

DECEMBER 1994



BYTE

THE MAGAZINE OF TECHNOLOGY INTEGRATION

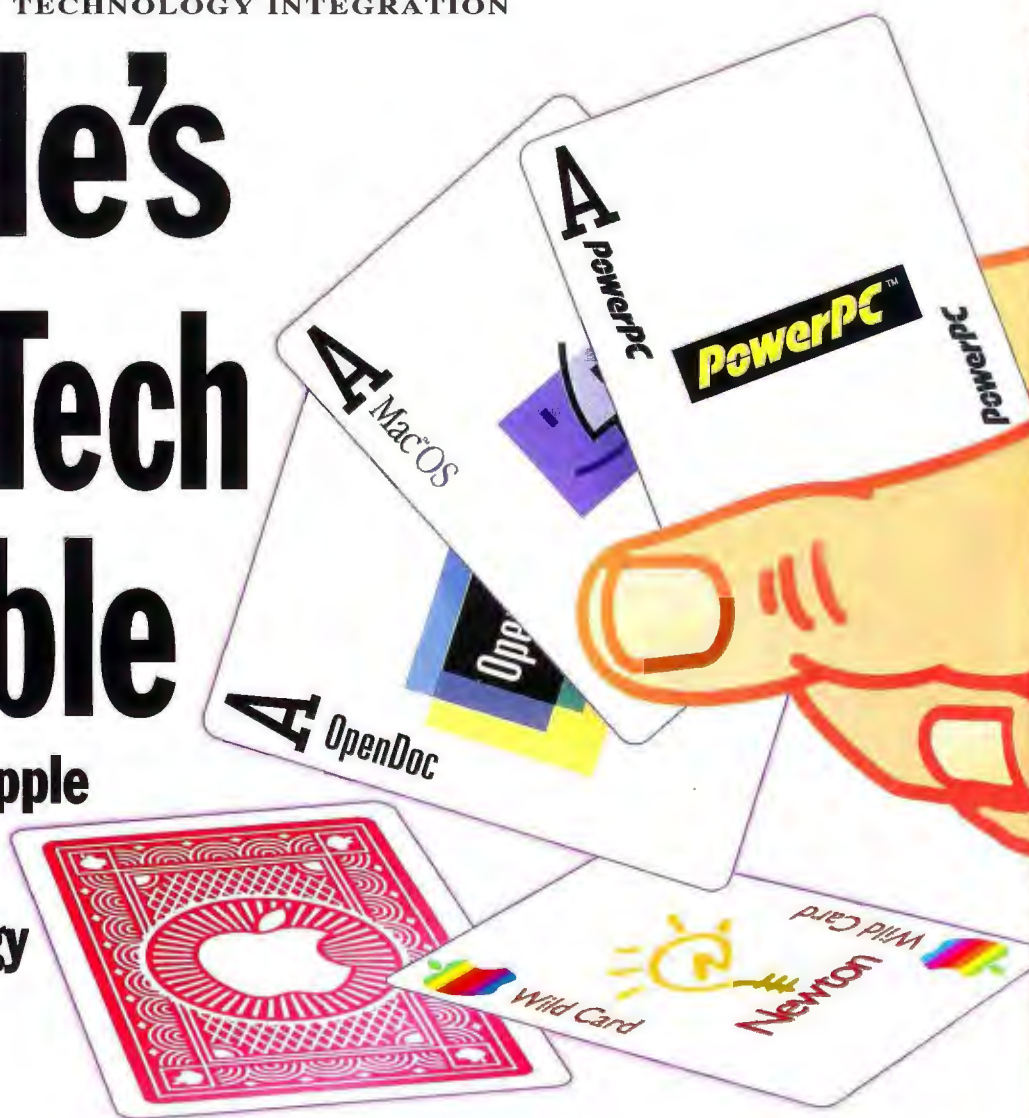
**Reviewed: 4 Peer
Operating Systems**

Great Holiday Gifts PAGE 34

**New Color Laser Printers
from HP, QMS, and Xerox**

Apple's High-Tech Gamble

Once again, Apple
is betting on
new technology
to transform
its future



PLUS

- **How Andersen Consulting Trains Its Staff** PAGE 74
- **(Mis)using Network Bandwidth**



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A McGraw-Hill Publication/0360-5280

So sophisticated, it's simple

Paradox

Paradox for Windows - [WorldOptics Order Entry System]

File Edit View Form Record Properties Tools Window Help

Customer

Contact Name: Loren Niday
 Telephone: +44-71-123456
 Company Name: The Camera Shop

WORLD OPTICS

Order

Order No	Date	Total Amount
2199	1-Jul-94	2,723.00
2286	12-Jul-94	1,235.23
2350	3-Aug-94	1,913.55

Status:
☒ In Stock
☐ Back Ordered
☐ Discontinued

Ship via: Two day
 Ordered by: Telephone
 PO No.: M1209

Camera		
Qty	Unit Price	Total Price
2	1,195.00	2,390.00



Filters		
Qty	Unit Price	Total Price
2	19.00	38.00



Video Camera		
Qty	Unit Price	Total Price
1	1,565.00	1,565.00



Print Invoice Upload Orders

WordPerfect [Paradox For Windows - Paradox 5] - FILTERS.DOC

File Edit View Table Record Properties Window Help

Andrew H. Brown
 Executive Consolidated Enterprises
 12345 East Seventeenth Street
 Santa Ana, CA. 99979

WORLD OPTICS

Dear Mr. Brown

We appreciate your giving our valued customers an opportunity to test your new product. Furthermore, we are very pleased that you will drop ship the filters directly to our customers, thus saving us the shipping and handling.

Here are the names and addresses to that you can fulfill the orders.

CUST	Company Name	Street	City	Postal Code
1	The Camera Shop	123 High Street	London, UK	SW1 1RG
2	Visuals	38, rue du Temple	Pans, France	76004
3	Consignat & Company	Rua Antonio, 187	Sao Paulo, Brazil	13206

Thank you for your cooperation. We look forward to working with you in the future.

Sincerely,

HP LaserJet 450/4500 (Win) August 26, 1994 5:09PM Pg 1 L: 572 P: 152



▲ Paradox for Windows, an integral member of PerfectOffice Professional, has superior integration with suite applications. Thanks to OLE 2.0, you can place any "live" Paradox table directly into a WordPerfect or Word document and edit it in place. (This is not available in Access 2.0.)



February 1994



May 1994



June 1994

◀ With over 20 major industry awards for excellence, Paradox for Windows is the most award-winning Windows database on the market.

OX

NEW VERSION 5.0



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New version is easier than ever

The new Paradox 5.0 for Windows is here, and suddenly managing your business data and building database applications just got faster and easier. You'll be amazed at what you can do with the new tools that let you start fast and do more. For example, 13 new Interactive Coaches quickly teach you how to accomplish any task. The Coaches even let you work with your own "live" data, so you complete your work as you learn. Then there are the on-line Experts™ that guide you step-by-step in creating professional-looking forms, reports, and mailing labels. Even your largest data management tasks will be completed in record time.

Office integration outshines Access

Full client and server support for OLE 2.0 and DDE make Paradox the best database for use with other applications including PerfectOffice and Microsoft Office. For example, you can place a "live" Paradox table in a WordPerfect or Word document, edit the table in place, and your changes are automatically updated. (This is not available in Access.) And Paradox gives you record level locking, that provides enhanced productivity in multiuser environments. (Access locks up your whole page!)

Want to increase your workgroup productivity? Paradox's built-in Workgroup Desktop and new Mail Enablement make it easy to publish and subscribe the latest data, using your existing network or e-mail system. This makes it simple to get weekly or monthly updates like sales and expense information.

Why Paradox beats Access

End-user Features	Paradox 5.0	Access 2.0
Built-in computer-based training	✓	
Experts/Wizards to guide you step-by-step	✓	✓
Integrated graphics	✓	
Built-in workgroup and mail capabilities	✓	
Quick Filter without query process	✓	
Power-user/Developer Features		
OLE 2.0 client and server support	✓	
Compatibility with applications from previous version	✓	
Superior network support	✓	
Transparent connectivity and scalability with database aliases	✓	
Record level locking	✓	
Full range of data types, including Time, Graphic, and Autoincrement	✓	
Graphical Integrated Development Environment (IDE)	✓	
ODBC-compliant	✓	✓
Dedicated high-performance native SQL drivers	✓	

More speed, developer enhancements, and Client/Server connectivity

New Paradox 5.0 for Windows has been tuned to give you better performance. It stores and retrieves data faster, and delivers answers to queries with more speed than ever before.

And Paradox 5.0 for Windows has kept developers in mind too. There's a new Integrated Development Environment and more than 300 new Methods and Properties help you develop ObjectPAL™ for Windows applications faster. Plus, with Borland's new high-performance native SQL links, Paradox is ready when you are to upsize your applications to the Client/Server environment.

Get started fast with Paradox 5.0 for Windows' ease-of-use and you'll quickly discover it's the one database with the depth and performance you want to stay with.

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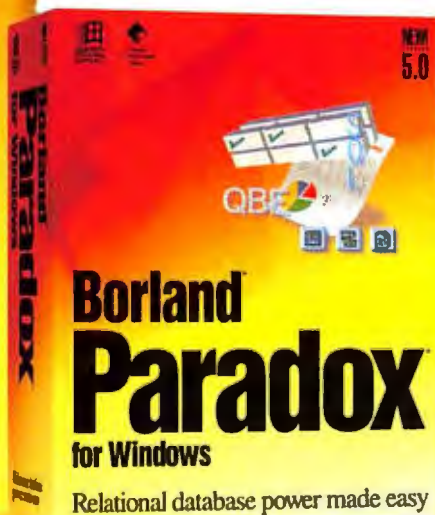
* \$99.⁹⁵ to existing owners of Paradox (DOS or Windows) after \$30.⁰⁰ manufacturer's rebate.

What makes Paradox for Windows the #1 selling database?

(Everyone has their reasons)

“The hands down
best Windows database...
easier than ever.”

—InfoWorld 7/18/94



Users say...

“The ease-of-use is a very key feature with Paradox for Windows.”

—William Vannerson,
Blue Cross of Illinois

“It’s one of the easiest databases, or any other computer product, I’ve ever picked up off the shelf.”

—Timothy Riley,
U.S. Army Corp of Engineers

“There are plenty of new features in Paradox 5.0 for Windows that make it easier for clients to use, and lots of things about it for a developer to love.”

—Greg Salcedo,
Para/Matrix Solutions

“Paradox is the best database on the market.”

—Al Beckett-Lemus, Toyota Motor Sales

“With Paradox 5.0 for Windows, users don’t have to sacrifice performance over ease.”

—Dan Paolini,
DataStar International, Inc.

Reviewers say...

“With (new) Coaches and other ease-of-use features, Paradox’s power can be put to practical purposes more easily than ever before.”

—*Windows Magazine* 9/94

“I found the Experts (in Paradox 5.0 for Windows) more flexible to work with than FoxPro or Access wizards.”

—*Government Computer News* 8/15/94

“A strong choice for standalone or workgroup development.”

—*PC Magazine* 9/13/94

“If you need a powerful interactive database system and application development environment for Windows, then Paradox is an excellent choice.”

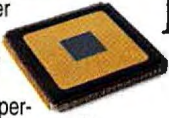
—*DBMS* 1/1/94

“Paradox 5.0 solidifies position as the top Windows database.”

—*InfoWorld* 7/18/94

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like me. I take my risks on the weekend."

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Power Macintosh



Steve Archuleta
Director, Systems for Mass
Markets Service Delivery
USWEST, Phoenix

During the week, Steve manages the systems and processes that support 11 million customers in 14 western states. On weekends, he dotes on his granddaughter, rushes the net on the tennis court and, "when I'm feeling daring," scales the face at local rock climbing havens.

News & Views

MOBILE COMPUTING

New Products Help Road Warriors Stay in Touch26

A new round of telecommunications-savvy products seek to improve the communications of telecommuters and mobile workers.

PERSONAL DIGITAL ASSISTANTS

Sony Releases Magic Cap Device.....27

Sony's new Magic Link PIC-1000 offers a break from traditional computing that at times enables and at other times hinders communications.

LAN MANAGEMENT

Network Management Gets Physical30

To help make management easier for LAN administrators, vendors like NHC Communications are integrating physical network capabilities with their SNMP management programs.

ENTERTAINMENT

Holiday Gift Sampler34

Holiday gift ideas for the BYTE reader include a build-your-own robot kit; cool CD-ROM games for DOS, Mac, and Windows; 3-D graphics/video accelerator cards; screen savers; and a card that brings 3DO games to the PC.

MAPPING

These Maps Lead to the Desktop38

Companies are making their geographic information systems products available for personal computers in increasing numbers.

PERSONAL FINANCE

Electronic Banking Faces Numerous Hurdles40

The merger between Intuit and Microsoft will align two powerful software companies in the personal finance arena. Yet software vendors face numerous hurdles before electronic banking becomes ubiquitous.

NEW PRODUCTS

What's New238

The V41 notebooks travel with multimedia; Personal Archiver manages your hard drive; SpinWizard greases your ride through Windows; and more.

Cover Story

NEW TECHNOLOGIES

Apple's High-Tech Gamble

50

BY TOM R. HALFHILL Apple is betting on three new technologies that it hopes will transform its future. But if Apple guesses wrong, it could finish the decade as a minor player.

Macs in the Enterprise—64

A 110-MHz PowerPC Speed Demon—68



Features

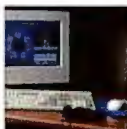
MULTIMEDIA

Solutions Focus: High-Tech Training

74

BY MICKEY WILLIAMSON

Computer-based training keeps employees up to speed.



APPLICATIONS DEVELOPMENT

Write an NT WinSock Service

89

BY CHUCK CHAN, MARGARET K. JOHNSON, KEITH MOORE, AND DAVID TREADWELL
The emerging WinSock standard can make writing networked services for Windows NT more palatable. This hands-on guide answers WinSock design questions.



State of the Art

NETWORKS

Network Management 104

BY RUSSELL KAY

Take a look at how you can sort out the pieces of your network puzzle.



Monitoring Your Net

109

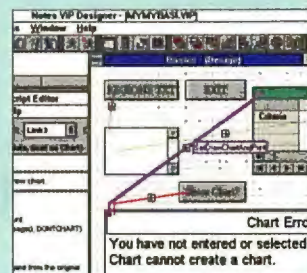
BY PAUL KORZENIOWSKI

You say you don't know what's happening on your network, bucko? What's with every interface card, router, bridge, and hub? Where the bottlenecks and problems are? Here's how to find out.

Reviews



PAGE 138



PAGE 183



PAGE 191



(Mis)using Bandwidth

117

BY BRETT HUSSELBAUGH

Increasing network performance tops almost everyone's wish list. But be careful when deciding to use a more glamorous technology just to gain bandwidth. Other factors may have a greater influence over network performance than bandwidth.

PRINTERS

- Low-Cost Color Lasers** 139
BY TOM THOMPSON New laser models offer color-printing quality and per-page costs competitive with the best ink-jet printers but with laser-printer speed and networking capabilities. Tom Thompson reviews the color lasers from HP, QMS, and Xerox.

PERSONAL DIGITAL ASSISTANTS

- Simonizing the PDA** 145
BY CHRIS O'MALLEY BellSouth's Simon is here. Able to send and receive E-mail, faxes, and pages, it's easily the most communicative PDA to date.

ELECTRONIC FORMS

- Collecting Facts from Fax** 153
BY STAN MIASTKOWSKI The third incarnation of Teleform adds a raft of new features for automatic recognition and data entry of faxed or scanned forms.

INTERFACE ADAPTERS

- SCSI Rides High on PCI** 163
BY STEVE APIKI SCSI host adapters from Adaptec, BusLogic, and Future Domain bridge Fast SCSI-2 to faster PCI. But performance testing under NetWare shows that all PCI SCSI cards are not created equal.

NETWORKING

- Software Roundup: Four Peer Operating Systems** 169
BY BARRY NANCE Peer-to-peer LANs are now better at managing resources, and file integrity will improve as future OS/2- and Windows 95-based systems emerge. Tests of four top players reveal important differences in speed, compatibility, and security.

DEVELOPMENT TOOLS

- Visual Programming for Lotus Notes** 179
BY RICK DOBSON Lotus Notes ViP delivers some essential capabilities sorely lacking in Lotus Notes.

HARD DRIVES

- Speedy Data Delivery** 187
BY STAN MIASTKOWSKI Micropolis's high-capacity AV drives deliver uninterrupted data transfer to match the needs of serious audio and video developers.

90-MHZ PENTIUMS

- Lab Report: 19 Pentiums at 90 MHz** 192
As 90-MHz Pentium systems make their way into the mainstream PC market, vendors are differentiating their wares by providing systems designed for specialized markets. The 19 systems in this lab report represent a mix of market-driven designs.

- High-Performance Pentiums for General Business—194
90-MHz Pentiums as SQL Servers—194
How We Tested—198
Best Pentiums for CAD and Graphics—201
Best Pentiums for Unix—203

- The Dual-Processor Pentium—204
Honorable Mentions—204



Core Technologies

CPUS

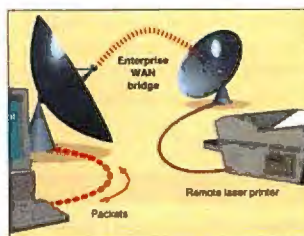
- Pentium Chip's Dual Personality** 211
BY ROELAND VAN KRIEKEN Here's how the P54C supports dual-processor configurations.

OPERATING SYSTEMS

- CTOS Revealed** 213
BY DIRK S. FAEGRE AND JON UDELL CTOS shows the practical business benefits of a microkernel architecture.

PROGRAMMING

- Programming in Tight Spaces** 217
BY RICK GREHAN Programmers for ultrasmall microchip processors must be innovators to survive in a world where every resource is precious.



NETWORKS

- Network Spoofing** 221
BY JEFFREY FRITZ Network protocols constantly exchange management information. LAN users normally don't notice the lost bandwidth, but over a slower WAN connection, it can be significant. Worse, WAN connections are often charged on a usage basis. Spoofing is one technique to reduce network overhead.



- ATM Traffic Control** 129
BY MARK JULIANO How the ATM traffic cops maintain orderly data flow and guarantee service to high-bandwidth applications.

ATM with a French Accent—130

Opinions

- Pournelle: Can You Say Network?** 225
BY JERRY POURNELLE Jerry looks at networking.

- Books and CD-ROMs: Not-So-Successful Reengineering** 45
BY THORNTON MAY AND OTHERS Reengineering, trip-planning CD-ROMs, a multivolume set on BSD Unix, and Unix whiners.

- Commentary: Teach Formal Methods** 292
BY JOHN CUADRADO A look at the development of safety-critical systems.

- Editorial** 10
BY DENNIS ALLEN

- Blasts from the Past** 41
Highlights from two decades of covering the PC revolution.

- Letters** 18
Plug and Play criticism and the OS/2 debate.

- Reader Survey** 234

READER SERVICE

- Editorial Index by Company 290
Alphabetical Index to Advertisers 286
Index to Advertisers by Product Category 288
Inquiry Reply Cards: 144A, 288A

BUYER'S GUIDE

- Mail Order
Hardware/Software Showcase
Buyer's Mart 247

PROGRAM LISTINGS

- From BIX: Join "listings/frombyte94" and select the appropriate subarea (i.e., "dec94").
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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This page presents the articles in this issue according to computing platform.

DOS/WINDOWS

These Maps Lead to the Desktop38

With PC processing power and the demand for demographic data on the rise, mapping programs for desktop computers are increasing in popularity.

Step-by-Step Windows Database Development40

DataBoss, a Windows database applications builder from Kedwell Software, generates C++ source code that you can compile and distribute royalty-free.

Write an NT WinSock Service89

Here are some guidelines for writing WinSock services for Windows NT.

Collecting Facts from Fax...153

Cardiff Software's Teleform for Windows is a powerful forms-processing package for automatically converting customized paper forms to computer data. Version 3.0 adds features, such as toolbars and customizable grids, that make it easier to use than its predecessors. And its character-recognition abilities have been honed to make them impressively fast and accurate.

Four Peer Operating Systems169

Although they are tied to DOS's network-unfriendly file system, four peer-to-peer LAN operating systems offer impressive resource sharing, reliability, and ease of use. Newer operating systems promise better resource management, however.

Visual Programming for Lotus Notes179

Similar in design and ease of use to Microsoft's Visual Basic, Lotus Notes ViP delivers a visual programming environment to Lotus Notes. Applications built with Notes ViP integrate seamlessly with Notes, inheriting all of Notes's rich groupware functionality, including full-text searching, replication, remote access to data, encryption support, and mail-enablement.

Lab Report: 19 Pentiums at 90 MHz192

NSTL tests 19 high-end Pentium systems and ranks them in three categories: General Business (DOS and Windows applications), CAD and Graphics, and Unix to help you select the best Pentium system to fit your needs.

OS/2

Peer into the Future172

The future of peer LANs may rise or fall with the success or failure of OS/2 and Windows 95.

MACINTOSH

Apple's High-Tech Gamble ...50

Apple bets its future on three new technologies: the PowerPC, the Mac OS, and componentware.

Low-Cost Color Lasers139

Tom Thompson reviews new color laser printers from Hewlett-Packard, QMS, and Xerox. For networkable printers with spot-color capability, the new lasers are finally cost-effective. Any company doing heavy-duty color production with lots of jobs and different typefaces should consider the QMS Magicolor because of its SCSI hard drive option and the Crown operating system.

UNIX

Lab Report: 19 Pentiums at 90 MHz192

NSTL tests each of the high-end Pentiums for speed, ease of use, expandability, features, and price to identify the top performers. The Unix tests stress the CPU/cache/memory architecture of the system, evaluating each system as a generalized workstation.

NETWORKS

Network Management Gets Physical.....30

Wireman, a LAN management package that lets administrators manage both the logical and the physical network, is part of a growing trend toward linking logical and physical network management.

Write an NT WinSock Service89

The emerging WinSock standard is becoming a common programming-interface choice for independent software vendors who are porting existing services to Windows NT.

Monitoring Your Net.....109

The shift from proprietary, stand-alone, device-level applications to network management platforms simplifies the task of managing far-flung networks. Here's a look at the three major players in the platform arena: SunNet Manager from SunSoft, OpenView from Hewlett-Packard, and NetView for AIX from IBM.

(Mis)using Bandwidth117

You might be considering increasing your network's bandwidth to increase performance. But factors such as media-access time and average payload size may drown out any increase in bandwidth.

ATM Traffic Control.....129

Looking for ways to increase data flow on your network? You may want to consider an ATM-based network. Here's how it works.

Low-Cost Color Lasers139

Here's a comparison of new color laser printers from Hewlett-Packard, QMS, and Xerox. These printers offer networking and spot-color capabilities at per-page costs that rival the best ink-jet printers.

SCSI Rides High on PCI163

Fast network servers demand fast access to multiple devices in a multitasking environment. PCI SCSI cards from Adaptec, BusLogic, and Future Domain can deliver fast SCSI response. NetWare performance tests provide a point of comparison between these three designs.

Four Peer Operating Systems169

Barry Nance tests four peer-to-peer network operating systems: Artisoft's LANtastic 6.0, Microsoft Windows for Workgroups 3.11, Novell's Personal NetWare 1.0, and Performance Technology's PowerLan 3.11. Here's how the top players measure up.

Network Spoofing.....221

Spoofing is a hot topic in the networking world. It holds the promise of reducing network management overhead, improving bandwidth and reducing costs for WANs. Although it is not without risks, potential alternatives are on the horizon.

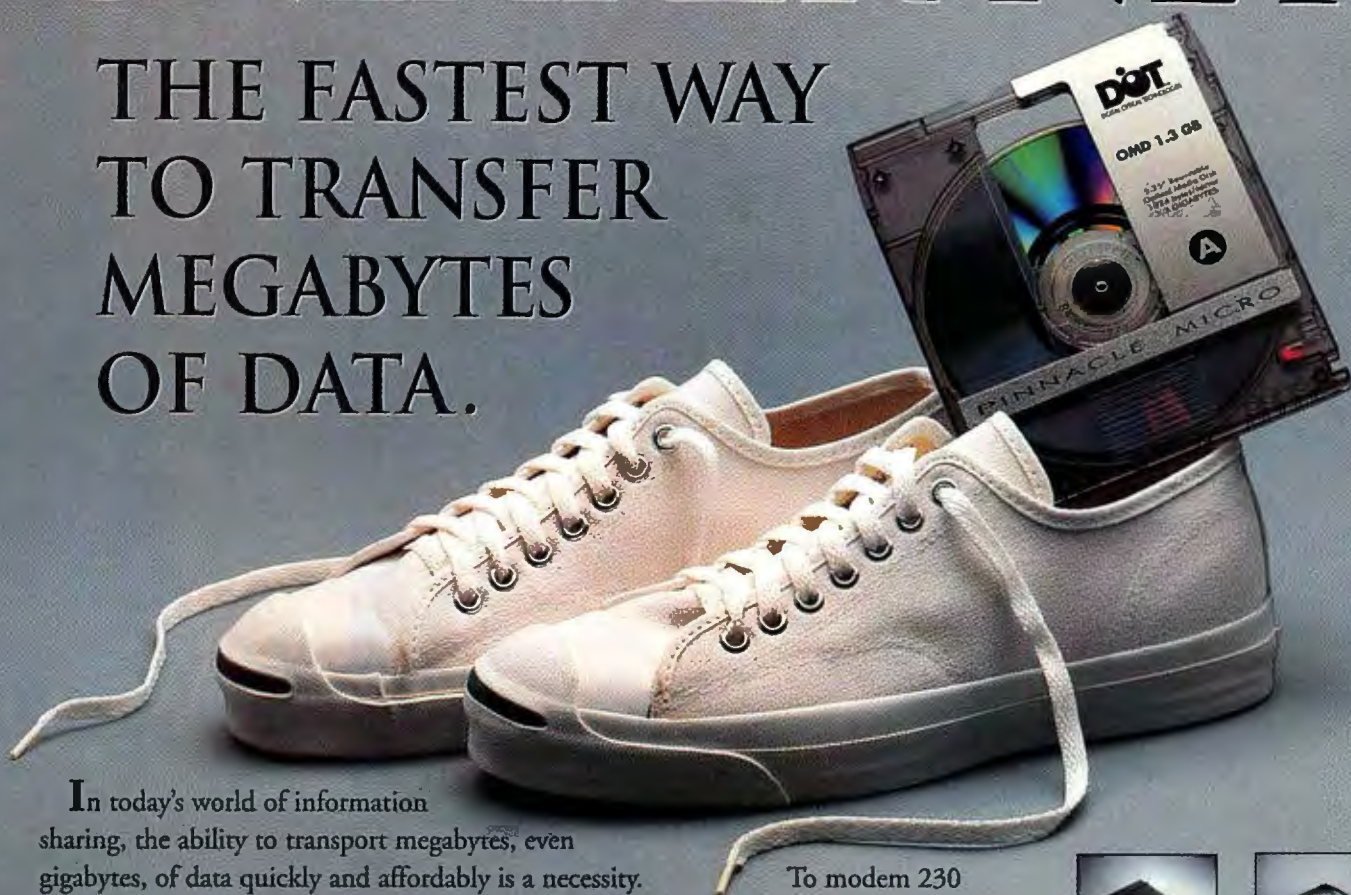
Can You Say Network?225

Jerry discusses various networking strategies.

Audio/video drives	189
Books	45
CAD	201
CD-ROM.....	34, 45
CISC	50
Color	139
Communications.....	26, 145
CPUs	50, 211
Databases	40, 153
Electronic banking.....	40
Entertainment	34
Fax	153
Forms processing.....	153
Graphics.....	201
Macintosh.....	50, 139
Magic Cap	27, 38
Mapping.....	38
Mobile computing	26, 145
Multimedia	74, 189
Networks.....	30, 89, 104, 109, 117, 129, 139, 163, 169, 221
OLE	50
OpenDoc	50
Operating systems.....	50, 89, 169, 213, 225
OS/2.....	172, 225
PCI SCSI adapters	163
PDAs.....	27, 38, 52, 145
Pentium	192, 211
PREP.....	50
Printers.....	139
PowerPC	50
Programming	40, 89, 179, 217
RISC	50
SNMP.....	110
Systems	50, 192
Taligent	50
Tape drives	225
3DO	34
Training	74, 292
Unix	192
WANs.....	221

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Used to be the expression “powerful end-user database” was like “the Long Island Expressway” or “jumbo shrimp.”

A contradiction in terms.

Of course, that was before the introduction of Microsoft Access® relational database system 2.0: the database that's as powerful as it is easy to operate.

Are you a seasoned developer? Or are you working with a database for the first time? As people are discovering, it's no longer an issue. Because with Microsoft Access, routine tasks are automatic. And complex tasks aren't complex at all.

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Have to add a functional button to a form? Use the Command Button Wizard. (Microsoft Access will even write the code for you.) Have to locate some hard-to-find data? Let the Query Wizard hunt it down. Have to set up a mail merge between Microsoft Access and Word? Click on – you guessed it – the Mail Merge Wizard.

What is it that makes this wonderful stuff so easy? Something we call IntelliSense™ technology: a feature unique to the Microsoft® Office family of programs, and one reason why Microsoft Access has garnered

so much critical acclaim.

Suppose you're ready for something more adventurous. Like developing a database application of your own. Microsoft Access can help you do just that. Pose a query and its Rushmore™ query technology will provide an answer – not quickly, but immediately. Revise a piece of data and that revision will be reflected wherever your data is used – automatically. Plus, no matter where your data happens to be stored – Paradox™, Microsoft SQL Server™, you name it – with Microsoft Access you can, well, access it.

As if that weren't enough, even finding a helping hand is pretty easy. Microsoft Access comes with unlimited product support at no service charge.*

It adds up, clearly, to the first database that does everything you want – precisely the way you want to do it. And we find nothing contradictory about that. For the Microsoft retailer nearest you, call (800) 240-4782, Dept. 3HY.



Microsoft Office

Betting on Apple



If Apple's new strategy succeeds, the entire computer industry might also shift

Why are we focusing on Apple in this issue? It's a fair question to ask in that it's unusual for BYTE to single out one company for our cover story. However, Apple is a major player that has represented the alternative to the original IBM/Intel/Microsoft troika, and the challenges Apple faces and the technologies it is embracing will affect the rest of the computer industry.

Apple has held the image of marching to a different technological drummer. It made plug and play for the Mac a reality years ago. And Apple was the first to bring windowing software with a point-and-click feature to the masses. Apple also set the standard for graphical applications such as desktop publishing and design.

Lately though, a lot of folks have wondered if Apple may have lost its steam. Nearly every advantage that Apple enjoyed with the Mac has been rivaled by Windows-based PCs. Of course, 10 years ago, everyone predicted that other computers would catch up to the Mac. What no one predicted was that Apple would not have continued advancing its technology lead.

To be fair, Apple has made substantive advances with the Mac over the years. However, those advances have been small steps, relatively speaking, while the rest of the computer world was taking giant leaps to catch up to the milestones laid by Apple.

So here we are entering the mid-1990s, and Apple is coming out of what some consider a dead-end street created by the complex architecture of the Motorola 68000 CPUs. They were good for their time—and still are for certain applications—but even Motorola acknowledges that it's time for a change to the PowerPC platform.

Also interesting is that to widen its potential market in the mainstream of computing, Apple must surely give up its proprietary approach to the Mac OS. Is it too late to begin licensing it? Apple would have done well to have licensed the Mac OS years ago, when a good many manufacturers were clamoring to make Mac clones. Now, it's not so clear that other manufacturers are as eager to do so.

That could change, though, and here's why. Apple

has committed to moving its design to the PReP (PowerPC Reference Platform) standard. If IBM and Apple succeed in evolving that standard so that any PReP-compliant computer can run the Mac OS, the outlook for Apple begins to look brighter. Because Apple already has a significant following of Mac developers porting their software to run natively on Power Macs, Apple and its operating system could be in the best strategic position for laying claim to the PowerPC systems frontier. That's what makes those secret talks between Apple and IBM so important.

(Let's not even get into the debate about whether PowerPC systems will become a market force. They will. Count on it, take it to the bank, and tell them I said so.)

Also consider what Apple is doing with component software. Instead of working alone to bring componentware to fruition, Apple is deeply involved with OpenDoc. OpenDoc is a nonproprietary standard for component software development, and embracing an open technology that will be the core to developing Mac applications marks a departure from the old way of doing things at Apple.

So why is all this so important? Simple: If Apple, one of the biggest computer manufacturers, succeeds, the whole industry might shift. Specifically, that shift would be away from Microsoft Windows. In reality, it would mean that while millions and millions of systems will run Windows, more and more new systems would be delivered with the Mac OS. Conceivably, the PowerPC system you buy in the future might effectively be a Mac with an IBM moniker.

All this makes me recall that a woman at the Newton announcement last year told me she would buy anything Apple made because it was "such a neat company." Well, emotional charge or not, Apple is entering a new era. Given its pioneering success in shifting platforms (remember the Apple II?), there is good reason to believe that Apple will again succeed. Only time will tell, of course, but as the reporting by Tom R. Halfhill and Tom Thompson in our cover story (see page 50) suggests, it's difficult to find fault with the technology reasoning for which Apple has opted. ■

A stylized, handwritten signature in black ink, likely belonging to Dennis Allen.

DENNIS ALLEN, EDITOR IN CHIEF
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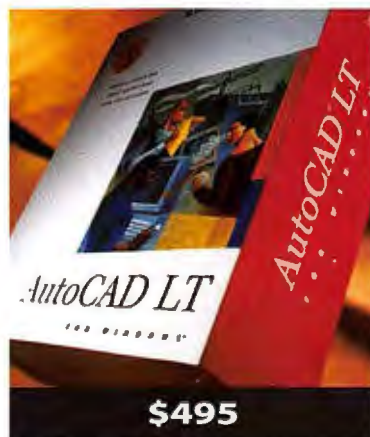
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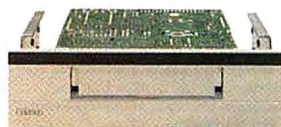
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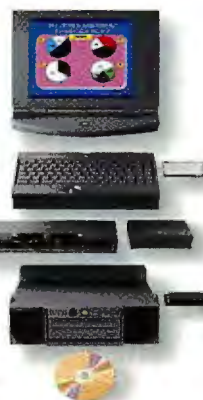
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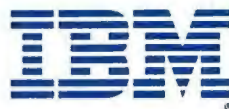
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Poor Standards, Poor Timing

Your September editorial on "Plug and Play" is absolutely correct but about 10 years too late. Your belated recognition of the albatross of PC compatibility is ironic and even hypocritical, because BYTE was in the forefront of those magazines proclaiming "Industry Standards *über alles*" during the formative period of the industry. Never mind that such standards were ill-designed and deficient as a base from which to evolve future computing environments. The situation is somewhat equivalent to that of the QWERTY keyboard, widely acknowledged to be deficient, but so deeply embedded as to be impossible to change. I have this recurring nightmare that on *Star Trek: The Next Generation*, Geordi LaForge has to debug the difficult computer problems with a hexadecimal dump and an x86 code card. But the actual immense costs of deficient embedded standards aren't paid in large amounts at critical times, they're paid in small installments every day.

David A. Bridger
St. Louis, MO

Plug-and-Drive Auto Mechanics

I'd like to back your excellent Plug and Play cover story (September) with an example. Last month, I had to upgrade a 486/66 (with an attached CD-ROM drive, built-in SoundGrabber, and Ethernet) to W4W (Windows For Workgroups). After the pure software installation of W4W, the multimedia capabilities of the 486 were gone, as well as its ability to print through LPT1. After a morning's work, I discovered that W4W needed an IRQ (interrupt request), so it simply took the IRQ of the LPT1. It also needed a DMA buffer, so it seized the DMA buffer of the CD-ROM drive...all without any warning! This inspired me to write the following analogy, a Plug and Play version of an instruction manual for an electric top to a VW bug:

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nator for a more powerful model.

