produces offspring that are superior to their parents.

An Imperfect World

It's important to take note that, at least in Moody's case, the GA does not produce a perfect schedule. There are other approaches that can guarantee a mathematically optimal schedule, but they don't guarantee it in any particular time frame. A perfect schedule might take two weeks to compute.

Although SOGA doesn't produce perfect schedules, it does produce good ones, and it spits them out every 10 minutes. "In an academic environment," says Stein, "you need an exact solution. But in a business domain, it's different. If you have a system that doesn't give you perfectly optimal schedules, you are often not concerned—you just want very good schedules."

Maybe, he muses, with a lot of hard work somebody could figure out a more efficient schedule, "but what's the cost of that?," he asks. And because schedules are based on the average time needed to complete a given task, there's no guarantee that a perfect schedule would be any more efficient. And besides, says Stein, it's not enough to schedule all the right tasks at the right time; you've got to keep the users happy, too.

Warm Fuzzies

But what does *happy* mean? It's a hard concept to define precisely, but the real world is full of concepts that are hard to define: *hot*, *fast*, *long*, and *heavy*, to name a few (e.g., Is it hot outside? Is this a fast computer? Is this a hot computer?). The answer to this dilemma is *fuzzy logic*, which deals with such hard-to-define terms and allows things to be, say, somewhat heavy or absolutely not empty.

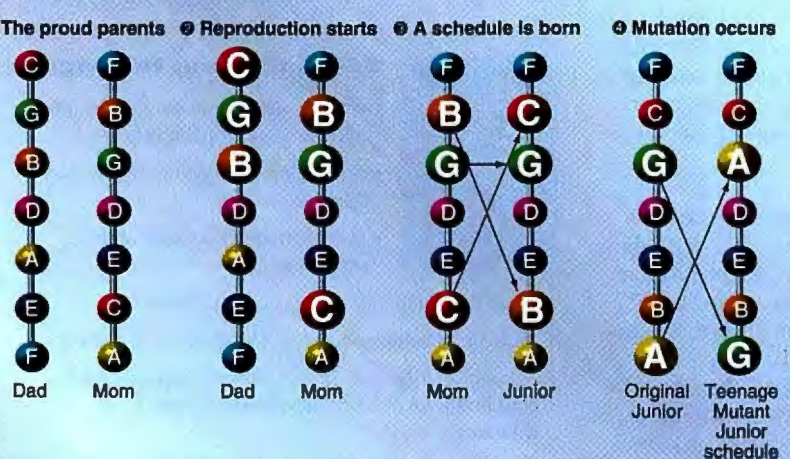
SOGA uses fuzzy logic to define the sketchy idea of user satisfaction in terms of how long a user has been waiting and how much longer he or she must continue to wait before a problem is resolved. In SOGA's framework, a user's satisfaction can fall anywhere on a scale from 1 to 0, where 1 means totally satisfied and 0 is totally dissatisfied. The initial priority given to a task at Moody's is divided or modified by the user's satisfaction so that, as the user becomes less happy, the problem's priority climbs higher. Thus, if a user's satisfaction drops to 0.5, a ticket's priority doubles; should his or her satisfaction drop to 0.1, the ticket's priority increases by an order of magnitude.

As time passes and a Moody's user becomes less satisfied, even tasks that started out with low priorities will rise in the queue. A low-priority software update, for example, can't be put off forever by higher-priority repairs.

A Culture Change

"I was surprised," admits Rich Nelson, Moody's director of technical support, "at the degree to which we fell in love with the visual part of the system." With a terminal program that runs under Windows, the help-desk manager can monitor tickets as they arrive at the help desk, are routed to

Genetics at Work in the GA



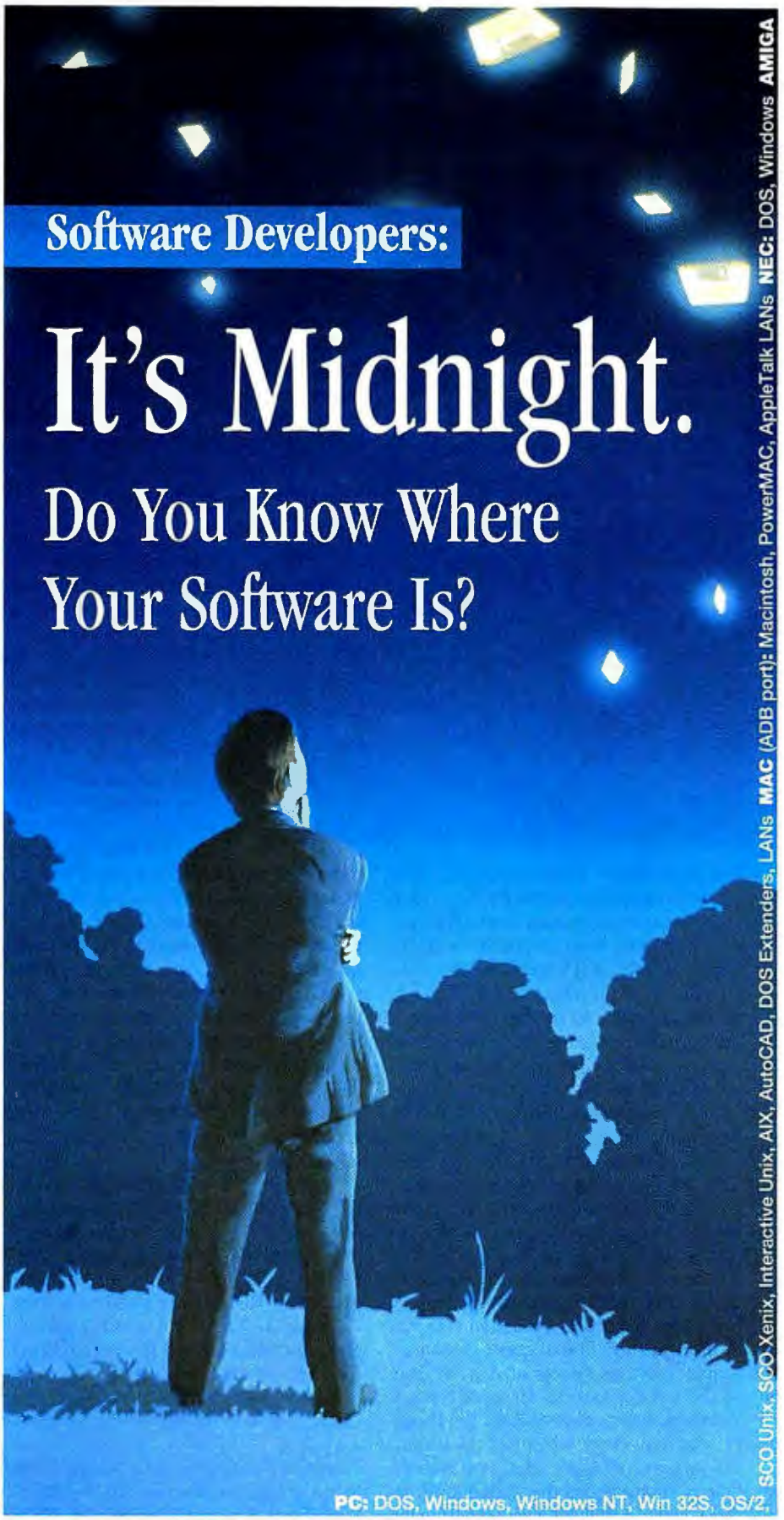
To produce children that differ from their parents, SOGA performs two different operations: crossover and mutation. In a crossover, genetic information is copied from one parent's chromosome to the child's chromosome up to a certain point. After that crossover point, all genetic information comes from the other parent. In SOGA, all genes from both parents are carried over to the child schedule. Only the order of the genes is affected.

For example, suppose the two fittest parent schedules, or chromosomes, are CGBDAEF and FBGDECA—called Dad and Mom, respectively, as shown in ❶. They unite through a crossover operation to create a new child schedule, Junior, which inherits the order of specific genes from both parents.

In ❷, a set of genes—in this case, the first three—are chosen from the Dad schedule. These same genes are selected in the Mom schedule; note that they appear in different places and in a different order within Mom, because Mom and Dad are different.

To create a new schedule, you start with the Mom schedule and then rearrange the order—which starts as B, G, C—of her three selected genes so that they match the order of Dad's first three genes—C, G, B. Note that you do not change the relative position of any other genes ❸. The result is Junior, a new schedule that has characteristics of both its parents.

But there's more to evolution than just sexual reproduction. There's also mutation, as shown in ❹. Here, you create a mutation by selecting any two genes at random within Junior—G and A—and swapping them to create a new, mutant schedule.



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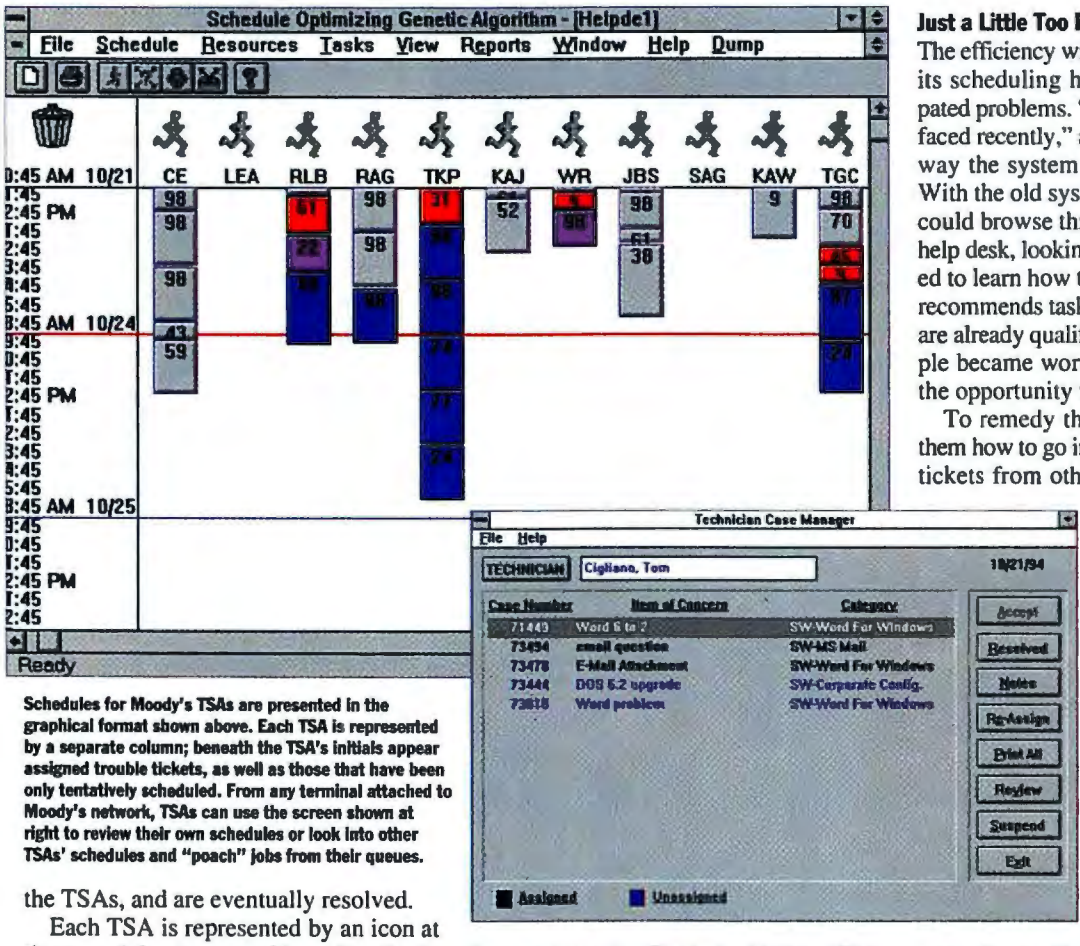

Schedules for Moody's TSAs are presented in the graphical format shown above. Each TSA is represented by a separate column; beneath the TSA's initials appear assigned trouble tickets, as well as those that have been only tentatively scheduled. From any terminal attached to Moody's network, TSAs can use the screen shown at right to review their own schedules or look into other TSAs' schedules and "poach" jobs from their queues.

the TSAs, and are eventually resolved.

Each TSA is represented by an icon at the top of the screen, with a pile of colored tickets beneath it. Each ticket's length represents the average resolution time for that type of problem. At the top of the pile, in gray, are tickets assigned to that individual. The border of the ticket is colored blue, pink, or red. The hotter the color, the hotter the job's priority (i.e., red-bordered tickets are the hottest, followed by pink, then blue). See the screen above.

Underneath these tickets are any currently unassigned tickets that SOGA is recommending for that TSA. Again, a ticket's color, ranging from blue to red, indicates its priority. Clicking on a ticket reveals further details about the job.

Although help-desk personnel never lost many tickets before SOGA's introduction, they now lose even fewer. "One of the surprise benefits of this system," says Nelson, "is the way it lights up the tickets and puts them 'on stage.' We can find tickets now that in the old days would have been dropped, or disappeared, or gone into the 'Twilight Zone.' [SOGA] allows us to find a problem 20 minutes after the ticket is created rather than letting it twitch in the wind for weeks."

Still, the transition to the new system caused some discomfort. At first, some people resisted the idea of taking orders from a computer. To deal with this, TSAs were reminded that although the system recommends that certain individuals accept particular tasks, it doesn't actually assign the jobs. A TSA can accept a ticket, refuse it, throw it back to the help desk, or even assign it to another TSA who is more qualified for the job. "We did not want to create a system that jammed tickets down people's throats," says Nelson.

Some people were uncomfortable with the way in which unassigned tickets jump around in the system. SOGA runs every 10 minutes, building new schedules for all unassigned tasks. A unassigned ticket that appears in one TSA's queue might have appeared in someone else's queue 10 minutes ago, and it might move to yet another queue in another 10 minutes. Once a TSA has accepted a ticket, it is assigned to him or her and stays in that queue, but unassigned tasks might be rerouted at any time.

There was also some degree of concern that the new system represented Big Brother, watching every move that the technical-support staff made. But, says Nelson, "there's nothing that this system tells me that I couldn't find out with a report in the old system. We just want to get tickets out there faster and to make people more productive."

Just a Little Too Perfect

The efficiency with which SOGA performs its scheduling has led to some unanticipated problems. "Some concerns have surfaced recently," admits Nelson, "about the way the system doles out assignments." With the old system, TSAs with free time could browse through paper tickets at the help desk, looking for problems they wanted to learn how to solve. But since SOGA recommends tasks only to technicians who are already qualified to perform them, people became worried that they would lose the opportunity to learn new skills.

To remedy this problem, "we showed them how to go into the system and 'poach' tickets from other people's queues," explains Nelson, "and how to look at all the tickets throughout the system and find those that interest them." Now TSAs can once again stretch and grow. Nelson notes that working only on the problems that you already know how to solve "gets pretty dull and depressing."

By placing networked PCs throughout the building, Moody's allows the TSAs to spend more time with their customers. Instead of having to return to the help desk on the seventh floor, they can simply check in with the nearest networked PC for more assignments. Also, with the new system, everybody on the technical-support staff—not just management—can see when things are going well and when they aren't and can take appropriate steps much sooner. "This system," says Nelson, "gives people a tool to verify that whatever they are working on right now is really the most important problem."

With people's initial fears dispelled and the inevitable shakedown bugs swatted, Moody's SOGA is now being expanded to bring more technical-support personnel on-line. SOGA first came on-line supporting six TSAs. It now builds schedules for about 30 TSAs and is still growing. More technical-support groups are being added all the time.

So what's next? "Probably a bigger machine," Nelson says. ■

Mark Clarkson is a freelance science writer living in Wichita, Kansas. His new book, Windows Hothouse *(Addison-Wesley, 1995), explores genetic algorithms and other artificial-life topics. You can contact him on the Internet or BIX at mclarkson@bix.com.*

Gambling on WAN Services

RICK FLOTT AND LARS POULSEN

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Connecting LAN users in remote sites is often a compromise between performance and recurring communications charges

Until recently, it was difficult to justify the cost of extending a network's reach to small, remote sites. But in the last couple of years, many remote users have turned to dial-up services as their link to the home-office's E-mail and database.

Companies with far-flung satellite offices can use low-cost analog and digital dial-up services, such as the PSTN (Public Switched Telephone Network), Switched 56, and ISDN, to connect two LANs (see the figure "Dial-up Connectivity"). These dial-up services work best where communication between the LANs isn't heavy, because phone charges are typically accrued on a per-usage basis.

Data travels at slower speeds over dial-up lines than traditional leased lines, which typically operate at 56 Kbps or 1.544 Mbps. But for occasional use, such as linking users and remote branch offices to the company LAN, connecting to the Internet, or providing emergency backup paths for back-bone routers, high speeds are not as critical as keeping connection costs to a minimum.

The concept of dial-up is easy to understand. When a modem, router, or similar device intercepts a packet destined for the remote end of the line, the device dials a connection to the remote end and transmits the packet.

PSTN is the most convenient choice for a dial-on-demand connection. It's available everywhere, it's quick and inexpensive to install, and you can use a modem to hook into it.

These modems can use either of the serial-connection protocols, SLIP or PPP, to insure compatibility. PPP is more robust because it includes security options such as passwords and authentication. It also supports more network protocols—you can use SLIP only for remote TCP/IP connections; it doesn't allow NetWare or AppleTalk connections.

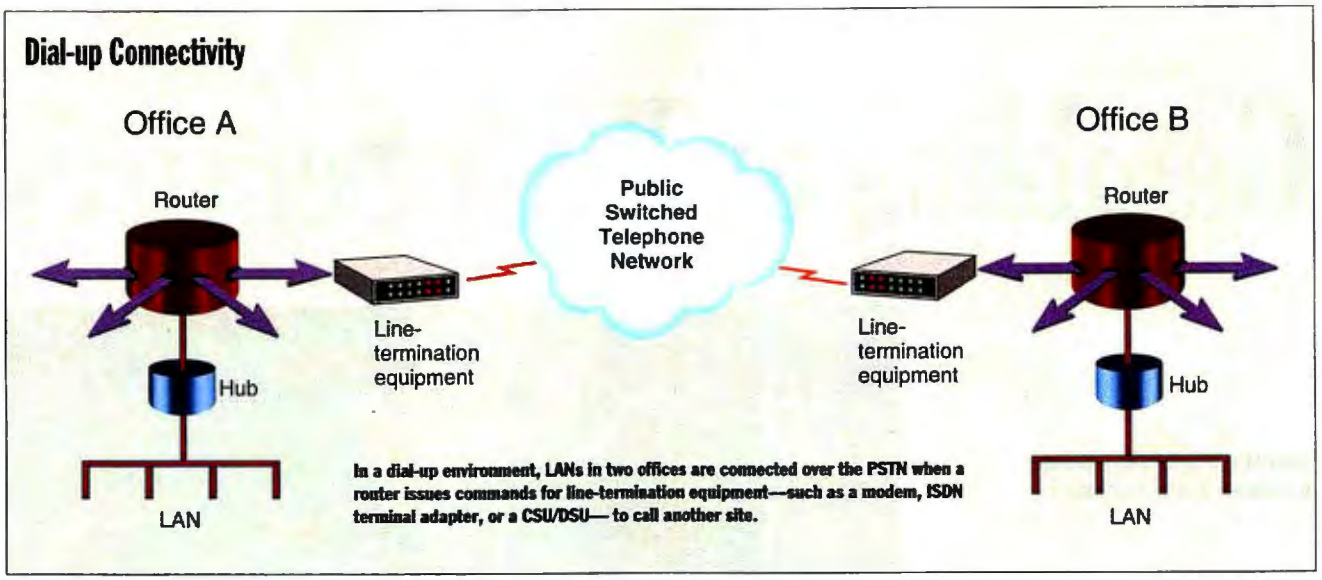
Obviously, modem speed will limit dial-up access over analog lines. Even a 14.4-Kbps modem with 4-to-1 compression is slower than ISDN and Switched 56 service.

Other Low-Speed Options

Depending on the traffic you're sending, it might make more sense to use a low-speed analog leased line. If your connection time is 4 or more hours per day, you might find that leasing a two-wire voice-grade line with a continuous link is less expensive than a dial-up connection.

When selecting a WAN service, corporations often overlook the fact that most telephone companies offer several types of leased analog (two-wire) lines. These services were originally intended for alarm services or specialized voice services.

How can you tell if you can use the service to connect your



LANs? If the particular service will work with an ordinary telephone, which needs battery voltage and ringing to signal the other end, it will work with an ordinary modem.

The most suitable type of leased analog line is the two-way ringdown line, a dedicated voice line that delivers a normal ringing signal whenever the other end goes off the hook. Ringdowns are often used in such applications as airport hotel hotlines—when you take the telephone off the hook at the airport and it rings the phone at the hotel. Of all the voice-grade leased lines, ringdowns are the most trouble-free. In many places, a local ringdown line is offered for less than the cost of two regular business lines.

A leased line with battery voltage and no signaling is designed for remote monitoring purposes and works with Hayes-compatible modems. The telephone company may offer a leased line with no battery or signaling, sometimes called a "dry pair," for a local connection. This type of line will not work with many modems, but you can augment it with a separate ringdown box, thus converting it to an equivalent of the two-way ringdown line.

Stepping Up a Notch

If connectivity between sites requires more bandwidth than an analog line can deliver, one of the digital dial-up services—Switched 56 or ISDN—may be the best solution.

Switched 56 is typically a time-measured business service that local and long-distance telephone companies offer. It provides the 56-Kbps pipe (64 Kbps in Europe) for data to pass through, but you're still charged per call. Also, all local telephone companies don't offer Switched 56 service; it is often not tariffed, and it is often difficult to find telephone-company staff who know how to install, configure, or troubleshoot the service and lines.

ISDN provides the same services as an analog line or a Switched 56 line, but it also handles two calls simultaneously. ISDN calls generally cost the same per minute as calls on an ordinary phone line. Unfortunately, the service is not available everywhere in the U.S.

Because the ISDN tariffs vary widely, it's important to ask questions before ordering the service. If your remote office is close by, the link may qualify as a free local call. In many areas, however, only residences qualify for unmeasured service.

A company may also be able to order both ends of the link as a Centrex group, which is sort of a virtual PBX that the telephone company sets up for you in their central office. Calls between "extensions" in such a group are usually free.

Finding the Right Match

To select the most appropriate type of WAN connection, decide how much you expect to use it, what your minimum performance requirements are, and how much each option should cost. Estimate the online hours you'll log in a typical month, and calculate the total costs for a year of service, including the phone company's installation charges.

You've also got to consider the cost of termination equipment—a modem for analog lines, an ISDN terminal adapter for dial-up ISDN links, or a CSU/DSU (channel service unit/data service unit) for leased or

ESTIMATING FIRST-YEAR CHARGES FOR CONNECTIVITY

These comparison costs are based on typical tariffs for each service. Usage includes exchanging E-mail, transferring files, and accessing applications running on host computers or servers at another site. Note that the yearly cost for a dedicated leased line is actually less than for a switched line ($3000 vs. $3738, respectively).

	RINGDOWN	ANALOG	DDS-1	SW56	ISDN
Installation	$150	$100	$1000	$1000	$390
Interface equipment[1]	N/A	$300	$800	$1400	$1990
Total capital[2]	**$150**	**$400**	**$1800**	**$2400**	**$2380**
Performance (Kbps)	28.8	28.8	56/64	56/64	128
Throughput (Kbps)	57.6	57.6	112/128	112/128	256
Monthy usage charge x 12 months	$420	$360	$1200	$900	$936
Minutes of connect time per day	N/A	180	N/A	90	45
Per call charges	N/A	$657	N/A	$438	$657
Total[3]	**$420**	**$1017**	**$1200**	**$1338**	**$1593**
Cost per kilobit	$7.29	$17.66	$10.71/$9.38	$11.95/$10.45	$6.22

[1] Many vendors integrate modems and terminal adapters into their bridging/routing equipment.
[2] Total required to start using the service.
[3] Annual expenses after installation.

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dial-up digital lines (see the text box "Terminating Digital Lines").

The first-year costs for using different services to connect two sites two miles apart can range from about $570 for a ring-down analog link to about $4000 for a Switched 56 link (see the table "Estimating First-Year Charges for Connectivity" on the previous page).

While local calls are always less expensive than long-distance calls, shorter distances are not always less expensive than longer distances. In fact, the most expensive long-distance calls are those in the 20- to 50-mile range, which are non-local, but still subject to a local telephone monopoly (technically called intra-LATA long-distance calls).

Naturally, selecting a service will depend on the volume of traffic sent between sites. And as the table illustrates, the average cost per kilobit varies from a low of $6.22 per kilobit with ISDN service to $17.66 per kilobit when using an analog dial-up line.

However, cost alone should not determine which service to use. You also need to consider how the volume of traffic is distributed over the course of a typical day and the initial cost of using a service (the one-time installation charge for the line and the cost for interface equipment, such as a modem, ISDN terminal adapter, or CSU/DSU).

For example, in many retail store environments, LAN-attached point-of-sale cash registers update an on-site inventory database as sales are made during business hours. Once the store is closed for the day, all the inventory data pertinent to that day's sales are uploaded to a centralized host computer. An analog modem hook up, though more expensive per kilobit, might be a good solution in this case, because it saves installation charges.

"To minimize your dial-up access charges, you've got to minimize the time you spend on-line. You'll want to make fewer connections and keep those that you do make short."

Making the Best Use of Dial-up Internetworking

To minimize your dial-up access charges, you've got to minimize the time you spend on-line. You'll want to make fewer connections and keep those that you do make short.

Select software and hardware that use the dial-up connection intelligently. For example, some E-mail programs can store messages and forward them later, so you can send several messages at once.

A client/server-style application that allows users to work locally, and once the work is completed connects and sends the updated information to the remote server, will also cut your connect time.

Bandwidth-saving features, such as data compression, will also help limit the time on-line. Look for internetworking products that perform spoofing and link optimization techniques that can keep nonessential traffic off the lines. These techniques are essential in NetWare environments in which the remote ends constantly poll each other for status information. When unlimited, this constant polling can significantly increase line charges.

When You Need More Bandwidth

Dial-up and analog technologies are meant for low-volume, noncritical applications such as E-mail, file transfer, remote log-in, and client/server database access. When the network use grows so much that the disadvantages of dial-up technologies become intolerable, network administrators have few low-cost WAN service alternatives.

This will force a manager to choose one of the higher-priced services; here, direct comparisons are hard to make because tariffs vary greatly or are not available.

For example, a four-wire leased line (i.e., a 56-Kb DDS leased line), costs about the same as dial-up service, but pricing is mileage-sensitive. In some cases, a DDS line is as expensive as a T1 line, but generally T1 is more expensive, with installation and monthly charges running as much as six to ten times that of a DDS service.

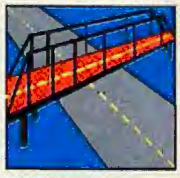
Frame relay, a technology based on the X.25 protocol with error checking removed to enhance performance, operates between 56 Kbps and 512 Kbps. In many places, its price makes it an attractive way to connect sites. However, frame relay is not yet widely deployed.

ATM-precursor SMDS (Switched Multimegabit Data Service), available at speeds ranging from 56 Kbps to 10 Mbps, is also not widely tariffed. And ATM, for all practical purposes, has been adopted only by large customers.

All these factors can make for some difficult connectivity choices. It can be tough to estimate communications charges for many of these newer services, because there are no tariffs on them yet. There is hope, however. Economically priced dial-up services can adequately handle the bandwidth requirements to link sites for many companies. ■

Rick Flott and Lars Poulsen are both senior members of the technical staff at Rockwell Network Systems. You can reach them on BIX c/o "editors."

Terminating Digital Lines



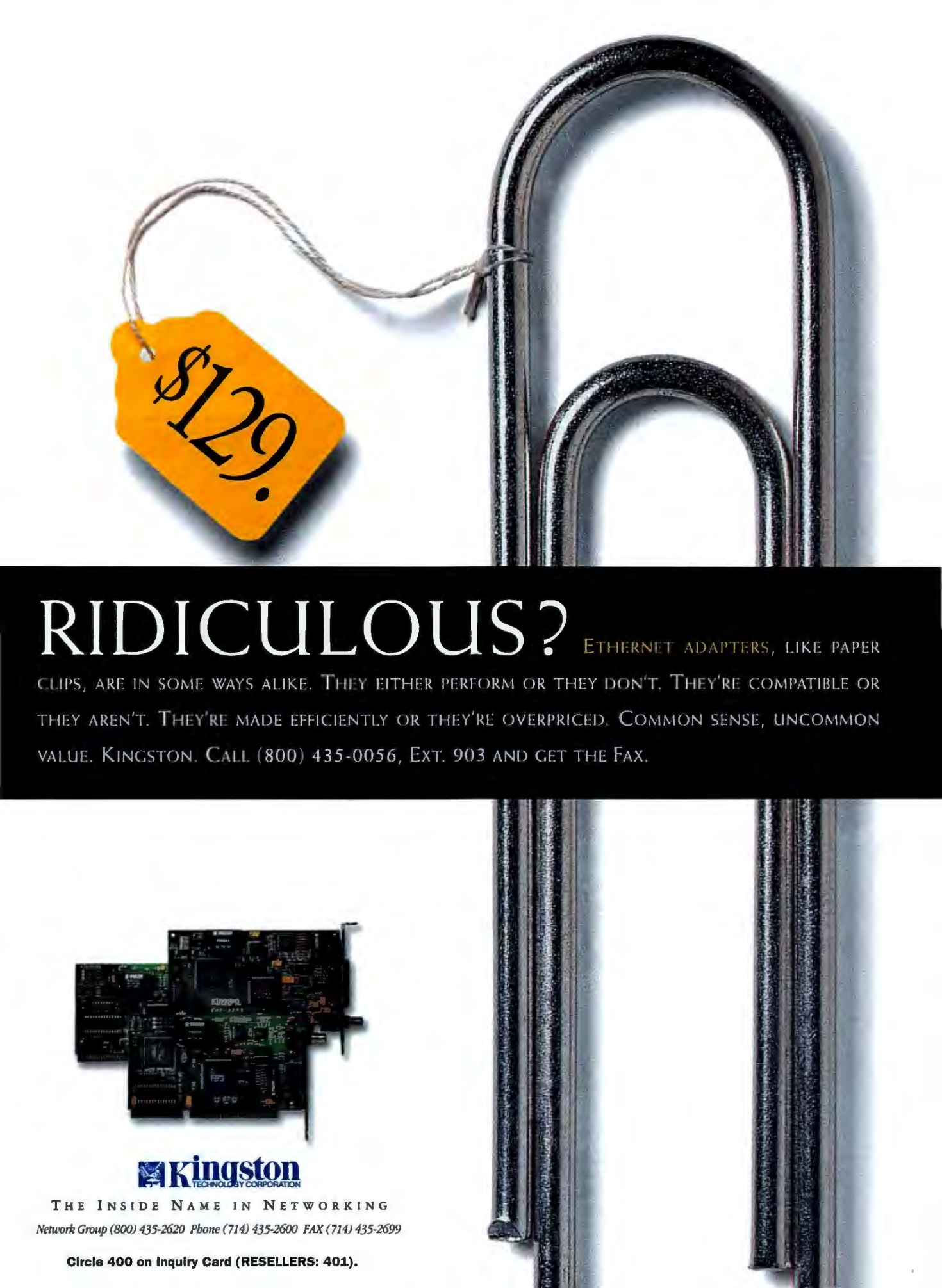
Most people know how modems work, but not many managers are familiar with the termination equipment used with digital lines.

Instead of terminating a line into a modem, CSU/DSUs, often called "digital modems," are the adapters used to link bridges and routers to DDS or Switched 56 leased lines. A DSU for Switched 56 is more expensive than a DSU for DDS leased lines. CSU/DSUs are a commodity, so look for a good price (the average is about $500).

Typical features of CSU/DSUs include terminal interface options (RS-232 or V.35), status-indicator lights, push buttons for line loopback and testing, and multiple data rates (important if you are supporting slower terminals).

TAs (terminal adapters) are the data service units for ISDN. Usually, the same companies that make CSU/DSUs make TAs, so you can make calls back and forth between ISDN TAs and Switched 56 CSU/DSUs.

Most TAs have configurable modes, such as synchronous/asynchronous, automatic dialing to a preprogrammed number, or terminal-controlled dialing using either the ATDT-style modem command set or the V.25bis synchronous dialing method. Synchronous TAs range in price from $600 to $1000.



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STEPHEN COBB

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Today it's a generally accepted notion that the client/server paradigm is not just logical. It also makes good business sense, offering flexibility, scalability, cost reduction, and superior productivity, all of which are vital in today's volatile economic climate. The problem, however, is that this view of the world is object-based and has proved to be more aesthetically pleasing than practically implemented.

Still, it has much to offer. Rather than coding each application from the ground up, recompiling for different platforms, and hard-wiring connections to remote databases, developers are working with objects that are prebuilt, reusable, portable, and scalable. Applications are therefore quicker to build, easier to maintain and expand, and, because they often use code that has already been debugged, inherently more reliable.

However, a number of problems remain. When vendors talk about offering cross-platform, object-oriented development tools, for instance, they often mean that these products simply allow you to develop applications that will run on Macintoshes as well as on Intel-based PCs.

Developers are finding they need better communications between objects when distributing applications beyond the LAN environment

But that's no longer enough. While the client/server paradigm has its roots in humble file and printer sharing on desktop networks, it now extends to midrange machines. Some of these systems must act as clients of mainframes, as servers for networked PCs, and as mainframes themselves, some of which have found a brand new role as network superservers.

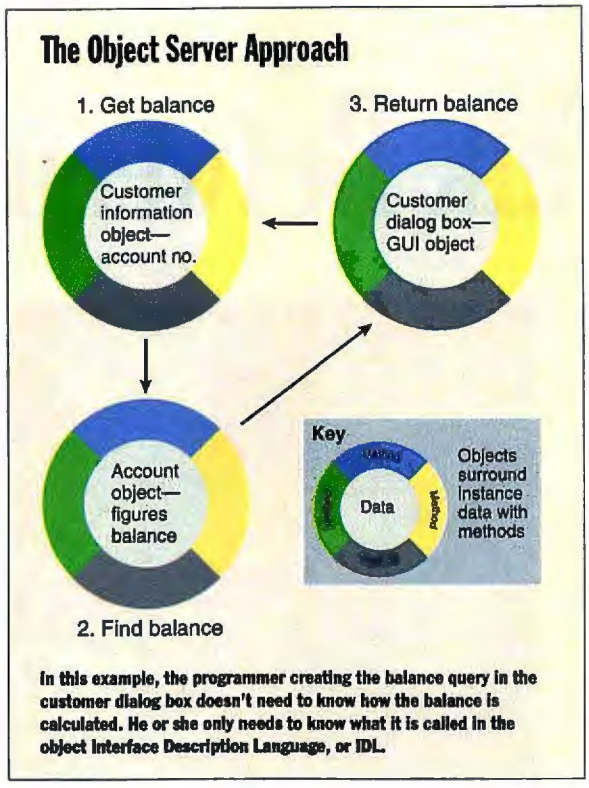
As the client/server paradigm evolves from a departmental-LAN level—where it has been implemented quite successfully—to the enterprise level, the risks and required investment of resources are far greater. Therefore, corporate management is often, understandably, reluctant to try a new paradigm.

There are other good reasons for this reluctance. At this level, serious obstacles confront applications developers in three areas: when they break out into the heterogeneous world of multiple network operating systems, when they attempt to give the desktop full read-and-write participation in mission-critical data processing, and when they attempt to enrich legacy applications with desktop data.

The key to successfully getting past these obstacles is developing ways for client and server objects in a distributed application to communicate. But this is an enormous task when you consider that a client can be anything from a hand-held device with limited memory and processing power to a Pentium-based PC or a RISC-based workstation, and a server can be anything from a PC running NetWare to an IBM mainframe.

continued

With such a vast range of platforms and associated operating systems to cover, vendors have sliced up the market and are going after particular segments of this object-based applications development field from different perspectives. For example, behind the OLE banner, Microsoft is staking out territory well beyond the desktop using the COM (Common Object Model) standard that it co-developed with DEC. Meanwhile, heading toward the desktop from the mainframe-oriented SNA (Systems Network Architecture) standard is IBM's DSOM (Distributed System Object Model). And somewhere in between are the OSF's (Open Software Foundation's) DCE (Distributed Computing Environment) standard and the OMG's (Object Management Group's) CORBA (Common Object Request Broker Architecture) standard.



In this example, the programmer creating the balance query in the customer dialog box doesn't need to know how the balance is calculated. He or she only needs to know what it is called in the object Interface Description Language, or IDL.

At the departmental-LAN development level, objects seem to be working well. Tools such as Microsoft's Visual Basic have brought a new ease of use to object-oriented applications development. At the C++ level, there are visually oriented versions of object-based software from Borland, Microsoft, Symantec, and others. In fact, rapid coding is now a realistic prospect with tools and resources such as Borland's ObjectBrowser and Object Windows Library. Thanks to Microsoft's OLE, even end users are becoming familiar with the benefits of objects and are creating compound documents that seamlessly integrate information supplied by multiple applications from different vendors.

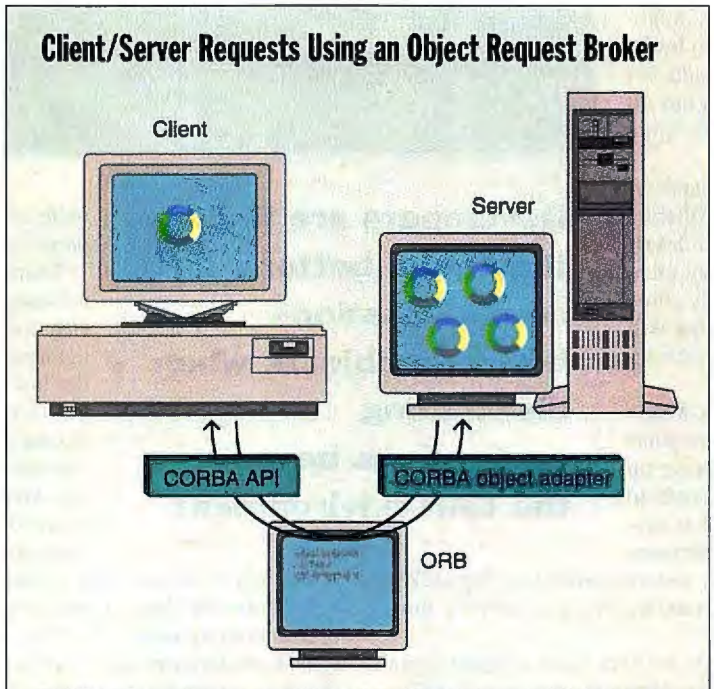
But it is at a much higher level of abstraction that the real object-based revolution is taking place, in products such as Easel's Object Studio, IBM's SOMobjects, Iona's Orbix (more on this later), Next's NextStep, Taligent's Framework, and Unifaces' UnifaceSix. These products vary greatly with respect to the environments that they run in, but they all share the goal of defining objects as much more than chunks of reusable code. In these high-level approaches, objects are free from rigid database structures and platform constraints and are able to reside anywhere on a network, thus facilitating interoperability, scaling, replication, and other performance and integrity enhancements.

Of course, these advantages can be realized only if objects can communicate with each other. And there's the catch: Some forms of communication, such as the use of RPCs (remote procedure calls), are traditionally established early in the applications development cycle. This is unfortunate, because it obviates much of the flexibility necessary for successfully deploying applications.

For this reason, objects in high-level approaches are designed to communicate by sending messages that contain two pieces of information: an *object identifier*, which explains which object is to receive the message, and the message itself, which tells the receiving object which procedures to invoke. Thus, a network-based name server can enable objects to dynamically locate other objects within the network and then determine the appropriate object to send a message to. By going beyond the traditional methods of exchanging requests between clients and servers, this approach makes distributing data and parts of an application easier.

Evolving Object Communications

During the development of distributed client/server applications, many levels of object communications have to be considered. At the simplest level, clients request file records by using a series of message exchanges. In a more sophisticated scenario, clients pass SQL requests as messages to a database server.



An ORB locates a suitable server object, delivers the invocation, and then passes the results back to the client object.

These two approaches are the most common methods used in today's LAN-based applications. However, when trying to create applications that stretch across multiple operating systems and server types, developers must use other methods.

One commonly used alternative method, which is often called the *transaction server* approach, has the client communicating with the server using an RPC. The RPC can invoke procedures that reside on a server and execute a group of SQL statements. The network exchange thus consists of a single request or reply for a group of queries. That's in contrast to the typical database-server approach, where there is one request or reply for each SQL statement.

The grouped SQL statements in an RPC approach

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are called *transactions*. Programs that use them are known as *OLTP* (on-line transaction processing) applications. An example of such an application is a customer-balance inquiry at a bank.

Another alternative client/server method, which is typified by Lotus Notes, is sometimes referred to as *workgroup information*. In this approach, information contained in such items as documents, messages, mail, and images is exchanged.

Yet another alternative approach, called the *object server* method, has the potential to deal with both OLTP applications and workgroup information. That's because both data and methods are encapsulated as objects with communications capabilities (see the figure "The Object Server Approach" on page 80DM 8). In fact, objects can act as both clients and servers in this method, communicating with each other by means of an ORB (object request broker).

With ORBs, a client object invokes a method supported by a server object (without necessarily being aware of where, or even what, that object is). The role of the ORB is to locate a suitable server object, deliver the invocation, and then pass the results back to the client object (see the figure "Client/Server Requests Using an Object Request Broker" on page 80DM 8).

The use of objects gives developers more flexibility. For instance, it means that company officials do not have to make decisions about the relative merits of IPX versus IP at the same time that they are deciding where customer data will be stored and what the data-entry form for new accounts will look like.

The Slash in Client/Server

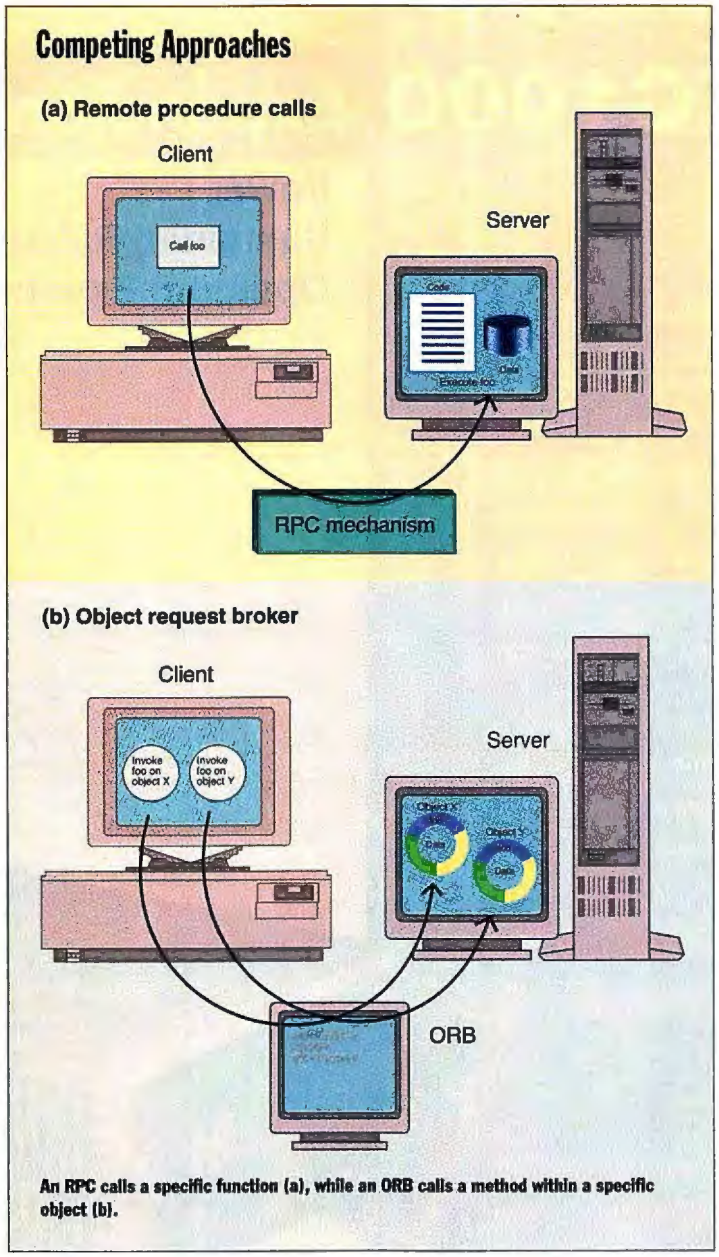
While the use of objects eliminates some of the obstacles to distributed client/server applications development, low-level issues still exist. But they are increasingly being settled by the use of *middleware*. Middleware is sometimes described as "the slash in client/server"; in other words, it acts as the glue that holds the entire process together.

Middleware comes in various flavors and has been appropriated for a wide variety of offerings. For example, ORB technology, which handles communications between objects, has been described as the mother of all middleware. That's because an ORB intercepts and delivers client calls that invoke methods residing in server objects and then returns the response to the client object. While this sounds a lot like a conventional RPC, it isn't, because an RPC calls a specific function, which is separate from the data.

Instead, an ORB calls a method within a specific object. Since objects are polymorphic, different object classes might respond differently, yet appropriately, to the same invocation. For example, accounting objects might all respond correctly to a balance request, even though balances are calculated differently for different types of accounts. Since each object manages its own data, the method is executed on the data specific to that object (see the figure "Competing Approaches").

The use of ORBs is clearly a cleaner and more precise mechanism than the use of RPCs, but, ironically, it sometimes has to subsume the network aspects of typical RPC programming to carry its messages. Although this adds an extra layer of complexity to the system, it can be dealt with independently of the application, so its flexibility and productivity benefits probably outweigh any performance penalties.

Below the ORB and RPC are the more basic forms of middleware. These include the transport layer of communications stacks. Because objects are implemented above this layer, object-based applications can take advantage of middleware that offers portability and interoperability. That includes DCE, which, after years of delay, is finally appearing in serious offerings from major vendors. One such vendor is IBM, whose Networking Products Division also offers a range of AnyNet middleware products for mixing protocols across platforms.



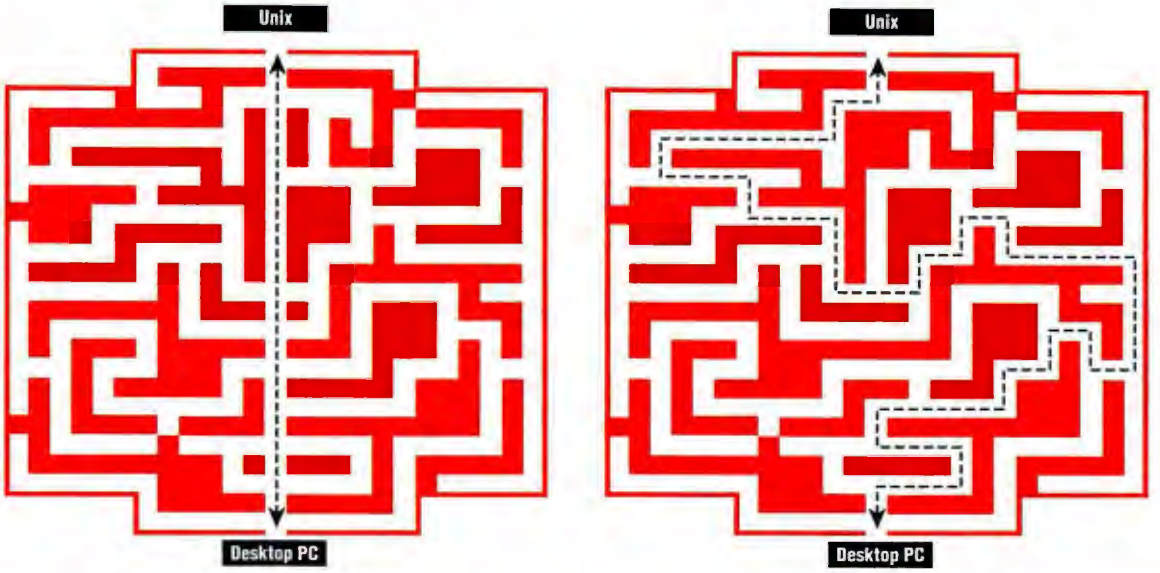
An RPC calls a specific function (a), while an ORB calls a method within a specific object (b).

Moving Forward

While skeptics still have their doubts about whether object-based applications can ever rise to the challenge of OLTP, the OMG is well on its way toward establishing the necessary Object Transaction Service standard that will make such applications possible.

For example, there have recently been some interesting developments concerning the aforementioned Orbix, a CORBA-compliant ORB developed by Dublin-based Iona Technologies, one of the key participants in the OMG. Iona is developing fault-tolerant capabilities in conjunction with Isis Distributed Systems (Ithaca, NY). Iona is also working with

Desktop-To-Unix Network Integration?



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Novell's Tuxedo standard to develop the distributed two-phase commit protocol necessary for serious OLTP applications. This protocol synchronizes updates distributed across numerous machines so that they either succeed, or are rolled back, in unison.

At the other end of the scale, Microsoft has been pushing its own idea of object orientation: OLE within the context of COM (Component Object Model). While nobody seems to have a clear idea of how Microsoft will resolve the communications demands that will result from an enterprise-wide implementation of OLE, the company has, according to Dave Seres, OLE marketing manager, "poured a ton of resources into this." And Microsoft is also planning its object strategy to cope with communications beyond the enterprise, although it's unclear at this point how much cooperation from other vendors this will require.

Understandably, Microsoft would like both the servers and the clients to be running its operating system and, according to Annrai O'Toole, vice president in charge of development at Iona, "Microsoft may have little need for the interoperability provided by something like CORBA." John Rymer, of the Patricia Seybold Group (Boston, MA), observes that, in the past, "the market has shown a surprising willingness to wait for Microsoft to develop solutions, even if they don't really deliver until version 3." Nevertheless, Microsoft has recently been quite active in the OMG, talking about developing links between COM and CORBA and thus raising the possibility of yet more middleware.

The question for developers and network managers is this: Will a network grind to a halt under the weight of all this middleware? Probably not. As a general rule, hardware evolves faster than software does. For instance, networking technologies that allow more bandwidth to be delivered to the desktop, such as switched Ethernet, ATM (Asynchronous Transfer Mode), and FDDI (Fiber Distributed Data Interface), are dropping in price.

The situation is also improving on the client side of the network-hardware equation. While a great deal of attention has recently been focused on the server side, client hardware standards have been rising as well. It's unlikely that desktop clients will choke on their part of the middleware workload.

The vast majority of desktop machines sold over the past two years are 486-based, which means there's enormous room for growth, particularly in terms of memory. In addition, a significant proportion of these machines have some kind of 32-bit bus. Thus, the next wave of network traffic is unlikely to run up against the architectural constraints that killed off the 286.

Finally, a decade after IBM introduced the 286, it can be said with some confidence that we now have the technology to enable applications to be distributed beyond the LAN—all the way to the mainframe and back if we so desire. It is hoped that the exploitation of this technology will be delivered by a vendor community firmly committed to standards-based object communications, such as those developed by the OMG, rather than by a dominant, proprietary architecture that returns us to the inflexible days of single-vendor solutions. ■

Stephen Cobb is the author of many books and articles about hardware and software and is a technology analyst with the National Computer Security Association (Carlisle, PA). He can be reached on the Internet at cobb@iu.net, on CompuServe at 72662,546, or on BIX c/o "editors."

Is Success Spelled C-N-E?

SUSAN FARRAR

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Jane, the network manager next door, tells you she gave her notice this morning. After congratulating her on her new position, you rush down to Human Resources to submit your application for her position. After all, you've been working on LANs for 10 years, configuring operating systems, and installing hubs and cabling. You even spearheaded the Internet access project. You were really surprised when you found out that you weren't qualified to apply because you haven't been certified.

Increasingly, experienced networking professionals are finding that they are being locked out of jobs and cannot be promoted simply because they have not passed a series of networking technology exams that Novell deems to be important. In other words, they have not become CNEs (Certified Novell Engineers).

Experienced networking professionals have started to raise questions about the role of certification

Novell Certification

Many experienced network technicians argue that CNE classes can be completed without any practical experience, thus generating a graduating class of "paper CNEs." Novell disagrees. It believes the training certifies a baseline level of knowledge about NetWare. Thus, an employer can be sure of an employee's basic competence. "Completion of the program assures that students can install and service Novell products," says Carolyn Rose, vice president and general manager of Novell Education. "Novell surveys employers on what are the competencies they require of their network managers and then builds those competencies into course objectives."

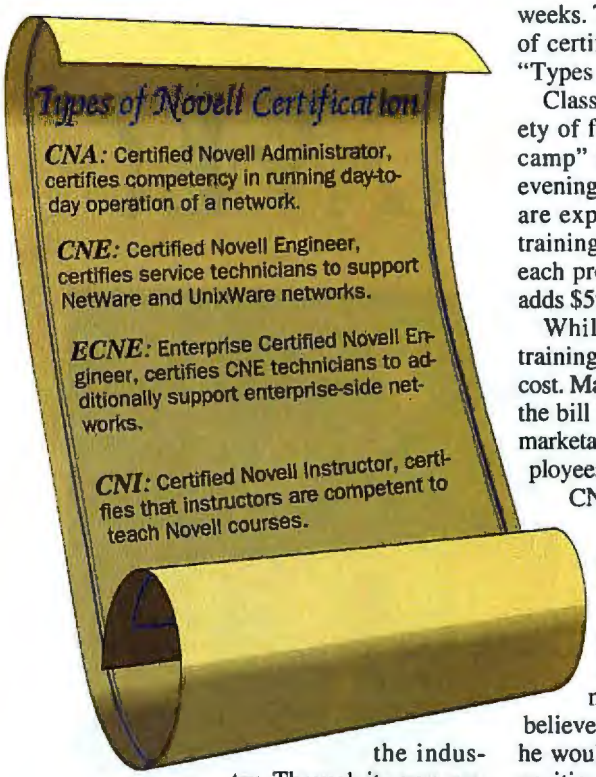
While this may seem like an age-old battle of practical experience versus having a degree, it goes beyond that. Requiring a CNE is now common with employers. They believe it provides a measure of the qualifications of network technicians.

Novell began marketing the CNE program in April 1989 because of two problems. First, it had a large number of resellers and independent consultants supporting NetWare. The technical expertise in installing and supporting NetWare varied widely among these people. In response, Novell required resellers to have a CNE on their staff to ensure that the product performed well for their customers.

Second, Novell believed it could not adequately provide in-house support for its products, considering its large sales volume. The company reasoned that by requiring certification, this would let it move direct support to the reseller, who could charge for that service.

For these reasons, the CNE program has been successful for both Novell and technicians. In the early days, technicians with this certification were paid substantially better than their uncertified counterparts.

For the most part, the CNE program has been well received by



the industry. Through its own surveys, Novell finds that 80 percent of CNEs say they would repeat the training. And over 95 percent of managers surveyed by Novell say the training of their employees has been helpful, according to Rose.

With satisfaction levels like that, it's not surprising that the program has been a success. Currently, there are about 50,000 CNEs worldwide, and an additional 60,000 students are working on their certification, according to Novell. Considering that Novell anticipates selling about 300,000 new licenses this year, the continuing need for competent network managers seems to be assured.

However, criticisms of the CNE program abound. These come from vendors, customers, and students over issues such as training costs, tests, and the nature of proprietary training in general.

Getting With the Program

CNE training involves the completion of a core curriculum and course electives covering installation, operation, and troubleshooting of Novell products (see "The Right Stuff on page 80DM 16). The student must then pass a proficiency exam for each course, completing all the exams within one year.

Students must complete courses and proficiency exams in seven areas. The most popular method of instruction is classroom training. It is also the most efficient method of study because instruction can be completed in as little as a few weeks. The CNE is only one of the levels of certification Novell has to offer (see "Types of Novell Certification").

Classroom training is offered in a variety of formats, from an intensive "boot camp" to a series of sequential day or evening classes. The training and exams are expensive. The cost for classroom training can exceed $5500. In addition, each proficiency exam costs $85, which adds $595 to the cost of obtaining a CNE.

While some companies pay for this training, the student usually absorbs the cost. Many employers are reluctant to foot the bill because the CNE credential is so marketable. Companies often find that employees leave shortly after acquiring their CNE to obtain a better position.

The certification is most appealing to those just embarking on a networking career. "How else would someone just starting get a foothold in the business?," asks Jerold Kiedrowski, a student at a midwestern university. Kiedrowski believes that without the CNE credential, he would be unable to get a networking position. Also, by studying for the CNE while in college, he will be able to bypass an entry-level networking position when he graduates.

Experienced network technicians are also pursuing this credential, usually when they wish to widen their employment opportunities. As noted earlier, many employers are requiring the CNE credential, using it to differentiate among the candidates applying for positions.

For these professionals, classroom training is often not a practical solution—they do not have the time to spend away from their jobs. They also may not want to spend the money for the formal training because they typically know the technology.

Exam Time

If that's the case, you may ask, why not just take the exams and be done with it? Like certification in other professions—the bar exam for law students, for example—a person may know more than enough to do the job but may not be able to pass a written test on every aspect of the job. A network administrator may be proficient on NetWare but not on UnixWare, and thus might not be able to complete the CNE.

Additionally, there has been a substantial evolution in the nature of the exams. The new *adaptive tests* use a sample of 10 to 20 questions for each proficiency, selecting the questions from a large database. The adaptive test "adapts" to the response of the student. If the student answers a question correctly, the next question is more difficult; if the answer is incorrect, the next question is easier. These exams are able to rank comprehension as

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FLASHD.ZIP: DOS-based shareware CNE flash-card practice for NetWare 3.11 administration exam.

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JSENOTES.ZIP: Study notes for several CNE-related courses. These are authored by Jay Elvove of the University of Maryland.

NETTECH.WP: Study notes for Chapters 15–29 of Novell's Networking Technologies course in WordPerfect 5.1, authored by Tom Foley of the University of Maryland.

NETEST.ZIP: Demonstration module of NETest for the DOS/Micro Hardware practice test, a DOS-based suite of CNE practice tests published by KP Enterprises ($49.95).

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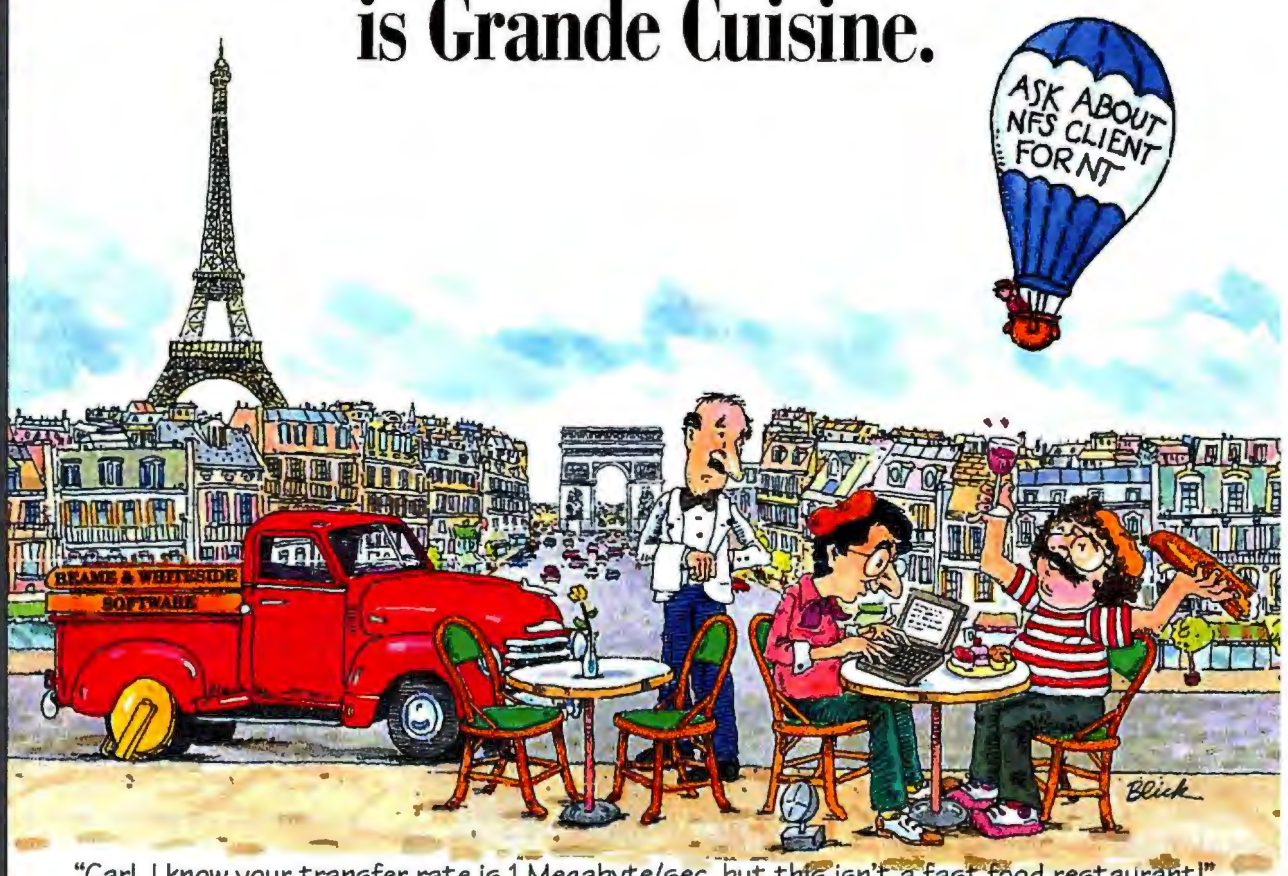

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well as the old 100-question "form" exams did.

Experienced network technicians complain that even with years of experience, they could not have passed the exams without the training. Many believe that the questions are not representative of the type of knowledge field technicians normally require.

For experienced networking professionals who simply need to prep for the exams, there are alternatives to classroom training. Novell offers self-paced training manuals at about half the cost of its classroom instruction. Wave Technology offers a CNE self-study program containing a study guide, videos, and computer-based tests for 11 of the CNE courses for $1995. Many students use reference books to study for the proficiency tests (see "Self-Study Books").

Recently, several computer-based shareware and freeware training options have appeared. These can be downloaded from a variety of Internet sites (see "Computer-Based Training Options" on page 80DM 14). Although this substantially reduces the cost of the training, students assert that these alternative modes of training increase the number of hours they must commit to training compared to traditional classroom training.

Alternate Credentials

Another issue in the debate over the role of the CNE is the relevance of being certified on a single network operating system. Many networking professionals now work in a mixed operating-system environment. This issue is sure to become more important because of the growing use of Unix and Windows NT.

Recently, Microsoft has entered the fray with its networking certification program, the CSE (Certified Systems Engineer). This program certifies students in Windows, Windows NT, and Windows NT Advanced Server. Microsoft is seeking converts from the CNE program by offering a fast track for CNEs.