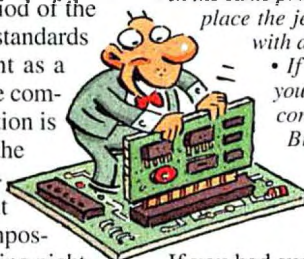
- We suggest you swap the positions of the alternator belt and the air-conditioning system to bring the alternator nearer to the crankcase and reduce wear on the crankshaft, which has only three bearings.

- After that, if your engine is difficult to start, we suggest you change the ignition advance by replacing the 10-microfarad capacitor with a 15-microfarad model.

- In the same process, you will want to replace the jet hose of the carburetor with a larger one.

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Vu Tien Khang,
Khang.VuTien@cgin.fr
Toulouse, France

The Internet and the Promise of Information

I enjoyed Craig Nova's commentary (October). He writes, "I can smell the sweet perfume of (information) paradise." Alas, it's an illusion. There have been regular attempts to provide "universal access to information." I remember when this was the rallying cry in the 1970s for those who wanted to build the ideal MIS, instant answers to all management's questions. In the 1980s, there were a number of ambitious ventures to furnish a universal front end to different database services. Currently, we have the Internet and the promise of information paradise. It's not likely to happen in the 1990s, because data is for the most part uninteresting. We want information—answers to questions that interest us. And that's the key to the difference between data and information: Information is data provided as a response to particular questions. This question of shifting frames of reference was the reason no one delivered real MIS in the 1970s, and it will be the reason the perfume you think you smell will prove to be an illusion.

Bob Fabian,
rfabian@interlog.com
Toronto, Ontario, Canada

As with Craig Nova, I also recognized the Internet as a somewhat magical medium, like a purse that will produce a hundred gold pieces for every piece put in. After investigation, the reality seems more like a hefty garbage bag that needs to be carefully sifted through to find anything of value. The cliché "garbage in, garbage out" applies to the Internet. As the Internet gains popularity, there will be more and more worthless information, with the occasional bit of gold to tempt us further in. The Internet is a reflection of the people who contribute to it. I hope that those who use it will be careful about what they contribute, so the reflection won't scare us into imposing senseless rules and regulations.

David Miller,
dzm@cvsd.cv.com

I was charmed by Craig Nova's October commentary. People are slowly beginning to realize that being computer-literate and being just literate are not inconsistent, and I thank you for helping to bring that about.

André Vellino,
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Ottawa, Ontario, Canada

Strategy in Standards

Jon Udell makes some interesting points in his article "Why IBM Should License Win32" (September). However, I cannot agree with his conclusions. IBM's licensing of the Win32 API would secure its place as the standard desktop API. Win32s support is not currently part of OS/2—not because IBM doesn't know how, but because IBM is delaying a wholesale move to the Win32 API. If Win32 becomes the standard API while ownership remains with Microsoft, Microsoft will continue to evolve it to conform to the company's view.

Many would like to see Microsoft transfer ownership of Win32 to an industry-standards body, where it could continue to evolve, nourished by the joint efforts of the entire industry. Some control of the Win32 API may be wrested from Microsoft if the development of Win32 API emulators, such as those from Sun Microsystems,



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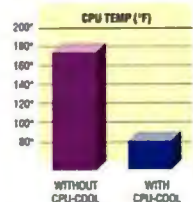
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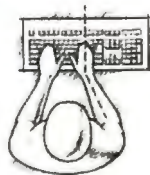


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sloping keyboard that fits more closely to the natural positions of your hands and wrists. And one that is more comfortable, if a bit odd-looking.

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The Microsoft Natural Keyboard fits you, not the other way around.

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there. So we gave the keys a nice, soft touch and feel.

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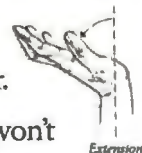
keys, a simple keyboard manager and mouse cursor accelerators.

Suffice it to say, it's like nothing you've ever gotten your hands on.

To experience the Microsoft Natural Keyboard for yourself, simply pay a visit to your

local computer retailer. And slip one on. You won't believe how comfortable it feels.

And you won't even have to wait for a dressing room.



Microsoft

is successful. Then there will be two routes to Win32, license the real thing from Microsoft or the emulation technology.

IBM has a strategic interest in many of the new microkernel-based operating systems and RISC-based processors. The success of any of these will have an impact on the relative value of the Win32 API. Now is hardly the time for IBM to yield total control of the desktop to Microsoft.

Steve Brewin
Winchester, Hampshire, U.K.

In the three years that I have been buying BYTE, never have I seen such utter nonsense as Jon Udell's commentary (September). He assumes that Win32 is going to be an instant success with the release of Windows 95, just because Win16 has such an enormous user base. But this didn't happen with Windows NT, and Windows 95 is reportedly not nearly as good as OS/2. Microsoft has even stated its intention to *not* multithread the first entries in the Win32 market. The fact is that there are more PM (Presentation Manager) applications than there are Win32 applications.

Udell still doesn't seem to realize that the Windows support in OS/2 is a stop-gap measure to let people keep using their software. When their old software is written off, there's no reason to buy a Win32 application over a PM application.

Illya Vaes,
ivaes@ib.ns.nl
Utrecht, The Netherlands

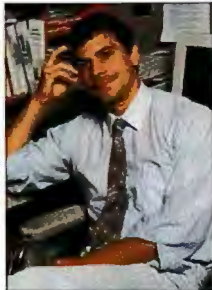
Software Tools for Embedded Processors

I was interested in your article comparing families of embedded microprocessors ("Processors Proliferate," September). Despite the vast differences in internal architecture between each family, the required external functionality of ports, timers, RAM, and program memory area are similar. The introduction of high-level language tools for these embedded microprocessors has let designers develop products that can use any one of the three families. This technology has reduced the concerns of availability and second source for silicon. Byte Craft has been developing software tools for these processor families for several years.

Walter Banks,
President, Byte Craft, Ltd.
Waterloo, Ontario, Canada

Computer Telephony

I really enjoyed Jon Udell's article "Computer Telephony" (July). However, based on my experience, I think it is about 50 years ahead of its time. I have been trying to locate a hardware/software combination that will cause a screen pop-up identifying which line is ringing on our phones. This is necessary to assist a blind employee in answering our 30 discrete-line phones. The advice I received from an AT&T GIS technician was to install an ISDN board in the computer. I contacted about 45 computer vendors, none of whom had any idea what an ISDN board was. I tried working



with Ameritech, but its solution would have cost \$210,000, way outside our price range. A call to Northern Telecom was equally unproductive. Do you have any sources that may help me finally resolve this problem?

Bruce L. Brown,
brubro@aol.com

I hope it's not 50 years ahead of our time! Anyway, I sympathize with your problem and with your frustrating encounters thus far. I don't have an answer at the tip of my tongue, but maybe our readers will see this and respond.

—J. Udell

IBM was noticeably absent from your July cover story on computer telephony, even though the company has over 40 percent of the market share in this arena. Customers

have told us that our CTI (computer telephony integrated) products, CallPath and DirectTalk, have helped them greatly improve customer service and reduce their costs of doing business. Also, analysts have told us that our CTI and interactive voice-response solutions are unmatched by any other vendor in this marketplace. Not including IBM in this article is like leaving out General Motors when discussing cars.

Stephen S. Cawn,
Marketing Manager, CallPath, IBM
Research Triangle Park, NC

FIXES

In the review "Due Recognition for OCR" (October), we did not enable the enhanced fax recognition feature for Xerox Textbridge 2.0. With the feature enabled, Textbridge achieved an 86 percent recognition rate on our fax test, up from 78 percent. In fact, by adjusting the scanner's brightness (we ran all tests with the scanner's default settings), the fax score rose to 96 percent accuracy.

In the July software roundup "Network Management Systems," Frye Utilities, LANdesk Manager, LANLord, and Brightwork Utilities support HP's OpenView.

In our August issue (page 48), the phone number listed for Kurzweil Applied Intelligence is actually the company's fax number. The correct phone number is (617) 893-5151. ■

COMING UP IN JANUARY

• PRESENTATION GRAPHICS PROGRAMS

An excellent presentation leads to an excellent first impression. We test the major presentation packages for Windows, delving into the sophistication of their charts, sound, video, and animation, as well as the degree of user interaction.

• 62 MONITORS

Using both hardware and software test equipment, we evaluate a mix of 17-, 20-, and 21-inch monitors to discover which have the sharpest, clearest, and consistent displays with the most sensible controls.

• SOLUTIONS FOCUS: A CUSTOMIZED PORTABLE

Apple is repositioning the Newton as a hand-held device for vertical market applications. One of the first examples is a joint development with the Dracon division of Harris to create ruggedized terminals for phone-repair technicians. Read how and why Dracon chose the Newton, and how the device has been retrofitted for this use.

• AWARDS OF EXCELLENCE

After a year of hands-on experience, BYTE editors choose the products they like best.

• QUADRUPLE-SPEED CD-ROM DRIVES

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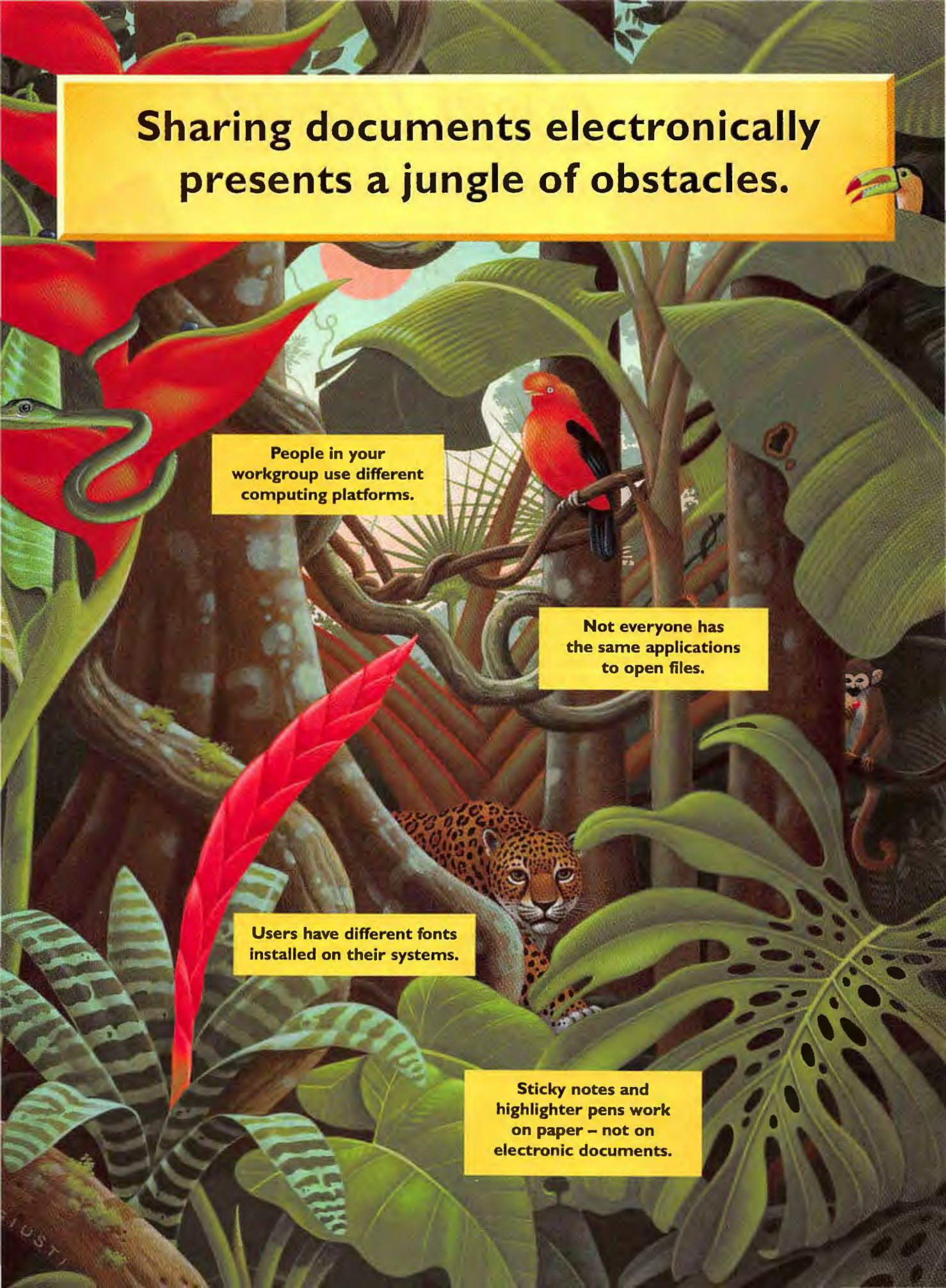


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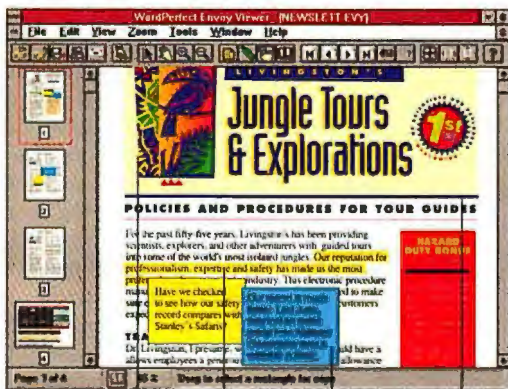
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Envoy portable documents can include both vector and bitmapped graphics.

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News & Views

MOBILE COMPUTING

New Products Help Road Warriors Stay in Touch

A new group of communications products seek to improve the efficiency of telecommuters and mobile workers

DAVE ANDREWS

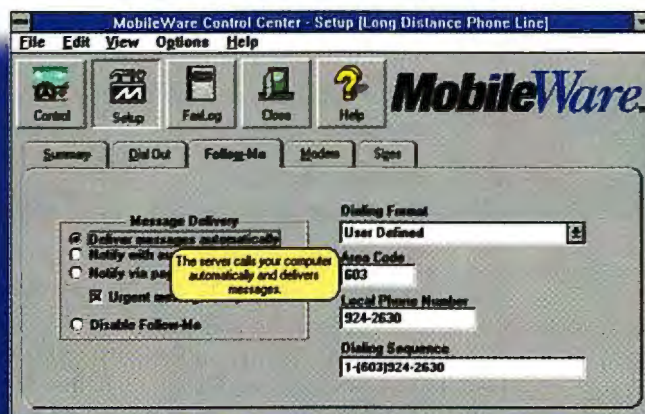
Whether it's voice-mail tag, busy fax machines, or E-mail overload, telecommuters and mobile workers must overcome many hurdles when trying to stay in touch with the main office. Telecommuting professionals must respond quickly to critical business communications or risk lost opportunities. A new wave of products—some complement existing messaging technologies such as E-mail and voice mail, and others ambitiously exploit emerging technologies, like voice recognition—can make it easier for the corporate road warrior to keep updated.

One such product, called the Wildfire Electronic Assistant, uses speech recognition to translate spoken commands into a series of contact management tasks that help you connect to key people. Instead of making a series of calls from a hotel or cellular phone, you dial into the Wildfire server. In a single session, you can screen and route calls, dial out to several contacts by saying a name or phone number, return a call immediately after reviewing a message, and schedule reminders and follow-up calls.

Wildfire lets you assign priority levels to contacts so that only important phone calls are forwarded to your phone. If you need to speak to an important client whose voice pattern is in the program's database, you can tell Wildfire to forward that caller to your cellular phone when it recognizes that person's voice. If a caller's voice isn't in the database, Wildfire can prompt the customer to enter a phone number to verify his or her identity. When you are in a Wildfire session, the program will also whisper the name of an incoming caller, letting you accept the call and put your current call on hold or have Wildfire take a message. The sys-

tem can also act as a virtual hallway. You can ask, "Who else is around?," and Wildfire will provide a list of your colleagues currently in a session. If you like, you can initiate a call to one of them.

Wildfire is not meant for the casual phone user. The system



consists of intelligent communications software running on a Pentium-class computer, an embedded version of Unix System V release 4.0, and an object database from Object Design (Burlington, MA, (617) 674-5000). Slated to ship in the first quarter of 1995, the program requires a T1 line. Prices start at \$46,850 for a four-port

system that handles 12 to 24 users. Developers at Wildfire Communications (Lexington, MA, (617) 674-1590) say future plans for the product include integration with PDAs (personal digital assistants), E-mail, and faxing. For now, Wildfire notifies you of recent messages via an alphanumeric pager and lets you call and interact with your non-Wildfire voice mail via the traditional Touch-Tone navigation.

Wildfire's reliance on emerging voice-recognition and object-database technologies makes it a new type of communications product, analysts say. "They've taken a quantum leap forward," says Jim Burton, an analyst for C-T Link (Boston, MA), a computer-telephone integration consulting firm for vendors. "When I look into the future, I see [Wildfire] as the way people communicate." Burton adds that the key to the company's success will be the accuracy of the voice recognition, including its performance over cellular phone calls.

More evolutionary is the MSX system from Priority Call Management (Wilmington, MA, (508) 658-4400). Think of MSX as an off-premise extension on steroids. MSX is an intelligent switching system that integrates with your organization's existing phone and data networks. It provides services where a person rather than a dumb extension sitting on a PBX is the destination for voice communications. MSX delivers flexible call completion and management to an individual, regardless of a person's location, as long as he or she has a Touch-Tone phone. From any remote location, you can answer, screen, and transfer phone calls.

The MSX system seamlessly routes phone calls over cellular, wireless (i.e., pagers), and wired devices. MSX supports call screening and also lets you receive faxes directly at your regular business phone number. MSX stores the fax, and the next time you call in, the system informs you of the fax and lets you print it at a remote

device. "Unless their workers can work from their homes as if they were at their desktop, companies will be reluctant to promote telecommuting," says Andrew Dale, vice president of marketing at PCM. "MSX delivers to any Touch-Tone phone the enhanced features that you normally get only from proprietary phones that work with your PBX." Dale says future versions of the product will offer tighter integration to LANs and will support voice recognition. The pricing for MSX starts at \$60,000.

Both MSX and Wildfire focus on maximizing the effectiveness of your voice communications but don't currently integrate with the types of electronic communications (e.g., E-mail) that fly across a typical company LAN. Companies like 3Com and Shiva have developed remote-node solutions that allow a mobile worker to use a modem-equipped PC to dial into and use the LAN's resources. Air Access 2.0, which is remote-LAN-node software from AirSoft (Cupertino, CA, (408) 777-7500), uses a highly optimized TCP/IP-like transport-level protocol along with caching to minimize the traffic across standard phone lines.

MobileWare (Dallas, TX, (214) 952-1200) takes a different approach to LAN access. The company's namesake software lets mobile users connect to LANs via a modem over wireless or standard phone lines. You can use it to send and receive E-mail, faxes, files, and printed documents between your notebook PC and the server in a single phone call.

MobileWare is sold in five-, 50-, and 250-user packages. The price, \$279 per user, includes the necessary MobileWare server components for NetWare, Windows client software, and cc:Mail client post office licenses (the company says it will support Microsoft Mail in 1995). MobileWare integrates with existing cc:Mail gateways, includes system administration, and supports DES. However, MobileWare currently does not integrate

with Lotus Notes or support cellular networks such as Ardis or RAM Mobile Data.

With MobileWare, one call from Windows client software can spawn multiple communications tasks that the server can execute when you're disconnected, including multiple fax distribution, remote printing, file transfer, and mail ex-

change. It thus saves time and reduces long-distance phone charges. If you're disconnected during a transmission, MobileWare reestablishes the connection from the point the drop occurred, without losing data.

The products mentioned here address different communications needs, but they all extend users' mobility options be-

yond simple voice mail, says Andrew Seybold, editor in chief of *Outlook on Mobile Computing* (Brookdale, CA): "Today when people leave the office, they leave three quarters of their communications behind them. Many people rely only on voice mail, but messages come by fax, E-mail, and voice mail."

P D A S

Sony Releases Magic Cap Device

The latest entrant in the quest for the killer PDA (personal digital assistant) is Sony's Magic Link PIC-1000. It offers a break from traditional computing and ushers in a new era of mobile communications. This is the first available device based on General Magic's Magic Cap operating system and Telescript communications software. Magic Link (\$995) was introduced this fall on the same day that AT&T publicly activated its PersonaLink Services (\$9.95 per month), the first WAN service designed around intelligent mobile agents (see "The Network with Smarts," October BYTE).

You interact with Magic Link by writing on its touch-sensitive screen using a plastic stylus. Unlike Apple's Newton MessagePad, Magic Link doesn't use handwriting recognition: If you want to enter text, you tap on the pop-up image of a keyboard.

Based on tests of the device, the lack of a keyboard isn't an impediment. This is because Magic Link is primarily a communications device. Its intended applications are paging, voice calls, faxing, light E-mail, simple financial work, and on-line browsing and shopping. The tap-and-drag GUI reduces demand for typing, and the on-screen pop-up keyboard is effective for entering text.

I found the Magic Cap interface easy to use, and I especially liked its audible feedback. Magic Cap eliminates conventional computer concepts (e.g., separate files and appli-

cations), substituting an object-oriented model similar to PenPoint or the Newton operating system. I found the pop-up error messages and information boxes informative. The combination of Magic Link and PersonaLink's agents made E-mail a new experience.

But Magic Link is not without its drawbacks. The device is somewhat underpowered. Multitasking performance is sluggish, the 2400-bps modem is too slow, and the non-backlit LCD screen can be hard to read.

Most troublesome is the lack of built-in terminal-emulation or general communications software. Magic Link is richly endowed with communications features (see the summary box), but out of the box, it connects only to PersonaLink or America Online. Sony says third-party providers will offer ASCII terminal-emulation packages for Magic Link, but for almost \$1000, I'd prefer it to be built in.

The missing terminal emulation highlights the conceptual quandary of Magic Link and Motorola's Envoy, another Magic Cap device that was introduced earlier but has not yet been released. These devices target consumers and nontechnical users, yet they're priced at a point that's more acceptable to business users. To break from the past, the devices sport new user interfaces and architectures, but they don't support standard business applications like desktop software or conventional on-line or WAN services. This makes the purchase decision more difficult for a mobile executive. Magic Link is the most usable pen-based PDA yet, though its full value unfolds only when used with PersonaLink. As successful a design as it is, I still don't believe it represents the final word in portable communicators.

—Andy Reinhardt



Magic Link Highlights

- Built-in serial and 38.4-Kbps infrared ports (non-IRDA)
- 2400-bps data/9600-bps fax send modem
- RJ-11 jack, phone/microphone/speaker
- Optional PCMCIA pager card receives SkyTel pages and forwarded PersonaLink E-mail
- Weighs 1.2 pounds (550 grams)
- Up to 10 hours of battery life
- Six AAA batteries or a rechargeable lithium-ion battery pack
- No handwriting recognition
- 16-MHz Motorola "Dragon" 68349 CPU
- 4-MB ROM holds built-in PenCell spreadsheet, Pocket Quicken, spelling checker, PersonaLink, and AOL access software
- 1 MB of RAM workspace (expandable to 2 MB with optional PCMCIA SRAM card)



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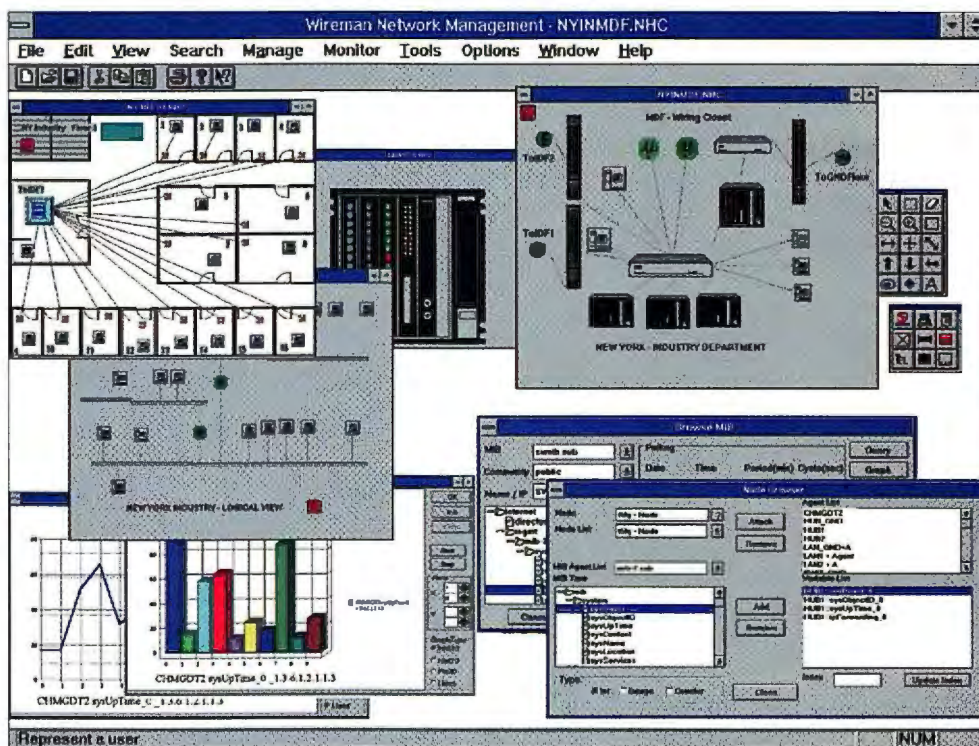
LAN MANAGEMENT

Network Management Gets Physical

The term *LAN management* can refer to a myriad of tasks, ranging from the management of such devices as bridges or hubs on a network to managing servers, PCs, and software. However, one key element that people often neglect is the management of the physical network, including mundane but critical elements like cabling, connectors, and faceplates.

Network downtime costs U.S. companies \$3.8 billion annually. Cabling and other physical-network problems account for half that cost says Walt Dymek, associate analyst of network management systems at Datapro Information Services Group (Delran, NJ), a research and consulting firm. However, most LAN management packages help administrators manage the logical network, not the physical network. On the other hand, packages like Cable System Manager from Apsylog (Palo Alto, CA, (800) 275-2779), which offer cable management, typically ignore logical-network management. Thus, the best an administrator could do was to have two separate systems: one for logical-network management and one for physical-network management.

The lack of products that integrate physical- and logical-network management translates to lost synergies for network administrators. For example, one of the most time-consuming and repetitive tasks a LAN administrator has to perform is handling user moves, additions, and changes. When a user moves from one desk to another, someone usually has to go to a wiring closet and physically move the wire from one hole to another in a punch-down block. Without a way to



With NHC's Wireman and switching hardware, you can accomplish many physical-network management tasks from your PC instead of sending a technician to the wire closet.

associate the physical wire segments and holes in the punch-down block with logical network elements (e.g., the wire to Fred's desk), this task can eat up time.

To make management easier, NHC Communications (Mount Royal, Quebec, Canada, (514) 735-2741) developed Wireman, a low-cost (prices start at \$495) SNMP program that also manages the physical network. With Wireman, a LAN administrator can build a database of network elements and SNMP devices. The database stores inventory, warranty, and service histories for items like faceplates, cable segments, hubs, PCs, and any SNMP device on the network.

The information in the Wireman database can help reduce the time required to perform routine tasks. Using the exam-

ple of moving a person to a new desk, information in Wireman's database can indicate which hub port, wire segment, and faceplate are associated with the person's new location. The program can also send an SNMP command to the hub to activate the new port.

More time can be saved if Wireman is used with NHC's SwitchEx and ShareIt, which are physical switching products. You can "move" a user by simply tagging his or her PC on the Windows management screen, dragging the icon of the PC to its new location on a diagram of the network, and dropping it into place. Wireman then sends a command to the switching equipment, and the wire connection is made automatically.

Like higher-end management packages, such as Hew-

lett-Packard's OpenView for Windows, Wireman can act on information from SNMP MIBs (Management Information Bases). For example, you can set thresholds on traffic flow through a hub port and receive alarms when conditions exceed the set value. Integrated Wireman for Windows' price is roughly one-fifth the cost of other PC-based, higher-level management platforms.

Wireman is part of a growing trend to link physical- and logical-network management. For example, Isicad (Anaheim, CA, (714) 533-8910), developer of Command, a physical-network management system, and NetLabs (Los Altos, CA, (415) 961-9500), which sells Asset Manager, a network asset management program, say they will integrate their products in 1995.

—Salvatore Salamone

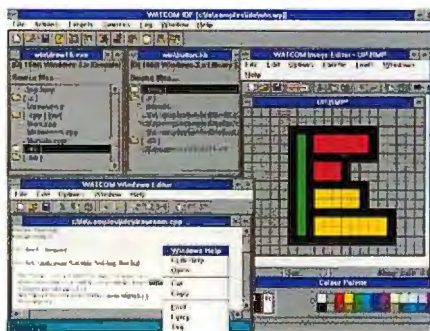
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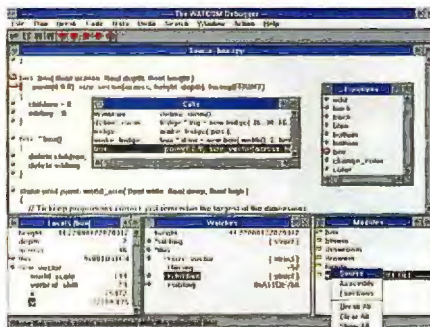
The new Watcom C/C++ 10.0 development system simplifies and accelerates development of high-performance, multi-platform 16- and 32-bit applications. Watcom C/C++ 10.0 delivers productivity and performance, combining our state-of-the-art compiler technology with a new, integrated development environment (IDE) and comprehensive set of tools.

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The new IDE is built to simplify the complexities of real-world application development and make it easy to exploit the high-performance, multi-platform power of Watcom C/C++ 10.0. In a single "project" you can build multiple EXEs, DLLs, and LIBs, targeting several different platforms. The IDE simplifies each stage of development from compiling and linking to debugging and performance tuning. The package includes versions of the IDE and tools for all three host platforms (Windows 3.x, OS/2 2.x and Windows NT).



Watcom C/C++ 10.0 includes a source editor with syntax highlighting, a suite of resource editors, testing and monitoring tools for Windows 3.x and NT development.



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This extensive support is amplified by the cross-platform capabilities of the IDE and tools, which enable building applications for a wide range of target environments from any of the host systems.

The Best Optimization Technology

Watcom C/C++ 10.0 combines both 16- and 32-bit compilers in a single package, providing you with the industry-leading optimizing compiler team. PC Magazine tested performance of industry standard C and C++ compilers and said: "the fastest executables created during testing came from Watcom C/C++³², Version 9.5, while the 16-bit version of the same compiler produced the smallest executables". Now, with Watcom C/C++ 10.0, this competitive advantage is delivered with our easy-to-use development environment and tools.

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- Professional source editor, resource editors, testing and monitoring tools hosted on Windows and Windows NT
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 - 32-bit: Extended DOS • Windows NT • Win32s • OS/2 2.x • 32-bit Windows 3.x • Novell NLM • AutoCAD ADS/ADI
- Both 16-bit and 32-bit compilers for C and C++, the industry's best code optimizer, faster compile times with pre-compiled headers, C++ supports templates, exception handling and the Microsoft Foundation Class library (MFC)
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 - Novell NLM SDK v4.0
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Circle 145 on Inquiry Card.

When all else fails,

There are three types of computer users: those who have lost data due to a power problem, those who are going to, and those who have protected themselves against the inevitable surge, blackout or brownout with the most reliable UPS they can buy: Back-UPS by APC. In fact, editors and users alike agree that if your system demands absolute reliability, you can depend on APC Back-UPS.

According to a study by Bell Labs, undervoltages represent the overwhelming majority of power problems likely to hit your computer. The question is not if a failure will occur, but when. Whether due to construction, wiring, weather, other office

APC Voted most reliable by 3-to-1

Tripp

Best



In a recent poll by PC Magazine's MagNet, APC was voted the most reliable UPS manufacturer by a 3-to-1 margin. That's dependability that will see you through years of unmatched power protection.

equipment, or accidents, power problems are as inevitable as death and taxes. That's why you need instantaneous battery backup power from the Back-UPS to prevent data loss, hard disk crashes, and hardware damage.

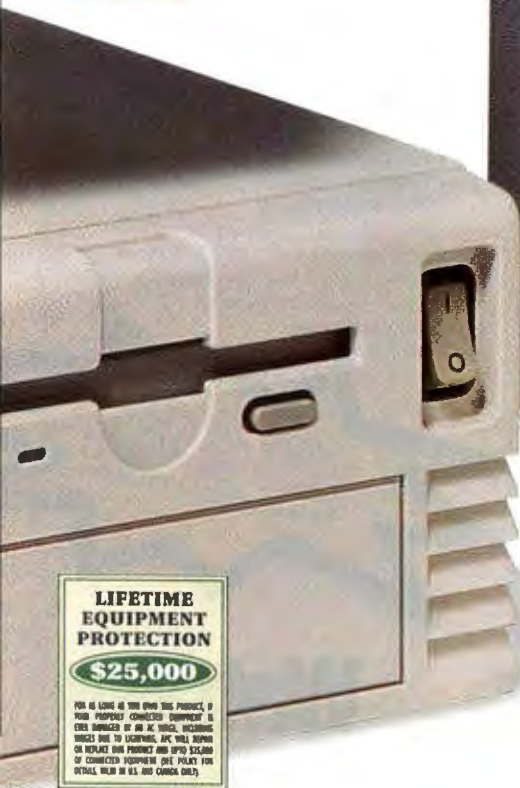
If you're concerned about lightning, rest assured that when measured using the ANSI/IEEE 587 Category A test wave, Back-UPS are superior to virtually all separate surge suppressors. Surge performance is even backed by a \$25,000 Lifetime Equipment Protection Guarantee.

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"All other brands of UPS die regularly in this lightning prone environment. My APC won't die!" said Paul Sisilli, Systems Analyst, City of Port St. Lucie. "With other brands, users don't find out until it is too late. The power interruptions here are very hard to live with. The other brands are dying off. Typically they last just beyond their warranty period. My Back-UPS is going on three years...no other brand is as reliable."



Don Truax knows first hand about Back-UPS reliability: "It ought to be against the law to buy a computer without an APC Back-UPS 250. I recently had a direct lightning hit right outside the house...my computer never blinked. Each morning I get a surge down the line and both APC's hate it - they simultaneously 'holler 'n clamp' while my 'Brand T' quietly sleeps in. I've relegated that unit to non-critical household stuff like my VCR."



Andrew Wargo, Manager at Baxter Land Company, tried two other brands before Back-UPS. "One lasted a few days, a second one went up in smoke after 48 hours, a third lasted less than 24 hours! I then bought my Back-UPS for less than half of what I had paid for the others. We've purchased three more Back-UPS and for the past 14 months they've been just hummin' away on the same power line that was eating the other brands alive!"

If you're protecting a network server, a communications interface port (on models Back-UPS 400 and higher) provides the security of an automatic shutdown to all major OS including NetWare, Windows, Windows NT, LAN Server, LAN Manager, LANtastic, SCO Unix, OS/2, Banyan Vines, AppleShare/System7 and more, so your data is safe whether the system is attended or not. (PowerChute software and interface kits sold separately.)

And since data processed on networked clients needs protection too, the \$139 Back-UPS 280 provides an economical solution for all your LAN workstations. And if you have a new green PC, the price is even better at \$119 for the new Back-UPS 200.