A program called the A+ Certification is being developed by an industry consortium that includes Apple, Compaq, Epson America, Intel, and the Computing Technology in Industry Association. This program certifies the competency of individuals in the microcomputer industry and is aimed primarily at service technicians. The testing covers a broad range of hardware and software technologies that are not related to a specific vendor's products.

If these other programs gain the same level of acceptance as the CNE, managers may need a string of letters after their name just to be promoted or to seek a job elsewhere. For many, this will not be possible. Most managers would not have the time to earn multiple certifications. Also, the cost associated with earning the certifications would be excessive.

Still, some people will seek multiple certifications because they'll rightly believe it will make them more employable. Too often, because they lack any better gauge of a technician's skills, employers will turn to an industry's standard measure of proficiency. Today, that usually means having a CNE. If Windows NT takes off, managers might also need a CSE.

Are employers being too demanding? Or do they just lack a way to measure an employee's competency? For the most part, it's not this way for other managers in a corporation. Most managers get an advanced business degree, usually an MBA, and that's that. Why should it be different for networking professionals?

One reason for the growing number of certifications is that there is virtually no equivalent of a networking degree offered by universities. Typical of most schools, the University of Texas-Dallas (UT-D) offers some undergraduate courses related to data communications and networking in the computer science curriculum. It also offers a graduate program in computer networks, but it deals with fundamental networking concepts.

Dr. Hal Sudborough, who is a professor at UT-D, says that this program is geared toward educating students so they'll be able to develop network applications. He also says that the students who go on to jobs managing networks must gain technical expertise about an operating system through vendor channels.

The industry needs a tool for recognizing the skills that computer professionals bring to their jobs. This tool needs to be broad-based and not vendor-specific, because most environments are heterogeneous. Colleges and universities are not likely to be the source of this certification; their goal is to impart general, concept-oriented knowledge. Also, rapid changes in the marketplace make it difficult for educational institutions to keep pace.

Therefore, it is more appropriate that industry groups develop the tools for assessing and recognizing networking skills. However, if vendors get into certification wars, network managers will be the losers. They will not only have to determine whether it is necessary to get a certification for career advancement, they may also have to guess which certification will be required by future employers. ■

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Susan Farrar is director of academic computing at Collin County Community College in Plano, Texas. She can be reached on the Internet at sfarrar@fs7host.ccccd.edu or on BIX c/o "editors."


Does the P5-100XL cause a family feud?
Will the P5-75 Family PC come between Julia and Trevor?
As the Hard Drive Turns
Sponsored by
GATEWAY2000
Will Simone try to make the 4DX2-66 vanish with wrinkle cream?

**Furs pictured are made from artificial materials.*

Setting: Lawyer's Office

Characters:
Jonathan Mattison: Lawyer
Kiki: Young widow of the deceased
Anna: Evil daughter of the deceased
Richard: Anna's wimpy husband
Victor: The deceased

Featured Gateway 2000 PC: P5-100XL with 1GB hard drive, quad-speed CD-ROM and 17" Vivitron color monitor.

We now resume our story already in progress. Victor's family has gathered for the reading of his will. While vacationing on the island of Maltase with his lovely bride Kiki, Victor slipped on the rocks and plummeted over a cliff. His body never found, Anna, Victor's power-hungry daughter, greedily bribed Mattison to read the will.

Anna: Could we get on with it? I have a 1 o'clock appointment with my plastic surgeon and I don't intend to be late.

Mr. Mattison reads the will: "I, Victor Robinson, being of sound mind and body, do hereby bequeath my Gateway 2000® P5-100XL to a woman who is very close to me. This PC's super-powered Pentium™ processor, 16MB of RAM, quad-speed CD-ROM and whopping 1GB hard drive have served me well. I successfully kept two sets of books for the sawmill with this powerful PC. With Microsoft® PowerPoint® presentation graphics program, just one of the applications in Microsoft Office Professional, and the 17-inch Vivitron™ color monitor, I created amazing slide show presentations and lured many investors into my business schemes. Because the P5-100XL is my most prized possession, it's my request that it be given to my young and spirited wife Kiki. I know she loves to dance to the heart-pounding stereo sound from the ACS-31 speakers. Kiki, at $4,299 the P5-100XL from Gateway 2000 is the best value in the PC industry. Please treat it well."

Anna: What?! I was supposed to get that system. Not that child! I've had my eyes on that P5-100XL since the day Daddy ordered it from Gateway 2000. It's Intel® 100MHz Pentium™ processor is the fastest processor available today that can still run the most popular software applications. It should be mine, not that little gold digger's! Richard! Don't be a spineless jellyfish! Make them give me the PC!

Mattison: Oh, wait Anna, here's something for you. "To my dear Anna, I leave my Yorkshire terrier, Fifi. Remember, it's a dog's life."

Anna: AAAUUUGGGHHHH!

Fifi: Ruff.

Join us next month for "As The Hard Drive Turns." Will Anna seek revenge against Kiki? Will Anna and Fifi be compatible?

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intel inside
Pentium
IDE

Setting: Collapsed Office Building

Characters:
Julia: Successful Realtor
Trevor: Sexy construction worker

Featured
Gateway 2000 PC:
The P5-75 Family PC multimedia system with 16-bit sound card and Altec speakers, TelePath II 14.4K fax/modem and six exciting Microsoft software applications.

Trevor met Julia every afternoon in her office. Since she's married to the contractor who oversees Trevor's construction crew, it's the only way they can continue their torrid affair. But now they are trapped in her collapsed office after Mt. Eruptus exploded into a volcano causing an earthquake measuring 7.1 on the Richter scale.

Julia: Oh, Trevor, what are we going to do. I can't die! I just spent thousands of dollars on fertility treatments so we can conceive our love child after my fortieth birthday party tonight!

Trevor: Let me get this tourniquet on my severely broken arm and then I will use my brute strength to save us.

Julia: Trevor, look! There's my Gateway 2000® P5-75 Family PC™ multimedia system underneath the rubble.

Trevor: Wow! I may look like your average, sexy, suntanned, hunk construction worker, but I love PCs. You know this P5-75 Family PC multimedia system is a lot like me. It has a powerful Pentium™ processor, a massive 730MB hard drive and a 15-inch Vivitron™ monitor for stunning color images. This P5-75 will give us all the PC power we'll need for years to come. And at only $2,499, it's a great value.

Julia: Yes, and the brawn and raw vigor of this PC also reminds me of you. I can run tons of applications simultaneously. The double-speed CD-ROM, 16-bit sound card and Altec speakers give me amazing multimedia capabilities. And with the fax/modem I can order sexy little numbers from Elizabeth's Enigma for our trysts.

Trevor: That's it! We'll call the Emergency Headquarters with the modem and let them know we're here.

Julia: Oh Trevor! Do we have to? That plaster in your hair is lighting my flames of passion.

Trevor: We'll have plenty of time for love while we wait for the emergency crew. Look at this cool software. I'll use Microsoft® Works to write a letter to Mom and then I'll hit the links with MS Golf.

Julia: Trevor! What about me? This is our window of opportunity for conception!

Trevor: Just a second dear. Look at this ... .

What was Julia going to do? She couldn't lose Trevor to a PC! How humiliating! Sure it's younger and faster, but does it love Trevor like she does?"

Join us next month for "As The Hard Drive Turns." Will Julia and Trevor conceive before they're rescued? Will Trevor leave Julia for his new love — Bob?

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GATEWAY2000 FamilyPC

intel inside
pentium


All soap opera stars portrayed by Gateway 2000 employees.

atured Gateway 2000 PC:
2-66 Family PC multimedia
with a double-speed CD-ROM,
-bit sound card and Altec
ers, MS Works, Encarta '95,
Money, Cinemania,
Golf and Fine Artist.

Setting: A fancy living room in a stately home.

Characters:
Dirk: A debonair businessman
Simone: An emotionally distraught woman

Simone: Oh Dirk, I can't stand it! Our 4DX2-66 Family PC™ multimedia system from Gateway 2000® is taking over our home. It organizes the family schedule down to Jimmy's flights to Paris to see his real mother, and Sally loses all sense of time when she uses Microsoft® Fine Artist. Why only last week she was six and now she's sixteen. The family has no need for me!

Dirk: That's not true Simone. Didn't I profess my love for you by purchasing another city block of Gateville even though you're carrying my brother Rock's baby? Don't I stand by you through your bouts of schizophrenia when you think you are your sister Cheryl? The 4DX2-66 Family PC multimedia system is a productivity tool. We can use MS Money to track your pregnancy expenses so Rock will have an itemized bill, and the children can use MS Encarta™ for their homework. And most importantly we can track your daily medication with the spreadsheet and database in MS Works. Remember last year when you got your prescriptions confused. We don't want you handing out May baskets to the neighbors in nothing but your birthday suit again, now do we? Remember, this family's reputation is at stake here.

Simone: Oh Dirk, you're so good to me. I should've known you're only concerned with my well-being. The 4DX2-66 Family PC multimedia system has everything we need for multimedia including PCI graphics, double-speed CD-ROM drive, 16-bit sound card and Altec speakers. And at $1,899, we have plenty of money left for that experimental wrinkle cream I want to try!

Dirk: Yes, Simone, Gateway's 4DX2-66 is a wonderful addition to our family. We get a 30-day money-back guarantee and a three-year warranty on parts for our desktop PC and Gateway monitor. Gateway's friendly employees will provide us with technical support for the life of our PC. On-site service is available during the first year in most U.S. locations and may be provided without charge if their technicians determine it's necessary. They'll even send us a free written copy of their warranty if we request it.

Simone: Marvelous! Catch me Dirk. I love this Gateway PC so much I'm feeling faint!

Join us next month for "As The Hard Drive Turns." Will Simone hit her head on the coffee table and start to think that the Gateway 4DX2-66 is her long lost brother Charlie?

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P5-90 FAMILY PC

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- 3-Year Limited Parts Warranty

4DX2-66 $1599
4DX2-50 $1299

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P4D-66

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- PCI Enhanced IDE Interface
- PCI Local Bus Graphics with 1MB
- Double-Speed CD-ROM
- 3.5" Diskette Drive
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P5-75

- Intel 75MHz Pentium Processor*
- 8MB RAM, 256KB Cache
- 730MB 10ms IDE Hard Drive
- PCI Enhanced IDE Interface
- PCI Local Bus Graphics with 1MB
- Double-Speed CD-ROM
- 3.5" Diskette Drive
- 15" Vivitron Color Monitor
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- 3-Year Limited Parts Warranty

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P5-90

- Intel 90MHz Pentium Processor*
- 8MB RAM, 256KB Cache
- 540MB 11ms IDE Hard Drive
- PCI Enhanced IDE Interface
- PCI Local Bus Graphics with 2MB
- Quad-Speed CD-ROM
- 3.5" Diskette Drive
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P5-100XL

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- 16MB RAM, 256KB Cache
- 1GB 10ms IDE Hard Drive
- PCI Enhanced IDE Interface
- ATI Mach 64 with 2MB VRAM
- Quad-Speed CD-ROM
- 16-Bit Wavetable Sound Card & Altec ACS-31 Speakers w/subwoofer
- 3.5" Diskette Drive
- 17" Vivitron Color Monitor
- Tower Case
- AnyKey Keyboard & Mouse
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State of the Art

PIECING TOGETHER PUZZLES

Using pattern recognition to glean meaning from masses of data is becoming faster and more accurate thanks to sophisticated algorithms and powerful, but economical, processors

An infant's first intellectual accomplishment is to recognize a parent's face from among the numerous people that walk into his or her life. Although the business world would benefit if computers could routinely perform the same skills, real-time pattern recognition with computers has traditionally been restricted to military applications and expensive supercomputers and mainframes.

Yet the value to the civilian world is obvious. Pattern recognition can help you classify and find meaning in masses of data, be it numerical, textual, audio, or video. The analysis techniques can also help you find matches between a target piece of data (e.g., a frame of video) and a database of millions of video images.

It's the underlying technology that makes today's pen systems recognize (or not) the written word. When you tell a computer to open a file in a pioneering speech-recognition system, it does so by matching your spoken words with a stored vocabulary of sounds. The quality-control systems that scan mass-production assembly lines for defective products find rejects thanks to pattern recognition. In time, cameras mounted on an ATM (automatic teller machine) may do more than just record your visit: A recognition system will match your face with a stored digital image to give you access to your bank account.

The following stories present three threads in pattern-recognition development. They illustrate how systems are becoming faster and more accurate.

Facial Recognition

CFR (computerized facial recognition) has been possible before today's generation of systems, but the large computational tasks often took hours to complete even on the fastest hardware. Horsepower aside, a different facial expression, a new hairstyle, or differences in lighting often confused the algorithms written to match a "live" face with a reference image held in a computer's database.

In "Face Value," Edmund X. DeJesus explores a new CFR system being deployed by the Commonwealth of Massachusetts. Built around an Alpha server and technology developed at MIT, the CFR system will hold the digitized faces of 4.2 million registered drivers. Within about 1 second, the state will be able to match a face with a digitized image. Unlike previous CFR systems, the Massachusetts implementation will be able to "look" past hairstyles and eyeglasses to make matches even when the digital facial images and the "target" image aren't exactly alike.

Key to the system's success will be its ability to select and store only the essential details that distinguish one person's face from another. This will be important for making accurate matches and for keeping the storage requirements down to manageable levels. Filtering out all but the essential facial features, called *eigenfaces*, is also key to the system's fast response time.

So far, the program has proven to be quite accurate. In one test using a database of 7562 facial images, the program achieved a recognition rate of 95 percent. The immediate benefits for Massachusetts will be a crackdown on fraud by those who use duplicate licenses as false IDs. In addition, the facial database will streamline the process for drivers who need to replace a lost license. However, in the future, the same CFR system could create and search for stored digital images in multimedia databases. Soon, CFR-savvy computers may be smart enough to recognize their owners and automatically log onto a network, with all the proper security and access privileges, using facial verification rather than passwords.

Enabling Hardware

Real-time pattern recognition has been the domain of supercomputers and mainframes because each sample usually requires billions of recognition operations. Expensive hardware—and the custom programming that went along with it—slowed the growth of pattern recognition for civilian applications. However, business-class CPUs are now handling recognition tasks with the help of DSPs (digital signal processors) and neural-network processors.

In "Eyes, Ears, & Brains on a Chip," Mark Clarkson talks to companies that are developing pattern-recognition applications around these hardware components. In one case, a company that developed a fingerprint-identification system replaced 28 circuit boards and four microprocessors with a single add-in board that holds twin DSPs. The cost for the two DSPs was about $800.

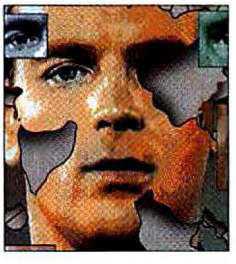
Similarly, a neural-network accelerator chip packaged within a development system, costing a total of $10,000, helped another company ship an OCR system that now reads 1000 characters per second, up from 15 cps in the previous version of the system. In the future, these processors can provide the scalable architectures and ability to work in multiple-chip implementations to meet future processing demands.

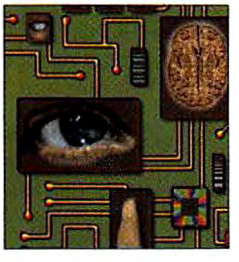
Patterns in Statistics

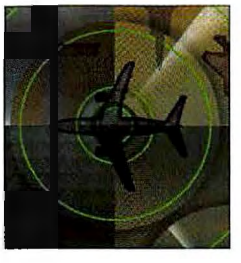
If tomorrow's pen-based computers become more accurate at recognizing handwriting, SPR (statistical pattern recognition) techniques will probably play a pivotal role in this increased accuracy. Handwriting recognition is one of a number of applications that depend on accurately classifying data, and classification is SPR's forte.

In "Mining Statistics," John L. Cuadrado describes the underlying principles of SPR to explain how these techniques can efficiently tackle data-classification problems. SPR will evolve with theory-based classifiers to help doctors diagnose disease and help engineers avoid failure points in physical structures. ■

—Alan Joch, Senior Editor







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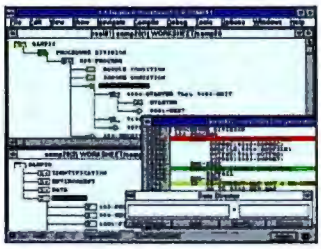

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FACE VALUE

Faster and more sophisticated algorithms are helping computerized facial-recognition systems come of age

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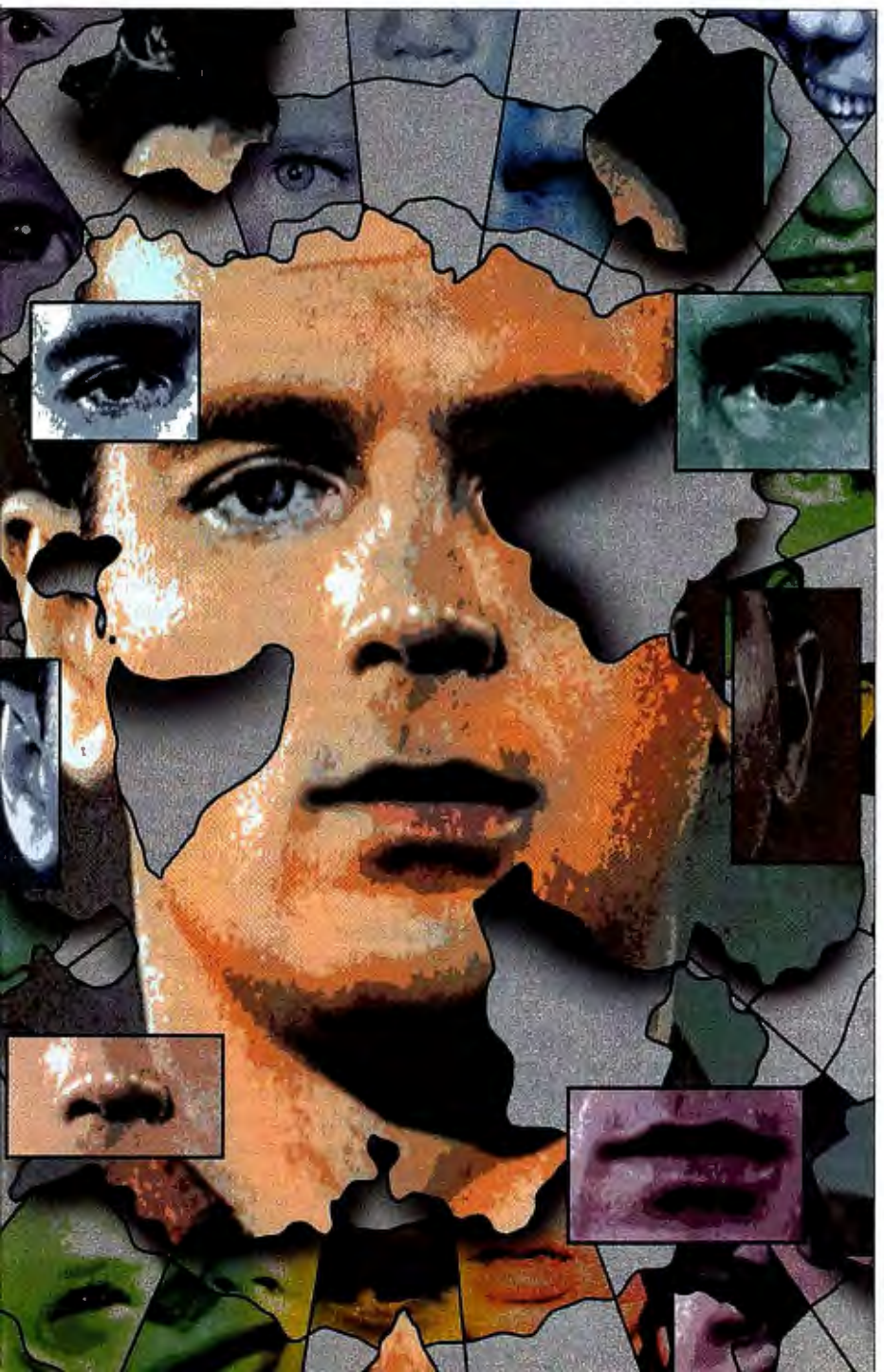

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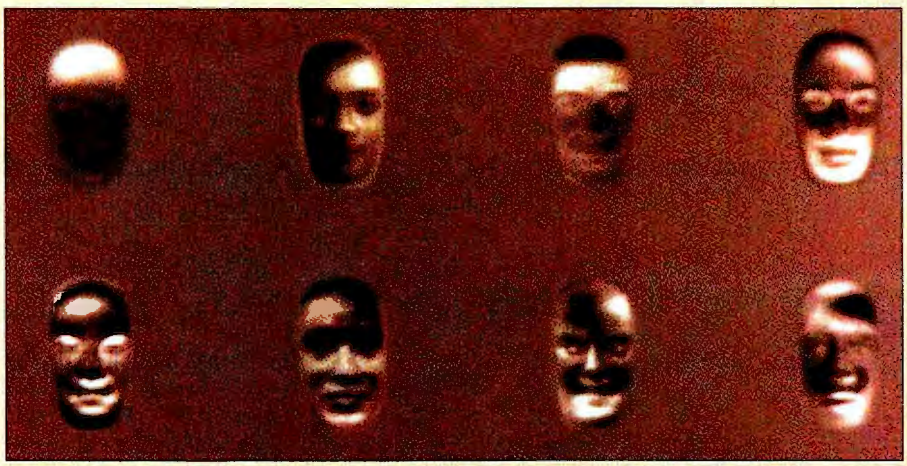
Most pictures on driver's licenses challenge peoples' facial-recognition abilities. Until recently, real-time facial recognition has been impossible for computers. Now, however, the MRMV (Massachusetts Registry of Motor Vehicles) is betting that the algorithms to control a CFR (computerized facial recognition) system are sophisticated enough to quickly analyze its entire database of driver's licenses and help eliminate false IDs.

The Commonwealth of Massachusetts is implementing a CFR application built on Photobook, a research project at MIT. David Lewis, senior deputy registrar for the MRMV, expects the system will store digital images of 4.2 million Massachusetts drivers and will be operational at the central Boston headquarters and at over 30 branch offices by this summer. The system will use a central DEC Alpha-based server to hold the digitized facial images, and an existing IBM mainframe will handle the names, addresses, and other demographic data of licensees. Branch offices will use DEC PCs as local servers and clerk terminals.

According to Lewis, the facial-recognition capability will be added once the hardware is in place. The opportunity to compare a picture from a driver's license with millions of digital facial images is only one reason that motor vehicle registries are storing digital images of licensed drivers. Another use is to accommodate people who have lost their license. With no identification other than their face, a Massachusetts driver may soon be able to apply for a duplicate license.

In the future, CFR might help thwart crime. For example, although they're convenient, ATMs (automatic teller machines) are the source of annual fraud that in some estimates totals millions of dollars per year in the U.S. Fraud in government-benefits payments is estimated at tens of billions

How Photobook Recognizes Faces



Photobook creates a reference set of facial characteristics by analyzing all the faces in a database. Rather than trying to match features humans might remember (e.g., hair color or the shape of a nose), Photobook uses essential characteristics of each facial image, called *eigenfaces*, to provide the patterns with which to compare a target face. The images above show the first eight eigenfaces in one reference set.

The program builds a composite of a face using all the eigenfaces in a database (in this case, 7000 images) to represent the average face.

of dollars per year. CFR systems promise immediate verification of ATM cardholders or benefits recipients.

The facial-image database at the MRMV might be made available to law enforcement officers searching for criminals. However, Lewis says that photo images would not be considered public record and their distribution would be limited only to the police to avoid the specter of Big Brother and the potential fear by some people that a central facial database might lead to civil rights abuses.

Better Algorithms

What makes implementing CFR possible is the recent research that is beginning to yield fast, accurate, and commercially viable algorithms for a variety of facial-recognition applications. Previous attempts at incorporating CFR required powerful and expensive computers, which were often slow and produced inaccurate results. A person's new hairstyle or eyeglasses could confuse and defeat many systems.

Now, with Photobook, a set of interactive computer tools for browsing and searching images, you can use the system to recognize various types of images—including shapes, textures, and decorative patterns. Its facial-recognition capabilities are perhaps its most intriguing features. For example, Photobook lets you find all the faces that most closely match a target face. An entire search through a database of thousands of faces takes less than a second.

According to professor Alex Pentland, a Photobook developer at MIT's Media Laboratory, facial recognition is also a convenient means of identification because you don't have to worry about losing your ATM card or forgetting your PIN (personal identification number). "You always have your face with you," he quips.

Pentland regards the explosion of multimedia applications, accompanied by the growing use of computers to create visual images and store digital images in databases, as a vast potential market for CFR. Currently, it's difficult to automatically search stored digital images for content. Typically, you must create text descriptions of each image and then search the text descriptions for keywords. Manual searches for images are tedious, slow, and expensive. However, programs like Photobook create and search for compressed versions of images. Editors could use this content-based database to rapidly search for, say, all photographs showing both the president of the United States and the prime minister of Japan.

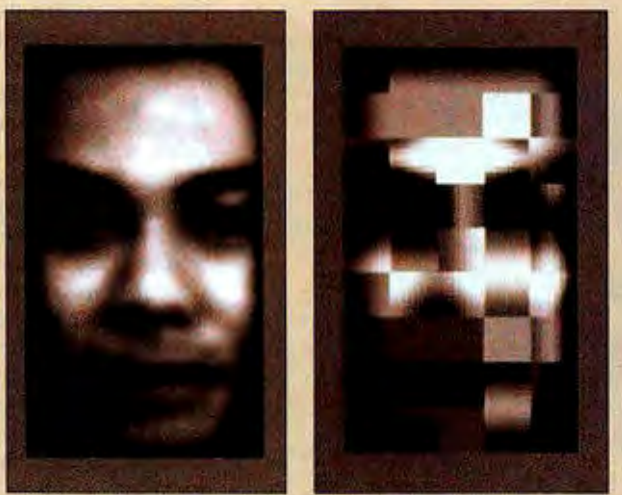
Similarly, in film and video productions where postproduction costs can eat up large portions of the budget, the ability to search for particular actors in certain scenes and simplify editing makes CFR economically attractive. In offices, CFR-savvy computers may also be able to recognize their own users. Some computers now come with video cameras mounted in the monitor. You can use these cameras with CFR to recognize users, log users onto the computer or network, and configure the computer with the user's known preferences. Pentland is further researching ways for computers to interpret the human emotions behind facial expressions.

Another CFR application that takes a different approach from that of Photobook is TrueFace, developed by Miros (Wellesley, MA) (see the text box "A Neural Net that Knows Faces"). According to Dr. Michael Kuperstein, a neural-network researcher formerly with MIT and currently the president of Miros, TrueFace is a better biometrics security solution than fingerprints, retinal scans, voiceprints, or hand-geometry systems. Besides beating most of these other biometrics systems in verification accuracy (with rates often over 98 percent), TrueFace and other CFR applications are passive and nonintrusive.

About Faces

In CFR, computers perform three distinct but related tasks: verification, recognition, and locating the face within the image. With *verification*, the system attempts to match a live face with a specific reference digital image. *Recognition* (or identification) lets the system try to match a live face with any saved faces in a central computer database. The *location task* lets the system ask the question, where is the face in this picture? This task is also necessary to perform verification and recognition, because the face must first be located with-

The screen above appears at the end of a Photobook facial-recognition search to present the closest matches (in descending order) to the target face (encircled in red in the upper left corner). Note that the target and the top three matches are different images of the same individual.



In addition to accuracy, Photobook's eigenface model is also an efficient way to store images. The eigenface image on the left requires only 85 bytes of storage space; the murkier image on the right is a JPEG-compressed version of the original that requires 540 bytes of storage.

in the digital image before any verification or recognition can take place. The location task can also be an independent application.

Verification is considered a much simpler task than recognition, because only a single comparison is necessary. System developers can adapt verification algorithms to perform one-to-one comparisons of the target face with each image in the database and then retain all those images that match. They can also adapt recognition algorithms to perform verification tasks by limiting the database to the single reference face and testing to see if the computer adequately recognizes that face.

Naturally, because recognition requires many more comparisons, recognition algorithms must be quick to be practical. By contrast, verification algorithms need not be nearly as fast, because only one comparison is necessary.

Location identification can be relatively simple (e.g., finding two circles that are assumed to be eyes), or it can consist of complex minirecognition algorithms that divide the entire image into smaller subimages and attempt to recognize a face in each subimage.

Real World

The goal of Photobook and other CFR systems is not only to perform these functions but to do so in real time or near real time. Photobook runs on Unix platforms, and a commercially available version of the recognition algorithm software, which is written in C and called Sherlock, supports DOS, Windows, and OS/2 platforms. Pentland serves as an adviser to Facia Reco Associates (Waltham, MA), a company set up to distribute the recognition software. Victor Colantonio, principal of Facia Reco, points out that Sherlock can identify other images besides faces. For example, in a medical application the system could recognize specific patterns in microscope slides. Facia Reco licenses Sherlock to customers seeking to add its recognition capabilities to their own products and systems.

While people might remember a person's face by the size of their nose, the shape of their eyes, and the curve of their mouth, Photobook eschews such obvious features. Instead, its algorithm uses basic concepts from information theory. First, the program separates each face into a 2-D arrangement of light and dark areas (see the screens "How Photobook Recognizes Faces"). Then the algorithm determines the best facial features to discriminate the features of one face from those of another. Researchers call these discriminating features *eigenfaces*. The algorithm then represents each facial image as a combination of the eigenfaces. The Photobook stores an eigenface representation of each face in the database.

To identify a target facial image, the program compares its eigenface characteristics with all those in the database. The algorithm selects those faces whose representations most closely match the target face. If a recognition threshold has been defined and any of the matches satisfy the threshold, then the target face is recognized. Alternatively, the program can display any matching faces for you, in order of matching, and you can manually recognize the target face.

The eigenface algorithm is attractive for several reasons. Typically, a sample of only 40 eigenfaces gives excellent recognition results. This amount of data is far smaller than the number of features (i.e., pixels) in the actual face image (16,384 pixels for a 128-by-128 black-and-white image, and three times that number for a color image). Each face can be represented by a small number of bytes. If a 2-byte floating-point number is used for each eigenface value, only 80 bytes are required to represent each face. This is far less than the original image (which may be 250 KB before compression) or the 128-by-128 facial image of 16,384 bytes (before compression). The original image can be recovered quite faithfully from this small number of bytes (as a linear combination of the eigenfaces). Clearly, this property can be useful in itself, as it offers a way to compress facial images in otherwise unmanageably large digital databases, while allowing extraction of recognizable faces.

The representation of a face using eigenfaces is simple and fast. A face can be evaluated in as little as 1 second, according

A Neural Net that Knows Faces

TrueFace from Miros (Wellesley, MA) is a neural-network-based facial verification system and one of the first of its kind to be commercially available. It runs under Windows on a 486- or Pentium-based PC. TrueFace is available as a software system (the recognition program; a demonstration program; a C-callable 32-bit library; sample application source code; sample facial images; documentation; and a security dongle) for $4850 in single-unit quantities (the price for 11 or more units is $1750). Miros also offers TrueFace to integrators who incorporate the system into solutions for security at hospitals, businesses, and immigration stations.

Miros sells a proprietary TrueFace neural-network algorithm that has been trained on what a face is and how to compare faces. In live use, the algorithm compares a live face image with a compressed reference face image encoded on an identification card or in a computer database. Compressed images require only 500 bytes. The algorithm then decides if the two images are of the same person. The algorithm is adaptive, enabling it to accommodate changes in appearance, like hairstyle.

One unique property of the TrueFace system is an adjustable threshold of acceptance. Some businesses (e.g., banks) place a premium on not irritating their customers. As Dr. Michael Kuperstein, president of Miros, observes, "Security adds inconvenience." Such businesses might select a lenient threshold, which although it might be less accurate, would be less likely to annoy customers. On the other hand, extremely secure installations might require an extremely stringent threshold.

to Pentland. In addition, the comparison of one face to other faces is simple and fast. Comparisons can be done at the rate of millions per second. From a hardware perspective, the comparison process is memory-intensive: The more memory that's available, the better for recognition performance.

Saving Faces

Depicting faces as 2-D images and then encoding those images to preserve the most important discriminating characteristics involves two related processes: initialization (or training) and recognition. The initialization process uses a set of digital facial images to produce an average face and eigenfaces.

The more controlled the circumstances of image acquisition, the simpler subsequent steps will be. Eliminating background clutter, using consistent and simple lighting, and limiting orientation of faces are all important. The creators of one database that Pentland used captured images at a booth during a Boston photography show. The booth's controlled environment allowed photographers to consistently set lighting and the background. Participants snapped their own picture when they could see two LED lights simultaneously, which ensured that their faces were uniformly oriented.

The size of the facial image also strongly affects algorithm performance, so each image should be scaled to approximately the same size. This can be as simple as expanding or contracting the image to make sure the eyes always appear in the same position or if conditions vary, become more complex. Orientation of the face is also important. You can rotate images clockwise or counterclockwise to ensure that the eyes are on a horizontal line or to satisfy symmetry or some more complex criterion. In addition, you can adjust brightness and contrast of the digital image to produce a standard image. Using a 2-D Gaussian window, you can clip the face. Besides simplifying the image, this also eliminates some possibly confusing hairstyle effects.

At this point, Photobook is ready to calculate an average face. To do this, the system averages (using the simple arithmetic mean) the brightness values at each pixel of the set of standardized digital facial images. These averaged values form the average face. The system then subtracts the average face from each individual digital face, and the result of this step is a set of differences from the average face. These differences are the basis for the next series of calculations.

Photobook performs a principal components analysis (or Karhunen-Loeve expansion) on these facial differences. This analysis finds the eigenvectors and eigenvalues of the covariance matrix, each column of which is formed from an image. To perform this on, say, a 128- by 128-pixel image (N=128) involves finding the eigenvectors of a 16,384-by-16,384 matrix (N-squared-by-N-squared matrix)—an intractable computational problem. Instead, Photobook users decide beforehand how many eigenfaces they want to analyze. In practice, M=40 eigenfaces have proven adequate. Users thus seek the M orthonormal eigenfaces that best discriminate one face from another. These are the M eigenfaces with the M largest eigenvalues. In effect, this reduces the dimension of the image space from N-squared dimensions to M dimensions (from 16,384 by 16,384 to 40, in the example). This smaller M-dimensional subspace of the original image space is called *face space*. The M eigenfaces span face space (i.e., any face can be represented as a linear combination of the M eigenfaces). The M eigenfaces become the eigenfaces. Although eigenfaces represent the most discriminating features of the set of digital face images, they do not represent any particular recognizable features that people would use to identify a face.

The results of this initialization process are threefold: the average face for this set of digital facial images, the M eigenfaces for this set of digital facial images, and a database of known faces encoded in terms of the eigenfaces.

Face to Face

With this work completed, it's now possible for Photobook to perform the recognition process. First, it locates and standardizes the target face image, as described in the preceding section on initialization. Photobook then subtracts the average face from the target face. The system decomposes the difference in terms of the eigenfaces. In matrix terms, this is the product of the difference with the transpose of the matrix of eigenfaces. The result is a set of M coefficients (or M weights) of the eigenfaces that characterizes the target face. This set of M coefficients can also be regarded as the M coordinates of a single point in face space or as the M components of a vector in face space. These coefficients are like a recipe for constructing the target face out of the eigenfaces: so much of this eigenface plus so much of that eigenface.

Photobook can compare the M coefficients of the target face with those of each encoded face in the database. The simplest way to do this is to regard each face (including the target) as a point in face space, and to calculate the Euclidean distance between the target face point and each other face point in the database. (Actually, using the square of the distance precludes

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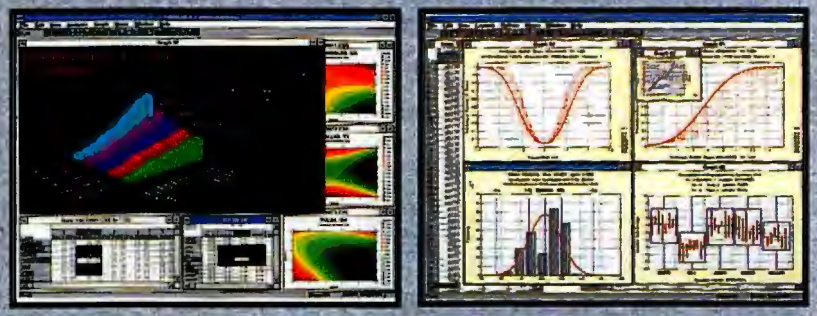

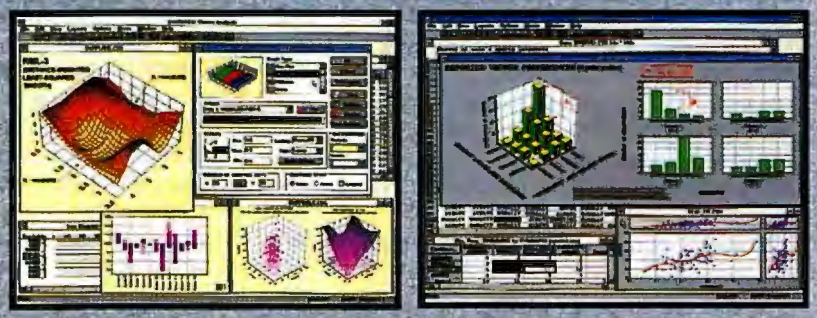

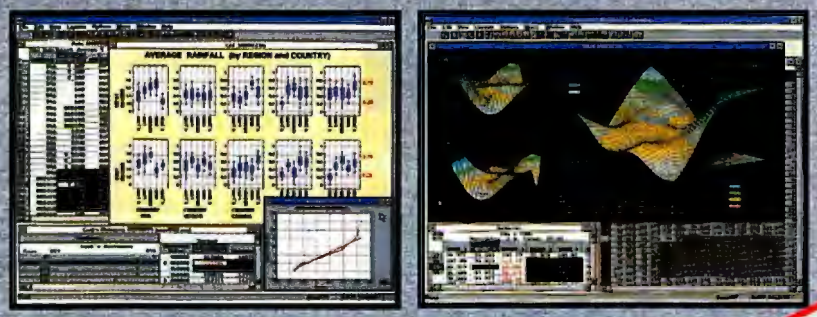

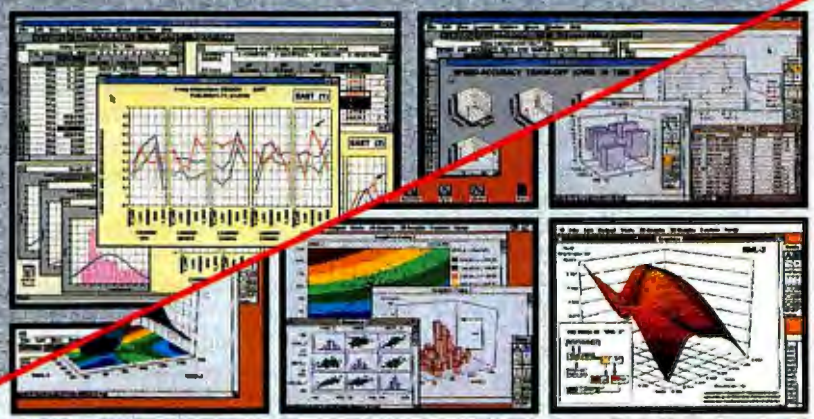

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performing a time-consuming square root for each point in the database.) Computationally, this involves M subtractions, M multiplications (squaring), and M-1 additions. The smallest calculated distance is the closest match, the next-smallest distance is the next-closest, and so on. Alternatively, you can perform the search as a database lookup (assuming that the faces are sorted by their coefficients).

At this point, the system is ready to order the faces by distance and present the results to the users. The result is a list or display of the closest matching faces. Notice that it is the simple nature of the comparison step described above that makes this algorithm so fast. You don't need a supercomputer to use Photobook; a high-end PC or Unix workstation is adequate. If the target face image is not an actual face, the distance from the database faces will be huge. This is one way to test if an image is actually a face. When faces are added to the database, the average face, the eigenfaces, and all the coefficients of each saved face must be recomputed. If a new face is closer to the average face than one of the existing database faces, then recomputation isn't essential. In any event, the recomputation can be done off-line.

The Eyes Have It

Pentland and Baback Moghaddam, an MIT graduate student, have recently added a new layer of discrimination to the eigenface algorithm. Called *eigenfeatures*, this layer can locate and compare specific facial features, such as eyes, noses, and mouths. The eigenfeatures algorithms are similar to the eigenface algorithm and use discriminating characteristics (e.g., *eigeneyes*, *eigennoses*, and *eigenmouths*) to help distinguish similar faces from each other. Using eigenfeatures boosts the accuracy of recognition by several percentage points, Pentland says.

Photobook usually isn't fooled by complications such as hats, eyeglasses, and changed hairstyles. In addition, it can handle different facial expressions, changes in lighting, inclination of the head, and changes in facial hair. Of course, extreme efforts at disguising a face can fool the algorithm (as they fool humans). However, for most commercial CFR applications, a person wants to be recognized, for example, to use an ATM, gain entrance to a building, or receive benefits payments. As a result, getting them to pose correctly or remove eyeglasses or headgear usually isn't a problem.

Test Drive

In a typical session with Photobook, you select a face from a random sample of faces displayed. Practically instantaneously, Photobook finds all those faces that most closely match the selected face, sorts those faces, and displays them on the screen for further use.

Despite its simplicity and speed, the Photobook algorithm appears to be accurate. In one test, Pentland used a database of 7562 facial images of nearly 3000 different people. These images included a number of participants with different facial expressions, eyewear, hairstyles, and headgear—all factors that you would expect to complicate the task of recognition. The test used 200 faces chosen randomly from this database, and Photobook selected the most closely matching face. If Photobook's selection was in fact the same person, it was scored as correct. If Photobook's selection was not the same person, it was scored as incorrect. According to Pentland, even with the complicating factors mentioned above, Photobook achieved a 95 percent recognition rate.

In a similar test emphasizing verification over matching, Photobook scored 99.9 percent accuracy using the same database, Pentland says. For comparison purposes, this level of verification is at least as good as that provided by a single fingerprint, although CFR is far simpler and less intrusive than fingerprinting.

The U.S. Army recently conducted tests of several different algorithms and approaches to CFR to verify the sometimes inflated claims of researchers. Preliminary results from these tests indicate that the Photobook algorithm had the best overall performance with scores of over 90 percent in recognition and nearly 100 percent in verification.

"The positive aspect of face recognition is that it's a little bit like living in a small town," Pentland observes. "You walk up to the cash machine, and it knows who you are."

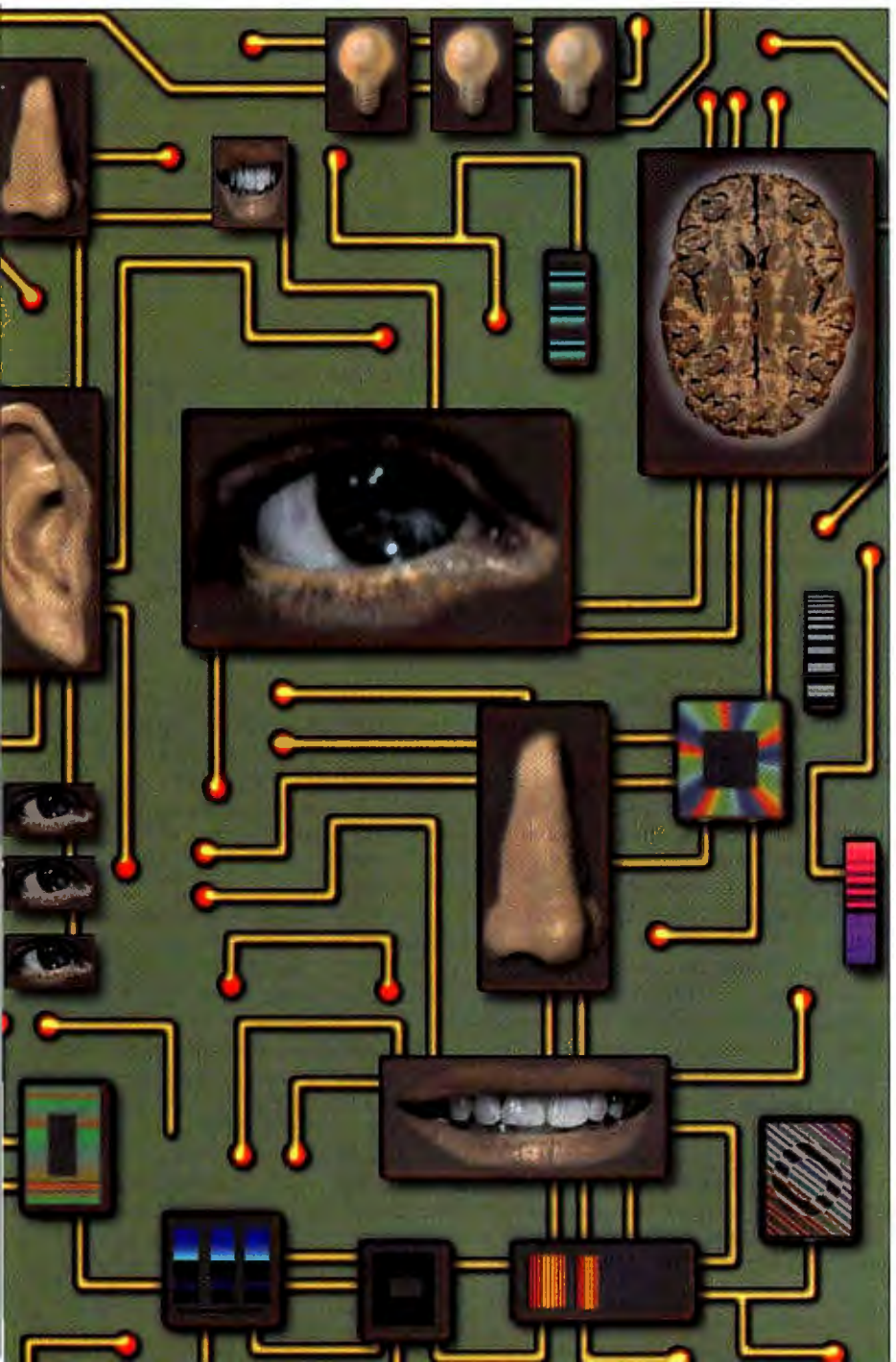
The widespread use of CFR may turn the world into a small town: Wherever you go, your face will be recognized, and you will be trusted. This may have a distinctly humanizing effect on the world. ■

Edmund X. DeJesus is a BYTE senior editor. He has a Ph.D. in physics and has been a professional programmer for over 15 years. You can reach him on the Internet or BIX at edejesus@bix.com.

EYES, EARS, & BRAINS ON A CHIP

DSPs and neural networks power faster image, speech, and character-recognition engines

MARK CLARKSON



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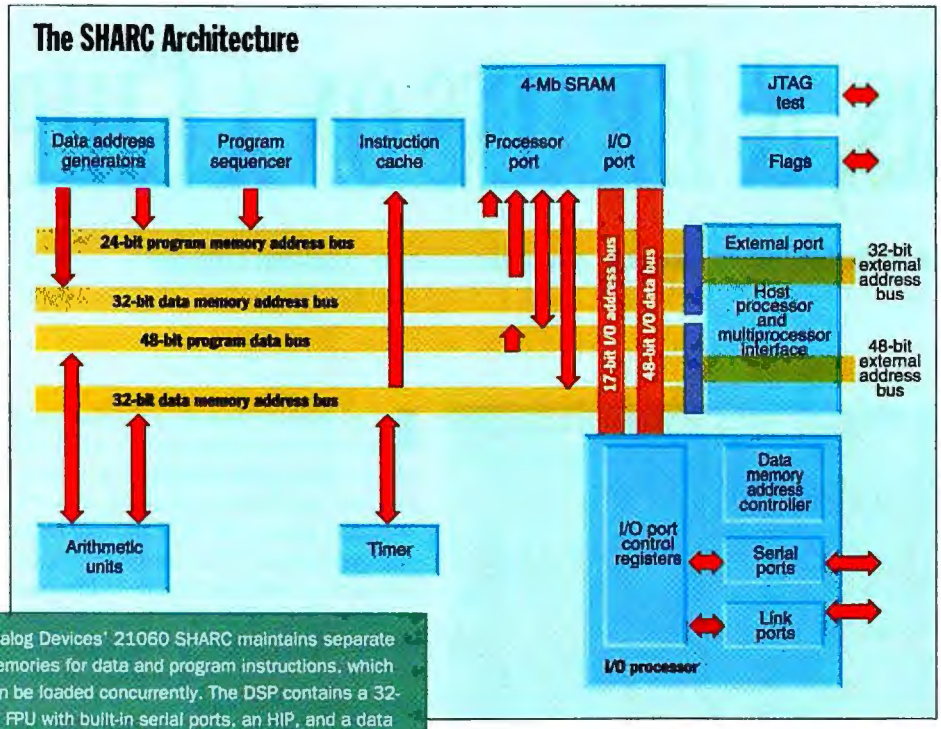
Law enforcement agencies that relied on Printrak International's AFIS (Automatic Fingerprint Identification Systems) formerly needed the processing power of 28 circuit boards, 7000 ICs, and four 68000 microprocessors. The horsepower in this dedicated system enabled the AFIS to read a scanned fingerprint, enhance it, and, most difficult of all, extract distinguishing features from the collection of loops, whorls, curls, and bifurcations.

Today, however, the Anahiem, California–based company's latest recognition system, the Series 2000, performs the same tasks as the earlier hardware, but it does so with a single board that holds twin DSPs (digital signal processors) from Texas Instruments. Thanks to the DSPs—called the TMS320C80 MVP (Multimedia Video Processor)—the latest AFIS designs are only 2 percent the size of the earlier versions.

The price of the AFIS varied because each installation was custom built—costs ranged from $300,000 to over $3 million. Printrak says that even though the new Series 2000 design has fewer hardware components, the price remains the same as the old system. However, the recognition speed of the Series 2000 is much faster than that of the old system. For example, the old system typically used 10 terminals, which connected to a central server that housed the recognition engine and the database of fingerprints. The server performed all the feature extraction and recognition processing in batches. Law enforcement officials sometimes had to wait overnight for a large batch to complete processing.

Instead of having 10 terminals, the Series 2000 has 10 workstations, each with its own recognition engine. A central fingerprint database serves the workstations. In this arrangement, fingerprint feature extraction happens locally on each workstation and takes only about 20 to 30 seconds. The central server has the less-



Analog Devices' 21060 SHARC maintains separate memories for data and program instructions, which can be loaded concurrently. The DSP contains a 32-bit FPU with built-in serial ports, an HIP, and a data memory address controller. Its 4 Mb of dual-port SRAM on-board can hold entire applications and data sets for faster performance compared to processors that must access system memory.

demanding task of matching features against the database. The entire process is shortened by an order of magnitude compared to the batch-processing approach.

Leading-Edge DSPs

The complex nature of real-time pattern recognition—whether for fingerprint matching, speech recognition, shop-floor quality control, automatic mail sorting, or dozens of other computationally intense commercial applications—typically requires the ability to process billions of recognition operations per sample, which for years has often meant mainframe computers or expensive dedicated systems like the former AFIS processor. Desktop system microprocessors, such as x86, Pentium, 680x0, PowerPC, and SPARC, can perform many of these tasks but are too slow for applications like AFIS.

More recently, however, common business-class computers are handling pattern- recognition jobs with the help of relatively inexpensive DSPs and dedicated processors that reside on expansion boards that can plug into ISA or other system buses. An example of such technology is the neural-network Ni1000 Recognition Accelerator chip, which was jointly developed by Nestor and Intel.

DSPs, a special kind of math coprocessor, act on a digitized signal (be it audio, video, or text data) and alter the signal by filtering, amplifying, or enhancing it. Digital signal processing was once the domain of expensive specialized hardware, but as the price of silicon plummets, dedicated DSP technology became not only affordable but, in some cases, less expensive than general-purpose hardware solutions.

In pattern-recognition applications, such as a speech-recognition board, a designer might use a DSP for traditional DSP tasks like filtering out line buzz, background noise, and echoes from a stream of spoken text data. The DSP would then undertake more sophisticated tasks (e.g., recognizing individual sounds or breaking speech into phonemes, which are the unique sounds of a spoken language).

DSPs are fully programmable. You can load a DSP with different algorithms to perform different processing tasks or to upgrade the capabilities of your system without replacing hardware. By switching from one algorithm to another, a DSP can optimize a video signal for picture clarity one minute and for compression level the next.

DSPs range in size and power from 8-bit fixed-point processors that digest data 1 byte at a time to 64-bit screamers, with the trend—exemplified by the MVP and Analog Device's ADSP-21060 SHARC (Super Harvard Architecture Computer)—toward complex architectures with high levels of integration. Highly integrated chips translate into simpler circuit designs with fewer overall components, lower component costs, and less heat dissipation. The latest generation of DSPs come equipped with A/D and D/A converters, ROM, RAM, serial ports, and in some cases multiple processors on-board.

TI's MVP and Analog Device's SHARC represent the flagship products of new DSP lines. The SHARC maintains two separate memories for data and program instructions (see the figure "The SHARC Architecture"). Instructions and data can be loaded concurrently. The DSP is a 32-bit FPU with built-in serial ports, an HIP (Host Interface Port), and a data memory address controller. It can attain peak speeds of 120 MFLOPS.

The 21060 SHARC has 4 Mb of dual-port SRAM (static RAM) on-board (a 2-Mb version is also available), which can give systems designers a speed advantage over other DSPs. Earlier DSP designs for speech recognition, for example, might use the processor to break up the incoming signal into separate phonemes. But DSPs with more on-chip resources (e.g., the SHARC) have the ability to recognize entire words, and even grammar and syntax can be placed on the chip to directly run the entire application without having to use slower system memory.

The military drove advanced DSP design, where less expensive, smaller, less-power consuming hardware was needed for pattern recognition and image processing. Today, such DSPs are performing similar tasks in civilian applications. The 21060 SHARC costs $296 each in 1000 units.

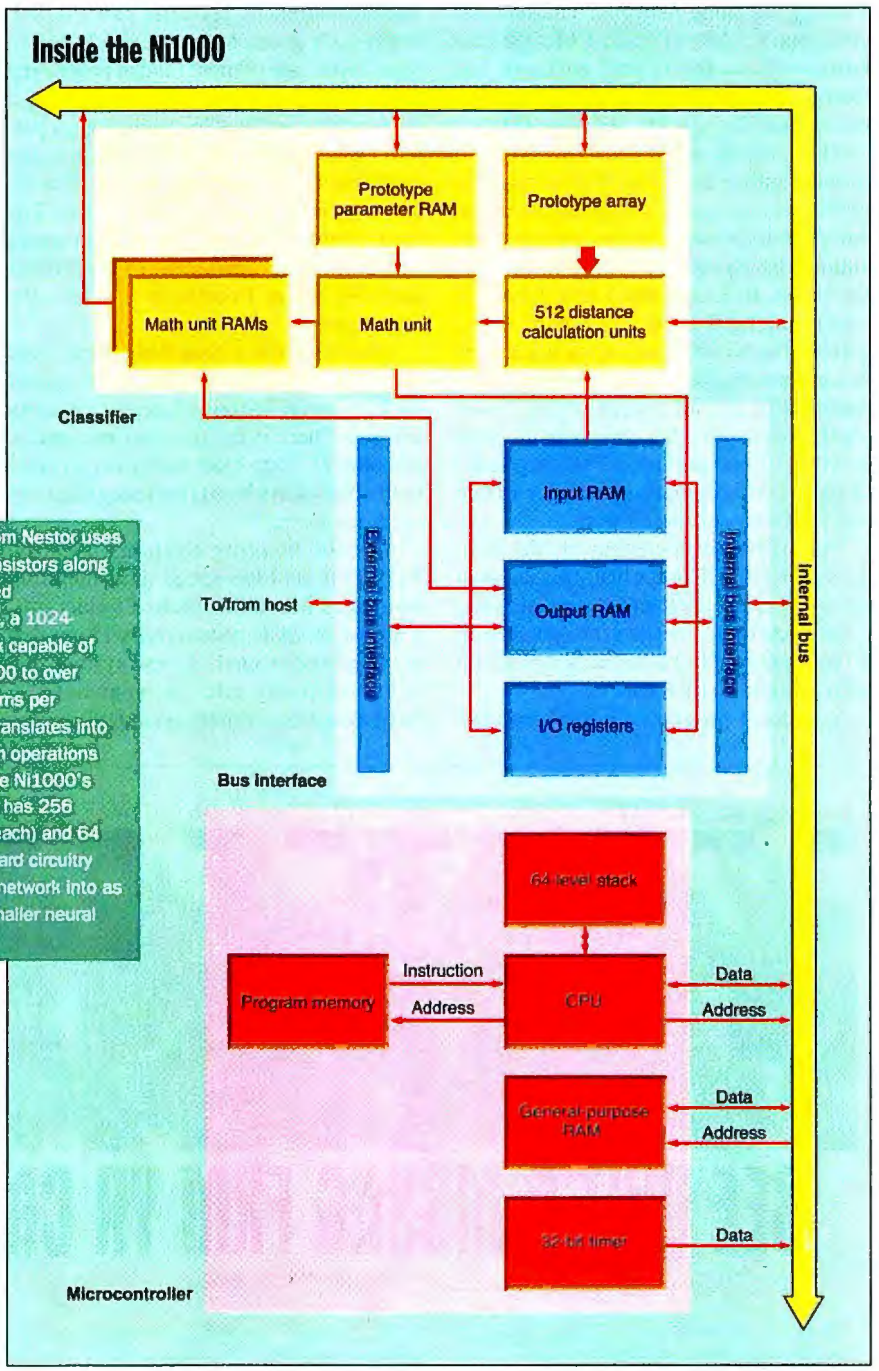
TI's MVP measures three-quarters of an inch on each side, a size that makes it a Godzilla in the world of DSPs (see "Multimedia Powerhouse," June 1994 BYTE). The MVP combines four 64-bit DSPs, a 32-bit RISC processor with 100-MFLOP FPU, a DMA controller, dual video controllers, and 50 KB of SRAM in a single chip. Prices for the MVP are approximately $400 each in large quantities.

According to Dr. Behnam Bavarian, manager of R&D at Printrak, the DSP-based systems forced changes in how engineers approached their work. On the one

hand, DSPs mean system updates are easier. "The older 28-board system was purely a hardware implementation," says Bavarian. "Image processing and feature extraction were hard-wired with discreet logic components—discreet ALUs, registers, and so on. You couldn't program it to do anything else without changing the boards and the layout, which was a big change. Going to the MVP opens the door. Everything is now programmable."

The MVP's flexibility lets Printrak consider custom programming the Series 2000 for new applications. In addition, the DSPs allow Printrak to offer software upgrades for installed systems when better recognition and compression algorithms are developed. For the future, Printrak is considering designing a portable unit that law enforcement officers or paramedics can carry to perform quick, on-sight fingerprint-based identifications of suspects and patients.

The flip side, however, is that traditional DSP-programming techniques don't always apply to the MVP. Printrak writes code in C and assembly language, using TI's MVP development environment, on a Sun SPARC platform under the X Window System. "Good old DSP programmers cannot simply jump on the MVP and start programming it," says Bavarian. "With the MVP, you need to know precisely what the transfer controller is doing, what the master processor is doing, and what each of the parallel processors is doing all the time. The MVP has its own Unix-like kernel for a multitasking operating system. To program it, you need a real-time, multitasking-system programming background. We originally had some programmers with traditional DSP backgrounds, and they had some hard times."



The Ni1000 from Nestor uses 3.7 million transistors along with a dedicated microcontroller, a 1024-neuron network capable of processing 4500 to over 100,000 patterns per second. That translates into about 17 billion operations per second. The Ni1000's neural network has 256 inputs (5 bits each) and 64 outputs. On-board circuitry can divide the network into as many as 64 smaller neural networks.

Neural Chips

But ever-more-sophisticated DSPs are not the only route to faster pattern processing and recognition. Nestor is exploring a different path with the Ni1000 Recognition Accelerator chip. Rather than traditional components like DSPs and FPUs, the Ni1000 consists of synthetic neurons that make it a neural-network computer on a chip. An ISA add-on card with the Ni1000, software, and a development system sells for about $10,000.

Neural networks are relatively simple in concept: Each neuron in your brain has many inputs (called dendrites) and one output (called the axon). A neuron's dendrites spread out to brush against the axons from many neighboring neurons. The more energy a neuron picks up from other neurons firing, the more excited it becomes. If this level of excitement crosses a certain threshold, the neuron fires, sending a pulse down its own axon.

The Ni1000's 3.7 million transistors make up, along with a dedicated microcontroller, a 1024-neuron network capable of processing 4500 to over 100,000 patterns per second. That translates into about 17 billion operations per second. The Ni1000's neural network has 256 inputs (5 bits each) and 64 outputs. If individual processing chores don't require this capacity, the Ni1000 includes on-board circuitry to divide the network into as many as 64 smaller neural networks. These smaller networks can overlay each other,

sharing the same neurons. The Ni1000 contains 1.3 Mb of flash EPROM that stores values the neural network has learned within an application (see the figure "Inside the Ni1000" on page 93).

The system addresses the Ni1000 through either an I/O port or a range of memory addresses. To facilitate its use in embedded systems, Nestor and Intel designed the Ni1000 for low power consumption, so it consumes less than 2 W when running flat out. In a typical application, the Ni1000 serves as a pattern-recognition engine in a vision-based intelligent traffic control system, where it must identify cars and other objects in the field of view of six cameras. The chip idles along at 4 or 5 billion operations per second and uses a modest half a watt.

One of Nestor's customers, the IRS, uses a custom OCR application that must recognize 300 characters per second. The agency had been powering the system with 60 transputers. Nestor recently replaced it with a single Ni1000 card.

You don't program a neural network like the Ni1000 to recognize patterns; you teach it. A given neural network has an input layer, one or more hidden processing layers, and an output layer. You teach it to recognize patterns by "showing" a pattern to the input layer and monitoring the response on the output layer. If that response is wrong, you tell the network. The neural network adjusts the ways in which its neurons are connected to each other and tries again. Eventually, it learns the right answers.

Information in a neural network is not stored in any particular place. You cannot look at an OCR-trained neural network and say, "here is the part that recognizes the letter *H*," any more than you can point to the part of my brain that recognizes my mother's face.

Profold Imaging Systems uses the Ni1000 in its high-speed mail-handling equipment with OCR. Profold's older software-based OCR system reads 15 cps that are machine printed. A new system that began shipping late last year uses an Ni1000 and fast floating-point DSP to read up to 54,000 machine-printed addresses an hour. At that speed, says Profold president and design engineer, Charles Sooley, "We only have 70 milliseconds to read each envelope. That's about a millisecond per character, or a thousand characters per second."

"The transition from the software-based to the silicon-based system was just a case of replacing the calls to the software neural network with calls to the routines that access the Ni1000," Sooley says.

To train the Ni1000 system on a particular font, Profold runs about 500 pieces of mail through it. The Ni1000 does its best to recognize the characters and sends its translation to a separate PC. At this point, people enter the loop: They compare the characters on the original envelopes to the OCR system's interpretations. Wherever the system has incorrectly identified a letter (e.g., mistaking the letter *N* for an *H*), a person types in the correction. The corrected data goes back to the Ni1000 so that it can learn from its mistakes. The Ni1000 learns faster than did its software predecessor. "To train

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*Official 1993 Monitrak U.S. monitor sales research.

Circle 73 on Inquiry Card (RESELLERS: 74).

the software neural network, we ran 5000 envelopes instead of 500," says Sooley. The training software is a combination of Nestor's application development kit and Profold's own custom code.

An upcoming system is designed around a more powerful board combining four Ni1000's and four SHARC DSPs, which Sooley hopes will have enough horsepower for handprinting recognition.

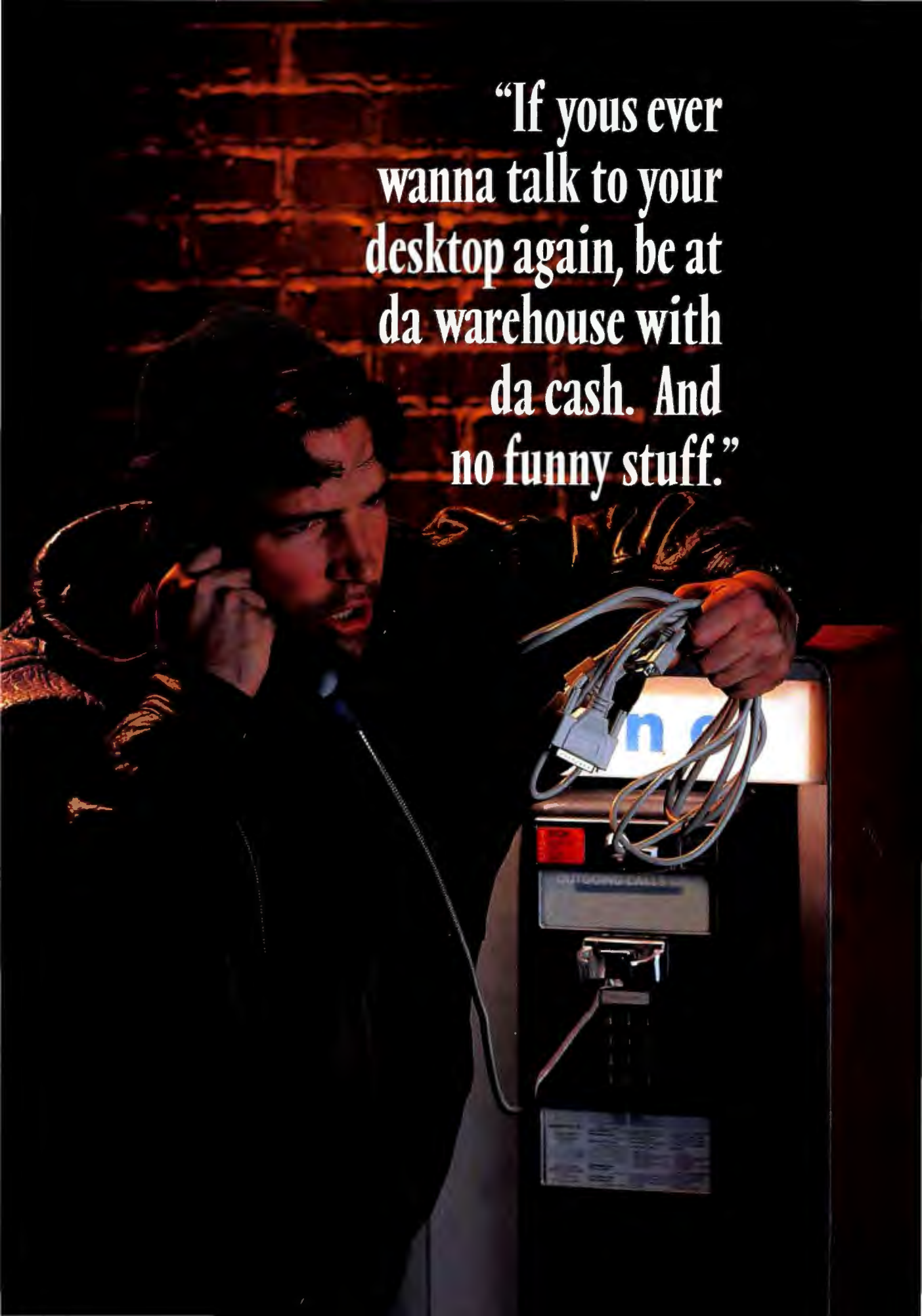
The Department of Civil Engineering at Louisiana State University has been working on a prototype intelligent traffic-control system for two years. The system uses a neural network to interpret information from a video camera positioned near an intersection. The system identifies cars waiting at the light and adjusts the green light time accordingly to optimize traffic flow through the intersection. "We were doing it in software before," says assistant professor Darcy Bullock. "But even with the fastest Pentium, we couldn't get real-time performance, and it took 3 hours to train. The Ni1000 takes 3 minutes to train, and we can keep up with real-time video at 30 frames per second and don't come close to running out of time." The system is running on an Ni1000 board plugged into a 486-based PC.

Interesting Times

Real-time pattern recognition requires scalable architectures and the ability to stack multiple processors together. The SHARC, MVP, and Ni1000 allow for multiple-chip implementations, which enhances their already formidable processing power. These chips are on the cutting edge in terms of die size and number of components and transistors, and their coming is not without labor pains.

Full production always seems just around the corner, and developers with systems built around these chips may still find themselves waiting for full production quantities. TI's MVP wasn't expected to reach full volume until last month, and while the Analog Devices SHARC was shipping in quantity at press time, according to the company, customers reported problems in getting all the SHARCs they needed. "We're not on the market [with Profold] due to lack of parts," says Sooley. A reminder that, for all its promise, the leading edge is not always a comfortable place to be. ■

Mark Clarkson is a freelance writer based in Wichita, Kansas. He can be reached on the Internet or BIX at mclarkson@bix.com.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You see, Rex is doing whatever he can to keep my exposé about Gateway's new portables under wraps. But while I was working the PC beat with my trusty Liberty, I got the scoop on the new ColorBook^{2}™ from Gateway. It has the same great

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MINING STATISTICS

Statistical-pattern recognition could be the underpinning for tomorrow's smarter voice processors and machine-vision systems

JOHN L. CUADRADO

DAVID TEICH © 1995

Dense fog shrouds your reconnaissance plane as it reaches the target area. You can't visually inspect the airfield below, but the SAR (synthetic aperture radar) system in your plane's cockpit reports four large aircraft parked on the tarmac. Unfortunately, the scattered radar signal can't tell you if the aircraft belie a heightening of tensions (fighters and bombers) or retrenchment (troop carriers). Your objective is to identify the planes on the ground or at least determine to which class they belong.

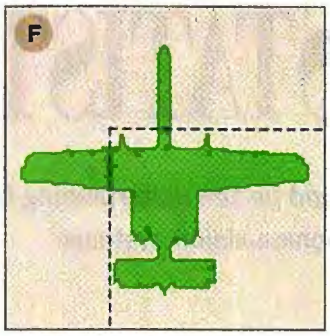
The key to answering these questions is statistical-pattern recognition, which can process raw radar data into feature sets, called *vectors*, that can help classify the planes. This hypothetical problem is drawn from the military, a sector where much of the work in statistical-pattern recognition has taken place. But statistical-pattern recognition development is active today in the academic and the industrial worlds, where researchers from different disciplines—from document processing to engineering to medicine—are creating and applying new, more powerful techniques. As a result, the technology that will help make tomorrow's handwriting-recognition products, speech processors, or machine-vision systems more accurate will likely have roots in statistical-pattern recognition.

Today's activities are fueled by two catalysts: First, solutions to the recognition problems in these areas rest with the accurate classification of data, which is the forte of statistical-pattern recognition. Second, today's relatively inexpensive hardware brings the requisite processing horsepower to the desktop and factory floor. Here's how statistical-pattern recognition works.

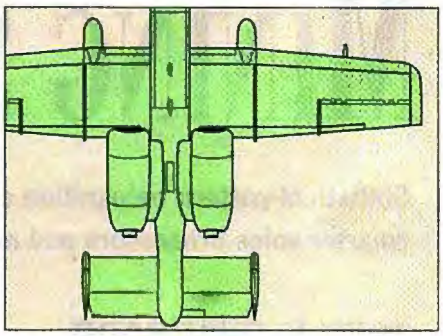
Aircraft ID

Think of the radar data in the hypothetical example as a bit map that contains all the pictorial information about the airfield (see

Step 1: In a hypothetical military application of statistical-pattern recognition, radar data informs the system that four aircraft of unidentified class sit on an airfield tarmac.



Step 2: The aircraft images become input to various segmentation algorithms that divide the image into components.



Step 3: After taking measurements of subimage components (e.g., the largest and shortest axes), the recognition system develops a set of feature vectors, which are the keys to unlocking each aircraft's identity.

"Five Steps to Identifying an Aircraft"). This type of image serves as input to various segmentation algorithms that partition the image into components. These components are further identified as possible candidates that represent objects of interest—subimages of aircraft in the above example.

The system extracts a set of measurements from each of the component subimages. For example, it might compute the centroid of the subimage or the largest and shortest axes. These measurements are referred to as the features of an object in the context of pattern recognition. The result of this processing is an n-dimensional vector of features (i.e., each detected subimage is characterized by one of these feature vectors). The number of features and what they represent varies with each problem.

You now have a feature vector that might indicate the presence of a type of aircraft. This feature vector is data you input into the pattern-recognition system. The system's goal is to determine whether the feature vector belongs to one of several classifications that the system knows about. The final output of the system might be an image of the airfield with a tag next to each of the planes indicating their type.

The Basic Problem

The issues that your pattern-recognition system must address include how the system distinguishes plane types, how you train the system to identify different types of aircraft classes, how to make the classification system accurate, how computationally intense are the underlying algorithms, and how the system classifies planes in real time. If you abstract the SAR problem, you will see that the pattern-recognition challenge consists of partitioning a vector space F (feature vectors) into the various aircraft types. Each vector in F consists of a set of features that describe characteristics of the objects.Two pattern-recognition approaches address these issues.

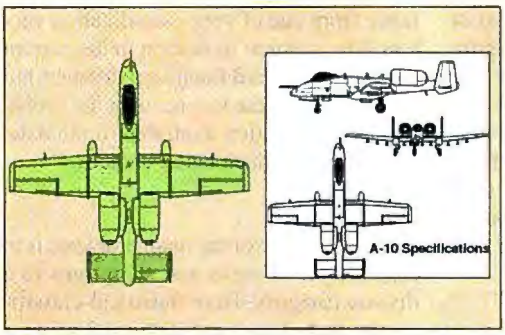
In one approach, you have a set of feature vectors that characterize some objects, and your goal is to find out if some partition of the space F groups these objects into any meaningful sets. This is known as the *cluster* problem. By contrast, this article deals with the second approach, where you are given a partition of the space F into a set of classes and a new vector. Called the *classification* problem, this approach determines to which of the given classes a new feature vector belongs.

To delve further into the classification problem, consider an example that was used in the 1930s by R. A. Fisher to develop his theory of discriminant functions. Here, the objects to be classified are sets of flowers called irises. There are three classes of irises: Iris Setosa, Iris Versicolor, and Iris Virginica. Botanists had studied these flowers and made many measurements on such things as petal and sepal length and width. Therefore, data exists to characterize 4-D vectors where the first two components correspond to petal length and width and the last two components correspond to sepal length and width. To simplify the problem even more, just consider the petal information. The final vector is 2-D: $v = (x1, x2)$, in which the first component corresponds to petal length and the second to petal width.

For each vector, you know to which class of iris the vector measurements belong. Further, you estimate a probability function P and assign a number between 0 and 1 to each of the three iris classes. These functions are known as the *prior probabilities*. You can estimate their values based on sample data. For example, to assign a value to P(Versicolor), you count the number of flowers you are given in the Versicolor class and divide by the total number of flowers from all three classes. You need to devise a procedure that will let you determine the class of a new, unknown vector (see the figure "Iris Classes").

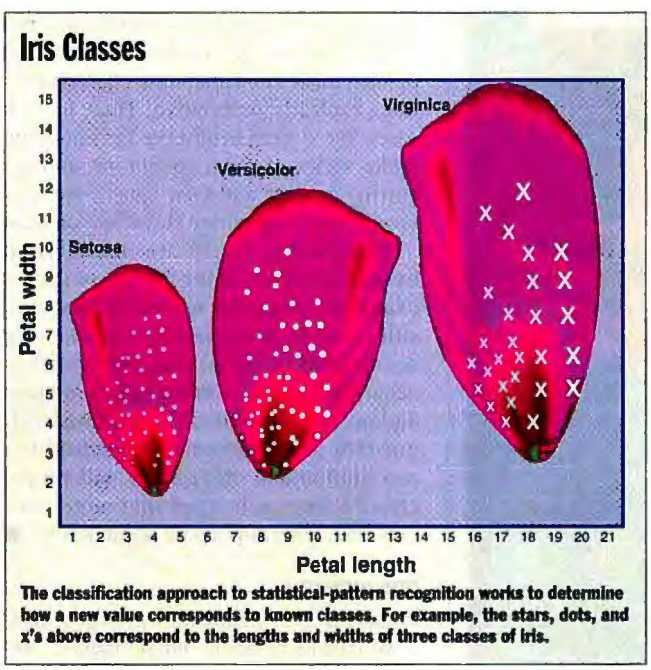
Many techniques have been developed to solve problems like this one. These techniques can be broadly categorized as either *parametric* or *nonparametric*. In the parametric case, you assume that the underlying population from which the data comes has some known probability distribution that depends on some parameters. In this case, the goal is to determine, or estimate, these parameters from the sample data that you are given (i.e., the 2-D petal measurements on known examples of the three classes of irises). By contrast, nonparametric methods come into play when the data has no known limits.

Now, given a feature vector v, you can ask what the conditional probabilities P(Setosa|v), P(Versicolor|v), and P(Virginica|v) are. Think of these probabilities as saying, given a feature vector v, what is the probability that it comes from one of the three classes? If you know these conditional probabilities, you can solve the problem. The classification rule is simple: If you are trying to classify a new vector v, you simply compute the conditional probabilities for each of the classes. The class that results in the largest number "wins," and you classify v as belonging to that class. It turns out that this is the best you can do if the goal is to minimize the total error of classification. This classification rule is known

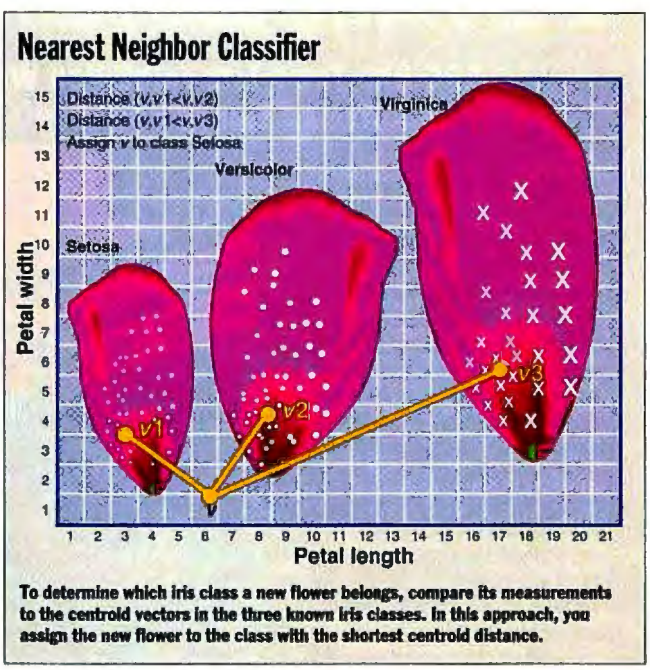


Step 4: The system compares feature vectors of the unidentified aircraft with specifications of known aircraft held in the system's database.

Step 5: After matching the feature vectors of known and unknown aircraft, the system classifies the images captured by radar.



The classification approach to statistical-pattern recognition works to determine how a new value corresponds to known classes. For example, the stars, dots, and x's above correspond to the lengths and widths of three classes of iris.



To determine which iris class a new flower belongs, compare its measurements to the centroid vectors in the three known iris classes. In this approach, you assign the new flower to the class with the shortest centroid distance.

as Bayes' rule, and it forms the starting point for most other approaches.

The problem with Bayes' rule is that you need to know the conditional probabilities P(Setosa|*v*), P(Versicolor|*v*), and P(Virginica|*v*), and these are almost never available. A much easier set of numbers to obtain is P(*v*|Setosa), P(*v*|Versicolor), and P(*v*|Virginica). These conditional probabilities represent the likelihood of having a certain set of features given that the vector *v* comes from the corresponding class. These conditional probabilities can be estimated by sampling the objects from each of the classes. In practice, a large number of samples from each class would be examined to isolate characteristics of particular common features that are specific to each class.

In theory, you could compute tables for conditional probabilities P(*v*|Setosa), P(*v*|Versicolor), and P(*v*|Virginica). Unfortunately, what you want is P(Setosa|*v*), P(Versicolor|*v*), and P(Virginica|*v*). But not to worry; you can use a form of Bayes' rule that requires that you assign the new feature vector *v* to the class that produces the largest of the following three numbers:

P(*v*| Setosa) P(Setosa)
P(*v*| Versicolor) P(Versicolor)
P(*v*| Virginica) P(Virginica)

This is clean and simple, but in the real world, obtaining even these conditional probabilities can be difficult. In practice, the most common approach is to assume that the underlying probability distribution is normal (i.e., the familiar bell-shaped curve). This distribution is determined by two parameters, the mean and the variance (or covariance matrix).

To estimate the mean and the variance of the iris population, you need large samples of data for each iris class. Many techniques exist for estimating these parameters. Assuming you're armed with the values of the estimated mean and covariance, you can construct the discriminant functions that will serve as classifiers for any new feature vector. In the example previously described, you are given a new iris, and you measure its petal's length and width. This produces a new vector that you input into your classifier. The result is

an assignment of the new flower to one of the three classes of irises.

Many other techniques exist for solving the classification problem. Among the more common nonparametric techniques is the *k*-Nearest Neighbor method. The basic premise of this algorithm involves the use of centroids. Again, to keep things simple, assume that you have computed the centroids of each of the three classes of irises. You have found three representative vectors—*v*1, *v*2, and *v*3—that are typical of each of the three classes (see the figure "Nearest Neighbor Classifier" on page 99). Given a new flower, you again measure its petal's length and width and form a new vector *v*. You compute the distance from this new vector to each of the class centroid vectors *v*1, *v*2, and *v*3 (distance can be defined in many ways). You assign the new flower to the class with the smallest distance from one of your classification vectors. The simplest definition in the current case is the standard Euclidean distance, but if you want to take into account the probabilistic information available in the data, then there are much better choices.

Applications

In medicine, one of the main problems is to assign a set of signs and symptoms to a disease category. Here statistical-classification techniques are designed using a combination of medical theory and empirical knowledge.

Another area where these techniques are used is in engineering diagnostics. Here, you have theory-based and empirical classifiers. For example, in many complex devices, the possible failure modes may run into the millions. A brute force enumeration of such modes and attending characterizations is clearly prohibitive. Thus, in such cases, the system is observed in operation under various typical conditions, and occurring failures and their causes are analyzed to develop failure classification data.

These failure modes are characterized by feature vectors along the line of the iris examples. Using this empirical data, classifiers can be developed so that when the device is out on the field and a new failure occurs the feature vector can be produced and quickly classified. In the future, algorithm development for handwriting recognition and other areas will propel classification techniques into more business and general-purpose applications. ■

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John Cuadrado is an independent consultant in Maine. His primary areas of interest include distributed database systems, applied AI, and theories of parallel computation. You can reach him on the Internet or BIX c/o editors@bix.com.

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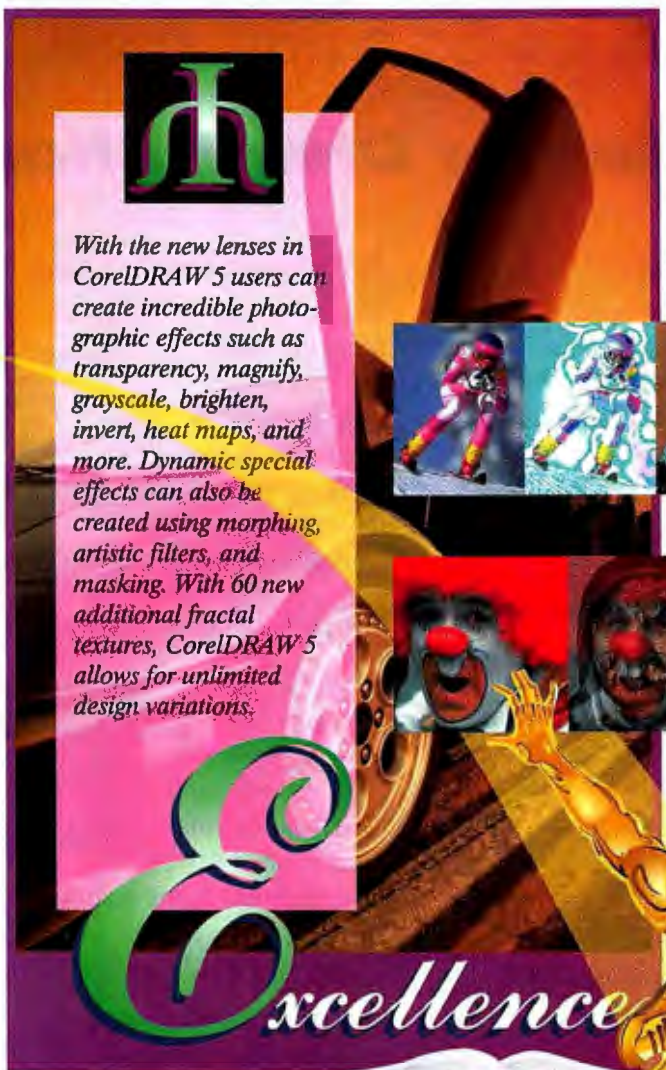

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Agent-Enhanced Communicator

Sony conjures up a new standard in PDAs with the help of Magic Cap

PETER WAYNER

Magic Link runs a 16-MHz Motorola 68349 processor and holds the Magic Cap operating system in its 4-MB ROM. Magic Cap's interactive metaphor includes your office desktop (see the inset), other rooms in your home, and the street outside. Options include the keyboard and headset shown.

For the last several years, the computer industry has flirted with the notion of a palm-size computer able to communicate with the world. Companies like Sharp, Tandy, and Apple have offered versatile portable hardware that hasn't yet lived up to hype promising a computer that can nearly read people's minds. The latest stab at the promise is Sony Electronics' Magic Link Personal Intelligent Communicator. It's a $995 pen-based tablet that is the first device to use General Magic's Magic Cap object-oriented software environment and Telescript remote programming language.

Connect Magic Link to a phone line, and you can place voice calls, send faxes, or log onto America Online. Receiving SkyTel pages is an option. Most important, Magic Link connects to AT&T's new Telescript-enabled PersonaLink Services, which supports Magic Cap E-mail messages enriched with sound, audio, and penned electronic ink, as well as Telescript agents for automating tasks like filtering and forwarding messages or exchanging address information.

Sony's new unit won't yet satisfy everyone's dreamy cravings for the perfect PDA (personal digital assistant). It is, however, a useful portable computer for managing basic E-mail and other communications.

Compact Communicator

The Magic Link is a 7.5- by 5.2-inch charcoal-gray tablet encased in rubberized plastic, with a 480- by 320-pixel, touch-sensitive, black-and-white display screen. The 1.2-pound package is well thought out and graced with several intelligent touches. The screen stylus, for example, stows completely inside the PDA itself—a big improvement over designs that leave you no secure place to park it. There is also a clever plastic shield that prevents you from changing the regular batteries and the lithium back-up battery at the same time.

A major difference between Sony's PDA and others on the market is that Sony designed the rectangular screen to be held horizontally instead of vertically (landscape mode as opposed to portrait). This makes it slightly more challenging to hold the Magic Link in one hand and write with the other, but the horizontal arrangement mirrors what I'm used to on desktop systems.

The film-resistive screen responds to both finger touch and stylus. As a simple LCD without backlighting, it isn't revolutionary. People accustomed to the crisp, bright colors of an active-matrix display won't enjoy using Magic Link's screen, but until new display and battery technology come along, PDA users will continue to trade some readability for portability.

Sony claims that with the right usage the Magic Link's optional lithium-ion rechargeable battery ($69.95) will last for 10 to 12 hours on one charge. I was able to get 7 hours with continuous use. Magic Link can also run on six standard AAA batteries (included) for up to 3 hours.

Outside of the screen, most of Magic Link is devoted to connectors for linking the PDA with the outside world. There is an external port for attaching an optional keyboard ($129.95) with almost full-size keys. It fits together smoothly with Magic Link to make a laptop PC. You can also enter text by tapping the stylus on a keyboard displayed on the screen. Unlike Apple's MessagePad (aka Newton), the system software doesn't attempt handwriting recognition with pen input.

The primary communication port is an RJ-11 phone connector that attaches Magic Link to a standard phone line. The port connects the internal modem (only 2400-bps data and 9600-bps send-only fax). Magic Link can dial and log your calls, but doesn't work as a speaker phone, though it has a built-in microphone and speaker. It can work as a telephone, however, with the optional $79.95 headset.

Alas, there are no cellular connection options available, but SkyTel sent me one of its Sony-labeled paging cards, a $249.95 option available from Sony that slips into the Magic Link's PCMCIA slot. You can receive pages or short messages anywhere in the country with SkyTel's service. The device is well integrated with the Magic Cap, and incoming pages appear as messages in the E-mail system. You can arrange for E-mail received at your PersonaLink mailbox to be routed to you immediately through the pager. This service is customizable (through Telescript

agents), and you can arrange for filters to ship only messages from selected people. The paging system is unidirectional only, but SkyTel promises future two-directional capability.

The right side of the Magic Link accepts the batteries and a single Type II PCMCIA card like the SkyTel pager. Sony also sells 1-MB memory cards ($219.95) that you can use for downloading important information. This is a good idea because Magic Link's main memory is small, with 512-KB RAM allocated for storage and 512-KB RAM for temporary work. (The lithium backup battery protects only the storage area.)

You might also want the $99.95 kit that attaches the Magic Link to a Windows-based PC so you can transfer files. To transfer files between Magic Links, you can use the built-in 38.4-Kbps infrared link.

Under Magic Cap

While Sony created the hardware, Magic Link owes its personality to the Magic Cap software environment, developed by General Magic (Mountain View, CA). This software won't be limited to just the Magic Link; General Magic plans a version of Magic Cap that will run as an application on both Macintosh and Windows-based systems in 1995.

Magic Cap is an object-oriented, multitasking applications environment that extends the desktop metaphor to even more literal levels. You can use the stylus to click in and out of rooms, corridors, and even buildings. At the highest level is a street with buildings representing the major software packages. The basic unit comes with three buildings: your home, America Online, and PersonaLink. To link up with the outside world, you go to the appropriate building. To use your own files and the bundled desktop apps, you go to your home.

The corridor in your house is the next level down in the abstraction. Rooms off of this corridor are your office (in which you'll find Intuit's Pocket Quicken, Penware's PenCell spreadsheet, a spell checker, datebook, notebook, and calculator), a storage room, the library, and a game room. Each room allows you to do pretty much what you would expect. The library's on-line documentation is adequate. The control room lets you fiddle with parameters like the amount of idle time before the machine turns itself off.

If you buy new software (or download it), it might appear as either a new item in a room, a new room on your hallway, or a new building on the street. The multiple levels of hierarchy are an improvement over the current popular desktop metaphors. Some people might argue that the differences between the rooms and the street are just window dressing, and they're correct, but I've found it a bit easier to navigate around the Magic Cap world with this additional gloss of metaphor.

The object-oriented structure makes possible some levels of customization. If you've turned on Magic Cap's "construction" mode, you can drag a class of visual objects called "stamps" around the Magic Cap world and leave them wherever you want. For example, you can place a stamp of a big pair of lips on your desk and it will speak when you touch it. This is how you can use the built-in microphone to leave verbal reminders or voice annotations in various places in the Magic Cap environment or include them in E-mail messages.

Some stamps control the Magic Link's actions. If you want a message to go via a particular communications network, you attach the appropriate stamp to the message and fill in the address. There are stamps for the Internet, X.400, American Online, and many other networks. You can also place stamps on the address cards in your Magic Link rolodex. When you want to address a letter, just copy the stamp over to the new outgoing message.

The stamp concept unifies this virtual world. Most objects are stamps, and the common way to modify anything you see is to add a stamp. One stamp, for instance, will lock a door. You can't open the door without typing in the password. Clever stamps can add significant functionality to the Magic Cap interface.

Telescript Agents

At the bottom of all the software layers is General Magic's agent-empowering network Telescript operating system. This technology promises to let people send executable programs called agents through the network. Although this capability has awesome potential, most people will notice it first as just making life a bit easier. For example, one of the first messages in my E-mail box came with a button that I could push to install new software. Once I pushed it, the software installed and the button disappeared. Sure, I could have inserted a disk and typed "install," but that's not as automatic nor as flexible.

It will be interesting to see how many people use all the programmable capabilities of Telescript. General Magic suggests that future software packages will let you do things like make reservations with a distant airline computer by encoding your date, time, and seat preferences in a little program that picks and chooses when it runs on the airline's computer. Encoding all of these choices in a single program saves the cost of shipping all of the intermediate information back and forth.

AT&T's PersonaLink provides a few other nice agent capabilities. By contacting to PersonaLink's central computers, I managed to find the address of a friend who had purchased his own Magic Link. The response was an address card with the right network address that Magic Cap automatically inserted in my rolodex. Because we both had Magic Cap systems, we were able to exchange several cards highlighted by scribbles and multiple animated stamps. Otherwise, E-mail is limited to text only. More agents should become obvious once AT&T opens up its Market Square virtual shopping mall on PersonaLink. AT&T promises that a mall filled with such stores as Land's End and Tower Records will be online early this year.

About the Product

Magic Link Personal Intelligent Communicator $995
Sony Electronics Inc.
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Circle 1004 on the Inquiry Card.

All Together

Sony has packed Magic Link with all the capabilities that the laws of physics, battery life, and its design budget will allow. It's attractive and relatively rugged but could easily use more memory and a better screen. The well designed Magic Cap software is a pleasure to use, and the included applications are solid enough to handle daily chores.

You won't want to write anything longer than three paragraphs without the keyboard, but you might be quite happy to keep it on your desk to handle your communications. You'll be even happier if you spend time on the road and need something to juggle messages, faxes, and phone numbers. The combination of PersonaLink, the pager option, and the Magic Cap operating environment make this one of the best integrated packages for keeping it all together. ■

Peter Wayner is a BYTE consulting editor. You can reach him on the Internet or BIX at pwayner@bix.com.

Video for Free

Thanks to new hardware and software technologies, accelerated motion-video playback is no longer a premium, and MPEG is on the move

STANFORD DIEHL AND
GREG LOVERIA

Both the Diamond Stealth 64 VRAM and Jazz Jakarta start from a baseline graphics engine with integrated motion-video acceleration, and both offer snap-on upgrade modules. The Jakarta (left) includes a Tseng Labs graphics engine, Viper f/x video accelerator, and hardware MPEG decompression on-board. Upgrade modules add a cable tuner and NTSC/PAL output. The Stealth 64 VRAM (below) includes S3's new single-chip graphics/video accelerator. Add-on modules support MPEG decompression and video capture.

A very short time ago, accelerated playback of digital-video files was a value-added feature that differentiated the commodity market for Windows graphics cards. A number of technological and market developments promise to drive motion-video playback to the mass market. Given the power of today's mainstream hardware, video bandwidth can now be negotiated across a local bus instead of the slower system bus, and high-end CPUs can crunch more sophisticated decompression algorithms. Video-enhanced titles for training, reference, education, and entertainment are in high demand. And virtually every graphics-chip vendor, enabled by Microsoft Windows' DCI (Display Control Interface), has announced a graphics architecture to support full-motion playback of digital video.

Digital-Video Playback

A number of factors affect video playback quality under Windows. The first is *frame rate*, measured in frames per second. To ensure quality, the video must be captured at an acceptable frame rate. The standard for TV-quality, full-motion video is 30 fps.

Video for Windows will drop frames to match the capability of the playback hardware, producing a fluid or jerky motion depending on the system it's played back on. The number of colors the sequence was captured at also affects quality because more data flows across the video adapter's data bus. If the video sequence was captured at 24-bit color depth, you have three times more data to move across the display bus than with an 8-bit (256 colors) video clip.

An uncompressed 24-bit video file, recorded at 640- by 480-pixel resolution and at 30 fps, would require a throughput rate of over 26 MBps. Clearly, the video data must be compressed. Compression not only allows more video to be stored on your computer's hard drive, it also lowers the bandwidth requirements for video playback.

While compression algorithms significantly reduce bandwidth requirements, they demand intensive computational resources. Dedicated hardware has been required to decompress the video data at an acceptable rate while the host CPU took care of other chores, such as *color space conversion* (converting the video data from the compressed YUV format used for motion video to the RGB format necessary for display on computer monitors) and *video scaling* (scaling algorithms help maintain video quality when the video window is stretched beyond the captured size).

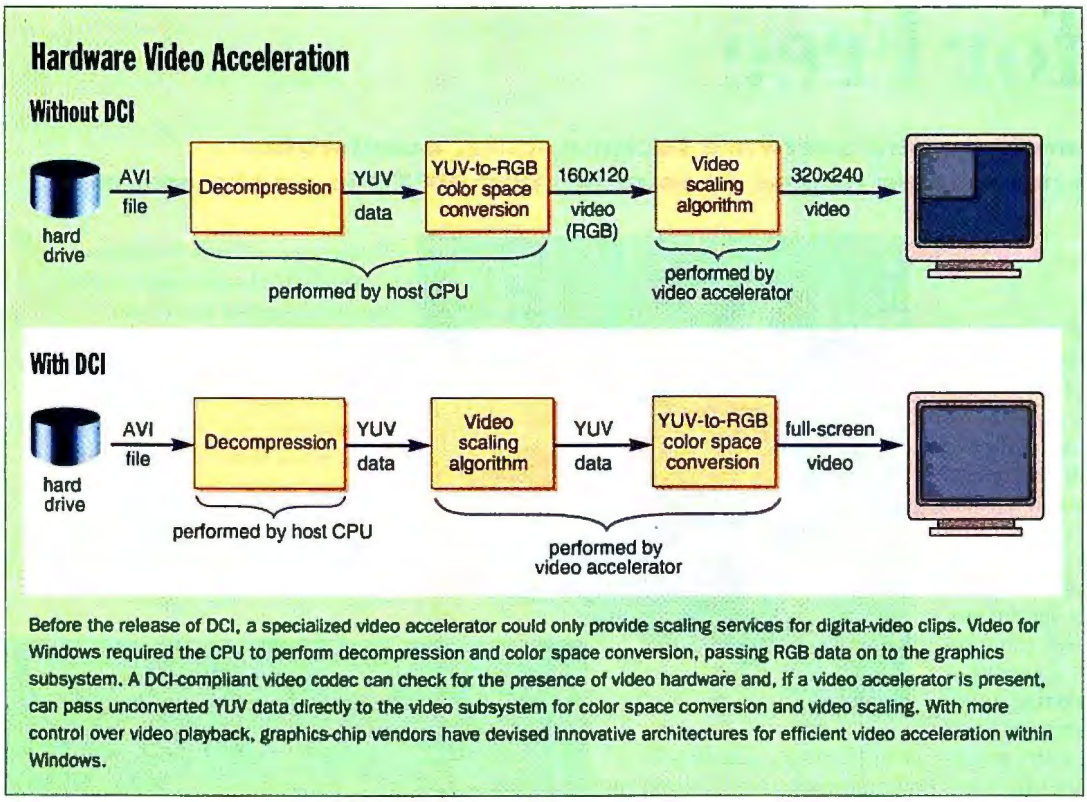
Video Playback's First Pass

Digital-video boards for Windows have been available for quite some time, but they have been expensive and difficult to install and use. Sigma Designs was the first company to successfully bring digital-video playback to a mainstream audience with its RealMagic board (dubbed ReelMagic at the time). RealMagic provided hardware-based decompression of MPEG video files. Sigma employed C-Cube's CL450 video processor along with its own proprietary video-acceleration chip (called Piccolo) to perform all pixel interpolation, line doubling, smoothing, and scaling algorithms.

RealMagic proved that there was a market for MPEG decompression boards, even at a time when few MPEG titles were available, but the board suffered from some limitations. RealMagic had no on-board VGA. Digital-video boards have typically relied on *VGA pass-through*, routing the VGA signal across a feature connector. Given the bandwidth limitations of a standard VGA feature connector, the graphics subsystem is confined to a maximum 640- by 480-pixel screen resolution. The feature-connector architecture has also been plagued by performance and compatibility problems.

Color shifts and shimmering problems afflict some models of VL-Bus cards when connected to RealMagic through the VGA feature connector. According to Sigma, this problem is caused by the way the VESA (Video Electronics Standards Association) pass-through specification delivers MPEG 1 video's 15-bit color depth (the same color depth as NTSC TV) to a VL-Bus display adapter working in higher color modes.

Sigma recently announced RealMagic Rave, its MPEG playback adapter with an on-board graphics accelerator. It will continue to offer RealMagic Lite as well, but if you opt for the feature-connector solution, you should call Sigma first and make sure your VL-Bus adapter works correctly with RealMagic. Despite the limitations,



Before the release of DCI, a specialized video accelerator could only provide scaling services for digital-video clips. Video for Windows required the CPU to perform decompression and color space conversion, passing RGB data on to the graphics subsystem. A DCI-compliant video codec can check for the presence of video hardware and, if a video accelerator is present, can pass unconverted YUV data directly to the video subsystem for color space conversion and video scaling. With more control over video playback, graphics-chip vendors have devised innovative architectures for efficient video acceleration within Windows.

RealMagic continues to be a driving force in pushing MPEG 1 as a major digital-video standard. With a compatible graphics adapter, the quality of video is outstanding. However, RealMagic does not accelerate more common software codecs such as Microsoft's Video 1, Intel Indeo, and SuperMac Cinepak.

VideoLogic's AVI Accelerator

One of the first single-board solutions for graphics and video acceleration is VideoLogic's 928Movie. The card uses S3's 86C928 graphics accelerator with 32-bit memory interleaving. The primary purpose of the 928Movie is to accelerate motion-video playback of Indeo, Cinepak and Microsoft Video 1 digital-video files.

The 928Movie uses VideoLogic's custom PowerPlay32 Digital Movie Accelerator ASIC (Application-Specific IC) and SmoothScale algorithm for YUV-to-RGB color space conversion and video scaling. The result is excellent full-motion playback even for video stretched beyond a 320- by 240-pixel window. Subjectively, though, we found that the AVI clips—even with the 928Movie's help—did not approach the quality of MPEG digital video. The motion is smooth, but the picture quality is somewhat blocky because of codec limitations. An announced upgrade to the Indeo codec may help.

The 928Movie also hosts a VMC (VESA Media Channel) architecture. The VMC provides an optimized data path for passing video data to other video components, such as capture cards, codec accelerators, or scan converters. By using the VMC, video components avoid passing data across the host system bus. Unfortunately, the general market has not embraced the VMC.

One of the VMC options VideoLogic offers is a hardware MPEG decoder. The $349 MPEG Player occupies a second slot and, like Sigma's RealMagic, uses C-Cube's CL450 acceleration chip. VideoLogic also employs its own Powerstream ASIC, a video-acceleration chip that works in conjunction with the CL450. Color palette shifts didn't affect video data passed across the VMC, even when we used the same graphics accelerator that caused problems with the RealMagic adapter.

We found the quality of VideoLogic's 928Movie, coupled with the MPEG Player adapter, simply superb. A 928Movie matched with the MPEG Player delivers a unified, expandable solution for accelerating AVI (Audio Video Interleave) and MPEG digital video. VideoLogic is now shipping a PCI (Peripheral Component Interconnect) adapter, the PCIMovie, with the PowerPlay32 video accelerator, a Weitek P9100 graphics accelerator, and the VMC architecture.

The DCI Interface

Before Intel and Microsoft released the software DCI layer, video accelerators such as the PowerPlay were very limited in what they were able to do. This limitation was not inherent to the chips themselves; video-playback software that could not take advantage of the specialized hardware imposed it.

Before DCI, Video for Windows would use the host CPU for compression and YUV-to-RGB conversion and then pass the RGB data to the video subsystem. Under this scenario, a specialized motion-video chip would get the data only after it was converted to RGB format. The only video function left for it to accelerate was video scaling.

DCI is a low-level interface that allows the video-playback software direct access to hardware-specific capabilities of the video subsystem. DCI coordinates with the Windows GDI (Graphical Device Interface), allowing the GDI to be bypassed for video playback when appropriate. DCI-compliant applications can check for the presence of specialized video hardware through the hardware's DCI driver. The DCI driver can then directly access the video frame buffer to dramatically improve throughput. With DCI, the video accelerator's driver can instruct the playback software to pass YUV data to it, allowing the video chip to perform color space conversion instead of the host CPU (see the figure "Hardware Video Acceleration").

Windows Accelerators Do the Video Thing

The DCI design enables a device-independent way for digital-video codecs to access specialized hardware features. DCI promises to drive innovation from both the software end and the hardware end. The graphics subsystem can now request raw YUV data and then process the video data totally within the confines of the graphics architecture. The graphics-chip vendors have responded with a flurry of announcements, heralding optimized motion video and graphics acceleration within a coordinated

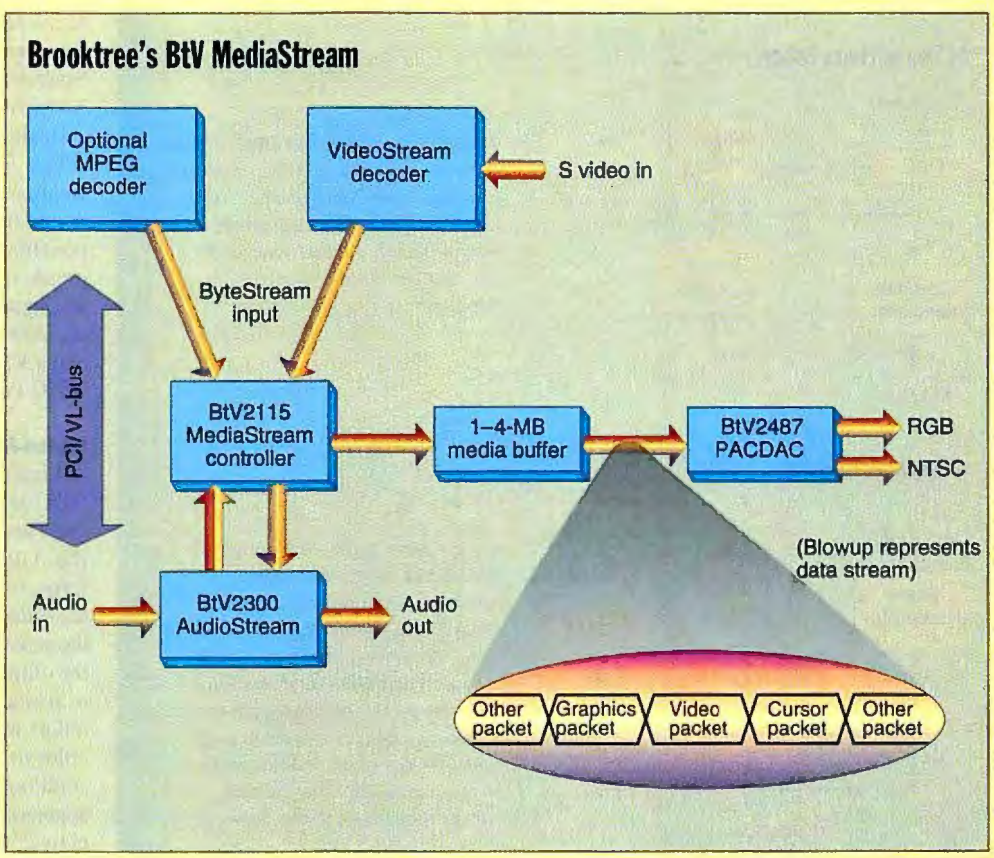
Packetized Multimedia

Brooktree (San Diego, CA, (619) 452-7580) plans to take multimedia integration a step further by combining video, graphics, and audio data within its BtV MediaStream chip set. The chip set supports accelerated graphics at up to 1280- by 1024-pixel resolution, 16-bit stereo sound, and full-motion (30 fps) video windows. A single media controller caches audio, video, and graphics data types into a common buffer (called the MediaBuffer). The video-memory-based MediaBuffer feeds a special RAMDAC (dubbed the PACDAC) that can store packetized data.

All multimedia data is converted into small data packets that stream across a high-speed internal bus and are stored in the MediaBuffer (see the accompanying figure). Audio packets are passed back through the controller to the audio chip. The compressed display data consists of separate graphics, video, and cursor packets that flow along a 200-MBps bus to the PACDAC.

The MediaBuffer is logically separated into a graphics frame buffer and a video frame buffer, so that video and graphics can remain in their own color space. The PACDAC performs color-space conversion and video scaling as it sends the RGB data to the screen. Retaining separate color spaces enables graphics and video to display at independent color depths. Video can remain in its most compact format until converted by the PACDAC. A MediaStream-based graphics card will be able to support 1024- by 768-pixel by 256-color resolution on the Windows desktop while also displaying true-color video playback in a window.

Brooktree will target BtV MediaStream at both the add-in card market and as a motherboard component of PCI-based Pentium PCs.



architecture. Some architectures are already in place but will benefit greatly from the DCI initiative.

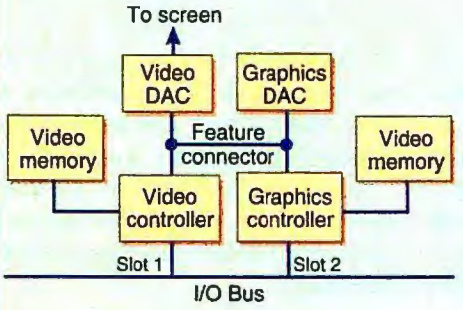
Weitek Corp. (Sunnyvale, CA, (408) 738-8400) uses a dedicated chip—the Video Power coprocessor—for video scaling, color space conversion, and dithering (to emulate high-color video in 256-color mode). And yet Weitek also integrates video and graphics acceleration into a single architecture. Unlike earlier feature-connector solutions, the Weitek Power 9100 graphics controller and the Video Power coprocessor share a single video-memory frame buffer (see the figure, "Video Architectures"). The *shared frame buffer* not only reduces the cost by requiring less video memory, it also enhances performance by passing video data along the frame-buffer bus instead of the system bus.

The Tseng Labs (Newtown, PA, (215) 968-0502) architecture relies on a *single frame buffer*. A shared frame buffer requires two memory controllers that must negotiate for access to the video memory. Instead of arbitrating the frame buffer between the video processor and graphics accelerator, the Tseng Labs W32p graphics chip uses a "multiport cache" design. A fast cache sits on the front end of the W32p. YUV data flows to a Viper entry port of the VGA (Viper is the Tseng Labs video-acceleration chip). The Viper accepts the data, converts and scales it, and then loads it into the multiport cache. All the display data—video and graphics—is then stored in the frame buffer. The single-frame buffer design avoids any latency caused by arbitration between two controllers for buffer access.

Tseng Labs' latest video accelerator, the Viper f/x supports screen resolutions of

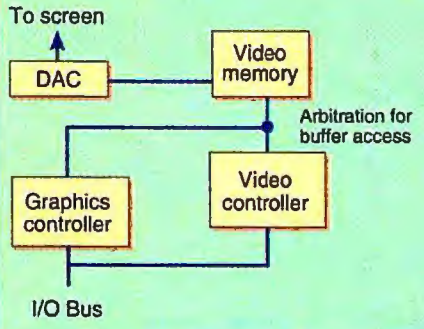
Video Architectures

a) Dual Frame Buffer



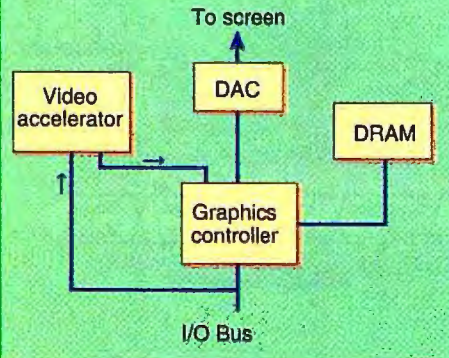
In a dual-frame-buffer architecture, the video-acceleration board plugs into the host system's I/O bus and connects to an existing graphics adapter via the feature connector. Each accelerator uses its own video memory and DAC (D/A converter). The feature connector limits screen resolution to 640 by 480 pixels and suffers from incompatibilities with some board combinations.

b) Shared Frame Buffer



With a shared-frame-buffer interface, the graphics accelerator and video processor share one video-memory buffer, lowering memory requirements. Both accelerators feed the buffer, and each requires its own controller to arbitrate access to video memory.

c) Single Frame Buffer



A single-frame buffer routes converted video data through the graphics controller. All the display data—video and graphics—is then stored in the frame buffer. No buffer arbitration is needed because the graphics controller alone feeds the buffer. The single-frame-buffer architecture also requires only a single communications port to video memory, so inexpensive DRAM can be used instead of dual-ported video memory.

up to 1024 by 768 pixels by 24-bit color. Tseng Labs has also announced a single-chip solution for graphics and video acceleration. The company will continue to market a dedicated video processor as well, claiming that a dedicated video accelerator can support a wider range of video formats and functionality. A dedicated processor does not have to make as many size and cost trade-offs as a single-chip architecture, so it can support a wider range of YUV conversions, for instance.

By the same logic, a dedicated processor could support more sophisticated interpolation algorithms than is possible with a single-chip architecture. To scale video beyond native size, video chips must add pixels to enlarge the video window. These pixels can be created by *replication* (simply replicating an adjacent pixel) or by *interpolation* (using an algorithm to determine the optimum characteristics of the pixel). Clearly, interpolation is the preferred method, but interpolation algorithms vary widely. At the most basic level, the chip could simply average the color values of two adjacent pixels and create the new pixel with the resulting color value. Very little memory would be required to process this logical operation. But as more sophisticated algorithms are employed for pixel interpolation, more memory and chip complexity are required as well. Again, these requirements may exceed the size and cost limitations of a single-chip solution.

Jazz Multimedia's Jakarta board uses the Tseng Labs chip combination—the Viper video accelerator and the ET4000/W32P graphics accelerator—as a base platform to build a modular video solution. The standard Jakarta board delivers video-playback acceleration, including hardware MPEG decompression and graphics acceleration. Snap-on modules add a TV tuner and NTSC/PAL output. The Jakarta represents a strategy many graphics vendors will adopt: Deliver a standard video-playback solution on the graphics card and add higher-end functionality through modular components. The latest version of MGA Impression Plus starts with a 64-bit graphics accelerator and DCI driver; a snap-on module includes the new 64-bit PowerPlay64 and a VMC connector to support any other VMC-compatible video hardware.

On-the-Fly Video

Alliance Semiconductor (San Jose, CA, (408) 383-4900) takes a similar approach to the Tseng Labs single-buffer design, but the Alliance ProMotion-3210 chip performs scaling and color space conversion as the video data shifts out of memory and to the screen. As the screen is being refreshed, the chip can switch color depth on-the-fly as it scans across the screen, sending 256 colors to the graphical desktop and 24-bit color to a video window. The single-chip solution supports full-motion, 24-bit video acceleration along with 1024- by 768-pixel by 256-color graphics acceleration within a single megabyte of DRAM. Alliance claims that its chip can enable motion-video acceleration for an additional cost of less than $10 per system.

Once again, DCI is the key to this technology. DCI creates a surface in video memory that can be on-screen or off-screen. This surface is an area that the video codec can write to directly. Different vendors take advantage of this capability in different ways. Currently, many implementations perform video scaling and color space conversion before sending the processed data to the frame buffer. Scaling and conversion in real time requires high-speed circuitry that can match the refresh

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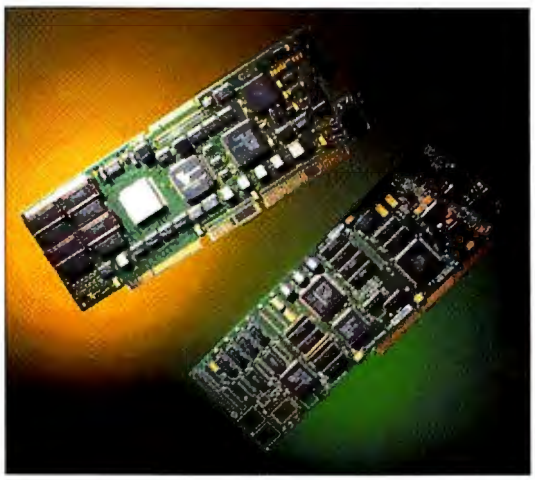

Two early harbingers of the coming wave of low-cost PC-based video accelerators: Sigma Design's RealMagic MPEG decoder (below) and VideoLogic's 928Movie (above), one of the first cards dedicated to accelerated playback of AVI files. The 928Movie was also first to implement the VESA Media Channel.

rate of the computer monitor, but overall cost is lower because a small amount of DRAM can be used effectively. In addition, the Alliance chip delivers true high-color video, instead of resorting to dithering to simulate high color in the video window.

All-in-One Chips

The trend is clearly toward integrating all video- and graphics-acceleration components onto a single slab of silicon. S3 (Santa Clara, CA, (408) 980-5400) has introduced the Vision868 (DRAM-based) and Vision968 (video-memory-based) Multimedia accelerators. The Vision series integrates a 64-bit graphics engine, color space conversion, scaling, and dithering on a single chip. The latest version of Diamond MultiMedia's Stealth 64 VRAM series will soon offer an extensible architecture featuring the Vision968. The baseline adapter comes with graphics and video acceleration; add-on modules enrich the architecture with MPEG playback and video capture.

Similarly, Cirrus Logic (Fremont, CA, (510) 623-8300) has announced its MotionVideo Architecture. Cirrus goes even further than S3: The company not only integrates a graphics engine and video accelerator into its CL-GD5440 chip but also packs in a 24-bit DAC (D/A converter) for good measure. Internally, the chip uses a single frame buffer that supports different color depths between video and graphics. The company has also announced an 800- by 600-pixel LCD VGA controller with integrated video acceleration.

Perhaps the most ambitious new architecture is Brooktree's MediaStream (see the text box "Packetized Multimedia"). MediaStream sends multimedia packets to a specialized DAC that decodes the packets on-the-fly. Brooktree, along with other chip vendors, is already shipping a video-enabled DAC that performs on-the-fly color conversion and scaling. These video DACs are pin-compatible with existing DACs; theoretically, a board maker could simply plug in the video DAC to video-enable an existing graphics adapter. In operation, though, the graphics accelerator must be able to let the video DAC know that YUV data is being passed to the DAC for conversion and scaling. Not all graphics chips deliver the signaling requirements to support a pin-compatible video DAC.

And the Winner is . . .

After all these new digital-video solutions come to market, the big winner could be the MPEG video codec. MPEG is generally accepted as a higher-quality codec than Indeo or Cinepak. In fact, MPEG 1 was specifically designed for high-quality playback from a single-speed CD-ROM (150 KBps). Unfortunately, the high compression ratios supported by MPEG (up to 200 to 1) require sophisticated algorithms and, hence, intensive computational resources. The demands of MPEG decompression created the market (that RealMagic currently owns) for MPEG boards.

But these new video-playback architectures present a clear threat to hardware MPEG decompression boards. With other processor-intensive tasks such as color space conversion and video scaling being off-loaded to mainstream graphics adapters, high-end host CPUs can now handle real-time MPEG decompression. In fact, many of the graphics chip makers plan to ship a software-based MPEG player from Xing Technology (Arroyo Grande, CA, (805) 473-0145) with the new video-enabled graphics accelerators. Consumers will then be able to play MPEG-1 CD-ROM titles without dedicated MPEG hardware.

Commodity Video

By midyear, graphics adapters with accelerated playback of digital video will be in the same commodity market as today's Windows accelerators. This is great news if you appreciate the latest applications and multimedia titles that feature motion-video clips. But it will require more understanding of video technologies. A vendor's claim of "video accelerated" will not necessarily translate into high-quality, full-motion video playback. The video tag will be somewhat like the claims of "all natural" on supermarket shelves. More than ever, you'll need to do your homework to make sure you're getting what you think you are. ■

Stanford Diehl is director of BYTE reviews. You can reach him on the Internet or BIX at sdiehl@bix.com. Greg Loveria is a technical writer, animator, and consultant. He is also a contributing editor for McGraw-Hill's DataPro books and president of the National Association of Music Shareware. Greg lives in Binghamton, New York and can be reached on the Internet or on BIX at loveria@bix.com.

About the Products

RealMagic Lite $349
RealMagic Controller with audio playback $449
RealMagic CD-ROM Upgrade Kit $799
RealMagic Rave (with graphics accelerator) $489

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2MB VRAM without audio $449
2MB VRAM with audio $549
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MPEG Player $299
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Jazz Jakarta $499
Jazz Multimedia
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Stealth 64 VRAM $399
4MB VRAM $599
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Make Bulletproof SQL Queries

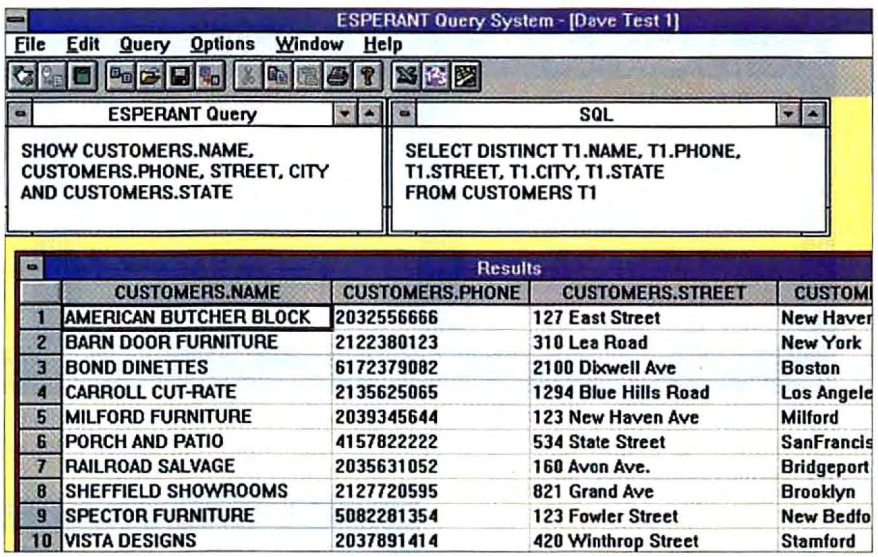
Esperant's natural-language expert protects you from the perils and pitfalls of SQL code

DAVID S. LINTHICUM

Can the vice president of your company use SQL to create ad hoc database queries and reports? Is the very thought so farfetched that it makes you smile? If so, you're probably all too aware of the harsh reality of end-user database querying: Nontechnical users are as unready, unwilling, and unable to write SQL in the 1990s for ad hoc database access as they were to write COBOL for the same purpose in the 1980s.

Several products, including PowerSoft's PowerViewer and Microsoft Access, have entered the market in response to the need for ad hoc database access that's easier for users to work with. These tools provide an intelligent layer between you and the language through a point-and-click graphical interface. Even with such help towards constructing SQL statements, though, you might find SQL too complex and vulnerable to human error.

Software AG's Esperant offers a friendlier, less error-prone way to get at data without going through the pain of generating your own SQL statements. The Windows-based program delivers an intuitive interface and protects users from the complexities of SQL, and from themselves. It also provides an easy means of defining, customizing, and protecting data. Esperant supports most databases, including Sybase, Oracle, ADABAS SQL, Rdb, DB2, and most ODBC (Open Database Connectivity) or QELIB data sources.



	CUSTOMERS.NAME	CUSTOMERS.PHONE	CUSTOMERS.STREET	CUSTOM
1	AMERICAN BUTCHER BLOCK	2032556666	127 East Street	New Haver
2	BARN DOOR FURNITURE	2122380123	310 Lea Road	New York
3	BOND DINETTES	6172379082	2100 Dixwell Ave	Boston
4	CARROLL CUT-RATE	2135625065	1294 Blue Hills Road	Los Angele
5	MILFORD FURNITURE	2039345644	123 New Haven Ave	Milford
6	PORCH AND PATIO	4157822222	534 State Street	SanFrancis
7	RAILROAD SALVAGE	2035631052	160 Avon Ave.	Bridgeport
8	SHEFFIELD SHOWROOMS	2127720595	821 Grand Ave	Brooklyn
9	SPECTOR FURNITURE	5082281354	123 Fowler Street	New Bedfo
10	VISTA DESIGNS	2037891414	420 Winthrop Street	Stamford

The Query System lets you create queries in Esperant's English-like language. The SQL translation is automatically displayed in a separate window. The results of the query appear at the bottom.

The Tool Set

Esperant consists of two major subsystems: the Query System and the Administration System. The Query System helps you construct queries and reports by writing statements in an English-like, proprietary Esperant language. You can enter information in an intuitive graphical interface that offers expert assistance, or you can create SQL statements directly. A set of interface components let you create, save, and recall queries as well as reports. You can then take the results of any query and export the information to other applications.

The Administration System is a tool designed more for database administrators than for casual users. It lets you create conceptual views of the database (called DataViews), as well as specify centralized security, user privileges, and resource constraints.

Hiding SQL

Esperant differs from competing SQL interfaces in that it can isolate you from the SQL layer while guiding you with an "expert system" interface. It uses its own SQL Expert running behind the scenes to encode and control the SQL rules and database descriptions so you don't have to deal with the details. Before defining a query, the SQL Expert gets information about the databases it is using, storing it in an Esperant DataView. Using this information, the expert system determines how you can best deal with the database structure, disallowing mistakes and providing vital information during the construction of the query.

You deal with the Query Assistant, which tells you how to construct each database query to assure success and accuracy. As you use the Query Assistant's point-and-click interface to define your query, Esperant generates Esperant language statements as well as SQL in separate windows. The SQL Expert works behind the scenes as you define your query, instantly changing and displaying only valid query clauses, tables, and columns. With SQL Expert on the job, it's hard to make an SQL syntax error.