Discovering how essen-



Back-UPS (L to R)	Application	Sugg. List
200	Green PCs, small desktop systems	\$119
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400	Desktop 486, 386 systems, servers	\$229
450	Tower 486, 386 systems, servers	\$279
600	Heavily configured systems, CAD/CAM workstations	\$399
900	Multiple systems, longer runtime applications	\$599
1250	Multiple systems, LAN hubs, small minis, telecom equipment	\$799



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LAN Interface (on Back-UPS 400 and up) provides automatic shutdown to all major OS: Windows, NT, NetWare, LAN Server, LAN Manager, LANtastic, Unix, OS/2, Vines, AppleShare/System7 and more.

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Dept. A2

ENTERTAINMENT

Holiday Gift Sampler

3DO Arrives for PCs

In October 1993, Panasonic released the 3DO Interactive Multiplayer system for playing multimedia 3DO games with photo-realistic graphics, full-motion video, and 16-bit, 44-kHz CD-quality sound. Since then, the 3DO has been gathering momentum as a home-entertainment platform, with the number of available titles growing from 18 in January 1994 to over 100 as of October. Now,



thanks to Creative Labs (Milpitas, CA, (408) 428-6600), you can play 3DO games on your PC.

The 3DO Co. (Redwood City, CA) doesn't make 3DO players; it licenses the technology to companies that do, such as Panasonic, Goldstar, Sanyo, and Creative Labs. The players have double-speed CD-ROM drives, 2 MB of RAM,

1 MB of video memory, and 1 MB of ROM. Processors include the CPU (a 32-bit ARM 60 running at 12.5 MHz), a DSP (digital signal processor) that performs complicated graphics manipulation and full-motion-video decompression, and specialized audio and graphics chips. The 3DO architecture allows for expansion with an optional on-the-fly MPEG decoder. The company says its M2 Accelerator upgrade, which will include a specially designed 64-bit PowerPC-based processor, will be released at the end of 1995.

The ability to play 3DO titles makes the 3DO Blaster a valuable addition to a home PC. The 3DO Blaster is a full-size ISA card that plugs into an available 16-bit ISA slot. Internally, it connects to your CD-ROM drive and to the feature connector of your video card to synchronize with the PC's video signal.

Based on tests of an early version of the product, the 3DO

Blaster is now the ultimate in computer-gaming upgrades for your computer. However, the card is not without its drawbacks. It now works only with the Matsushita-563 CD-ROM drive. If you don't have this drive, you will have to buy one at an additional cost over the 3DO Blaster's \$399 price. If you want to play cool 3DO games like Electronic Arts' Road Rash or Crystal Dynamics' Star Control II, the 3DO Blaster is a valuable addition to your PC.

—Eric J. Garland



Iron Helix displays a map of your location as you probe the interstellar warship.

Interactive Science Fiction for the Mac

Here's a neat interactive CD-ROM science fiction game called Iron Helix. It requires you to survive by your wits rather than mindlessly shooting things. An interstellar war-

ship, armed with a planet-busting bomb, experiences a combination biologic accident/computer glitch during a war-game simulation. This incident kills the crew, but the ship's computer finds a new target for the bomb: an inhabited world.

You, on the only ship in the vicinity, must use three unarmed probes to explore the vessel and find clues that let you shut the ship down. However, the warship's own defensive system—a blaster-packing robot that shoots first and asks questions later—is out to get you. You must explore the

Something in the Myst

If you have a double-speed CD-ROM drive or faster, there is one game you must own. Myst, distributed by Broderbund, shows just what is possible with fast computers, multimedia capabilities, and a lot of imagination.

This is not your traditional action game, where you have to kill a thousand nameless aliens. Instead, you find yourself alone on a mysterious island, filled with odd buildings, hidden rooms, and an old spaceship. You have to figure out what happened, traveling beyond the island to solve all the mysteries. It requires a lot of wandering around, looking for clues, and trying all sorts of combinations. All the scenes are rendered with loving detail, and I rather enjoyed just walking around this virtual world on my PC. The sound effects and music are well integrated with the story, and they really enhance the experience. The interface is simplicity itself—a little hand icon that you click to interact with objects on the screen.

A little movie on the making of Myst is included on the CD. There are Windows and Mac versions. For Windows users, you need an MPC-compatible sound card and CD-ROM drive to play both the game and the movies.

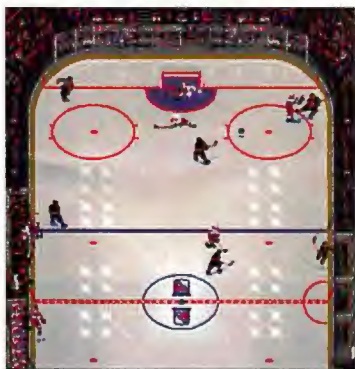
—Rex Baldazo



empty decks of the ship and listen to the logs of crew members for crucial information as you avoid the robot. Created by Drew Studios, Iron Helix features sumptuous graphics, QuickTime movies that display crew logs, and catchy sound tracks. The CD-ROM has been carefully organized so that the game plays on 68020-based Macs and single-speed CD-ROM drives. —Tom Thompson

Hockey Starts on Time in PC Land

More Windows games should be available this holiday season, thanks to WinG (see "WinG Addresses Windows' Weakness in Games," November BYTE, page 48), but DOS continues to thrive as a games platform. Keep an eye out for DOS games like Id Software's new version of Doom called Doom II Boom. Another hot new game for DOS is NHL Hockey '95 (\$59.95). This game is seri-



NHL Hockey '95 delivers realistic hockey action, and you don't have to worry about player lockouts or losing your teeth.

ously addictive. There's nothing like the feeling of weaving through a pair of defensemen, slipping a perfect pass to the wing, and slapping a winning shot just past the goalie's mitt.

If the rules get in the way, you can disable them, race off-side, and pass across blue lines with impunity. Penalties and power plays, face-offs, brutal cross-checking—all the subtle intricacies and in-your-face brute strength of hockey are

part of the package. Excellent graphics and CD-quality sound enhance the action. You even get expert analysis from TV announcers, game highlights, instant replays, and complete stats.

NHL Hockey '95 (Electronic Arts, (415) 571-7171) lets you simulate an entire season, adopting any of the NHL teams and stars, right through to the Stanley Cup. And these guys even start the season on time.

—Stanford Diehl

Matrox Delivers 3-D Video for Games

Complex computer games require significant computer resources, especially when it comes to video and memory. The Matrox Impression Plus (Matrox Graphics, (514) 685-2630) delivers the hardware performance features—3-D functions, accelerated motion video, and a 64-bit graphics engine—that a serious player demands.

The Impression Plus (\$499) ships with MGA 3D-SuperPack, a CD filled with 3-D images, games, and demonstrations. The bundled 3-D games promote the promise of the MGA series as a platform for 3-D development. In 47-Tek's Sento, four battle lords from different zones of time, space, and dimension fight for supremacy of the astral plane. Their assortment of moves is fairly primitive, generally limited to a few basic attacks. But the characters are beautifully rendered, and they can freely maneuver in 3-D space. Ice Hawk, a jet-fighter simulation game, is also limited in functionality, but it displays intricate models of enemy planes and the 3-D terrain of the ice planet Valkor.

You wouldn't buy the Impression Plus just for the bundled MGA 3D-SuperPack, but it is a nice freebie, and it shows the power of the MGA board as a video subsystem.

—Stanford Diehl

Machines That Move

If you're looking for something a little different to do this holiday season, consider building the Mobile Robot kit from A. K. Peters (Wellesley, MA, (617) 235-2210). This kit contains all the electronic components required to build the Rug Warrior robot that's described in the popular book *Mobile Robots: Inspiration to Implementation*.

The Mobile Robot kit (\$289.95) is a small (3¼ by 4½ inches) battery-powered computer consisting of a Motorola 68HC11 processor, 32 KB of RAM, and assorted supporting electronics to provide a final board that's complete with microphone, piezobuzzer, LCD, an infrared detector/emitter, and two photocells. Power is provided by two DC motors (which are not included), such as those that are found in Lego building-block kits.

Computer programming is accom-



The Mobile Robot kit lets you build robots that respond to light variations, noises like hand clapping, and other stimuli.

plished by downloading programs via serial cable from either a Mac or PC. Each kit contains a copy of Interactive C for either the Mac or PC. Interactive C is a subset of ANSI C and compiles to p-code. And most important, it's multitasking, which allows you to build a sophisticated robot control system.

Dust off the old soldering iron and break out a set of Legos, and you can have all sorts of entertaining robot systems running around your house by the New Year.

—Raymond GA Côté

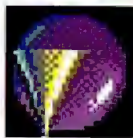
Cool Practical Gifts

If you are looking for something besides games and multimedia upgrade kits to give for the holidays, check out any of the screen savers. One of these stars the Simpsons and is available from Berkeley Systems (Mac and Windows versions). Some programs combine screen savers and organizers (e.g., Delrina's Dilbert Screen Saver for Windows). In addition to lightening up your day, screen savers typically provide a password to protect your computer from nosy neighbors.

A new twist on this theme is provided by the Seinfeld screen saver and planner CD-ROM (\$39.95) from Byron Preiss Multimedia ((800) 482-3766). The program lets you play live-action video clips from the hit TV series and will let you personalize stationery, memos, and fax forms with a photo album of classic Seinfeld scenes. Retailers say that more traditional planners like Berkeley Systems' Espresso Calendar and Address Book for Windows or the Mac are also big sellers.

Finally, Computer Expressions sells through mass merchandisers a wide variety of mouse pads with themes from *Gone with the Wind*, M. C. Escher, *The Wizard of Oz*, and even the *Grateful Dead*. Ranging from \$5 to \$10, the price for these accessories won't send you down the road feeling bad.

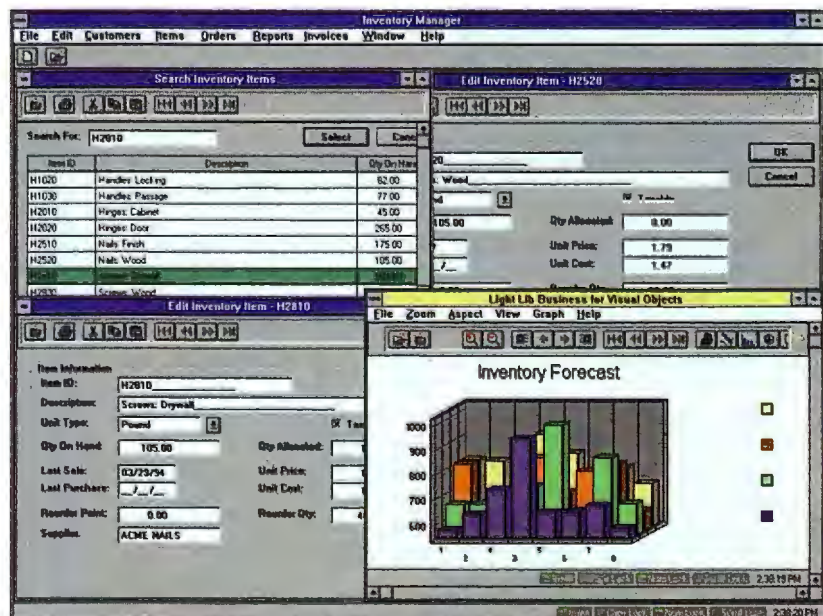




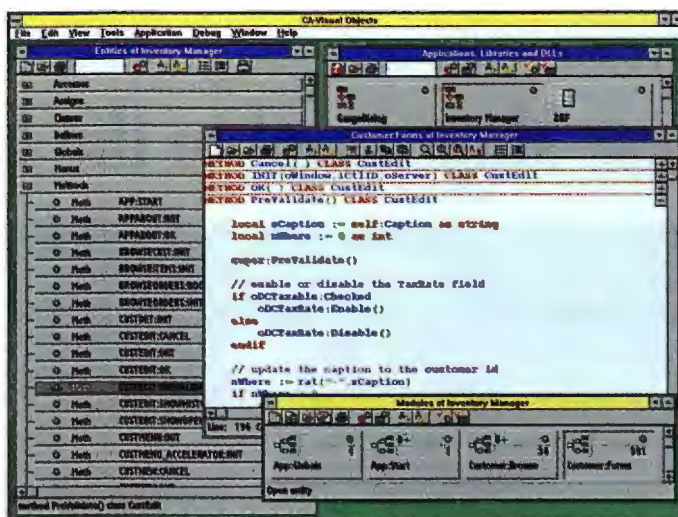
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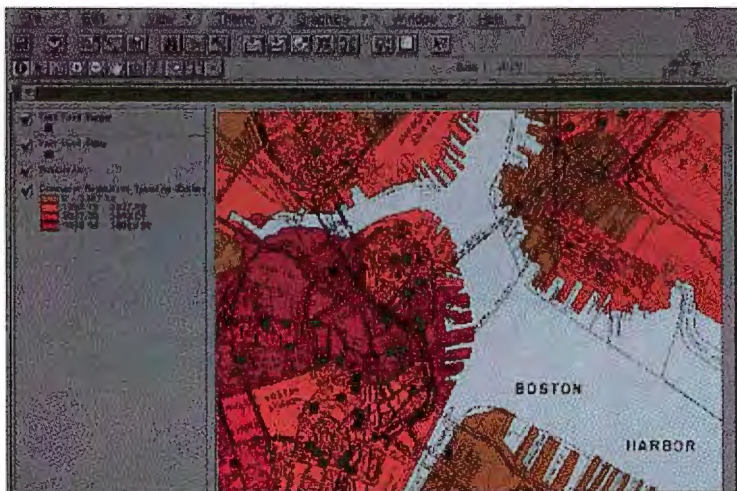
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MAPPING

These Maps Lead to the Desktop



Desktop mapping lets you combine maps with a wide variety of demographic information. Here, ArcView 2.0 for Windows (\$995)—slated to ship this fall with Unix, Mac, and Power Mac versions to follow—provides a detailed map of the eating habits of Bostonians.

The symbiotic sciences of mapmaking and demographics—otherwise known as charting the social and economic lay of the land—on computers have long been the domain of specialists in GISes (geographic information systems). But with increasing frequency, companies are making their GIS products available for personal computers.

Desktop mapping programs

let you pair predrawn maps or map outlines with tabular data to describe one or more aspects of a particular region (e.g., a map of San Francisco might use colors, symbols, and labels to illustrate average income distributions throughout the city). The supporting data is usually kept in a separate file, either in the mapping program itself or in a spreadsheet or database.

Due to their graphical nature and often large data sets, mapping software has traditionally run on workstations, minicomputers, and mainframes. But with PC processing power and the demand for demographic data on the rise, mapping programs for desktop computers are increasing in popularity (see the chart).

Strategic Mapping's Atlas GIS (Santa Clara, CA, (408) 970-9600) and MapInfo's MapInfo (Troy, NY, (800) 327-8627) are two well-known

names in the field, but the field is getting crowded. Environmental Systems Research Institute (Redlands, CA, (800) 447-9778), a developer of high-end GIS products, recently introduced a desktop mapping product called First St., which it will market with Wessex (Winnetka, IL, (800) 892-6906), a supplier of CD-ROM-based data products. First St. provides a set

of data on 22 CD-ROMs that includes all the streets in the U.S., over a dozen levels of census boundaries, and all the results of the 1990 U.S. census for \$1995.

Although these products are expensive by PC standards, a price war may happen. Strategic Mapping recently reduced the list price of Atlas GIS from \$1595 to \$495. At this writing, MapInfo lists for \$1295. But these prices are inexpensive compared to the thousands of dollars that GIS programs for larger systems cost.

Because it relies on tabular data, mapping is also finding its way into spreadsheets. Lotus's latest version of 1-2-3 for Windows includes a mapping tool that lets you plot spreadsheet data as a demographic map. You can also buy maps and data from Strategic Mapping, Lotus's partner. Software Illustrated (Pleasanton, CA, (510) 463-9898) makes a mapping add-in for Excel and Quattro Pro for Windows called MapLand (\$99.95).

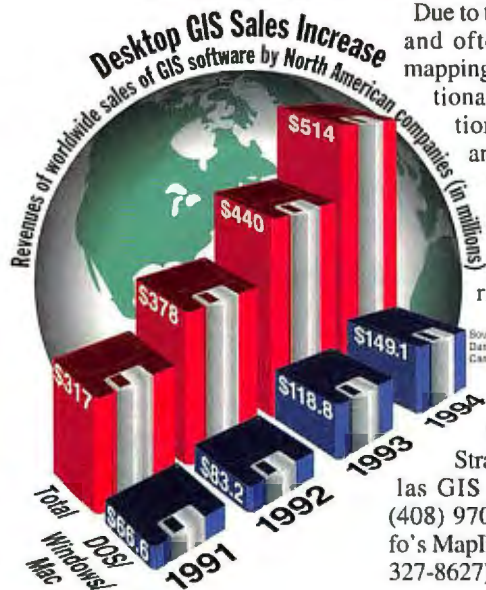
Sales of GIS software are expected to keep climbing. About \$625 million worth of GIS products will be purchased in 1995, and that number should double to \$1.2 billion

Whatever Happened to...

Motorola's Envoy Device for Magic Cap (see "Motorola's Envoy First to Run Magic Cap," May BYTE)

Sony's release of the Magic Link, the first available device that's based on General Magic's Magic Cap operating system and Telescript communications software, has people wondering about the status of Motorola's Envoy.

Company officials say the product has been delayed due to problems in integrating Magic Cap, Telescript, and wireless messaging in a single product. Motorola, which confirmed that it is also developing a Newton-based PDA, says it extended the Envoy's customer feedback period to ensure robust functionality and says the device will ship by the end of the year. Developers at IBM also had difficulty with the wireless component of the company's Simon PDA, but that product has finally been released (see "Simonizing the PDA" on page 145).



by 1998, according to forecasts from industry research firm Daratech (Cambridge, MA). James Rapinac, Daratech's industry analyst for GIS, says that the percentage of GIS products for the desktop will likely increase, due to lower prices of software and high-powered PCs and Macs and the friendly GUIs of desktop GIS programs. A greater level of interest in demographic data, which has become grist for colorful charts in newspapers and magazines, is also fueling demand, Rapinac notes. These products, coupled with spreadsheet mapping features, make GIS much more approachable for businesspeople than the specialized software of old.

—Christopher O'Malley



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PERSONAL FINANCE

Electronic Banking Faces Numerous Hurdles

Much as vendors of imaging and electronic-forms software want to create the paperless office, developers of personal-finance software are introducing on-line services that let you handle financial transactions without paper. These electronic links have many benefits for consumers: faster and more accurate data entry, PC-based transaction verification and funds transfers, and the ability to download data like current stock prices.

Quicken, the personal-finance program from Intuit (Menlo Park, CA), has a feature called IntelliCharge that, when used in conjunction with a special Visa card, lets you eliminate data entry by downloading transactions directly into Quicken. Money, from Microsoft (Redmond, WA), offers a similar feature for statements issued by a few select banks. Both programs also let you pay your bills electronically.

Microsoft and Intuit, which recently announced plans to merge, say they want to broaden the electronic-commerce services they will offer their customers. But both companies also admit that only a small percentage of their current customer base takes advantage of these features. Software developers and financial institutions must overcome hurdles that are both cultural and practical.

"Electronic banking is a ship that's been coming in for a long time," says Tom Smith, a certified financial planner and moderator of the financial conference on BIX, an on-line service. "People that don't use computers are afraid of them, and the people that do use computers know that they can

break. If you aren't consistently backing up and your hard drive freezes [with all your electronic bank statements], that's not a very good feeling."

Smith says there are other practical reasons why users haven't yet eagerly embraced electronic banking. Electronic bank statements do not include the canceled check, which can be needed as a backup. "The average ATM is capable of much more than just dispensing cash," Smith notes. "But many people don't trust it for after-hours bank deposits." Smith says ATMs are analogous to electronic banking. "There is something about having all of those tangibles under your control that automated systems may never be able to address."

Another problem is that electronic statements are not universally provided by banks. To address that problem, Microsoft and Intuit are actively recruiting banks to do so. Matt Glickman, product manager of Quicken for Windows, says the company plans to offer a wide variety of electronic services. Says Glickman, "We're putting all the building blocks in place so that we can deliver these services at a cost that people will want to use them."

Still, vendors acknowledge that widespread acceptance of electronic financial services is not imminent. "I think we're at the start of a many-year task toward automating financial services for individuals," says Glickman. "But there's no question that in the long term it saves people money and time and hassle."

—Ken Sheldon

CODE TALK

RICK GREHAN



Step-by-Step Windows Database Development

I don't think I've ever seen an applications builder that takes the step-by-step paradigm to the extreme as does DataBoss, a Windows database program builder from Kedwell Software (Portsmouth, NH, (603) 431-0536). When you launch DataBoss, you're taken to its desktop window, where—lo and behold—you see a list of steps numbered 1 to 8. Step 1: pick a title for the application; step 2: choose an icon; step 3: choose the data files to be used (or build them, if need be); step 4: construct the windows your application will use; step 5: build a menu to lash it all together—and so on. Boom, boom, boom; and out pops a completed application.

At the level of simply naming steps, this process might seem absurdly simple. But so would a Dickens novel if you described it by reading the table of contents. However, each step sits atop an elaborate activity (except for, perhaps,

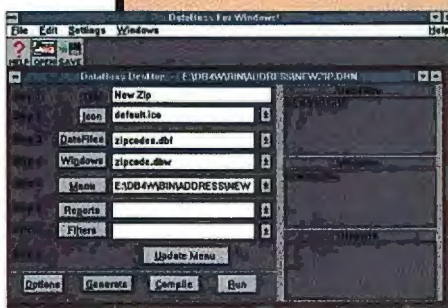
DataBoss generates C++ source code that you can compile and distribute royalty-free.

picking the application title) that DataBoss automates, so that all parts of application building are nearly as simple as following the uppermost eight steps. Constructing the data files is a process of selecting field names (column names, if you prefer that term) and attaching attributes to them through dialog-box selections. DataBoss's window designer lets you assemble a window by simply selecting what type of item (push button, data-file field, bit map, or other item) you want and placing it wherever you choose in the window. The menu designer is as close to in situ menu building as you can get. It's as good as the 4GL (fourth-generation language) database front-end systems' form builders I've seen.

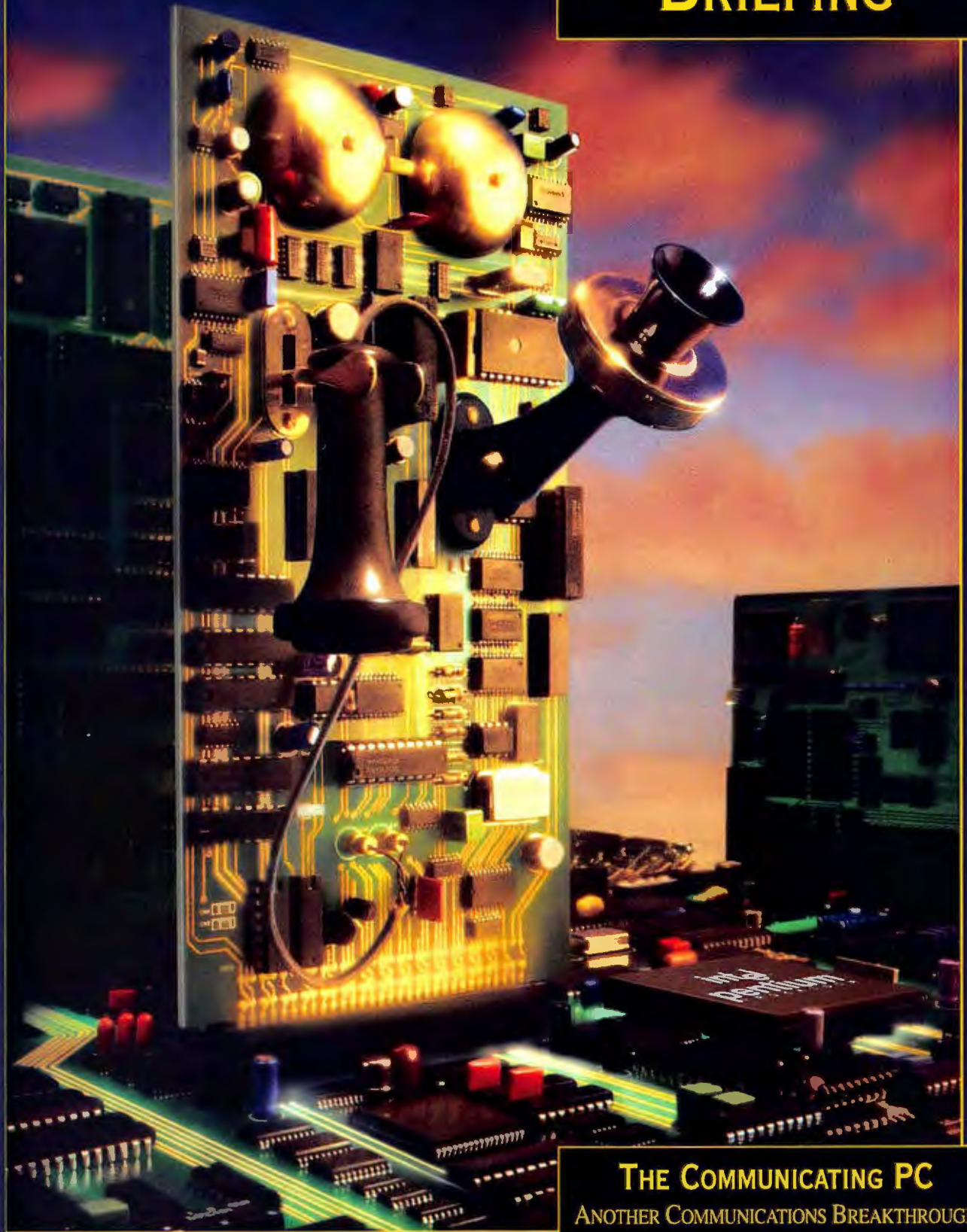
What pops out at the end is actually not a complete application; more accurately, it's the C++ source code for the application. You must already have a recent Borland or Microsoft C++ compiler installed on your system. Just tell DataBoss what kind of compiler you've got, where it is, and DataBoss does the rest. Once you've built the data files, the windows, and the menus, you click on the "generate" button.

Having all the source code available means you always have the option of tweaking your application's code. Toward the back of the manual, you'll find a detailed programmer's guide that gives you an inside look at how the system's objects are put together, in case you want to alter the source code. (I discovered another benefit to having the source code around. Any application I built crashed when I ran it a second time. Kedwell's technical-support people recognized the problem instantly and talked me through editing one of the supplied files. I rebuilt the libraries, recompiled, and the problem was solved.)

I could go on about DataBoss: no royalties, multiuser-ready, uses dBase files, your application gets a fully functioning toolbar and query-builder dialog box "for free," and so on. If you're in the business of building Windows databases and you want a package that puts applications together quickly and easily, plus gives you the luxury of access to the source code, the \$299.95 DataBoss is worth investigating.



INTEL TECHNOLOGY BRIEFING



THE COMMUNICATING PC
ANOTHER COMMUNICATIONS BREAKTHROUGH

PLUGGING COMMUNICATIONS INTO THE PC.

Originally dedicated to stand-alone computing, the PC is evolving to become the center of communication tasks. It is faxing, video conferencing, and retrieving information from many sources. This briefing discusses how Intel is working to further advance PC communications and incorporate new capabilities into the PC.

THREE TOOLS FOR THE BANDWIDTH BATTLE.

Thanks to innovations like Intel's Pentium™ processor and the PCI local bus, the PC is more powerful than ever before. And in an effort to help communication technologies keep up with these faster PCs, Intel is improving modem capabilities, supporting ISDN technology, and developing a new Ethernet standard.

MODEMS GET FASTER AND SMARTER.

Modems have been around for a long time, but their speed continues to improve. The latest modem technology, based on the new V.34 standard, has data transmission rates of 28.8 Kbps (Kilobits per second).

In addition to speed, modem capabilities are increasing. For instance, Intel and other industry leaders are improving modem technology by developing a specification for Digital Simultaneous Voice and Data. This technology splits a single

telephone line into two virtual channels, enabling modems to concurrently transmit both voice and data over one line. So PC users will be able to simultaneously talk and share the same data or applications with just one telephone call.

DIGITIZING THE PHONE LINES.

Simply put, Integrated Services Digital Network (ISDN) is the telephone line turned digital. By using digital rather than analog technology, ISDN can transmit information much faster than modems. The most common form of ISDN line, called the Basic Rate Interface (BRI), contains two high-bandwidth 64 Kbps channels which allow the communication of data, voice, graphics and video at speeds of 128 Kbps.

Because ISDN sends information digitally, the telephone companies' switches must be upgraded to be ISDN-compatible. On the PC end, an ISDN add-in board similar to a modem



WHERE INFORMATION COMES TOGETHER.

A PERFECT EXAMPLE OF HOW THE PC IS GAINING MORE COMMUNICATION CAPABILITIES IS THE PROSHARE™ PERSONAL CONFERENCING PRODUCT FAMILY. THIS FAMILY OF PRODUCTS BRINGS THE POWER OF THE PC TOGETHER WITH MODEMS, ISDN LINES, AND LANs. AND IT ADDS NEW CAPABILITIES TO THE PC LIKE DOCUMENT SHARING, APPLICATION SHARING, AND VIDEO CONFERENCING.

is required to enable the PC to place and maintain calls.

After years of promise, ISDN is finally becoming widely available worldwide. It is now the standard for digital communications. Intel is fully supporting ISDN technology, and Intel's ProShare™ Personal Conferencing Software (see visual) is one of the PC-based applications that utilize ISDN's increased bandwidth capabilities.

ETHERNET PULLS A FAST ONE.

Most LANs currently deployed are based on the Ethernet standard, which provides a maximum of 10 Mbps throughput rate. But today's businesses are putting greater demands on networks and 10 Mbps is quickly becoming inadequate.

To remedy this problem, Intel worked with over 40 industry partners to develop the Fast Ethernet standard. It provides 100 Mbps of bandwidth while maintaining the original CSMA/CD protocol. This way, companies can easily move to Fast Ethernet performance while still utilizing their initial Ethernet investment.

A MODEM'S 9,600+ BPS ALLOWS DOCUMENT AND APPLICATION SHARING.

AT 128 Kbps, ISDN ENABLES VIDEO CONFERENCING.

SAN FRANCISCO

THE COMMUNICATING PC

intel

COMPUTER TELEPHONY

THIS TECHNOLOGY ALLOWS THE PC TO CONTROL THE ADVANCED FEATURES OF DIGITAL TELEPHONES AND UNDERLYING PBX SYSTEMS. THE PC CAN AUTOMATICALLY MAKE TELEPHONE CALLS, ACT AS A SMART ANSWERING MACHINE, AND ROUTE A CALL BASED ON THE CALLER'S IDENTITY.

Sales Projections

- Western Region sales increased 25% during the third quarter



PERSONAL CONFERENCING

WITH PROSHARE SOFTWARE, TWO PEOPLE CAN SIMULTANEOUSLY SHARE PC-BASED DOCUMENTS AND APPLICATIONS WITH ONLY A MODEM. WHEN SHARING A DOCUMENT, A COPY OF THE INFORMATION CAN BE MARKED UP AND CONTROLLED IN REAL TIME USING THE KEYBOARD AND MOUSE. OR IF THE ORIGINAL DOCUMENT NEEDS TO BE JOINTLY EDITED, APPLICATION SHARING CAN BE USED TO SIMULTANEOUSLY RUN THE SAME PROGRAM ON THE TWO PCs.

PERSONAL CONFERENCING WITH VIDEO

PC-BASED VIDEO CONFERENCING LETS TWO PEOPLE COMMUNICATE USING LIVE MOTION VIDEO WHILE SHARING AN ELECTRONIC DOCUMENT. WITH THE PROSHARE VIDEO SYSTEM, VIDEO IS COMPRESSED AND DECOMPRESSED USING INDEO™ VIDEO TECHNOLOGY AND TRANSMITTED OVER AN ISDN BRI LINE TODAY OR A LAN IN THE FUTURE.

LANs PROVIDE MORE THAN ENOUGH BANDWIDTH FOR MULTIPLE VIDEO CONFERENCES. BUT BECAUSE LANs ARE SHARED RESOURCES, THEIR BANDWIDTH NEEDS TO BE MANAGED TO ENSURE THAT VIDEO CONFERENCES CAN BE ESTABLISHED AND MAINTAINED WITHOUT ANY INTERRUPTIONS.



INCREASED BANDWIDTH LEADS TO BETTER COMMUNICATIONS



AS BANDWIDTH CAPACITIES INCREASE, SO DO THE PC'S CAPABILITIES. FOR EXAMPLE, MODEM TECHNOLOGY ONLY SUPPORTS THE TRANSFER OF TEXT AND LOW-RESOLUTION GRAPHICS. BUT ISDN TECHNOLOGY, WHICH

PROVIDES A MINIMUM BANDWIDTH OF 128 KBPS, ENABLES MORE DATA-INTENSIVE PC APPLICATIONS LIKE VIDEO CONFERENCING.

A BIGGER PIPELINE, HOWEVER, IS NOT THE ONLY CRITERION. ETHERNET-BASED

TECHNOLOGY IS GENERALLY LIMITED TO LOCAL COMMUNICATIONS, WHEREAS MODEMS AND ISDN LINES HAVE THE CAPABILITY TO TRANSFER INFORMATION LOCALLY AS WELL AS OVER LONG DISTANCES.

MORE PLANS FOR THE PC.

In addition to advancing PC communications and creating the ProShare™ family of personal conferencing products, Intel is working on other efforts to bring the PC and communication technologies together.

For instance, Intel is developing a high-speed cable adapter to connect home PCs to the cable network. By combining

hardware and software, this adapter technology will enable the PC user to access a variety of on-line services and content through the existing cable infrastructure.

And together with 12 leading communications and computer companies, Intel is developing the Personal Conferencing Specification which will result in a wide range of

interoperable conferencing products and services—from desktop to room systems. This will help make video and data calls from a

PC as easy as making calls from a telephone.

WANT MORE INFORMATION? CALL 1-800-955-5599.

For a complete package of information on "The Communicating PC," dial our toll-free number and ask for literature package #237.

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Blasts from the Past



DENNIS BARKER

As we approach our twentieth year of publishing BYTE, we'll be looking back at highlights from two decades of covering the PC revolution.



Big laptop issue: We looked at new portables—Compaq's LTE/286, Grid's GridPad, the T1000SE and T3100SX from Toshiba, and Zenith's Super-sport SX—and claimed they "point to the future of small computing." Looking back, their farsightedness was spotty. The Compaq and Grid machines probably pointed the farthest. The LTE had a 20-MB hard drive only three-quarters of an inch high, and Compaq engineers had designed a very small circuit board (7.5 by 2.5 inches). The GridPad,

precursor to the PDAs of the 1990s, could read handwriting. Looking not so futuristic, the T1000SE used the "now-ubiquitous battery-backed RAM card," which we apparently thought would be the big thing in tomorrow's notebooks. Battery life for these units averaged 3 hours.

Happy birthday, Visi-Cal.

In the tenth year of the spreadsheet, our interview with inventors Dan Bricklin and Bob Frankston serves as a reminder of how small big things could be: Their "visible calculator" ran on a 24-KB machine. (In contrast, Lotus 1-2-3 would require a 256-KB machine; today's Windows version needs at least 4 MB.)

Toward the other end of the issue, Intel engineer Neal Margulis wrote about the new 860, Intel's foray into RISC. Promoted as a supercomputer on a chip, the 860 was expected to hit 50 MHz (although the designers generally spoke of it as a 40-MHz chip). This million-transistor processor made big use of pipelining, could execute two instructions in the same clock cycle, and put a CPU, FPU, MMU (memory management unit), graphics unit, and separate instruction and data caches on the same silicon slab. Today, you can find it used in laser printers and other embedded applications.