For example, to select and display information from a customer table using Query Assistant, you use the mouse to choose both the table and the columns you want to see. You simply select from lists; you don't need to know the structure of the database. You can then further define the query by adding more selection criteria or calculations.

Simply put, the Esperant language is easier to comprehend than SQL. Esperant expresses the query using structured English-like syntax that lets you "talk" to the database. You can use SQL or the Esperant language to create or modify a query, but you don't really need to know either when using the Query Assistant. Once you're happy with the query, you simply choose Run Query from the Query Assistant or from the icon bar, and the information you requested appears on the screen. From there, you can save your query, print the information, define a formal report, or move the information to a spreadsheet.

continued

Right Syntax, Wrong Result: How SQL Can Go Awry

Esperant's SQL Expert is designed to prevent you from making choices that, though syntactically correct, violate the underlying logic of the query, producing inaccurate reports. Software AG offers the following scenario to illustrate how such a mistake can happen.

Start with a database that consists of the following three tables for customer name, orders, and order detail:

Customer Table

CUST #	CNAME
1	Acme Manufacturing
2	Custom Supplies

Order Table

CUST #	ORD#	ORDER$
1	10	5
1	11	3
2	20	6
2	21	4

Order Detail Table

CUST #	ORD#	ITEM#	QTY
1	10	100	2
1	10	200	3
1	11	100	5
2	20	100	3
2	21	200	6
2	21	300	7

To create a query that returns each customer's total number of orders and order dollars, most query tools would allow a point-and-click query that generates the underlying SQL SELECT statement below. The database would perform the required joins to construct the following (undisplayed) table:

```
SELECT T1.CNAME,SUM(T2.ORDER$),
    SUM(T3.QTY)
 FROM CUSTOMER T1, ORDER T2,
    ORDER_DETAIL T3
 WHERE T1.CUST# = T2.CUST#
   AND T2.ORD# = T3.ORD#
 GROUP BY T1.CNAME
```

=

CUST #	CNAME	ORD#	ORDER$	ITEM#	QTY
1	Acme Manufacturing	10	5	100	2
1	Acme Manufacturing	10	5	200	3
1	Acme Manufacturing	11	3	100	5
2	Custom Supplies	20	6	100	3
2	Custom Supplies	21	4	200	6
2	Custom Supplies	21	4	300	7

SQL would then do the summing against the internal table, displaying the following report:

CNAME	SUM ORDER$	SUM QTY
Acme Manufacturing	13	10
Custom Supplies	14	16

The SUM(ORDER$) results, though they look fine at first glance, are actually incorrect. That's because ORDER$ has been duplicated for each Order Detail record, causing it to be overstated when the summing is performed.

According to Software AG, only a user with a good grasp of SQL theory would have known that summing at two levels of detail in the same SELECT statement would produce erroneous results. Unlike most query tools, Esperant's SQL Expert would have grayed out the QTY column the instant you chose to SUM the ORDER$ column. The query would produce the following SQL code along with the correct report table:

```
SELECT T1.CNAME, SUM(T2.ORDER$)
 FROM CUSTOMER T1, ORDER T2
 WHERE T1.CUST# = T2.CUST#
 GROUP BY T1.CNAME
```

=

CNAME	SUM ORDER$
Acme Manufacturing	8
Custom Supplies	10

Esperant has no trouble performing complex queries using multiple databases and joins. For example, you can display the total sales (from an order table) for each customer (from a customer table) who ordered more than three products. To define the query, you can use Query Assistant to walk through each step, or you can enter the Esperant language directly.

One of the best things about the Query Assistant is that it uses an expert system that "understands" the database and knows what operations can be performed on particular columns and tables. In other words, it doesn't give you the opportunity to make mistakes. For instance, when selecting columns defined as characters, Query Assistant automatically grays out such numerical operations such as total, average, minimum, and maximum. If it allowed you to perform these operations, you'd get SQL syntax errors or, worse, the wrong data. Other products, such as Microsoft Access and PowerViewer have yet to implement this type of protection, but in Esperant, it's what lets Software AG guarantee that the program won't produce erroneous query results.

Reporter Notes

It doesn't take long to master the Query Assistant; once you've done so, it's time to see how Esperant can take the results of your queries and create professional-looking reports. From the Query System main menu, you select Format Result. The Esperant Reporter then uses a "banded" approach to create a report, in which each band represents a section of the report. In true Esperant fashion, the Reporter provides a Helping Hand (wizard) feature that automatically generates basic columnar, cross-tab, mailing-label, or row-oriented formats.

If you need to do further customization or create a report from scratch, Esperant handles that, too. Creating a report is just a matter of dragging and dropping such items as data fields and text labels onto your report. You also have controls for grouping, sorting, subtotaling, and generating special effects, such as fonts, colors, drawing tools, shading, or even embedding of OLE 2.0 objects. To create calculated fields, you have a choice of Esperant's own Reporter BASIC language or—if you're feeling bold—SQL. The Reporter lets you combine the results of several Esperant queries using different databases, and even different database engines in a single report.

Administrative Assistance

If you need to do some basic database administration, you use the Administration System to create Esperant DataViews and administer access to the databases. Although they're not required for query and report operations, DataViews can translate the physical view of the database into a business view that's easier for most people to understand.

The tables and columns in the databases become business categories and items, so you can select tables and columns without understanding the database structure or SQL. Moreover, DataViews provide the data semantics that the SQL Expert system employs, protecting you from semantic errors.

To create a DataView, you simply select AutoBuild from the File Menu and choose a connection type (e.g., Entire Access, Q+E Library, ODBC, Oracle Native, Sybase native, or TechGnosis SequeLink). From there you select your database source and specify the storage location for your DataView (each DataView must have its own directory). The final step is the Options dialog box, where you let Esperant know if you want to include tables, views, synonyms, or a combination of the three. After that, your DataView is generated automatically, and it is ready for use in the Query System.

In addition to defining DataView, the Esperant Administrator also lets you add and delete users and user groups from the database. The program allows the administrator to assign all users unique IDs and passwords, which in turn are mapped to a user group. You can also set resource limits for each user group, restricting the amount of time one can execute a query, as well as the number of records one can retrieve in a single operation.

2.1 = 1.0

Despite the fact that Esperant is identified as version 2.1, this is really the first release of the product, and it has a few kinks to work out. First of all, Esperant doesn't provide business graphics. Some competing query tools can create pie, bar, and line charts, along with other ways to represent your data graphically. On the other hand, Esperant makes it easy to export the data to spreadsheets that support graphics. Built-in graphics will show up in an upgrade planned for later this year, according to Software AG.

Another problem involves poor links with other applications. If you want to integrate the power of Esperant with other applications using DDE or OLE, you're going to be disappointed. Esperant can only act as a DDE server: It can send data to other applications, but it can't receive data (Software AG says you wouldn't expect a read-only tool like Esperant to have this capability anyway). Esperant can act as an OLE 2.0 client, allowing the embedding of images inside reports, but it does not take advantage of all OLE capabilities. Full OLE support is planned for the new version, scheduled for released in mid-1995.

There are a few bugs in Esperant as well. During my testing, it produced a few Windows GPFs (General Protection Faults) which were only solved by shutting down and restarting Windows. Experienced Windows users might take such crashes in stride, but this problem will annoy the less technical—Esperant's primary target audience. (Software AG reports no serious complaints from customers who have also experienced GPFs, which it considers an unpredictable phenomenon of Windows memory management that a single program patch can't fix.)

Esperant is not a development tool. It's a program you give end users, so they can perform do-it-yourself, ad hoc database querying and reporting. The Query System is first rate, and even the most inexperienced users will be retrieving data in no time. The Query Assistant acts as a friendly tour guide through the construction of each query, and more important, it protects you from making mistakes that could result in syntax problems or erroneous information.

The reporting facility is adequate for most uses. The Administration System is not a full-blown database hack tool, but it does allow you to represent the most perplexing physical database structures in ways that make sense to business users. Overall, Esperant is an effective SQL interface for those who would rather not deal with SQL. ■

About the Product

Esperant 2.1 ..... $595
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David S. Linthicum is a systems manager for Mobil Oil in Fairfax, Va., and an adjunct professor of computer science at Northern Virginia Community College. He can be reached on BIX c/o "editors."

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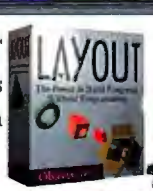

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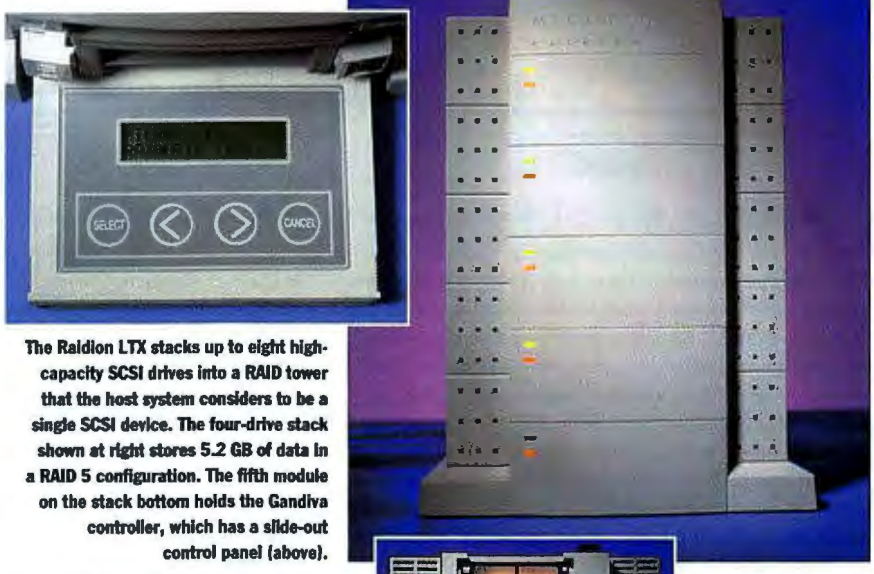
Simple, Scalable RAID

A scalable stack of drives and built-in RAID controller make Raidion LTX a flexible, off-the-shelf RAID solution

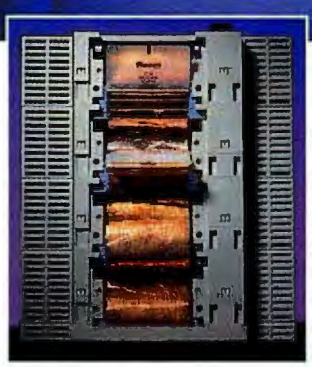
STEVE APIKI

RAID has never been generic. For all its appeal as a low-cost fault-tolerant technology, RAID has often been limited to custom-tailored, platform-specific, monolithic installations. The Raidion LTX from Micropolis takes a new approach: a scalable stack of drives that can start small and grow with storage requirements. What's more, the Raidion looks to the outside world like a single SCSI target, making it a RAID solution for Unix and Mac systems, as well as more commonly targeted NetWare servers.

Raidion LTX is designed to scale readily, and it meets this goal nicely. But like all RAID systems, its primary goals are maximum uptime and bulletproof data protection. Performance tests of the Raidion LTX show that it's a fast system, and I certainly didn't find any problems with data reliability. If there is a downside, it's that the design features of the Raidion that make it so modular (e.g., its cabled backplane) also provide the potential for some minor failure when compared to less flexible RAID systems.



The Raidion LTX stacks up to eight high-capacity SCSI drives into a RAID tower that the host system considers to be a single SCSI device. The four-drive stack shown at right stores 5.2 GB of data in a RAID 5 configuration. The fifth module on the stack bottom holds the Gandiva controller, which has a slide-out control panel (above).



A terminated daisy chain of SCSI ribbon cables (left) connects drive modules, allowing flexible configuration of SCSI channels within a Raidion stack and making it possible to chain multiple Raidion stacks (with up to 28 drives) together via a single Gandiva RAID controller.

Building Blocks

A Raidion LTX array is built from between two and eight drive modules stacked on top of a base containing Micropolis' Gandiva RAID controller. The drive modules consist of a plastic shell that interlocks with the modules above and below, to which the SCSI connectors attach at the rear. The drive unit inside each module can be hot-swapped in and out of the array. To replace drives, you just pop off the module front cover, pull the drive handle to unlock the unit, and slide it out of the shell.

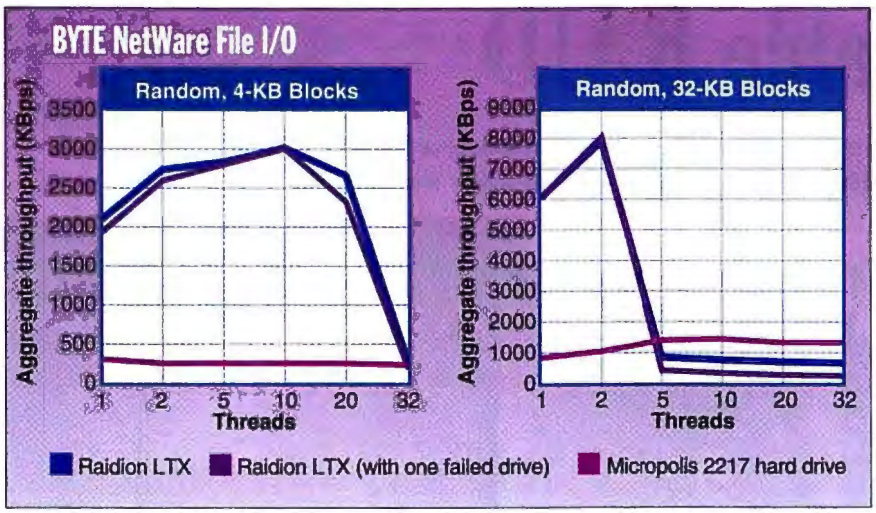
Hot-swappable drive units, complete with individual power supplies, plug into the back plane connector in each module shell.

Each module, including the controller, has its own power supply. As you build up an LTX array, stacking one module atop another, you plug each module into the power outlet sticking up from the module below and hook the new drive into the SCSI chain that runs up the back of the array. The host system connects to the controller module via a Fast-and-Wide SCSI-2 connection at the base of the stack.

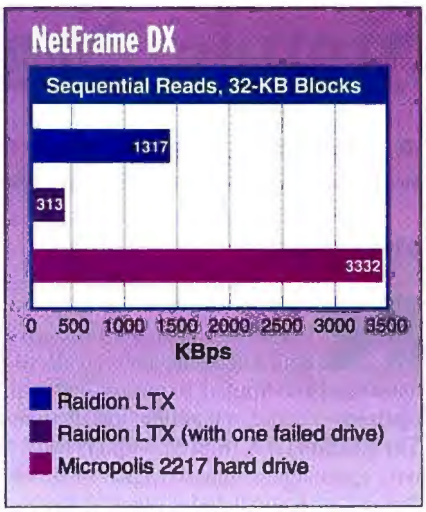
Instead of the rigid back plane found in most RAID systems, the Raidion SCSI bus consists of a daisy chain of short ribbon cables that connect at the rear of each module. The Gandiva controller supports up to four independent, synchronous SCSI-2 channels. Ribbon cables run from the Gandiva up through the drives in each channel, ending with a terminated cable stub. Because the Gandiva can support up to seven drives per channel, you can also daisy chain entire arrays by simply running an external SCSI cable from the last drive in the first stack to the first drive in the next. In this manner, you can build a single logical array of up to 28 drives (four stacks) from a single controller.

Although this scheme provides unparalleled flexibility, it is also the source of two potential problems. First, because a single power supply runs the controller module, it is a single point of failure on which the entire array depends. Second, large Raidion LTX configurations rely on a host of interconnected cables that must be installed carefully and kept securely attached. To this end, the cable connections within stacks are designed to fit tightly and attach at right angles to the cable plane, making it virtually impossible for them to work loose accidentally. They're also housed in an enclosed space accessible by removable panels. Further reducing the chance of problems and making installation easier is the fact that three- and four-drive Raidion units come as preassembled stacks.

In addition to preconfigured stacks, Micropolis also sells all the parts (and excellent documentation) for building your own arrays. I tested a preconfigured four-drive unit; hardware setup didn't involve much



Raidion LTX performance on the random portion of BYTE's NetWare File I/O tests. Each graph shows aggregate throughput as additional tasks (test threads) are added. Both figures show results for a single Micropolis 2217 1.7-GB hard drive for comparison. With small block accesses, (4 KB) the Gandiva controller's over 6 MB of cache keeps the Raidion operating at high-throughput levels until about 20 tasks are running, when throughput begins to degrade rapidly. With large block sizes (8 KB) the throughput is impressive, but once the cache is overwhelmed, the array's performance drops below that of a single drive. Both figures show only a small performance drop when operating with a drive down. The test does not take advantage of NetWare software caching.



Differences between a fully functional and an impaired array (with one of the four drives down) are more dramatic on sequential-access tests, where overhead from recalculating missing data takes its toll. The early LTX firmware I tested (in OLTP, not Multimedia configuration) did not implement a read-ahead cache, which Micropolis plans to add. As a result, the array did worse on this test with sequential I/O than a single hard drive (one of the Micropolis 2217 drives used in the array).

more than plugging in the SCSI cable. Micropolis sells both a wide-to-wide and a wide-to-narrow cable for attaching the drive to SCSI-2 host adapters, but connecting to a Mac isn't so easy: You need either a SCSI-2 add-in card or a (hard-to-find) converter from Mac DB-25 SCSI to SCSI-2. Micropolis says that it recommends NuBus SCSI-2 cards for performance reasons but is working with cable manufacturers to find a more readily available solution for standard Mac SCSI.

After hardware setup, you need to configure and format the array. Gandiva supports RAID levels 0, 1, and 5. You can set various stripe sizes and set up hot spares (spare drives that automatically come online to replace a failed drive), so you have a variety of configuration options.

Configuration, drive recovery, and other tasks are handled either through a menu-driven front panel or with software utilities. The panel pops out from the Gandiva controller module providing a two-line LCD and four input keys. I used the DOS and NetWare utilities, but preferred the front panel (which you can use while the array isn't attached to any host system). Full access to maintenance functions through the front panel makes the Raidion LTX a truly host-independent system.

Raidion LTX 5.2 Building Blocks

General specifications	
Array capacity	5.2 GB
Test configuration	4 drives, RAID 5
Drives/stack	2–8
Interface	Wide Fast SCSI-2
RAID controller	
Model	Gandiva
RAID levels supported	0, 1, 5
Maximum drives/controller	28
Processor	33-MHz R3051
Cache memory	8 MB
Drive units tested	
Model	Micropolis 2217
Capacity	1.76 GB
Seek time	10 ms
Latency	5.56 ms
External transfer rate	10 MBps
Power system	one power supply/drive, one power supply/controller
Software	configuration utilities for: DOS, NetWare, Macintosh, Sun OS/Motif[1], HP-UX[1], SCO/Motif[1], UNIX Ware/Motif[1], AIX/Motif[1]

[1] Motif-based configuration utilities are planned, but were not available at press time.

About the Product

Raidion LTX 5.2.....$13,470
Host interface cable....$125
Micropolis Corp.
21211 Nordhoff St.
Chatsworth, CA 91311
(800) 395-3748
(818) 709-3333
fax: (818) 701-2809
Circle 1001 on Inquiry Card.

Array Performance

With a fast hardware RAID controller like the Gandiva, a RAID-5 configured Raidion array benefits from increased performance as well as fault tolerance. In addition to a fast 32-bit RISC processor for performing RAID parity calculations, the controller has 8 MB of memory. In the test configuration, the Gandiva operating system takes up about 1.5 MB of that 8 MB of on-board RAM, leaving the balance available as a data cache.

Micropolis will offer the Raidion in two firmware versions, one for OLTP (on-line transaction processing) and the other for multimedia. It will also support a customized video-on-demand configuration through resellers. At this writing, Micropolis offers only the OLTP configuration that I tested. The OLTP firmware maintains a write-through transaction cache but does not support read-ahead caching, which is in the works for OLTP. As a result, random-access performance was much better than sequential access. My speed tests focused on random data access.

I ran BYTE's NetWare File I/O test with the Raidion LTX, the Raidion LTX with one failed drive (pulled), and a stand-alone 1.7-GB Micropolis 2217, which is the drive used in the test array (see the figure "BYTE NetWare File I/O"). The test measures throughput as access threads (simulating multiple users) are added. I ran these tests with a stripe size of eight 512-byte

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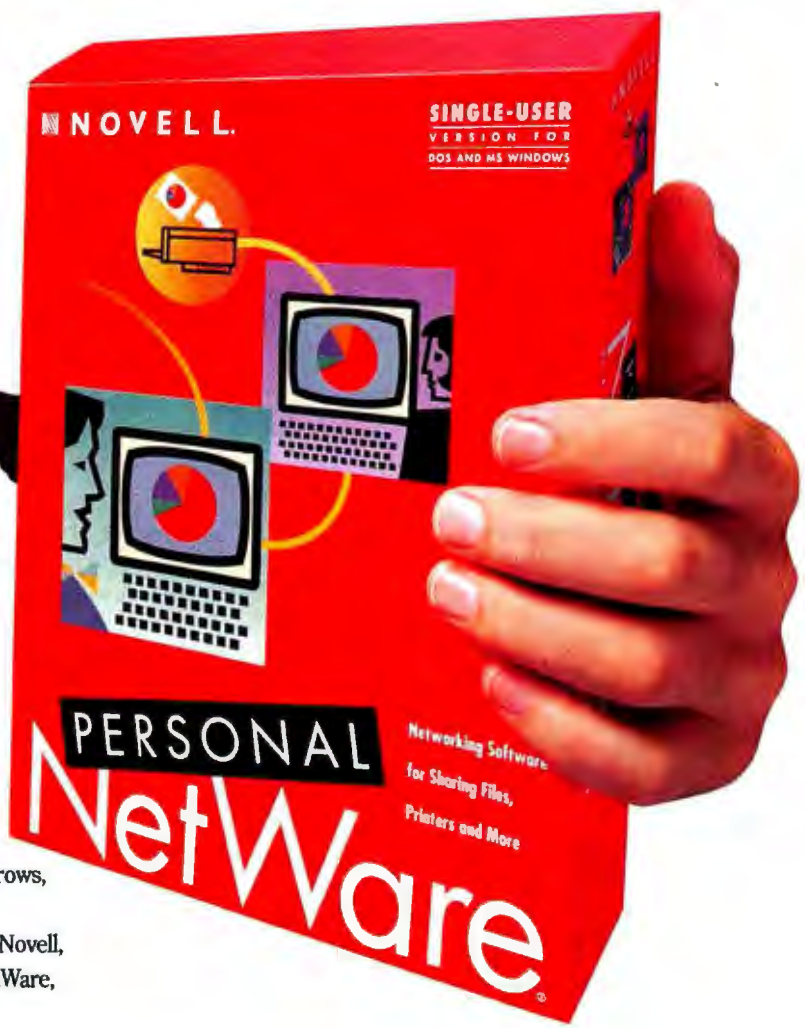

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blocks. With small access sizes (see the figure, "BYTE NetWare File I/O"—Random, 4-KB Blocks), the array peaks at just over 3-MBps throughput, much better than the single drive. With large access sizes (see the same figure—Random, 32-KB Blocks) aggregate throughput goes even higher (over 8 MBps), but once the cache is exceeded, performance drops off rapidly. In general, Raidion LTX showed excellent performance; the real lesson from the 32-KB test is that you must tune the stripe size to accommodate the size of typical data requests if you expect peak performance. In that test, block size was much larger than stripe size.

The random-throughput figures show little loss in speed when a drive is lost. This can be critical if you must maintain a certain performance level even under failure conditions. However, sequential performance, as measured by NetFrame's DX benchmark, does fall a bit off the pace when a drive goes down (see the figure "NetFrame DX").

The last critical performance metric is the time it takes to rebuild the array after failure. This is the window of vulnerability during which a second failure would be disastrous. It took just over 90 minutes (unloaded) for the Raidion to swap in a hot spare in a three-drive array.

How Raidion Stacks Up

There are some changes in the works for Raidion LTX: The 1.76-GB Micropolis 2217 drives will be replaced by larger 2.1-GB 4221 drives. Another option will be 9-GB drives. More important, the release of multimedia-tuned firmware and read-ahead caching should provide a big performance boost for sequentially oriented applications.

I found the Raidion LTX reliable, fast, and unbelievably easy to configure and maintain. Raidion's scalability and flexibility makes it a natural for smaller sites with critical data (like my consulting office) as well as larger, traditional RAID installations. At a price per megabyte of about $2.50, Raidion LTX stacks up reasonably against other fault-tolerant options, and larger companies with mixed-platform networks will save money from reduced spares. ■

Steve Apiki is a BYTE contributing editor and senior developer at Appropriate Solutions, Inc., a Peterborough, NH-based consulting firm specializing in multiplatform development. You can reach him on BIX at apiki or on the Internet at apiki@apsol.com.

Networks for the Enterprise

NSTL evaluates IBM OS/2 LAN Server 4.0, Microsoft Windows NT Server 3.5, and Novell NetWare 3.12 and 4.02

TADESSE W. GIORGIS

The NOS (network operating system) wars are hotter than ever. With the release of Windows NT 3.5, Microsoft has delivered a stable, robust system that runs on a variety of high-end hardware. NT is now poised as a powerful applications server for the coming wave of 32-bit multithreaded Windows programs. IBM is making lots of noise, pushing a revamped OS/2 as a premier enterprise platform. And Novell, feeling the heat like never before, has revamped its venerable NOS from the bottom up, vowing to keep its market strangle-hold.

This month, NSTL evaluates four major players in the fierce NOS market: OS/2 LAN Server from IBM; Windows NT Advanced Server 3.5 from Microsoft, and NetWare versions 3.12 and 4.02 from Novell. (Although NSTL originally planned to test Banyan Vines 5.54, hardware incompatibility forced us to drop the product from our evaluation.)

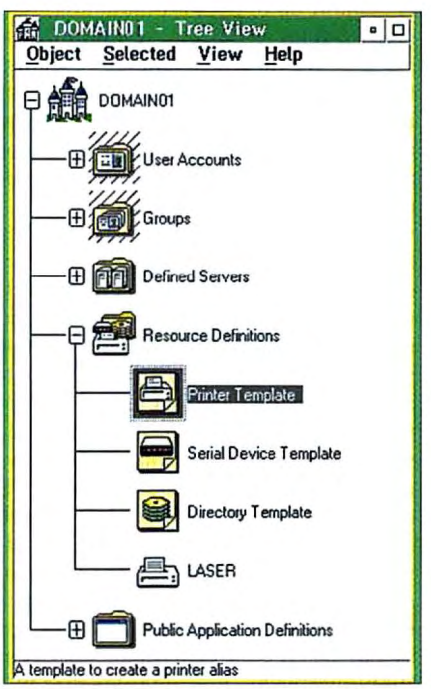
All of these products support multiple network interface cards in the server for multisegment network connections, although, to date, only Banyan and Novell allow internal bridging of multiple network segments in a single server. In addition to multiple adapter support on the server, the NOS product should be able to operate with large, multigigabyte disk array subsystems on Intel 386/486 and Pentium processors systems. Our evaluation criteria also required multiclient support (DOS, DOS/Windows, OS/2, Macintosh, and other desktop clients).

IBM OS/2 LAN Server 4.0

IBM's OS/2 LAN Server 4.0 provides resource sharing for files, printers, and serial devices among LAN Server, DOS LAN Requester (with and without Windows), and OS/2 LAN Requester systems on a Token Ring or Ethernet LAN (LAN Server also supports the broadband-based PC Network adapters). With the LAN Server for Macintosh option, Apple Macintosh computers on an AppleTalk network can access server machines on an IBM OS/2 LAN Server network and exchange System 7.0 files with DOS and OS/2 files.

IBM has made some major changes and additions to OS/2 LAN Server in version 4.0. The LAN Server administrative tools now use the object technology in the OS/2 Workplace Shell by representing all network resources as OS/2 icons. A user can be added to a group by simply picking up the icon and dropping it on the group. Administrators can manage multiple domains from any workstation, regardless of where the domain servers are located. To share server resources, the administrator just has to open a menu for the given object's icon to have the option of sharing, denying, and managing access rights, including printers, CD-ROM drives, and asynchronous resources. Public applications stored on the server can be allocated to a user or a group by dropping the application on that icon. The command-line interface is still supported for all version 4.0 functions, however. The following are other key enhancements made to IBM OS/2 LAN Server 4.0:

- **LAN adapter detection**—To address third-party adapter support issues, LAN Server includes a detection facility to identify a machine's installed network adapter and the jumper and switch settings on the card.
- **Multiple domain browse**—LAN Server clients have always had the option of a single log-on into multiple domains, but version 4.0 allows for global resource availability (regardless of a user's native domain). These cross-domain links allow users to access the tools they need, regardless of where they log on. In addition, LAN Server's aliasing feature lets users reference network resources without knowing where they are located on the network.
- **Enforced disk-space limits**—Network administrators can now enforce disk-space limitations on network users through the GUI or command-line interface.



With the object technology of the Workplace Shell, LAN Server 4.0 now represents all network resources as OS/2 icons.

OVERVIEW

NSTL RATING		VERSION	PERFORMANCE	VERSATILITY	EASE OF LEARNING	EASE OF USE	PRICE (10 USERS)
★★★★	Microsoft Windows NT Server	3.5	▲	▲	▲	▲	$1099
★★★★	Novell NetWare	4.02	▲	▲	▲	▲	$3195
★★★	Novell NetWare	3.12	■	▲	▲	▲	$2495
★★★	IBM OS/2 LAN Server	4.0	■	▲	▲	▲	$2795

KEY

★★★★★	Outstanding
★★★★	Excellent
★★★	Average
★★	Below average
★	Poor
▲	Good
■	Fair
▼	Unacceptable

Novell's recently released NetWare version 4.1 offers the following new features:

- More robust directory services, including tools for cutting, pasting, and merging directory trees and renaming containers.
- NetSynch synchronizes with NetWare 3.x networks. You can update NetWare 3.x servers from a NetWare 4.x server transparently.
- NetWare for OS/2 runs NetWare 4.x on top of OS/2 as a nondedicated server.
- Full NetWare support for Macintosh.
- A single point of administration for a user network ID and mail ID (mail is integrated into the NetWare directory).
- Smaller, 200-KB messaging engine integrates and uses a common directory (requires 6.5 MB on the back end).
- Price equal to that of NetWare 3.x. SFT3 integrated into the product. Licensing cost reduced from $11,000 to $1495 for 100 users or less and $3995 for 100 users or more.
- NLSP and NetWare/IP wide-area protocols.
- Includes French, Italian, German, and Spanish languages. Versions in Korean, Simplified and Traditional Chinese, Japanese, and Portuguese scheduled for release in August.
- Simplified installation only requires entering company name, password ,and time zone when installing single-server networks.

See this month's cover story by Jon Udell for an examination of Novell products and market forecast.

• **Performance improvements**—OS/2 symmetric multiprocessing is supported in LAN Server 4.0; OS/2 and LAN Server support up to four processors. To exploit Pentium processors, version 4.0 supports native-mode operation in caching. Peer-to-peer support is now available for DOS, DOS/Windows, and OS/2 clients, and Microsoft's Windows for Workgroups and Windows NT clients can connect directly to LAN Server machines.

• **DOS enhancements**—LAN Server takes advantage of client-server caching to reduce the number of DOS clients' cross-network requests for data, resulting in reduced network traffic. The DOS client now ships with an optional GUI that enables point-and-click connection, peer messaging, application launching, and resource sharing.

• **Transport improvements**—LAN Server is implemented with OS/2's MPTS (Multi-Protocol Transport Services), which allows for integration into a number of networking environments. On the protocol side, it includes full TCP/IP support, and a new version of the NetBIOS API for TCP/IP that is faster than before. Also, NetBIOS caching has been added to the OS/2 NetBIOS over the TCP/IP component.

As in version 3.0, the latest IBM NOS offering comes in two packaged versions: OS/2 LAN Server Entry and OS/2 LAN Server Advanced. LAN Server Advanced differs from LAN Server Entry on three key capabilities and functions that are available only on the high-end product: 386 HPFS (High-Performance File-System) support, fault tolerance for fixed disks (to support disk mirroring and disk duplexing), and local security support for the 386 HPFS partitions.

Microsoft Windows NT Server 3.5

With the release of Windows NT 3.5, Microsoft is shipping two distinct products, Windows NT Workstation and Windows NT Server. Windows NT Workstation is optimized to provide a high level of interactive application responsiveness, while Windows NT Server provides optimized network responsiveness. Specific workstation optimization measures include overall reduction of memory usage, higher system priorities for foreground (i.e., interactive) applications, and improved efficiency of both 16- and 32-bit desktop application operations. Similarly, specific optimizations for the server include better memory usage to cache large amounts of data, higher system priority for network users, and improved efficiency of 32-bit server application operations.

Microsoft Windows NT Server 3.5 is a hardware-independent NOS that runs on systems with Intel 80x86, RISC, and Digital Equipment Alpha processors. It is scalable to symmetric multiprocessing systems, where users can add extra processors for greater performance. Its 32-bit flat memory model does away with 64-KB

Highlights

	Strengths	Limitations
OS/2 Lan Server 4.0	•Uses high-performance 32-bit 386 HPFS •Domain-based naming system •Remote server management •Full electronic documentation facility	•Does not support global naming of all network objects •Users require multiple log-on IDs across domains •No system or group log-on scripts •Workstation installations are time consuming
Windows NT Server 3.5	•Domain-based naming system •Memory protection and preemptive scheduling •Symmetric multiprocessing support •Remote server management	•Does not support global naming (multidomain) of all network objects •Requires primary-domain controller •No system or group log-on scripts •Limited wide-area connectivity options
Novell Netware 3.12	•Simple workstation installation and fast shell updating •Good multiple-environment client support •Excellent remote management features •Workgroup administrators	•Lack of memory protection and preemptive scheduling •Does not support global naming of all network objects •Users require multiple log-on IDs for individual servers •Does not support sliding window transport protocol
Novell Netware 4.02	•Feature-rich global network directory and naming service database •Extensive client support •Supports internal bridging/routing •ODI multiprotocol workstation support •Very good fault-tolerant features, including Transaction Tracking System	•Complex directory tree setup •New server console interface adds to the learning curve •Some gaps in completeness of printed documentation set

Conceptual design by Robert P. Hunneniuk and Jerry D. Flynn of McDonnell Douglas Space Systems

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PLATFORMS AND PROTOCOLS
● = yes ○ = no U = unlimited

	IBM OS/2 LAN SERVER 4.0	MICROSOFT WINDOWS NT SERVER 3.5	NOVELL NETWARE 3.12	NOVELL NETWARE 4.02
PLATFORMS AND ARCHITECTURE				
Runs on Intel 80x86 family	●	●	●	●
Runs on Digital Alpha	○	●	○	○
Runs on other RISC platforms	●	●	○	○
Supports multiprocessing	●	●	○	○
Dynamic memory cache	●	●	●	●
Dynamic loading of services	●	●	●	●
Structured exception handling	●	●	●	●
Provides protected subsystems	●	●	●	●
Provides Unicode support	○	●	●	●
Installable file system	●	●	●	●
Transaction-based file system	○	●	●	●
SERVER PARAMETERS				
Maximum user connections	2048	U	250	1000
Maximum simultaneous users per server	1000	U	250	1000
Maximum server volume size	64 GB	17 TB	32 TB	32 TB
Maximum volumes	24	24	64	64
Maximum shared printers per server	24	U	16	16
Minimum server memory requirements	8 MB	4 MB	4 MB	6 MB
FAULT TOLERANCE/DISK MANAGEMENT				
UPS monitoring	●	●	●	●
Disk mirroring	●	●	●	●
Disk duplexing	●	●	●	●
Server duplexing	○	○	●	●
Hot fix	●	●	●	●
File replication across servers	●	●	●	●
Disk striping support	●	●	●	●
RAID Level 5 redundancy support	○	●	○	○
Redundant directory structures	○	●	●	●
FILE SERVER INTEROPERABILITY				
DEC VAX as a file server	●	●	●	●
Unix-based system as a file server	●	●	●	●
IBM AS/400 system as a file server	●	●	●	●
IBM VM system as a file server	●	●	●	●
FILE SYSTEM SUPPORT				
Supports OS/2 version 1.x	●	●	●	●
Supports OS/2 version 2.x	●	●	●	●
Supports DOS 3.x and above	●	●	●	●
Supports MS Windows 3.1	●	●	●	●
Supports MS Windows NT	●	●	●	●
Supports Macintosh workstations	●	●	●	●
Supports VAX workstations	●	●	●	●
Supports Unix workstations	●	●	●	●
Supports NFS (Network File System) at server	●	●	●	●
Supports DOS "diskless" workstations	●	○	●	●
Supports OS/2 "diskless" workstations	●	●	●	●
COMMUNICATIONS PROTOCOLS				
IPX/SPX	●	●	●	●
NetBios	●	●	●	●
NetBEUI	●	●	○	○
TCP/IP	●	●	●	●
OSI	●	●	●	●
AppleTalk	●	●	●	●
DECnet	○	○	●	●
DLC	●	●	●	●
Supports ODI (Open Data-Link Interface)	●	●	●	●
Supports NDIS (Network Driver Interface)	●	●	●	●
Packet burst	○	●	●	●
Internal routing	○	○	●	●

memory segments and DOS's 640-KB barrier. The NOS has multiple threads of execution, allowing applications to be more powerful, but memory protection assures stability by providing applications with separate memory spaces to prevent data corruption. NT Server's preemptive multitasking also lets the NOS allocate to each application efficiently.

Microsoft has made several major improvements to NT Advanced Server 3.1, introduced in the summer of 1993, after it failed to steal any significant portion of NetWare's NOS market. NT Server 3.5 is 4 MB to 6 MB smaller than version 3.1, has 200 percent better file-server performance (according to Microsoft), and has improved connectivity. Microsoft completely rewrote the TCP/IP stack, making it faster and smaller, and added two services that make TCP/IP much easier to administer.

The DHCP (Dynamic Host Configuration Program) assigns IP addresses dynamically from a centrally managed pool of addresses. This relieves network administrators of the burden of assigning IP addresses to individual workstations and maintaining those addresses. WINS (Windows Internet Naming Service) maps computer names to IP addresses, allowing a user to refer to a machine by a user-specified (and easily recognizable) name, rather than by its cryptic address code.

Microsoft has increased support for NetWare in version 3.5 by including a Gate-Way Service for NetWare that allows users access to NetWare servers without running dual stacks at the client. A migration tool for NetWare aids network administrators by copying user accounts and files from NetWare servers to a Windows NT Server system while maintaining security. Other improvements include support for long filenames beyond the 8.3 naming restriction, TCP/IP printing, account lockout for too many incorrect password attempts, and administration tools for 16-bit Windows applications.

These highlighted improvements are most evident when NT Server is used with the preferred client—Windows for Workgroups. Windows for Workgroups 3.11 supports 32-bit protected-mode network components (32-bit network protocols such as NetBEUI and an IPX/SPX-compatible transport, as well as a 32-bit network redirector) to communicate with Windows NT Server. With an NDIS 3 network-card driver, the system provides a 32-bit code path from the network card to the network redirector, resulting in even

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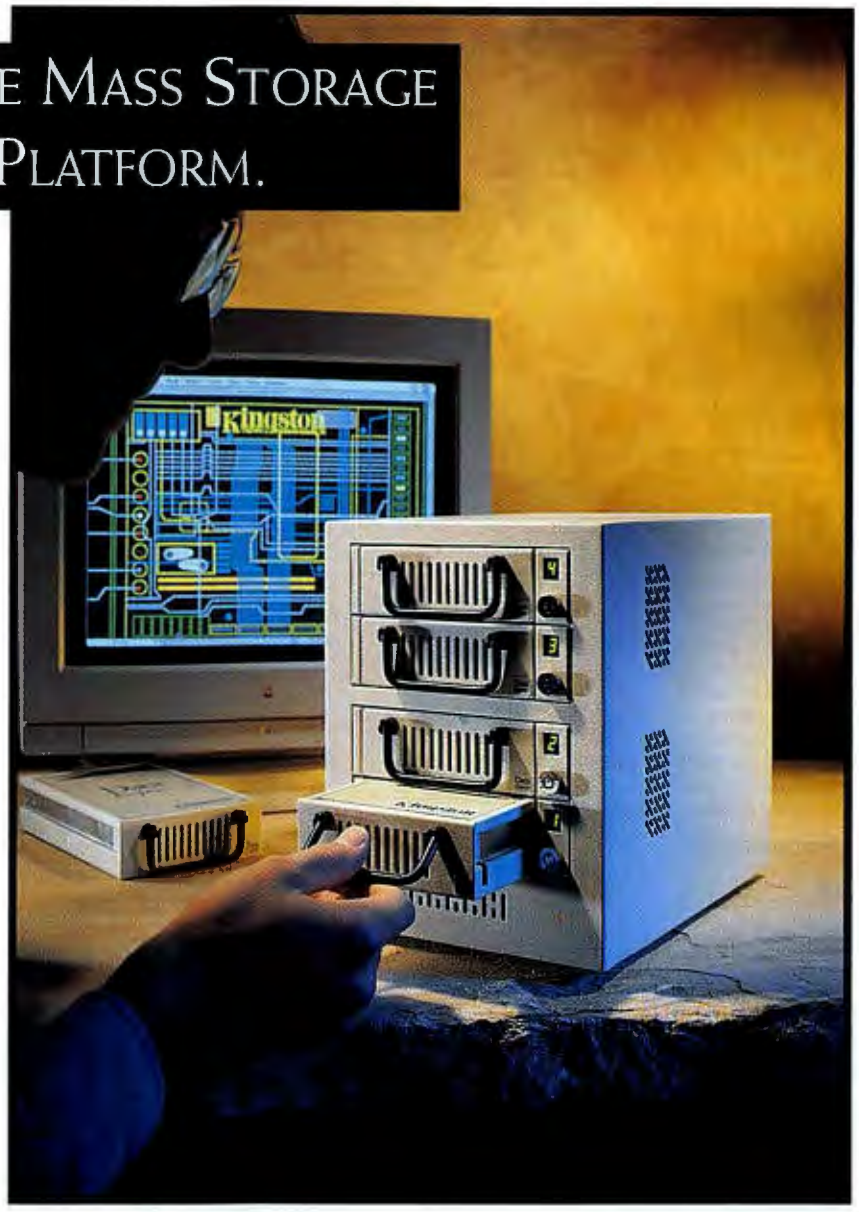
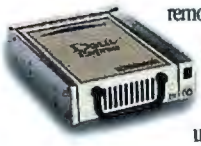


Data Express: Rugged Removability



Data Express, a family of durable removable carriers, houses a hard disk or DAT (Digital Audio Tape) device, adding up to 36GB plus the many benefits of storage removability to your PC or workstation. Data Express is available internally; mounting into your computer system drive bay, or externally; housed in steel enclosures and equipped with a fan and power supply. Data Express boasts an industry leading 25,000 insertions for long lasting removability. Constructed of steel and equipped with superior ventilation, Data Express provides the peripheral cooling needed when using large capacity devices.

Data Silo: Durable External Housing

Kingston's Data Silo is a family of stand alone external storage enclosures for half-height or full-height 5.25" or 3.5" SCSI peripherals. Data Silo is available in versions to house one, two, four, or nine SCSI devices simultaneously providing the utmost flexibility for storage expansion, disk array environments, and peripheral integration. Each Data Silo is equipped with its own power supply and fan and constructed of 100% steel, making Data Silo the most durable external storage enclosure available today.

Storage Versatility

Kingston's Data Silo four and nine bay units provide ideal drive stacking features for use in disk array environments. Data Silo also houses Kingston's Data Express products, which provide all the benefits of storage removability including data security and portability.

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Every Product 100% Tested

Kingston guarantees the highest quality available by testing every product prior to shipping.

Information At Your Fingertips

To get the facts on Data Express and Data Silo, call our convenient RAMFax fax on-demand service toll-free and request document number *8310*. For immediate assistance, contact Kingston's Storage Products group at:

RAMfax
CALL TOLL-FREE
(800)435-0056

(800) 435-0670

Kingston
TECHNOLOGY CORPORATION

THE INSIDE NAME IN UPGRADES

Kingston Technology Corporation
17600 Newhope Street, Fountain Valley, CA 92708
(714) 438-1850 • Fax (714) 438-1847

Circle 89 on Inquiry Card (RESELLERS: 90).

SECURITY AND MANAGEMENT
● = yes ○ = no

	IBM OS/2 LAN SERVER 4.0	MICROSOFT WINDOWS NT SERVER 3.5	NOVELL NETWARE 3.12	NOVELL NETWARE 4.02
DIRECTORY SERVICES				
Global name service	●	○	○	●
Naming of users and groups within domain	●	●	○	●
Naming of all objects within domain	●	●	○	●
Names directory service	○	○	○	●
X.500-compliant naming system	○	○	○	○
Hierarchical database structure	○	○	○	●
Automatic distribution of names across network	●	●	○	●
Single network log-in	●	●	○	●
Single user account per enterprise	○	●	○	●
Trusted domains	○	●	○	○
SECURITY				
User-based security	●	●	●	●
Share-level security	●	●	○	○
Security equivalences	○	●	●	●
Set account expiration date	●	●	●	●
Time restrictions	●	●	●	●
Lock account after multiple failed passwords	●	●	●	●
Auto-disconnect after specified inactive period	●	●	○	○
Password encryption	●	●	●	●
Designed to meet C2 security	○	●	○	●
ADMINISTRATIVE UTILITIES				
System log-in script	○	○	●	●
Group log-in scripts	○	○	●	●
User log-in scripts	●	●	●	●
Nested scripts	●	●	○	○
Forced disconnect	●	●	●	●
Automatic update of workstation shell	○	●	●	●
Assignment of group administration to users	●	●	●	●
USER UTILITIES				
Creates/modifies user log-in scripts	●	●	●	●
Explicit file locking	○	●	●	●
16-bit windows administration utilities	○	●	●	●
Event log for trouble shooting	●	●	●	●
RESOURCE ACCOUNTING				
Tracks user access time	●	●	●	●
Tracks user data reads	○	●	●	●
Tracks user data writes	○	●	●	●
Tracks user server requests	○	●	●	●
Tracks user space usage	●	●	●	●
Charges users for services	○	○	●	●
Sets user credit line	○	○	●	●
PERFORMANCE MONITORING				
Average response time	●	●	○	○
Cache statistics	●	●	●	●
Server CPU utilization	●	●	●	●
Packets/bytes per second	●	●	●	●
Number of bad packets	●	●	●	●
Peak files open	●	●	●	●
Peak number of record locks	●	●	○	○
Peak number of connections	○	●	●	●
Peak packets routed/second	○	●	●	●
Log performance statistics	●	●	○	○
NETWORK MANAGEMENT SUPPORT				
Agent for Netview	●	●	●	●
Agent for SNMP	●	●	●	●
Agent for CMIP	●	●	○	○
Remote administration of file servers	●	●	●	●
Remote session security	●	●	●	●
Remote modem callback	○	●	●	●

greater performance improvement over a real-mode redirector, while consuming only 4 KB of conventional memory.

Windows for Workgroups 3.11 also supports client-side cache. A new feature in Windows for Workgroups 3.11 called 32-bit File Access provides a 32-bit protected-mode replacement for the MS-DOS-based SmartDrive disk-cache program. 32-bit File Access caching routines are implemented as 32-bit protected-mode code, thus reducing the need to transition to real mode to cache disk information. 32-bit File Access read-ahead routines work on a per-file basis rather than on a per-sector basis, resulting in a higher probability that information read into the disk cache will be used. And 32-bit File Access caching routines share cache memory with the protected-mode network redirector (VREDIR.386), thus reducing the memory overhead for maintaining multiple cache buffers.

Novell NetWare 3.12 and 4.02

Although Novell is preparing to release the next major upgrade, NetWare 4.1, NetWare 3.11 and 3.12 continue to be very popular NOS products, maintaining their market leadership. By the time you read this, NetWare 4.1 should be available.

When introduced in 1993, Novell's top-of-the-line product incorporated several key features. Topping the list of new network services is NDS (NetWare Directory Services), a distributed database of network-wide information that replaces the NetWare 3.xx flat-file bindery. Designed along the general outlines of the X.500 international directory services standard, Novell's NDS aggregates names and associated information for every object on the network (including users, groups, servers, printers, server volumes, and other network services) into a common NDS database. Because NDS is a single, logical database, it allows users to log in to the network once, with only one authentication, and provides them access to all authorized network resources and services.

NetWare Directory Services views all network resources and physical entities as objects in a distributed database known as the NetWare Directory Database. An NDS object consists of categories of information known as properties and the data or value about those properties. NDS operates in a hierarchical organization known as the directory tree. The directory tree is made up of two types of objects: container objects and leaf objects. The hierarchical directory tree starts with a root object

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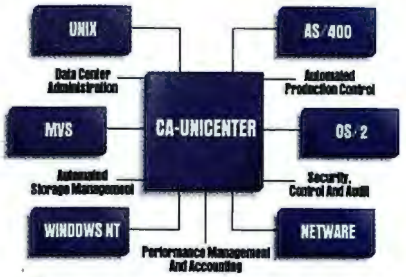

3. Choose A Client/Server Application That's Interoperable, Scalable and Portable.

4. Demand An Open Solution That Supports All Key Industry Standards And Protocols.

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and branches out in a multitier organization, adding other container objects at each level, and ends with leaf objects. While container objects can hold other container objects (parent objects), leaf objects do not contain other objects. They generally represent users, computers, printers, and lists. The installation program creates the root object and places it at the top of the directory hierarchy. It cannot be deleted.

Security is an important element of the NetWare environment. Its implementation can be made as centralized or as dispersed as desired. The four levels of security in NetWare—NDS security, file-system security, server security, and log-in and password security—can be used separately or in any combination to ensure effective access management and control. After the log-in and password security check has authenticated a user and grants access to the network, the remaining three security provisions can control the user's further access to network resources and services.

Server security attempts to limit or prevent server-console access, while NDS security (through either object or property rights, or both) controls a trustee's rights to NDS objects and information stored within objects. File-system security controls access to NetWare volumes, directories, and individual files through Rights security and Attributes security. Rights security controls what a user can do to directories and files, while Attributes security assigns specific access-control characteristics to prevent tasks that effective rights would allow. For example, Attributes can be used to prevent anyone who has full access to a specific directory from deleting directories and/or files. Controlling access to the directory tree can be approached either from the natural hierarchical structure of the tree, in which rights flow top-down, or through an IRF (Inherited Rights Filter), in which access rights of a parent object are blocked from flowing down to the child object, thereby controlling access at any level of the directory tree. Among the four kinds of access rights that exist in NetWare (object, property, directory, and file), only object and property rights apply to NDS objects. Directory and file rights apply, as in previous versions of NetWare, to controlling access to the file system.

BACKUP AND APPLICATION SUPPORT
● = yes ○ = no

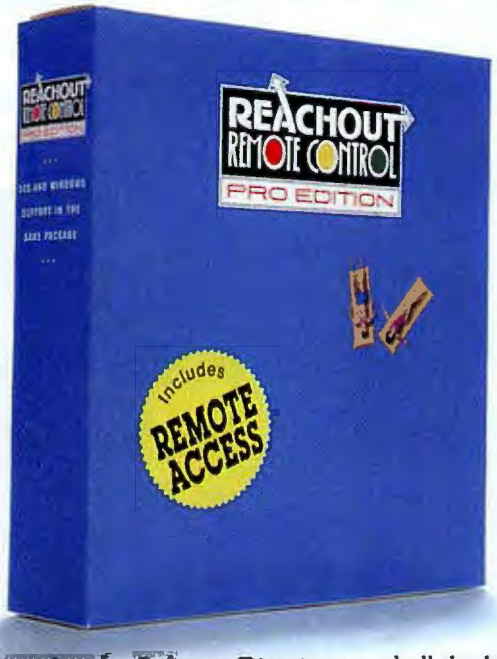
	IBM OS/2 LAN SERVER 4.0	MICROSOFT WINDOWS NT SERVER 3.5	NOVELL NETWARE 3.12	NOVELL NETWARE 4.02
BACKUP AND ARCHIVAL SERVICES				
Backup/restore whole server disk	●	●	●	●
Backup/restore selected directories	●	●	●	●
Backup modified only	●	●	●	●
Server-based backup	●	●	●	●
Backup utility included with NOS	○	●	○	○
SERVER BRIDGING				
Supports workstation defined as external router	●	●	●	●
Supports internal server adapter routing	○	●	●	●
TCP/IP bridge support	○	●	●	●
Gateway service for other operating systems	●	●	●	
HDLC/synchronous bridge	○	○	●	●
T1 bridge	○	●	●	●
X.25 point-to-point bridge	○	○	●	●
X.25 multipoint packet switched bridge	○	○	●	●
IBM mainframe bridging	○	●	○	○
REMOTE ACCESS				
Supports remote workstation connections	●	●	●	●
Supports remote servers	●	●	●	●
Security on remote link—CHAP security	○	●	○	○
Security on remote link—PAP security	○	●	○	○
Multiprotocol support—IPX	●	●	●	●
Multiprotocol support—TCP/IP	●	●	●	●
Multiprotocol support—NetBEUI	●	●	○	○
ISDN support	●	●	●	●
X.25 support	●	●	●	●
Software compression	○	●	○	●
Automatic IPX net assignment numbers	○	●	●	●
Automatic IP addressing	○	●	○	○
INTERNET ACCESS				
DNS server	●	●	●	●
Gopher server	●	●	●	●
WWW server	●	●	●	●
WAIS server	○	●	○	○
Telenet server	●	●	●	●
Graphical utility for FTP	●	●	●	●
APPLICATION PROGRAMMING INTERFACES				
File/Print APIs	●	●	●	●
Application APIs	●	●	●	●
APPC	●	●	●	●
E-mail API	○	●	●	●
Accounting API	●	●	●	●
Administrative APIs	●	●	●	●
Auditing API	●	●	●	●
Indexed file manager	○	●	●	●
Transaction logging and rollback support	○	●	●	●
IPC APIs	●	●	●	●
SERVER APPLICATIONS				
E-mail	○	●	●	●
Calendar and scheduling	○	●	○	○
Video	●	●	○	○
Telephony	●	●	○	○
Database support	●	●	●	●

The Enterprise Option

Windows NT Server's excellent performance, ease of use, and ease of learning features, combined with its excellent networking, make it a strong candidate for many network environments. Organizations with client-server application models would also find Windows NT Server a very good network platform, since that is its strength. Installations considering the Microsoft Windows NT and Windows for Workgroups operating systems for their desktops will find Windows NT Server

Remote Control Software. Rated #1. Over and Over and Over...

- #1 Overall Evaluation
- #1 Overall Power
- #1 Overall Usability
- #1 Performance
- #1 Versatility
- #1 Ease of Learning
- #1 Ease of Use



The 45-page review for *Software Digest* covered all the bases. It was the most extensive review ever done on remote control software. In the end, the experts called ReachOut Remote Control simply "the best program in the...evaluation." It outscored the competition in not one, not two or three, but in seven categories. In its report for *Software Digest's* June '94 issue, National Software Testing Laboratories wrote:

NSTL recommends ReachOut Remote Control for its excellence in almost every category. No other program matches its number of features or ease of use, and it is the unanimous choice for best program in the testers' general usability evaluation.

The recommendation confirms the findings of exhaustive corporate evaluations. And it parallels assessments by such leading publications as *Byte, LAN Magazine, PC User, Network Computing, Government Computer News* and *InfoWorld.*

But why not judge for yourself? We will be happy to send you more information on the NSTL report. Better yet, take advantage of our 60-day money-back guarantee and order your copy of ReachOut today. Call **1-800-677-6232** ext. **214** for your nearest dealer location.

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THE MOST COMPREHENSIVE REVIEW OF REMOTE CONTROL SOFTWARE

SOFTWARE DIGEST RATING	OVERALL EVALUATION	PROGRAM
★★★★	8.5	Reachout Remote Control
★★★	7.5	Close-Up
★★★	7.3	Norton pcANYWHERE 1.0 for Windows
★★★	7.3	Carbon Copy for Windows

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the ideal network environment for centralized management, security, and fault-tolerant support.

For large installations planning to implement an enterprise network infrastructure, Novell's NetWare 4.02 is a logical choice. Excellent multiplatform support, very good performance, a proven network foundation, a powerful global directory service, and an expanding base of connectivity options make NetWare 4.02 a powerful candidate for large interconnected networks with multiple bridged servers. ■

About the Products

OS/2 LAN Server 4.0
First server, $795; each additional server license, $715; OS/2 LAN Server 4.0 Advanced, $2,295 (each additional license, $2180); OS/2 LAN Server-Entry Upgrade, $395 (each additional license $315); OS/2 LAN Server Advanced Upgrade, $495 (each additional license $415); Requester, $50 ($500–$2250, 10–50 clients)
IBM Corp.
Old Orchard Road
Armonk, NY 10504
(800) IBM-2468
Contact local branch or dealer.
Circle 1009 on Inquiry Card.

Windows NT, Version 3.5
Server, $699; Windows NT Server 3.5 MLP, $599; Windows NT 3.5 (single-user client license), $39.95; Windows NT 3.5 (20-user client license), $569; upgrade from 3.1 Advanced Server, $699; upgrade from 3.1 Advanced Server MLP, $599
Microsoft Corp.
One Microsoft Way
Redmond, WA 98073-9717
(206) 882-8080
Circle 1010 on Inquiry Card.

NetWare, Version 3.12
Server and client software: 20 users, $3495; 100 uses, $6995; 250 users, $12,495

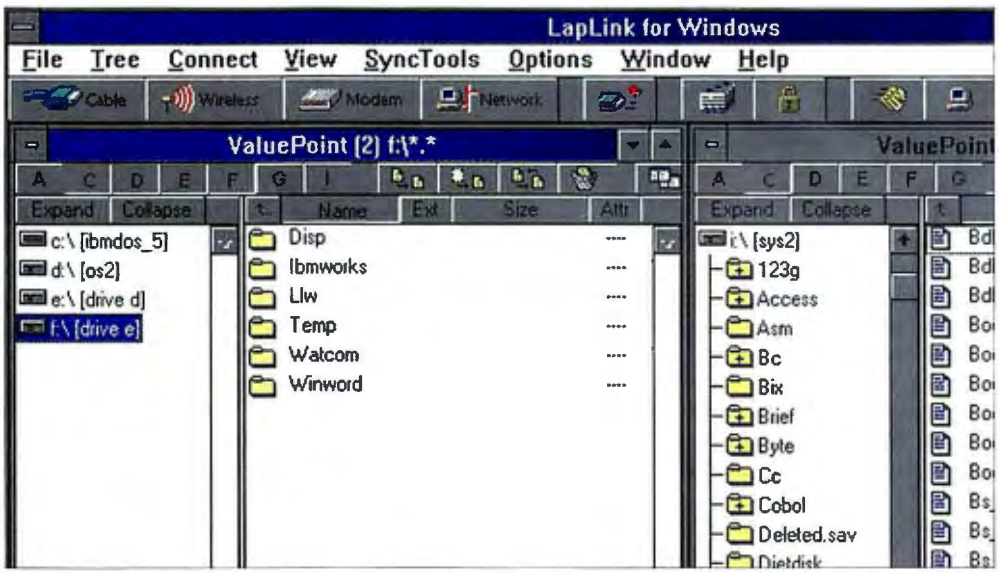
NetWare, Version 4.02
Server and client software: five users, $1395; 10 users, $3195; 25 users, $4695; 50 users, $6295; 100 users, $8795; 250 uses, $15,695; 500 users, $26,395; 1000 users, $47,995
Novell, Inc.
122 East 1700 South
Provo, UT 84606
(801) 429-5900
Circle 1011 on Inquiry Card.

This report contains the partial results of a recent issue of Software Digest, *a monthly publication of NSTL, Inc. To purchase a complete copy of the report, contact NSTL at 625 Ridge Pike, Conshocken, PA 19428, (610) 941-9600; fax (610) 941-9950; on the Internet, editors@nstl.com. For a subscription, call (800) 257-9402. BYTE Magazine and NSTL are both operating units of McGraw-Hill, Inc.*

File Transfer on Steroids

LapLink adds Windows, remote control, and synchronizaton that saves time and money on file transfers

BARRY NANCE



If you're familiar with Windows File Manager, you should find navigating drives and directories in LapLink for Windows simple and easy. The program retains the split-screen view of the previous DOS-based versions.

Traveling with a notebook PC is easy, productive, and convenient—but only after you get the right files onto the notebook's hard disk. While you might use a docking station or pocket network adapter to log on to the network and then transfer files from a file server to the notebook, neither of these options is available to you when you're on the road. Copying files to a floppy disk and taking the disk with you is a hit-or-miss proposition, because you might forget to copy a vital file. Furthermore, subnotebook computers often don't have floppy drives. You could use remote access to dial into the central LAN, but remote-access products require nontrivial setup and configuration.

Alternatively, you might use LapLink for Windows to transfer and synchronize files. With LapLink for Windows, you use a serial or parallel cable in the office to transfer files to your notebook. On the road, when you need to make occasional connections to your office computer, you dial in through a modem to synchronize updates to your notebook's files or to transfer updates back to the office. You just leave your desktop PC running LapLink for Windows while you're away.

I evaluated LapLink for Windows 6.0 on an IBM PS/ValuePoint 486/25 and a Compudyne 486/33 notebook. Using the parallel, serial, and network connection features of LapLink for Windows, I transferred files, synchronized files that I modified after the original transfer, exercised a remote PC through LapLink's remote-control feature, and chatted with myself across a LapLink connection. Overall, I found the software easy to install, quick and painless to use, and reliable in everyday use.

It's important to note that LapLink is a feature-rich, Windows-based file-transfer package. If all you need is file synchronization, and you use OS/2 or Unix, you'll be interested in Binary Software Development's UniBeam 1.24 [$189.95 for the OS/2 version, $289.95 for SCO Xenix and SCO Unix; (404) 977-7102].

ADVANCED FEATURES IN LAPLINK FOR WINDOWS

- **SpeedSync—A patent-pending technology that cuts transfer times by sending only the changed parts of an existing file**
- **Universal Video Driver—Allows up to 16.7 million colors during remote-control sessions (previous remote-control products were limited to 256 colors)**
- **Scale to Fit—Higher-resolution image on remote computer is scaled to fit in any size window on local computer's lower-res display**
- **Multiple Tasks on Multiple Connections—Allows simultaneous LAN, modem, wireless, or parallel/serial connections, each capable of handling simultaneous remote control, file transfer, and chat sessions**

Multiple Connections

LapLink for Windows is primarily a file-transfer and synchronization utility. You connect two PCs with LapLink over a serial cable (between two COM ports), a parallel cable (between two printer ports), a pair of modems (one PC dials the other), or over a network (two PCs transfer files without using a file server as an intermediary). The package includes color-coded serial and parallel cables. Additionally, LapLink supports wireless connections using AirShare radio modules from National Semiconductor. The range of the wireless connection is only about 30 feet—less than useful for most mobile applications. However, I'm impressed that Traveling Software is at least making the effort to take advantage of the new technology. LapLink supports over 250 modems, including several cellular and ISDN modems. Over a LAN, LapLink uses IPX (commonly found on NetWare LANs).