"Thousands of books could be on-line, available at the touch of a button."
—Senator Al Gore, on his proposal for a National Digital Library and advanced communications network

It Sounded So Fast Back Then

Maximum clock rates was the big debate at the Microprocessor Forum. Our news story quoted one designer: "The electrical environment becomes a real problem at clock speeds higher than 33 MHz." *Microprocessor Report's* Michael Slater and others predicted clock speeds would top out at about 50 MHz. But former IBMer Andrew Heller had the clearer crystal ball, predicting speeds of 100 to 150 MHz in the "next few years."



Communications was the theme that month, and one of the hot issues was the debate over the best high-level protocol for four-year-old Ethernet: TCP/IP or the Xerox Network System. (Ethernet grew out of Xerox's scheme for connecting its office machines.) Manufacturers were supporting one of these protocols, and their Ethernet boards were consequently incompatible.

Love and War at Chaos Manor

Jerry Pournelle finally got his hands on one of the first HP LaserJets. Despite some flaws—problems with proportional spacing, a paper tray that held only 80 sheets, a useless print-intensity control—Jerry wrote, "I think I'm going to be in love."

The Chaos Manor game of the month was Gulf Strike from Victory Games, a simulation of war in the Persian Gulf. What if Saddam Hussein had been reading?



PC of the Month: The Tandy 1000 Perceived highlights: "will give a lot of homes the advantages of a fully functional 16-bit machine"; base price of \$1358.95; "will run Flight Simulator and most other IBM PC and PCjr software"; "clever use of gate arrays to handle multiple graphics modes";



"DeskMate software"; "more compatible with IBM PC than Tandy 2000 (can read disks used with the IBM but not those with the 2000)."



Numerical analysis was the focus. "If Leibniz were alive today, he would be employing a friendly desktop computer as a tool for examination of concepts ranging far beyond the calculus he helped shape."

He'd also be reading this issue of BYTE to learn how to analyze polynomial functions with a TI-59 calculator, cop some code for performing trigonometric functions and printing curves on an HP plotter, and maybe even ordering one of the new Heathkits.

In the News

The number of BBSes had jumped in a year from three to an estimated 60. . . . Computer Systems Design Group was offering a new "Unix-like" operating system for 8080 and Z80 systems. . . . Motorola and Zilog were developing MMUs for their 68000 and Z8000 chips. . . . The FCC benevolently granted permission to amateur radio operators with PCs to zap ASCII files around using the OSCAR satellite. . . . Shugart was cranking out a thousand floppy drives a day, while number 2 Micropolis was producing 200.



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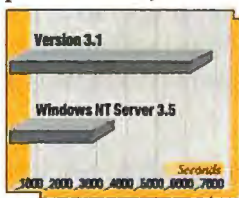
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Introducing the 4PleX Quad Speed CD-ROM Drive with a 1MB Buffer.

If you've been waiting for CD-ROM drive performance to really take off, get ready to hold on tight. The new Plextor 4PleX leaps past the capabilities of 2X and 3X drives, and puts you in the forefront of the multimedia revolution. The fastest (600KB/sec) data transfer rate yet seen will whiz multimedia video, graphics and animation across your screen, providing you with realism and excitement that slower CD-ROM drives can't match.

4PleX quad speed drives are available in both internal (standard half-height size for easy mounting in your PC) and external configurations. Both models feature a massive 1MB buffer, the largest ever found on a CD-ROM drive. They connect to your system through a SCSI-2 interface, which offers tremendous performance advantages over the IDE- and ATAPI-interfaces used by many competing drives. 4PleX drives surpass MPC-2 specifications, and are XA and Kodak Photo CD multisession compatible.

Plextor drives are designed for maximum performance and minimum downtime. They are built at an ISO 9002-approved factory in Japan, boast an industry-leading 70,000 MTBF (15% duty), and are covered by a two-year warranty. If you encounter any difficulty installing or operating a 4PleX drive, call our toll-free technical support line, where real people with real answers (CD-ROM is all they do!) will assist you.

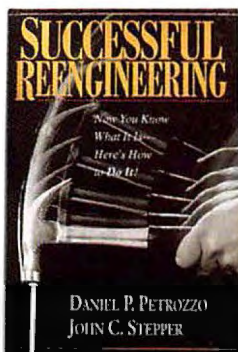
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Not-So-Successful Reengineering

THORNTON MAY

Most BYTE readers will not get value from or enjoy *Successful Reengineering* by Daniel P. Petrozzo and John C. Stepper. The book, for all its faults, is grounded on a very accurate premise—most reengineering projects fail. The authors are correct in their belief that BYTE readers need a real-world guide to making such projects work. Unfortunately, this book is not that guide.

Much like the reengineering projects these two aging guru-wannabes protest to be expert in, the book starts with lofty promises, wanders around in a surprisingly unstructured manner (a problem of poor editing), takes too long, delivers too little, and in the end disappoints. Three major points of disappointment appear consistently throughout the book: (1) There's no new empirical evidence, (2) It's grounded in managerial "old think," and (3) It's dated technologically.

Reengineering is arguably the hottest thing on the managerial agenda of the Business Week 600 these days. In 1991, fully 45 percent of the top 600 companies in the U.S. had launched some type of reengineering initiative. By last September, the participation rate had increased to 63 percent. With these types of numbers, you would think the authors would be able to serve up a steamy plate of live case studies—what works and what doesn't. One would expect pearls of wisdom and telling anecdotes from Petrozzo's consulting experience. One yearns for live lessons from Stepper's days laboring in the trenches of Morgan Stanley. No such luck—not one personalized "I was there, I watched it happen, and this is what I learned" piece of information.

One might forgive the lack of granular realism if, in its place, one found conceptual brilliance, an eloquent articulation of reengineering projects, and how they actually operate. No such luck here, either. The authors chose as their organizing framework the amazingly unconvincing I. discover; II. hunt and gather; III. innovate and build; IV. reorganize, retrain, retool.

What a yawn. Even the names are tiresome. In presenting their framework for *Successful Reengineering*, there is no empirical benchmarking data. We are never told how long each reengineering phase should take, how much it should cost, and what roles the various team members might play. The authors ad nauseam acknowledge some imagined debt they owe to Michael Hammer and James Champy. They confront you incessantly with phrases like "similar to Hammer and Champy," "not unlike Hammer and Champy," and "as Hammer and Champy correctly pointed out." If we wanted to read Hammer and Champy's book, *Reengineering the Corporation*, we would have. In short, there is nothing new here.

The authors make no reference to collaborative work management software or groupware. One of the most exciting developments in reengineering is the business application of video-game technology to simulation or simulation modeling tools. The book reeks of technical talk, with cameo appearances from hot topics like intelligent agents and virtual reality. However, there is limited discussion regarding the cause and effect between distributed computing and reengineering.

What emerges is a well-intentioned though poorly executed view by outsiders into the fascinating world of reengineering. It's lacking a Hemingwayesque grounding in the realities, what the technical team leader experiences when the prototype works and when it fails. ■

SUCCESSFUL REENGINEERING

Daniel P. Petrozzo and
John C. Stepper
Van Nostrand Reinhold
ISBN 0-442-01722-7

\$24.95

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HIT THE ROAD, JACK

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The AAA Trip Planner answers the age-old question "How do you get from here to there?" with both authority and panache. The program calculates your best route and traces it on finely detailed, printable maps. You get accurate directions, drive time, and mileage for most destinations in the U.S. Simply type in a starting point and your destination; the program does the rest.

In addition to planning your trip, the CD-ROM lists restaurants, attractions, and hotels (including average prices and credit-card acceptance) along your route. The listings are fairly comprehensive. Searching for restaurants near a small town in southern Vermont produced a list that included some of the better eateries in the area. The AAA Trip Planner is available in MPC format.

Virtual Landscapes lets you navigate and explore the hiking paths in Rocky Mountain National Park without leaving your home. A terrain map shows you the trails, and you pick the one you want to hike through. Digitized pictures of the trail from every point of view give you the eerie feeling of being there. You "trudge" up a slope, following the trail of crisp, snow-clad landscape images. Then you look back the way you came to admire the view. Views appropriate for glancing left and right are all there. In certain instances, you can even look up and down. It's really good, but just wait until these folks hook this stuff in with Apple's QuickTime virtual reality.

Certain scenes have hot spots that you click on to find out about local flora or weather. A continuous musical accompaniment is provided, and if easy listening is to your taste, it adds to the experience.

Virtual Landscapes is an amazing piece of work, seamlessly letting you experience the trails of the Rocky Mountain National Park. It's a good way to get a feel for the place before going there for a visit.

—Rich Friedman and Tom Thompson

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Books & CD-ROMs

IMMORTALITY

4.4BSD-LITE O'Reilly
& Associates,
ISBN 1-56592-082-1, \$150



BSD Unix is one of the best-known, most widely distributed, and most-revised versions of public domain Unix. Produced in the 1970s by the Computer Systems Research Group of the University of California at Berkeley, it has been distributed to and modified by educational communities worldwide. Last year, UC-Berkeley stated it would no longer provide maintenance and upgrades for it following the last release, 4.4BSD.

However, BSD Unix is too good a resource to throw away. It is a rich source of both reusable source code and overall system architecture that can be mined for years to come. O'Reilly & Associates has released a CD-ROM of 4.4BSD sources and the full five-volume set of accompanying documentation—*System Manager's Manual*, *Programmer's Reference*, *User's Reference*, *Programmer's Supplementary Documents*, and *User's Supplementary Documents*.

The usefulness of 4.4BSD is not limited to Unix aficionados. It contains a wealth of information for all professional programmers—no matter what your programming platform. At the very least, it contains reams of reusable source code for implementing operating systems, networking, file sharing, and security (i.e., Kerberos), not to mention a large number of utility programs and languages (e.g., AWK, C, C++, Pascal, and Perl).

Equally as important as the source code is the accompanying documentation. O'Reilly & Associates has taken the effort to provide these in printed form for easy reference. This is particularly important for the two *Supplementary Documents* volumes, which contain original documentation from many of the most important designers of Unix and its supplementary utilities. These volumes provide the designer's own view of the system architecture. It is here that the system architecture that influenced a generation of programmers comes to life.

—Raymond GA Côté

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THE UNIX HATERS HANDBOOK by Simson Garfinkel, Daniel Weise,
& Steven Strassman IDG Books ISBN 1-56884-203-1, \$16.95

Lord knows it's easy to whine and complain about anything these days. It must also be easy to get silly junk published, too. All you need to do is what these "authors" have: Pull together a collection of messages from an Internet mail server dedicated to complaints about Unix, thread other people's diatribes with a few comments and some cute but unrelated art, add a gimmick (a customized motion-sickness bag), and put the sorry mess on the shelves of bookstores. The Anti-Foreword by Dennis Ritchie, who, along with Ken Thompson, created Unix at Bell Labs some 25 years ago, suggests that if you have a problem with Unix, there is no problem—build your own version, as the Free Software Foundation has done. Unfortunately the "Unix barf bag" is too small to contain the book that it comes with. ■

—Ben Smith



Network utilities—vital, but set aside 100K



DOS 6 utilities—handy, but about 120K



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



Internet utilities—where will you get 120K?

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

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



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Introducing QEMM 7.5 It Makes Room for All the Good Stuff

Our newest QEMM takes into account the greater demands you're putting on 'conventional' memory today: device drivers, sound cards, disk compression, caches, network utilities, CD ROM drivers, etc. Not to mention all the stuff you want for tomorrow, like the drivers you'll need for Internet utilities. It finds room for all those things so you don't have to sacrifice capabilities you want—now or in the future.

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

Say you wanted to run a mouse, sound card, SmartDrive, your DOS 6 and Novell utilities, and your Microsoft Bookshelf '94 CD ROM. You couldn't with MemMaker. Not unless you were willing to manually

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- PCMCIA support
- Stealth Stacker saves 8-32K
- QuickBoot saves time
- Optimize/Restore lets you revert to recent settings

'tune' it. And then you might end up with 490K or so to use. But QEMM 7.5 routinely returns 634K of conventional memory. And when you consider as little as one 'K' of memory makes the difference between a program loading or not, you can see where an additional 140K or so could be vital.

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QEMM 7.5 comes with a new version of our award-winning memory utility, Manifest, which reports details you can't find out any other way—like how Windows and the programs running under it are using memory or what software is using your IRQs.

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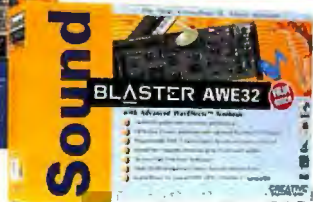


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APPLE'S HIGH-TECH GAMBLE

In the 1970s, VisiCalc was the killer application that made the Apple II a hit. In the 1980s, desktop publishing did the same for the Macintosh. In the 1990s, Apple is hoping once again that breakthrough technology will help it leapfrog the competition.

TOM R. HALFHILL

Apple is gambling its future on three new technologies that could transform the computer industry and redeem Apple's destiny. But if those technologies should fail, or unfold too slowly, Apple probably won't finish the century as a leading computer company.

If that judgment sounds too harsh, consider recent events. Apple has slashed prices to stay competitive with companies selling commodity PC clones, at the expense of watching its once-luxurious profit margins tumble by half. Thousands of employees have been laid off, including high-profile CEO John Sculley, who was replaced with a more down-to-earth manager, Michael Spindler. New operating systems from Microsoft are catching up with, and even surpassing, the Mac OS in key areas of technology, while PCs are finally acquiring some long-standing hardware advantages of the Macintosh, such as plug and play. Most of all, in a risky effort to increase its stagnant worldwide market share—10 percent, according to market-research firm Dataquest (San Jose, CA)—Apple is turning to a drastic strategy: licensing other vendors to clone the Mac.

Of course, dire predictions are nothing new for

Apple, and few companies have such a remarkable record of confounding the experts as Apple does. In the past, some new technology has always come along to save the day. That's because Apple is a technology-driven company that relies on innovation to differentiate its products from those of the bargain-basement clone makers. Unique technology is what allowed Apple to charge high prices in the Sculley era, when profit margins took precedence over market share.

Although Apple is now pursuing a market-share strategy and has altered the price/performance equation in its favor, make no mistake: Apple still considers itself to be a technology company. It has no more intention of competing on price alone in the 1990s than it did in the 1980s. Once again, Apple is gambling on technology—actually, three new technologies—to rescue its fortunes.

By far the company's biggest bet is on RISC. Apple believes that the horsepower of RISC processors will be required to run the system software and applications of the future, and that anyone who invests in CISC hardware and software is on a dead-end road. RISC chips, such as the PowerPC, says Apple, will keep getting faster and less expensive, while CISC chips, such as the x86, will run out of gas. Operating systems closely tied to the x86, such as Windows 95, are equally doomed in this view. Eventually, says Apple, PC users will realize they must move to RISC, just as they eventually accepted the GUI and numerous other technologies pioneered by the Mac.

Apple's second bet is on the 11-year-old Mac OS. Although the operating system is falling behind the competition in some



important categories—most notably, preemptive multitasking and memory protection—it still offers features that are just starting to appear in Windows, such as 32-bit addressing and color matching. Its collaboration software, digital signatures, speech recognition, and telephony functions have been shipping for a year or more. Plug and play has been standard since 1987, and Apple is applying this experience to new device interfaces, such as PCI (Peripheral Component Interconnect) and PCMCIA.

Apple's third bet is that large, monolithic software will give way to small, efficient componentware. This is another obvious shot at Microsoft, which happens to be the market leader in large, monolithic software. Apple is counting on new technologies such as OpenDoc and the Taligent operating system to catch on.

The idea behind componentware is that users can build their own customized solutions by linking together software parts optimized for specific tasks. Microsoft's OLE is a similar technology, but Microsoft is trying to protect its large applications (e.g., Excel and Word) by promoting them as components. Apple is betting that componentware will not only change the way people use computers but will also change the software industry by lowering the barriers that now discourage small, innovative developers.

In addition to these three technologies, Apple is making a wild-card wager on mobile computing. Laptops, such as the PowerBooks, are definitely part of this strategy, but Apple is preparing for the day when PDAs (personal digital assistants) are as ubiquitous as calculators. Despite the almost unprecedented storm of negative publicity that drowned the introduction of the Newton MessagePad, Apple has not retreated from this technology. On the contrary, Apple is quietly laying a foundation that could give the Newton a crucial advantage when the hardware catches up with the vision. (See the text box "The Newton and the Hare" on page 52.)

Several other technologies and products are important to Apple—indeed, the company constantly wrestles with overdiversification—but the PowerPC, the Mac OS, and componentware appear to make up the fulcrum on which Apple's future is balanced. Apple might survive a wrong bet in one or two of these areas, but if all of them tilt the wrong way, the company will find itself in serious trouble. Although outright collapse is unlikely, Apple could succumb to a fate almost worse than death: irrelevance. That's what happened to Commodore after its disastrous fall in the mid-1980s, despite the cutting-edge technology of the Amiga.

The RISC Debate

Apple believes that users who buy x86-based PCs are stam-

ping headlong into a brick wall: CISC processors, such as the Pentium and its successors, won't deliver the raw performance demanded by tomorrow's advanced operating systems and applications. Eventually, PC users will realize their folly and turn to RISC, rendering most of their hardware and software obsolete. Why not switch now rather than later?

"Apple has already made the transition," says Ian Diery, executive vice president and general manager of Apple's Personal Computer Division. "We're already a known quantity. That's going to help us gain market share. I'm not suggesting that Intel and Windows are going to disappear, but I do think Apple will prosper because we are making the RISC transition sooner."

It's a compelling argument—one that's widely supported by other companies with a vested interest in RISC: DEC, IBM, Motorola, SGI/Mips, and Sun Microsystems. And they certainly have a lot of cards in their favor. All the latest and fastest microprocessors are pure RISC designs: DEC's Alpha 21164, IBM/Motorola's PowerPC 604 and 620, Mips's T5, and Sun's UltraSparc. The newest architectural innovations usually appear first on RISC, and RISC chips generally have smaller dies and fewer transistors than



The Newton and the Hare

Negative reviews are bad enough, but when your company's new product is ridiculed for a whole week in *Doonesbury*, you know you've got a public-relations disaster.

Most products wouldn't survive such a withering blast. But Apple keeps plugging away with the Newton MessagePad, keeping a low profile while building for a hopefully brighter future.

"People ask me what it's like to work on the Newton," says Steve Capps, an Apple Fellow (senior scientist). "I tell them I'm thick-skinned, but not thick-headed. We've got to stick with the Newton but be wise about it."

Although the Newton MessagePad has not lived up to its early promises, it has quietly moved to the forefront of the embryonic market for PDAs (personal digital assistants). Rivals such as the Eo (owned by AT&T) have dropped out, and other competitors postponed their plans when they

saw what happened to the Newton. That's giving Apple an opportunity to retrench and build a solid foundation of software developers, applications, licensees, vertical-market users, and experience.

The Newton's greatest strength is its operating system, perhaps the most advanced on any personal computing device. It's CPU-independent, and programs that are run on it don't have to be recompiled for different processor architectures. It's oriented around the task, not the application, so users can switch seamlessly among programs. Its persistent object database eliminates the hassles of file management and incompatible file formats. And its user interface is deceptively powerful, while shielding users from confusing hardware details. In fact, the Newton gives us a peek at the kind of operating systems we'll see on future desktops.

Without much fanfare, Apple is leverag-



ing vertical markets to subsidize the development of true consumer PDAs. Newton MessagePads are being used by soybean farmers to manage crops, by telephone technicians to communicate with central offices, by medical workers to record patient data, and by real estate salespeople to retrieve listings.

PDAs will inevitably succeed and become as widespread as calculators and Walkmans are now; the only question is whether Apple's commitment (or, indeed, Apple) will last that long. Capps thinks it will. "[Apple CEO Michael] Spindler really gets it," says Capps. "He understands that you have to think long-term about the Newton. You have to be very Japanese about this, thinking long-term while the product matures."

comparable CISC processors, so they cost less to make.

Furthermore, say RISC proponents, the price/performance gap between CISC and RISC is widening. They claim that CISC in general, and the 16-year-old x86 architecture in particular, is on a flattening curve that will not keep pace with RISC. Apple says its first Power Macs with PowerPC 604 and 620 chips—which are planned for 1995 and 1996—will blow away the Intel-based boxes and make this fork in the road crystal-clear to even the most loyal PC devotee.

The truth is not quite so clear-cut, however. For one thing, the manufacturing costs of microprocessors are determined by volume as well as die size, and nobody approaches Intel's volumes. Dataquest says Intel holds 74 percent of the worldwide microprocessor market, followed by Motorola, which has 8 percent. Part of the reason why Pentiums cost

more than RISC chips may be that Intel is simply amortizing its expensive chip factories more quickly. At \$1 billion per factory, that's no small factor.

What's even more important is the fact that the architectural differences between CISC and RISC are becoming rather fuzzy. The newest x86-compatible chip is the K5 from Advanced Micro Devices (Sunnyvale, CA). It's virtually a pure RISC design: quad-issue superscalar pipelines, five parallel functional units, dynamic branch prediction, speculative execution, out-of-order execution, an expanded register file, and large primary caches. To feed this core, the K5 has an ingenious decoder that reduces complex x86 instructions to RISC-like operations that issue in parallel (see "AMD vs. Superman," November BYTE). The latest x86 chips from Cyrix (Richardson, TX) and NexGen (Milpitas, CA) are similar CISC/RISC hybrids.

CPU design

is so wide open that there is no architectural technique used in RISC processors that doesn't find its way into CISC chips. The only real difference goes back to the original definitions of CISC and RISC, which stated the relative complexity of the instruction sets. CISC chips still must devote more cycles and transistors to decoding complex, variable-length instructions. But even that distinction is minimized by modern compilers, which generate most of their code using a subset of faster, simpler instructions.

If CISC isn't dying, RISC fans counter, then why did Intel recently form a partnership with Hewlett-Packard to develop a new microprocessor based on HP's Precision Architecture RISC technology? Again, this question dodges the basic issue, which isn't really RISC versus CISC at all. For one thing, the jointly developed Intel/HP chip may not fall neatly into

Apple's Technology Milestones



April 1, 1976:
Apple Computer founded.



April 1977:
Apple II, first personal computer with color graphics.



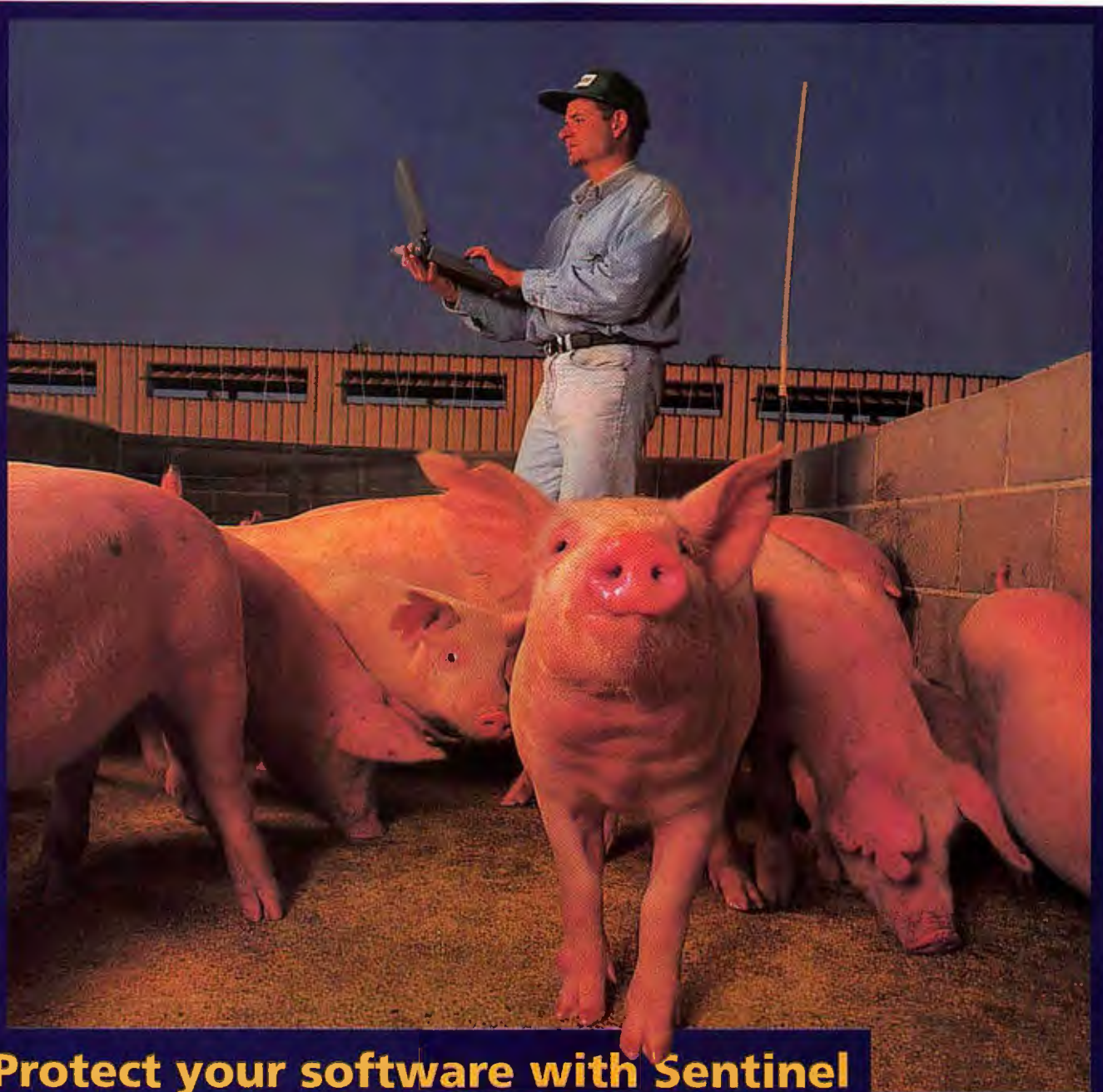
October 1979:
VisiCalc, the first spreadsheet program, released for the Apple II.



January 1983:
Lisa, forerunner of the Macintosh, first personal computer with a GUI.



January 1984:
Macintosh debuts. First personal computer with dynamic memory allocation, API programming support (the Toolbox), a graphics API (QuickDraw), a global clipboard, undo, and 3½-inch floppy disks.



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either category; rumors indicate that it will use VLIW (very long instruction word) technology. More to the point, the chip will be backward compatible with the x86, underlining that this is really a battle between instruction sets, not architectural styles.

Right now, Intel is winning the instruction-set battle. Apple has done a commendable job of building a solid base of native PowerPC software—more than 200 applications, including most of the mainstream programs that Mac users really need. But so far, there aren't any truly unique programs that aren't also available for the x86. There's no killer application like Aldus PageMaker, which can't run in a character-oriented environment such as DOS. Although Apple has established itself as the leading vendor of RISC-based personal computers, the x86 instruction set continues to attract *more* users and software, not less.

This is especially true in the business world, where the Mac has only about 6 percent of the market, compared to 14 percent in homes and 28 percent in schools worldwide, according to Dataquest (see the text box "Macs in the Enterprise" on page 64). Even Apple bows to this reality by promoting x86 compatibility on the Macintosh, either with emulators, such as SoftWindows, or plug-in x86 boards.

Apple's experiment last spring with the 486 Houdini board for the Quadra 610 was so successful that a new line of 486 boards for the Power Macs was to be announced in November (see the text box "Houdini Reappears" above). Apple is also rumored to be looking at IBM's PowerPC 615, a RISC chip that will execute x86 instructions—virtually the same concept as that used for the Intel/HP hybrid processor.

Apple embraced RISC

Houdini Reappears

Apple was so pleased by the test marketing of its first DOS-compatible board—nicknamed Houdini and briefly bundled last spring with the Quadra/Centris 610—that a new line of 486 plug-in boards will be announced at Fall Comdex. The first one is designed for use with the Power Mac 6100, but Apple says more versions will follow.

"We want to make sure that anyone who is considering a Mac won't have to pass us by just because there's one application that isn't available for the Mac OS," says Dave Daetz, cross-platform product-line manager for Apple's Personal Computer Division.

The new Houdini incorporates several improvements suggested by users, especially corporate buyers. First, it has a 66-MHz Intel 486DX2 processor instead of the 25-MHz 486SX in the original version, and it plugs into the 6100's PDS (Processor Direct Slot) instead of a NuBus slot. Both changes will significantly boost performance. Second, the new Houdini supports NetWare or TCP/IP networking via the Mac's built-in Ethernet port. Third, it includes a 16-bit stereo SoundBlaster-compatible chip set. And fourth, it accepts up to 32 MB of local RAM on 72-pin SIMMs. Like the previous board, it can also share the Mac's RAM, but this reduces performance by about 25 percent.

At Comdex, Apple will show a "technology demonstration" of a 68040-based Quadra 630 with a Houdini board, but that product isn't official. Apple says it may enlist third-party vendors to make DOS-compatible boards for some Macs.

Apple estimates that a Power Mac 6100 bundled with the new Houdini board plus 16 MB of RAM, a 350-MB hard drive, a color monitor, and a keyboard will sell for about \$2899, which works out to a cost of roughly \$500 for the Houdini. The board will also be available separately for about \$700.

not because CISC is inherently inferior, but because Motorola's CISC chips were falling behind Intel's and there was no viable alternative. If Motorola had shipped the 68040 and the 68060 a year before Intel released the 486 and the Pentium, Apple might still be in the CISC camp.

Finally, while it's true that the latest CISC chips are not as fast as their RISC counterparts and also tend to cost more, the price/performance delta does not directly translate into street prices for complete systems. For instance, the PowerPC

601 chip costs about half as much as a comparable Pentium chip, but a 601-based Power Mac does not cost half as much as a Pentium-based PC. The Mac is slightly less expensive and slightly faster, but currently the differences are not dramatic enough to lure significant herds of buyers away from the x86.

Widening the Gap

Part of the reason why the PowerPC's edge over the Pentium does not translate into desktop performance is that Apple's transition to RISC was tied to backward compatibility, not maximum performance. The primary goal of Apple was to preserve its users' investment in existing software and hardware.

Moving to a new microprocessor architecture is so fraught with danger that only one personal computer company has ever successfully made such a transition: Apple. In the 1980s, Apple successfully switched from the 6502-based Apple II series to the 680x0-based Mac. Competitors who attempted the same metamorphosis (e.g., Commodore and Atari) failed to repeat their past glories. Tandy appeared to survive its move from the Z80 to the x86, but the company later sold off its computer manufacturing to AST Research.

Operating-system transitions are hazardous, too. When IBM and Microsoft first tried to move PC users from DOS to OS/2, very little software was available, and DOS programs couldn't be multitasked. After the companies' divorce, OS/2's slow take-off opened up a window of opportunity for Microsoft.

Recognizing this danger, Apple made several compromises while designing the Power Macs. The biggest compromise was not porting the entire Mac OS to PowerPC-native code. Of course, time-to-market



January 1986:

Macintosh Plus is the first personal computer with built-in SCSI.



March 1988:

Plug-and-play SCSI CD-ROM.



April 1989:

32-bit QuickDraw allows Macs to display photo-quality, true-color images.

January 1985:

The Mac becomes the first personal computer with built-in networking (LocalTalk). Also, the LaserWriter laser printer helps establish the Mac as the standard for desktop publishing.



March 1987:

Macintosh II introduces NuBus and easy plug-and-play expansion.

August 1987:

HyperCard introduces visual programming; MultiFinder brings multitasking to the Mac.

September 1988:

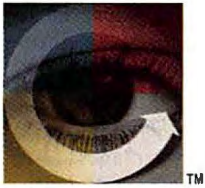
SuperDrive can read/write Mac, DOS, OS/2, and ProDOS floppies.

January 1991:

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considerations also played a major role in this decision, but the result is that most of the Mac OS is still 680x0 code. The operating system relies on the 68LC040 emulator—the same one used by 680x0 applications software—to run the nonnative portions of itself. In fact, only about 15 percent of the Mac Toolbox—the low-level functions called by the Mac OS—runs natively.

Skeptics (including this writer) questioned the wisdom of this scheme, but Apple miraculously pulled it off. Indeed, the difficult shift to a new CPU architecture has broken less software than earlier, relatively minor, transitions—such as the move from the 68030 to the 68040 or from System 6 to System 7 (or, for that matter, from Windows 3.0 to Windows 3.1). But now Apple needs to pay more attention to performance.

The Mac OS is so vast (with more than 4000 Toolbox calls), and so much of it is written in hand-tuned 680x0 assembly language, that it's unlikely the whole thing will ever be ported to the PowerPC. Instead, Apple is concentrating on the most frequently called and the most time-consuming routines. This makes sense, but the process is progressing slowly. BYTE and others think Apple should release native Mac OS components in stages to lengthen its performance lead over the Pentium.

Hardware improvements are also required. Apple is moving toward a more industry-standard platform that will provide more headroom for better performance, but its laudable desire to protect the investment of existing users will spread the project over a period of two or three years (see "Apple Redefines the Macintosh," November BYTE).

In any case, a RISC victory still won't guarantee a triumph for Apple, because Microsoft is covering both bets: If CISC sinks, Microsoft has Windows NT, which runs on the Mips R4x00, DEC's Alpha, and, soon, the PowerPC. IBM's OS/2 is moving to RISC as well, and Unix was there all along. In other words, Apple isn't the only RISC game in town.

Microsoft's "Windows every-

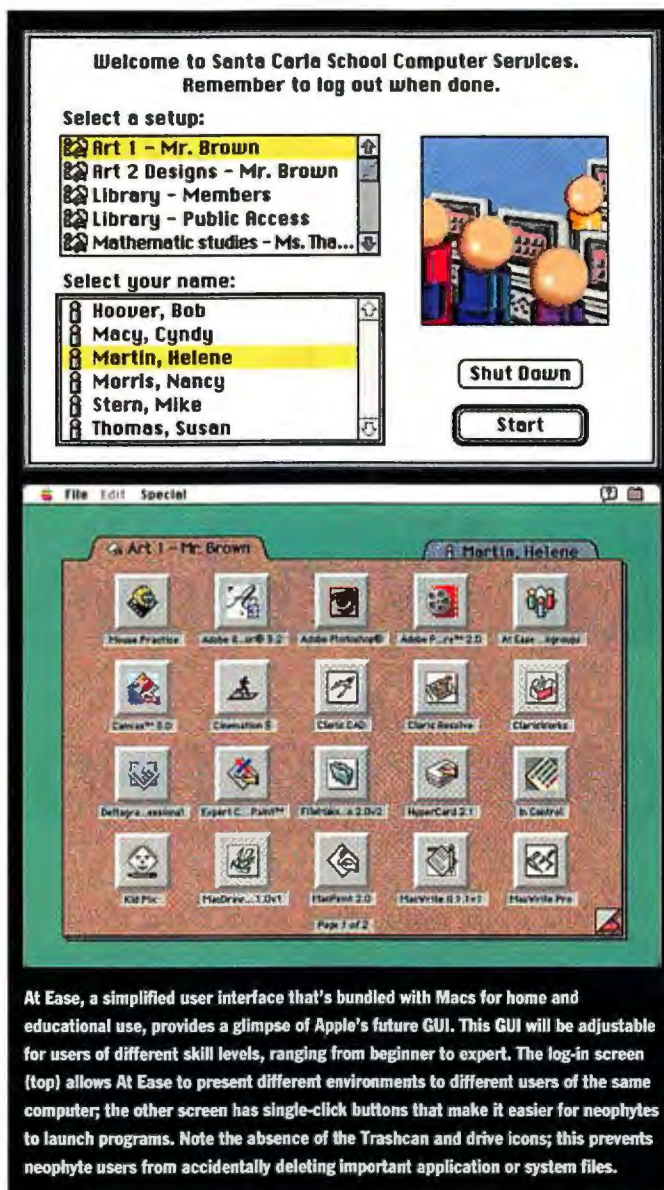
where" strategy erects a safety net for software developers, too. By writing for the Win32 API and avoiding x86 dependencies, developers can ship to the huge x86 market now and easily recompile for a variety of RISC chips if CISC goes sour later. Options for Mac developers are more limited because the Mac OS runs only on the Mac.

Operating-System Wars

Behind Apple's argument for RISC is the promise that extra horsepower will raise system software and applications to a new level of performance unattainable by CISC. But staying ahead of Microsoft and other competitors will not be easy.

Already, millions of users don't perceive a qualitative difference between Windows 3.1 and the Mac OS. Apple's attempt to defend the Mac's uniqueness by suing Microsoft in federal court backfired badly; when the court ruled that almost no aspect of the Mac's GUI is protectable, the doors opened wide for Microsoft to blur the differences even further. As a result, Windows 95 sports a radical, Mac-like facelift, and the Mac is losing its most visible advantages.

Of even greater importance, however, are the less-visible features. Windows 95 and Windows NT (not to mention OS/2) are pulling ahead of the Mac in some critical areas: preemptive multitasking, multithreading, memory protection, multiprocessing, security, and portability. The last three features are provided only by NT, and Windows 95 has yet to ship, but Microsoft still makes a strong case that RISC isn't a prerequisite for state-of-the-art system software.



At Ease, a simplified user interface that's bundled with Macs for home and educational use, provides a glimpse of Apple's future GUI. This GUI will be adjustable for users of different skill levels, ranging from beginner to expert. The log-in screen (top) allows At Ease to present different environments to different users of the same computer; the other screen has single-click buttons that make it easier for neophytes to launch programs. Note the absence of the Trashcan and drive icons; this prevents neophyte users from accidentally deleting important application or system files.



May 1991:
QuickTime, the first standard architecture for dynamic media.

January 1993:
ColorSync, the first color-matching technology built into an operating system.



August 1993:
Newton MessagePad debuts.



January 1991:
Apple petitions the FCC to allow personal computers to exchange information via wireless radio.

May 1992:
WorldScript, the first worldwide language support for an operating system.

November 1992:
QuickTime for Windows makes QuickTime the first cross-platform dynamic-media standard.

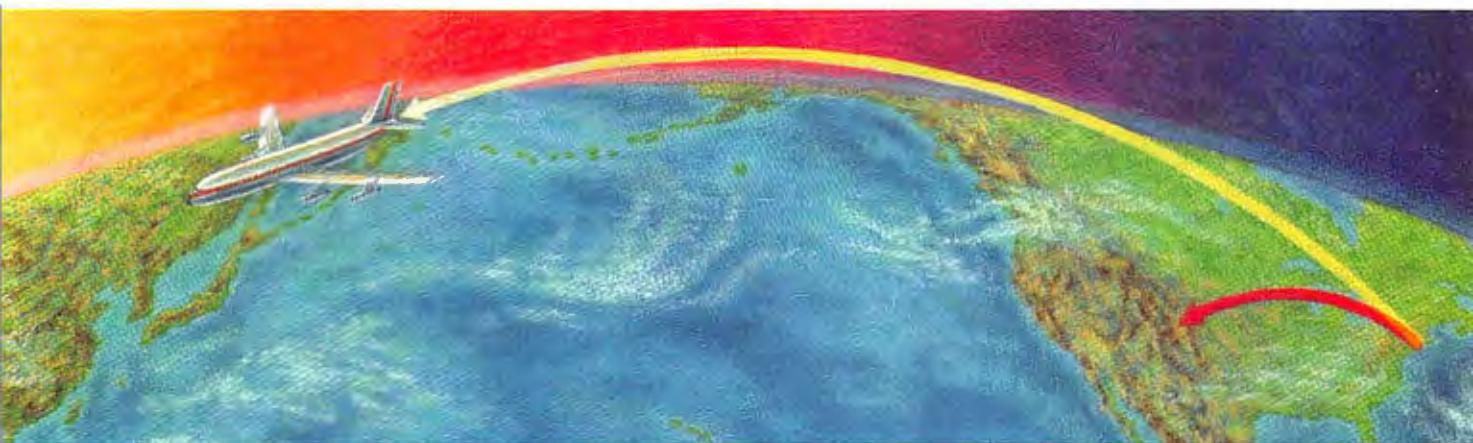


July 1993:
Quadra 660AV and 840AV, the first personal computers with built-in video digitizers and speech recognition.

October 1993:
PowerTalk and PowerShare, the first unified telephony and E-mail architecture for a personal computer operating system.



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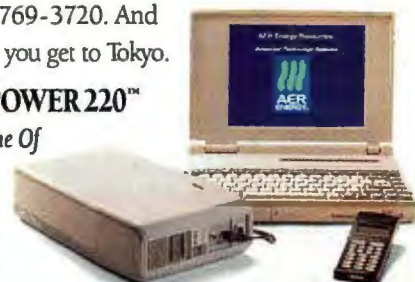
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Although Apple added a thread manager to System 7.5 (which was released in September), other advanced features require architectural changes that will shake the foundations of the 11-year-old Mac OS. The transition to RISC and other diversions have delayed this critical project. The next major release of the Mac OS, code-named Copland, is not expected until late 1995. It will be followed by another major upgrade, Gershwin, in 1996.

Among the improvements in Copland will be a microkernel, limited memory protection, and a new I/O architecture. These are the first steps toward full preemptive multitasking and memory protection, which won't arrive until Gershwin's debut.

Copland's microkernel will allow such low-level operations as concurrent I/O and networking to multitask preemptively; it will also allow applications to spin off preemptive tasks in protected memory partitions. But the applications themselves will continue to multitask cooperatively in a shared memory space. The limitation is that most Toolbox routines won't be reentrant in Copland, and the only tasks that can take advantage of protected memory and preemptive scheduling are those that call reentrant code. Fortunately, because device drivers and network services call lower-level routines that *will* be reentrant, Copland should measurably improve the Mac's reliability and performance.

Gershwin will convert still more of the Toolbox to reentrant code, allowing all tasks to run preemptively in protected memory. Any of the less important Toolbox calls that aren't reentrant could be replicated in protected memory to avoid scheduling conflicts.

A lot more code in Copland will be native to the PowerPC. Apple is vague on details but says more than half the code will be native. However, much of this native code will be in new parts of the Mac OS, not the existing Toolbox. As mentioned before, some Toolbox routines simply aren't called often enough to warrant a rewrite. Another consideration is the code expansion

that's inevitable when finely tuned CISC code is ported to RISC.

Other new features of Copland will include improved networking, a revamped user interface, and integrated OpenDoc (which will be released as an extension for System 7.x before Copland ships). The improved networking will come via Open Transport, a new abstraction layer that shields applications from network protocols. By communicating with this API, programs don't need to know whether the underlying network protocol is AppleTalk, NetWare, TCP/IP, or whatever.

But the new user interface will not be the kind of major face-lift that sets Windows 95 apart from Windows 3.1. Apple is coy about this because it doesn't want to tip its hand to Microsoft, but the general direction is toward a GUI that is scalable for users of different skill levels and that offers much more *active assistance*—Apple's term for interactive on-line help assisted by smart agents or scripts. The first examples of active assistance appeared in the Newton operating system and the Apple Guide extension to System 7.5. It's impressive technology, going beyond static on-line help to walk users through complex tasks or to automatically perform tasks delegated by the user.

Apple's new GUI may take on some of the look and feel of the company's At Ease software, which is bundled with home-market PerFORMas. The Finder is hidden behind a simplified GUI that makes it easier to launch programs and more difficult to delete important files. With a password option, it can present different working environments to different users on the same computer. At Ease is a remarkably elegant solution to the problem of sharing a Macintosh among fam-

PowerPC Alliance Near?

As this issue went to press in mid-October, Apple, IBM, and Motorola were reported to be nearing an agreement on a common PowerPC system platform that would redefine the PReP standard. The new reference platform would resolve the technical differences between Apple's Power Macs and the PReP-compliant systems that IBM and other vendors plan to introduce. It was also reported that IBM may be among the initial group of vendors that will license the Mac OS and manufacture PowerPC-based Mac clones. Other companies named as possible licensees were Fujitsu, Motorola, Olivetti, and Toshiba. However, BYTE was unable to confirm these reports before our press deadline.

ily members, some of whom (either the adults or the children) may be computer neophytes (see the two screens on page 58).

To get some idea of where Apple is going next, simply imagine At Ease and the traditional Finder as two disparate points on a spectrum of usability. Now imagine a highly customizable environment that can be adjusted to any point in between. Add active assistance, and you've got a rough picture of Apple's future GUI.

This could be Apple's best chance to reassert the Mac's uniqueness. Apple is justly famous for its human-interface design and traditionally leads the industry in that area. It's no coincidence that every new version of Windows looks more and more like the Mac. While Windows users are celebrating the end of their 10-year wait for long filenames, Apple is pushing forward into bold new territory.

But the flashy new GUI still needs an industrial-strength foundation, especially if Apple wants to make inroads into corporations. Full preemptive multitasking, memory protection, and advanced 3-D graphics won't arrive until Gershwin's debut. Mac users are fairly well served by the robust cooperative multitasking and crash recovery of System 7.x, but Apple would be playing a stronger hand if it could deliver these basics sooner.

The Clone Question

One significant benefit of Copland's microkernel will be hardware independence. The Mac OS has always been tightly integrated with the Mac's underlying hardware. Removing those dependencies will make it easier for Apple to license Mac clones and will also move the Mac system architecture toward a more industry-standard platform. Both

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Macintosh TV, the first personal computer with a built-in TV and CD stereo system.

March 1994:
Power Macs debut, quickly becoming the leading RISC-based personal computers.

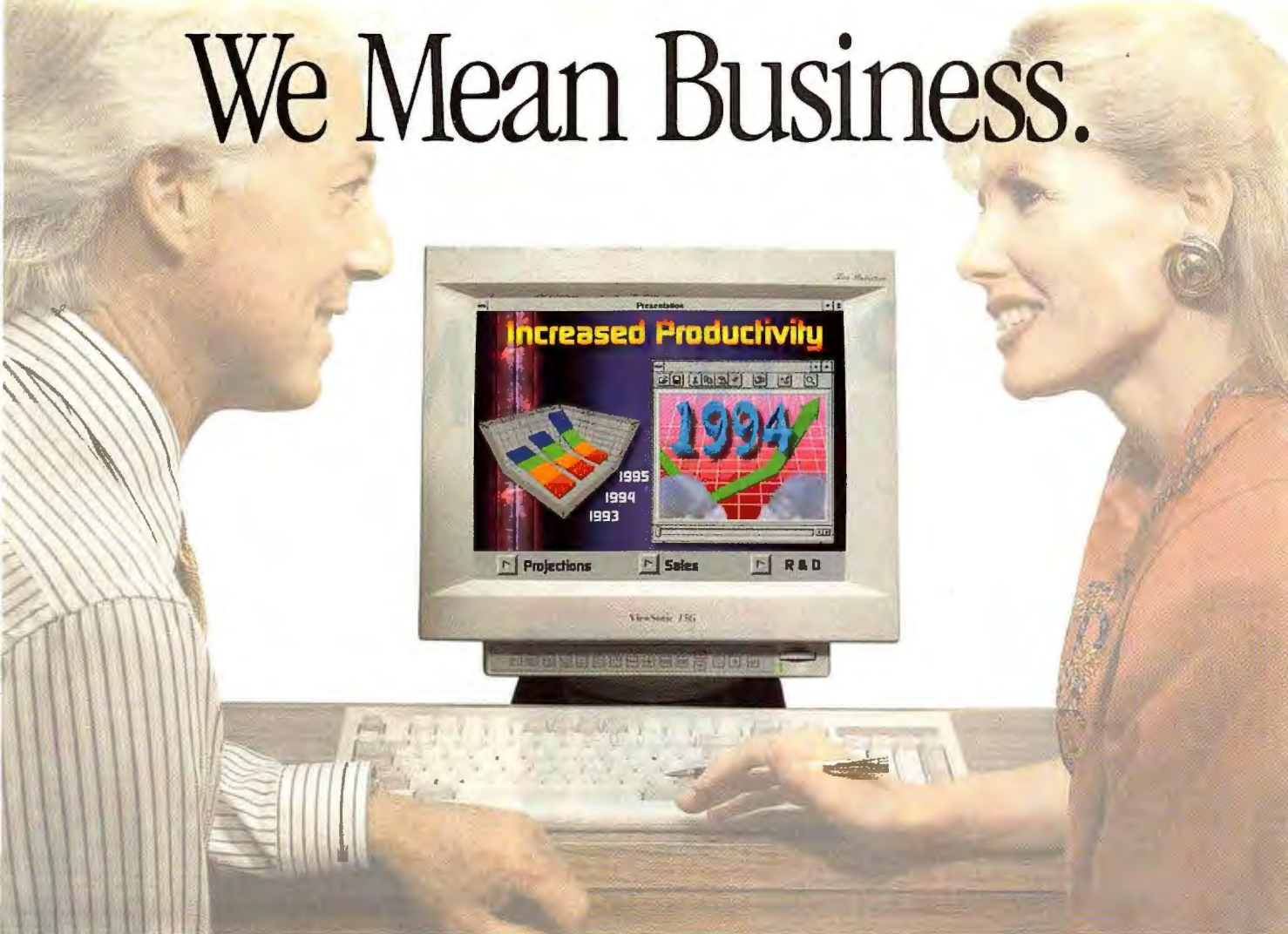
March 1994:
System 7.1 for Power Macs is the first operating system that relies on emulation to run parts of itself, as well as legacy applications software.

March 1994:
QuickTake 100, the first 24-bit color digital camera under \$1000.

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objectives are critical to Apple's future. Indeed, how this process unwinds will largely determine whether Apple ends the decade as a mainstream computer vendor or as a niche player.

The Mac's tightly integrated architecture is perhaps its greatest and most invisible strength. The advantages of tight integration didn't become obvious until the multimedia craze spread to PC users, who suddenly faced the dilemma of installing sound boards, video cards, CD-ROM drives, and other conflict-prone paraphernalia. If the resulting frustration didn't trigger a blip in the national suicide rate, it at least forced Microsoft and Intel to patch the PC system architecture with a catch-up technology called Plug and Play (see "Transforming the PC: Plug and Play," September BYTE).

Mac users have taken plug and play for granted since the introduction of the Mac II in 1987, and it probably accounts for Apple's strong showing in the home and educational markets. But the Mac OS and hardware are so interdependent that they pose problems for licensees working on Mac clones.

Licensing the Mac OS isn't just a matter of releasing the system software; everything is closely tied to custom ROMs and

ASICs (application-specific ICs). In fact, Apple is sharing Verilog models of its ASICs with licensees and is offering them the same volume discounts that Apple gets from its own suppliers. But this does not give the clone makers much latitude for differentiation. Apple's challenge is to break the system dependencies without losing the advantages of integration.

The first PC clone makers in the 1980s didn't confront this problem because the PC system architecture and MS-DOS were never so tightly integrated. Also, cloning the IBM PC was much easier because it wasn't nearly as sophisticated as the Mac. The biggest hurdle was writing a clean-room BIOS, which back then contained less than 32 KB of low-level code. Incidentally, the clone makers did this without IBM's help or blessing. Contrary to popular belief, IBM did not openly license the PC system architecture in those days; it was as proprietary as the Mac's. Only the operating system, Microsoft's MS-DOS, was openly licensed.

No one ever successfully cloned the Mac because the task of reverse-engineering its architecture was too daunting. Apple's decision to license the complete Mac architecture and overhaul it to help clone makers is therefore unprecedented.

Toward Common Ground

Licensing is a vital part of Apple's strategy to gain market share, but there is a more important motivation for decoupling the Mac OS from the metal. Apple wants to evolve the Mac toward a common PowerPC platform supported by IBM and other PowerPC system vendors.

While Apple has been shipping hundreds of thousands of Power Macs, IBM has been conspicuously quiet. IBM is selling PowerPC-based workstations, but no PCs. And while Apple is steadily accumulating a base of PowerPC applications software, there is no software for IBM's PReP (PowerPC Reference Platform). In fact, an industry joke is that PReP has more operating systems than applications (this is not quite true: Windows NT and OS/2 for PowerPC aren't available yet, either).

In great secrecy, Apple and IBM are negotiating the future of the PowerPC platform. The problem is that Apple's Power Macs and IBM's proposed PReP systems are fundamentally incompatible. There are several reasons for this, but the most vexing one comes down to the order in which bytes are arranged. Apple, with its 680x0 heritage, is big-endian; IBM, with its x86 heritage, is little-endian.

PowerPC chips can switch between the

Macs in the Enterprise

TOM THOMPSON

With a few notable exceptions, the Macintosh has been shunned by large companies ever since its introduction in 1984. In the past, there were some valid (and some not-so-valid) reasons for this. But many things have changed over the past few years, and it's time to revisit these reasons.

The Mac is expensive. This was certainly true until 1989, when Apple launched its first low-cost Macs. By sticking with proven components and slashing costs, Apple has made present-day Macs price-competitive with most PCs. In fact, in some cases Macs actually cost less than comparably equipped PCs. Today's Macs aimed at the business market ship with built-in Ethernet, built-in SCSI, 16-bit color, stereo sound, and integral plug and play. Several independent studies show that Macs are less expensive to set up and maintain in the long run.

The Mac is a proprietary system. This is a valid concern for managers who must

live with the decisions made regarding the purchase of hundreds of computer systems. However, now that Apple is licensing the Mac OS to other vendors, this objection will soon go away.

Macs are slower than PCs. This charge takes two forms: on a general system level and in the area of floating-point performance. Those who criticize the Mac's overall speed are generally comparing it to DOS or Unix. When you add a GUI, such as Windows or OSF/Motif, to comparable hardware, the difference disappears. Also, note that you typically need a 486-based PC to run Windows 3.1 at nonfrustrating speeds, while 68020- and 68030-based Macs still perform respectably with System 7.5. Power Macs run much faster, edging out today's Pentiums.

Any difference in floating-point performance is due to the overhead of the Mac's numeric API, which interfaces with the FPU. Most software developers who wrote programs that required heavy floating-point processing took the compatibility risk of bypassing the Mac API and talking directly

to the FPU. This issue becomes moot with the Power Macs, for two reasons. First, the PowerPC offers tremendous floating-point performance. Second, Apple is encouraging developers to use ANSI's FPCE (floating-point C extensions) to access the PowerPC's FPU directly. This should provide powerful floating-point performance while offering cross-platform compatibility for software developers.

The Mac requires nonstandard peripherals. Actually, Macs work with just about any printer, modem, or SCSI storage device that's available for PCs. Keyboards and mice don't work interchangeably because of the Mac's ADB (Apple Desktop Bus) connectors, and RS-422 serial ports require special cables or adapters. However, the Mac established SCSI as a standard for CD-ROM and storage devices, and some of the latest models (e.g., the Quadra 630 and the PowerBook 150) even use PC-style IDE drives. An optional module allows the 500-series PowerBooks to use PCMCIA cards, and future Power Macs will have a PCI (Peripheral Component Interconnect) bus, thus tapping into a growing market of industry-standard peripherals. Apple's recent announcement that it will move toward the PReP (PowerPC Refer-

two modes, but hardware dependencies in the Power Macs prevent them from cold-booting a little-endian operating system, such as OS/2 or NT. That's why SoftWindows must be launched on top of the Mac OS, wasting megabytes of RAM and precious processor cycles to simultaneously run two operating systems. Similar dependencies also prevent the Mac OS from running on PReP systems.

If the two sides don't reach some common ground, buyers will be confused by two mutually incompatible PowerPC platforms. It would be as if some x86-based PCs ran DOS and Windows software, while others required a whole different software library. Such a rift could prevent both PowerPC platforms from winning substantial market share.

Apple says that it needs at least a year to disentangle the Mac OS from the metal without breaking too much existing software. IBM, obviously, doesn't want to wait that long to launch PReP. Apple would seem to have a stronger position in these negotiations; unlike IBM, Apple has a growing installed base of PowerPC systems and software.

The ideal solution, from Apple's viewpoint, would probably be for IBM to manufacture Mac clones under license while

the two companies jointly evolved the architecture toward a more standard platform. Working together, they could probably accelerate this process and quickly reach something very much like PReP. Apple and IBM proved they can cooperate in this fashion by developing the PowerPC with Motorola. This new project, like that one, would serve the interests of both parties.

If Apple and IBM cannot agree on a course of action—and do so soon, ideally before the release of Windows 95—the PowerPC will pose a much smaller threat to the dominance of Intel and Microsoft. Apple and IBM could both end up as minor players in a high-stakes game.

Reinventing Software

The snowballing success of Windows over the past four years stole the Mac's uniqueness in more ways than one. In addition to retrofitting the PC with a Mac-like GUI, Windows lured away the software developers whose revolutionary applications set the Mac apart from any computer that had come before it.

None of the major developers writes exclusively for the Mac anymore. Nor do they automatically release their Mac versions sooner, as they once did. Programs

such as QuarkXPress, PageMaker, and Adobe Photoshop bring equal capabilities to both platforms, and the lucrative Windows market has attracted some big-league competition of its own, such as Aldus PhotoStyler and Corel's CorelDraw. Apple clings to a slim lead in some areas—for example, HSC Software's Live Picture is a breakthrough image editor available only for the Mac—but the old days of Mac supremacy are gone.

If RISC comes through and Apple can sell Power Macs that are insanely greater than x86-based PCs, there's a chance that Apple could reclaim its advantage. But the performance gap would have to open so wide that the new programs wouldn't work under Windows. And, of course, developers would have to find the inspiration to write those programs.

Apple is hedging this bet with another strategy: component software. If this concept pays off, big developers and applications might not be as important as they are today, and the Mac could attract some compelling software from a new generation of smaller, more inventive developers. Since Apple doesn't have a significant applications software business, it has little to lose—and possibly much to gain—by shaking up the software market.

"The software industry is in terrible shape," explains Apple's Ian Diery. "The market is dominated by one huge software company and by a small number of huge software applications. We have to move away from these huge programs to make room for more innovation."

If these big, monolithic programs could be broken up into smaller components, or if their features could be imported into other applications, the fatware trend might be halted. As a by-product, computing would be reoriented around the task, not the application. Users would work on compound documents, and systems would switch seamlessly among different programs and components (see "Componentware," May BYTE).

Microsoft is moving in this direction with OLE. Apple's answers are OpenDoc and Taligent. All three technologies have a similar goal: to reinvent the way software is constructed and used. However, Microsoft is taking a more conservative approach, promoting its huge programs as being both exportable components and containers for other components. Apple has a somewhat different model in mind and is portraying OLE as the more limited, proprietary solution. (It's proprietary because Microsoft controls OLE, while Taligent and OpenDoc are steered by open alliances of several different companies.)

continued

ence Platform) standard also bodes well for the future.

Macs cannot run specialized in-house software. This is another valid concern for business managers. Commercial software generally isn't a problem; most popular applications come in both Windows and Mac flavors. However, companies with lots of custom PC software often face a difficult job of porting those programs to the Mac, especially since there's no Mac version of Visual Basic (which is the business world's most popular development tool for Windows).

In many cases, the best solution is not to port the PC program at all, but rather to run it directly on the Mac. SoftWindows, from Insignia Solutions (Mountain View, CA), offers software emulation on a Power Mac that ranges from a 25-MHz 386 to a 25-MHz 486. Another alternative is an x86 add-on card, available either from Orange Micro (Anaheim, CA) or Apple (see the text box "Houdini Reappears"). If you decide to port the custom software instead, a couple of rapid applications development tools are HyperCard (from Apple) and ProGraph CPX, from ProGraph International (San Francisco, CA).

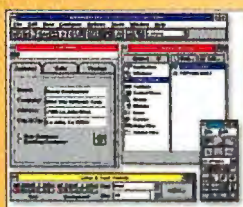
The bottom line? The Mac deserves a second look from managers who may have dismissed it several years ago for reasons that are no longer valid. The price/performance balance has changed considerably, and the Mac's easy setup and low maintenance are only now becoming appreciated by PC users struggling with the outdated PC architecture.

In addition, many companies are reducing their work forces and turning to telecommuting, and millions of people are starting businesses and working out of their homes. With no on-site MIS department to turn to for help, these people need computers that aren't a hassle to set up and maintain. The Mac offers all these capabilities now and is much easier to network in small workgroups with other Macs and printers.

Tom Thompson is a BYTE senior technical editor at large with a B.S.E.E. from Memphis State University. He is an Associate Apple Developer and the author of Power Macintosh Programming Starter Kit (Hayden Books, 1994). You can contact him on AppleLink as T.THOMPSON or on the Internet or BIX at tom_thompson@bix.com.

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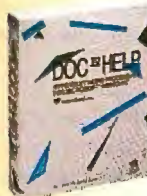
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Integra VDB by Coromandel Industries, Inc.

Available in separate versions for Visual Basic and C++ (Borland C++ and Visual C++). Integra VDB 2.0 is a visual database builder for developing ODBC compliant Windows database solutions, quickly, with virtually no code. It consists of database custom controls, high level functions, database classes, a visual query builder, a visual data manager, an ANSI SQL 92 SQL engine, ODBC drivers for dBASE, Btrieve, FoxPro, Access and Paradox. Distribution is royalty-free.

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Sample Spreadsheet		1992	1993
Yearly Sales			
Q1	\$25,176.00	\$31,301.52	
Q2	\$28,143.00	\$32,944.40	
Q3	\$27,128.50	\$26,884.22	
Q4	\$28,968.75	\$25,780.10	
Total	\$109,415.25	\$116,910.24	
Average	\$27,353.81	\$29,227.56	

CA-Clipper 5.2 for DOS by Computer Associates

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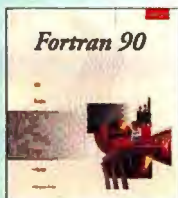


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The respective roles that Taligent and OpenDoc will play in Apple's future are not entirely clear, but it looks as if Taligent will be more specifically an enterprise solution, while OpenDoc will address the full range of users.

Components Everywhere

Taligent is an outgrowth of Apple's secret next-generation operating system, formerly known as Pink. Originally it rested on a microkernel, called Opus, that was 680x0-specific, but it was switched to a Mach 3.0 microkernel when Apple and IBM (who were later joined by HP) formed the partnership that became Taligent. Opus wasn't extensible to other platforms, and it also lacked industrial-strength security and multithreading. Mach is both more powerful and more portable, and it's the same microkernel that lies beneath Workplace OS.

TalAE (Taligent Application Environment) is the object-oriented framework that rests on Mach. It contains 1730 public object classes (and an equal number of nonpublic classes) and a stunning 53,000 methods, compared to about 4000 calls in the Mac API and 1500 in Windows. Indeed, TalAE is so rich in objects that Michael J. Potel, Taligent's vice president of technology development, describes it as "a whole OS of nothing but hooks."

Yet TalAE has just over 600,000 lines of code, compared to about 4 million lines in Windows NT and an estimated 16 million lines in Cairo, an object-oriented version of NT scheduled for 1995. In TalAE, objects can be as small as a single character and can even sit on the processor stack or in a register.

As Next discovered, convincing the world to switch to a whole new operating system isn't easy, despite the promised benefits of object-oriented computing. So, in addition to TalAE, Taligent is offering its technology in the form of

TalOS (Taligent Object Services), which provides portable system-software services, and TalDE (Taligent Development Environment). TalAE is portable across several CPU architectures (the PowerPC, x86, and PA-RISC) and operating systems (OS/2, AIX, PowerOpen, HP-UX, NT, and, eventually, the Mac OS).

TalAE, TalOS, and TalDE are scheduled to be released in phases throughout 1995. But TalAE won't run on the Mac OS until Gershwin's arrival in 1996, because it requires preemptive multitasking.

OpenDoc delivers componentware by another path. It is scheduled to ship as an add-on to the Mac OS, Windows, and OS/2 in 1995, and it will be integrated into Copland and OS/2 later. OpenDoc's evolution is controlled by an independent alliance known as Component Integration

Laboratories (Sunnyvale, CA)—CI Labs for short—whose backers include Adobe, Apple, Borland, IBM, Lotus, Novell, Oracle, Sun, and Xerox. Because OpenDoc appears to be a less radical make-over than Taligent, it will probably require less commitment from developers and users.

OpenDoc also promises several advantages over OLE, including wider cross-platform support (Mac, Windows, and OS/2); easier development (the OpenDoc API is claimed to be one-third the size of OLE's, and it handles the multitasking and event messaging that OLE pushes on developers); version control (successive changes to a document are stored as part of OpenDoc's Bento format); and more functionality (unlike OLE components, OpenDoc parts can be nested more than one level deep and aren't limited to rectangular screen regions).

But OLE, on the other hand, is already here and is gathering broad support from developers. And Microsoft is doing a good job of supporting OLE with its development tools and foundation classes.

Even OpenDoc's supporters know that OLE cannot be ignored, so CI Labs is working to make OpenDoc OLE-compatible. In fact, it is trying to turn OLE into a subset of OpenDoc; by writing to the OpenDoc API, developers could automatically gain OLE operability. CI Labs demonstrated this at Apple's Worldwide Developer's Conference last spring.

Technology demos are one thing, but do users really care about components? There is strong evidence that they do, often without realizing it. Photoshop Plug-Ins, QuarkXPress XTensions, Aldus Additions, and VBXes (Visual Basic custom controls) are all examples of successful componentware. But those components are specific to their applications. OpenDoc and Taligent promise a richer vein of components that will work across all applications and platforms.

continued

A 110-MHz PowerPC Speed Demon

On November 7, Apple announced its latest Power Mac system, the 8100/110. A look at the numbers in the name indicates that this new computer uses the existing system 8100 minitower design and that its PowerPC 601+ processor is clocked at 110 MHz, making it one of the fastest desktop systems on the market.

In addition, the 8100/110 has a nice base hardware configuration going for it: 16 MB of 80-nanosecond RAM and a fast 2-GB hard drive. At press time, the price for the system (without monitor or keyboard) was tentatively set at \$5700. The existing 8100/80 configuration remains available as a lower-priced alternative.

As the preliminary BYTE benchmarks shown in the table indicate, in many situations the 8100/110's 68LC040 emulator runs 680x0 applications faster than a Quadra 840AV, a 40-MHz 68040-based Mac. The Graphics, Scientific, and Spreadsheet application indexes are lower because these programs do their own floating-point computations, which bog down in the emulator. This makes the 8100/110 practically faster than any 680x0-based Mac on the market, and that's only its emulator.

Native PowerPC applications run much faster, of course. When we used the native version of Microsoft Excel 5.0 in the tests, we observed an eightfold increase in the performance of spreadsheet computations, and desktop publishing performance (using the native version of PageMaker 5.0) nearly doubled. The overall application index also nearly doubled when we used these two native applications out of a test suite of seven.

—Tom Thompson

Preliminary Application Indexes

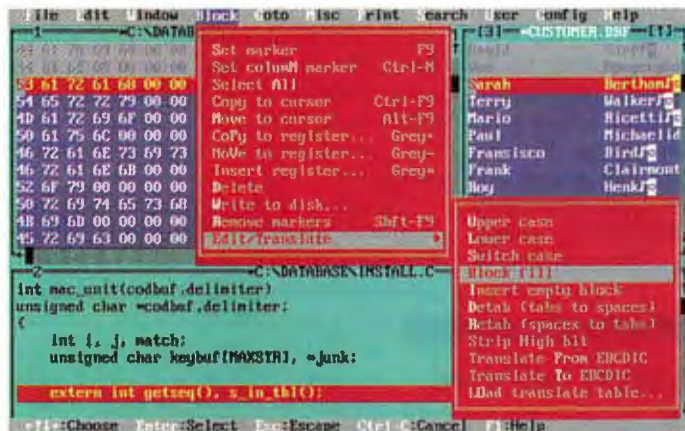
	QUADRA 840AV	POWER MAC 8100/80	POWER MAC 8100/110	POWER MAC 8100/110 (NATIVE)
Word Processing	2.61	3.67	4.35	4.35
DTP	4.50	2.52	4.90	9.47*
Database	6.28	5.93	6.86	6.86
Development	4.25	3.40	4.86	4.86
Graphics	4.57	3.13	3.63	3.63
Scientific	14.25	9.01	11.35	11.35
Spreadsheet	13.23	3.65	4.73	38.17*
Overall	49.69	31.31	40.68	78.69

*The native version of the application was used for this test.

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Almost every editor comes to a crawl with files bigger than a few megabytes. That may sound big, but look around. How about that 20Meg Postscript file, the 50Meg database and the 500Meg file you're putting on CD-ROM. With your existing editor, you probably don't even consider them editable.

What about mainframe files without "newlines", or with EBCDIC characters. Or a dBASE file with fixed length records and a complex header. Can you edit them? Unless you have VEDIT, you are again R.O.L. Too bad if the entire project depends upon it.

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File modes support DOS, Unix and Mac text files, plus data files with fixed or variable length records. Display modes include ASCII, Hexadecimal, Octal and EBCDIC or any combination in a split screen. A user created translation table can be used for custom display modes or for translating the file itself.

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"We didn't just stumble into component software," says Karl May, manager of solutions tools at Apple. "Customers may not be clamoring for components, but they are complaining about the problems they have, like increasing system requirements for software."

Eventually, users will embrace components, but that doesn't guarantee the software industry will change in Apple's favor. The big software publishers (who are almost unanimously supporting componentware) might still dominate the market, and Windows might still end up with the most components.

Apple's bet on componentware is a good one, though. If OpenDoc and Taligent live up to their claims, Apple could stir up the market, stem Microsoft's momentum, and gain lots of new software for the Mac.

Can Apple Change?

This article barely explores the many fronts on which Apple is fighting for its future. No mention has been made of Apple's strategies for enterprise servers, PowerBooks, printers, digital cameras, or system software for interactive TV set-top boxes. In BYTE's assessment, the outlook for all these products depends on the success of the core technologies discussed here. If the core technologies flop and an auxiliary product line emerges, it will be Apple that is transformed, not the computer industry.

Nor is this analysis intended to spread doom and gloom. Although Apple's market share is small, its volumes are quite healthy. Apple, Compaq, and IBM are virtually tied for the position of the world's leading computer vendor. Apple is pushing ahead with some exciting new technology, and the industry would be much poorer without Apple's technical leadership.

Indeed, it would not be an exaggeration to describe the history of the computer industry for the past decade as a massive effort to keep up with Apple. In 1984, critics derided the Mac for its appliance-like simplicity, but it went on to pioneer or popularize almost every innovation in personal computing: the GUI, desktop publishing, built-in networking, plug and play, integrated multimedia, API-based software development, visual programming, hypertext, 24-bit color, the global clipboard, undo, voice control, built-in color calibration, dynamic memory allocation, SCSI, and even 3½-inch floppy drives. Apple's R&D lab, located in Cupertino, California, is the inspira-

tional R&D center for the entire industry.

If Apple deserves blame for keeping the Mac proprietary for so many years, consider that few other companies have had as much unique technology to protect. It's easy to be open if your technology breaks no new ground. However, don't read too much into Apple's decision to license the Mac. It is not so much a change of corporate direction as it is an attempt to defend the Mac's viability as an alternative platform. Apple still seems bound by a mindset that in some ways is the opposite of Microsoft's.