To transfer files from a desktop PC to a nearby notebook, you connect the serial or parallel cable between the computers (Traveling Software recommends using the parallel cable for faster transfers). For remote operation through modems, you provide the telephone number and modem type to LapLink. When you install LapLink on a computer, you assign it a name. To create a logical connection between two cable-connected machines, you click on the Cable button, use the Connection box to select the other PC's assigned name,

SPEEDSYNC SAVES TIME

LapLink for Windows employs a new technology called SpeedSync, which transfers only those portions of a file that have been changed. A 1-MB test file took 18.48 minutes to transfer via modem the first time. When SpeedSync was applied after part of the file was changed, transfer times dropped drastically, though not in direct proportion to the number of bytes.

1-MB file	18.48 minutes
5 percent changed	1.82 minutes
10 percent changed	3.92 minutes
25 percent changed	8.55 minutes

and then choose File Transfer, Remote Control, or Chat. For cable-, network-, or modem-based access, you can tell LapLink to automatically reestablish the connection each time you run it.

An interface similar to Windows File Manager lets you point and click on the files you want to transfer. After you select the File Transfer button on the toolbar, two lists of files and directories appear on your screen. The left list displays the target PC's files; the right shows the other (source) computer's files (see the screen on the previous page). You can drag and drop file icons from the right window to the left window to transfer those files. Holding down the Ctrl key during the file selection process lets you transfer multiple files with a single drag-and-drop operation. LapLink will create directories as necessary on the target PC.

Native Windows

This first native Windows version of LapLink takes advantage of the Windows GUI and memory management. You can simultaneously perform multiple tasks over each connection—for example, you can monitor a file transfer in one window, chat with the recipient in a second window, and download E-mail in a third. Traveling Software says it added several video features to keep performance up to par during multiple operations, including intercepting GDI (graphics device interface) calls and intelligent video caching.

For security, Lap-Link offers password-restricted access; separate authorizations for file transfers, remote control, and chat functions; remote network log-in; logging of LapLink activities; and callback.

If the target computer has earlier or later versions of the files, you don't have to retransfer entire files to bring one or both computers up-to-date. LapLink's SmartXchange command will synchronize the directories for you. LapLink updates older files that it finds on either PC, but does not delete files.

Cloning directories as well as entire hard drives is also possible with LapLink. You include or exclude subdirectories with a menu option, and you indicate to LapLink whether you want a complete refresh that includes all files in the directory or merely an update of files that exist on both PCs. The synchronization process compares old and new files, then transfers just the changes (deltas) over the LapLink connection. If you have salespeople on the road who need to periodically update large price-list information files, this feature, called SpeedSync, can save hours of file-transfer time.

Technology for Impatient People

Transferring megabytes of files and directories through a parallel or serial cable takes time, especially if you're copying files for the first time. Through a LAN cable, of course, the transfer takes less time. Unless your file server is low on disk space, however, you'd probably just use the DOS XCOPY command, with the /S option, to copy files and directories to and from an intermediate file server. SpeedSync can reduce parallel- or serial-cable file-transfer times considerably, but it's with modem-based connections that SpeedSync really shines.

To discover how well SpeedSync improves modem-based file transfers, I used two Supra 14.4 Kbps modems, with error correction and compression disabled, to connect the ValuePoint and Compudyne computers running LapLink for Windows. LapLink transferred an entire 1-MB file through the link in 18.48 minutes. I then changed 5 percent of the source computer's file and used SpeedSync to update the target computer. LapLink's SpeedSync took 1.82 minutes to detect and transfer just the changes to the file. A file whose contents I changed by 10 percent took 3.92 minutes to update on the target computer. Changing 25 percent of the source file caused SpeedSync to take 8.55 minutes to update the target file. The table on the opening page summarizes these results.

SpeedSync itself keeps track of statistics that show how well it has performed. It records the number of bytes that would have been transferred if it hadn't been in effect and the number actually transferred. To see these statistics in LapLink for Windows, you choose SpeedSync Statistics in the SyncTools menu. For the most recent transfer, LapLink displays a graph that contrasts the number of bytes actually sent with the number that would have been sent without SpeedSync. LapLink for Windows also graphs a history of past SpeedSync-based transfers. As you'd expect, Traveling Software doesn't provide technical details on how SpeedSync works internally.

SpeedSync quickly transfers changes to non-volatile files, but files whose contents change dramatically require longer transfer times. If all or almost all the contents of a file change, SpeedSync can take longer to make the transfer because it must compare the two files before deciding what's changed, and the comparison time adds to the overall transfer time. Also note that SpeedSync doesn't merge the two files, but updates the older file to conform to the newer. The contents of the newer file will always replace the contents of the older file.

LapLink's remote-control and chat features work well. LapLink uses its own video drivers to minimize the transfer time for screen-update material. On each PC, LapLink saves local copies of Windows controls, such as toolbars, bitmaps, or icons. When you move the controls on one screen, LapLink only needs to send the identity and new position of the control to the other PC. The LapLink video driver, which works with existing drivers rather than replacing them, also reduces compatibility problems when the two PCs use different screen resolutions or have different brands of video adapters installed.

LapLink for Windows 6.0 is less expensive than most pocket network adapters, works remotely through modems, and can quickly synchronize non-volatile files when you're away from the office. It is easier to set up and configure than remote-access products, and it offers a useful remote-control feature. LapLink for Windows is an excellent tool for updating, seeding, or cloning PC files. ■

About the Product

LapLink for Windows 6.0 ....$139.95
Traveling Software, Inc.
18702 North Creek Pkwy.
Bothell, Washington 98011
(800) 343-8080
(206) 483-8088
fax: (206) 485-6786
Circle 1003 on Inquiry Card

Barry Nance is a BYTE consulting editor and the author of Using OS/2 Warp 3.0 *(Que, 1994),* Introduction to Networking *(Que, 1994) and* Client/Server LAN Programming *(Que, 1994). You can reach him on the Internet or BIX at barryn@bix.com.*

On-Line Service on the Cheap

Mustang Software beefs up its Wildcat BBS with a 32-fold increase in conference capacity, a programming language, and a robust suite of administration utilities

BILL ESPOSITO

Callers with new-user security profiles and ANSI graphics enabled are greeted with the above menu. Users with different security profiles would have different options enabled. The two lines at the bottom of the screen can only be seen on the system operator's local console.

Along with the growing popularity of on-line services comes increased interest in low-cost alternatives. BBSs are perhaps the most affordable way to get customers and in-house people exchanging files and messages. Put the BBS host computer on a LAN, and you've got an instant groupware conferencing system.

Since at least the late 1980s, Mustang Software's Wildcat has been on the short list of the most popular BBS programs. Version 4 is a major rewrite designed to meet the need for increased capacity and more powerful system administration. The basic Wildcat program now has more flexible menuing, a spelling checker, faster search and retrieval capabilities, and GIF Thumbnailer which lets you view miniatures of large, throughput-sapping graphics files before downloading them.

In addition, Mustang Software is now offering a separately priced BBS Suite that adds a slew of configuration and programming utilities.

Installation Made Easy

I took a look at the BBS Suite, which includes Wildcat 4. I installed the software on my pieced-together 486DLC40 with 16 MB of RAM, a U.S. Robotics Courier Dual Standard V.34 modem, a 14.4 Kbps Bocamodem, and OS/2 2.1.

Installation is relatively painless. Naturally, you first have to back up the entire system as a safety precaution. Once you've done that, be prepared for at least a few hours of upgrading, and possibly an overnight job if your system is large. Wildcat will convert most everything for you, but you will have to move a few things over to the new version, such as bulletin and menu files. Because the new message databases differ from those in previous versions of Wildcat, any program or utility that accessed them will no longer work and must also be upgraded.

Wildcat's Makewild, a menu-driven installation utility, made installation a snap. I did, however, run across a problem with the installation documentation. For setting up the modem options, the documentation says to select "Type of Modem" and press F2 to bring up a pick list of supported modems. Unfortunately, "Type of Modem" was not an option in the actual program, F2 wasn't highlighted as available, and pressing F2 did nothing. I noticed that pressing F3 would load something, so I tried it. Sure enough, a pick list of modems appeared. I selected the file for my U.S. Robotics modem, and the rest of the basic installation went without incident.

Makewild also made custom configuration painless. The BBSs I've used require you to edit long, complicated configuration files. For example, Scott Dudley's Maximus/2-CBCS, which I run on my own BBS, is highly configurable, but you must do all the configuring in a text editor. By comparison, in Wildcat 4, everything is configured in Makewild, which makes liberal use of drop-down menus and has context-sensitive help. BBS software hasn't made the transition from DOS to the drag-and-drop Windows world, and much of it still suffers the shortcomings of older terminal-based interfaces.

One of Wildcat 4's notable features is RIP (Remote Imaging Protocol) Graphics, which provides a fully graphical (though still DOS-based), mouse-driven interface for the BBS. To take advantage of RIP, the caller must be using a RIP-capable terminal program. Mustang Software does not supply a RIPscript editor to create the graphic screens, but you can download one from the company's BBS (805-873-2400) or any BBS with a good selection of shareware. With RIP, your BBS can look as professional as Prodigy or America Online.

Multi-Everything

Wildcat is a network compatible, multiuser BBS program. It comes in single-line, 10-line, 250-line, and Multiline Platinum (that supports up to 250 phone lines but permits as many as eight lines per PC) versions that retail for $129, $250, $499, and $799, respectively. The BBS Suite that I reviewed lists for $999 and includes the Multiline Platinum Wildcat and three support utilities: the wcCODE Custom Online Development Engine; the wcGATE Internet/MHS mail gateway; and the wcPRO Utilities, a collection of user and database utilities that includes a fax-on-demand processor.

If you plan on having two or more lines, you will need to run some sort of multitasking system. One popular method is to run Quarterdeck Office Systems' DESQview, which lets you get by with only 4 MB of RAM for a two-line system. OS/2 is an

On-Line Service on the Cheap

option that is more attractive than before, with the release of OS/2 Warp, which also runs in 4 MB. Windows is also an option, but it suffers from notoriously unreliable high-speed communications performance while multitasking.

The last recommended option is to run Wildcat on a LAN. This is attractive because it gives off-site personnel dial-in access to the LAN, as well as providing an alternative to more expensive groupware programs. Unfortunately, if you own an intelligent multiport I/O card or need to use a FOSSIL (Fido, Opus, Seadog Interface Layer), you'll have to spring for the $799 Platinum version of Wildcat.

At a glance, the BBS system operator can review overall system statistics on the idle screen (the screen that is displayed locally while there are no callers on the BBS). This screen is nearly identical to the one in the previous version of Wildcat.

Then, once you've decided on your environment, there are some configuration items to take care of. Regardless of whether you run Wildcat in a virtual machine operating in a memory partition on a standalone PC or on a PC connected to a LAN, each line must be separate. These lines communicate with each other through shared data files, which means there's a single, easier-to-maintain common database for user information, files, and messages.

If you run DESQview or a LAN, you need to load DOS SHARE from either your CONFIG.SYS or AUTOEXEC.BAT files. Wildcat itself will keep things straight by using a different node number for each line. You assign this node number in Makewild's General Information section. Mustang suggests that you get one line working before tackling multiple lines. I agree.

Downloadables

The next task is one that often proves to be a major project: creating the file lists that users will see and from which they will select files to download. If your CD-ROM or hard disk directories already contain a file-description file (e.g., FILES.BBS), the process is almost automatic. You need only run Wildcat's files-database-creation utility, wcFILE; enter the directory names and the name of the description file; and choose Go. All file names and descriptions will be assimilated into the files database. If there is no description file, however, you must manually enter the file names and descriptions. Once you've created the file area, you can set the security aspects, such as who can upload, download, or list files (Wildcat internally supports eight downloading protocols, including ZMODEM and YMODEM/G, along with up to 10 external protocols).

One notable file-area feature is the way that Wildcat handles CD-ROMs. For practical use in a multiline configuration, only one line can access a single CD-ROM at a time, which creates a problem when two callers try simultaneously to download a file from the same CD-ROM. Wildcat will copy the requested file to a hard disk before the transfer executes, freeing the CD-ROM for access by other lines. Wildcat also supports multiple CD-ROMs and CD-ROM changers.

The Messaging System

Setting up the message areas, or conferences as they are called in Wildcat, was straightforward. You simply enter a conference name, edit a few options, and hook the name to a file area. Users access the file areas via the customizable screen shown on the previous page.

One drawback of the messaging system is its lack of direct support for FTSC (FidoNet Technical Standards Committee) mail transfers. You must purchase a separate front-end package (such as BinkleyTerm, Front Door, or Intermail) from a third-party vendor to exchange mail via

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FidoNet, the mail standard for BBSs. Nor does Wildcat directly support dial-up data exchange between two Wildcat BBSs, for that matter. To do that, you must again resort to a third-party package or a kludge whereby Wildcat shells out to a terminal program, which in turn runs a script to log on to a BBS and download a QWK mail packet. Mustang should provide at least the ability for two Wildcat BBSs to communicate via the telephone lines.

On the plus side, the bundled wcGATE program provides a gateway between the BBS and the Internet for importing and exporting Internet E-mail and Usenet newsgroups. Wildcat also includes wcMAIL, a QWK mail door that lets users pack up selected mail for download. And, to keep messages relatively free of mistakes, the program comes with a spelling checker and 120,000-word dictionary.

BBS Security

Security in Wildcat is highly configurable, allowing up to 1000 different security profiles. Because Wildcat does not use the typical system of access levels that range from low to high, profiles are independent of each other, so changes in one profile do not affect other profiles. (In a level-based security system, levels are related to each other by order of precedence. For example, when you disable an option for access on level 5, it is also disabled for levels 0–4.) With the profiles, whatever you enable or disable on one profile has no bearing on another. Each profile can control access to each conference, file area, or door, for the most flexible security system that I've ever seen. You can also limit most of the functions associated with both the file and conference areas.

The suite also includes wcCODE, a QuickBasic-like language. At the heart of wcCODE is the IDE (Integrated Development Environment), an editor and compiler that is intuitive and supports the WordStar command set. The programming language itself provides access to Wildcat's functions as well as most of the standard QuickBasic commands. A business might use wcCODE to write a program that uses the output from an external credit-card verification utility to upgrade the user's security profile.

Also included in the suite is the wcPRO Utilities, a collection of programs that let sysops perform database operations on the user, file, and message databases. Included in wcPRO is wcFAX, an external fax-on-demand program that lets users view a list of documents, mark the ones they want, and then have them faxed to a number that they specify. wcFAX is completely configurable, and you can set it up to deduct fax charges from a user's account.

Fly Like the Wind

I set up a two-line BBS with a local-node connection for a total of three lines. Wildcat answered and connected with the caller's modems flawlessly. With all three nodes in operation and two simultaneous high-speed transfers, the resulting transfer speeds were in excess of 113-percent efficiency, which means you can expect about 1620-plus characters per second from a 14.4-Kbps connection (the same percentage applies at other line speeds). That's about as good as you'll get in any environment. The menu displays were somewhat slow, but I attribute this to OS/2's handling of DOS multitasking. Wildcat's multiple chatting options—sysop chat as well as public and private multiline chat—all worked well and were not in any way hampered by the multitasking system.

The Wildcat BBS Suite is undeniably a powerful BBS package, and with a suggested retail price of $999, it ought to be. Its menu-driven installation process and robust configuration utilities allow for much easier setup than is available in BBSs that use control files. Still, given such a richness of features, Wildcat's lack of a RIP editor and FTSC support surprised me, even though Mustang Software says it gets few requests to add either feature from its predominantly corporate customers.

By the time you read this, registered users will be able to download version 4.01, which Mustang Software says fixes almost 70 bugs while adding some new features. If you require a multiline BBS, and you don't need the FOSSIL or intelligent I/O board support, I suggest either the 10- or 250-line versions. With a BBS like Wildcat, you will never again need to use on-line services like CompuServe to communicate with your employees. ■

About the Product

Wildcat 4.0

single-line	$129
10-line	$249
250-line	$499
Multiline Platinum	$799
BBS Suite	$999

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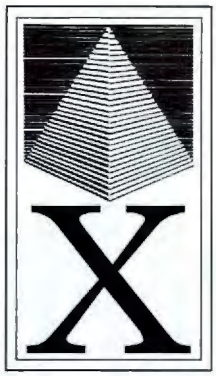
fax: (805) 873-2599
Circle 1002 on Inquiry Card.

Bill Esposito is a program integrator with the Department of Defense. A BBS user since 1982, for seven years he has been system operator of the Cereal Port BBS in Rindge, NH (603-899-3335). He can also be reached on the Internet at espo@cereal.mv.com and on BIX c/o "editors."



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TRUE-COLOR GRAPHICS

An in-depth inspection of 35 PCI and five Macintosh NuBus cards for ultrafast graphics and deep colors

JIM KANE, SIVA KUMAR, AND JOHN MCDONOUGH

Last February, we tested four types of graphics adapters: those with VL-Bus, ISA-bus, EISA-bus, and Macintosh NuBus architectures. At that time, we could round up only three PCI-based (Peripheral Component Interconnect) adapters. But as PCI has become the standard local-bus interface, the former trickle of PCI cards has turned into a flood. There has even been speculation that Apple will replace Mac NuBus slots with PCI slots in a few years.

This Lab Report describes our evaluation of 35 PCI-based graphics adapters and five high-end NuBus Mac adapters. At $399, the average price of the PCI cards here is $70 less than the average price of the VL-Bus cards we tested last February. The average price for the Mac NuBus adapters has dropped by $790.

This test set includes both DRAM- and VRAM-based accelerators, in configurations ranging from 1 to 4 MB of video memory. In general, a graphics accelerator with 1 or 2 MB of DRAM will suffice for everyday business applications. But for instantaneous, photo-realistic color, you'd be wise to purchase a more expensive VRAM-based board. And while the fastest boards we evaluated use VRAM, our tests show that the performance edge these boards have over DRAM-based accelerators is sometimes inconsequential.

The PCI adapters we tested represent a variety of graphics accelerator chip sets; the majority were from S3. This is a major change from last year, when Tseng Labs was the most popular chip provider.

Reviews tend to catch manufacturers at various stages of leapfrogging each other with better technology. Every six months or so, manufacturers upgrade their components; whichever one has upgraded most recently often reaps the better review.

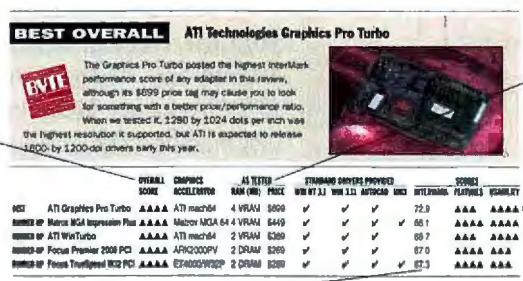
But there are specific price/performance trade-offs inherent in particular components, such as VRAM versus DRAM. Because DRAM chips must both update and display through just one port—whereas VRAM

How to use this guide

To find the best graphics accelerator for your needs, follow the main headings until you come to the appropriate bus architecture and then look for the subcategory that's most relevant to your work.

We grouped PCI adapters into best-overall (a weighted combination of performance, features, and quality scores), high-performance, and low-cost subcategories. We grouped the Mac adapters into best-overall and high-resolution groups.

Performance results are given in transactions per second: The higher the number, the more transactions an adapter was able to complete. The tests employ a collection of screens from popular Windows and Macintosh applications. Except for the motion video tests, higher numbers indicate better performance.



Prices shown are for the adapters as they were configured for our tests. Typically, the cost varies according to the amount, type, and speed of the installed RAM.

Boards rated as excellent came with installation software and the clearest manuals; a good rating identifies boards that can be installed without checking the documentation; fair-rated boards required a check of the user's manual; and boards that received a poor rating needed to have jumpers or IRQs reset.

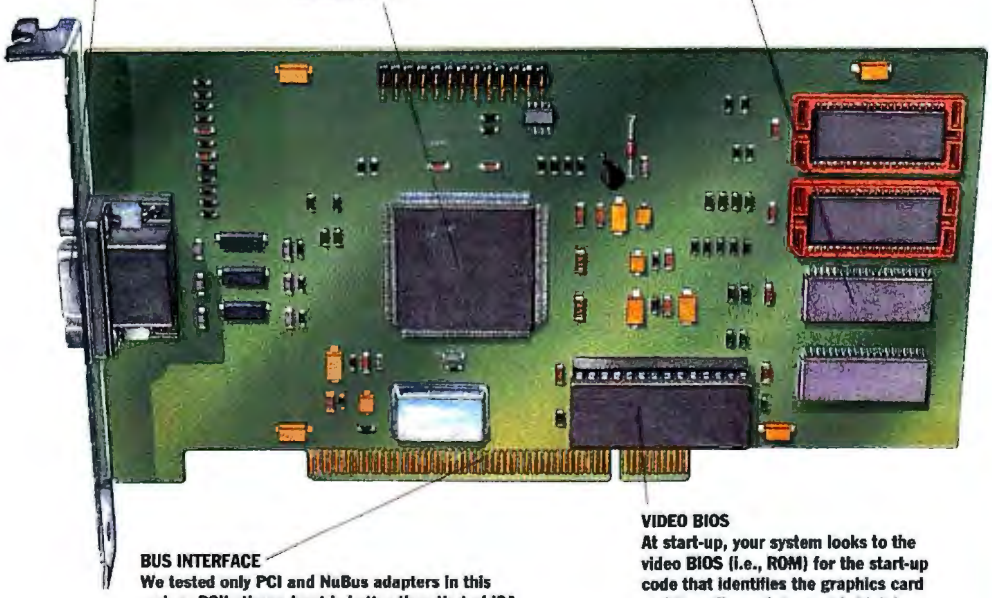
ACCELERATORS

The Gadgetry of Graphics

MONITOR INTERFACE
Most graphics adapters provide a single video connection based on the standard D-shell, 15-pin VGA connector. Some high-end boards offer RGB (i.e., BNC) connectors. Some boards have multiple active video connectors, allowing multiple monitor attachments.

GRAPHICS ACCELERATOR
Provides low-level graphics operations. A 64-bit chip can transfer data in and out of its internal frame buffer 64 bits at a time. DRAM, VRAM, and the local bus accept only 32 bits of data at a time. A 32-bit interleaved architecture prepares one bank of memory while transferring to a second bank, reducing the transfer to a single clock cycle. Look for 64- or 32-bit interleaved architectures.

VIDEO MEMORY
VRAM-based boards have the reputation of being dramatically faster than DRAM-based boards, but DRAM designs have improved to the point where they're not much slower. Choose DRAM for economy if you mainly operate in 1024- by 768-pixel resolution with 256 colors. VRAM is a must for refresh rates that provide clear images at higher resolutions and color levels.



BUS INTERFACE
We tested only PCI and NuBus adapters in this review. PCI's throughput is better than that of ISA and EISA; in addition, with its flexibility and ease of use, it's becoming the local-bus standard. For Macintosh systems, NuBus is the current accepted standard; it has been self-configuring for years.

VIDEO BIOS
At start-up, your system looks to the video BIOS (i.e., ROM) for the start-up code that identifies the graphics card and its software interrupt (which is almost always INT 10h) to control video actions. Sometimes the video BIOS is shadowed to system RAM for improved performance.

GENERAL BUSINESS

ATI Technologies Graphics Pro Turbo

The Graphics Pro Turbo posted the highest InterMark performance score of any adapter in this review. The $699 board is one of the highest-priced PCI boards we reviewed, but it delivers on performance. Our test model shipped with 4 MB of VRAM, used ATI's proprietary mach64 chip set, and boasted refresh rates of nearly 100 Hz.

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DRAFTING QUALITY

Elsa Winner 2000Pro

Elsa's Winner 2000Pro is clearly geared for CAD: It offers enhanced and accelerated video modes for fast, high-resolution color graphics under AutoCAD, and it performed well in both the DOS and Windows AutoCAD tests, making it the perfect choice for people who make their living with CAD.

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MACINTOSH

Radius LeMans GT

If you're looking for hot Macintosh performance at 1024- by 768-pixel resolutions, then take the LeMans GT for a test drive. Its features include 24-bit color support, up to 1152- by 870-pixel resolution, on-the-fly mode switching, bit-depth switching, and a Photo-Booster utility that offers additional Photoshop acceleration. Like all the Radius boards we tested, the 3-MB VRAM-based LeMans GT comes with a lifetime warranty.

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is dual-ported—at high resolutions and color depths there comes a point where VRAM is more efficient to use. This is especially true when you're working with full-motion video. Cards that have separate video accelerators offer the best performance for full-motion video playback. RAMDAC chips are also evolving rapidly. Some now include processes, such as hardware scaling and cursor control, that have traditionally been completed by the accelerator controller. Another innovative RAMDAC technology lets you display RGB and YUV windows on a screen simultaneously. Chip performance also varies by application, memory configuration, and vendor implementation. It helps to do some last-minute research when you're ready to make a purchase.

THE BEST GRAPHICS ACCELERATORS FOR

GENERAL BUSINESS

In the early years of local-bus graphics, VL-Bus graphics accelerator cards stole the show. But now PCI has overtaken the VL-Bus. Most cutting-edge Pentium systems include a PCI local bus, and most new systems use some type of local bus to accelerate graphics, whether integrated or via a slot.

To rank cards for the general-business category, we compared test results for resolutions of 1024 by 768 pixels with 256 colors. Most noninterlaced 15-inch monitors that come packaged with your average business system support this resolution.

While many adapters support higher resolutions, on small monitors these resolutions are hard on the eyes. But if you have a 21-inch monitor, such as the Nanao FlexScan F760i-W MultiSync we used for testing, you could certainly make complete use of any adapter that supports 1600- by 1200-pixel resolutions with as many colors as the card supports.

Although prices for graphics accelerators have dropped since last year, one thing remains the same: In most cases, you get what you pay for. For example, the lowest-priced adapter we tested, the $143 DFI WG-2000P, has just 1 MB of DRAM and, predictably, finished last in the best-overall category. And while you'll like the results of our best-overall winner, you might cringe when you see that ATI Technologies' Graphics Pro Turbo—while a good deal at $699 (configured with 4 MB of VRAM)—costs almost five times as much as the DFI WG-2000P.

The MGA Impression Plus, from Matrox Graphics, had one of the strongest combinations of features, usability, and performance; it finished second in the best-overall category. Its $449 price tag may seem a bit steep, but that's substantially lower than the price of many other comparable high-performance PCI boards on the market today. Its ability to change resolutions on the fly, its pioneering support of 3-D (unfortunately for testing purposes, it does not yet support OpenGL), and its high performance scores put it one step from the top.

Two of the runners-up in the best-overall category were priced under $300 and turned out overall scores that were nearly identical to those of the winner. The Premier 2000 PCI card, from Focus Information Systems, includes an ARK2000PV chip set and 2 MB of DRAM. This board's consistently high features and usability scores kept it in the running. The TrueSpeed W32 PCI, also from Focus, uses the Tseng Labs ET4000/W32P chip set and has 2 MB of DRAM; it ended up in a virtual tie with the Premier 2000 PCI.

PCI slots

Our high-performance rankings differ from the best-overall category in that we did not consider features and usability scores but relied solely on the adapters' InterMark performance numbers under Windows 3.11. ATI took high honors in this speedburner class with its Graphics Pro Turbo and WinTurbo adapters. The $369 WinTurbo has only

GRAPHICS GLOSSARY

BITBLT

Stands for bit block transfer, a hardware-based process that moves a rectangular block of bits from main memory into display memory.

BLTING

A straight-pixel copy from video memory to the screen.

NuBus slot

HARDWARE PANNING

A technique that allows you to pan across a large desktop more quickly than if you were using the normal interface.

MODE SWITCHING

The toggling between screen resolutions and pixel depths. Some video cards have special drivers that allow them to switch modes on the fly (i.e., without restarting Windows).

NUBUS

This 32-bit architecture is a self-configuring bus design used in Macintosh systems for peripheral expansion.

PCI

Stands for Peripheral Component Interconnect; a 32- or 64-bit local-bus design that uses a hardware layer that isolates the CPU and, therefore, is processor independent. It operates at 33 MHz rather than the speed of the processor. PCI devices are self-configuring.

REFRESH RATE

The number of times a display screen is redrawn per second. The higher the rate, the less flicker a display presents.

RESOLUTION

The number of pixels that can be activated on-screen at one time, expressed in the horizontal value by the vertical value (e.g., 1024 by 768).

64-BIT VS. 32-BIT INTERLEAVED

A 64-bit graphics accelerator uses a 64-bit data path to video memory. The 32-bit interleaved controller uses two passes to load data into odd and even banks of memory. While one bank is in precharge, the interleaved controller performs data I/O on the other.

SRAM

Stands for static RAM; describes chips that do not require a refresh cycle, as DRAM chips do, and thus can be accessed over twice as quickly. SRAM chips cost more than DRAM chips.

SVGA

Stands for Super VGA; originally referred to resolutions of 800 by 600 dpi at various color depths. Today, SVGA commonly refers to 1024- by 768-pixel resolution.

VRAM VS. DRAM

VRAM chips are true dual-ported memory chips that allow simultaneous reads and writes. A DRAM chip requires its content to be refreshed; read and write operations cannot occur simultaneously.

2 MB of VRAM (compared to 4 MB for the Graphics Pro Turbo), but it didn't lag too far behind in the InterMark tests. The Picasso 64-PCI from Actix Systems, which finished a whisker behind the WinTurbo, costs only $279.

Differences in InterMark scores of less than 5 percent can be discounted as relatively insignificant; every board has particular strengths and weaknesses. Determining exactly how a board scoring 9.6 is better than one scoring 9.5, for instance, can be quite difficult. You're likely to spot the difference in a board that runs 10 percent faster than a competitor, but the difference might not be enough to affect your productivity. A 25 percent speed difference is great enough for you to choose a board for the productivity gains it offers.

Our low-cost general-business category comprised only those boards priced under $250, which cut the test pool to 11 PCI boards. Of these 11, seven were based on an S3 chip set. All the runners-up in this class had 2 MB of DRAM, and the differences among the top five were insignificant.

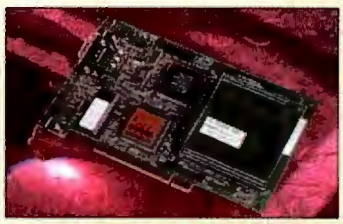
Orchid's Kelvin 64 PCI, the first low-cost runner-up, came in just under the frugal wire at $249. The other runners-up showed slightly better performance, but the Kelvin 64 PCI had the second-highest features and usability scores, excellent documentation, and a four-year warranty.

KEY	
Excellent ▲▲▲▲	Good ▲▲▲
Fair ▲▲	Poor ▲

Turbo-charged graphics

BEST OVERALL — ATI Technologies Graphics Pro Turbo

The Graphics Pro Turbo posted the highest InterMark performance score of any adapter in this review, although its $699 price tag may cause you to look for something with a better price/performance ratio. When we tested it, 1280 by 1024 dots per inch was the highest resolution it supported, but ATI is expected to release 1600- by 1200-dpi drivers early this year.



		OVERALL SCORE	GRAPHICS ACCELERATOR	AS TESTED RAM (MB)	AS TESTED PRICE	STANDARD DRIVERS PROVIDED WIN NT 3.1	WIN 3.11	AUTOCAD	UNIX	SCORES INTERMARK	FEATURES	USABILITY
BEST	ATI Graphics Pro Turbo	▲▲▲▲	ATI mach64	4 VRAM	$699	✔	✔	✔		72.9	▲▲▲	▲▲▲▲
RUNNER-UP	Matrox MGA Impression Plus	▲▲▲▲	Matrox MGA 64	4 VRAM	$449	✔	✔	✔	✔	66.1	▲▲▲▲	▲▲▲▲
RUNNER-UP	ATI WinTurbo	▲▲▲▲	ATI mach64	2 VRAM	$369	✔	✔	✔		68.7	▲▲▲	▲▲▲▲
RUNNER-UP	Focus Premier 2000 PCI	▲▲▲▲	ARK2000PV	2 DRAM	$269	✔	✔	✔		67.0	▲▲▲▲	▲▲▲
RUNNER-UP	Focus TrueSpeed W32 PCI	▲▲▲▲	ET4000/W32P	2 DRAM	$289	✔	✔	✔	✔	67.3	▲▲▲▲	▲▲▲

Inspired graphics performance

HIGH-PERFORMANCE — ATI Technologies Graphics Pro Turbo

For displaying 1024- by 768-pixel resolutions with 256 colors, no other board could match the greased-lightning speed of ATI's Graphics Pro Turbo. The board has 4 MB of VRAM and the ATI mach64 accelerator chip set. You get what you pay for with this board: high performance under Windows for lots of money. This adapter also supports instant mode switching, allowing you to change color and resolution on the fly with a single keystroke, without the usual restarting of Windows.

		OVERALL SCORE	GRAPHICS ACCELERATOR	AS TESTED RAM (MB)	AS TESTED PRICE	STANDARD DRIVERS PROVIDED WIN NT 3.1	WIN 3.11	AUTOCAD	UNIX	SCORES INTERMARK	FEATURES	USABILITY
BEST	ATI Graphics Pro Turbo	▲▲▲▲	ATI mach64	4 VRAM	$699	✔	✔	✔		72.9	▲▲▲	▲▲▲▲
RUNNER-UP	ATI WinTurbo	▲▲▲▲	ATI mach64	2 VRAM	$369	✔	✔	✔		68.7	▲▲▲	▲▲▲▲
RUNNER-UP	Actix Picasso 64-PCI	▲▲▲▲	ARK2000PV	2 DRAM	$279	✔	✔	✔		68.5	▲▲▲	▲▲▲
RUNNER-UP	Focus TrueSpeed W32 PCI	▲▲▲▲	ET4000/W32P	2 DRAM	$289	✔	✔	✔	✔	67.3	▲▲▲▲	▲▲▲
RUNNER-UP	Focus Premier 2000 PCI	▲▲▲▲	ARK2000PV	2 DRAM	$269	✔	✔	✔		67.0	▲▲▲▲	▲▲▲

The best PCI adapter under $250

LOW-COST — ATI Technologies Graphics Xpression

The Graphics Xpression offers great value for a fast 64-bit Windows accelerator. We picked it as the top under-$250 board because it had the best low-cost performance. It performs high-speed fills, line draws, BITBLTs, and bit masking in accelerated modes with up to 16.7 million colors and 1280- by 1024-pixel resolutions. Instant mode switching lets you toggle between high-resolution and true-color modes with a single keystroke. Since the Graphics Xpression has no jumpers to set, it's also easy to install.

		OVERALL SCORE	GRAPHICS ACCELERATOR	AS TESTED RAM (MB)	AS TESTED PRICE	STANDARD DRIVERS PROVIDED WIN NT 3.1	WIN 3.11	AUTOCAD	UNIX	SCORES INTERMARK	FEATURES	USABILITY
BEST	ATI Graphics Xpression	▲▲▲▲	ATI mach64	2 DRAM	$249	✔	✔	✔		63.3	▲▲▲	▲▲▲▲
RUNNER-UP	Orchid Kelvin 64 PCI	▲▲▲▲	CL GD5434	2 DRAM	$249	✔	✔	✔	✔	58.7	▲▲▲	▲▲▲▲
RUNNER-UP	Mirage Storm 1600-PCI	▲▲▲▲	S3 Vision864	2 DRAM	$245	✔	✔	✔	✔	60.1	▲▲▲	▲▲▲
RUNNER-UP	STB PowerGraph 64	▲▲▲▲	S3 Trio64	2 DRAM	$199	✔				61.0	▲▲▲	▲▲▲
RUNNER-UP	PraeoTek FastMax P20	▲▲▲▲	S3 Vision864	2 DRAM	$235	✔	✔	✔		58.8	▲▲▲	▲▲▲▲

Smooth Movies

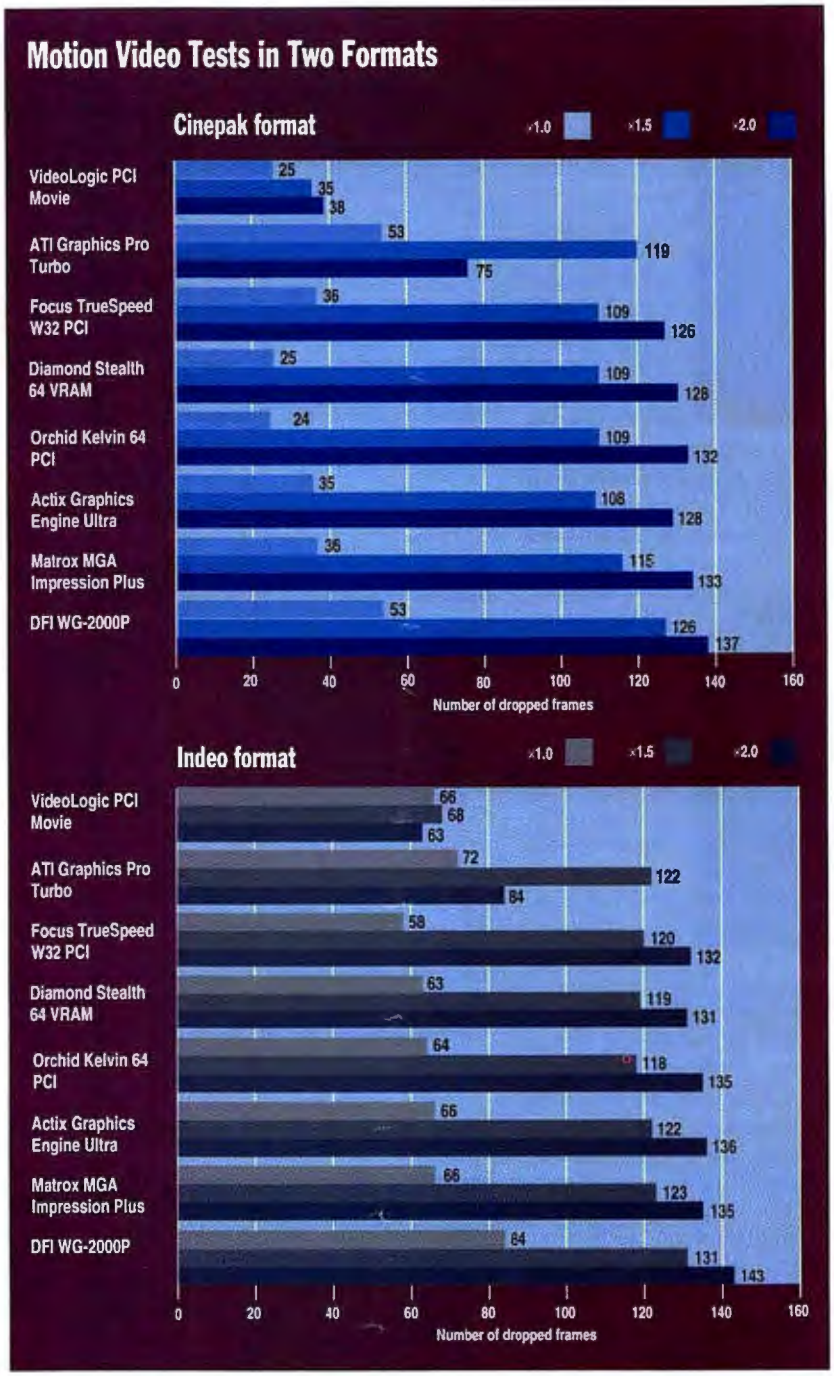
The InterMark video test, devised by NSTL, tests the video capabilities of an adapter by forcing it to play video at a consistent speed and monitoring the number of dropped frames. We tested a representative cross-section of chip sets from our test-bed of PCI graphics adapters by testing one board for each chip set. We played 30-frame-per-second video clips under the Indeo and Cinepak compression formats at normal, ×1.5, and ×2 resolutions.

We predicted that adapters equipped with video-accelerator chips would have a clear advantage in this test; this proved to be the case. The VideoLogic PCI Movie accelerator and its sidekick, the PowerPlay 964 video-accelerator chip, had significantly fewer dropped frames than the competition as resolution increased. At normal (i.e., ×1) resolution, the PCI Movie performed more slowly than the Focus TrueSpeed W32 PCI, the Diamond Stealth 64 VRAM, and the Orchid Kelvin 64 PCI cards. But, as the charts show, there was little to compare to the PCI Movie at ×1.5 and ×2 resolutions. In fact, it dropped fewer frames at ×2 resolution than it did at ×1.

The largest differences between the PCI Movie and the other adapters manifested themselves at ×1.5 resolution, where a board with hardware pixel interpolation should have the biggest advantage. A *hardware pixel interpolator* allows videos to be scaled during playback without causing more work for the host processor. *Pixel interpolation* is the rough averaging of pixels between the original pixels when the resolution is stretched beyond the normal ×1. The space between the normally mapped pixels is increased, and the adapter must make a decision as to what color pixel to place there. (See the review "Video for Free" on page 105.)

A board with pixel interpolation will average the value of the surrounding area and put an averaged value in between. This process results in shadings between sections of an image. A board without pixel interpolation will put in one of the pixels from the surrounding area, creating a blocky effect. For complex video streams, the additional work of scaling the image via software results in dropped frames and jerky playback. A hardware pixel interpolator may also result in higher-quality playback, as the video driver typically uses faster techniques (e.g., pixel replication) at the expense of image quality.

The PCI Movie has hardware pixel interpolation; it dropped only 68 frames at ×1.5 resolution, while its closest competitor, the Orchid Kelvin 64 PCI card, dropped 118 frames. This is not to say that the PCI Movie offers cinema-quality video, but it provides better-quality PC video than the other adapters that we tested.



For video tests, we selected one adapter to represent each chip set in this Lab Report. We forced each clip to run at 30 frames per second at normal, ×1.5, and ×2 resolutions using Indeo and Cinepak compression formats. Unlike most of our tests, lower numbers indicate better performance (i.e., fewer dropped frames).

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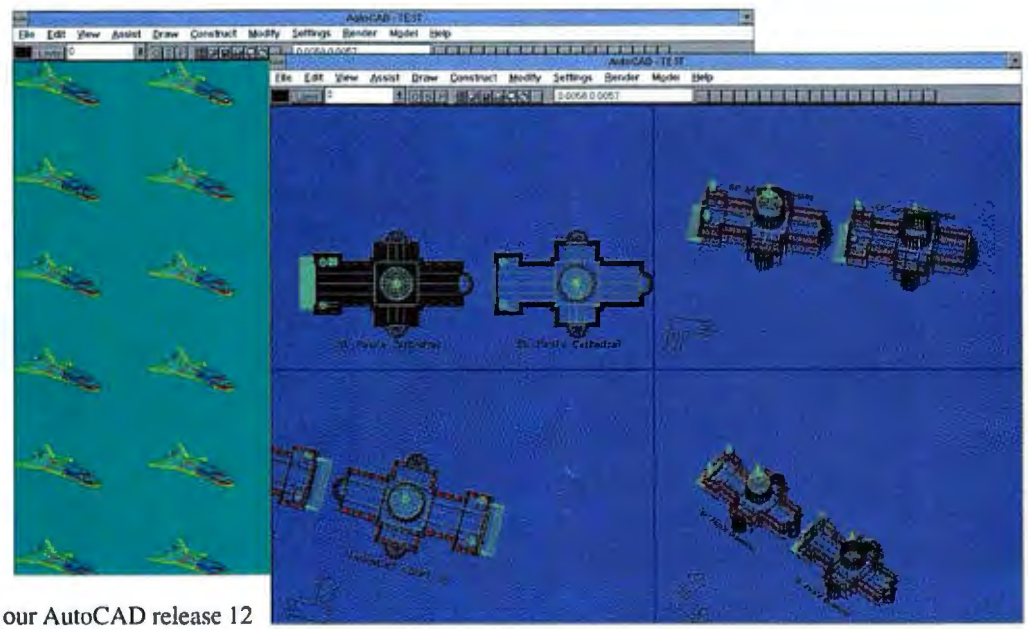
THE BEST PCI GRAPHICS ADAPTERS FOR

DRAFTING QUALITY

If you work with Windows- or DOS-based CAD packages, you will want to have a fast, high-resolution graphics adapter that can handle large, complex drawings. The screen-redraw process should not make you want to slap the monitor as you wait and wonder if you could do it faster with a ruler and compass. The graphics adapters we tested provide several solutions for high-resolution CAD problems, and some of them proved to be adequate low-cost alternatives.



Our CAD performance tests involve drawing and manipulating CAD drawings in AutoCAD release 12 for DOS and Windows at 1024 by 768 dpi and at 1600- by 1200-pixel resolution. Predictably, the adapters with specialized CAD drivers posted the highest scores.

We rated boards using our AutoCAD release 12 performance tests under DOS and Windows 3.11. If the vendor supplied a Windows driver for AutoCAD, we used it; otherwise, we used that adapter's supplied Windows driver. We tested the 14 adapters that qualified for high-level tests under DOS and Windows at 1600 by 1200 pixels in 256 colors. We tested 11 in the low-cost category, which are all steals for under $250.

In general, the overall CAD winners are not the general-business winners. They have completely different drivers for DOS, and some have specialized AutoCAD for Windows drivers. It was no surprise that the boards equipped with specialized drivers—the Matrox MGA Impression Plus, the Elsa Winner 2000Pro, and all three graphics adapters from miro Computer Products—performed the best in the Windows AutoCAD test suite.

Two adapters proved to be nice alternatives to the Elsa Winner 2000Pro: the Graphics Pro Turbo and the WinTurbo, both from ATI Technologies. These two earned higher Windows AutoCAD scores than the Elsa Winner 2000Pro, and they tied it in the DOS tests. In addition, the ATI cards are less expensive than the $799 Elsa card, costing $699 and $369, respectively. But pricing was not considered in our rankings. Overall, Elsa did the little things better, such as providing an indexed user's manual and memory-expansion options.

If you need high-quality DOS performance, consider Diamond's Stealth 64 VRAM. This $599 board had the best DOS scores among the best-overall winners. And it's also one of the few that supports on-the-fly mode switching in Windows.

Precision, an important aspect of CAD work, increases with resolution. So, for the high-resolution/performance CAD subcategory, we considered only the 1600- by 1200-dpi AutoCAD scores and the features and usability scores.

Diamond Multimedia Systems' Viper SE PCI and Genoa Systems' Video Blitz 9500 PCI finished neck-and-neck in the high-resolution arena. They shipped with the same AutoCAD driver, the DL-Xpress from Vibrant Graphics, and the same chip set, the Weitek P9100. This combination produced the best high-resolution DOS performance. We gave the final nod to the Viper SE PCI only because it had a slight performance edge. The Viper SE PCI has 4 MB of VRAM, and the Video Blitz 9500 PCI has 2 MB, but this didn't seem to affect the DOS AutoCAD scores.

For the same category in Windows, the top performer was the Matrox MGA Impression Plus, a $449 graphics adapter with 4 MB of VRAM. This 64-bit accelerator card includes support for 3-D and useful DynaView CAD utilities, such as a pop-up window with a fully scrollable AutoCAD command field, and DynaView's Spy-Glass feature, which allows you to roam through an enlarged section of your drawing.

The least expensive board in the high-resolution category is the Phantom 64 8864 PCI from Genoa Systems. The only DRAM-based board ranked here, it comes with 2 MB of RAM for an economical $279. Among the top high-resolution boards, this S3 Vision864–based card had the second-highest Windows scores, but it was tied for last in the DOS tests.

Our low-cost CAD category includes adapters priced at less than $250. These boards offer performance that is almost equivalent to that of some of the top-ranked general-business boards. This is an indication that good performance is not out of the reach of draftspersons on a tight budget.

Of the products that we reviewed, only the Matrox MGA Impression Plus supports 3-D rendering. This year, however, 3-D chips will become common options on graphics cards. For example, 3DLabs will soon begin shipping its Glint 300SX 3-D graphics processor for PCI; it supports all the rendering operations of OpenGL. Omnicomp Graphics will include the Glint chip on its 3Demon adapter. Cirrus Logic's Mondello 3-D chip set, which is also for PCI, consists of a VRAM-based high-performance 2-D GUI and a 3-D rendering accelerator with a 135-MHz true-color palette DAC (D/A converter). DEC and Brooktree, who jointly developed the DECchip 21030, will collaborate on all its associated drivers and support. The 21030 is also a high-performance 2-D and 3-D accelerator. Finally, Kubota has announced its ActionGraphics 300 3-D accelerator, which is specifically designed to take advantage of Pentium speeds and advanced operating systems, such as Microsoft NT 3.5 and Windows 95.

This flurry of 3-D technology is due in large part to the WinG OpenGL 3-D modeling library, Microsoft's implementation of Silicon Graphics' technology in NT 3.5 and Windows 95. There are also other 3-D libraries and APIs to support; some of the most significant ones belong to the CAD market.

KEY	
Excellent ▲▲▲▲	Good ▲▲▲
Fair ▲▲	Poor ▲

BYTE BEST — DRAFTING QUALITY

Draft with the pros

BEST OVERALL — Elsa Winner 2000Pro

This 64-bit accelerator card was a top performer among the higher echelon of CAD adapters we tested. Its protected-mode Elsa ADI AutoCAD driver offers useful extensions, including a bird's-eye view, dynamic panning, and zoom. At $799 with 4 MB of VRAM, the Winner 2000Pro supports up to 8 MB of VRAM. Its chip set, the S3 Vision964, also powers the Diamond Stealth 64 VRAM, a runner-up in this category.

		OVERALL SCORE	GRAPHICS ACCELERATOR	AS TESTED RAM (MB)	AS TESTED PRICE	STANDARD DRIVERS PROVIDED WIN NT 3.1	WIN 3.11	AUTOCAD	UNIX	AUTOCAD SCORE (TPS) DOS	WIN	SCORES FEATURES	USABILITY
BEST	Elsa Winner 2000Pro	▲▲▲▲	S3 Vision964	4 VRAM	$799	✔	✔	✔		3.2	1.2	▲▲▲▲	▲▲▲▲
RUNNER-UP	ATI Graphics Pro Turbo	▲▲▲▲	ATI mach64	4 VRAM	$699	✔	✔	✔		3.2	1.4	▲▲▲	▲▲▲▲
RUNNER-UP	ATI WinTurbo	▲▲▲▲	ATI mach64	2 VRAM	$369	✔	✔	✔		3.2	1.3	▲▲▲	▲▲▲▲
RUNNER-UP	Diamond Stealth 64 VRAM	▲▲▲▲	S3 Vision964	4 VRAM	$599	✔	✔	✔		3.3	0.6	▲▲▲	▲▲▲▲
RUNNER-UP	Diamond Viper SE PCI	▲▲▲▲	Weitek P9100	4 VRAM	$579	✔	✔	✔		3.2	0.8	▲▲▲	▲▲▲▲

La crème de la CAD

HIGH-END — Diamond Multimedia Systems Viper SE PCI

Ideal for professional color imaging, the Viper SE PCI maximizes the performance of large-screen, high-resolution monitors running DOS AutoCAD. While it fared poorly in comparison to the top five placers in Windows AutoCAD scores, it had the highest usability score, due in part to its easy installation and excellent documentation. The Viper SE PCI has an AutoCAD driver that accelerates zooms and pans and creates regenerations, moves, and erases. In addition, its edge-panning utility, one of several supplied CAD controls, lets you navigate through your drawing by nudging screen edges with your cursor.

		OVERALL SCORE	GRAPHICS ACCELERATOR	AS TESTED RAM (MB)	AS TESTED PRICE	STANDARD DRIVERS PROVIDED WIN NT 3.1	WIN 3.11	AUTOCAD	UNIX	AUTOCAD SCORE (TPS) DOS	WIN	SCORES FEATURES	USABILITY
BEST	Diamond Viper SE PCI	▲▲▲▲	Weitek P9100	4 VRAM	$579	✔	✔	✔		2.6	0.7	▲▲▲	▲▲▲▲
RUNNER-UP	Genoa Video Blitz 9500 PCI	▲▲▲▲	Weitek P9100	2 VRAM	$599	✔	✔	✔		2.5	0.8	▲▲▲▲	▲▲▲
RUNNER-UP	Matrox MGA Impression Plus	▲▲▲▲	Matrox MGA 64	4 VRAM	$449	✔	✔	✔		1.7	1.8	▲▲▲▲	▲▲▲▲
RUNNER-UP	Genoa Phantom 64 8864 PCI	▲▲▲	S3 Vision864	2 DRAM	$279	✔	✔	✔		1.6	1.3	▲▲▲▲	▲▲▲
RUNNER-UP	PraeoTek GraphMax P24	▲▲▲	S3 Vision964	4 VRAM	$615	✔	✔	✔		1.6	1.0	▲▲▲▲	▲▲▲▲

If you're not made of gold, buy Diamond's

LOW-COST — Diamond Multimedia Systems Stealth 64 DRAM

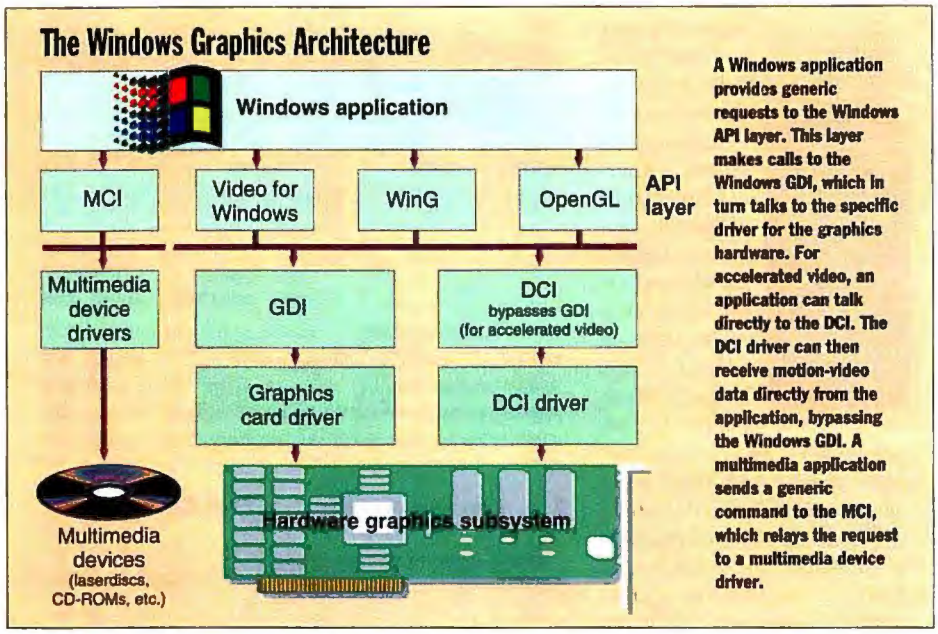
If you're tight on funds but still need a decent CAD system, we recommend the 4-MB Stealth 64 DRAM. This adapter has twice as much DRAM as any of the others in the top five. It also has very good Windows AutoCAD scores, though only average DOS AutoCAD scores. Its strong points, such as drivers for Windows NT, OS/2, and AutoCAD; a five-year warranty; and on-the-fly resolution switching in Windows, pushed it over the top.

		OVERALL SCORE	GRAPHICS ACCELERATOR	AS TESTED RAM (MB)	AS TESTED PRICE	STANDARD DRIVERS PROVIDED WIN NT 3.1	WIN 3.11	AUTOCAD	UNIX	AUTOCAD SCORE (TPS) DOS	WIN	SCORES FEATURES	USABILITY
BEST	Diamond Stealth 64 DRAM	▲▲▲	S3 Trio64	2 DRAM	$249	✔	✔	✔	✔	3.2	0.6	▲▲▲	▲▲▲▲
RUNNER-UP	ATI Graphics Xpression	▲▲▲	ATI mach64	2 DRAM	$249	✔	✔	✔		2.5	1.3	▲▲▲	▲▲▲▲
RUNNER-UP	Mirage Storm 1600-PCI	▲▲▲	S3 Vision864	2 DRAM	$245	✔	✔	✔	✔	2.1	1.0	▲▲▲	▲▲▲
RUNNER-UP	PraeoTek FastMax P20	▲▲▲	S3 Vision864	2 DRAM	$235	✔	✔	✔		1.9	1.0	▲▲▲	▲▲▲▲
RUNNER-UP	miroCrystal 20SD	▲▲▲	S3 Vision864	2 DRAM	$239	✔	✔	✔	✔	1.6	1.3	▲▲▲▲	▲▲▲

How We Tested

To create a comprehensive series of tests to determine the best graphics accelerators, we first identified the most important markets for them. We concentrated on two categories for PCI cards and one for high-end Macintosh graphics adapters, as outlined below.

- General business: 1024- by 768-pixel resolution with 256 colors; for mainstream Windows users and people who use general-business applications.
- CAD: 1024- by 768-pixel resolution with 256 colors, and 1600- by 1200-pixel resolution with 256 colors; for engineers, architects, and draftspersons.
- Macintosh graphics: 1152- by 870-pixel resolution with 16.7 million colors; for desktop publishers and graphic illustrators.



For testing on the PC side, we required the adapters to support a minimum of 1024 by 768 pixels with 256 colors in noninterlaced mode. They had to have a minimum of 1 MB of memory. We tested the boards in a DECpc XL 590, a 90-MHz Pentium system with 32 MB of RAM. We used a 21-inch Nanao FlexScan F760i-W MultiSync monitor.

Our Macintosh test-bed consisted of an Apple Mac Quadra 840AV with 16 MB of RAM and the same Nanao monitor. We concentrated on 24-bit, true-color adapters capable of displaying 16.7 million colors on monitors with screens measuring up to 21 inches.

Performance was our primary criterion for selecting the winners. After we chose the top performers, we ranked the winners and runners-up by considering cost, support options, usability, and any unique features the boards offered. Because of differences in retail and street prices, we considered a 15 percent cost difference to be insignificant.

In the ease-of-use scores, an excellent ranking was reserved for adapters with exceptionally clear and complete documentation and installation software. Adapters received a good rating if an average user could install them without referring to the manual. Boards that were rated fair required our testers to consult the documentation, while poor ease-of-use scores indicate we had to reset some setting or jumper and/or consult the vendor's technical-support personnel.

Although ease of installation was a factor in our usability scores, this judgment was tempered somewhat by the fact that once you get even the most troublesome board up and running, you're likely to be concerned only about performance and compatibility for the rest of the board's life.

PERFORMANCE

We produce tests whose scores give a meaningful reflection of real-world conditions. Our graphics application tests use images produced from CorelDraw, Excel, PowerPoint, and Word for Windows. This month, we expanded our testing to include AutoCAD, which stresses a different set of graphics operations.

We required each PCI adapter to display a variety of Windows and AutoCAD images, ranging from straight text to two-dimensional and 3-D bar charts to complex full-color drawings. For the Macintosh tests, we used Corel's export filters to convert drawings into PICT format. We also incorporated images from Mac versions of Aldus Persuasion, Excel, and Microsoft Word. Because many of the test images are platform specific, avoid making direct comparisons between Mac and PC results.

We designed our tests to be resilient to benchmark-optimized drivers (i.e., cheating). And, to increase the accuracy of the tests, we used microsecond timing. This allowed us to accurately measure a single screen paint, and it avoided the necessity of drawing the same screen repeatedly (which is unrealistic and also easy to optimize in the driver).

Our Windows tests drew each of the 15 Windows application screens into both system memory and video memory using four different color modes for more than 120 tests. We also measured the time it took to refresh the screen from an image cached in memory at screen depths of 1, 2, 4, 8, 16, and 32 bits per pixel. Well-written applications cache display images whenever possible to improve response times.

Contributors

Jim Kane, *Project Manager/NSTL, has been testing network and PC hardware and peripherals for NSTL for the last five years.*

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The Lab Report is an ongoing collaborative project between BYTE magazine and National Software Testing Laboratories (NSTL). BYTE magazine and NSTL are both operating units of McGraw-Hill, Inc. Contact the NSTL staff on the Internet at editors@nstl.com; at NSTL, Inc., Plymouth Corporate Center, Plymouth Meeting, PA 19462; or at (610) 941-9600. Contact BYTE on the Internet or BIX at editors@bix.com or at (603) 924-2643.

While some desktop publishing and graphics illustration applications are slowly migrating to the PC, most seasoned graphics professionals still prefer to use a Mac. With that in mind, we tested five two-page, true-color display adapters for Mac systems.

All but one of the NuBus cards we tested support 1152- by 870-pixel resolutions. We used a Mac Quadra 840AV for testing because its maximum 2 MB of VRAM leaves it 1 MB shy of what's needed for dual-page, true-color displays.

The Macintosh graphics adapters range in price from $699 to $2599, but we did not consider price in our rankings. In this category, there is no low-cost subset.

Our best-overall category identifies the speed leaders in low-resolution (1024 by 768 dpi) and high-resolution (1152 by 870 dpi) performance tests, with high-resolution test scores weighted more heavily than low-resolution results. Features and usability scores are also mixed into the equation for the best-overall rankings. But in the high-performance subcategory, we considered only the high-resolution performance test results.

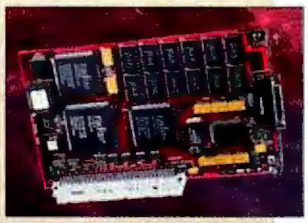
Radius, a leading Macintosh graphics vendor, provided us with four of the five NuBus boards. The $1999 LeMans GT (the best-overall winner), the $1399 PrecisionColor Pro 24X, and the $999 PrecisionColor Pro 24XK all deliver fast and accurate color for high-end graphics. Although the 24XK doesn't support as many resolutions as the other boards do, it might be the right board for you if you have a small- to medium-size monitor. The PrecisionColor Pro 24XK outscored the 24X in both the low- and high-resolution tests.

The Radius Thunder II GXT 1152, the high-resolution winner, allows you to add memory for applications that take advantage of *GWorlds*, images that exist in memory but are not displayed on-screen. You may have to balance that value by putting more memory into your system. The advantage of putting more memory on the display adapter is that the acceleration hardware can be used to update off-screen images, and, more important, the off-screen images can be copied to the screen without having to squeeze through the NuBus.

The lowest-priced NuBus adapter, the Tornado from Mirror Technologies, finished last every time. The Tornado offers roughly one-third the performance of the Radius LeMans GT, and it is priced accordingly. As is, it would not be a good choice for image-editing applications, such as Adobe Photoshop. However, Mirror offers an optional Charge-Card Photoshop accelerator that can be attached to the Tornado via two pin connectors. Unfortunately, we did not get a chance to test this option.