Apple's Future System Software

Copland Late 1995

- Microkernel architecture that separates operating system from hardware dependencies
- Preemptive multitasking and memory protection for low-level processes
- Faster I/O architecture
- Integrated OpenDoc
- Open Transport network-abstraction layer
- Scalable user interface with active assistance
- Mostly native code for PowerPC

Gershwin 1996

- Preemptive multitasking and memory protection for all processes
- Further-improved GUI, customizable for different users and applications
- Integrated 3-D graphics
- Ability to run TAE (Taligent Application Services)

For instance, Apple needs to strengthen its development tools. HyperCard's debut in 1987 brought visual programming to the masses for the first time, but Apple let HyperCard languish for years. Not until Microsoft released Visual Basic was the HyperCard concept advanced toward its full potential.

Apple's componentware strategy would be a lot more credible if it offered a tool like Visual Basic, which has sold well over a million copies, mostly to the corporate developers Apple hungers for. HyperCard and AppleScript let you control OpenDoc containers and parts, but not create them. Apple hints that this gap may be filled by a future tool or by an enhanced version of HyperCard: "Apple is aware of Visual Basic and has analyzed what Visual Basic does—not just what it does technically, but also the market perception of what it does," says Apple's May. "That is part of what goes into our thinking when we plan what we'll do with HyperCard."

Apple has also been slow to support the

Power Macs with good tools. In fact, all the software released at the introduction of the Power Macs last spring was built with beta versions of compilers because final versions were not available. There would be a lot less Power Mac software in existence today if a small Canadian company, Metrowerks (St.-Laurent, Quebec, Canada), had not plugged the gap with CodeWarrior.

The next missed opportunity could be Apple's QuickTime VR, an astounding virtual-reality technology that can meld a series of photographs or rendered images into a seamless 360-degree panorama. Without any special hardware, you can pan the wraparound image in complete circles, zoom in on details, and examine objects from any angle. The software automatically corrects distorted perspectives and smooths out jagged lines with real-time antialiasing. QuickTime VR is practically a reinvention of photography, and it's also a prime example of the innovation that continues to emerge from Apple's Advanced Technology Group.

Another company might put this wonderful creative tool in a box and sell millions of copies at a few hundred dollars a pop, as Microsoft did with Visual Basic. Within months, there would be thousands of commercial and freeware panoramas available on CD-ROMs, BBSes, and the Internet. But Apple is restricting the QuickTime VR tools to a relatively small group of registered developers—a marketing strategy that seems perversely devised to capture the smallest possible market share.

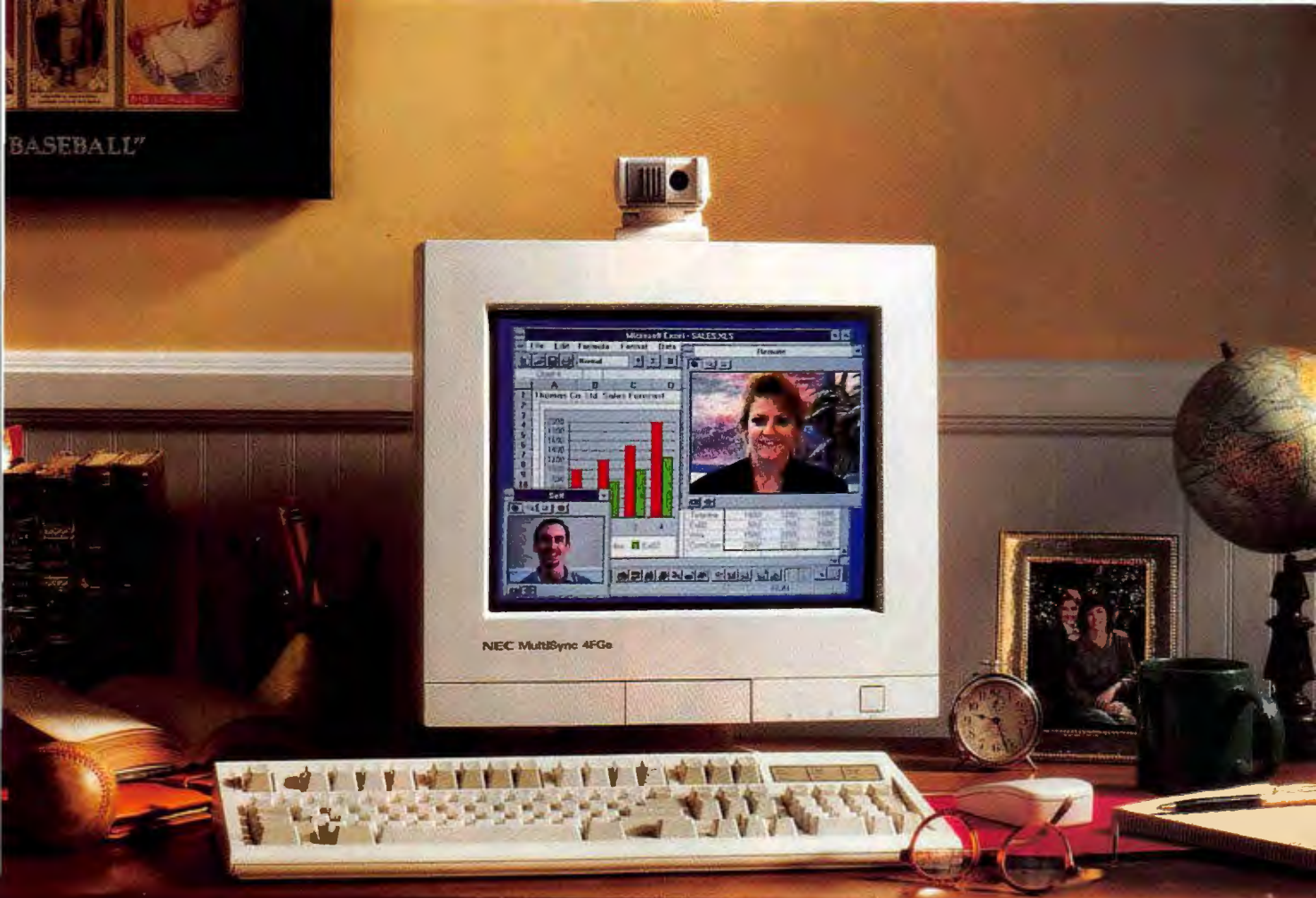
Technology has never been a problem for Apple; marketing is another story. You would expect a company that has scored as many technological firsts as Apple to dominate the industry, yet the PC industry is swamped by clone makers who rarely, if ever, invent anything new.

Now, once again, Apple is gambling its future on new technology. Can it shift market forces, cut through fierce competition, and regain momentum? One thing is for sure: Apple will raise the technological ante for the whole industry. ■

ACKNOWLEDGMENTS

BYTE senior technical editors at large Tom Thompson and Jon Udell also contributed to this article.

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Butch was here to see it. (*Hey Butch, na na na na na —
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How's the box of orange wool socks from Aunt Doris?*) I
think I'll invite Butch over to show off my new P5-100XL.
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smoother and cleaner. Gateway's quad-speed CD-ROM includes a motorized tray and is ATAPI compliant, something you'll need when Microsoft® Windows '95 comes along.

Gateway's New Vivitron Color Monitors!

For decades, Sony Trinitron technology has been the choice for millions who insist on only the *very* best. Now the best computer system in the world is paired with the best screen display in the world. Introducing Gateway 2000's new Vivitron color monitors. Using Sony Trinitron tube technology, these monitors give you the highest quality screen images available. Our 17-inch Vivitron monitor, standard with the P5-100XL, gives you brighter, richer, and crisper colors, a sharper focus and clearer image. With a .26 fine pitch, you'll also get an incredibly high screen definition. The new Vivitron monitor is standard on all Gateway systems that include a 15-inch or 17-inch monitor.

Microsoft Office Professional

This collection of Microsoft's most popular software applications is pre-installed on your Gateway P5-100XL. You get Microsoft Word, Excel, PowerPoint® presentation graphics program, Access® database, and Bookshelf®. Bookshelf includes seven best-selling reference books that include *The American Heritage Dictionary*, *The Concise Columbia Encyclopedia*, and *The World Almanac and Book of Facts*.





Ida, age 7

*"I can't stand secrets. My husband and kids always hide my presents because they know I'll try to sneak a peek if I can. This year was no exception. I waited until they were all asleep, then padded down the hallway, crept down the stairs, very quietly...yikes...remember the second step creaks! And...oh, wow, HOORAY! It's a Gateway 2000 P5-75 Family PC! I didn't care if the whole family heard me. Did I feel like a kid again? You bet! Suddenly I was back in circa 1965, when a tip-toe trip to the tree meant first having to free Fluffy's claws from the gold shag carpeting. Then while reaching for my Howdy Doody slippers, I was suddenly rendered blind by the glare of the silver tree, and I went crashing through the aluminum branches and piles of presents! I woke up the whole house that year. *This* year I soared through a billion applications in mere seconds with the 75MHz Pentium processor in that Gateway machine. I was sure the vivid colors of the new 15-inch Vivitron monitor were going to jump right out of the screen! My husband says the friendly salespeople at Gateway made sure we got the computer just right for us. The entire family can join in on my fun, because this powerful multimedia system has something for all of the 'kids' in this house!"*

 **GATEWAY2000**

8 0 0 - 8 4 6 - 2 0 5 8

Your family's days and nights will be merry and bright with a P5-75 Family PC™ from Gateway 2000®

Cruising at 75MHz

This full-featured multimedia Family PC is an investment in your family's future with a super-charged 75MHz Pentium™ processor, so all the included software applications in our Home Bundle run faster than ever!

Family PC Power

As your family grows and changes, this Pentium processor-based Family PC will still be right in style. Power users are right at home with Intel®'s 75MHz Pentium processor and 730MB hard drive. For multimedia enthusiasts, a PCI local bus graphics card, double-speed CD-ROM, 16-bit sound card and Altec Lansing speakers are the coolest. And a TelePath™ fax/modem keeps everyone connected with the on-line universe. The Pentium processor lets you take full advantage of all these features and the many new generations of software applications. For tomorrow's multimedia superhighway, the P5-75 Family PC is your ticket to ride.

A Bright New Outlook!

Your P5-75 Family PC also includes Gateway 2000's new 15-inch Vivitron™ color monitor. All your colorful images will now be richer and brighter with Sony®'s Trinitron® tube technology built into these new monitors.



pentium
PROCESSOR





8 0 0 - 8 4 6 - 2 0 5 8

Shawn, age 5



Shelly, age 4

"Get outta my way!"

"Watch out Shelly, you doorknob! It's mine!"

"No, Shawn, it's mine!"

"Ah, it's just like being kids again, Shelly.

Remember 1977? The presents, the fun, and Dad's dumb leisure suits? He'd always warn us, 'Kids watch out for that 8-track player, and don't touch your mother's shrine to Elvis!' We were so competitive, always fighting over each other's gifts. I'm glad we're all grown up now, and we get along so well, especially since you finally stopped being such a spoiled brat."

"Whatever, Shawn, I'm still Mom's favorite, you buttface."

"Well, I guess Gateway 2000's ColorBook and HandBook portable PCs have brought out the little hellions in us again. But we just can't help fighting over them!"

"Shawn's in awe of my HandBook's ultra-slim size, light weight and powerful 486 processor."

"And Shelly can hardly live with herself because she can't believe the full color capabilities of the ColorBook."

"Gosh Shawn, isn't it nice to have Gateway 2000 here to make us feel like kids again?"

"Yeah, it sure is. In fact, Mom thought now would be a good time to tell you that we really adopted you from Martians."

HandBook® 486SX-33

Now you can have the revolutionary HandBook portable PC from Gateway 2000® for as low as \$999! You're getting a real 486 PC that measures a mere 10 by 6 inches and weighs just under three pounds. This little stocking stuffer is the subnotebook to have by your side at all times. It's perfect alone or as a go-between when you're traveling from desktop to desktop.

HandBook 486SX-33

- 2.94 Lbs., 9.75" x 5.9" x 1.6"
- 4MB RAM
- 250MB Hard Drive
- Leather Carrying Case
- Microsoft® Works

\$999



ColorBook™ 486SX-33 QuickShip*

Quick! Make your (or someone else's) holidays brighter with Gateway's ColorBook portable PC. You can have the ColorBook 486SX-33 QuickShipped to your door within 48 hours* of ordering. And there's no reason to worry about that hard-to-buy-for person on your list. Everyone needs the colorful desktop performance of a Gateway 2000 ColorBook! Call today and ask about these and other great deals on Gateway portables.

ColorBook 486SX-33

- 5.7 Lbs., 11.7" x 8.5" x 1.77"
- 4MB RAM
- 250MB Hard Drive
- 9.4" Dual-Scan LCD
- 96/24 Fax/Modem
- Carrying Case
- Microsoft Works

\$1999

*48-Hour QuickShip program applies only to the ColorBook 486SX-33 configuration. Your PC will be delivered within two business days from the time of order. No additions or deletions can be made to the configuration. Available for approved credit card orders only. Domestic U.S. orders only.





 **GATEWAY2000**

8 0 0 - 8 4 6 - 2 0 5 8



Rusty, Lily, Mary and John

"The warmth and fun of the holiday season is timeless. I guess with today's ultra-busy lifestyles, it's even more important to make memories and build traditions with family."

Well, as long as you can stand sitting through the kids' 75 verses of 'Jingle Bells' and Uncle Ricky always stopping by to borrow the nutcracker. But years from now, my wife Lily and I will sit down to watch our holiday videos, and after we fast-forward past the cat eating tinsel off the tree, we'll remember how excited little John and Mary were to open that huge cow-spotted box from Gateway 2000. For just \$1,899, Gateway gave us a full-featured multimedia system. And with all the great software titles pre-installed on our 4DX2-66 Family PC, Lily and I started feeling like kids too! Not enough to eat a whole tin of peanut brittle or anything, but we sure stayed up late that night exploring Microsoft Golf and Cinemania '95. Our Family PC has opened up whole new worlds for John and Mary, too. They've been entranced by MS Fine Artist, and Encarta multimedia encyclopedia. Lily and I are happy knowing that the fun and learning they experience with Gateway's 4DX2-66 Family PC will last them a lifetime."

The Gateway 2000® 4DX2-66 Family PC™ brings all the rewards of a fully featured multimedia system into your home at a price that defines "family values." Our Family PCs start from \$1,499 for the 4DX2-50 model and include a local bus graphics card, double-speed CD-ROM, 16-bit sound card and Altec Lansing speakers for a quality audio system. Listen to your music CDs, experience all the sights and sounds of the included multimedia software, and connect with people from all over the world through the standard fax/modem, including communications and on-line software.

A Cornucopia of Software!

An incomparable array of software is included with all Gateway 2000 systems — the most you'll get for your money...anywhere. All Gateway 486 and Pentium processor-based desktops are pre-installed with Microsoft® DOS® 6.22, Windows™ for Workgroups 3.11, and *now* Microsoft Money.

The Incomparable Home Bundle from Gateway

All Gateway Family PC configurations include our Home Bundle. This incredible collection of Microsoft software applications has literally everything your family needs to work, play and learn at home. You'll get MS Works, Encarta '95, Money, Cinemania '95, Golf and Fine Artist.

Microsoft Works 3.0 for Windows Multimedia Edition

You'll never need another software package for your home office. This program combines: a word processor, spreadsheet

with graphing, database, electronic communications, financial analysis, charting and illustration.

Microsoft Encarta '95 Multimedia Encyclopedia

Learning is an adventure with text, images, animations and sounds that work together to create a fascinating universe of knowledge. Over 25,000 articles, 17,000 multimedia elements and the complete text of Funk and Wagnall's New Encyclopedia are included.

Microsoft Money 3.0

Now every Gateway desktop system includes Microsoft Money, your personal financial wizard that'll help you take control of your finances and plan for the future.

Microsoft Cinemania® '95

Explore the magic behind the movies with hundreds of reviews, biographies, photos and sound clips.

Microsoft Multimedia Golf

Traverse the wonder of Torrey Pines, consult a golf pro, and play a game of golf any way you please. You'll experience real sounds of chirping birds, swinging clubs and gurgling water.

Microsoft Fine Artist

Kids can create animated pictures and projects like posters and comic strips, and hear dozens of wacky sounds!





 **GATEWAY2000**

8 0 0 - 8 4 6 - 2 0 5 8

Gateway 2000® Family PCs™

4DX2-50 FAMILY PC

- Intel® 50MHz 486DX2 CPU*
 - 4MB RAM
 - 340MB 13ms IDE Hard Drive
 - Local Bus Graphics with 1MB
 - 🔧 Double-Speed CD-ROM, 16-Bit Sound Card & Altec Speakers
 - 🔧 2400/9600 Data/Fax Modem
 - 3.5" Diskette Drive
 - 14" Color SVGA Monitor
 - Mini Desktop Case
 - 101-Key Keyboard & Mouse
 - MS-DOS® 6.22 & WFW 3.11
 - 🔧 MS Works,™ Encarta '95, Money,™ Cinemania '95, Golf & Fine Artist
 - 🔧 3-Year Limited Parts Warranty
- \$1499**

4DX2-66 FAMILY PC

- Intel 66MHz 486DX2 CPU*
 - 8MB RAM
 - 730MB 13ms IDE Hard Drive
 - Local Bus Graphics with 1MB
 - 🔧 Double-Speed CD-ROM, 16-Bit Sound Card & Altec Speakers
 - 🔧 TelePath™ II 14.4K Fax/Modem
 - 3.5" Diskette Drive
 - 14" CrystalScan® Monitor
 - Mini Desktop Case
 - 101-Key Keyboard & Mouse
 - MS-DOS 6.22 & WFW 3.11
 - 🔧 MS Works, Encarta '95, Money, Cinemania '95, Golf & Fine Artist
 - 🔧 3-Year Limited Parts Warranty
- \$1899**

P5-60 HOLIDAY SPECIAL

🔧 At press time, the Gateway 2000 elves were still busy finalizing this very special configuration to brighten your holidays. You'll get an unbelievable value on a 60MHz Pentium processor-based system so incredible that we needed more time to make it extra special!

Call today for all the details!



P5-75 FAMILY PC

- Intel 75MHz Pentium™ Processor*
 - 8MB RAM, 256KB Cache
 - 730MB 13ms IDE Hard Drive
 - PCI Enhanced IDE Interface
 - PCI Local Bus Graphics with 1MB
 - 🔧 Double-Speed CD-ROM
 - 🔧 16-Bit Sound Card & Altec Speakers
 - 🔧 TelePath II 14.4K Fax/Modem
 - 3.5" Diskette Drive
 - 🔧 15" Vivitron™ Color Monitor
 - Desktop Case
 - AnyKey® Keyboard & Mouse
 - MS-DOS 6.22 & WFW 3.11
 - 🔧 MS Works, Encarta '95, Money, Cinemania '95, Golf & Fine Artist
 - 🔧 3-Year Limited Parts Warranty
- \$2499**

The Special Treatment Only From Gateway 2000

Gateway's friendly employees are dedicated to providing our customers with only the best service and support. We'll custom configure any system to your specifications. You also get toll-free technical support for the life of your system and a 30-day money-back guarantee. All Gateway 2000 desktop PCs and monitors are backed by a three-year limited warranty on parts. Call or write us and we'll send you a free copy of our warranty.

Easy Payment Options

Gateway accepts most major credit cards and C.O.D. terms, with net 30-day terms and leasing options available to qualified commercial customers.

Gateway 2000 DuoLine™ MasterCard® card

You can apply for the Gateway 2000 DuoLine MasterCard card, issued by Dial National Bank, Des Moines, Iowa. Be sure to ask about our "90 Days No Payment" Program!

P5-90 FAMILY PC

- Intel 90MHz Pentium Processor*
 - 8MB RAM, 256KB Cache
 - 🔧 1GB 10ms IDE Hard Drive
 - PCI Enhanced IDE Interface
 - 🔧 PCI Local Bus Graphics with 2MB
 - 🔧 Double-Speed CD-ROM
 - 🔧 16-Bit Sound Card & Altec Speakers
 - 🔧 TelePath II 14.4K Fax/Modem
 - 3.5" Diskette Drive
 - 🔧 15" Vivitron Color Monitor
 - Desktop Case
 - AnyKey Keyboard & Mouse
 - MS-DOS 6.22 & WFW 3.11
 - 🔧 MS Works, Encarta '95, Money, Cinemania '95, Golf & Fine Artist
 - 🔧 3-Year Limited Parts Warranty
- \$2899**

Professional Systems

4DX2-50

- Intel 50MHz 486DX2 CPU*
- 4MB RAM
- 340MB 13ms IDE Hard Drive
- Local Bus Graphics with 1MB
- Double-Speed CD-ROM
- 3.5" Diskette Drive
- 14" Color SVGA Monitor
- Mini Desktop Case
- 101-Key Keyboard & Mouse
- MS-DOS 6.22 & WFW 3.11
- MS Works & Money
- 3-Year Limited Parts Warranty

4DX2-50 \$1299

4DX2-66 \$1599

(w/ 540MB Hard Drive & 8MB RAM)

P4D-66

- Intel 66MHz 486DX2 CPU*
- 8MB RAM, 256KB Cache
- 730MB 13ms 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
- Desktop Case
- AnyKey Keyboard & Mouse
- MS-DOS 6.22 & WFW 3.11
- MS Office Professional, Bookshelf & Money
- 3-Year Limited Parts Warranty

\$1899

P5-75

- Intel 75MHz Pentium Processor*
- 8MB RAM, 256KB Cache
- 730MB 13ms 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
- Desktop Case
- AnyKey Keyboard & Mouse
- MS-DOS 6.22 & WFW 3.11
- MS Office Professional, Bookshelf, & Money
- 3-Year Limited Parts Warranty

\$2299

P5-90 BEST BUY

- Intel 90MHz Pentium Processor*
- 8MB RAM, 256KB Cache
- 540MB 13ms IDE Hard Drive
- PCI Enhanced IDE Interface
- PCI Local Bus Graphics with 2MB
- Double-Speed CD-ROM
- 3.5" Diskette Drive
- 15" Vivitron Color Monitor
- Desktop Case
- AnyKey Keyboard & Mouse
- MS-DOS 6.22 & WFW 3.11
- MS Office Professional, Bookshelf & Money
- 3-Year Limited Parts Warranty

\$2499

P5-100XL

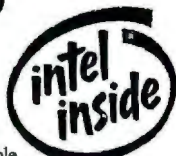
- Intel 100MHz Pentium Processor*
- 16MB RAM, 256KB Cache
- 1 GB 10ms IDE Hard Drive
- PCI Enhanced IDE Interface
- ATI Mach 64 with 2MB VRAM
- Quad-Speed CD-ROM
- 16-Bit Wavetable Sound Card & Altec ACS-31 Speakers w/ Subwoofer
- 3.5" Diskette Drive
- 17" Vivitron Color Monitor
- Tower Case
- AnyKey Keyboard & Mouse
- MS-DOS 6.22 & WFW 3.11
- MS Office Professional, Bookshelf & Money
- 3-Year Limited Parts Warranty

\$4299

Ask about our
"90 Days
No Payment"
Program



Intel
Verified:
Upgradable



"You've got a friend in the business."®

8 0 0 - 8 4 6 - 2 0 5 8

Celebrate the season with festive extras from Gateway!

Gateway 2000 peripherals and software sold only with purchase of a system. Systems can be custom configured with the options listed below pre-installed.

Multimedia

Audio Starter Kit

Here's everything you need to add multimedia to a Gateway PC.

- Gateway 2000 16-bit CD-quality sound card, compatible with Sound Blaster™ cards, with MIDI/game port, mic in, stereo line in/out
- 2 Altec ACS-5 speakers
\$99 (with system purchase)

Wavetable Audio Multimedia Kit

Once you've heard wavetable audio, basic audio will never do!

- Ensoniq Soundscape 16-bit wavetable sound card, MT-32 and FM mode compatible. Supports most software for popular sound cards and standards including General MIDI, Sound Blaster, AdLib, Roland MPU 401, MS Windows Sound System and MT 32
- New Altec Lansing ACS-31 three-piece speaker system
\$249 (with system purchase)
\$119 (to upgrade from systems that include the Gateway 16-bit sound card and Altec speakers)

Altec Lansing ACS-31 Speakers

A Gateway exclusive from Altec Lansing: a three-piece speaker set at a two-piece price. Two 3-inch free-standing speakers crank out up to five watts per channel while the subwoofer can deliver 15 watts of heart-pounding bass.

\$99 (with system purchase)

\$60 (to upgrade from systems that include Altec speakers)

Multimedia Software Starter Pack

You get nearly \$700 worth of software for less than \$100! Package includes Mad Dog McCree, Tuneland, Mayo Clinic Family Health Book, Better Homes and Gardens Cookbook, The Lawnmower Man, Sitting on the Farm, Mavis Beacon Teaches Typing, Chess Master 3000, U.S. Atlas and World Atlas. You also get a compact disc cleaner and 20-disk storage rack. **\$75**

Call and ask about flight pack software including some of the latest flight titles from Gateway.





High-Tech Training

MICKEY WILLIAMSON

Walk into virtually any computerized classroom—whether in an elementary school or corporate training center—and you will find the same basic process in use. Students are expected to read a static screen of information and then press a key or select an answer from a list of options to advance to the next screen. Just as early computer technology did little but automate manual methods of doing business, so, too, instructional technology, or CBT (computer-based training), has provided scant improvement over printed books and standardized test forms.

This scenario reduces the student to the role of passive reader, a selector of multiple-choice answers. A student who picks the wrong answer sees a message such as "Incorrect. Try again." This process assumes that a student can learn by passively absorbing information, and the degree of learning is measured by a student's ability to recognize the correct answer from among a set

lets the user, not the developer, determine the sequence of events.

Andersen Consulting (Chicago, IL) has capitalized on both these technologies to produce multimedia training courses for its employees. Its efforts are based on research from the ILS (Institute for the Learning Sciences) at Northwestern University (Evanston, IL) and its controversial director, Roger Schank (see the text box "The Gospel According to Roger Schank").

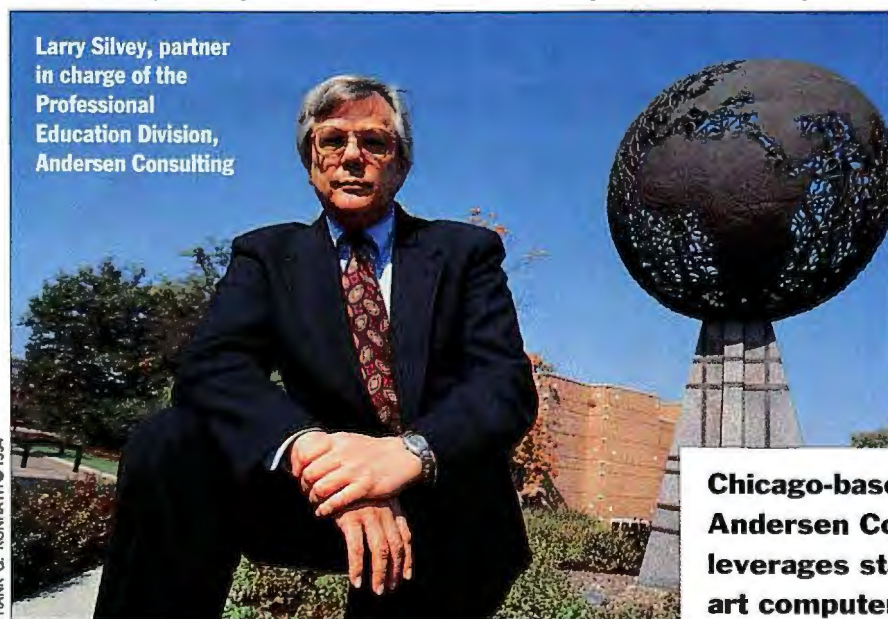
That effort has already paid big benefits. In a typical year, Andersen Consulting was spending \$200 million, including payroll and travel, on training for 30,000 employees, about half of whom required education in basic business practices. Now, thanks to the ILS-Andersen collaboration, training time is compressed. Until the advent of these CD-ROM-based multimedia courses, employees would take a six-week training course before their first consulting assignments. Today, employees can get "just-in-time training" before they begin a new consulting engagement.

Even the one or two weeks per year that partners and managers used to spend in training is likely to be shortened.

Changing Times, Changing Procedures

Here's a typical training experience prior to the CBT project. Pedro Suriel, a staff consultant with Andersen's change management service and a member of the multimedia CBT group, described his six-week introductory training course under the old regime. The first three weeks were spent at his local office. Instructors provided an orientation to the company and its policies, introduced standard procedures used in the change management service when working with clients, and taught about tools used in the service to produce deliverables for the clients. Suriel spent the final three weeks at Andersen's Center for Professional Education (St. Charles, IL). He and

Chicago-based Andersen Consulting leverages state-of-the-art computer-based systems to train its people, saving money in the process



Larry Silvey, partner in charge of the Professional Education Division, Andersen Consulting

of choices. The only real difference between this scene and the traditional teacher/classroom style of pedagogy is that the computer lets each student move through the material at his or her own speed. But information is always presented in the same way and the same order.

This approach to CBT is based, in part, on outmoded theories of learning. Procedural programming methods enforce a linear, sequential interaction between the student and the computer; these methods couldn't help but require every user to learn in the same fashion. On the other hand, event-driven programming coupled with TV-quality video, which has finally matured to industrial-strength levels, adapts to each individual's learning style and

other trainees were introduced to a hypothetical company about which they had to gather information and put together a set of observations and recommendations for a consulting engagement.

The new system, known as the BPC (Business Practices Course), is a self-paced, interactive replacement for the traditional instructor-led program. BPC cuts training time from 65 to 40 hours, according to the company. Also, Andersen personnel can

take the BPC in their home offices, eliminating the need (and time and expense) to travel to the St. Charles center. The reduction in training time translates to a payroll saving of about \$2 million and a training delivery saving of some \$8 million per year, according to Larry Silvey, partner in charge of Andersen's Professional Education Division. Furthermore, BPC's developers have been able to incorporate the experience of some of Andersen's most senior consultants. A trainee about to undertake an assignment in unfamiliar territory (e.g., manufacturing) can visit that portion of the BPC and be briefed on what to expect in the field.

The multimedia application's platform requirements are relatively simple: It runs on a PC compatible with a 33-MHz 386DX processor, 8 MB of RAM, a 256-color VGA card and monitor, a mouse, a CD-ROM player, an Intel ActionMedia II DVI board, an external audio amplifier, and headphones, running DOS 5.0 and Windows 3.1. The 180 minutes of professional-quality video runs satisfactorily on a CD-ROM drive.

BPC Modules

The BPC has 15 modules that simulate a business challenge that an Andersen staff member might encounter in a consulting engagement at the hypothetical Perrin Printing and Publishing Co., a publisher of hardcover and paperback books. Using audio and video clips stored on CD-ROM, you interview PP&P personnel, receive phone calls, get advice from senior Andersen consultants, review internal Andersen memos, and attend meetings with senior PP&P management. At the end of the BPC, you deliver a presentation outlining the kinds of findings and recommendations that would normally be delivered to a client.

With the BPC, you control the pace of learning using a vertical button palette on the right side of the screen (see the text box "A Palette of Buttons"). The button palette, standard for all modules, lets you access various support systems and navigational tools. Working in a local office, you can tape a memory aid to the monitor, explaining the action of each button.

You can work on department modules in any order; the course map indicates which modules have been completed or partially done and which have yet to be started. This flexibility lets trainees analyze the business in whatever fashion makes sense to them, depending on how their own backgrounds and experience lead them to view the business. By contrast, in an instructor-led course, the teacher would choose the path, and the course trainees would be obliged to adopt the teacher's point of view.

BPC's operating features are designed to take into account good instructional technique and the fact that for many Andersen trainees, English is not their primary language. For example, trainees can use the button palette to replay and review the material as often as desired, and they can elect to have subtitles appear on any video clip. A small user manual provides time-to-completion estimates for each module to aid trainees in budgeting time, but everything else they need to know is built into the CBT system.

This Is Your Mission

The course begins with a simulated telephone call from Andersen's staffing department. The caller assigns the trainee to a consulting engagement at PP&P designed to provide an overview of the company's business processes and areas where improvement is possible. The caller tells the trainee that PP&P's sales have been good but that profits are down; the caller refers the trainee to the PP&P project manager, who wants a meeting that morning.

continued

WHAT CONTEMPORARY MULTIMEDIA TRAINING OFFERS

Andersen Consulting wanted to improve the quality and cost of the training it must provide for over 15,000 employees per year. It needed to do the following:

- Present knowledge of the company's business practices, procedures, and policies.
- Provide up-to-date training tailored to an employee's new assignment.
- Improve managerial skills.
- Make training accessible at any Andersen facility.



The Course Design

- 15 integrated modules, expandable to cover new areas.
- Consistent user interface.
- Use of digital video to reinforce points and present options.



The Hardware

- 33-MHz 386 PC compatible, 8 MB of RAM, and a 120-MB hard drive.
- CD-ROM drive.
- Intel ActionMedia II DVI video board with VGA monitor.



The Savings

- 40 percent reduction in course time.
- Eliminates need for most travel.
- \$10 million total annual savings.



Lessons Learned

- A good CBT system provides for a variety of learning styles.
- There's more than one correct answer to a question and more than one way to approach a task.
- People learn more from their mistakes.
- Correction should come immediately after the mistake is made and should take the form of pointing out alternatives, not presenting a single correct response.
- Information is often best remembered if it comes in the form of stories told by expert veterans.
- People with different backgrounds and experience may choose to approach course material differently. There is no single correct way to begin.



What's one without the other?

Your notebook PC and the new HP DeskJet 320 printer.

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High-quality mobile printing.

*Compact and light,
just 4 lbs.*

*Upgradable to color for
just \$49. And ColorSmart
technology makes it
vibrant and easy to use.*



*\$379 list price, actual
price may be lower.*

*Bundled with optional sheet
feeder for a list price of \$455.*

*Check the Yellow Pages for
the HP dealer nearest you.*

HP Printers



In a video clip, the manager briefs the trainee on PP&P's situation and on the makeup of the Andersen Consulting team assigned to the project. Here is one place where the course departs from reality in the interests of educating the trainee. Trainees are not told to take notes during the briefing; those that don't will probably have to replay the video clip, a luxury not often available in real life. The lesson that note-taking is important is hardly lost on those who have to backtrack, but the point is not made explicitly. Instead, the course accommodates different learning and organizational styles. According to

Schank's theories, you are likely to learn more from your mistakes than from being told what to do.

Each module begins with a memo from the senior consultant on the project, providing detailed information relating to the business function being analyzed. Also, working papers for each module set out a final goal and contain a list of tasks to complete in reaching that goal. In working through this list, the trainee uncovers business issues and records them in the key problems section of the binder. Gradually, the trainee develops an understanding of how the problems in one business area re-

late to those in other areas.

For example, to analyze the product development function, the trainee must create a work-flow diagram using built-in graphics tools. The system offers suggestions on how to build the work-flow diagram, but the trainee can disregard them and proceed in some other way—perhaps interviewing a company official—which may be just as productive as the suggested approach.