Fast as a sports car

BEST OVERALL — Radius LeMans GT

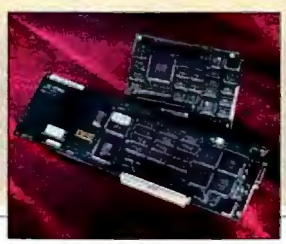


Macintosh users searching for a graphics accelerator with sports-car performance should look into the LeMans GT. Our pick for the best-overall NuBus adapter blew away the competition in our 1024- by 768-pixel resolution tests. In fact, it bested the competition in features and usability scores, too. Its features include 24-bit color support at up to 1152- by 870-pixel resolution, on-the-fly resolution and bit-depth switching, and a PhotoBooster utility that offers additional Photoshop acceleration. Like all the Radius boards we tested, the 3-MB, VRAM-based LeMans GT comes with a lifetime warranty.

		OVERALL SCORE	GRAPHICS ACCELERATOR	AS TESTED RAM (MB)	AS TESTED PRICE	GRAPHICS SCORES 1152 × 870/ 16.7M COLORS	GRAPHICS SCORES 1024 × 768/ 256 COLORS	SCORES FEATURES	SCORES USABILITY
BEST	Radius LeMans GT	▲▲▲▲	Radius Custom ASICs	3 VRAM	$1999	4.4	9.7	▲▲▲	▲▲▲▲
RUNNER-UP	Radius Thunder II GX 1152	▲▲▲▲	Radius Custom ASICs	3 VRAM	$2599	4.4	6.8	▲▲▲	▲▲▲▲
RUNNER-UP	Radius PrecisionColor Pro 24XK	▲▲▲▲	Radius Custom ASICs	2 VRAM	$999	3.7	7.4	▲▲	▲▲▲
RUNNER-UP	Radius PrecisionColor Pro 24X	▲▲▲	Radius Custom ASICs	3 VRAM	$1399	3.1	3.0	▲▲▲	▲▲▲▲
RUNNER-UP	Mirror Tornado	▲▲	Proprietary ASIC	3 VRAM	$699	1.4	2.8	▲▲▲	▲▲▲

High cost, high quality

HIGH-RESOLUTION — Radius Thunder II GXT 1152



The $2599 Thunder II GXT 1152 board is the most expensive Mac board we tested, and it posted the highest numbers in our 1152- by 870-pixel resolution test. The Thunder II's outstanding performance can be attributed in part to its dual-DSP design. DSP acceleration speeds up image filtering for processor-intensive applications, such as Adobe Photoshop. The 12½-inch-long card, which has a proprietary graphics accelerator chip set, was shipped to us with 3 MB of VRAM, its maximum configuration.

		OVERALL SCORE	GRAPHICS ACCELERATOR	AS TESTED RAM (MB)	AS TESTED PRICE	GRAPHICS SCORES 1152 × 870/ 16.7M COLORS	SCORES FEATURES	SCORES USABILITY
BEST	Radius Thunder II GXT 1152	▲▲▲▲	Radius Custom ASICs	3 VRAM	$2599	4.4	▲▲▲	▲▲▲▲
RUNNER-UP	Radius LeMans GT	▲▲▲▲	Radius Custom ASICs	3 VRAM	$1999	4.4	▲▲▲	▲▲▲▲
RUNNER-UP	Radius PrecisionColor Pro 24XK	▲▲▲▲	Radius Custom ASICs	2 VRAM	$999	3.7	▲▲	▲▲▲
RUNNER-UP	Radius PrecisionColor Pro 24X	▲▲▲	Radius Custom ASICs	3 VRAM	$1399	3.1	▲▲▲	▲▲▲▲
RUNNER-UP	Mirror Tornado	▲▲	Proprietary ASIC	3 VRAM	$699	1.4	▲▲▲	▲▲▲

KEY	
Excellent ▲▲▲▲	Good ▲▲▲
Fair ▲▲	Poor ▲

Video Glossary

AVI Stands for Audio Video Interleave, a file-format extension given to Video for Windows files wherein audio and video data are stored in alternate blocks.

Cinepak A software file-compression scheme for video that's well suited to low-power CPUs. Established by SuperMac (now Radius Technologies), it is common on Windows and the Mac OS.

DCI Stands for display control interface, the software interface for display device drivers. It communicates directly with the video hardware, bypassing the Windows GDI.

Feature connector

DSP Stands for digital signal processor, a specialized, programmable CPU capable of performing high-speed mathematical processing. Ideal for use in compression algorithms.

feature connector The 26-pin cable that delivers pixel data from a VGA board to an external device, such as a video-capture board.

FLI, FLC File extensions denoting animations created in Autodesk Animator. FLI supports VGA; FLC supports SVGA resolutions. These compression techniques are more effective for animations than they are for natural video, since they work best on large areas of a single color.

Indeo A software file-compression scheme for video established by Intel; it uses a lossy compression/decompression algorithm.

lossy compression A scheme that, after decompression, does not produce exactly the same data that was given to the compressor. Due to the nature of image data, the losses are often imperceptible to the human eye.

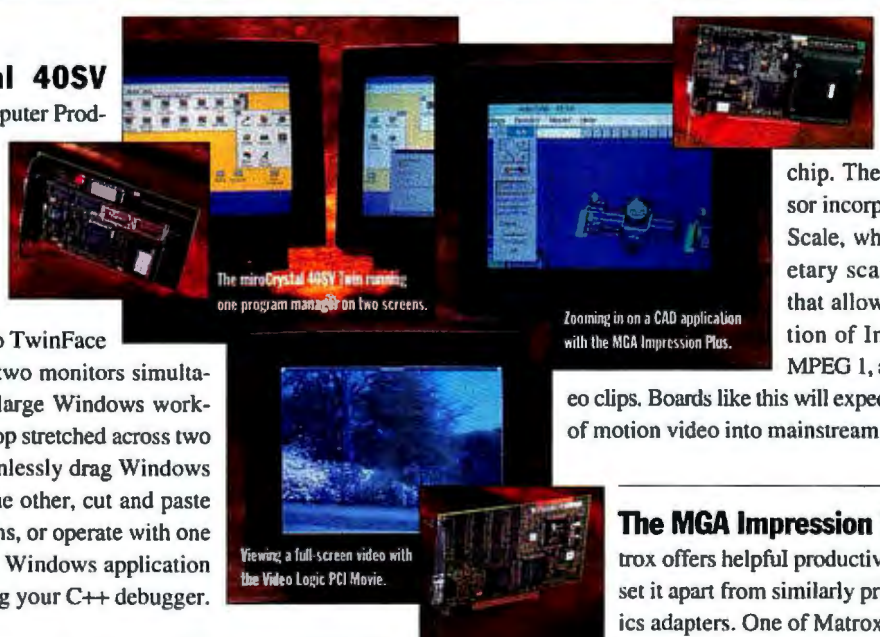
AT&T DSP chips

MCI Stands for media control interface. Controls multimedia devices and includes standard commands, such as Open, Close, and Play; C functions; and MPEG.

motion JPEG A simplified version of the JPEG compression scheme. It loads a fixed Huffman table (which lists bit streams and their abbreviations) for all frames of a video rather than for each frame.

VM channel Stands for VESA media channel, a standard connector that provides a link between adapter cards and a computer's graphics subsystem, providing a dedicated channel for real-time video that's independent of the system bus.

HONORABLE MENTIONS

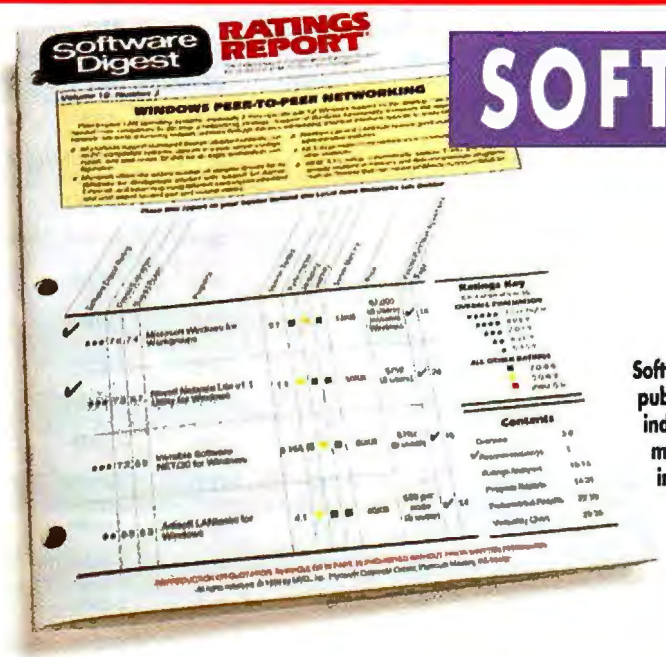


The miroCrystal 40SV Twin, from miro Computer Products, includes not just one, but two graphics accelerators. To add the second S3 processor, it uses a daughterboard mounted on the main adapter. The miro TwinFace driver can control the two monitors simultaneously, creating one large Windows workspace. With your desktop stretched across two monitors, you can seamlessly drag Windows from one monitor to the other, cut and paste between two full screens, or operate with one screen displaying your Windows application and the other displaying your C++ debugger.

It may not provide the grandeur of the silver screen, but VideoLogic's PCI Movie can run full-screen movies plus accelerate Windows multimedia presentations. The board is powered by a Weitek P9100 graphics accelerator as well as VideoLogic's PowerPlay32 Digital Movie accelerator chip. The movie processor incorporates SmoothScale, which is a proprietary scaling algorithm that allows the acceleration of Indeo, Cinepak, MPEG 1, and Video 1 video clips. Boards like this will expedite the adoption of motion video into mainstream computing.

The MGA Impression Plus from Matrox offers helpful productivity features that set it apart from similarly priced PCI graphics adapters. One of Matrox's way-cool innovations is a feature called Pixel Touch, which allows you to zoom up to ×2 and ×4 magnification and pan in a window within AutoCAD via a hot key. A QCDP (Quality Color Dithering Process) feature simulates true color in 8- and 16-bit modes at resolutions up to 1600 by 1200 pixels.

TEST BEFORE YOU BUY



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COMPANY	ADAPTER NAME	PRICE AS TESTED	WARRANTY (YEARS)[1]	ACCELERATOR CONTROLLER	VIDEO DAC	VIDEO BIOS	VIDEO-PLAYBACK CHIP SET	BUS CONNECTOR (PCI/ NUBUS)	VIDEO CONNECTOR	RAM MAX./ AS TESTED (MB)	SPEED (NS)
Actix Systems, Inc.	Graphics Engine Ultra 64-PCI	$529	3 PL	S3 Vision864	AT&T 491	Quadtel 1.44	N/A	PCI	DB 15	4 DRAM/4	70
Actix Systems, Inc.	Picasso-PCI	$259	3 PL	ARK1000	AT&T 490	Phoenix 1.1	N/A	PCI	DB 15	2 DRAM/2	70
Actix Systems, Inc.	Picasso 64-PCI	$279	3 PL	ARK2000	AT&T 491	Phoenix 1.1	N/A	PCI	DB 15	4 DRAM/2	70
BYTE ATI Technologies, Inc.	Graphics Pro Turbo	$699	5P/1 L	ATI mach64 88800GX	Spectra DAC (ATI 68860)	ATI Custom BIOS	ATI mach64 88800GX	PCI	DB 15	4 VRAM/4	70
ATI Technologies, Inc.	Graphics Xpression	$249	5P/1 L	ATI mach64 88800GX	SG-1701	ATI Custom BIOS	ATI mach64 88800GX	PCI	DB 15	2 DRAM/2	70
ATI Technologies, Inc.	WinTurbo	$369	5P/1 L	ATI mach64 88800GX	Spectra DAC (ATI 68860)	ATI Custom BIOS	ATI mach64 88800GX	PCI	DB 15	2 VRAM/2	70
Brilliant Computer Products	Cloud9 Thunder64	$195	2 PL	S3 Vision864	S3 SDAC	Phoenix 1.03	N/A	PCI	DB 15	2 DRAM/2	70
DFI	WG-2000P	$143	2 PL	ALG2301	ALG1201	Quadtel 2.0	N/A	PCI	DB 15	1 DRAM/1	60
DFI	WG-3000P2	$229	2 PL	S3 Vision864	S3 86C716	Phoenix 2.0	N/A	PCI	DB 15	4 DRAM/1	70
Diamond Multimedia Systems, Inc.	Stealth 64 DRAM	$249	5 PL	S3 Trio64	Integrated	Diamond 2.01	N/A	PCI	DB 15	2 DRAM/2	60
Diamond Multimedia Systems, Inc.	Stealth 64 VRAM	$599	5 PL	S3 Vision964	Brooktree 485A	Diamond 1.05	N/A	PCI	DB 15/BNC	4 VRAM/4	70
Diamond Multimedia Systems, Inc.	Viper SE PCI	$579	5 PL	Weitek P9100	IBM RGB525	Diamond 1.05	N/A	PCI	DB 15	4 VRAM/4	70
Elsa, Inc.	Winner 1000Pro	$329	3 PL	S3 Vision864	AT&T 21C498	ELSA 1.06	N/A	PCI	DB 15	2 DRAM/2	70
BYTE Elsa, Inc.	Winner 2000Pro	$799	3 PL	S3 Vision964	TI TVP3020	ELSA 1.00.04	N/A	PCI	DB 15	8 VRAM/4	70
Focus Information Systems, Inc.	Cheetah 34 PCI	$439	4 PL	Cirrus Logic GD5434	Integrated	Cirrus Logic 1.01B	N/A	PCI	DB 15	4 DRAM/2	70
Focus Information Systems, Inc.	Premier 2000 PCI	$269	5 PL	ARK2000PV	STG1700/	Phoenix & Ark Logic 2.3	N/A	PCI	DB 15	4 DRAM/2	70
Focus Information Systems, Inc.	RoadRunner 864 PCI	$279	2 PL	S3 Vision864	SDAC STG1703	Phoenix 1.03	N/A	PCI	DB 15	2 DRAM/2	60
Focus Information Systems, Inc.	TrueSpeed W32 PCI	$289	3 PL	Tseng Labs ET4000/W32P	AT&T C490	Tseng Labs 1.4C	N/A	PCI	DB 15	2 DRAM/2	70
Genoa Systems Corp.	Phantom 64 8864 PCI	$279	2 PL	S3 Vision864	S3 SDAC RAMDAC	Phoenix 1.2	N/A	PCI	DB 15	2 DRAM/2	70
Genoa Systems Corp.	Video Blitz 9500 PCI	$599	2 PL	Weitek P9100	IBM RGB525 64-bit RAMDAC	Weitek 1.0	N/A	PCI	DB 15	4 VRAM/2	70
Genoa Systems Corp.	Windows64 VGA 8534 PCI	$239	2 PL	Cirrus Logic GD5434	Integrated	Cirrus Logic 1.0	N/A	PCI	DB 15	4 DRAM/2	70
Matrox Graphics, Inc.	MGA Impression Plus	$449	2 PL	Matrox MGA 64	TI TVP3026	LSI Logic 3.5	VideoLogic PowerPlay 32	PCI	DB 15/BNC	4 VRAM/4	60
Mirage Multimedia Systems	Mirage Storm 1600-PCI	$245	5 P/1 L	S3 Vision864	SGS Thompson	S3 2.2	N/A	PCI	DB 15	4 DRAM/2	45
miro Computer Products, Inc.	miroCrystal 20SD	$239	2 PL	S3 Vision864	AT&T 40C491-135	Phoenix/miro 3.3	N/A	PCI	DB 15	2 DRAM/2	70
miro Computer Products, Inc.	miroCrystal 40SV	$599	2 PL	S3 Vision964	TI TVP3025-135	Phoenix/miro 1.1	N/A	PCI	DB 15	4 VRAM/4	70
miro Computer Products, Inc.	miroCrystal 40SV Twin	$1199	2 PL	S3 Vision964/ S3 Vision864	TI TVP3025-220/ AT&T 40C490-135	Phoenix/miro 1.1	N/A	PCI	DB 15	4 VRAM/ 2 DRAM	70
Nth Graphics	Apex/PCI 2 MB	$495	1 PL	S3 Vision864	AT&T 498	Phoenix S3 1.02-00	N/A	PCI	DB 15	4 DRAM/2	70
Orchid Technology	Kelvin 64 PCI	$249	4 PL	Cirrus Logic GD5434	Integrated	Orchid 1.02 GD5434	N/A	PCI	DB 15	2 DRAM/2	70
PraeoTek, Inc.	FastMax P20	$235	5 PL	S3 Vision864	S3 SDAC	S3 1.03.07	N/A	PCI	DB 15	2 DRAM/2	70
PraeoTek, Inc.	GraphMax P24	$615	5 PL	S3 Vision964	TI TVP3025	S3 1.03.07	N/A	PCI	DB 15	4 VRAM/4	70
Spider Graphics, Inc.	Spider 64	$364	2 PL	Cirrus Logic GD5434	Integrated	Spider Graphics 1.25	N/A	PCI	DB 15	4 DRAM/4	60
Spider Graphics, Inc.	Tarantula 64	$499	2 PL	S3 Vision964	Brooktree 485/KPJ 135	Spider Graphics 1.25	N/A	PCI	DB 15	4 VRAM/4	70
STB Systems, Inc.	PowerGraph 64	$199	Lifetime (limited)	S3 Trio64	Integrated	S3/STB Systems 1.0	N/A	PCI 2.0	DB 15	2 DRAM/2	60
VideoLogic, Inc.	PCI Movie	$399	1 PL	Weitek P9100	Brooktree 9485	Weitek 1.24	VideoLogic PowerPlay 32	PCI	DB 15	2 VRAM/2	70
Western Digital/Paradise	Bahamas 64 PCI	$299	3P/1 L	S3 Vision864	S3 SDAC	S3/Phoenix 1.03-.08	N/A	PCI	DB 15	2 DRAM/2	60
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BYTE Radius, Inc.	LeMans GT	$1999	Lifetime	Radius Custom ASICs	Analog Devices	Radius ROM 2.0 & Quickcolor	N/A	NuBus	DB 15	3 VRAM/3	60
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Radius, Inc.	Thunder II GTX 1152	$2599	Lifetime	Radius Custom ASICs	Brooktree Custom DAC01	Radius ROM 3.0 & SuperPower	N/A	NuBus	DB 15	3 VRAM/3	60

BYTE = BYTE Best.

[1] P = parts; L = labor.

GRAPHICS ADAPTERS TESTED

FEATURE CONNECTOR	SUPPORTS MULTIPLE ADAPTERS?	NI MAX. REF. RATE (HZ)/MAX. HOR. FREQ. (KHZ)	UTILITY SOFTWARE: SCREEN SAVER/ ZOOM	UTILITY SOFTWARE: DIAGNOSTICS/ FONT EDITOR	NONINTERLACED MODES: MAX. COLORS/MAX. REF. RATE (HZ): 1024 × 768	1280 × 1024	1600 × 1200	640 × 400	832 × 624	PHONE	TOLL-FREE PHONE	INQUIRY NUMBER
Yes	No	100/94	Yes/No	No/Yes	64K/90	256/75	256/75	N/A	N/A	(406) 986-1625	(800) 927-5557	1346
Yes	No	90/84	Yes/Yes	No/No	256/75	256/60	256/67	N/A	N/A	(406) 986-1625	(800) 927-5557	1347
Yes	No	90/67	Yes/Yes	Yes/Yes	64K/75	64K/70	64K/67	N/A	N/A	(406) 986-1625	(800) 927-5557	1348
Yes	No	100/80	No/Yes	Yes/Yes	16.7M/100	16.7M/75	64K/70	N/A	N/A	(905) 882-2600	N/A	1349
Yes	No	75/80	No/Yes	Yes/Yes	64K/75	256/70	N/A	N/A	N/A	(905) 882-2600	N/A	1350
Yes	No	100/80	No/Yes	Yes/Yes	64K/100	256/75	N/A	N/A	N/A	(905) 882-2600	N/A	1351
Yes	No	75/80	No/No	Yes/No	64K/75	256/75	256/75	N/A	N/A	(408) 942-3315	N/A	1352
Yes	No	75/80	Yes/No	Yes/No	256/75	N/A	N/A	N/A	N/A	(916) 568-1234	(800) 275-3342	1353
Yes	No	75/80	Yes/No	Yes/No	64K/75	256/75	N/A	N/A	N/A	(916) 568-1234	(800) 275-3342	1354
Yes	Yes/2	120/82	Yes/Yes	Yes/No	64K/100	256/75	N/A	N/A	N/A	(408) 736-2000	(800) 468-5846	1355
Yes	No	120/82	Yes/Yes	Yes/No	16.7M/120	64K/75	N/A	N/A	N/A	(408) 736-2000	(800) 468-5846	1356
Yes	No	120/82	Yes/Yes	No/No	16.7M/100	16.7M/75	64K/66	16.7M/130	N/A	(408) 736-2000	(800) 468-5846	1357
Yes	Yes/4	200/164	Yes/No[1]	Yes/No	64K/85	256/76	256/52	16.7M/130	16.7M/64	(415) 615-7799	(800) 272-3572	1358
Yes	Yes/4	200/213	Yes/No[1]	Yes/No	16.7M/104	64K/105	64K/67	16.7M/160	16.7M/157	(415) 615-7799	(800) 272-3572	1359
Yes	No	75/60	Yes/No	Yes/Yes	256/75	N/A	N/A	256/70	N/A	(510) 657-2845	(800) 925-2380	1360
Yes	No	90/83	Yes/Yes	Yes/No	16.7M/75	64K/70	64K/60	N/A	N/A	(510) 657-2845	(800) 925-2380	1361
Yes	No	72/80	No/No	Yes/No	64K/75	256/75	N/A	16.7M/75	N/A	(510) 657-2845	(800) 925-2380	1362
Yes	No	72/75	Yes/No	Yes/Yes	64K/75	256/63	N/A	64K/50	N/A	(510) 657-2845	(800) 925-2380	1363
Yes	No	106/60	Yes/No	No/No	64K/75	256/75	256/60	N/A	N/A	(408) 432-9123	(800) 934-3662	1364
No	No	72/60	Yes/No	No/No	16.7M/70	16.7M/60	64K/60	N/A	N/A	(408) 432-9123	(800) 934-3662	1365
Yes	No	114/60	Yes/No	No/No	64K/70	256/60	N/A	256/70	N/A	(408) 432-9123	(800) 934-3662	1366
Yes	Yes/2	120/90	Yes/Yes	Yes/Yes	16.7M/90	16.7M/90	64K/76	64K/60	N/A	(514) 685-2630	(800) 361-1408	1367
Yes	Yes/2	110/85	No/Yes	Yes/Yes	64K/72	64K/60	256/60	16.7M/60	N/A	(310) 301-4545	(800) 228-3349	1368
Yes	No	100/85	Yes/Yes	No/Yes	64K/100	256/75	N/A	N/A	N/A	(415) 855-0940	(800) 249-6476	1369
Yes	No	100/100	Yes/Yes	No/Yes	16.7M/100	64K/75	N/A	N/A	N/A	(415) 855-0940	(800) 249-6476	1370
Yes	Yes/2	100/107	Yes/Yes	No/Yes	16.7M/100	64K/100	256/75[4]	N/A	N/A	(415) 855-0940	(800) 249-6476	1371
Yes	No	100/95	No/No	No/No	64K/75	256/75	256/80	N/A	N/A	(512) 832-1944	(800) 624-7552	1373
Yes	No	75/85	Yes/Yes	No/No	64K/75	256/70	N/A	N/A	N/A	(510) 683-0300	(800) 767-2443	1374
Yes	No	75/80	Yes/No	Yes/No	64K/75	256/75	256/60	N/A	N/A	(612) 633-6000	(800) 752-8033	1375
Yes	No	75/85	Yes/No	Yes/No	16.7M/75	64K/75	64K/60	N/A	N/A	(612) 633-6000	(800) 752-8033	1376
Yes	No	75/64	No/No	No/No	16.7M/75	64K/70	N/A	N/A	N/A	(408) 526-0535	N/A	1381
Yes	No	90/80	No/No	No/No	16.7M/80	64K/75	64K/60	N/A	N/A	(408) 526-0535	N/A	1382
Yes	Yes/8	75/61	Yes/Yes	No/No	64K/75	256/75	N/A	16.7M/75	N/A	(214) 234-8750	(800) 234-4334	1383
Yes	Yes/15	120/79	Yes/No	No/No	64K/90	256/75	N/A	N/A	N/A	(415) 875-0606	(800) 578-5644	1384
Yes	No	75/80	No/No	No/No	64K/75	256/75	256/60	N/A	N/A	(714) 932-5000	(800) 568-9272	1385
Yes	No	75/69	No/Yes	No/No	16.7M/75	N/A	N/A	N/A	16.7M/75	(612) 830-1549	(800) 654-5294	1372
No	No	75/100[3]	No/Yes	No/No	16.7M/75	16.7M/75	N/A	N/A	16.7M/75	(408) 541-6100	(800) 572-3487	1377
No	No	75/100[3]	No/Yes	No/No	16.7M/75	1152 × 870: 16.7M/75	N/A	N/A	16.7M/75	(408) 541-6100	(800) 572-3487	1378
No	No	75/80[3]	No/Yes	No/No	16.7M/75	1152 × 870: 16.7M/75	N/A	N/A	16.7M/75	(408) 541-6100	(800) 572-3487	1379
No	No	75/100[3]	No/Yes	No/No	16.7M/75	16.7M/75	N/A	N/A	16.7M/75	(408) 541-6100	(800) 572-3487	1380

[2] In development. [3] Resolution-dependent. [4] 256 colors at 75 Hz; 1280 by 1024 pixels on second monitor. N/A = not applicable.

Transport-Triggered Architectures

Getting higher performance through greater instruction parallelism

DICK POUNTAIN

The ultimate expression of the RISC philosophy must be the TTA (Transport-Triggered Architecture), in which there's just the MOVE instruction. As the name suggests, it's the moving of data from one unit to another that triggers computation in a TTA design. TTAs rely on smart compilers rather than hardware to schedule instructions, allocate resources, and handle dependencies. A research team led by Henk Corporaal at Holland's University of Delft recently built an experimental 32-bit TTA processor.

You program a traditional processor by specifying operations that move data between registers and modify it in ALUs—for example, an ADD operation typically moves two operands and one result. Such machines (which includes CISCs and RISCs) can be described as having OTAs (Operation-Triggered Architectures). A TTA machine breaks these operations down further into individual data moves, so that an ADD now becomes three separate instructions. This finer-grained approach can offer higher performance through greater instruction parallelism.

A TTA processor consists of several FUs (function units), a bank of GPRs (general-purpose registers), and some transports (i.e., buses) that move data from unit to unit (see "A Transport-Triggered Processor"). The transports constitute a communications network between the units, which might be fully or only partially connected.

The registers of a TTA fall into four categories; operand registers, trigger registers, result registers, and GPRs. The first three types belong to function units—in an OTA machine they would be called latches, but in a TTA they have names and are visible to software. Only the GPRs correspond exactly to the register file of an OTA machine.

An operation on a TTA begins by loading operands into an FU's operand registers. The last operand goes into the trigger register, which signals the FU that all the operands are ready, and the operation starts. The result goes into the FU's result register. You must store the result in a GPR if you need to keep it for more than one cycle. For example, the TTA code to add two numbers might look like this:

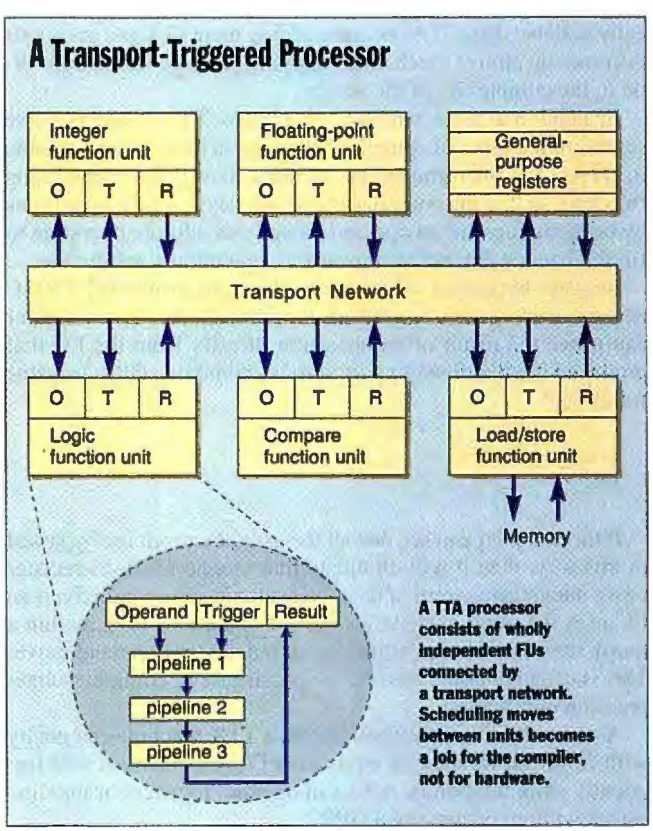
```
r2 -> add_o
r3 -> add_t
add_r -> r4
```

The arrows represent the TTA's single MOVE instruction. The first statement moves an operand from the GPR called `r2` into the `add` unit's operand register. The second line puts the second operand into `add`'s trigger register (`add_t`) and causes the addition to occur, leaving the result in the `add` unit's result register (`add_r`). The last line saves this result into GPR `r4`.

Two points need to be made here. First, though the trigger move can't be performed before its other operand moves, it can be made in the same cycle. In principle, you can perform as many independent moves per cycle as there are transports. Second, the time interval between the trigger and result moves can't be less than the `add` unit's latency time. However, unlike a superscalar RISC in which units share pipelines, each unit in a TTA has its own internal pipeline, and it's the compiler's job to space out the instructions to account for the latency of each unit.

Control flow in a TTA is managed by "guards" that determine whether or not a move will actually be executed, based on the values of special 1-bit predicate registers (like status bits in an OTA). Comparison FUs set the values of these bits. The program line `if r = r3 then goto label` compiles into the following moves:

```
r2 -> eq_o ; load operand into 'equals' unit
r3 -> eq_t ; second operand triggers comparison
eq_r -> b4 ; result into predicate register b4
b4 ? label -> pc  ; if b4 then jump to label
```



Jumps are performed by moving an address directly into the program counter, which is exposed to software in a TTA. The last line shows `b4` guarding such a move. TTAs also make the instruction register visible, to allow the fetching of long immediate values from the instruction stream. Short immediate values are specified directly in a move, as in `48 -> r2`.

TTA Advantages

The TTA concept offers several advantages from a hardware designer's point of view, the most important of which are faster clocks and the potential to increase the utilization of the FUs compared to superscalar RISC designs.

Superscalar RISC designs are already showing signs of diminishing return; as they issue more instructions per cycle, the hardware required to detect dependencies and resource conflicts between operations becomes more complex and consumes more chip area. A TTA design dispenses with all this complex scheduling and issue logic. Furthermore, the separation of the FUs from the transport network means each FU's pipeline can be optimized for the best cycle time. The transport network itself may be superpipelined, in which case the only lower limit on the chip's cycle time is the register-to-register transfer time across the bus.

Superscalar OTA machines also have to provide abundant transport bandwidth because they must cater to the worst case of three buses (two operands and one result) and three register ports for each operation issued per instruction cycle, even though most instructions will not use them all. In a TTA machine, the separation of transport from operation means that the FUs share a common pool of transports, so the total bandwidth required is closer to the actual utilization than to the worst case. Put another way, the same amount of metal spent on the transport network of a TTA serves more FUs than it would in a superscalar RISC machine. This separation also makes TTAs more inherently scalable than OTAs because adding more FUs and transports becomes an almost mechanical copying process, which adds little to the complexity of the design.

In addition to these hardware advantages, TTAs make possible several new classes of compiler optimization that are not available to OTAs. The finer-grained instructions allow greater scheduling freedom, so that the compiler might interleave whole operations by bringing forward an operand move from a future operation to fill the latency gap before the current operation's result move.

Register-bypassing, which the hardware in current OTA RISC designs performs, is a software issue for TTAs. The compiler can move the result of an operation directly from the FU that produced it without waiting for it to be stored in a GPR, as in the following:

```
add_r -> mul_o
add_r -> r2
```

If the compiler can see that all the uses of a result are bypassed in this way, then it will eliminate that second result-to-register move altogether, a form of dead-code elimination. Similarly, if an FU uses the same value in a series of operations (e.g., within a loop), the compiler can eliminate all but the first operand move. This is called *operand sharing*, a special case of common subexpression elimination.

As a result of these optimizations, a TTA machine can get by with fewer GPRs than an equivalent OTA, because it will frequently store temporary results in operand registers or pipeline stages without occupying a GPR.

Compiler Technology

As you might have guessed by now, compilers for TTA machines need to be very clever indeed in order to find sufficient instruction-level parallelism and take advantage of all those optimization opportunities. TTA machines represent the end point of a historical sequence from CISC to RISC to VLIW (Very Long Instruction Word) computers, in which those tasks that microcode or hardware on the chip (i.e., instruction decode, scheduling, register allocation, and dependence checks) once performed have been progressively off-loaded onto the compiler.

In particular, compilers for TTA machines need to examine a much wider scope than the single *basic block* inspected by many conventional compilers. (A basic block is a sequence of consecutive statements in which flow of control enters at the beginning and leaves at the end, without halting or without the possibility of branching, except at the end.) The modified Gnu C/C++ compiler under development at Delft works at the level of "regions," which are groups of basic blocks corresponding to higher-level structures such as loops. The scheduler works by visiting each basic block in the region in topological order, scheduling each block with a simple list algorithm and then inspecting all the other basic blocks reachable from the current one to see if any of their operations can be pulled back into it.

The modified Gnu C/C++ compiler begins scheduling by placing a trigger move in the earliest cycle in which it finds a suitable FU and a move bus available. The operand and result moves are then placed, subject to checks on pipeline depth, register availability, and instruction ordering (i.e., operand > trigger > result). Should a check fail, a move may have to be switched to an earlier (for operands) or later (for results) cycle. If this move doesn't work, then the scheduler must scrap the whole deal and backtrack by rescheduling the original trigger move one cycle later.

This sort of complex behavior belongs in the territory of AI programming techniques, so it's no coincidence that I first heard of TTAs from a compiler writer at a workshop for functional-language developers.

The Future of TTA

The team at Delft has produced an experimental 32-bit integer TTA processor with eight function units and four buses, called MOVE32INT. Even implemented in a conservative 2-micron process, MOVE32INT runs at 80 MHz, and benchmarking suggests that it's between 25 percent to 50 percent faster than a superscalar OTA with equivalent FUs.

However, speed is not the only consideration, and many of the same objections leveled at VLIW also apply to TTA designs. Principally, it's hard to preserve binary-code compatibility between successive processor generations because the code is so intimately tied to the hardware. MOVE32INT is actually part of ongoing research into the automatic generation of ASIC (application-specific IC) layouts from software specifications, and was never intended as a general-purpose CPU.

Nevertheless, it's known that Intel and H-P have both done research into TTAs, and that one of the Delft team, Dr. J. M. Mulder, now works at Intel on the P7 project, so it's not inconceivable that some TTA ideas might find their way into the joint Intel/H-P VLIW products. ■

Dick Pountain is a BYTE contributing editor based in London. You can reach him on the Internet or BIX at dickp@bix.com.

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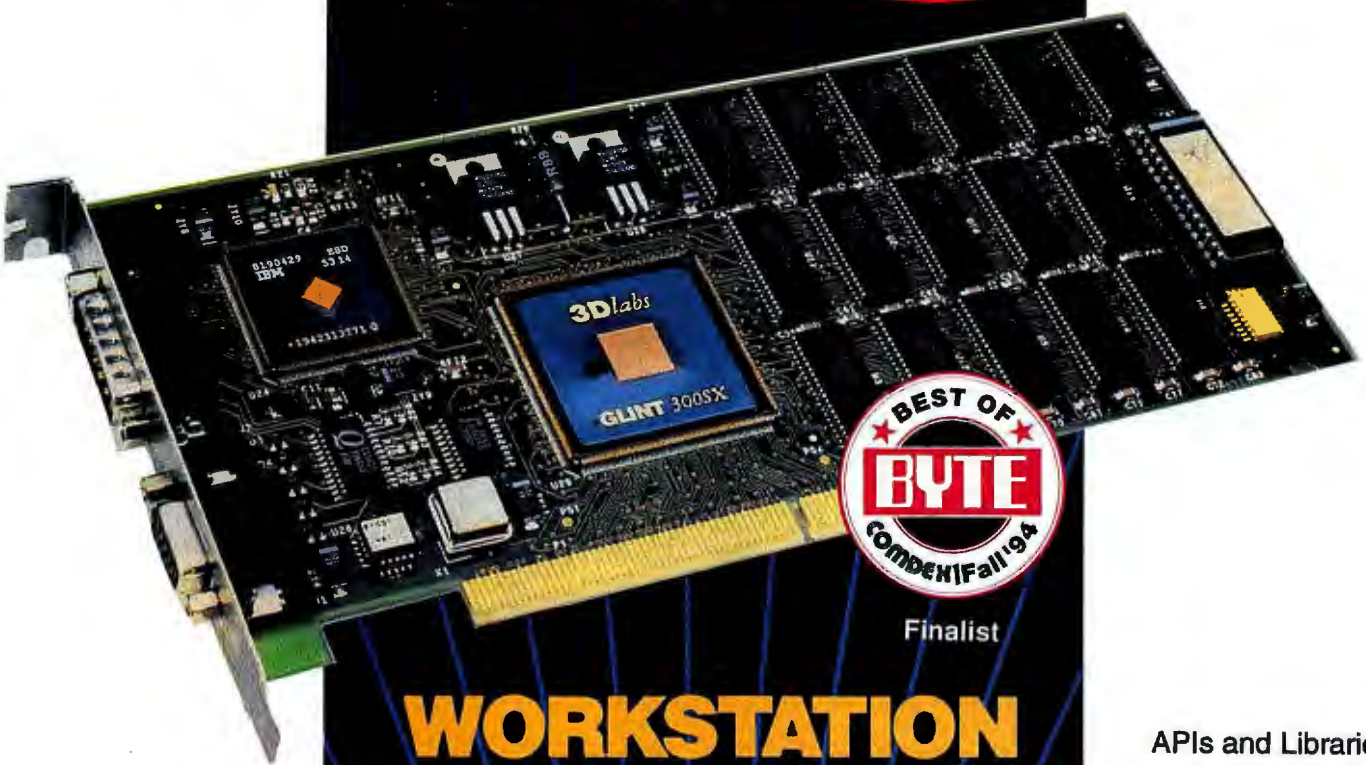

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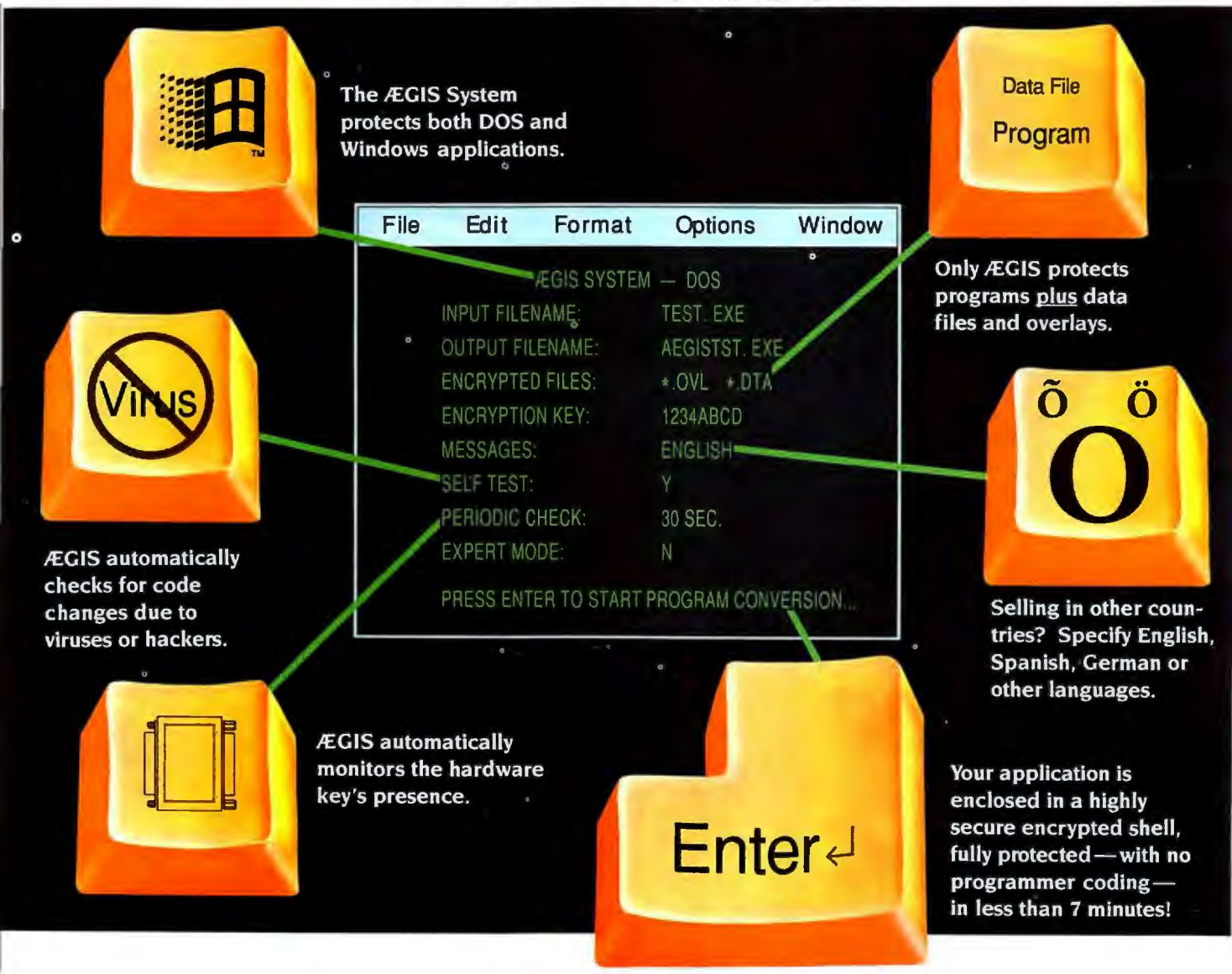

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The Great Little File System

Veritas provides flexible, secure data storage for Unix SVR4.2 systems

TOM YAGER

When you save a file, you trust your system to put it in the right place. But what justifies that faith? PC users routinely depend on file systems that date back to CP/M. Easily disrupted, these data-layout schemes have spawned a whole subindustry for disk-repair and file-restoration utilities. But why should you have to pay extra for one of the most important, and most basic function of your system? An operating system's primary job is to store and retrieve disk-based data, and it should tackle that job with the determination of a celebrity attorney.

The best example I've seen of how a file system should work comes from a quiet company called Veritas. This vendor has created a well-rounded file-storage and management scheme built around `vxfs` (the Veritas file system). Designed for systems running System V Release 4.2 Unix, `vxfs` defines a flexible structure for file layout, and provides a set of tools to manage that structure.

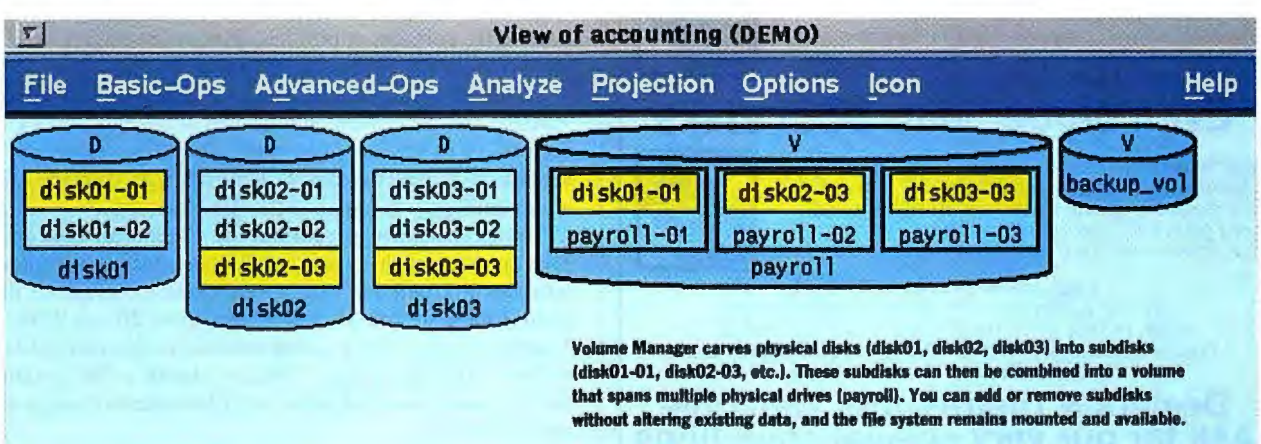
File System Woes

Despite Unix's maturity, most commercial implementations still use some variation of `s5fs` (System V) and the BSD-derived `ffs` (Fast File System). Differences between the two have fueled operating-system wars for years. It's a battle `ffs` deserved to win. It accesses much faster than `s5fs`, thanks to the replacement of linked-list free-space tables with random-accessible bitmaps. `ffs` splits each logical drive into *cylinder groups*, distributing vital data structures across the drive's geography, and keeping structures close to the data they manage. `ffs` offers users clear advantages, too, such as 255-character file names (vs. `s5fs`'s 14-character limit) and symbolic links, pointers to files in other directories.

However, `ffs` isn't perfect. Let's say there's a power failure while your system is writing a file. That affects the process involving both the writing of data blocks containing the user-visible portion of the file and the altering of various file-system structures. The writing of new data may require changes to directories, free-space maps, inodes (which hold housekeeping data for the file), and resource counters. The system can't change all this data simultaneously. When the system needs to change several pieces of structural data, the premature interruption of that process—by, say, a power failure—corrupts the file system. Space is allocated in the free map, but no data is written. Or perhaps a new directory entry is created, but the inode for the directory hasn't been updated to reflect the directory's new size.

The traditional approach to fixing these interrupted data postings has been to run a utility called `fsck`, short for file system check. `fsck` walks through all the file system's data structures, locating trouble. It checks the inode and directory data, making sure that valid files are using all the space allocated to them. Except in cases of physical damage and unusual circumstances, such as sabotage, `fsck` can restore a file system to health, usually by discarding partially completed operations. However, on the multigigabyte drives common to modern systems, `fsck` takes a *long* time to run. The system remains unavailable until `fsck` finishes.

Another `ffs` shortcoming relates to management. Unix's file layout is superior to other operating systems, letting you mount a new drive at any location in the directory hierarchy. If your database outgrows the drive it shares with other applications, you can give it a drive of its own: Delete its previous directory, and replace it with a *mount point* (an empty directory) of the same name. Then attach the new, larger drive to that mount point. The



Volume Manager carves physical disks (disk01, disk02, disk03) into subdisks (disk01-01, disk02-03, etc.). These subdisks can then be combined into a volume that spans multiple physical drives (payroll). You can add or remove subdisks without altering existing data, and the file system remains mounted and available.

change is transparent to users and to applications.

But what happens if that database outgrows the drive you allocated to it? That's a thorny problem, leaving most administrators with the unpleasant duty of backing up the old drive, replacing it with a still larger one, and running the database in the larger space. And what about drives with more than one file system? To keep errant (or irresponsible) users from chewing up all your disk space, you might put the users' home directories in a separate file system. As you add users to the system, however, you may need to make that file system larger. With `ffs`, you must restructure all the file systems on that drive, wiping out existing data, to change a file system's size.

A Transparent Solution

The Veritas file system started life with a dilemma: No matter how innovative its approach, it had to be transparent to be accepted. To manage this, Veritas capitalized on a feature of System V Release 4.2 known as the installable file system. This provides a means for extending the operating system's set of support file systems. Once extended, the operating system—all the way down to the kernel—knows how to talk directly to the file system, and layout-sensitive storage-management tools (like `mount` and the `fsck` file-system check/repair tool) are infused with knowledge of the new layout. That's how `vxfs` gets in the door.

Once there, `vxfs` sets about solving the weaknesses of `ffs` and other Unix file-system layouts. Probably its most well-known feature is its *intent log*. This is a circular buffer that holds a list of pending changes to the file-system structure. It adds a brief step: First you log it, then you do it. If the system loses power in the middle of changing a resource table, no problem. Instead of climbing through every structure in the entire system to sleuth out the missing link, Unix looks at the intent log. If a log entry is complete and valid, it replays it, painting the changes described in the log onto the file-system structures. If a log entry is incomplete or invalid, it is discarded.

The likelihood of lost data is somewhat diminished because the intent log absorbs data faster than the scattered data structures. But the biggest advantage of the intent log is increased system availability. Large systems doing failure recovery can spend several minutes or even hours slogging through every structure on every drive with `fsck`. The same system, using `vxfs`, need only spend a few seconds playing each file system's intent log. The system is back on-line in a flash.

Beyond intent logging, `vxfs` distinguishes itself by supporting spanning, mirroring, and striping. Veritas' Volume Manager extends the basic layout that `vxfs` provides. This lets you reach beyond the confines of physical drives in managing your storage and provides data-protection features.

To do its work, Volume Manager carves physical drives into *subdisks* (see the screen on page 155) unmanaged blocks of disk sectors. To build a new file system, you first select one or more subdisks to contain the data. Volume Manager combines these into a *plex* and lets you initialize the file structure.

The subdisks you select for a file system can exist anywhere, even on different physical drives. Volume Manager spans subdisks transparently, building what appears to be a contiguous file space from storage scattered across two or more drives. What's more, Volume Manager lets you add subdisks to an existing file system without altering its data. You can shrink a file system by removing subdisks—all while the file system remains mounted and available.

Volume Manager supports mirroring, the protection of data

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through duplication, the same way. You just set up two subdisks with one defined as the mirror for the other. If one disk in the mirrored set should fail, Volume Manager will sense the failure, report it, and continue running with the good drive. You can enable block-change logging to extend the fast recovery benefits of `vxfs` to mirrored volumes.

Normally, when you combine multiple subdisks to create a file system, data is written to those subdisks in the order in which they were joined. Data is written to subdisk 1 until it is filled, then to subdisk 2, and so on. On striped file systems, the first block of data is written to block 1 of subdisk 1. The next block is written to block 1 of subdisk 2, and so on, with each subdisk filling "from the top down" in concert with the others. Each subdisk must be on a separate physical drive, and preferably, subdisks should be equally split amongst two or more disk controllers. The result is increased performance. At the minimum, seek time will be reduced relative to the number of subdisks applied to the volume. At best, with multiple disk controllers, the system will gain the ability to write to several subdisks of a striped volume simultaneously (or very nearly so).

One last `vxfs` facility worth mentioning is the *snapshot*. This creates a new, read-only file system that is a duplicate of an existing one. This is most often used to create on-line backups of vital data. `vxfs` doesn't copy an entire drive to create a snapshot. Instead, it creates a set of dummy file-system structures that point to the real file system. As the real file system changes, the snapshot is altered to ensure it retains an accurate image of the file system at the time the snapshot was taken. A deleted file, for example, is copied to the snapshot image before being deallocated from the real file system. Snapshots are a convenient and space-efficient way to protect yourself prior to making some potentially damaging change.

How It Looks

Rounding out `vxfs`'s versatility is its variety of front ends. You can manage `vxfs` volumes through command-line utilities, text-based menus, or graphical means. The commands that manage `vxfs` volumes are a superset of the standard Unix storage-management commands. The `mount` command, for example, has new options for managing the intent log and for forcing the zeroing out of newly allocated data blocks. Text menus ease administration for manual-fearing users, and X Window-based graphical tools give you point-and-click access to all the functions of the Volume Manager.

In a few years, it's likely that most operating systems, large and small, will incorporate some of the benefits present in `vxfs`. For now, Veritas' efforts stand as an impressive benchmark against which other file systems should be judged. If you're managing critical data, you've got to understand how your operating system stores that data. If the file system you're using doesn't measure up, replace it. ■

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Constraint Logic Programming

A child of Prolog finds new life solving programming's nastier problems

DICK POUNTAIN

Which programming paradigm will likely gain the most in commercial significance over the next five years? I'd bet on CLP (constraint logic programming), even though few programmers today understand it well. CLP's potential lies in its power to tackle difficult combinatorial problems—such as those encountered in job scheduling, developing time tables, and routing—that stretch conventional programming techniques beyond their breaking point. Though CLP is still the subject of intensive research, it's already being used by large corporations, including the manufacturers Michelin and Dassault; the French railway authority SNCF; the airlines Swissair, SAS, and Cathay Pacific; and Hong Kong International Terminals, one of the world's largest privately owned container terminals.

Children of Prolog

As its name suggests, CLP is descended from logic programming, which shot to fame via the Prolog language, widely used in the Japanese 5th Generation project and the expert-systems boom of the mid-1980s. Its relatively poor efficiency (compared to procedural languages like C) hindered Prolog's commercial acceptance, and its use has declined in recent years. Now, by focusing on a particular problem domain, CLP languages make logic programs execute efficiently.

Prolog is based on first-order predicate logic, and the objects that it manipulates are pure symbols with no intrinsic meaning. For example, in the Prolog proposition "likes (jim, baseball)" the constants "jim" and "baseball" have no deeper interpretation beyond syntactic identity (i.e., jim = jim). Execution of a Prolog program proceeds by a process called *unification*, which searches a database of such facts and finds those values that will satisfy a user's query. Unification is based on syntactic identity. Since Prolog tries to find the set of all solutions to a query, during this search, a program may encounter many dead-ends to explore and then abandon by backtracking to an earlier state and trying a different branch. For complex problems, this search process can become greedy in both space and time, which is the root of Prolog's inefficiency.

In a CLP language, objects that have meaning in an application domain—for example, the integers or the real numbers, with their associated algebraic operations (e.g., addition and multiplication) and predicates (e.g., =, <, and >)—supplement this purely abstract logical framework. Hence, there isn't a single CLP language but a whole family of them defined for different application domains. A CLP programmer introduces arithmetic expressions called *constraints* (e.g., $X > 0$ or $Y + Z < 15$) into programs, which have to be satisfied for successful execution of the program. (For a more formal explanation of how CLP works, see "Theme: Prolog," August 1987 BYTE).

In such a CLP system, the simple unification algorithm that lies at the heart of Prolog must be augmented by a dedicated solver for the particular domain of application. The solver can decide at any moment whether the remaining constraints are solvable. For efficiency's sake, solvers for CLP systems need to be incremental so that adding a new constraint to an already solved set does not force them all to be solved a second time. Constraint-solving algorithms are quite well understood from other branches of computing; you'll have used one if you've ever done goal-seeking in your Excel spreadsheet. For example, a useful solver for linear rational constraints is the well-known simplex method.

Another significant way in which CLP differs from Prolog is that it's perfectly happy to do mathematics with uninstantiated variables; therefore, in the absence of

An Eclipse program to solve the DONALD + GERALD = ROBERT word puzzle.

```
lib(fd).

addNum(Num1,Num2,Result) :-
 addwithcarries(Num1,Num2,0,Result).

addwithcarries(Num1*Digit1,Num2*Digit2,Carryin,Num3*Sum) :-
 Carry::0..1,
 addDigit(Carryin,Digit1,Digit2,Sum,Carry),
 addwithcarries(Num1,Num2,Carry,Num3).

addwithcarries(Digit1,Digit2,Carryin,Digit3) :-
 is_domain(Digit1), is_domain(Digit2),
 addDigit(Carryin,Digit1,Digit2,Digit3,0).

addDigit(C,N1,N2,Sum,CIn) :- Sum #= C+N1+N2-10*CIn.

solve :-
 Letters=[D,O,N,A,L,G,E,R,B,T],
 Letters::0..9,
 alldistinct(Letters),
 addNum(D*O*N*A*L*D,G*E*R*A*L*D,R*O*B*E*R*T),
 label(Letters),
 writeln([D,O,N,A,L,D]),
 writeln([G,E,R,A,L,D]),
 writeln([R,O,B,E,R,T]).

label([]).
label(List) :-
 deleteff(Digit,List,Rest),
 indomain(Digit),
 label(Rest).
```

complete information, the answer might be a symbolic expression like 10 – X or even a constraint like X > 23.

Constrained Search

A CLP program still needs to search a database of facts, but it can use constraints to rule out many possible outcomes and prune away large parts of the search tree. The improved efficiency that results is comparable to custom solutions written in C.

We all use facts as constraints to guide reasoning as a key part of everyday common sense. For example, a few minutes ago, a public-relations person called to ask if I'm interested in document management and to alert me to a press briefing next Wednesday in London. A glance at my calendar revealed that I'll be in Cambridge all next Wednesday—end of conversation. We no longer needed to explore my interest (or lack thereof) in document management because an absolute geographical constraint had lopped off that branch. Without such constraints, every little decision might set off an avalanche of philosophical speculation.

Herbert A. Simon, Nobel laureate and theorist of heuristic problem-solving, has used popular word-for-number puzzles to illustrate this pruning process. For example, in the puzzle DONALD + GERALD = ROBERT, there are 3,628,800 possible assignments of digits to letters, and it would take you several years to solve the problem by unconstrained search. Yet most of us can solve it in just minutes by incrementally applying constraints (e.g., T must be even) to rule out more and more options. "An Eclipse program to solve the DONALD + GERALD = ROBERT-Word Puzzle" shows a typical CLP program to solve this puzzle. (Mark Wallace of IC Parc wrote the solution.)

Slaying NP-Hard Dragons

This constrained-search ability makes CLP languages good at precisely those problems that conventional programming techniques find hardest: NP-hard search problems where the time needed for an unconstrained search increases exponentially (or worse) with the problem size.

Consider the simple problem of a commercial harbor that needs to schedule the loading and unloading of 10 ships using only five berths. There are many criteria for choosing the berth for a particular ship: Some berths are too small for some ships, some ships need to be turned around faster than others, some berths cost more than others, ships' intended cargoes are stacked nearer to certain berths, and so on.

You can find the optimal schedule by trying all permutations of ships in berths and calculating the cost of each, which means considering 5^{10} (or around 10 million) alternatives. Assuming that your computer can try an alternative every millisecond, it can solve the whole problem in around 3 minutes. Now imagine it's a decade later, and business has been good and the harbor has expanded to 10 berths, with 20 ships to unload. Determining the optimal schedule now means trying 10^{20} alternatives, which will take 3000 million years on the same computer (of course, you can ante up for an accelerator card and cut that to 300 million years).

There are many other problems in planning and scheduling that exhibit this kind of unreasonable scaling behavior for which an exhaustive search is not a feasible strategy. So how do you solve these problems? A naive but tempting approach is to divide the harbor in two and schedule each half using the old program, taking 6 minutes in all. Unfortunately, such a schedule is unlikely to be anywhere near optimal, and worse, you won't even know how far from optimal it is and how much money you are wasting. Actually running the 3000-million-year program for 6 minutes and choosing the cheapest alternative so far would give just as good (or bad) a result.

Where CLP languages score for this class of problem is that you can explicitly employ all the real-world constraints that are particular to the problem and so reduce the search space enormously. In our harbor example, adding a constraint like "shipLength <berthLength" might immediately remove millions of possibilities.

Languages like CHIP (Constraint Handling in Prolog) and Eclipse offer direct control over the search strategy (via the "deleteff" function in the word-puzzle solution). If this still doesn't yield an optimal solution in reasonable time, you must then deploy approximation algorithms to reach a solution that lies close to the optimum with a high degree of probability. Researchers are working hard to integrate algorithms like hill-climbing, simulated annealing, and genetic algorithms into the newer CLP languages.

Don't get the idea that CLP can perform magic. You need a great deal of experience before you can choose the correct algorithms and correct expression of the constraints to get a good solution for big problems. Nevertheless, the interactive nature and highly expressive power of CLP languages makes it easy to experiment with different combinations. This results in much shorter and more maintainable programs than when using a procedural language.

CLP Implementations

The founding work on the CLP scheme was done at Monash University in Melbourne, Australia, by J. Jaffar and J. L. Lassez around 1987. They created the CLP(R) system, which works on the domain of real linear arithmetic. This system, extended as CLP(X), is still being developed at Monash as well as in the U.S. at IBM's Yorktown Heights research facility and at Carnegie Mellon University.

In Europe, CLP research was originally concentrated at the ECRC (European Computer-Industry Research Centre) in Munich, and it led to what is probably the most widely known CLP system at present: CHIP. The French company Cosytech commercially markets CHIP, and two of ECRC's industrial sponsors, Bull (as Charme) and ICL (as Decision Power), sell CHIP derivatives. CHIP provides constraint solvers over finite arithmetic, linear rational, and Boolean domains.

In 1990 in Marseilles, France, Alain Colmerauer (one of the founding fathers of Prolog and CLP) created Prolog III, a CLP language over the domains of linear rational arithmetic, Booleans, and finite strings or lists. More recently, London's Imperial College has set up IC Parc, a university/industry collaboration that uses CLP techniques to tackle hard planning problems, such as work-force management, routing, and resource allocation. IC Parc's language, Eclipse, began life at ECRC and shares many features with CHIP; but where CHIP's constraint solvers are hard-coded in C, Eclipse's are written in itself for easier modification. Eclipse also employs the powerful generalized propagation technique, and a parallel version of Eclipse is currently under development.

Interesting non-Prolog-based CLP languages include Trilogy, from the Vancouver-based Complete Logic Systems, and Oz, an object-oriented concurrent CLP being developed at DFKI (German Research Center for Artificial Intelligence) in Kaiserlautern. ■

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The PGP Web of Trust

How to certify public keys without a central authority

WILLIAM STALLINGS

PGP (Pretty Good Privacy) is a widely used E-mail security package that relies heavily on public-key encryption (see "Pretty Good Privacy," July 1994 BYTE). Use of PGP involves two keys—a private key known only to one user, and a corresponding public key made known to all users. With these two keys, it is possible to create digital signatures that guarantee the authenticity of a message and to encrypt a message so that only the intended recipient can read it.

Each user guards his or her private key and publishes the corresponding public key. Unfortunately, an impostor can generate a public/private key pair and disseminate the public key as if it were someone else's. Suppose Alice wants to send a secure message to Bob. Meanwhile, Darth creates a public/private key pair, attaches to it Bob's name and an E-mail address that Darth can access, and disseminates the public key. Alice acquires this key, uses it to prepare her message for Bob, and sends it to the attached E-mail address. Result: Darth receives and can decrypt the message, and Bob never receives the message (which he wouldn't be able to read anyway, lacking the required private key).

One solution is to insist on the secure exchange of public keys. Users can, for example, store keys on disks and pass them from hand to hand or send them via snail mail. But for PGP to be more widely useful, it should be possible for people to exchange keys electronically with others whom they have never met and may not even know.

Public-Key Certificates

The tool that enables widespread use of PGP is the public-key certificate. The following items are essential ingredients of a public-key certificate:

- The public key itself
- A User ID, which includes the name and E-mail address of the owner of the key
- One or more digital signatures for the public key and User ID

A signature testifies that the User ID associated with this public key is valid. It is formed using the private key of the signer. Anyone in possession of the corresponding public key can verify that the signature is valid. If any change is made to either the public key or the User ID, the signature will no longer compute as valid.