The HR Model

All but one of BPC's 15 modules present tasks that a trainee would be expected to perform in the course of a consulting

A Palette of Buttons

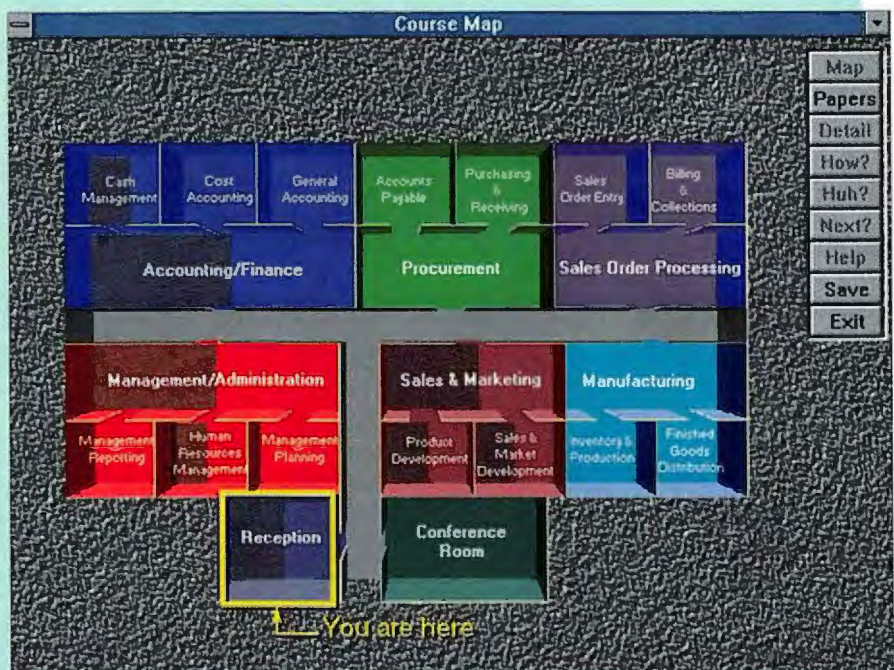
Map The Map button provides a view of the Perrin Printing and Publishing Co., depicted as a floor plan of the company's offices. The floor plan parallels the available course modules and provides navigation support. There are reception and conference rooms, as well as accounting and finance, procurement, sales-order processing, management and administration, sales and marketing, and manufacturing departments. Offices in each department are organized around a specific function; for example, the management and administration department has offices for management reporting, human resources management, and management planning.

Papers Clicking on the Papers button gives you access to a virtual loose-leaf binder that accumulates information from each business department as you visit it. Like a paper binder in which you flip through a consultant's notes, you can revisit this feature at any time.

Detail You can click on the Detail button—which identifies business terms, processes, and functions—for more detailed explanations.

How? This button accesses a reference for descriptions of how particular business functions or processes are performed.

Huh? With the Huh? button, you can call from the reference system a high-level overview graphic that permits



The BPC map provides you with a bird's-eye view of the offices of the hypothetical Perrin Printing and Publishing Co., whose business procedures and problems are the subject of the CBT system. The map may also be used to navigate from the subject matter of one department to another.

searching for specific business terms, processes, and functions.

Why? The Why? button provides you with specific feedback based on actions previously taken.

Next? This button suggests what to do next to complete an activity.

Play and Pause The Play button toggles to Pause, causing the scroll bar to rewind or fast-forward voice and video

clips. Both buttons are designed to increase the course's effectiveness over that of an instructor-led curriculum.

Help The Help button offers tutorials containing specific instructions on what to do to complete a module and how to navigate through the course.

Save You can save your work to a floppy disk using the Save button.

Exit Returns you to the reception area.

One button. One finger.
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T2:17



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engagement. The exception is the HR (human resources) module, which requires the trainee to run the HR department for four simulated years. The goal is to manage the department in such a way that the morale and productivity of three employees (taken to represent the entire employee class) remain high. Dials that show morale and productivity are visible throughout the exercise. A box showing company profits is also displayed to underscore the relationship between employee attitudes and actions and the corporate bottom line. If productivity and morale dip too low, the trainee is fired.

The HR task involves examining each personnel file, which includes position, salary, experience, performance, attitude, and ability. One file reveals that an employee's ability and experience are appropriate for the job, but his or her performance has been consistently low. A simulated counseling session with the employee reveals that he or she has no problem with the work. The trainee can click on a button that gives suggestions on improving performance (e.g., training is important to increase ability, rewarding the employee can increase motivation, and so on).

Clicking on a context-sensitive How? button tells you when additional training is appropriate. This leads to a video clip of an Andersen partner telling a war story that training is inappropriate when the employee already has the required skills. These video clips were made by real Andersen consultants talking about specific experiences.

Throughout the module, events occur based on the trainee's actions. A trainee who neglects to document the employee's poor performance before firing him will

later on get a notice that the ex-employee is suing the company for wrongful discharge. At any time, the trainee can advance the simulation time on a scroll bar to see the results of past actions, including the productivity and morale meter readings.

Your Point Is Noted

In some modules, you can view taped interviews and type notes into the Windows Notepad. The system automatically connects the video clip with the note file so that both are available on replay. No attempt is made to judge the quality of the notes; but the system does record which clips—and thus which problems—have attracted your attention and which problems have been overlooked.

At all times, you can browse through the BPC's underlying reference system, which defines business terms and other useful information. The system also monitors your mistakes. If you seem uncertain about how to proceed, the system will locate an appropriate place in the reference system for you. If a mistake is repeated more than once, the system will seek another reference that provides somewhat different information.

When the Done button is active, you can decide whether to end the task or continue working. Selecting Done means it's time for feedback. You may be challenged to substantiate all the problems identified, and this is where note-taking pays off. If there is no justification for listing a problem, it must be deleted. Guessing at the list of problems won't work, either, because you must substantiate each one on the list. Fortunately, interview clips and other information can be revisited at will.

To stop using the BPC, click on the Save button to save your session information to a floppy disk, and then click on Exit. This lets you continue your course work on a similarly equipped computer in any Andersen office. Each module takes between one-and-a-half to two-and-a-half hours to complete.

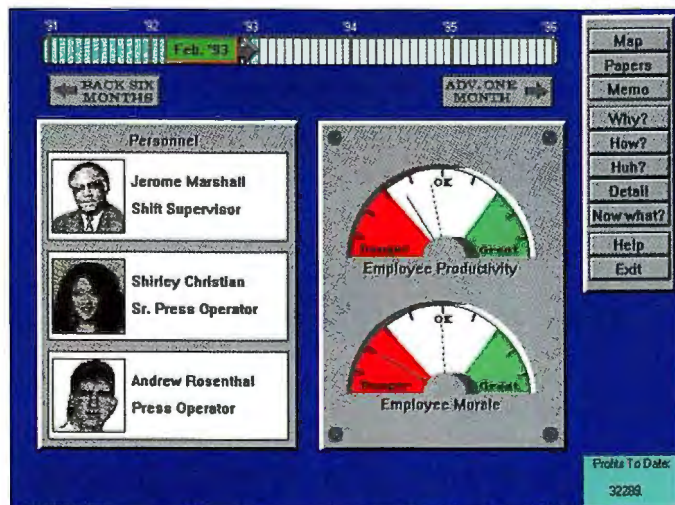
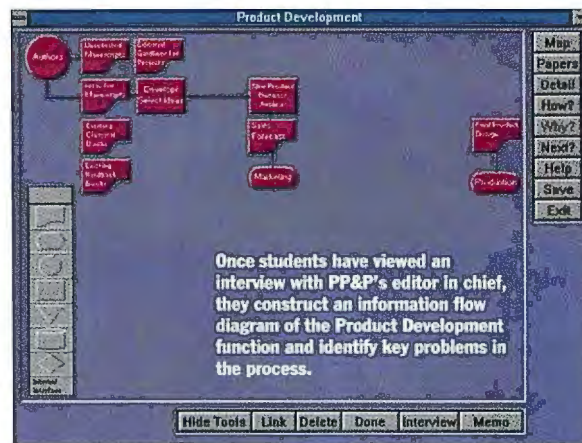
Module Development
Instructional designers and content ex-

perts work together to create new BPC modules. The development process is iterative, and content experts act as trainees to ensure the accuracy of information. Employees who would normally take the course are also involved in testing. In addition, screen layouts, menu structure, and other aspects of the user interface are scrutinized at this point. Suggested changes are assigned priority according to their impact on learning. After making and debugging indicated changes, between 50 and 100 users test the module. In some cases, trainees are brought to St. Charles; in others, disks are sent to field offices for testing. Feedback on both interface and content is collected and analyzed. At this point, few changes are usually needed, because the major content and interface issues were identified earlier. A pilot test comes next—the final hurdle before the completed system is released to the Andersen community.

Andersen's BPC draws some of its inspiration from the ASK tool developed at ILS. The ASK engine is designed to access multimedia databases consisting of 1- to 4-minute video clips culled from interviews with experts, as well as archival video material and text. ASK systems let developers build video-based "corporate memories"—repositories of expertise that might otherwise be lost to junior members of an organization as their elders retire. Developers try to think of every possible question a person might have about a particular application, to make it easy for people to navigate among the bits of information contained in the system.

ASK's influence appeared, for example, in the HR module, when the trainee wondered whether sending a nonproductive employee for additional training might improve his or her motivation. A button click produced a video in which a senior Andersen consultant told a war story showing that training would be useless where an employee already had the requisite skills but was not motivated to use them.

continued



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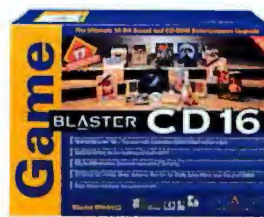
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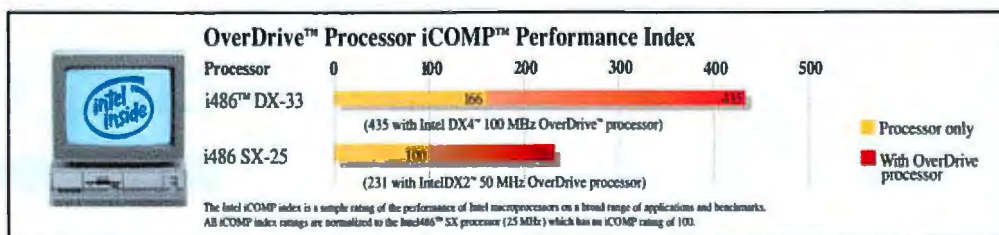
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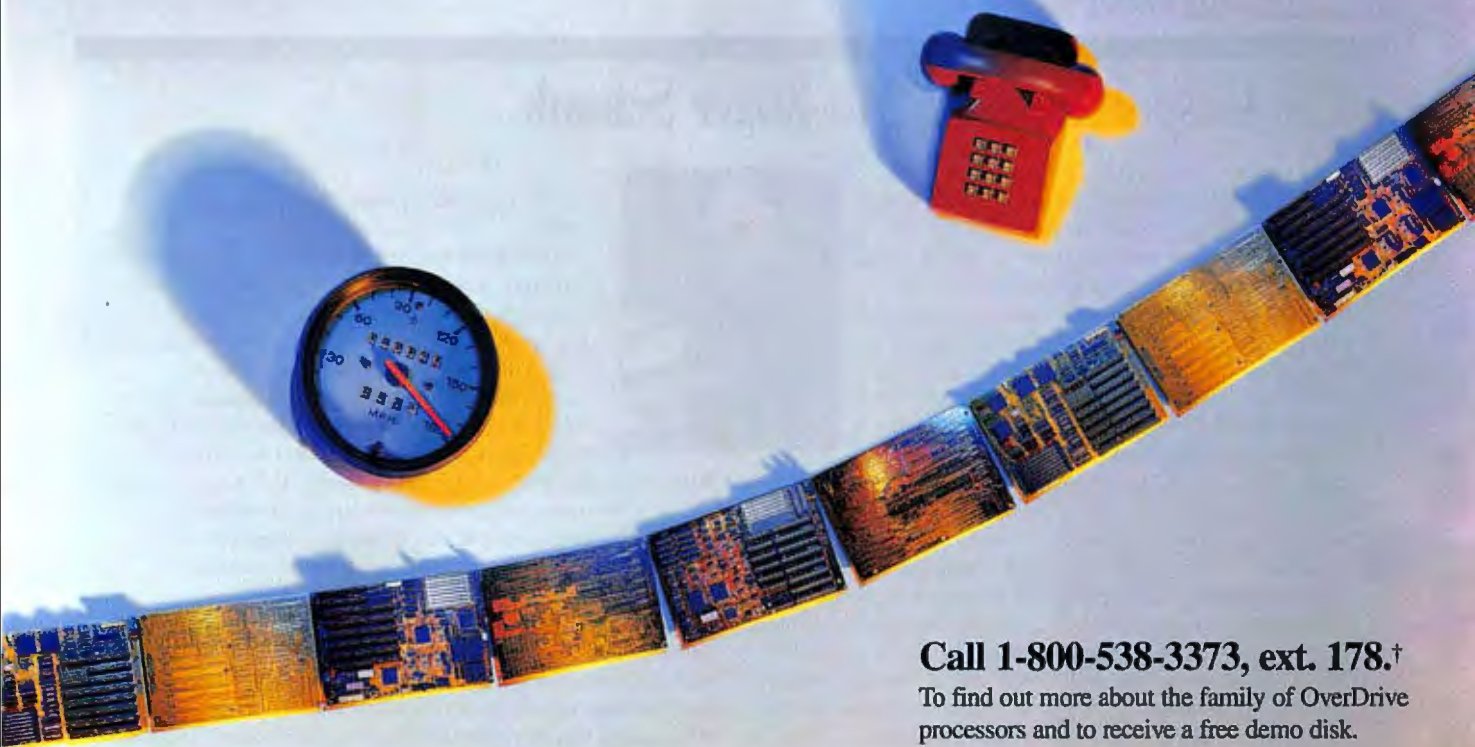
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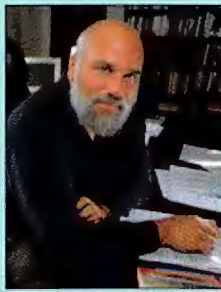
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The Gospel According to Roger Schank

Roger Schank, the Brooklyn-born head of Northwestern University's ILS (Institute for Learning Sciences), is one of the more colorful figures in the AI community, perhaps known as much for his blunt speech as for his work in education, cognitive science, AI, and creativity. Schank is a persuasive critic of school systems everywhere. Children and adults, he argues, learn best when they receive information at the moment they need it. This makes classroom learning an oxymoron by Schank's standards. In a class of 25, a teacher who answers one student's question is wasting the time of the other 24, because the information being given is not what they need at that moment.

Schank calls the traditional mode of education by computer "the page-turning architecture" and the reason most educational software today is devoid of excitement or educational value. For the most part, the current model of learning sees the student as a kind of sponge, willing and able to soak up whatever material is presented, regardless of whether it is perceived as interesting or useful. Provision for individual learning styles is missing, and there is no hint that learning can be exciting, or



that making mistakes might be a better way of learning.

Schank has a vastly different view of how people learn: They learn by doing, making mistakes, and having experts share experiences to show people what has gone wrong. To test his theories of how people actually learn, remember, and reason, Schank founded ILS in 1989, with sponsorship by Andersen Consulting, one of two business units of The Arthur Andersen Worldwide Organization,

which is headquartered in Chicago, Illinois. ILS's mission is to create innovative, computer-based learning environments based on leading-edge research in cognitive science and AI. ILS employs some 160 professional staff and graduate students.

Unlike some of his academic colleagues, who have shunned commercialization of their work, Schank doesn't mince words when he's asked about Andersen Consulting's sponsorship of ILS. Instead, Schank quotes notorious thief Willie Sutton who, when asked why he robbed banks, is reported to have replied, "That's where the money is."

Teaching Management Skills

Imparting knowledge of procedures and specific techniques is only one aspect of CBT. A more complex problem is building skills that involve such intangibles as social interaction and employee management. ILS has created another tool called GUSS (Guided Social Simulation), which is designed to teach complex social tasks in a low-risk, simulated environment that shields you from embarrassment. But experience-based learning needs an instructor to monitor progress and, when appropriate, to offer commentary and anecdotes (by way of video clips).

The GUSS shell has three major components: the interface, which handles input and displays information; the simulation engine, a general-purpose mechanism for manipulating the simulated world; and the teaching modules, which look for opportunities to present useful feedback.

GUSS-based applications could serve a variety of purposes, such as providing a risk-free environment in which budding foreign service officers could practice diplomacy without starting a war. The GUSS components remain the same regardless of the application; developers provide the application's data. In the simulation engine, these consist of agents, locations, and artifacts (e.g., a telephone and project papers). Teaching data includes videotaped anecdotes from real experts, analyses of your actions, coaching data to provide background information, and eval-

uation criteria used to provide you with feedback at the end of the session.

Agents observe and react to events in the simulated world. They are capable of speech acts. Agents can move from one place to another in the simulated environment, use artifacts (e.g., answering the phone or reading a document), and also react to events generated by the trainee that affect them, whether or not they have directly observed the event. Agents are endowed with a mental state, represented internally as a list of states of mind, selected by decision rules whose subject or IF statements are states of mind and whose predicates or THEN statements are mental or physical actions. When you view a representation of an agent on screen, three meters indicate the agent's state of mind along three axes: happy to angry, calm to threatened, and interested to bored.

Who's the BOSS?

Using GUSS, ILS and Andersen have collaborated to build an application called BOSS (Basics of Supervisory Skills), which lets trainees practice management techniques by supervising a simulated performance-evaluation process. BOSS works through computer agents endowed with personalities, mindsets, goals, agendas, and motives. Trainees interact with these agents, and the agents react to the trainee's inputs. Agents can be configured for various personality traits. For example, if a consultant is preparing for a meeting with a prospective

client known to be highly argumentative, then an agent can be given argumentative traits. The trainee can then try out a variety of approaches with the agent to gauge the client's likely reaction to each approach.

One BOSS module is aimed at new managers with little or no experience in evaluating subordinates. If the course trainee wants some philosophical background on evaluations, expert agents can provide a brief video orientation. BOSS then sets up typical situations relating to employee evaluations. The trainee plays the role of the manager and can seek expert advice before making a decision. The advice comes from video clips of Andersen managers and partners, who answer questions based on experience they have acquired in handling specific situations. The knowledge of experienced people is an important part of a corporation's capital assets, according to Doug Holyoak, an ILS-trained education specialist at Andersen. "The big thing right now is to make sure that we can capture it, then index and retrieve it at appropriate times," he said.

BOSS's developers thought long and hard about how people could converse with the computer agent. The developers rejected natural language input as too complex and settled instead on constrained responses in a variety of categories, each represented by an on-screen button. Trainees can ask for additional information; request an agent to do something,

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such as set up an appointment; respond to something the agent has said; tell the agent about something (e.g., make a recommendation); engage in small talk; perform a courtesy, such as apologizing; go to another place; or read documents. The trainee's action will determine the agent's response, which will be in keeping with the agent's underlying personality and state of mind.

Agents inherit their decision rules and initial mental states from a set of tables relating to gender, personality type, company, department, and position. Male and female agents inherit different conversational attributes. An agent defined as a CEO inherits decision rules associated with a "generic" CEO. For example, the CEO expects employees to be interested in the company's success. In BOSS, all employees are initially endowed with the values and beliefs that Andersen identifies as common to the people it hires.

Developing the Courses

Developers created the BPC using Authorware Professional for Windows (MacroMedia, San Francisco, CA), an object-oriented authoring tool that supports the incorporation of text, graphics, audio, animation, and digital video. Supplementary code was written in Microsoft C, Smalltalk, and Microsoft's Winhelp. Development of the first BPC version took about 18 months. The development schedule reflected the reality that two of its most important tools—Authorware, along with the Intel ActionMedia II video board that was chosen to enable smooth-running video—were still being beta-tested. Nonetheless, the project came in on time.

The original design team consisted of seven multimedia designers and developers, with assistance from ILS. At its peak, the team had 30 full-time members. Some team members were responsible for making textual style consistent in all 15 modules; others managed graphics standards for uniform application of such nuances as highlighting and shadows. An important design goal was to provide a video war story or explanation when the trainee made a mistake. Despite all the

available technology, the development team needed to build its own tool to link Authorware code and the Winhelp file system.

At the project's inception, collaboration with ILS could hardly have been closer. The seven original development team members, normally based at Andersen's Center for Professional Education, went to work at ILS, studying learning theory. "They helped us think about what the participant would actually do on the job with the information we were providing," said Marianne Acovelli, the BPC project manager.

in their home offices on their own schedules, Silvey notes, "we strongly believe we're getting more effective education in less time spent in the learning process." Silvey figures the company regained three times its original investment (estimated at between \$3 million and \$4 million) in just the first year of BPC's use and will continue to save as much with each passing year. The 40 percent reduction in training time translates to a payroll saving of about \$2 million and a training delivery saving of some \$8 million per year.

Two technology issues remain for Andersen. One is cross-platform deployment.

While most Andersen offices have standardized on PC compatibles, ILS is a Unix and Mac shop, so some of Andersen's development work had to be done on the Mac. Porting across platforms is an ongoing issue, according to Joe Carter, managing partner for Andersen's Center for Strategic Technology and Research in Chicago. "We're currently using a lot of different tools to address the problem, but we'd like to have a single set of tools that we could use across the board," he said.

Silvey is waiting for fully multimedia-capable 3-pound notebook computers so that consultants can pursue their training wherever they may be. In addition, he wants to hook CBT into Andersen's Knowledge Xchange system, a worldwide communications network based on Lotus Notes that is currently under construction. Then, he says, networked workstations will allow you to

call a central location and take advantage of expert advice, process guidelines, and industry-specific information to help with consulting assignments. "I think Knowledge Xchange is going to make a big difference in the way we look at things. We're going to be able to pass information and ideas around and make the best possible use of our knowledge capital," he said. ■

Mickey Williamson is a journalist based in Warwick, Massachusetts. She can be reached on the Internet at wmsn@equinox.shaysnet.com or on BIX clo "editors."

CBT BUILDING BLOCKS

Organizations interested in developing their own CBT (computer-based training) systems using the principles pioneered by Andersen Consulting and the Institute for Learning Sciences could start by experimenting with DVI technology, which allows playback of professional video. Andersen Consulting built a small system using Asymetrix's (Bellevue, WA) Tool Book authoring software together with a proprietary knowledge management shell built by Andersen's Center for Strategic Technology and Research in Chicago. For your own purposes, an off-the-shelf expert-system shell could be substituted for the proprietary component.

The idea is to implement an on-screen navigation button so that the trainee can trigger playback of the video elements, which would include company veterans relating helpful anecdotes or sales staff demonstrating company-approved sales techniques. Later on, you might try invoking video clips for when the trainee answers a question the system poses. In either case, the information would be presented when the trainee has the greatest need for it.

A further enhancement might be to link the system to a product such as Lotus Notes that lets trainees ask questions and match keywords to call up relevant audio or video clips or textual explanations of the principles being taught. You could easily add an object-oriented architecture, video, audio, or text objects to the system and readily modify the behavior of existing objects. Finally, an attractive GUI can make the system more appealing.

Savings and More

According to Larry Silvey, the ILS/Andersen relationship has grown considerably from its early days. Today's focus on applied research has Silvey wondering about several problems that the Northwestern University organization can help Andersen solve.

The mathematics of Andersen's investment in CBT are "pretty compelling," says Silvey. At least half of the 30,000-member Andersen organization requires business practices training. Moving those people to the St. Charles facility is costly. By creating educational tools that people can use

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Walter S. Mossberg, Wall Street Journal, 9/8/94, Personal Technology Section

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Write an NT WinSock Service

**CHUCK CHAN,
MARGARET K. JOHNSON,
KEITH MOORE, AND
DAVID TREADWELL**

To reduce the resource investment required for client software or to ensure easy porting to a range of platforms, many developers of client/server applications choose to use a sockets interface as the IPC (interprocess communications) mechanism between a client and a service. Most Unix utilities, including ftp and Telnet, are written to a sockets interface. On NetWare, this is true of many NLM (NetWare loadable module) environments, such as SNA (Systems Network Architecture) gateways and databases.

WinSock (Windows Sockets) is becoming a common programming-interface choice for independent software vendors that are porting existing services to Windows NT or that must work with multiple-client platforms that do not share a common higher-level protocol. (For details about WinSock alternatives and NT's networking components, see the text box "Windows NT Network Architecture" on page 94.)

Unlike other networking APIs, a sockets interface does not introduce a protocol on the wire. This means that an application written for one vendor's sockets interface is on-the-wire-compatible with an application written for another vendor's interface. For example, applications written for Novell's communications interface—ECB/ESR (Event Control Block/Event Service Routine)—can communicate with a WinSock application that is listening on an IPX/SPX socket. Similarly, Unix applications written for the Berkeley sockets interface or TLI (Transport-Level Interface) can communicate with a WinSock application listening on a TCP or UDP (User Datagram Protocol) socket.

Those who write services for Windows NT have additional advantages offered by the Service Control Manager. These ben-



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Here's a hands-on guide to answering the design questions posed by Windows sockets on NT

efits include automatic service start-up (independent from user log-ins); automatic start-up of any dependent services; service program installation and control (e.g., service start, stop, pause, and query state) via Win32 APIs; access to services on other machines on the network; the ability to revert to the "last known good" configuration; and the ability to manage access-control lists for security.

But before you rush off and write your own WinSock service, you should understand two important areas: address resolution and the threading model. Address-resolution issues that must be resolved include how to register the service in a namespace (e.g., NetWare's Bindery), how the client will find the service, and what protocols you should use. Issues that are involved in determining the appropriate threading model include how to use file handles, choosing the best thread structure, and how to implement asynchronous support. In this discussion we will address these matters, providing guidelines for those who want to

write a WinSock service for Windows NT.

Address Resolution

Service-address registration and resolution and the selection of an appropriate threading model constitute two of the most important considerations you encounter when writing a WinSock service. We will look at addressing first.

When a service loads, it registers its address, and perhaps additional information, with one or more namespaces (see the figure "Service-Address Registration and Resolution"). The service then listens for incoming requests. When a client needs a service, it looks up the service's address in one or more namespaces. The client binds to the address and then starts sending data to, and receiving data from, the service.

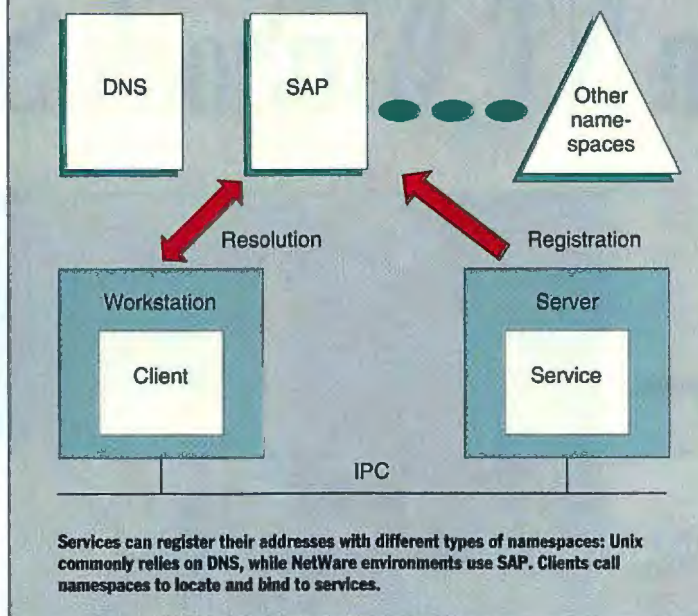
Each namespace handles registration and resolution of a service's address differently. What's more, different namespaces have different characteristics. In Unix environments, for example, services commonly rely on a preconfigured DNS (Domain Naming System), as well as the `/etc/services` file, to determine the address. For service lookup, the client commonly uses the `gethostbyname()` function to resolve the host name into an IP address.

In NetWare environments that use SAP (Service Advertisement Protocol) to resolve service addresses, services send out periodic SAP requests that register a word object type with a 48-character service name. Entries registered by the service are dynamic, and clients can access them by sending a SAP request for services of a given object type or by scanning the object database (i.e., the Bindery).

In NetWare environments that use the NDS (NetWare Directory Service), a service must first add itself to the directory schema, defining the properties of the service object, and it must then add the object within a container of an NDS tree. The service object is prominent within the NDS tree and thus does not have to broadcast its existence.

Ideally, the choice of where a service registers itself should be left to a network's administrator. Services should not have to determine which namespace to register in or what the differences between name-

Service-Address Registration and Resolution



spaces are. Likewise, to find a property of a service, such as its service address, clients shouldn't need to know which namespace they require.

Dealing with multiple protocols can be tricky because protocol families use different addressing structures. For example, TCP uses IP addresses, and SPX uses IPX addresses. Both addressing schemes can get you to the same machine running a particular service; however, you must treat a 4-byte IP address differently from a 12-byte IPX address.

New APIs, called RnR (Registration and Resolution) APIs, have been added to the Windows NT 3.5 SDK (Software Development Kit) to address multiple-protocol issues. (You can obtain a copy of the RnR specification via `ftp on rhino.microsoft.com under winsock\winsock2\nameres.`) Microsoft is working with the WinSock 2.0 group to evolve the RnR APIs into the WinSock 2.0 name-resolution standard. The new release of the SDK for Windows NT 3.5 includes the necessary header files, library files, and documentation.

Among the new RnR APIs are the following:

- `EnumProtocols`, which enumerates the protocols that are available on the computer. It also returns information about the quality of service of the available protocols, such as whether each is connectionless, whether delivery is guaranteed, and so on.
- `GetAddressByName`, which, given a

service-type GUID (globally unique identifier) and name, resolves the network address. Multiple addresses might be returned.

- `GetNameByType`, which, given a service-type GUID, returns a human-readable name for the service type.

- `GetTypeByName`, which is the reverse of `GetNameByType`.

- `SetService`, which sets the properties of a service. The `dwOperation` parameter lets a caller specify whether to add or remove a new service type or to register or delete a service instance.

- `GetService`, which obtains information about a particular service.

Note that service enumeration for client-side browsing will be added to a later version of Windows NT.

Threading Issues

Another key consideration when writing a WinSock service is the best way to handle network I/O. The architecture of a WinSock service heavily influences the service's performance, resource resolution, and effectiveness when it is used with a large number of clients. The text box "Threading Models" on page 91 explains five of the most common threading models for small and large networks.

Which one should you choose? No single model is best for every service. Selecting the right one for an individual service depends on the constraints and goals of that service. Does it need to handle hundreds of clients? Is performance critical? Is it acceptable for the service to be complex? The service developer must evaluate the trade-offs between performance and complexity when choosing which model to follow.

The Details

Now that we've highlighted key design considerations, we'll roll up our sleeves and look at some code. The sample code supplied in this article is an implementation of a simple multiprotocol Windows NT echo service called `EchoExample`. The server accepts incoming socket connections from clients running the `RnrCln` application, and the clients send uninterpreted data over the socket. The server receives the data and then writes it back to the client unaltered. When the transfer is

Threading Models

The threading model you choose when writing a WinSock service has a direct impact on how the service performs on a particular network. Here, in ascending order of complexity, are five common threading models designed to handle service networks of varying sizes.

Single thread, single client at a time is the simplest of all threading models. A service has a single loop in which it accepts (via the `accept()` API) an incoming client and then services it immediately in that thread. New clients must wait until the current client is serviced.

This model is easy to implement and has low resource requirements; it uses only a single thread and no more than two socket handles at a time. However, it cannot support more than one client at a time, which makes it inappropriate for all but the most basic services.

With the *single thread, multiple clients with `select()`* model, the service still uses only one thread, but it can handle multiple clients simultaneously by multiplexing among them with the Windows Sockets `select()` API. A single loop calls `select()` repeatedly to poll the listening socket and all the connected sockets. When `select()` indicates that one of the sockets is ready, the service determines which socket that is. If it's the listening socket, the service calls `accept()` to take the new connection. If it's a connected socket, the service calls `send()` or `recv()`, as appropriate, to send data to, or receive data from, the client.

This model creates a powerful service, but performance can suffer because every network I/O call passes through the `select()` API. This is acceptable when CPU use is not an issue but presents a problem if the service requires high performance.

One thread per client is probably the most commonly used model because it is reasonably simple to implement and is the fastest model for installations that have fewer than approximately 40 clients. The service sits in a loop calling `accept()` to take incoming connections. When a connection arrives, the service calls `CreateThread()` to spawn a thread that is responsible for handling the client for the duration of the connection. Using

a separate thread for each client has the advantage of reducing complexity, because each code path needs to perform only a single operation: The main thread accepts clients, and the child threads service them.

Programmers who have developed Unix sockets services (*daemons* in Unix terminology) will recognize this model as being similar to the single-process-per-client model that's often used on that operating system. In fact, it's possible to use a single process per client in Windows NT, but because processes make higher demands on resources than threads do, we do not recommend using it.

The downside of this model is that it does not scale well to large numbers of clients for two reasons: because of the demands that each thread places on resources and, more important, because of the length of time the system requires to do context switching among numerous threads. It takes several CPU cycles to switch contexts between two threads, and if a process has hundreds of threads all competing for one CPU, the system spends a large percentage of its time switching among these threads.

The *worker threads with synchronous I/O* model improves on the scalability of the one-thread-per-client model but increases complexity and slows performance when run with a small number of clients. The service uses a primary thread to accept incoming connections and dispatch tasks to worker threads. The primary thread typically uses `select()` to learn when sockets are ready for service and then notifies one of the worker threads that it has a job to perform. The worker thread wakes up, services the request, and then waits for more work.

There are a number of ways in which to break down the work between the primary thread and a worker thread. The primary thread can simply indicate to the worker that data is available on a socket; the worker then calls `recv()` to get the data and processes it. Alternatively, the primary thread can do the `recv()` and take a first look at the data



so that it can tell the worker thread what action to perform for the client.

The most powerful and flexible model—and also the most complicated one—is *worker threads with asynchronous I/O*. The key feature of this model is that socket handles are native file handles in Windows NT. As

a result, the Win32 APIs `ReadFile()` and `WriteFile()` can be used on connected sockets, and services can exploit the asynchronous, or *overlapped*, ability of these APIs. In asynchronous I/O, the application makes the initial request, and the system informs the application that its request is pending, meaning that the system is still working on it. This allows a single thread to start several I/O requests and then wait for one of them to complete.

By leveraging asynchronous I/O, a single service thread can simultaneously support several clients, but without the CPU overhead of the `select()` call. In addition, the service threads can handle more than sockets I/O, because the Win32 I/O mechanisms are integrated into the rest of the system. For example, a thread can wait for a semaphore or for I/O completion on seven socket handles.

Because this model lets a single thread support a number of clients, it scales well to hundreds, and even thousands, of simultaneously connected clients. It also performs well even for a small number of clients and provides the service developer with a flexible way of handling threads.

However, this model also introduces considerable complexity. For example, it raises the question of how many worker threads the service should use. If it uses too many, the system will thrash away, doing too many context switches between threads. If it uses too few, one or more CPUs may sit idle, waiting for work.

In general, it is advisable to use at least as many threads as the system has processors. More threads should be added if any existing ones spend a significant amount of time waiting for operations such as disk or network I/O to complete. However, the service should limit the total number of threads to no more than 20 or 30, depending on how the service uses the threads.



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complete, the client closes the socket and exits. The server then closes its socket and returns to its pretransfer state.

First we'll describe how EchoExample handles name registration and resolution using RnR APIs. For brevity, we show only the relevant parts of the code. (A complete listing can be obtained from ftp://ftp.microsoft.com/winsock/winsock2\nameres\samples.)

Remember that name registration and resolution have three basic parts. First, a service may need to perform up-front configuration. Then, the server side must register itself so that its clients can find it. Finally, the clients need to resolve the network address of the server from a human-readable name.

GUID Creation

```
//
// GUID for EchoExample created with UUIDGEN:
// "47da8500-96a1-11cd-901d-204c4f45d020"
//

GUID ServiceGuid = { 0x47da8500, 0x96a1, 0x11cd, 0x90, 0x1d,
                     0x20, 0x4c, 0x4f, 0x4f, 0x50, 0x20 };
```

GUID Creation

Because EchoExample is not a well-known service (as ftp is on Unix or file and print are on NetWare), the first step is assigning it a unique identifier. The service-installation code resides within the RnRSetup.c file. RnR uses a GUID, a 128-bit value that lets you uniquely identify a service without relying on service-type registration with a central authority.