How do you manage public-key certificates? One approach, used in the PEM (Privacy Enhanced Mail) scheme, relies on a central certifying authority. Each user must register with the central authority and engage in a secure exchange, which involves independent techniques for verifying user identity. Once the central authority is convinced of the identity of a key holder, it signs that key. If everyone who uses this scheme trusts the central authority, then a key signed by the authority is automatically accepted as valid.

PGP could take this approach, but that would violate its spirit as an E-mail security scheme for the masses. So PGP instead supports a "web of trust," in which individuals sign each other's keys and create an interconnected community of public-key users. Here's how it might work. Suppose Bob physically passes his public key to Alice, who signs it. Alice keeps a copy of the signed key and also returns a copy to Bob. When Bob wants to communicate with Carol, he sends her his public key, with Alice's signature attached. Carol, who has Alice's public key and who trusts Alice to certify other people's keys, need only verify Alice's signature on Bob's key to accept his key as valid.

continued

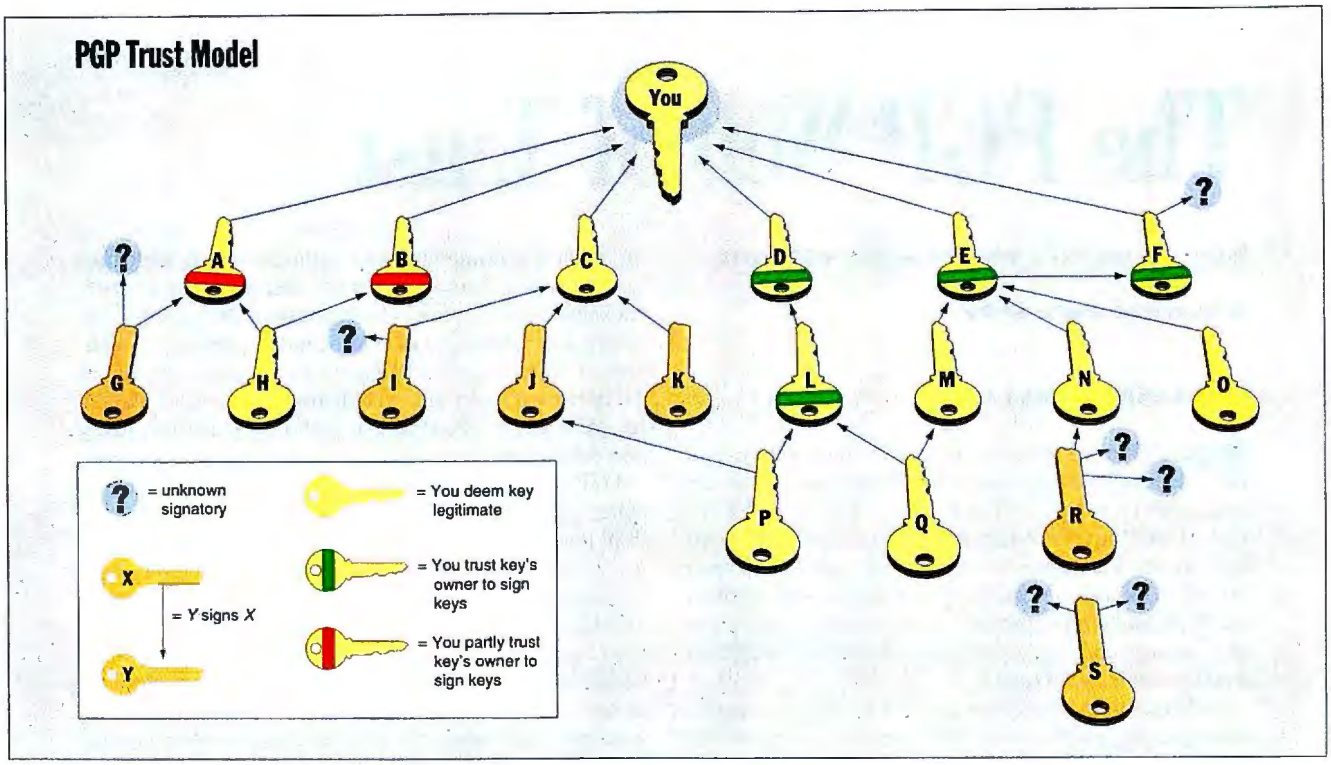
HOW PGP CALCULATES TRUST

When you add a new public key to your public-key ring, trust processing proceeds as follows:

❶ If you own the key, a value of ultimate trust is automatically assigned to the trust field. Otherwise, PGP asks that you assign a trust assessment to the key's owner. You can specify that this owner is unknown, untrusted, marginally trusted, or completely trusted.

❷ When the new public key is added to the ring, one or more signatures can be attached to it. (More signatures can be added later.) When a signature is inserted into the entry, PGP searches the public-key ring to see if the author of this signature is among the known public-key owners. If so, the owner trust value for this owner is assigned to the signature trust field for this signature. If not, an unknown-user value is assigned.

❸ The value of the key-legitimacy field is calculated on the basis of the signature trust fields present in this entry. If at least one signature has a value of ultimate trust, then the key legitimacy value is set to complete. Otherwise, PGP computes a weighted sum of the trust values. A weight of $1/X$ is given to signatures that are always trusted, and a weight of $1/Y$ is given to signatures that are usually trusted, where X and Y are user-configurable parameters. When the total weights of those introducing a key/UserID combination reaches 1, the binding is considered to be trustworthy, and the key legitimacy value is set to complete. Thus, in the absence of ultimate trust, at least X signatures that are always trusted or Y signatures that are usually trusted (or some combination thereof) is needed.



Computation of Trust

PGP does not specify a policy for establishing trust. It does provide mechanisms for associating trust with public keys and for using trust information. Each user collects signed keys and stores these in a PGP file known as a public-key ring. Each entry in the ring has a *key legitimacy* field—computed by PGP—that measures the degree to which this PGP user trusts that the key is valid for its user. The higher the level of trust, the stronger is the binding of this user ID to this key. For each signature collected by the PGP user, there is a *signature trust* field that measures how far the PGP user trusts the signer to certify public keys. (The key legitimacy field for an entry derives from the signature trust fields.) Finally, there is the public key itself, associated with an owner, and an *owner trust* field that indicates the degree to which this PGP user trusts the key's owner to sign other public-key certificates. PGP doesn't compute this level of trust; the PGP user assigns it. You can think of a signature trust field as a cached copy of the owner trust field from another entry.

Periodically, PGP processes the public-key ring to achieve consistency. For each owner trust field, PGP scans the ring for all signatures authored by that owner and updates the signature trust field to equal the owner trust field. This process starts with keys for which there is ultimate trust. Then, all key legitimacy fields are computed on the basis of the attached signatures. The figure "PGP Trust Model" shows how signature trust and key legitimacy are related. In this sample public-key ring, a PGP user has acquired a number of public keys, some directly from their owners and some from a third party, such as a key server. The root node, labeled "You," denotes the entry in the public-key ring corresponding to this PGP user. This key is valid, and the owner trust value is ultimate trust. Moreover, this user will always trust users D, E, F, and L to sign other keys and will partially trust users A and B to sign other keys.

Note that all keys whose owners are fully or partially trusted by the user have been signed by this user, with the exception of node L. Such a user signature isn't always necessary, as the presence of node L indicates, but in practice most users are likely to sign the keys for most owners that they trust. So, for example, even though E's key is already signed by trusted introducer F, the user chose to sign E's key directly.

Two partially trusted signatures may be sufficient to certify a key. Here the key for user H is deemed valid by PGP because it is signed by A and B, both of whom are partially trusted.

A user may deem a key valid (because one fully trusted or two partially trusted people have signed it) but still not trust its owner to sign other keys. For example, N's key is valid because E, whom this user trusts, signed it, but the user hasn't assigned N the trust value to sign other keys. Therefore, although N signed R's key, PGP doesn't consider R's key valid. This situation makes perfect sense. You can send a secret message to someone you don't trust; all you need is the correct public key for that individual.

The figure also shows a detached orphan node S, with two unknown signatures. Such a key may have been acquired from a key server. PGP cannot assume that this key is valid simply because it came from a reputable server. The user must declare the key valid by signing it or by telling PGP that it is willing to fully trust one of the key's signers.

It is the PGP web of trust that makes it practical as a universal E-mail security utility. Any group, no matter how informal and how dispersed, can build up the web of trust needed for secure communications. ■

William Stallings is an independent consultant and a frequent contributor to BYTE. He is the author of over a dozen books on data communication and computer topics, including Network and Internetwork Security *(Prentice Hall, 1995). This article is based on material from his most recent book,* Protect Your Privacy: A Guide for PGP Users *(Prentice Hall, 1995). You can contact him on the Internet at stallings@acm.org or on BIX c/o "editors."*

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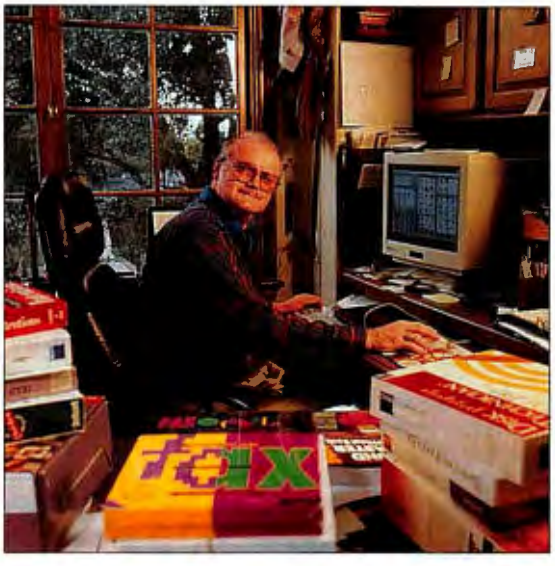
Software-Installation Hell



AMY ETRA © 1995

April may not be the cruelest month. Last February, Jerry's column was "Upgrades from Hell," and this month...

It all started with a jerky mouse. Now I'm 8 hours into the project, and I know more about installing software upgrades than I wanted to.

For some time, I've known there was something wrong with the mouse on the Cheetah 486DX2/50. This is the machine that Larry Niven uses at Chaos Manor. Since we finished *Beowulf's Children* a few months ago, Larry and I have been working on our own, so that machine has been used mostly for games lately.

Then I got the 6.0c upgrade for Microsoft Word for Windows. Incidentally, that is available by calling Microsoft at (800) 426-9400; choose option 4 and then 1. Have a credit card handy—they charge a nominal fee for shipping—and be ready to prove that you already own a copy of Word 6.0. In due time, you'll receive seven floppy disks that will let you install the new version (the original came on nine disks).

Given those seven disks of compressed files, my inclination was to copy the disk images onto a hard disk and install from there. Alas, you can't do that. One of the disks gives a "sector not found" error. This is due to a new disk format. A program that will copy it is available as shareware; but I didn't have any such program, so I prepared to swap disks a lot.

The first of those disks has a setup program that looks for your old version of Word 6.0, and it has a real bug. For no particular reason, we have Word installed on the Cheetah's D drive. The setup program found it and offered to install the update on D:\WINWORD. When I told it to do so, however, it trundled a while and told me there wasn't enough space on drive C. I thought I'd made a mistake and started the tedious setup again; but 5 minutes later I was back where I started. Setup will not install Winword on D until you have enough space on drive C!

That meant I'd have to do some disk cleanup. I didn't really have time to think about which files I could get rid of. Thus, the simplest thing was to use the network to transfer a bunch of files over to the glass disk on the Pentium. To do that, I had to reset and bring up the configuration that starts the network.

That was easy enough. As I've explained before, I use BOOTCON, a system that lets me choose among a bunch of combinations of CONFIG.SYS, AUTOEXEC.BAT, WIN.INI, SYS.INI, and any other files I want to control when I first start up. It's a good program that's fairly easy to use, and I recommend it, but there could be some improvement in the documentation, as we'll see shortly. Anyway, I rebooted, brought up the network, cleared enough space on the C drive to allow the silly setup program to proceed with installation of Word 6.0c on the D drive, and did the Word update.

That went fine, but I'd almost gone nuts transferring the files. The mouse—a Microsoft Home Mouse "Dove soap bar" model—was so jerky that half the time I was dragging things to the wrong place. Niven doesn't use a mouse much when he writes with Word—we've both discovered the trick of pressing F8 and using the arrow keys to mark blocks of text—but when he's not working, Larry likes to play the Caterpillar

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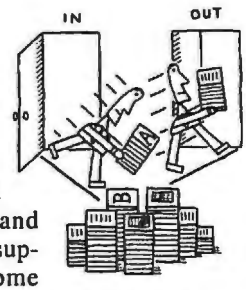

game from Microsoft Windows Arcade, and that's hard to do with a jerky mouse. Time to fix that rollicking rodent once and for all.

First, I took the mouse apart. The two steel rollers were absolutely clean. The plastic idler wheel seemed to have a fine line of felt around it. I thought that was odd, but it didn't come off when I rubbed it, and I wasn't sure it wasn't supposed to be there. I was sure that the software was very old, and I just happened to have updated mouse software handy; maybe installing the new mouse software would fix things. I did that and rebooted.

Apparently the new mouse software was a bit larger than what it replaced, because QEMM told me it couldn't load the mouse driver high and I ought to run Optimize again. All right, run Optimize. It trundled a bit and was done. Now enter Windows.

I can't enter Windows. The error message is that I have to run QWINFIX. I do that, but the next attempt to enter Windows gives the same error message. I can't get the system into Windows at all.

All right, I haven't upgraded QEMM on this system in a long time. It's running 6.03, and I have QEMM 7.5, so let's try that. First some preparations. I copied the old QEMM off to the D drive. Next, I used BOOTCON to find an older CONFIG .SYS, AUTOEXEC.BAT, and WIN.INI combination that works (including letting me into Windows). I saved that combination under the label GOOD and made copies of the files to be loaded under BOOTCON menu item TEST. This is a neat feature of BOOTCON: I can experiment all I want and still get back where I was when I started.

OK, install QEMM 7.5, turn off BOOTCON, and run Optimize. Optimize resets your system a lot while it's running. Each time it does that, it tells you that you may have to turn your machine off to get it to reset. Usually you don't, but this time there was no question about it. We were locked up tight, and there was nothing for it but to use the power switch.

Otherwise, things were running all right; but then Optimize said we couldn't pack everything into high memory and wanted to try the Stealth feature. This is a way to swap certain things in and out of memory as needed, giving the effect of more memory in the critical area between 640 KB and 1 MB. It doesn't always work, but an older version of Stealth had worked with this machine, and anyway, QEMM is supposed to perform some tests before installing Stealth. I said sure, let's try it.

Optimize trundled a while and then locked up again. I turned it off and back on. It trundled and locked up. And again. And again. It was quite clear that this machine wasn't going to boot. That's all right, though, because I had BOOTCON. All I'd have to do is turn BOOTCON menuing back on. To do that, I had to boot up with a floppy panic disk; but once that was done, I went to the C:\BOOTCON subdirectory, ran BCSETUP, and turned on BOOTCON menuing. Open the drive door and reset.

The machine trundled. Then up came a message: "BOOTCON has detected that QEMM Optimize is in progress. BOOTCON will disable itself in 5 seconds. OK?" It wasn't OK, but my choices were to click on OK or wait 5 seconds; either way got the same result. BOOTCON vanished, and

URGENT—YOUR INPUT NEEDED

On: 3-D DISPLAY TECHNOLOGY

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. Later this year, we're planning to cover the ways in which 3-D imaging technology is being used in the real world. We're considering such applications as manufacturing and design; medical and biological uses; and high-end simulations, such as those used for training ship and airplane pilots. But we'd like to hear your ideas, to find out about 3-D imaging applications we may not be aware of but should. Also, we'd like your help in identifying the people we should be talking to about this technology—users, vendors, researchers—you tell us! Finally, we're interested in hearing about what your organization is doing with 3-D imaging and displays—how you're using the technology and what problems and benefits you've encountered.

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the machine attempted to complete the Optimize process, failed, and locked up.

This wasn't what I wanted at all. The old BOOTCON required you to turn it off before you tried Optimize. Once you turned it back on, however, it intercepted the process and offered you a menu of CONFIG.SYS/AUTOEXEC.BAT combinations. The new-and-improved BOOTCON didn't do that; it just committed suicide when I ran Optimize.

I called Modular Software Systems. At first they didn't want to believe this was happening to me, so I went through the process, describing each event. Long silence. Then I was advised to boot up with the floppy disk again, get to C, run BCSETUP, and select Current Configuration. Doing that let me change the boot-up configuration. That let me boot up, and I could then go erase every trace of the QEMM optimization batch files. For good luck, I had BOOTCON totally eliminate the TEST configuration. Then I made a new one, named that TEST, and ran Optimize again. This time when it offered Stealth, I made sure to say *no*.

This time QEMM locked up on something called Quarterdeck Quickboot. It took about 10 minutes to find out what to do about that. I had to put the statement `BE:N` on the `Device=QEMM.SYS` line. That will turn off the Quickboot feature, which is guaranteed to lock up about half the systems I have tried it on. Some feature.

And that took care of the situation. QEMM and Optimize did their thing. I had well over 600 KB of free memory, I could get into Windows just fine, and the Windows for Workgroups network worked properly.

There was only one problem. The mouse was still jerky. I found another mouse and rebooted. Everything was fine. Clearly, my problem was that particular mouse. I opened it up and scraped at the felt ring on the idler wheel. It didn't want to come off, and I wasn't at all sure I wasn't breaking something by removing it. However, the mouse wasn't working properly anyway, so I used rubbing alcohol and eventually got all that goo off the wheel. The mouse works fine now.

Incidentally, today I got a fax from Modular Software Systems. The next version of BOOTCON will give you a chance to intervene even when there's an optimization going on. They're calling it the "Pournelle feature."

There are several morals to this story. At the simplest level, I learned that Microsoft Home mice are not supposed to have a felt ring on the idler wheel. If I'd known that, I'd have cleaned the jerky mouse, and nothing would have needed fixing.

At the next level, I learned once more that upgrades generally aren't as simple as I expect them to be. I also learned—again—that no matter how good software is, new releases can be a problem. As an example, BOOTCON remains a very useful program—it saves me hours when I experiment with configurations—and the new version is an improvement; but it doesn't work the same way as the old one. Also, some important commands have not only been changed, but the changes weren't properly documented.

The same appears to be true of QEMM. Version 7.5 may be a genuine improvement, but the advantages don't seem immediately obvious, and I sure don't understand why it defaults to something as unreliable as Quarterdeck Quickboot.

The most important moral of the story is

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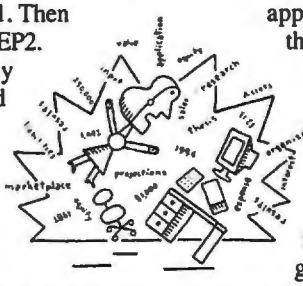
that as software gets smarter—BOOTCON detecting that a QEMM optimization is under way, QEMM deciding I need to try Stealth, QEMM turning on Quarterdeck Quickboot—users have to be even more clever to outwit software when it decides to do something you don't want done.

And finally, I'm really getting weary of having to use QEMM and other memory management programs in the first place. I have the Cheetah up and running again, and I don't like to change it; but frankly, I'm more than ready for an operating system that doesn't require memory managers and doesn't need tweaking with Optimize and Stealth and all the rest. I may have found it. We'll come back to that in a bit.

While I like having the latest versions of critical software, I wasn't upgrading Word 6.0 for fun. A few days before, I packed up SuperCow, the Gateway 2000 486DX/66, and took it off to the beach house where I hide out to get some work done. One of my tasks was to work on revising *A Step Farther Out*. This is a science nonfiction book published in 1980 and made up of columns I wrote in the 1970s. You'd think a book that old would be out of date, but it's not. The space program hasn't gone very far since then, and while the cold war is over, a number of science and energy issues remain about what they were then.

I still get mail from people who've read it, and there appears to be enough demand for it to warrant a new edition. My intent is not to rewrite *Step*; I'm adding notes to confess when I was wrong and crow when I was right. I'd done about a hundred notes, and I wanted to finish the book. Then I want to take the rest of my science essays, including some carefully selected computer articles, annotate them, and put out a companion volume entitled *Another Step Farther Out*.

I had *Step* in Word 6.0a for Windows format on SuperCow's hard disk, and I was busily adding footnotes when Word locked up. Alt-Tab and Ctrl-Esc did nothing. I had to use Ctrl-Alt-Del, which closed Word 6.0 and brought me back to the Program Manager. I then reloaded Word and loaded *Step*. The result was peculiar: I could do a few things, and then Word would lock up again. Eventually, I found that I could page down just so far before things would lock. I paged to a point just before that, hit F8 and Ctrl-Home to mark all the text from that point to the beginning, cut it, pasted it into a new Word window, and saved it as STEP1. Then I saved what was left as STEP2.



STEP1 was fine. Oddly enough, I was able to load STEP2 and work on it. It was only when I tried to combine the two halves into one document that Word locked up. That seemed very strange.

I made safety copies of both halves, put up STEP2, and worked on it for a while, being careful not only to save fairly often but to save under a different name every now and then. It got to be dinnertime and we went out to one of our favorite restaurants, the Green Flash. When I got back, I discovered (1) that Word had locked up tight, and (2) that the auto-saved copy of STEP2 that Word had made before it locked up couldn't even be read into Word.

When I tried to read that version of STEP2, I got a "General Protection Fault" error. That not only clobbered Word but Windows itself, requiring a complete reset of the machine. Needless to say, I was more than annoyed and sent off some quite angry E-mail to Microsoft. It didn't take long to get a reply.

They suggested two remedies. First, get the 6.0c upgrade, which corrects some of the save problems. Meanwhile, because I clearly had some kind of crud in my document, load the last version I could get Word to read, save that in RTF (Rich Text Format), and read it back in again.

That actually worked. I still don't know what was wrong with my document. In Word 6.0, footnote numbers start over at 1 whenever you have a section break, and apparently I had a section break that was driving Word crazy. In any event, saving in RTF and reading it back in again cured the problem. I've since organized *A Step Farther Out* in an even more complex manner, with endnotes that renumber at the beginning of each section. It all works again, but that's not good enough.

There is no excuse whatever for a word processor crashing due to input. A word processor ought to be able to handle any random bit stream. It might get confused about section breaks and footnote numbers. It might get confused about headers and footers. It might see strings of garbage that cannot possibly be text and not know

how to display it. It might initiate a dialogue with the user about what to read and what to ignore—but it should never crash due to input.

Word isn't the only culprit here. Other word processors can be made to crash on input. That's still no excuse for Microsoft. The Word team can be justly proud of their program. When it works, it works good, and I use it because I like it. I like the way it integrates with Access for mail merges. I like the way I can paste PCX files into documents and that it will print a color picture in acceptable black and white. I like many things about Word, but Microsoft should still be ashamed for letting it out the door with crash-on-input bugs.

Alex came home just as I was finishing my day's adventure. He suggested that even though it looked like everything was running properly, I might want to check for viruses. He'd discovered one on his Gateway HandBook. He had no idea where it had come from, but given that it had infected his portable computer, it might have infected systems here.

I got out my trusty write-protected DOS floppy disk and the latest version of Dr. Solomon's Anti-Virus Toolkit. There are a number of virus-detection programs, and I suppose some of them are pretty good. I can't say Dr. Solomon's is the best, because frankly I haven't tried most others. I am convinced that Dr. Solomon's is good enough, and I'm not inclined to experiment when the results are this important.

The symptoms of the Parity B virus are pretty alarming: your machine will randomly hang while displaying "Parity Error." This is a fair imitation of a progressive memory failure, and that's what Alex thought he had—until he noticed the HandBook had 639 KB, not 640 KB, of base memory. That often indicates that either your system has 1 KB of memory reserved for CMOS drive-type setup in the CMOS setup screen or it's infected. A quick check with Alex's copy of McAfee Associates' Scan program showed Parity B.

Parity B is a "nice" virus, if any such vandalism can have a positive side. On hard drives, it copies the original boot information to sector 14 of the C drive. If you're clever, you can copy it back with Norton's DiskEdit or the like. That's good, because Scan can't uninfect a hard drive with Parity B.

Anyway, I checked all the machines in Chaos Manor—there are a lot of them—and they're all virus-free. I expected as much. We have a house rule that says if we ever see the "not a boot disk" error, meaning that we have tried to boot up the system from a nonboot floppy disk, we stop right there, turn off the machine, boot up from a write-protected known-good floppy disk, and run Dr. Solomon's.

When I began writing with computers—back in the dark ages before the term *word processing* was invented—I was eager to get Larry Niven a system so that we could work on our novels at his place as well as mine. That had its downside. When Niven, who understands technology theory just fine but is sometimes a bit less informed on practical matters, needed help, he'd call me. Fortunately, we both keep vampire hours.

His hardware is maintained by Workman and Associates—generally meaning Alex. I still get midnight calls for technical support, but not as many as I used to.

Recently, Alex wanted to update Niven's machine so that it would automatically back up to tape during the middle of

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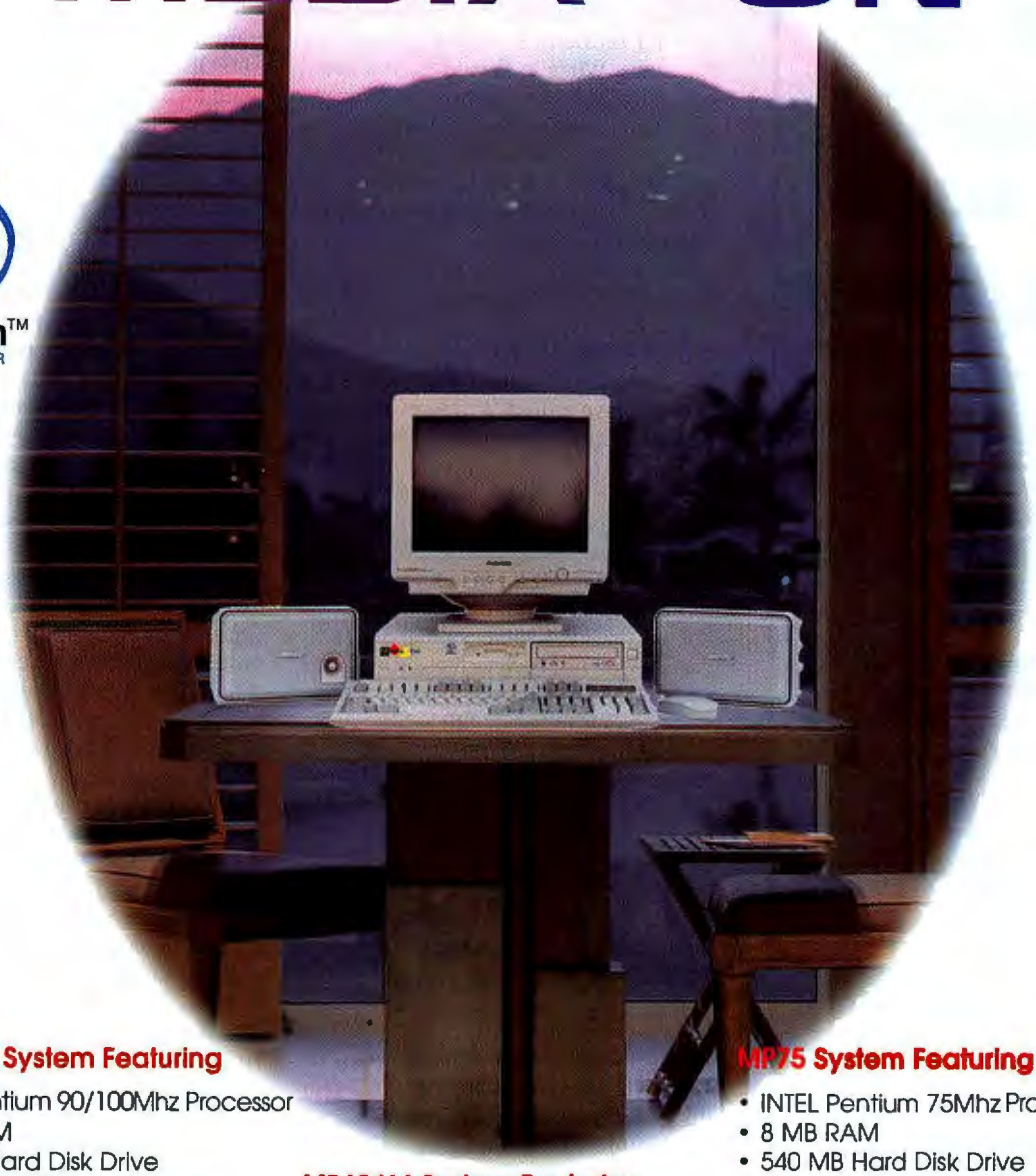

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the night. Previous versions of Colorado Memory Systems' tape-backup programs worked well enough, but installing version 1.1 on Larry's 486DX/50 blew up Windows. When in Windows, you could not find files, and going out to DOS would show that some files were missing and the drive was hash. Rebooting would bring all the files back. A download of Colorado Backup 2.02 for Windows produced the same results.

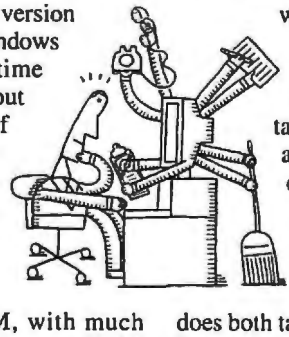
The remedy was to nuke Colorado Backup 2.02 for Windows, reinstall Windows from floppy disks, and go back to using Colorado Backup 4.05 for DOS. That can do automatic backups, but you have to have exited Windows first, and Niven can't be relied on to remember that.

When Alex called Colorado Memory Systems, he was assigned a problem number, but repeated attempts to reestablish contact have produced no results. We presume that Backup for Windows works on most hardware configurations.

Note that even some popular and fairly vanilla systems, such as those from Gateway 2000, can be subject to odd problems. Recently, installing Zenith Z-Stor on SuperCow munged Windows for Workgroups so badly that we would get the message that "Program Manager Caused a General Protection Fault" at start-up. I had to reinstall Windows from floppy disks—after which the problem went away as mysteriously as it had come. On the other hand, the same installation went quite smoothly on Pentafluge, our fire-eating Pentium, which isn't standard at all.

OS/2 comes in two major flavors, Warp and Borg. Warp, once known as OS/2 for Windows, requires that you have your own version of Windows running before you install it. Borg, also known as plain OS/2, is larger than Warp, and embedded within it is Win-OS/2, a version of Windows that IBM licenses from Microsoft. If you have that variety, you don't need your own copy of Windows.

As I write this, the latest version of OS/2 with embedded Windows is OS/2 2.11; but by the time you read this, they'll have out version 3.0. Borg will itself come in two flavors, regular and professional. Those aren't the names IBM will use, but that's what they'll mean. More on Borg another time.



A few weeks ago, IBM, with much hoopla, brought out a new version of OS/2 for Windows called OS/2 Warp 3.0. Then they withdrew it because of a faulty installation program. Now it's out again, and it's nifty.

The bug was this: if the installation program found a copy of CONFIG.BAK or AUTOEXEC.BAK in the root directory, it could do terrible things to your FAT (file allocation table). As part of the hoopla, IBM shipped "final-release" copies complete with the installation bug to a number of important reviewers. Several of them got burned, and the resulting reviews were understandably grim.

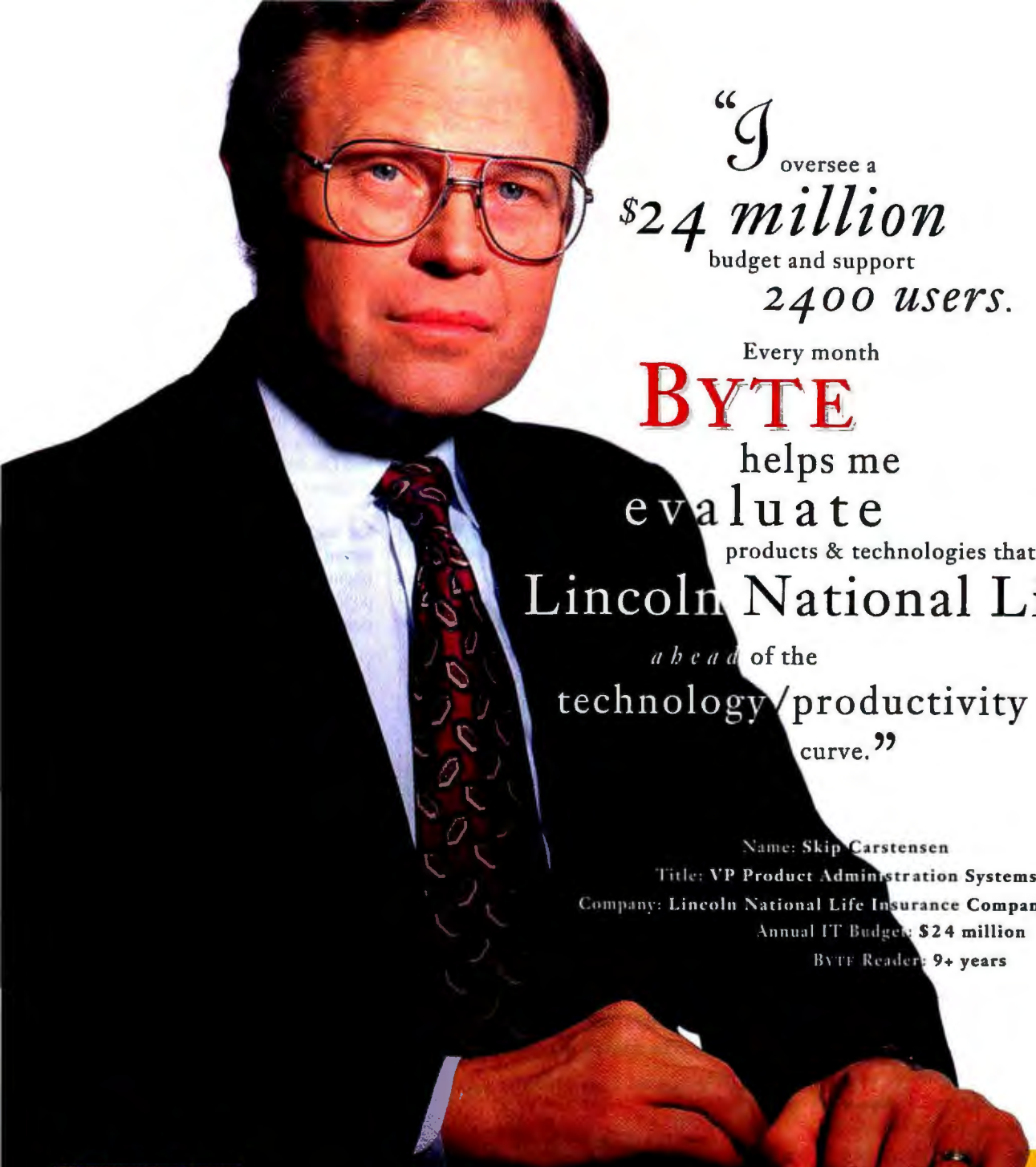
A very few of these final-release copies found their way to distributors. Alex bought one for a client before either of us knew about the installation bug. Fortunately, he installed it on a virgin system that had no BAK files on it. The installation went smoothly, and he came back quite enthusiastic about OS/2 Warp 3.0. It seems he bought the unbuyable and installed the uninstallable.

I never got a final-release copy, but I've had several beta versions of Warp here at Chaos Manor, and I like it. Alex had the same experience at his client's site. OS/2 Warp 3.0 really is a better DOS than DOS, as well as a *lot* better DOS than Windows. Because your Windows programs are running with your own copy of Windows, you'd think Warp couldn't be a better Windows than Windows, but that's not true. As an example, Warp can handle a big Word for Windows print job without monopolizing the machine. It's also a lot more reliable for communications.

Warp has an easier interface than OS/2 2.1. There's a shutdown button. Menus have been rationalized. It's a lot easier to fine-tune program settings. There are things I wish they did differently. Installing a new program is a tad more awkward in OS/2 than in straight Windows. All in all, though, the OS/2 interface is at least as handy as the Windows interface, and it won't take you long to learn it.

I'm still no great fan of multitasking without multiple CPUs—deep down, you don't want to share CPU cycles with anyone, including yourself. Most of us don't really do multitasking anyway; what we want is smooth and rapid task switching. However, there are some tasks, like communications, that demand multitasking. When I'm finished preparing a fax, I don't want to stop using my machine while it's being sent. OS/2 does both task switching and multitasking better than Windows. It's stable, too.

OS/2 is technically better than either DOS or Windows. If that's not enough to



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make you want to try it, there are some pretty good OS/2 applications. One is the IBM Personal Dictation System. More on that in a month or so.

And if that's not enough, OS/2 Warp 3.0 comes with a package of Internet access tools. I'll have a lot more on that in the next few months. However, if you've been wishing you could do some Internet surfing, OS/2 Warp right out of the box will put you on the Internet in as painless a manner as I know.

Bottom line: if you use Windows and you're at all inclined to experiment, get OS/2 Warp. Back up your system and have at it. I can't guarantee it will go smoothly, but it does for most people. Try it. You'll probably like it, and even if you don't, it will give you a head start on Windows 95.

I have a big collection of quotation programs, starting with the *Bartlett's* in Microsoft Bookshelf. Bookshelf remains the single most useful CD-ROM I own, but there are better quotation programs. In particular, I like MCR Software's Wisdom of the Ages, which has the best selection of relevant quotes I know. It's organized in an unusual manner, but I like it.

Great Bear Technology has a good program called The New American Library of Quotes, but it doesn't let you add quotes. I often use quotes as chapter epigraphs, with the notion of focusing reader attention. Quotation programs generally won't have just the one I want, although Wisdom of the Ages and askSam Systems' Quotes On Line have been useful. *Bartlett's* is often the place to start looking. When I find a quote somewhere, I want to be able to add it to my quote package and index it properly, and both Wisdom and Quotes On Line let me do that. I like Wisdom more, but they're both good.

For decades the U.S. Government has collected statistics, many valid but useless because no one had the computational power to do anything with them. The computer revolution has changed that.

Charles Murray started a new trend with *Losing Ground: American Social Policy 1950-1980* (Basic Books, 1986), a book that tried to establish a definite relationship between poverty and antipoverty programs. He concluded that most of, if not all, the social programs made things worse. Of course, his study was subjected to political, not scientific, analysis; but the point is that he included all the data, so it's possible to duplicate his analysis.

Now he has done it again. Murray and the late Richard J. Herrnstein have published *The Bell Curve: The Reshaping of American Life by Differences in Intelligence* (Free Press, 1994), a book that examines what you can and cannot conclude from various studies of IQ. I've read both these books. Neither says what most people seem to think they do. That's particularly true of *The Bell Curve*, which contains as good a popular introduction to population statistics in general and intelligence measurement in particular as I've ever seen. In addition, the book contains the primary data on which its conclusions are based.

Vilfredo Pareto once said, "Had Aristotle held to the course he in part so admirably followed, we would have had a scientific sociology in his early day. Why did he not do so? There may have been many reasons; but chief among them, probably, was that eagerness for premature practical applications, which is ever obstructing the progress of science, along with a mania for preaching to people as to what they ought to do—an exceedingly bootless occupation—instead of finding out what they actually do." *continued*

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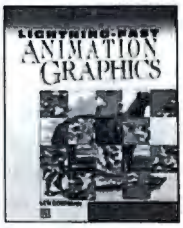

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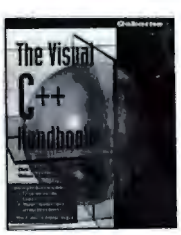

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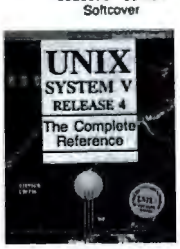

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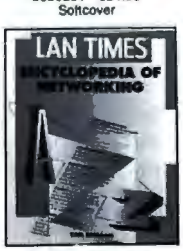

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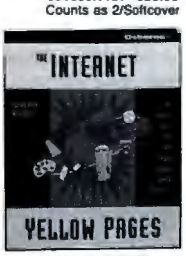

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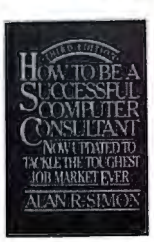

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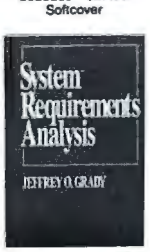

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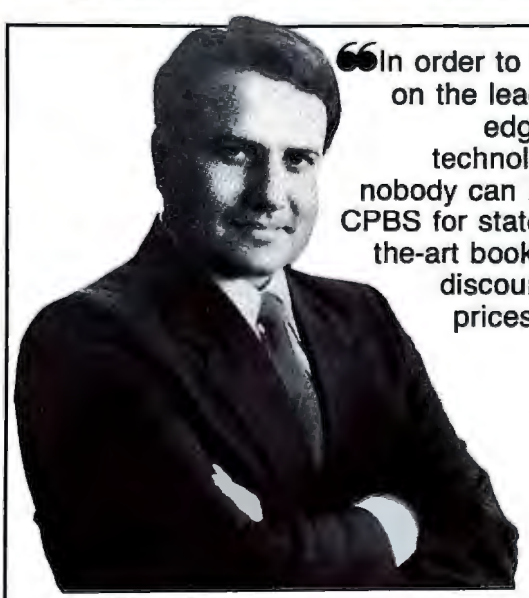

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Actually, a true social science is at least as difficult as quantum physics, and Aristotle simply didn't have the tools to form and test statistical hypotheses; we didn't even have those tools when I was in graduate school.

Matrix inversion is simple now, and so is regression analysis. *The Bell Curve* may or may not be correct in its conclusions—certainly some of them are unpleasant to think about—but at least it states its hypotheses in clear and precise terms and carefully presents both its evidence and its reasoning. Almost every BYTE reader has access to more than enough computing power to duplicate that reasoning and test the sensitivity of the conclusions to various assumptions, including the fundamental assumptions of statistical inference. Not everyone will do that, but I expect some will, and that's all to the good.

The gadget of the month is the Microtest COMPAS, a specialized hand-held (about the size of the Magellan GPS receiver) LAN protocol analyzer that most network managers would kill for. At $4995, it's not cheap. Fair warning, if you buy one in Southern California, you'll be steered to Alex at Workman and Associates. Press one button and you get a menu that includes: Are servers OK?, Why is network slow?, Why can't I log in?, Why does this connection drop?, and Is this cable OK? Even I can understand the answers it gives.

Unfortunately, this one doesn't do NetBEUI, (aka Windows for Workgroups and IBM OS/2 Advanced LAN Server protocols), but it's software upgradable. Stay tuned and watch the Microtest BBS.

It's not a full-blown cable tester (as in Microtest's PentaScanner), and it has some limits that a full Network General Expert Sniffer Portable Analyzer won't have, but it will let you plug in between a workstation and a network server to watch what's happening in real time. It will also introduce a printer test page into the network stream; if your printer doesn't print that, something's wrong. Note that you haven't had to disconnect anyone's workstation to test that. COMPAS isn't for everyone, but Alex says if you need this, you need it bad.

We took the Apple PowerBook 540c to the Hackers' Conference. Hackers in this instance doesn't mean criminals who use other people's equipment without permission. Instead, it harks back to the older definition of programming wizards. One of these is Donald Knuth, whose three-volume *Art of Computer Programming* is a fundamental work of computer science.

As always, I learned a lot at the Hackers' Conference. For instance, the general consensus was that Mosaic and other programs for surfing the WWW (World Wide Web) on the Internet will be "the killer applications of the 1990s." I'll have a lot more about both the Hackers' Conference and the Internet in future columns; just now, I wanted to comment on the PowerBook 540c. It's high-end expensive, of course; and it's neat. The screen is really easy to see. The keyboard is great. The machine is fast. The trackpad—a small touchpad that substitutes for a mouse—takes getting used to, but in an hour or less you'll wonder how you ever got along without it.

The computer book of the month is Adam C. Engst's *Internet Starter Kit* (Hayden Books, 1994). It's quite readable, and it goes into history, various ways to connect to the Internet, and what you can find there.

Note that Internet surfing is addictive. There's always one more place to visit and one more file to download. Soon it's dawn, and you've filled your hard disk.

The book of the month is Donald Norman's *Things That Make Us Smart: Defending Human Attributes in the Age of the Machine* (Addison-Wesley, 1994). Dr. Norman is a senior Apple Fellow. I met him at the Hackers' Conference. After spending an hour with him, I promptly bought his book and read it in two days.

Next month, Windows 95 vs. OS/2, and a lot more on networks. ■

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

BOOTCON 2.1 ($79) remains a very useful program, and the new version is a genuine improvement. Contact **Modular Software Systems**, Kent, WA, (800) 438-3930 or (206) 631-5781; fax (206) 631-5779. **Circle 1172 on Inquiry Card.**

Colorado Backup 4.05 for DOS ($19.95) and **Colorado Backup 2.02 for Windows** ($42) tape-backup programs work well. Contact **Colorado Memory Systems**, Loveland, CO, (800) 845-7905 or (303) 669-8000; fax (303) 667-0997. **Circle 1173.**

COMPAS ($4995) is a specialized hand-held LAN protocol analyzer that most network managers would kill for. **PentaScanner** ($3495) provides full-blown cable testing. Contact **Microtest, Inc.**, Phoenix, AZ (800) 526-9675 or (602) 952-6400; fax (602) 952-6401. **Circle 1174.**

I am convinced that **Dr. Solomon's Anti-Virus Toolkit 6.69** (for DOS, $125; for Windows, $149; both with quarterly updates) is good enough, and I'm not inclined to experiment when the results are this important. Contact **S&S Software International, Inc.**, Mission Viejo, CA, (714) 470-0048; fax (714) 470-0018. **Circle 1175.**

The **Expert Sniffer Portable Analyzer** (single topology, Ethernet or Token Ring, $9995) is a full-featured LAN protocol analyzer. Contact **Network General Corp.**, Menlo Park, CA, (800) 764-3337 or (415) 473-2000; fax (415) 321-0855. **Circle 1176.**

Microsoft Bookshelf ($69.95) remains the single most useful CD-ROM I own. Contact **Microsoft Corp.**, Redmond, WA, (800) 426-9400 or (206) 882-8080; fax (206) 883-8101. **Circle 1177.**

The New American Library of Quotes ($49.95) is a good quotation program. Contact **Great Bear Technology, Inc.**, Moraga, CA, (800) 795-4325 or (510) 631-1600; fax (510) 631-6735. **Circle 1178.**

Try **OS/2 Warp 3.0** under $80). You'll probably like it, and even if you don't, it will give you a head start on Windows 95. Contact **IBM Corp.**, Austin, TX (800) 342-6672 or call your local IBM dealer. **Circle 1179.**

The **PowerBook 540c** (base price, $4839) is a neat machine. Contact **Apple Computer, Inc.**, Cupertino, CA, (800) 776-2333 or (408) 996-1010; fax (904) 584-7481. **Circle 1180.**

QEMM 7.5 ($99.95) and Optimize did their thing. I had well over 600 KB of free memory, I could get into Windows just fine, and the Windows for Workgroups network worked properly. Contact **Quarterdeck Office Systems**, Santa Monica, CA, (800) 354-3222 or (310) 392-9851; fax (310) 314-4217. **Circle 1181.**

I found **Quotes On Line 1.0** ($89) useful. Contact **askSam Systems**, Perry, FL, (800) 800-1997 or (904) 584-6590; fax (904) 584-7481. **Circle 1182.**

A quick check with Alex's copy of **Scan** (one-year single-user license for DOS, Windows, or OS/2, $59) showed the Parity B virus. Contact **McAfee Associates, Inc.**, Santa Clara, CA, (408) 988-3832; fax (408) 970-9727. **Circle 1183.**

Wisdom of the Ages ($69.95; Wisdom++, $99) has the best selection of relevant quotes I know. Contact **MCR Software**, Oakland, CA (800) 767-6797 or (510) 763-9134; fax (510) 444-6561. **Circle 1184.**

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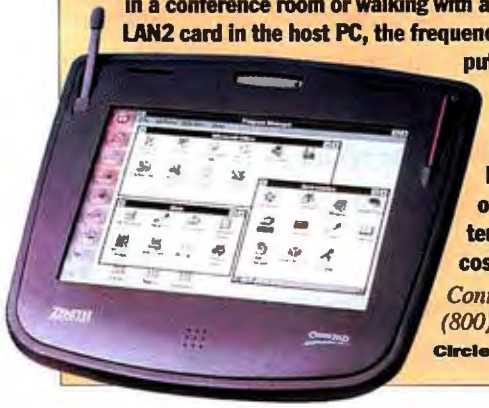
DBYTE45

What's New Hardware

Local Wireless Communications

A wireless remote interface for locally mobile networked and stand-alone PCs, Zenith Data Systems' CruisePad lets you wirelessly control a desktop or notebook PC while collaborating with a colleague in a conference room or walking with a customer. Paired with a CruiseLAN or Proxima RangeLAN2 card in the host PC, the frequency-hopping spread-spectrum radio in the unit sends input commands to the host PC directly or via a networked access point and instantaneously receives display updates. The CruisePad provides up to 500 feet of range within buildings. Used in conjunction with a CruiseLAN/Access Point, the range increases to 1000 feet in open spaces; Multiple CruiseLAN/Access Points can extend the range throughout a building or campus. The unit costs $1399.



Contact: Zenith Data Systems, Buffalo Grove, IL, (800) 533-0331 or (708) 808-5000.

Circle 1271 on Inquiry Card.

PLUG-AND-PLAY SOUND

A family of 16-bit stereo sound cards, the Crystalizer PnP cards (from $249.95) are self configuring when used in a computer that supports Plug and Play. From Crystal Computer (San Jose, CA), each card uses the Yamaha OPL3 20-voice FM stereo synthesizer, the Opti/MediaChips MAD 16 audio controller, and an A/D converter from either Crystal Semiconductor or Analog Devices. The cards are compatible with the AdLib, Windows Sound System, and SoundBlaster audio standards.
Phone: (408) 383-2100.

Circle 1275 on Inquiry Card.

A SPEEDY SYSTEM

National MicroComputers' (Salt Lake City, UT) Expert-System+ ($2695) is based on the 90-MHz Pentium processor. The system has a 64-bit PCI local-bus VGA accelerator with 2 MB of RAM, 8 MB of system RAM (expandable to 128 MB), and a 540-MB hard drive. Also included is a 14-inch noninterlaced SVGA display.
Phone: (801) 265-3700.

Circle 1276 on Inquiry Card.

SERVER SWITCHING

The Series 1800 ParallelSwitch switching hub card (from $1988) provides up to 60 Mbps of network bandwidth and server access. From Xnet Technology (Milpitas, CA), the card supports NetWare System Fault Tolerance technology in a switching domain. If the active server on a network fails, the card's ParallelGuard fault-tolerant switching function automatically channels the switching function to the second server.
Phone: (408) 263-6888.

Circle 1279 on Inquiry Card.

A BRIDGE FOR ONE

A full-function bridge and IP router, the Pipeline 50 HX (from $995) is targeted toward individual telecommuters and single Internet users. Functions integrated into the modem-size box include Ethernet-to-ISDN Basic Rate, dial-on-demand routing and bridging, inverse multiplexing, and dynamic bandwidth allocation. The Ascend Communications (Alameda, CA) device also integrates SNMP management, multilevel security, compression, filtering, and field-upgrade capability.
Phone: (800) 621-9578 or (510) 769-6001.

Circle 1277 on Inquiry Card.

NETWORK WITH A FRIEND

DuoNet ($69.95) from Leunig Communications (San Jose, CA) lets two people fully network their PCs via the computers' parallel ports. The package consists of a specially designed cable for hooking up the PCs and NDIS driver software for Windows for Workgroups 3.11.
Phone: (408) 441-6560.

Circle 1278 on Inquiry Card.

REMOVABLE C DRIVE

A desktop PCMCIA-IDE adapter, the ATA/B ($69.95) turns Type III PCMCIA-ATA hard drives and selected Type II ATA flash cards into removable boot drives. From ProTégé (Anaheim, CA), the adapter mounts internally in your desktop system as if it were a 3½-inch floppy drive.
Phone: (800) 232-1347 or (714) 961-7000.

Circle 1280 on Inquiry Card.

MPEG DECOMPRESSION

The Boffin (Burnsville, MN) MPEG Decompression Board ($299) decompresses and plays back ISO MPEG CD-ROM discs to provide 74 minutes of movies and music videos in standard video CD format. Color depth is as high as 16 million colors at VGA resolutions up to 1024 by 768 pixels. Interpolation hardware maintains original video quality; 16-bit stereo digital audio playback is included.
Phone: (612) 894-0595.

Circle 1281 on Inquiry Card.

APPLES ROAM ETHERNET

A wireless network adapter for Macs, PowerBooks, and Duo computers, the DaynaComm Serial Roamer (from $699) has throughput speeds between 200 and 400 Kbps. From Dayna Communications (Salt Lake City, UT), the 4½-ounce unit consists of a small, integrated antenna enclosed in a cellular-phone-size adapter. It's powered by a detachable cellular-phone battery and connects to a system's serial port to provide Mac users with a direct wireless connection to a wired Ethernet LAN.
Phone: (801) 269-7200.

Circle 1282 on Inquiry Card.

COLOR-IMAGING CARD

A color-imaging display card that fits into a single 16-bit PCI or ISA I/O slot in your PC, XipView ($1560) is compatible with high-performance, high-resolution, multiscan monitors from companies such as Hitachi, Idek, Nanao, Nokia, Philips, Sony, and ViewSonic. From Xionics (Peabody, MA), the controller card displays 256 colors. It supports 1600- by 1280-pixel resolution with vertical-refresh rates as high as 85 Hz.
Phone: (508) 531-6666.

Circle 1299 on Inquiry Card.

COMPACT PORTABLE PRINTER ▼

The Pentax PocketJet direct thermal printer ($499) weighs 17½ ounces with its rechargeable nickel-cadmium battery. Able to print up to 3 ppm at 300 dpi, it has full LaserJet IIP emulation with seven internal Hewlett-Packard fonts; it can download additional fonts and graphics. From Pentax Technologies (Broomfield, CO), the PocketJet uses letter- or A4-size paper.
Phone: (303) 460-1600.

Circle 1274 on Inquiry Card.

V.34 ON THE DESKTOP

In support of the V.34 specification, the 28.8-Kbps ProClass 288LCD and MacClass 288LCD desktop modems ($459 each) provide computer-to-modem speeds of up to 230.4 Kbps with up to 8-to-1 compression. From Practical Peripherals (Thousand Oaks, CA), the modems have a three-line LCD that can display more than 100 real-time messages. Other features include 14.4-Kbps send/receive fax capabilities, synchronous and leased-line operation, six help screens in ROM, and distinctive-ring detection.

Phone: (805) 497-4774.

Circle 1283 on Inquiry Card.

SBUS WITH TURBO GX

A single-slot SBus-based graphics accelerator, the SXT200 ($1995) has a Turbo GX controller that lets you work in CAD/CAM and desktop publishing applications. The X-Terminal card includes a 100-MFLOPS graphics RISC processor and a frame-buffer controller; they accelerate `Blit`, `Font`, and `Draw` commands and allow graphics processing on the card itself. From Integrix (Newbury Park, CA), the card includes keyboard and mouse ports, which let you expand a SparcStation into a server.

Phone: (805) 375-1055.

Circle 1285 on Inquiry Card.

FLICKER-FREE COMPUTER VIDEO ON TV

The pocket-size Presenter 3 Series of computer-to-TV adapters (from $349) allow you to display computer-generated images on standard TVs or to record presentations directly to a VCR videocassette. The PC and Mac adapters have a Video Stabilizer that uses line-averaging technology to virtually eliminate screen flicker, according to Consumer Technology Northwest (Beaverton, OR). The adapters draw a percentage of multiple lines simultaneously to produce video stability. Sharp View advanced circuitry cleans up any residual smearing that occurs when video lines are averaged.

Phone: (800) 356-3983 or (503) 643-1662.

Circle 1286 on Inquiry Card.

FAST ETHERNET CONNECTION

The four-, eight-, and 16-port PassaPort family of terminal servers (from $1149) let you connect PCs, ASCII terminals, printers, and modems to Ethernet LANs running at speeds as high as 115.2 Kbps. From Radlinx (Mahwah, NJ), the servers support TCP/IP, LAT, and PPP or SLIP protocols and provide asynchronous connections via a single wire to the Ethernet LAN. Other features include preloaded software on EPROM or flash ROM, modem control on all serial ports, and management support for SNMP and TSM.

Phone: (201) 529-1100.

Circle 1288 on Inquiry Card.

SEVEN DRIVES IN ONE ID

A compact CD-ROM tower for the Mac II and better systems, the CDT7-Mac, with its seven quad-speed drives ($6500), supports EtherTalk and AppleTalk networks while occupying only one SCSI ID. The Procom Technology (Irvine, CA) tower includes the company's Smart SCSI CD board and CD driver software with AutoCache, which monitors how the Mac requests and uses data from CD-ROM discs. The tower can store 4.5 GB of data; it has a seek time of 120 ms and a sustained data transfer rate of 600 KBps.

Phone: (800) 800-8600 or (714) 852-1000.

Circle 1287 on Inquiry Card.

REMOTE SERVER IN A HUB

Chipcom's (Southborough, MA) LAN Access Server Module (from $4495) is integrated within a hub to provide remote and mobile users access to resources on your corporate Ethernet or token-ring LAN. The module is powered by a RISC-based scalable architecture that supports popular WAN communications methods and can be controlled by any SNMP-based local or remote management console. The network manager sees all remote users in the context of the whole network and can monitor and control all nodes from a central management station.

Phone: (508) 460-8900.

Circle 1289 on Inquiry Card.

AUTOMATIC MONITOR SHUTOFF ▲

Designed for use with PCs and compatibles using PS/2 (i.e., mini-DIN) keyboard connectors, the Maximiser ($34.95) shuts off power to a computer monitor 15 minutes after the last keystroke. The unit returns power to the monitor when the keyboard is touched. From Panamax (San Rafael, CA), the Maximiser has one AC receptacle and plugs into a regular wall socket.

Phone: (800) 472-5555 or (415) 499-3900.

Circle 1284 on Inquiry Card.

QUICK DESKTOP COLOR PRINTING

The Phaser 540 color laser printer ($8995) can produce photographs, scanned images, and business graphics in continuous-tone, selectable, true 300- or 600-dpi quality. Geared for shared printing, the unit prints in full color at close to 4 ppm and in monochrome at 14 ppm. The Phaser 540 uses mono-component cartridges, which reduces the number of replaceable parts. A 250-sheet media tray is standard; options include a tray assembly for two additional 250-sheet trays and a special 100-sheet tray for transparencies.

Contact: Tektronix, Wilsonville, OR, (800) 835-6100 or (503) 682-7377.

Circle 1272 on Inquiry Card.

What's New Hardware

SCSI BUS BOOSTER

A PC-compatible plug-in board for ISA and EISA SCSI bus systems, the SCSI Booster (from $149) optimizes and boosts file-server and workstation performance by regenerating and conditioning internal SCSI bus signals. On-board active terminators provide SCSI termination to all devices. A standard Centronics or high-density SCSI-2 connector on the Applied Concepts (Wilsonville, OR) board provides the connection to external SCSI devices, which can operate up to the maximum cable distance of 19.7 feet away.
Phone: (503) 685-9300.
Circle 1290 on Inquiry Card.

CORDLESS BAR CODE READER

A cordless laser bar code reader, the Radio/Freedom Laser ($1775), from Worthington Data Solutions (Santa Cruz, CA), has a decoder and radio transmitter built into the handle; instead of a cord, an antenna protrudes from the gun. The unit scans from up to 28 inches away; it then transmits the data, via radio frequencies in the 49-MHz range, to the base station, which can be up to 150 feet away. The base station attaches as a second keyboard to a PC, Mac, or multiuser serial terminal.
Phone: (800) 345-4220 or (408) 458-9938.
Circle 1298 on Inquiry Card.

CASCADABLE HUB

The Hub-16E ($530) from Protec Microsystems (Pointe-Claire, Quebec, Canada) features an automatic link-integrity test for each of its 16 RJ-45 ports. One port is switch-selectable to connect a workstation or to cascade to another hub. The unit also comes with one AUI port and one BNC port for universal connection to Ethernet networks. Other features include automatic port partitioning and reconnection, automatic polarity correction, and diagnostic LEDs that indicate link and partition status for individual RJ-45 ports.
Phone: (800) 363-8156 or (514) 630-5832.
Circle 1291 on Inquiry Card.

SCSI ADAPTER FOR PCI BUS

A 10-MBps SCSI-2 adapter card for PCI-bus PCs, the FastSCSI PCI Basic ($134.95) directly accesses attached SCSI peripherals via its DMA bus mastering. From QLogic (Costa Mesa, CA), the card offers scatter-gather DMA transfers, SCSI disconnect/reconnect support, and active SCSI-chain termination. The PCI Basic is compatible with OS/2, Windows, Windows NT, and Windows 95 and is set up to support Plug and Play.
Phone: (800) 867-7274 or (714) 438-2200.
Circle 1292 on Inquiry Card.

A MENU FIT FOR A MONITOR

The OnView on-screen menu system in the ViewSonic 21PS flat-square color monitor ($1995) customizes screen images via an easy-to-understand menu. Designed for PCs, Macs, and Power Macs, the 21-inch monitor lets you select and adjust up to 20 settings, such as brightness, contrast, size, positioning, and pincushioning. The ViewMatch control adjusts the color temperature and intensity to match printer output. A special tilt management system in the ViewSonic (Walnut, CA) monitor counteracts the effects of the earth's magnetic field. The unit's vertical refresh rate is as high as 160 Hz.
Phone: (800) 888-8583 or (909) 869-7976.
Circle 1293 on Inquiry Card.

HIGH-SPEED SCANNING FOR WORKGROUPS ▶

Designed for small workgroups, the ScanPartner 10 ($1695) has a throughput of 10 ppm with 300-dpi resolution. From Fujitsu Computer Products of America (San Jose, CA), the 24-bit color scanner is compatible with DOS, Windows, Unix, and Macintosh environments. It has ISIS and TWAIN color drivers and a 50-sheet automatic document feeder; it accepts letter- and legal-size documents.
Phone: (800) 626-4686 or (408) 432-6333.
Circle 1294 on Inquiry Card.

DESKTOP CLIENT WITH MULTIVENDOR ACCESS

A combination of Alpha AXP technology, Windows NT, and an optimized X11.R6 server, the Multia MultiClient Desktop simultaneously provides access to Windows, NT, Unix, and existing host-based applications across your network. The system, which is centered around a 166-MHz Alpha AXP processor, runs Windows and NT applications locally and uploads them to networked servers for secure backup and storage. The entry-level system ($3495) includes a PCI-based graphics accelerator, 24 MB of SIMM memory, a 340-MB SCSI hard drive, two PCMCIA slots, Ethernet connections, and Multia software.

Contact: Digital Equipment Corp., Maynard, MA, (800) 777-4343 or (508) 467-7880.
Circle 1273 on Inquiry Card.

MULTIUSER CONNECTION TO WINDOWS NT

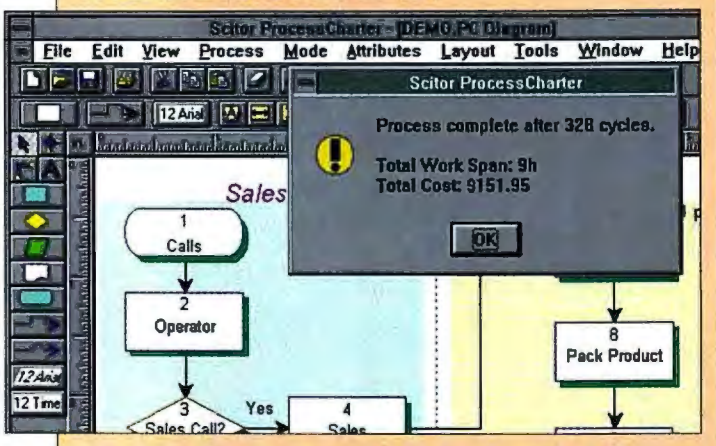
A hardware/software combination, the MultiGrafix for NT ($1090 per user) permits up to four SVGA displays to connect to a single NT server or console. The Specialix (Campbell, CA) system consists of a 16-bit host card, a four-way bus-extension cable, four display-adapter base units, and WiNTimes multiuser NT software. Host cards are available for ISA and EISA buses and can support eight user-selectable memory-address and interrupt settings.
Phone: (800) 423-5364 or (408) 378-7919.
Circle 1295 on Inquiry Card.

SOUND UPGRADE

With DSP capabilities, Orchid Technology's (Fremont, CA) WaveBooster daughtercard upgrade kits (from $129) provide highly realistic wavetable synthesizer sound for your PC. Compatible with FM-based audio cards, such as the SoundDrive and SoundBlaster 16, the kits can be used with all Windows applications, including music sequencers, presentation software, and CD-ROM titles. The basic kit has 2 MB of additional ROM samples, 118 percussion sounds, and 153 instrument and effects sounds.
Phone: (510) 683-0300.
Circle 1296 on Inquiry Card.

What's New Software

A Flowcharter with Brains



Much more than just flowcharting software, Scitor's Process Charter for Windows lets you analyze and hone your business's processes. As you map them out using the program's flowcharting tools, you identify the necessary resources in an integrated spreadsheet. After you've defined all your resources, the program can execute a process simulation that animates process flow and then generates reports and charts to help you identify critical bottlenecks and better manage your resources. The program costs $595.

Contact: Scitor, Foster City, CA, (415) 570-7700.

Circle 1300 on Inquiry Card.

CUT THE CONNECTION IN TELECOMMUTING ▼

Designed to let you remotely access and automatically update files, AnyPlace ($198) provides a view or map of the files residing on your office PC. When running in a networked environment, the remote directory map lets you create, retrieve, modify, delete, rename, and synchronize files while you're disconnected from the local server. Once your work is completed, AnyPlace, via a simple command, automatically synchronizes files between the remote PC and the local desktop or server. The program is from the Mobile Computing Division of Symmetrical Technologies (Amherst, NH).

Phone: (800) 867-0014 or (603) 598-4477.

Circle 1304 on Inquiry Card.

QUICK DATABASE CREATION

A 4GL from TopSpeed (Pompano Beach, FL), Clarion for Windows ($1299) provides a way to quickly create database applications. The QuickStart feature lets you assemble templates, and a database dictionary manages all file descriptions, including relations and referential integrity rules. The program has built-in networking, accommodates most database file formats, and supports the ODBC protocol.

Phone: (800) 354-5444 or (305) 785-4555.

Circle 1322 on Inquiry Card.

DISPLAY PHOTOS WHILE YOU WORK

FotoAttacher for Windows displays any image you choose on the caption bar of Windows-based applications. From ProCentric Software (Agoura Hills, CA), the TWAIN-compatible utility ($55.95) lets you either scan your own photos or send them to ProCentric for scanning. You can also customize the included photo gallery and screen saver, reposition an image anywhere on the caption bar via the mouse, and place your mouse arrow over the image to make the image disappear.

Phone: (818) 706-1282.

Circle 1305 on Inquiry Card.

NETWORK MODEM ACCESS

The network version of QmodemPro for Windows ($399) lets as many as five users simultaneously access the program's data-transmitting capabilities. From Mustang Software (Bakersfield, CA), the package supports Novell's Network Asynchronous Communications Service, which allows workstations without modems to access networked modems. Terminal emulation for the IBM 3270 is included, as is support for individual user files.

Phone: (800) 999-9619 or (805) 873-2500.

Circle 1306 on Inquiry Card.

NETWORK TRACKING

Mac-based Skyline ($795) lets network managers archive and analyze network-traffic patterns over time. The AG Group (Walnut Creek, CA) software consists of Skyline, a centralized, graphical interface for analysis of network traffic, and Satellite, a data-collection application that you can run on your local computer or on remote Mac nodes. The result is a centralized system for analyzing network usage in real time or using archived data.

Phone: (510) 937-7900.

Circle 1308 on Inquiry Card.

VIDEO-CAPTURE TOOL

A development tool for integrating video and still-frame capture capabilities into your Windows applications, the MediaRecorder Toolkit ($595) supports OLE automation, OLE Controls, C++ libraries, and DLLs. The customizable Lenel Systems International (Fairport, NY) tool lets you develop such programs as database applications that have the ability to capture video and images directly into a database field or a BLOB.

Phone: (716) 248-9720.

Circle 1309 on Inquiry Card.

PORTFOLIO PERFORMANCE TRACKING

Hamilton Software's (Englewood, CO) Easy ROR ($59) provides exact calculation of internal and time-weighted return on investment using minimal data input. The program uses deposit, withdrawal, and tax information to calculate the annualized rate of return for single or composite portfolios over any time period. Easy ROR can also export data to spreadsheets.

Phone: (800) 733-9607 or (303) 795-5572.

Circle 1310 on Inquiry Card.

VOICING NEW FEATURES

An open-architecture applications generator, Voice Window ($295), from Mystic Software (Alameda, CA), allows you to develop customized voice- and fax-processing applications. Features include the Builder Visual Flowchart graphics interface, call screening, an Auto-Attendant that answers up to 16 phones simultaneously, and pager support that works with tone or digital pagers. Also included are a multiple-line fax-on-demand feature, the ability to run voice-mail applications in the background, and support for ASCII, PCX, and DCX files.

Phone: (510) 865-9189.

Circle 1311 on Inquiry Card.

velopes, postcards, programs, and menus with a black-and-white laser or ink-jet printer. The software supports OLE 2.0.
Phone: (415) 473-3600.
Circle 1313 on Inquiry Card.

WEDGE DATA INTO APPLICATIONS ▲

For Windows or DOS, File Wedge ($199) from T.A.L. Enterprises (Philadelphia, PA) sends disk-file data to any PC application, either as keystrokes or via DDE. The utility lets you easily input data from any disk file into your applications; File Wedge then parses and filters the data and adds keystrokes, macros, or commands as needed.
Phone: (800) 722-6004 or (215) 763-5096.
Circle 1312 on Inquiry Card.

BROCHURES THE EASY WAY

MyAdvancedBrochures, Mailers, and More ($99.95), from MySoftware Company (Palo Alto, CA), lets you create bifold, trifold, and fourfold brochures on preprinted color paper. You can also create business cards, letterhead, mailing labels, en-

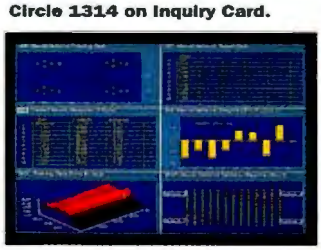
MAC MIGRANTS IN WINDOWS

An integrated programming tool for writing and organizing source code, Object Master for Windows ($249) lets C and C++ programmers write, edit, organize, and navigate through source code while using familiar drag-and-drop Windows functions. With the ACI US (Cupertino, CA) tool, Windows and Mac programmers can use the same project interchangeably on both platforms. Object Master integrates with major compilation systems and DOS compilers to trigger compilation and receive errors without switching to the compiler environment.
Phone: (408) 252-4444.
Circle 1318 on Inquiry Card.

A graphics application for creating full-color, publication-quality 3-D images, Ray Dream Designer 3 ($349) is now available for Windows. The Ray Dream (Mountain View, CA) software provides advanced modeling, shading, and rendering capabilities, as well as Bézier-based drawing tools, 3D Paint, the Modeling Wizard, and cross-platform compatibility.
Phone: (800) 846-0111 or (415) 960-0768.
Circle 1319 on Inquiry Card.

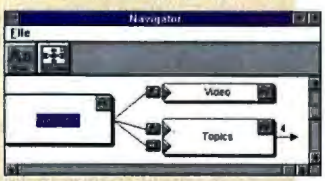
NEURAL-NETWORK POWER ▼

An add-on to the DADiSP graphical data-analysis software package, DADiSP/Neural Net ($695) is a back-propagation neural-network algorithm that lets you build and train back-propagation neural networks. From DSP Development (Cambridge, MA), the menu-driven module can be used in pattern-recognition, image-processing, cluster-analysis, computer-vision, and speech-recognition applications.
Phone: (617) 577-1133.
Circle 1314 on Inquiry Card.



Software Update

ForeHelp 2.0, ForeFront (Boulder, CO), can create and maintain multiple RTF files for multiple authors creating one help file, automatically generate a print document from the help file, display 256 color bit maps via an embedded Windows DLL, and

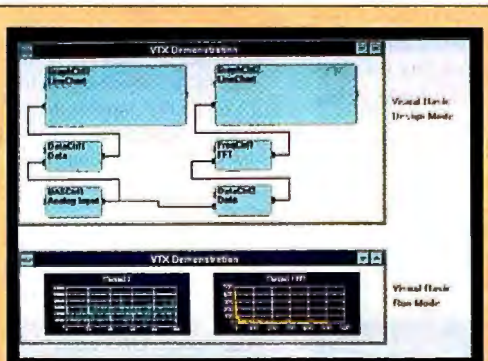


display the contents of embedded windows in test mode. $395.
Phone: (800) 357-8507 or (303) 499-9181.
Circle 1328 on Inquiry Card.

SPSS 6.1 for the Macintosh, SPSS (Chicago, IL), adds a Mac user interface that supports System 7; includes more statistics; has fully integrated and editable graphs; includes graphics in the base module; and improves data and file management with a spreadsheet-like Data Editor and built-in ODBC links. Base module, $695; add-on modules, from $395.
Phone: (800) 543-2185 or (312) 329-2400.
Circle 1330 on Inquiry Card.

PhotoGenix Professional Edition 3.0 for Windows, Firefly Software (Jericho, NY), supports FLI and FLC animation files and WAV files and lets you create royalty-free multimedia screen savers without programming. $199.
Phone: (800) 224-2778 or (516) 935-7060.
Circle 1332 on Inquiry Card.

Argus MeshMaker Pro 2.0, Argus Interware (Jericho, NY), runs on Windows and Unix machines in addition to Macs. A common file format lets you exchange data among the three platforms. From $1000.
Phone: (516) 931-4725.
Circle 1335 on Inquiry Card.



DATA ACQUISITION IN WINDOWS

An integrated set of Visual Basic custom controls for building measurement systems, VTX (Visual Test Extensions) adds to Visual Basic the ability to collect, analyze, and graph data with point-and-click programming tools. VTX custom controls, which are packaged in three separate modules, write data once and then use pointers to the data arrays. These pointers are shared by all custom controls that use the data, cutting down on rewrite time and memory space.

You develop programs using graphical programming functions or a mix of graphical and code-based programming. With graphical programming, you use the mouse to connect the VTX custom controls with lines that enable the flow of control logic or data. For complex applications, you can write code in Visual Basic or such languages as C or C++. The DAS Base Module costs $149; the optional Analysis and Graph modules cost $199 each.

Contact: Keithley MetraByte, Taunton, MA, (800) 348-0033 or (508) 880-3000.
Circle 1301 on Inquiry Card.

What's New Software

PLAN YOUR MARKETING STRATEGY

Plan Write for Marketing helps you write your marketing plan by providing features such as a word processor, an integrated spreadsheet, and a chart generator. The Business Resource Software (Austin, TX) program presents the marketing plan in a structured outline format, with each entry representing a concept critical to the documented marketing plan. You can customize the content of the outline structure and associated rationales. A sample plan is included with the $129.95 package.
Phone: (800) 423-1228 or (512) 251-7541.
Circle 1315 on Inquiry Card.

UNIX DEVELOPMENT TOOL

A Motif/X Window System client, Exemplar, the Man Page and Source Code Example Browser ($275), provides an integrated view of man pages with associated sample code fragments. Developers view a man page and then click on the mouse to simultaneously display a file with a working sample program for the items on that man page. From Melillo Consulting (Somerset, NJ), Exemplar features intelligent search capabilities for hard-to-find man pages, point-and-click access to related include files, and see-also lists. The program is available for AIX, HP-UX, OSF/1, Solaris, SunOS, and UnixWare platforms.
Phone: (908) 873-0075.
Circle 1317 on Inquiry Card.

INTELLIGENT CALL-CENTER REPORTING

An add-on to the Distributed Call Center application, Desktop Reports for Windows ($495 per user) delivers call-center reporting in a client/server environment. From Teloquent Communications (Billerica, MA), the software lets you set up a given query related to any call-center activity by entering the parameters of the query. Reports can be user defined to create custom reports or redefined with default selections and group criteria.
Phone: (800) 468-6434 or (508) 663-7570.
Circle 1316 on Inquiry Card.

MULTILINGUAL SUPPORT

Accent Special Edition ($189), an advanced multilingual word processor, provides language support for spelling checking, hyphenation, thesaurus, and the Berlitz Interpreter dictionary in English, French, German, Spanish, and Italian. From Accent Software International (Exton, PA), the program lets you export or import text to or from programs such as Word, WordPerfect, and Ami Pro. You can import graphics files from TIFF, PCX, EPS, WMF, GIF, and BMP formats.
Phone: (800) 535-5256 or +44 923 208 435.
Circle 1320 on Inquiry Card.

HELP WITH FORMS

Syncware Fill for Windows ($49.95), from Syncware (Aurora, CO), lets you accurately type over a screen image of a preprinted form. You can fill in similar or recurring forms from databases, mailing lists, or spreadsheets using saved templates. The forms can be read in from a scanner, fax software, or a collection of preprinted forms on CD-ROM.
Phone: (800) 308-3690 or (303) 369-6900.
Circle 1307 on Inquiry Card.

WATERMARKING DOCUMENTS

A background printing utility for Windows, Working Watermarker for Windows ($49.95) lets you print a watermark graphic onto a page behind any document. The program works with any application, including those that do not support graphics. From Working Software (Santa Cruz, CA), the program lets you create your own watermarks or use the ones provided.
Phone: (800) 229-9675 or (408) 423-5696.
Circle 1326 on Inquiry Card.

PUT PHOTO-REALISM IN YOUR CHARTS

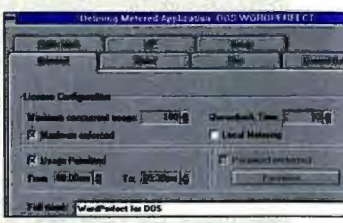
An analysis and presentation software tool, First Impression is based on a multidimensional data structure that can graphically represent data in many dimensions to reveal subtle trends and relationships within the data. You can use the program to create photo-realistic 3-D charts, with objects rendered in true 3-D space, using infinite light sources and perspective. The complete user interface has context-sensitive tab dialog boxes so that, as a Windows applications developer, you can customize your charts by pointing and clicking on options. The changes are automatically incorporated into the application. First Impression costs $249.

Contact: VisualTools, Lenexa, KS, (800) 884-8665 or (913) 599-6500.
Circle 1302 on Inquiry Card.

Software Update

PCBoard 15.2, Clark Development (Murray, UT), adds Fido networking, Internet-UUCP support, a credit accounting system, enhanced QWK networking, dBase file access, and PCBMail 1.0. From $150.
Phone: (800) 356-1686 or (801) 261-1686.
Circle 1331 on Inquiry Card.

SiteMeter 5.0, McAfee (Santa Clara, CA), supports metering across WANs; automates load balancing and license sharing over TCP/IP and IPX; consolidates multiserver metering and reporting under



one centralized graphical administration console; and adds agentless metering, a flexible enforcement option, and VIP metering, among other features. From $40 per node for 10 workstations.
Phone: (408) 988-3832.
Circle 1329 on Inquiry Card.

Link&Locate 386 2.0, Systems & Software (Irvine, CA), runs up to 50 percent faster than older versions, provides 32-bit COFF support, has improved run-time support, and offers enhanced control of segment ordering and greater ease of use. $895.
Phone: (714) 833-1700.
Circle 1333 on Inquiry Card.

XCAD 3.0, Xitron Software (Cincinnati, OH), adds DWG/IGES file compatibility, an XDS C language interface, a macro facility, support for unlimited layers, a customizable toolbar, and a 2-D/3-D symbols library. $495.
Phone: (513) 762-7638.
Circle 1334 on Inquiry Card.

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CERAMIC MUG.
11 oz. ceramic mug with gold band and 3-color, 2-sided logo. BYT 8. $4.50.

MOUSE PAD.
Hard top mouse pad. 4-color with 20th anniversary logo and tag line and repeating text background. 7.5" x 8.5" x 3/16". BYT 7. $5.25.

SWEATSHIRT.
11 oz. cross grain Lee sweatshirt with 20th Anniversary logo embroidered on left chest, features generous athletic cut and side gussets. 95% cotton, 5% polyester. Ash. Sizes: M-XL. M-BYT 1, L-BYT 2, XL-BYT 3. $31.20.

BALL CAP.
Soft brushed cotton free-form ball cap with adjustable Velcro closure back and 20th Anniversary logo embroidered on front. Black. BYT 11. $14.75.

PARKER VECTOR PEN.
Parker Vector Sport Roller Ball Pen. Black with 3-color BYTE logo repeated on barrel and cap. BYT 10. $6.25.

PARKER PEN.
Parker Insignia ball point pen. Laque black with 3-color BYTE logo on clip emblem. BYT 9. $34.50.

T-SHIRT.
100% Cotton Oneita Power-T. White with 1-color "technology" print on both sides and 4-color 20th anniversary logo on front. Sizes: L-XL. L-BYT 13, XL-BYT 14. $8.00.

COMPUTER TOOL KIT.
Deluxe computer service tool kit in black vinyl zipper case features: 2 nut drivers, 3 prong parts retriever, tweezers, torx driver, IC Extractor, one Phillips and 2 slotted screwdrivers. 1-color 20th Anniversary logo. BYT 12. $20.10.

Ordering: Credit card phone orders: Call 1-800-676-HALO (4256) (in IL, call 708/647-4902). We accept VISA, MasterCard, American Express and Discover. Merchandise in stock will ship within 2-3 business days of receipt. If an item is out of stock, the customer will be notified and given the option to backorder, substitute or cancel the item. Rush orders can be shipped the same day received if the order is placed by 2:00 p.m. CST. Rush orders will incur a $10 additional charge and express freight charges will be billed at cost.

Shipping: Include the following amounts for shipping via U.P.S. Ground. Up to $50.00-add $5.75, $50.01 to $100.00-add $7.75, over $100.00-add 8% to total. Air freight is additional. Shipping charges apply to domestic US orders only. International orders will incur a $12 documentation charge and will be billed at actual cost plus associated duties and taxes. F.O.B Point: Niles, IL 60714

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What's New Software

Windows on Unix

Based on the Windows NT 3.5 server, WinDD distributed desktop software runs on 486 or Pentium servers to deliver Windows applications to Unix desktops without software emulation. Currently available for the TekXpress family of X Window System terminals, WinDD enables desktops to simultaneously access PC, Unix, midrange, and mainframe applications. Multiuser access capabilities for NT allow a standard PC server to become an application server running CPU-related tasks at native processor speeds. Only compressed screen images and input commands are transferred between the X terminal and the PC. WinDD/Xpress, the local client application on the X terminal, displays the unmodified Windows environment at 486-class or higher speeds in a movable window on the screen. Prices for WinDD start at $3495.

Contact: Tektronix, Wilsonville, OR, (503) 682-3411.

Circle 1303 on Inquiry Card.

Control for Visual Basic

A version-control system designed for Visual Basic group development, SourceWorks/VB ($295) gives all developers simultaneous read and write access to all files while preventing unintentional overwriting of any source file. From ViewPoint Technologies (Sherborn, MA), the system uses unique Visual Basic–sensitive differencing to flag revisions of files, and it tracks all files in a project, along with their revisions, by team member. The program does not require a designated system administrator.

Phone: (508) 655-9595.

Circle 1321 on Inquiry Card.

DO OVER WINDOWS ▼

The Do-Over utility ($59) from Kansmen (Milpitas, CA) lets you change the look and feel of Windows. You can select the color and font of menu bars, dialog boxes, backgrounds, text, buttons, borders, and frames. The Do-Bar mini-application provides one-button access to each running program. You can locate the Do-Bar along any edge of the screen. When you want to switch from one application to another, you simply click on the desired application's icon on the Do-Bar; the application then opens and maximizes.

Phone: (408) 263-9881.

Circle 1327 on Inquiry Card.

STATISTICS IN WINDOWS

The StatMost for Windows program ($299) combines statistical-analysis tools and powerful, flexible graphics with an advanced report editor. From DataMost (Salt Lake City, UT), StatMost's comprehensive data sheet performs advanced data management, statistical analysis, numerical computation, time-series analysis, Fourier transform, nonlinear parameter estimation, and model development. You can put multiple plot types and axes in one document and choose from different axis scales. The program supports OLE 2.0.

Phone: (801) 484-3860.

Circle 1323 on Inquiry Card.

OBJECTS FOR UNIX

A complete C++ framework for cross-platform Unix systems development, ObjectSystems ($875 per user) is an object-oriented layer that sits between the application and Unix and hides the details of system calls, error detection, and cryptic flags. With ObjectSystems, programmers don't have to write code to interface an application with Unix. From ObjectSpace (Dallas, TX), the software has an expandable hierarchy that contains more than 120 classes. ObjectSystems supports IPC mechanisms, such as pipes, sockets, message queues, shared memory, and semaphores.

Phone: (214) 934-2496.

Circle 1324 on Inquiry Card.

HELP-AUTHORING TOOL

HelpBreeze—Work Group Edition ($379) is designed for development teams creating large-scale Windows help systems. The help-authoring tool lets you divide large help systems into manageable modules that you can compile and test individually. The workgroup tools let you create hypertext links between modules by selecting a target topic from a list. Information can be shared among team members with or without a network. The software is from Solutionsoft (Sunnyvale, CA).

Phone: (408) 736-1431.

Circle 1325 on Inquiry Card.

Software Update

PixelFX 3.0, Mentalix (Plano, TX), features integrated print management; an API that enables image scanning, file conversion, and OCR to be performed from a Unix shell or third-party application; support for 10 new scanners; and support for the WPG image file format. $1599.

Phone: (214) 423-9377.

Circle 1336 on Inquiry Card.

PageKeeper 2.0, Caere (Los Gatos, CA), adds PKDirect, on-line automation, and image-only scan capability; it also improves the integration of E-mail. $149.

Phone: (800) 535-7226 or (408) 395-7000.

Circle 1337 on Inquiry Card.

ATEasy 2.01, Geotest (Irvine, CA), includes new functions in its internal built-in library; new statements in its programming language; automatic subroutines for driver and systems initialization; and functions for measuring time, formatting test-log results, and calculating checksum for communications and file versioning. $99.

Phone: (800) 886-1201 or (714) 263-2222.

Circle 1338 on Inquiry Card.

Robofax Pro 4.0, FaxQuest, a division of Applied Systems Engineering (Sunnyvale, CA), adds smart dialing, runs up to four lines at once, provides LAN support, and simultaneously runs multiple decision trees. $1395.

Phone: (800) 995-9141 or (408) 736-1485.

Circle 1339 on Inquiry Card.

DaVinci eMail 3.0, On Technology (Cambridge, MA), features an enhanced BBS, a configurable toolbar, new message tracking, colored messages, collapsible hierarchical file folders, time zone support, simple MAPI support, and animated icons. From $199.

Phone: (617) 374-1400.

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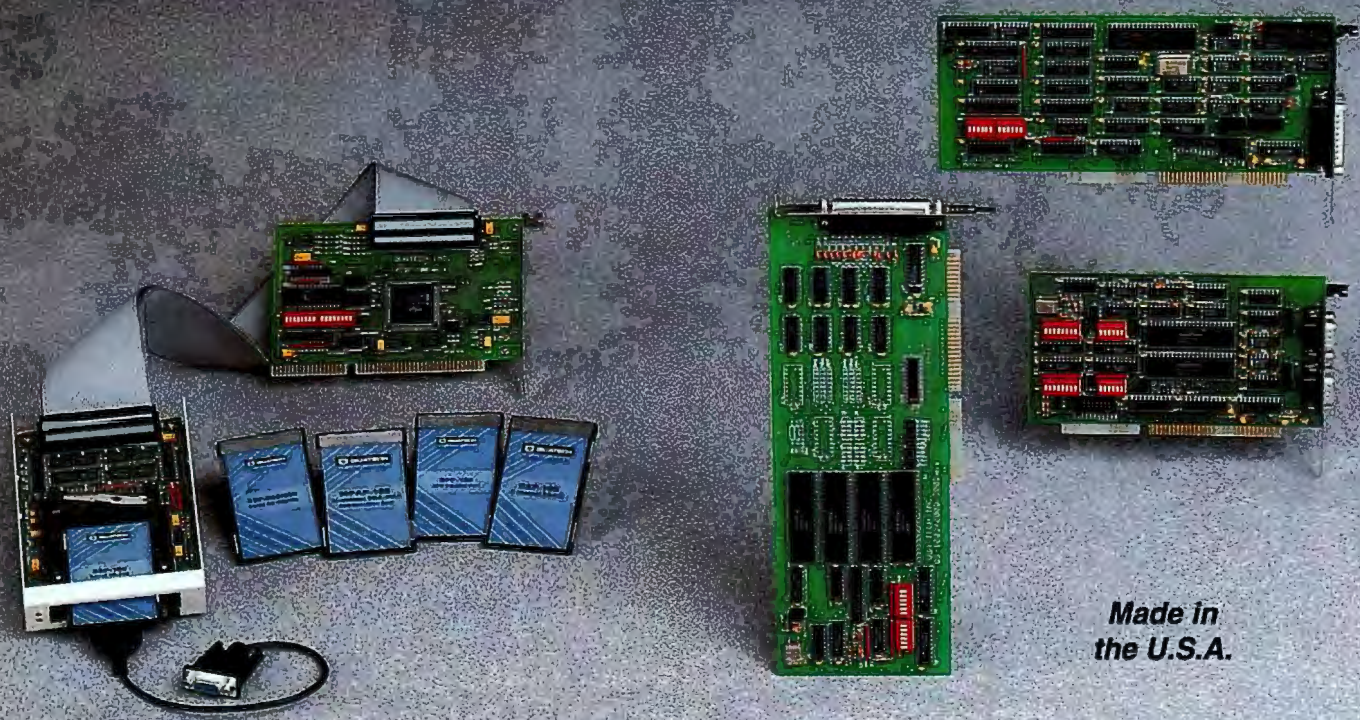

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Quatech's PCD2-F Internal Interface Adapter allows you to add PCMCIA capability to your desktop. The adapter is easy to install, and supports Type I, Type II and Type III memory and I/O cards. The PCD2-F and Quatech's PCMCIA I/O cards conform to 2.1 Specifications. The I/O cards support hot-swapping and include configuration software.

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Quatech's communication adapters for the AT bus meet asynchronous or synchronous and serial or parallel communication requirements with protocols such as RS-232, RS-422, RS-485, Current Loop, and IEEE488.

Expand your system with the DS-100, a dual channel RS-232 adapter. The QS-100D is a four channel RS-232 adapter. Both feature optional 16550 UARTS, all AT interrupts and flexible addressing. The QS-100D supports OS/2, UNIX, Xenix, DOS, and Windows®. The MPA-102 is a dual channel multi-protocol adapter utilizing an AMD 85C30-10 SCC. Other communication adapters for the AT bus are also available.

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80387-DX (Does All)	74.00
80387-SX (Does All)	249.00
Intel SX (Does All)	69.00
Intel SL Mobil	69.00
Intel 16SX	39.00
Intel 20SX	49.00

Lowest price on Intel overdrive chips

AMBRA

Ambra Pentium-60	4/8/16 Meg	175.00/339.00/599.00
Ambra MC 425SL	2/4/8 Meg	109.00/209.00/449.00
Ambra N Series	4/8/12/16 Meg	189.00/349.00/559.00/679.00
Ambra SW 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	209.00/399.00/659.00

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CX486 SRX2 16/32	244.00
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SIMM MODULES (Add $5.00 for SIPP)

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4Meg x 9	–	–	162.00	156.00	146.00	–
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1 meg x 36 4 mg	–	–	184.00	174.00	174.00	–
2 x 36 8 mg	–	–	359.00	339.00	339.00	–
4 x 36 16 mg	–	–	609.00	579.00	599.00	–
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16 x 36 64 mg	–	–	2699.00	2599.00	–	–
1 x 32 4 mg	–	–	164.00	159.00	–	–
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	8Meg	500987-003		330.00
	16Meg	500987-004		619.00
	32Meg	500987-005		1389.00
Premium 486/25, 25E, 33, 33E				
Premium 386/33TE, 486/25TE, 33TE				
Prem. Serv., Prem II 386SX/20, 25				
Prem. II 386/25, 386/33, 486/33, 486SX/20	8Meg	500780-001	64 pin	398.00
Premium 386/33T, Prem. 386SX/16				
Prem. II 386SX/20, 25	4Meg	500780-004		198.00
Premium 386/25, 33, 386/33T, 386SX/16,	1Meg	500780-003		58.00
Premia 4/33S, 4/33, 4/50D, 4/66D	8Meg	501159-002		379.00
Premia	16Meg	501159-003		789.00
Premia	32Meg	501159-004		1489.00
Premia	64Meg	501159-005		3111.00
AST Cupid 8d	0–32Meg	500818-001		178.00

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MODEL	AMT. UPGRADED	AST 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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30F5360 (2Meg)	30-286, 25-286, 80 MTHR BD.	194.00
6450375 (1Meg)	80-041	79.00
6450378 (2Meg)	80-111, 311-121, 321, 061, 161	84.00
6451093 (4Meg)	80-A21, A-61, 80-A31, 80-111, 80-311	189.00
6450604/92G7196 (25Meg)	70-081, 661, 121, 56Z, 55SX, 65SX, P-70, 55LS, 65LS, X-Station 120 & 130, 35SX, 35LS, 40SX, Val Pt. 325T	90.00
6450608 (2Meg)	70-A21, A-61, B-21, B-61, 35SX, 35LS, 40SX, Val Pt. 325T	90.00
76X8955 (128K)	25	35.00
34F2933 (4Meg)	35SX, 40SX, 55SX, 65SX, 56LS, 65LS	175.00
87F9977/92G7199 (4Meg)	55SX, 55LS, 65SX, 40SX, 35SX, 35LS	175.00
1057035 (512K)	P/S1-286	49.00
92F9035 (2Meg)	P/S1 & P/S1/386SX-2121	139.00
92F9894 (4Meg)	P/S1 & P/S1/386SX, Model-2121	189.00
92G7200 (4Meg)	PSI Expert, Consultant, Willow	175.00
92G7201, 73G5311 (4Meg)	Value Point Performance, PC Server 4/66	175.00
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92G7205 (32Meg)	Value Point Performance, PC Server 4/66	1239.00
6450902 (2Meg)	56, 57, 57SX, 90, 95, P-75, 57SLC	90.00
6450128/92G7200 (4Meg)	Value Point 77 486DX2, 486SX, SVR 85 57SX, 90, 95, P-75, 57SLC, 56, 56SLC, P/S1, 386SX, Mod-2122, 2133, 2155, Val Pt 77, 486DX2, 486SX, SVR85	175.00
6450129/92G7428 (8Meg)	Value Point 77 486DX2, 486SX, SVR 85 35SX, 40SX	339.00
6450130/92G7202 (8Meg)	56, 57, 57SX, 90, 95, P-75, 57SLC	339.00
6451158 (4Meg ecc)	Value Point 77 486DX2, 486SX, SVR 85 486, 95XP, 95A (install in pairs)	199.00
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	8Meg Module	116561-001	399.00
	32Meg Module	116568-001	1399.00
DeskPro 386/33L 486/33L	(Exp Bd)	116569-001	279.00
DeskPro 386/25, 386/20	1Meg Module	113131-001	79.00
DeskPro 386S-16MHz	4Meg Module	113132-001	199.00
	1Meg Exp Bd	113633-001	149.00
	4Meg Exp Bd	113634-001	279.00
	1Meg Module	113646-001	79.00
	4Meg Module	112534-001	199.00
DeskPro 386/20E	1Meg Exp Bd	113644-001	149.00
DeskPro 386/25E	4Meg Exp Bd	113645-001	279.00
	1Meg Module	113131-001	79.00
DeskPro 286N, 386N, 386SX20, all "M" series, system LT series, all "T" series	4Meg Module	113132-001	199.00
	1Meg Module	118688-001	99.00
	2Meg Module	118689-001	89.00
	4Meg Module	118690-001	199.00
	8Meg Module	128877-001	339.00
M Series Exp Bd	0-64Meg	129160-001	189.00
DeskPro 386/16	1Meg Kit	108071-001	99.00
	4Meg Kit	108072-001	299.00
	1-2Meg Exp Bd	108089-001	239.00
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DeskPro 286	512K Kit	113012-001	49.00
DeskPro 5/66, 5/66M, 5/66M ALL OF THESE MACHINES	2Meg Kit	149911-001	389.00
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	16Meg	149320-001	599.00
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LTE/386S/20	4Meg Module	121125-002	209.00
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LTE LITE/20, 25, 25C	8Meg Module	129769-003	409.00
LTE LITE/20, 25, 25C	16Meg Module	129769-004	809.00
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LTE LITE 425C/33C/25E/25L	8Meg Module	142337-003	349.00
LTE LITE 425C/33C/25E/25L	16Meg Module	142337-004	718.00
SLT/286	4Meg Module	110237-001	199.00
SLT/386	2Meg Module	118304-001	109.00
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	4Meg	139498-001	189.00
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Contura 400	4Meg/8Meg/16Meg		239/389/719
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T2000SX/T1000LE	4Meg	PC-PA8314U	189.00
T2000SX/T1000LE	8Meg	PC14-PA8315U	359.00
T2000SXE/T2200SX/T1800, 1850, C	2Meg	PC-PA2000U	89.00
T2000SXE/T2200SX/T1800, 1850, C	4Meg	PC-PA2001U	189.00
T2000SXE/T2200SX/T1800, 1850, C	8Meg	PC-PA2002U	359.00
T4400SX, EXC 1840, 1960	2Meg	PC-PA2004U	189.00
T4400SX, EXC 1840, 1960	4Meg	PC-PA2005U	359.00
T4400SX, EXC 1840, 1960	8Meg	PC-PA2010U	699.00
T4500, C 1900, 1905, 1960, C 1910, T1950 (3.3 V)	2Meg	PC-PA2012U	99.00
T4500, C 1900, 1905, 1960, C 1910, T1950 (3.3 V)	4Meg	PC-PA2013U	379.00
T4500, C 1900, 1905, 1960, C 1910, T1950 (3.3 V)	16Meg	PC-PA2014U	769.00
T3300SL	4Meg	PC-PA2008U	268.00
T3300SL	16Meg	PC-PA2009U	699.00
T3400CT, T2400, T3600	4Meg	PC-PA2019U	194.00
T3400CT, T2400, T3600	8Meg	PC-PA2020U	369.00
T3400CT, T2400, T3600	16Meg	PC-PA2021U	763.00
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T3100	2Meg	PC3-PA7135E	139.00
T3100e	2Meg	PC9-PA8340U	109.00
T3100SX	2Meg	PC15-PA8308U	109.00
T3100SX	4Meg	PC15-PA8310U	189.00
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T3200SX	2Meg	PC12-PA8307U	119.00
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T3200SXC	2Meg	PC19-PA8318U	119.00
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ALR Venture	4Meg	12407980	249.00
AST Ascentia 900R, 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	259.00
AST Power Exec 375C, 425EL, 425SL	4Meg/16Meg	501166-001, -003	199/899
AST Power Exec 4/33SL	4Meg/16Meg	501318-001,002	194/799
AT&T Safari 6312/20	4Meg	PC-37951	259.00
Brother HL-8300 831, 841, 845		23050-08100	109.00
Bondwell B310V, SX	1Meg		CALL
Bondwell B310V, SX	4Meg		109.00
Bondwell B310V, SX	8Meg		199.00
Brother HL-8300 831, 841, 845			CALL
Canon Innova 486	2Meg/4Meg/8Meg		109/209/449
Canon Innova 486-10	4Meg/16Meg		169/839
Canon Notepad 486	4Meg/16Meg		199/899
Dell Latitude	4Meg/16Meg		199/749
Epson Action Note 700	4Meg/16Meg		199/699
Epson N83	4Meg	A808511	199.00
Everex Tempo LX, LX20, Carrier	2Meg	PCA 00053-0001	100.00
Gateway 2000 Colorbook 4/33	4Meg/16Meg		199/679
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Goldstar GS386 386SX/16	4Meg	S386-4M	249.00
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NEC Ultralite Versa, E, V	4 Meg/8Meg/16Meg/20Meg	OP4104	183/339/739/819
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NEC Versa	4Meg/16Meg		229/899/799
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Packard Bell Statesman	2Meg/8Meg		119/389
Panasonic CF-370, CF270, CF370	4Meg	CF-BA165	59.00
Panasonic CF380, CF480	2Meg/4Meg/8Meg		119/199/309
Panasonic CF-V210F, CF-580	4Meg/16Meg		219/819
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Sharp 8150, 8650, 8660, 7700, 7760	4Meg/16Meg		199/879
Sharp PC-3620	1Meg	CE-161B	79.00
Tandon, PCTarga, Datarworld	2Meg	NB386SX/20	119/249
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4MB 6450128	$169	8MB 6450130	$356

PS/2 35SX; LS, 40SX, PS/Valuepoint

8MB	6450129		$356

IBM, continued

PS/2 80-A21; A31; A16

4MB	6451060		$193

Expansion boards for PS/2 80286 based models

4-16MB w/4MB	6450609 (use 72-pin)		$299

Expansion boards for PS/2 80386 based models

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NEC

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Ready 425, 433

4MB n/a	$148	16MB n/a	$559

PowerMate 386SX/20i; vi: 16i; 25i, 486/50i; 33i

8MB	OP-410-2101		$304

PowerMate SX Plus

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HP Laserjet IIIsi, 4, 4M, 4Si, 4SiMX, XL300, Deskjet 1200c

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4MB C2065A	$174	8MB C2066A	$339

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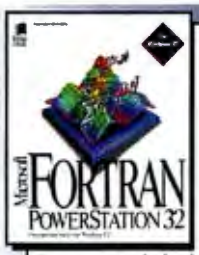

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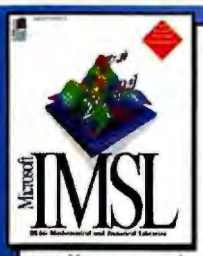

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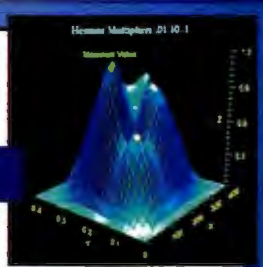

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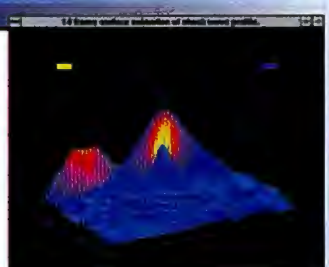

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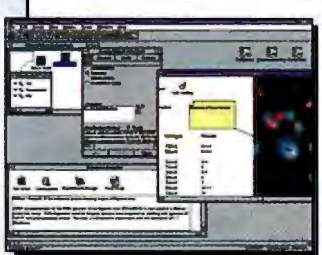

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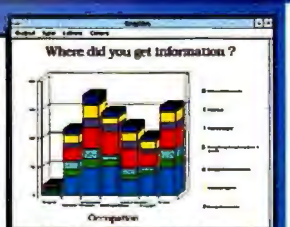

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CFA540A	540MB	12MS	IDE	$268
CFA810	810MB	12MS	IDE	$498
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80387-SX33	$64	80287-XL	$48
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80486 DX/25	$138	80486 DX4/75	$518
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386DX 16 & 20 (XD)	IT SXL2-20/40 MHZ	$248
386DX-25 MHZ (XD)	IT SXL2-25/50 MHZ	$318
386DX-33 MHZ (XD)	IBM B. LIGHTNING-33/66	$478
386SX-16 MHZ (XD)	IBM B. LIGHTNING-16/48	$418
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256 X 1	$1.85	$2.40	$3.00	$3.15	$3.20
256 X 4		$5.45	$5.95	$6.45	$6.95
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	8MB	N/A	$328
AMBRA Enterprise 486, Hurdle 486, Sprinta 486 (all models)	4MB	N/A	$178
	16MB	N/A	$648
PS/1 and 386/SX (2121)	2MB	92F9935	$88
	4MB	92F9694	$178
PS/2 30/286;25/286; Adpt Brd 1497259	512K	30F5348	$35
	2MB	30F5360	$88
PS/2 35SX, LS, 40SX,70-E61; 061; 121, Adpt brd 6450609; 34F3011, 34F3077, 502, 55SX, 65SX, P70, 55LS, 65LS X Station 120 & 130	1MB	6450603	$39
	2MB	6450604	$84
PS2 50, 502, 55SX, 60, 65SX	2-8MB	1497259	$198
	2-16MB	6450609	$368
PS/1 Consultant, Essentials & Expert models x43, x44 & PS/Valuepoint all models except Cxx series	2MB	94F9290	$174
	4MB	94F9291	$298
PS/2 70-A21, A61; 821, 861, PS/1 Consultant, Essential & Expert models x11, x13 & x14, PS/Valuepoint Cxx series	1MB	6450602	$39
	2MB	6450608	$89
PS/2 55SX, LS, 40SX, 555X, LS, 65SX,	4MB	34F2933	$168
PS/2 90 XP, 95 XP, P75 (Palm), 56 57 (all) 76, 77, PS/1 Pro 2123	2MB	6450907	$86
PS2 90, 95 XP, P75 (Palm) 56, 57, (all) PS/1 Pro 2133, RS/6000	4MB	6450128	$174
	8MB	6450130	$338
PS/2 55SX, LS, 40SX	8MB	6450129	$338
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PS/2 80-A21, A31; A61	4MB	6451060	$188
PS/2 80-041	1MB	6450375	$78
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	8MB	33G9289	$368
Thinkpad 350, 350C, 360, PS/NOTE	8MB	6060378	$338
	16MB	6060379	$647
Thinkpad 500, 510C3, 2618	4MB	8189098	$198
	8MB	8189099	$388
	16MB		$648
CL57SX	4MB	07G1420	$308
Thinkpad 700, 700C, 720, 720C, 750C	8MB	07G1421	$378
	16MB	6665109	$898
Thinkpad 710T	4MB	N/A	$188
	8MB	N/A	$318
PS/Note N45SL	2MB	92F8804	$108
PS/2, N51, SLC, SX	2MB	07G1826	$98
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	8MB	07G1828	$418
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T2000SX/T1000 LE	4MB	PA8314U	$188
	8MB	PA8315U	$358
T1200 XE	2MB	PA8306U	$98
T1600	2MB	PA8302U	$98
T2000 SXE/T2200SX/T1800 T1850, C	2MB	PA2000U	$78
	4MB	PA2001U	$188
	8MB	PA2002U	$358
T2400	4MB		$198
	8MB		$398
T3100	2MB	PA7135E	$138
T3100 E	2MB	PA8341U	$108
T2100 SX	2MB	PA8308U	$108
	4MB	PA8310U	$188
T3200 SX	2MB	PA8307U	$118
	4MB	PA8309U	$198
T2200 SXC	2MB	PA8318U	$108
	4MB	PA8319U	$198
T2200	3MB	PA7137U	$184
T3300SL	4MB	PA2006U	$118
	4MB	PA2007U	$238
	6MB	PA2008U	$258
	16MB	PA2009U	$698
T3400CT	4MB	PA2019V	$198
	8MB	PA2020V	$399
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	4MB	PA2004U	$198
	8MB	PA2005U	$358
	16MB	PA2010U	$698
	32MB		$1,548
T4500, T4600, T1900C	4MB	PA2012U	$198
(3.3VOLTS) T4700	8MB	PA2013U	$388
	16MB	PA2014U	$858
T5100	2MB	PA8301U	$94
T5200/T5200C/T8500/T5400	4MB	PA8304U	$179
	8MB	PA8313U	$418

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	8MB	50119-002	$358
	16MB	50119-003	$708
ADVANTAGE 386SX/20;25, PRO SX/25			
BRAVO 3/375	2MB	500962-001	$88
	4MB	500962-002	$168
BRAVO NB4N	4MB		$198
	16MB		$798
ADVANTAGE PRO 486DX/33,SX/25, BRAVO LC 4/25S; 33; 25S; 33S; 4/66D	2MB	500987-001	$88
	4MB	500987-002	$168
	16MB	500987-004	$578
PREMIUM 386/25, 33, 25T II 386SX/16,20,25	1MB	500780-003	$48
	1MB	500780-002	$48
ADVANTAGE 486/25, 33,33P,SX20, BRDVO 4/33, 486/25; PREMIUM 4/25, 25TE, SE 4/33	2MB	500718-004	$68
	2MB	500780-005	$68
ADVANTAGE 486/25,33,33P,SX20,POWER PREMIUM 3/33,4 25, 33S, 500,660; PREMIUM 386/25TE, 486/25,E; 25TE; 33, 33TE, PREMIUM II 386/25, 33, 486/33, 486SX/20			
PREMIUM SERVER SE 4/33	4MB	500780-004	$178
	8MB	500780-001	$348
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POWER-EXEC 3/25SL, 3/25SL-C,TL	4MB		$178
	16MB		$768
POWER-EXEC 4/25SL	4MB		$178
	16MB		$768
PREMIUM EXEC 386,386SX/20,25,25C	4MB		$148
BRAVO NB4Be	4MB		$198
	16MB		$818
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	8MB		$398

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	4MB	113122-001	$188
Deskpro 386S	4MB Board	113634-001	$254
	4MB Module	112534-001	$188
Deskpro 386 20E, 25E	4MB	113645-001	$238
Deskpro 386/33/33L 486/25; 33L,50L Systempro	2MB	115144-001	$108
	8MB	116561-001	$378
	32MB	116568-001	$1458
Systempro; Deskpro 6 SKT EXP BRD W/2MB		116569-001	$268
Compaq "M"	2-64MB	129160-001	$188
Deskpro 286N, 386N; 386SX/20, 20N, Portable 486c, Deskpro M, Systempro LT Series 129160-001, Pro Signia	1MB	118688-001	$49
	2MB	118689-001	$84
	4MB	118690-001	$168
	8MB	128877-001	$348
Prolina 3/25 & 25Z	2MB	141738-001	$88
	8MB	141740-001	$318
Prolina 4/25s, 4/33, 4/50	2MB Module	141683-001	$94
	4MB Module	141684-001	$178
	8MB Module	141685-001	$338
Compaq Pro Signia	16MB	149320-001	$684
	32MB	149147-001	$1524
DeskPro 5/60, 5/66M	8MB	149911-001	$388
Prosignia PC Server, 486/33/66	8MB	141685-001	$348
	16MB	149320-001	$648
Prosignia 5/60	32MB	149147-001	$1498
Proliant 1000 5/60	16MB	149949-001	$698
Proliant 1000 4/50, 5/66	32MB	149912-001	$1398
Proliant 2000 4/50, 5/66	64MB	149913-001	$2698
Proliant 4000 4/50, 5/66	128MB	149914-001	$5600

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Concerto 486	4MB $188	16MB $698	
Contura 320, 325, C	2MB	139497-001	$98
	4MB	139498-001	$174
	8MB	139499-001	$318
Contura 4/25CX	4MB	146520-001	$178
	8MB	146521-001	$338
	16MB	146532-001	$718
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	2MB	110237-001	$218
SLT386	1MB	118303-001	$79
	2MB	118304-001	$108
	4MB	118305-001	$198
Lte 286	1MB	117081-001	$79
	2MB	117081-002	$99
	4MB	117081-004	$178
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	4MB	121125-002	$208
Lte Lite/20, 25, 25C	2MB	129769-001	$138
	4MB	129769-002	$208
	8MB	129769-003	$388
	16MB	129769-004	$808
LTE Lite 486/25C	4MB	142337-002	$178
	8MB	142337-003	$348
	16MB	142337-004	$718
Aero 3.3volt	4MB	190532-001	$188
	8MB	190597-001	$358

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	4MB Mod	FR-PCM-BB	$298
	8MB Mod	FR-PCM-BD	$498
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Epson NB SL/	2MB Mod	AB08771	$168
EPSON 25C Notebook	4MB Mod	AB08781	$228
Everex Tempo LX, LX20	2MB	00160	$98
Everex Corner	2MB	00263-00	$108
Gateway 2000 Nomad 425 DXL/SXL	4MB		$188
	16MB		$1,475
Gateway 2000 486	4MB		$188
	16MB		$781
Grid 1500	4MB	52587	$238
Grid 1450SX	2MB	6200203	$148
Goldstar GS520, 386SX16	4MB	N/A	$98
	4MB	N/A	$298
NCR 3120 Notebook	4MB Mod	3120-K104	$299
NCR 3170 Notebook	4MB Mod	3123-K104	$399
Packard Bell, Magnavox, Mitsuba	1MB	N/A	$108
	4MB	N/A	$198
Panasonic CF170/270/370	1MB	CF-BA163	$64
Samsung Notemaster 386S	2MB	SNM002	$195
	8MB	SNM004	$395
Sanyo 17NB, 18NB & ZEOS	2MB	MBC-NBMEM2	$98
Sharp 6220	1MB	CE-6218	$78
Sharp 6640,6781,6681,6785	4MB	N/A	$198
Sharp 4700MZ-200	1MB	CE-471	$198
Sharp 8501 Colonial	2MB	N/A	$398
TI Travelmate 2000	1MB	2568034-0011	$78
TI Travelmate 3000SX, WINSX	2MB	2566996-0001	$84
TI Travelmate 4000, WINSX/25 SX/16, SX25, DX2/40	4MB	2581265-001	$188
DX2/50	16MB	AVAILABLE	$1298

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Epson Action Laser II, 8000	$88		$198		$268	
Epson + 6000 and many more	$128		$196			
Epson Action Laser 1000 & 1500	$98		$188			$399
Fujitsu 7100 & 7200	$199		$279			
HP Deskjet 500, 500C, 510, 550C and 560	$38 (256K)					
HP 2, 2D,	$98		$164			
HP 3, 3D, 3P, 29, 29+	$98		$168			
HP Laser Jet 4, 5SI, IIL300, 1200C	$84		$168			$318
IBM Laser 4019, 4019E (3.5MB)	$114		$164			
IBM Laser 4029 ALL MODELS	$95		$155			
NEC 90, 290	$104					
NEC 95	$88					
OKI 400	$68	$88				
Packard Bell PB9500	$125		$208			
Panasonic 4410/4430	$118		$174			
Panasonic 4420/4430	$118		$178			
Panasonic 4450	$98					
Panasonic 4400/5400	$90		$129			
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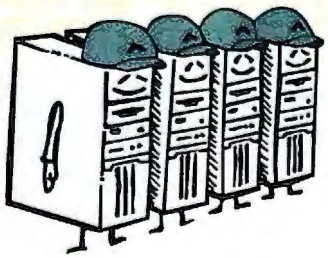

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2420	425MB	12MS	3.5" IDE	190
2540	540MB	12MS	3.5" IDE	235
2700	730MB	10MS	3.5" IDE	305
AC31000	1Gig	10MS	3.5" IDE	459

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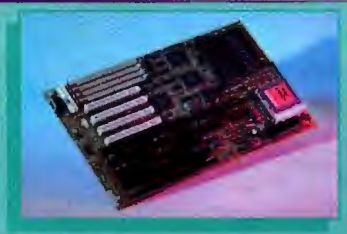

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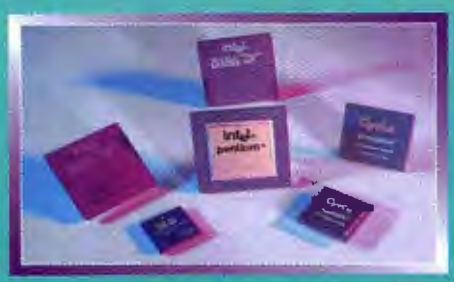

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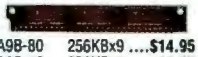

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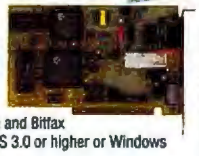

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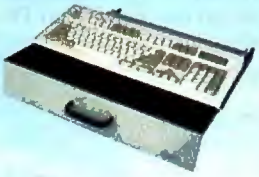

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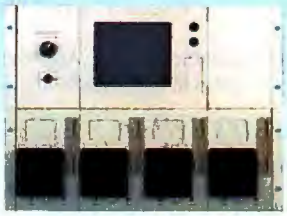

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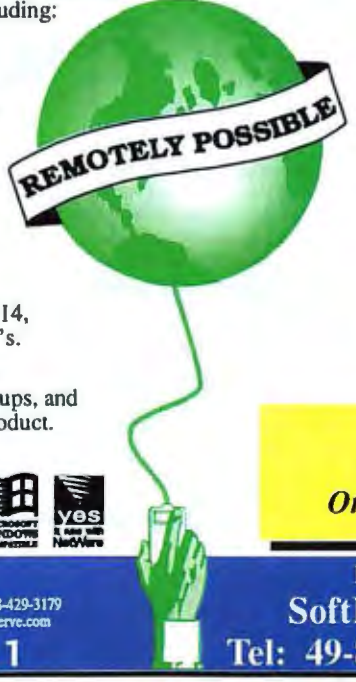

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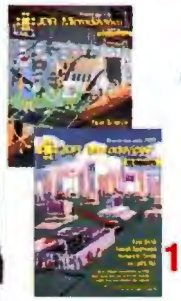

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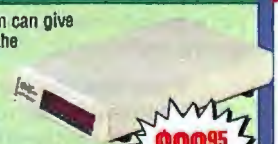

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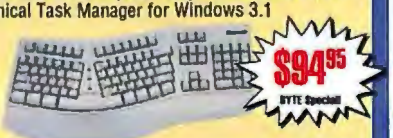

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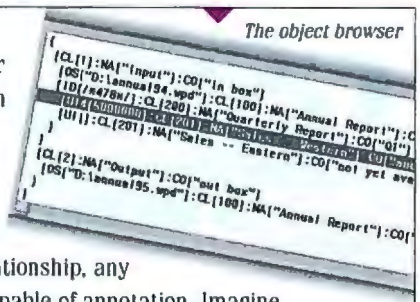

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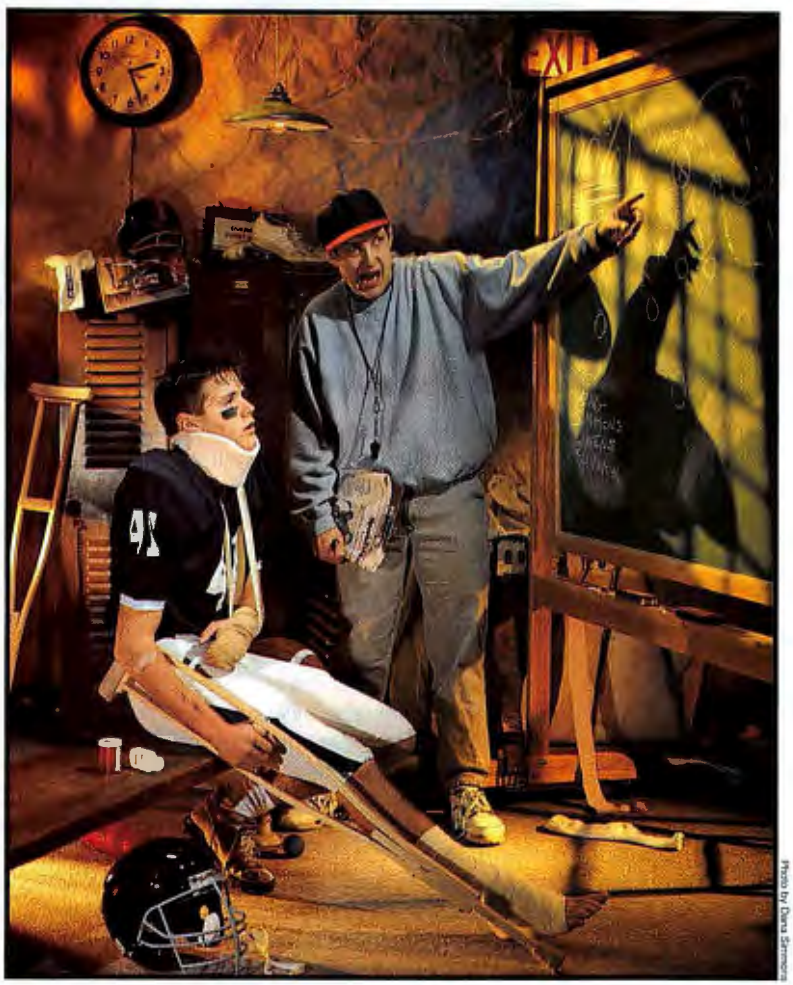

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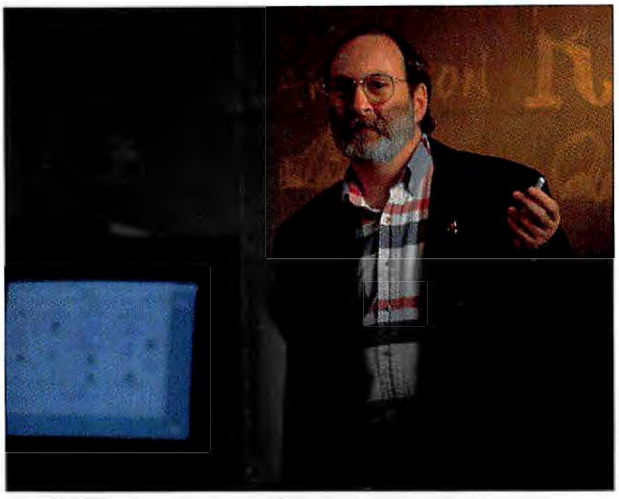
Needed: A GUI Revolution

Users of the world unite! It's time to overthrow the GUI status quo.



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History tells us that revolutions don't always result in a better lot for the masses. New regimes frequently become as unresponsive and entrenched as the ones they displace.

Take the revolution in computer interface design. Roughly 10 years ago, the windowing Xerox/Apple/Microsoft GUI marched into town, smoking a cigar and proclaiming liberation. We peasants were dazzled by the newcomer's shining uniform of pull-down menus and multiple windows—and we needed something to show us the typefaces we wanted to print on our new laser printers—so we welcomed the upstart. We cheered as the old command-line interface hurriedly packed its bags and fled into exile.

Sadly, the new interface soon grew accustomed to the pleasures of the palace. Improvements dwindled. The interface grew spoiled, fat, and irritable.

Today, we await the next round of excess from our master, be it System 8.0 or Cairo or whatever, knowing that we will be forced to pay for any benefits with bushels of memory, CPU speed, and disk space. In return, what will we get? Drag-and-drop icons? Phooey.

I yearn for a new revolution. Self-interest is a factor. I'm getting older. My increasing eyestrain now blurs even 12-point type on a 0.28-dot-pitch monitor. My repetitively stressed fingers and wrists cry out for relief.

In spite of my afflictions, year by year I move more and more of my life onto my machines. I do not think I am atypical. My hard disks have become so crowded with directories and subdirectories that I spend too much time looking for things (as opposed to working with them).

And now that I teach, it's clear from the reactions of my students that interfaces are not obvious. Why does the Mac Trashcan erase files but not disks? Why does the Windows Program Manager delete icons without deleting the associated files? What is "the desktop"—is it the screen, a place somewhere between the hard drive and the floppy drive, or a physical desktop? Why do all current interfaces assign primacy to applications when what matters is the work created with them? Isn't calling a letter to your mother a "word processing document" as dumb as calling your house a "hammer building"?

Sure, the past decade has brought significant change to the internal workings of operating systems, but all the advances in multitasking and multimedia have done little to alter the conventional look and feel of interfaces. What I want is change in the *externals*.

I'm not demanding sweeping reform that throws out everything all at once. We could start small and renovate slowly. For starters, there's color. At the moment, it's little more than decoration; all-important menus and dialog boxes are largely black on white. Must we forever cater to the needs of monochrome users? Color systems outsell monochrome systems by an overwhelming majority. Let the monochrome minority suffer.

Why not use color to group files, objects, or commands in a visually informative way? The priority-based color coding in the Mac Finder is only a hint of what could be done. Why not make destructive menu commands (e.g., delete, cut, and clear) flash in red, and commands for creating (e.g., new, open, and record) flash in blue? Why not divide the menu bar or the entire screen into colored regions organized by time or function?

Speaking of menus, why must we continue to put up with pull-down lists? A number of experiments have successfully used circular menus. Users let muscle memory guide their actions as they pull their pointing devices to choices around a circle; this turns out to be faster and easier than reading and selecting from text in a vertical menu. Pen-based systems have suggested all sorts of new menu approaches that are worth reconsidering.

And what of the file cabinet directory metaphor, in which programs and documents are icons or line entries of equal importance? Why not hide the programs altogether? Or let the user group files and programs into project relationships (rather than directory relationships) by freehand drawing with a pointing device?

You know, these suggestions are not radical or even very original. But shouldn't we try new things rather than wallow in the status quo? It's time to whine and demand and invent! And—who knows—maybe someday little more will remain of the faded Xerox/Apple/Microsoft interface than a muddy footprint and a smudge of cigar ash on the palace carpet. ■

Former BYTE editor and columnist Ezra Shapiro teaches journalism at California State University, Northridge, and writes for a variety of computer publications. You can reach him on the Internet at ezra@earthlink.net or on BIX c/o "editors."

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