Creating a GUID involves running the UUIDGEN.EXE utility, which ships with

the SDK. The service then uses this GUID, which never changes. UUIDGEN generated the GUID shown in the listing "GUID Creation" for EchoExample.

Before the service registers itself within a namespace, it adds itself to the list of services known to RnR.

Because EchoExample is not a well-known service, its GUID and other parameters, such as its object type for NetWare networks, are likewise not well known.

You can use the new SetService() API both during service installation and while loading a service. During service installation, you can call SetService() with SERVICE_ADD_TYPE to add a new service type to the system. Typically, the installation program does this, although the service's developer should make provi-

Windows NT Network Architecture

One of the goals of Windows NT's designers was to tightly integrate network protocols and services with the base operating system. Portability to a variety of processors (including RISC and Alpha chips) and scalability, which is made possible through symmetric multiprocessing, make Windows NT Server a desirable superserver platform for developing scalable network-server applications and services.

Packaged with Windows NT and Windows NT Server are several built-in networking protocols and APIs. Windows NT protocols include IPX/SPX, TCP/IP, and NetBEUI. Windows NT Server includes these three protocols, as

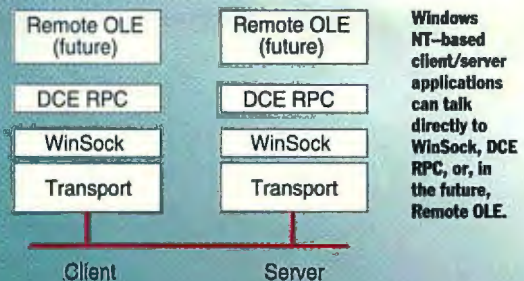
well as AppleTalk. Supported networking APIs include NetBIOS, DCE RPC (Distributed Computing Environment remote procedure call), and Windows Sockets (WinSock).

The figure "Windows NT Networking" illustrates the relationships among the base networking components in Windows NT. NDIS (Network Driver Interface Specification) enables network protocols to run unmodified over different

types of network hardware and media. The transports reside at the next level. All the transport protocols share a common TDI (Transport Device Interface), which provides a kernel-mode interface and user-mode programming interfaces for Windows NT's file and print components.

Another design goal for Windows NT networking was to provide an architecture on which interfaces and protocols can be strate-

API Layering

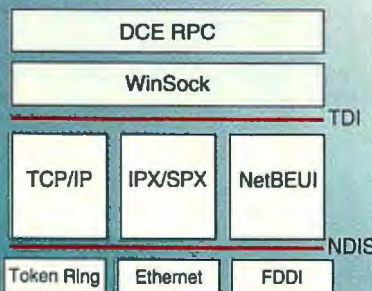


gically layered and extended. As the figure "API Layering" shows, the strategic interface and protocol layers include WinSock, DCE RPC, and Remote OLE.

Currently, a client/server application can choose to talk directly to WinSock or DCE RPC. In the future, Microsoft plans to add the ability to remotely call OLE objects.

Distributed object technology, such as Remote OLE, will enable developers of distributed applications to divest themselves of knowledge of communications tasks. Remote OLE is built on top of DCE RPC, utilizing such DCE elements as NDR (Network Data Representation) for data marshaling, authenticated packets, and encrypted sessions.

Windows NT Networking



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sions for rerunning this code if namespace providers are added to the system after the service is installed.

Calling `SetService()` with `SERVICE_ADD_TYPE` adds a service type for use only with RnR APIs. You must call additional Win32 APIs to add

`EchoExample` as a Windows NT service. When a service is removed from the system, it should do the reverse, calling `SetService()` with `SERVICE_DELETE_TYPE` to clean up.

In the code shown in the listing "Service Types," we pass a `SERVICE_INFO` structure with all the necessary information to `SetService()`, using `SERVICE_ADD_TYPE` as the operation and `NS_DEFAULT` (i.e., all default namespaces) as the namespace.

Service Registration

When the service starts, it registers itself by calling `SetService()` with the `SERVICE_REGISTER` operation. The service should do this after it has completed its initialization and is ready to begin serving clients. When registering, the service must supply several pieces of information, the most important being the GUID that identifies the type, the name identifying the service instance, and the service address.

Because a service can work over multiple transports, its address is described by the `SERVICE_ADDRESSES` structure. For each socket, we typically determine the local address by calling `getsockname()` and then add this address to the `SERVICE_ADDRESSES` structure. This is done in a transport-independent manner. `SetService()` is routed to each namespace provider, which uses an address's family type to decide whether it should advertise that address. When the service stops, it is important that it deregister itself by calling `SetService()` with `SERVICE_DEREGISTER` to remove itself from the various namespaces (see the listing

Service Types

```
err = SetService(
    NS_DEFAULT,           // all default namespaces
    SERVICE_ADD_TYPE,    // add the new service type
    0,                   // dwFlags not used
    &serviceInfo,         // the service info structure
    NULL,                // lpServiceAsyncInfo
    &statusFlags          // additional status information
);
```

"Service Registration").

Services that use `NS_DEFAULT` let the administrator determine the namespaces that the service is registered with. In addition, the service doesn't need to be changed when a new namespace provider is added or deleted.

Name Resolution

The `EchoExample` client code resides within the `RnRClient.c` file. The client must do several things before it starts talking to an `EchoExample` server. First, it calls `EnumProtocols()` to determine which protocols available on the system meet the type of service required. When the client finds the desired protocols, `GetAddressByName()` is used to resolve the network addresses for those protocols (see the listing "Name Resolution").

The client and service components that we've highlighted in the preceding sec-

tion, the RnR specification, and the sample code should all provide you with a clear impression of how to address name registration and resolution, as well as protocol transparency, within a heterogeneous networked environment.

The Threading Model

As mentioned earlier, when writing a service you must choose a thread model that strikes a balance among several conflicting system requirements. Here we will focus on a variation of the one-thread-per-client model (see the text box "Threading Models") as implemented in `RnRSvc`, the RnR sample service for `EchoExample`. In the interest of brevity, this example puts an upper limit on the number of worker threads.

Like any other multithreaded application, a Windows NT service must carefully synchronize access to shared resources. NT provides a rich set of synchronization primitives. `RnRSvc` uses a critical-section object to protect resources shared by multiple threads. Critical sections provide mutual-exclusion synchronization among the threads of a single process.

Only a single thread is permitted to enter a critical section at a time. If a second thread attempts to enter a critical section, it is blocked until the first thread leaves. If multiple threads are blocked on one critical-section object, only one thread is released after the owning thread leaves the critical section. These qualities make critical sections ideal for shared-resource synchronization in a multithreaded service.

Any server that handles more than one client simultaneously has to maintain a certain amount of state information for each connected client. This information is critical during service shutdown, when all connected clients are forcibly disconnected from the server. `RnRSvc` keeps an open socket handle as part of the state information that is maintained for each connect-

Service Registration

```
err = getsockname(
    SocketHandle,         // opened socket
    sockAddr,             // receives socket address
    &size);               // size of address

... package sockAddr in the serviceInfo structure

err = SetService(
    NS_DEFAULT,           // for all default namespaces
    SERVICE_REGISTER,    // we want to register (advertise)
    0,                   // no flags specified
    &serviceInfo,         // SERVICE_INFO structure
    NULL,                // no asynchronous support yet
    &statusFlags);       // returns status flags
```

Name Resolution

```
protocolCount = EnumProtocols( NULL, buffer, &bytesRequired );

... select the desired protocols

err = GetAddressByName(
    NS_DEFAULT,
    ServiceType,
    ServiceName,
    protocols,
    0,                                     // dwResolution
    NULL,                                // lpServiceAsyncInfo
    buffer,
    &bytesRequired,
    NULL,                                 // lpAliasBuffer
    NULL,                                 // lpdwAliasBufferLength
    );
```


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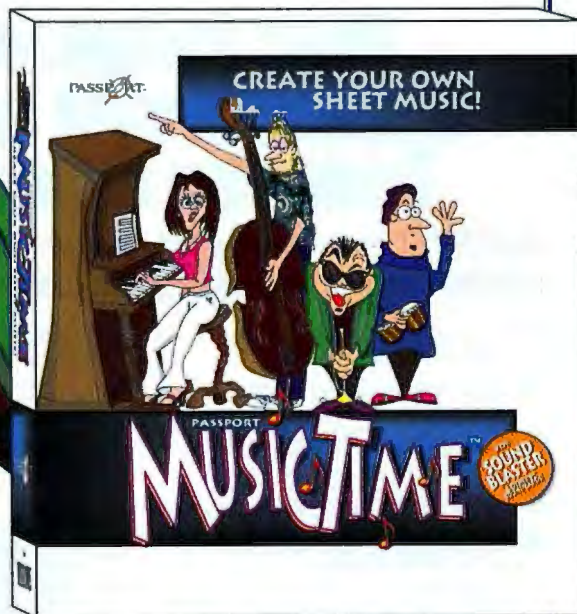


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ed client. During service shutdown, these open socket handles are closed, which terminates the client sessions.

RnrSvc includes the following modules:

- **CLIENT.C:** Manages client connections and state information. There are four versions; each one implements a different threading model.
- **CONNECT.C:** The connection thread responsible for accepting incoming connection requests. As connection requests are accepted, they are routed to CLIENT.C for processing.
- **GLOBALS.C:** Global variables shared by all modules.
- **LOG.C:** Event-logging functions. They can be built with BUILD_STANDALONE_EXE # defined to effectively disable logging.
- **MAIN.C:** Start-up code. This module contains all functions for communicating with the NT Service Controller. It can be built with BUILD_STANDALONE_EXE # defined to create a stand-alone executable file rather than a service. This makes debugging a bit simpler.

• **RNRUTIL.C:** General RnR utility functions useful for writing other services and applications.

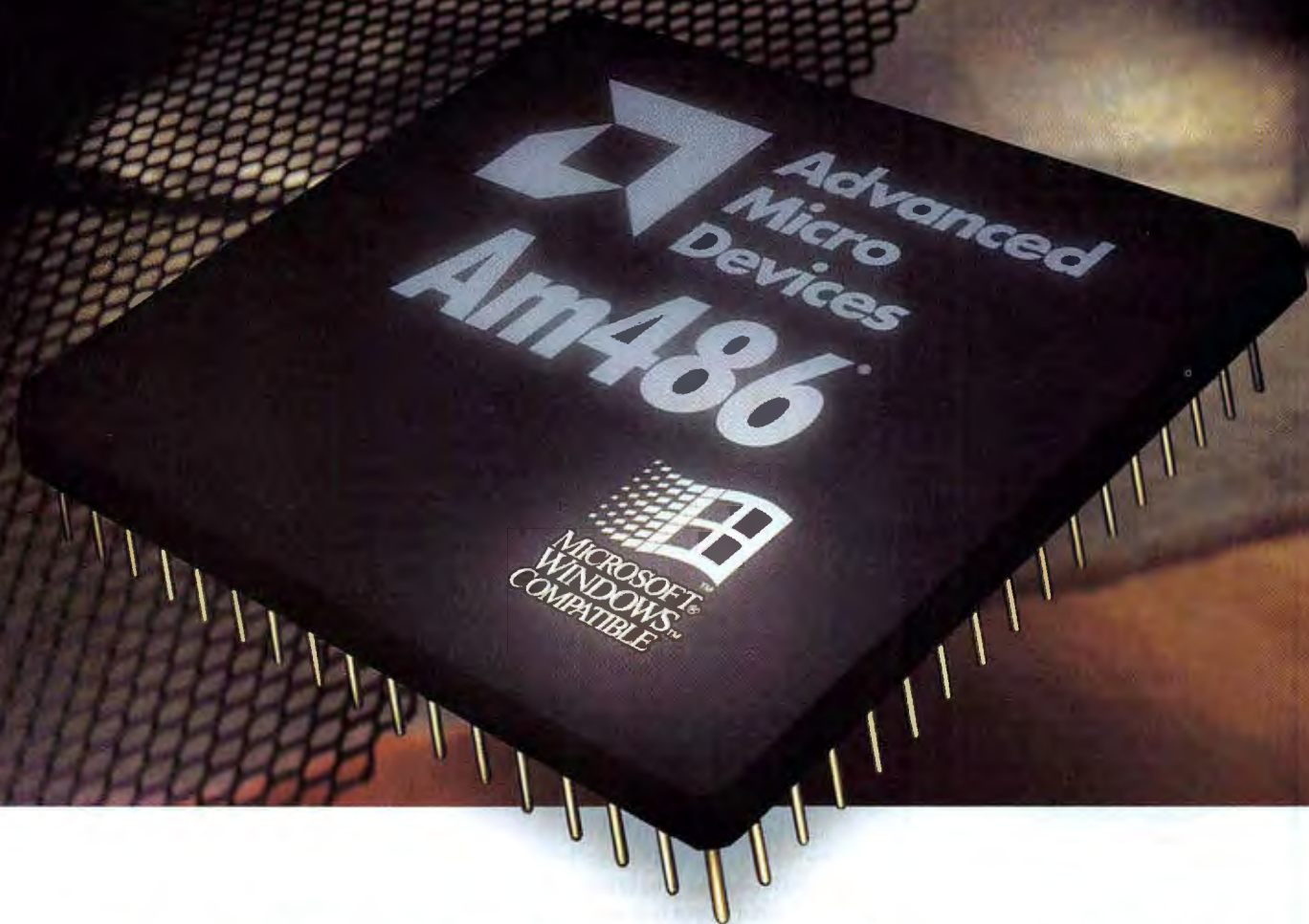
• **CLIENT.C:** Encapsulates all client-manipulation functions. As new clients connect to the server, they are tracked by parallel arrays of socket handles and thread handles. Whenever new entries are added to the arrays, a corresponding worker thread is created. When a client disconnects from the server, the worker thread removes the corresponding entries from the tracking arrays. When the service is shut down, the active list is scanned and all active clients are terminated.

Four global variables track connected clients: **CRITICAL_SECTION** (RnrpLock), **SOCKET** (RnrpActiveSockets[MAX_THREADS]), **HANDLE** (RnrpActiveThreads[MAX_THREADS]), and **DWORD** (RnrpNumActive). RnrpLock synchronizes access to the other global variables, RnrpActiveSockets holds the socket handles of all active clients, RnrpActiveThreads holds the thread handles of all active clients, and RnrpNumActive stores the current number of active clients.

Service Initialization and Termination

The service-initialization thread, RnrClientInitialize, initializes the critical section lock and active client counter.

```
InitializeCriticalSection
( &RnrpLock );
RnrpNumActive = 0;
```

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Feature

Service Termination

```
... call worker routine to perform the echo transfer ...

//
// Find the client socket in the active socket array. If found,
// close the corresponding thread handle and remove the socket
// and thread-array entries.
//

EnterCriticalSection( &RnrpLock );

for( Index = 0 ; Index < RnrpNumActive ; Index++ ) {
    if( RnrpActiveSockets[Index] == ClientSocket ) {
        CloseHandle( RnrpActiveThreads[Index] );

        //
        // Remove the socket and thread-array entries.
        //

        RnrpNumActive--;

        memmove( &RnrpActiveSockets[Index],
                &RnrpActiveSockets[Index+1],
                ( RnrpNumActive - Index ) * sizeof(SOCKET) );

        memmove( &RnrpActiveThreads[Index],
                &RnrpActiveThreads[Index+1],
                ( RnrpNumActive - Index ) * sizeof(HANDLE) );

        break;
    }
}

LeaveCriticalSection( &RnrpLock );
```

Service termination (RnrpClientTerminate) gets a bit complex. Its most important tasks are ensuring that worker threads shut down quickly and ensuring they do so in an orderly fashion. The service scans RnrpActiveSockets, and all sockets belonging to active clients are closed. As the sockets are closed, the array entries are set to INVALID_SOCKET to prevent the worker threads from closing their own thread handles (see the listing "Service Termination"). This enables the termination thread to wait for any remaining worker threads to terminate by calling the WaitForMultipleObjects API on the RnrpActiveThreads array.

Whenever a new client connects to the service, RnrpClientHandler is called to manage the client session. RnrpClientHandler checks RnrpNumActive to see if the tracking arrays have room for another client. If they do, then the newly accepted client socket is saved in RnrpActiveSockets, and a new worker thread is created by calling the CreateThread API.

The worker thread, RnrpWorkerThread, calls a utility function, RnrpHandleTransfer, to echo the data back to the client. (RnrpHandleTransfer is shared by the single-thread, single-client-at-a-time; the one-thread-per-client; and the worker-threads-with-synchronous-I/O models.) After the transfer is complete,

RnrpWorkerThread scans RnrpActiveSockets to find the client socket.

If the socket is found, the thread handle is closed. The socket-array entry and thread-array entries are removed from the arrays, and RnrpNumActive is decremented. If the socket is not found, it means that the service is shutting down, and the arrays are left untouched.

RnrpHandleTransfer performs the actual transfer. It sits in a loop, reading data from the client and then writing it back unaltered. If the receiving or sending portion of the transfer fails for any reason, the transfer is aborted. When a transfer is completed, the client socket is closed.

NT offers portability, scalability, and built-in networking support for popular transports. This brief tour, together with the sample code and additional on-line references, should give you a jump start for writing your own service for NT. ■

The authors are members of Microsoft's Windows NT development team. Chuck Chan is the lead software-design engineer responsible for NetWare connectivity in NT networking. Margaret K. Johnson is a program manager for NT networking components. Keith Moore is a software-design engineer responsible for designing and implementing the NT file server. Lead software-design engineer David Treadwell has primary responsibility for Windows Sockets and is one of the authors of the WinSock specification.



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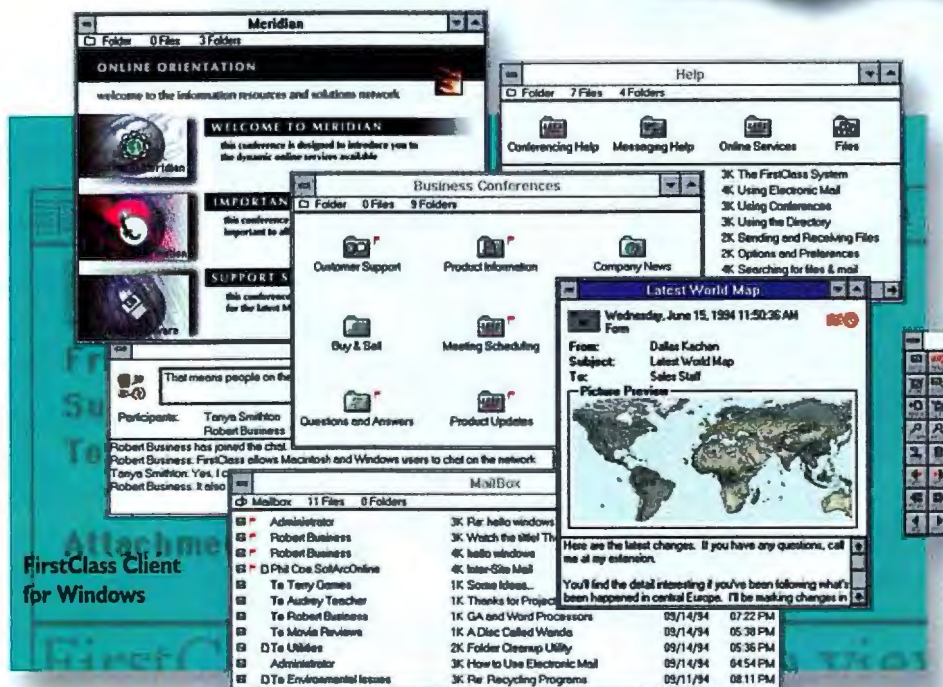
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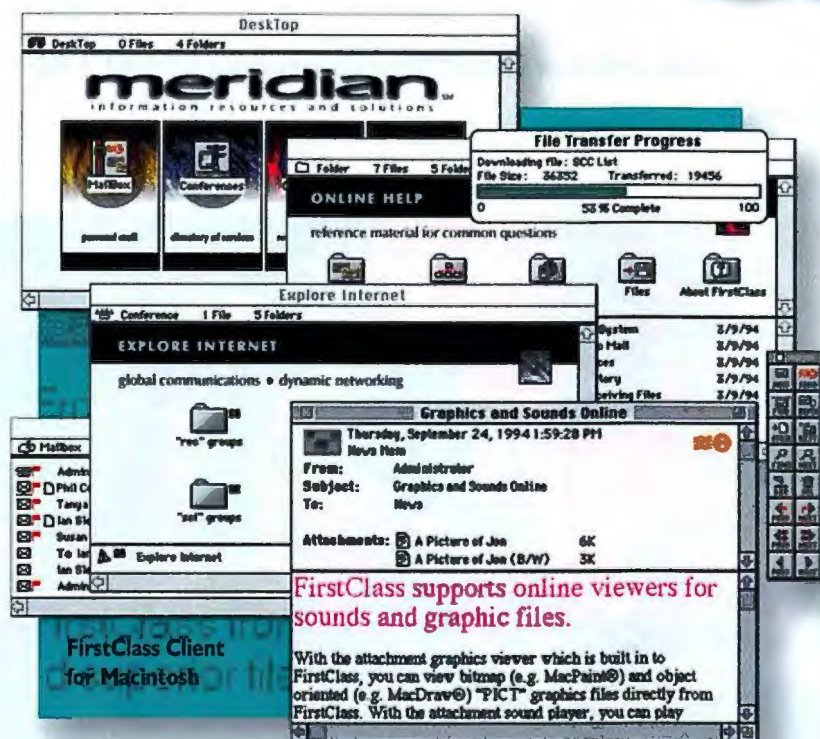
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FirstClass can communicate with mail systems such as Microsoft Mail, QuickMail or a host of others through optional Novell MHS or Internet gateways. SoftArc and various third parties have produced a number of options including fax gateways, database extensions and FirstClass client software for PDAs.



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Cross-Platform Chatting?	Y	Y	-	-	-
Fully Customizable Interface?	Y	Y	-	-	-
Bulletin Board Functions?	Y	Y	-	-	-
Modems Per Server?	Up to 48	8	1	1	1
Restrict Any Feature?	Y	Y	-	-	-
Internet News Gateway?	Optional	Optional	-	Y	-
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State of the Art

NETWORK MANAGEMENT

What's your network like? How big, how remote, and how varied? How do you keep tabs on it all? Here are a few answers to these questions.



No computer is an island, complete unto itself. Not any more. Virtually every computer used in business today is part of a network, and those networks are almost invariably connected to other networks. Most computer users would be seriously hampered in their work and productivity if they couldn't tap into network resources and communicate with other users on their LANs and WANs.

One result of this situation is the increased importance placed on managing an organization's network efficiently. This involves many critical tasks. First, you need to make sure that the various elements of the far-flung web are interconnected properly and operating the way you expect them to. Given the variety of equipment used to connect network segments and the various protocols that may have to be supported—TCP/IP, Novell's IPX, Apple's AppleTalk, IBM's SNA (Systems Network Architecture), and Digital Equipment's DECnet—this job is far from trivial.

A second important function is administering the normal network business (e.g., rights and privileges) for a user population that is constantly changing and usually growing. Doing this properly, with consideration for security and job-related needs, requires significant resources and a commitment from the organization.

Finally, needs change. In addition, it is the job of network managers to keep track of what's going on in the world of network design to be able to ensure that their network's design (not just its components) is capable of doing what users require. Internet connectivity, for example, is quickly becoming a major new factor in assessing the network's overall load and suitability. Managers must make significant decisions as to when to limit connectivity, when to expand it, and when the network may require a complete overhaul or redesign.

Picking Up the Pieces

Networks are made up of connected computers and other devices. The connections are made and maintained by still other devices and black boxes—bridges, concentrators, gateways, hubs, multiplexers, and routers. And because the network can have thousands of nodes and range across continents, if a problem occurs you can't just walk down the hall to investigate.

Today's network managers rely on a variety of tools—primarily software—to find out what is and is not happening. The first network management software was proprietary in nature, and for every different type of device—perhaps even for every different vendor supplying those devices—you required a different package with its different interface, training, and so on. That impossible situation is being cleaned up with a new breed of network management platforms that let third-party software feed into a common database and interface.

In "Monitoring Your Net," Paul Korzeniowski describes the development of these tools and shows where the industry is heading. The three major players in the development process include SunSoft, IBM, and Hewlett-Packard. Korzeniowski has assembled a healthy dose of user input as to how well these systems work.

Faster, Faster, Faster!

One issue that network managers hear about time and again is performance. Users are increasingly conscious of, and unwilling to put up with, delays in getting data across a network, whether it's from a file server in the next room or from an inter-network connection halfway around the world. Traditionally, the answer to performance issues has involved faster servers and higher-bandwidth network architectures.

Brett Hussenbaugh offers a somewhat different take on the performance ques-

tion. He believes that bandwidth is not the best measure of network performance and can be misleading. In "(Mis)using Bandwidth," he presents a way of modeling your network mathematically so that you can determine in advance the performance impact of proposed changes to the network.

One key consideration in analyzing network performance, he contends, is that most network accesses are relatively small read requests, and they carry an inherent overhead that is not accurately reflected by bandwidth measures. He draws some surprising conclusions about the relative efficiency of different types of networks. His model is based on years of experience in the field and has been tried and adopted by many network managers and planners.

And Faster Still (When You Really Need It)

Even with the best of planning and appropriate selection of hardware and connecting devices, it's not uncommon for some networks to get so big and so busy that they just run out of steam. When that happens, the answer may be to move to a data transmission scheme that is designed from the start for high-speed, high-volume data of varying types and different priorities.

The leading candidate for that seems to be ATM (Asynchronous Transfer Mode), which Peter Wayner described in detail in "On the Road to ATM," September BYTE. In this issue, Mark Juliano explains one of the principal reasons why ATM is so well suited to today's networking needs—its ability to allocate bandwidth, control traffic flow, and guarantee the level of service that an application needs.

"ATM Traffic Control" describes the techniques ATM hardware uses to solve these nontrivial problems and shows why you may want to consider changing to an ATM-based network. In that article, the text box "ATM with a French Accent" describes how France Telecom has recently made commercial ATM networks available throughout France and is extending them to the rest of Europe and across the Atlantic.

When you consider how quickly the world has become networked and is becoming ever more so, the true dimensions of the networking management problem begin to emerge. This is not a one-time obstacle but an ongoing concern that will continue to grow. We need better tools at all levels of network planning, maintenance, and administration. We'll get them, too, but we need to remember that the target is continually moving. ■

—Russell Kay, Technical Editor

Monitoring Your Net

Tools that can help you sort out the pieces of your network puzzle **109**



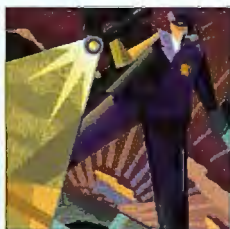
(Mis)using Bandwidth

To improve network performance, you add bandwidth, right? Maybe not. **117**



ATM Traffic Control

ATM networks manage data flow and guarantee service levels **129**





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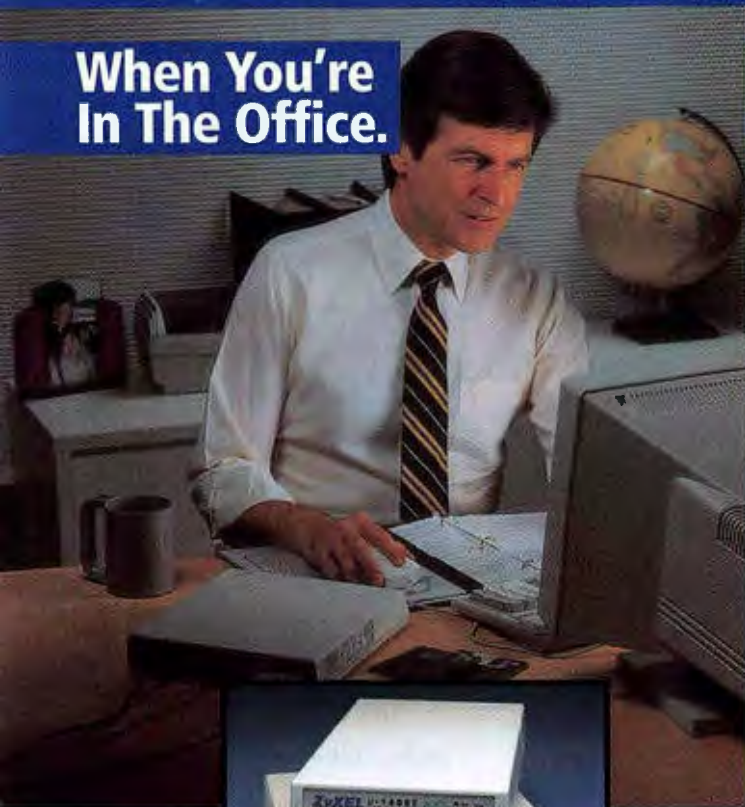
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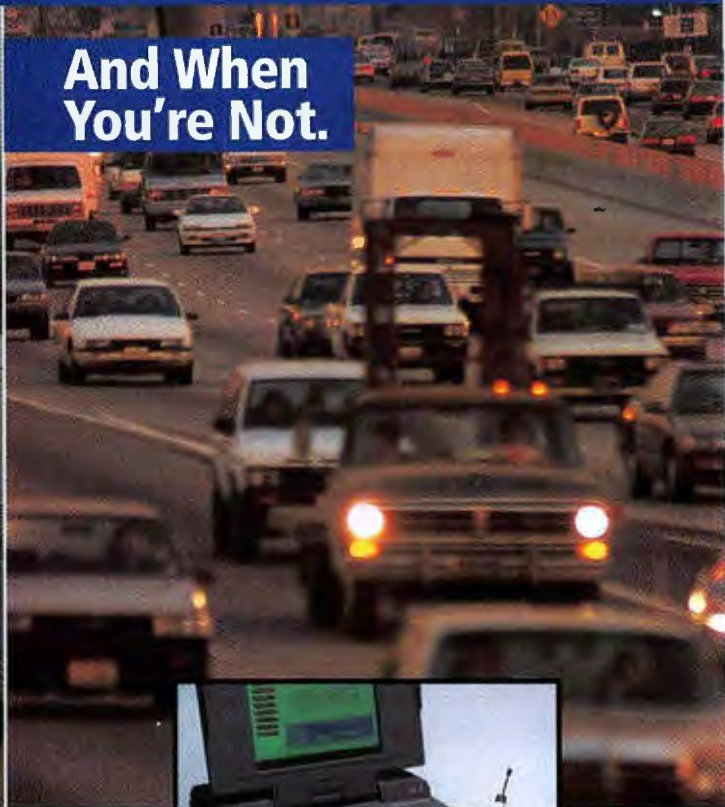
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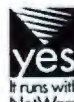
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MONITORING YOUR NET

A new generation of network management “platforms” can show what’s happening throughout a far-flung network, across every bridge, router, gateway, and hub

PAUL KORZENIOWSKI



It's a nightmare—keeping track of all the bits and pieces, nodes and workstations, and black boxes and connecting devices that make up a network; identifying trouble spots; and handling all the administrative chores generated by an ever-growing, ever-changing user population. What's needed is automated help in the form of a network management system. The primary goal of such a system is quite simple: to identify and replace faulty equipment. Actually doing that, however, is not so simple.

Consider the data path, for example. A user's PC might pass information to a network adapter card, then over an Ethernet LAN to a communications server, and then to a router that uses a T1 phone line, just to reach a front-end processor that sends information to a Unix server. And returning data has to retrace those steps. Problems can occur anywhere along this path, and the range of possible problems is large.

Finding a single network management application capable of doing the entire job used to be an impossible task. But now it's beginning to look more likely, because of a shift from proprietary, stand-alone, device-level applications to what are known as *network management platforms*—integrated systems that can gather data from a variety of third-party applications and present it in a consistent interface.

A platform offers network equipment suppliers a common set of services, such as a map displaying all connected equipment. Platform suppliers encourage third parties to build applications that run on platforms. So, a router manufacturer now designs an application that works with others on a central platform, not as a stand-alone program.

Device suppliers welcomed this change, because they could now hand over a portion of their software development activity to the platform vendors and thereby save themselves (and their customers) money. As a result, hundreds of applications

Moving from Proprietary Management to SNMP

There have been many false starts on the road to integrated network management. The problem of multiple management consoles became obvious in the mid-1980s as LANs grew.

Initially, vendors such as AT&T and IBM designed proprietary systems and tried to develop all the needed functions themselves. They jury-rigged existing applications into integrated suites and published proprietary APIs so that third parties could send information to their management consoles.

At that time, users were generally moving away from proprietary systems and toward industrywide standards. The ISO developed a suite of management specifications, dubbed CMIP (Common Management Information Protocol) and CMIS (Common Management Information System).

Unfortunately, these standards were too complex for vendors and users alike. They did find a niche, however, in large telecommunications networks from companies such as AT&T and Pacific Bell. And they may still eventually work their way into corporate networks.

The IETF (Internet Engineering Task Force), an ad hoc task force that handles common network problems, has had the

most success in tackling management issues. The vendor-independent group's work is not considered proprietary.

Rather than creating an all-encompassing standard like CMIP or CMIS, the IETF aimed to keep its work simple; it even named its protocol SNMP—the Simple Network Management Protocol. The initial goal of SNMP was to ease physical network management (e.g., identifying a faulty wiring hub or router). To this end, the group outlined a series of common functions, such as running an error-checking test.

The IETF recognized the myriad of incompatible equipment. But rather than forcing conformity, SNMP allowed a central console to store management information in databases known as *MIBs* (Management Information Bases).

As the IETF completed its SNMP specification, network management platforms began to emerge. Rather than relying on proprietary protocols, vendors based their systems on SNMP, which quickly became a de facto standard.

But even though SNMP soon won widespread support, it wasn't perfect. SNMP was designed to work with TCP/IP, which meant that SNA (Systems Network Architecture) and DECnet users

had to install separate TCP/IP lines to funnel information to central management stations. Also, SNMP's first iteration included no security features. Large companies with highly sensitive data found this a major limitation.

In response, in 1992 the IETF developed a second version of SNMP, dubbed SNMP 2. This version has moved along slowly. Only a handful of vendors have shipped SNMP 2-compliant packages, and few organizations are using them.

One strength of the original version was its automatic discover feature, which found and identified new network devices. That's incompatible with SNMP 2's security, which requires that a device supply a security clearance to be connected to a network.

Security administration is another problem area. To implement SNMP 2 security, a company must maintain and coordinate a handful of different databases; this adds significant overhead.

In June, Steven Waldbusser—manager of network development at Carnegie Mellon University (Pittsburgh, PA) and a leading SNMP architect—outlined a set of software conventions to ease security administration. Waldbusser wants to expand the use of SNMP 2 at Carne-

running on management platforms are now available on the leading systems.

This shift from proprietary to platform applications is a critical development, because it appears to be the only real hope for the effective management of continually growing and changing enterprise networks. The wide acceptance of SNMP is an important factor in allowing vendors to tie their applications into the platforms (see the text box "Moving from Proprietary Management to SNMP" above).

Filling In the Gaps

However, there are still some voids; some areas are still without third-party applications. Many network device suppliers are just beginning to port their management applications to the dominant platforms. For instance, Wellfleet (Billerica, MA),

the second-leading router supplier, sells a version of its SiteManager package that runs on only one of the three leading platforms. (Wellfleet recently merged with SynOptics Communications [Santa Clara, CA] to form Bay Networks.)

Links to PC LANs are just emerging. In addition, connections to Banyan Systems' Vines networks and Microsoft's Windows NT Advanced Server are hard to find.

Much of the network equipment currently in service dates from the mid-1980s. Some of these devices may not have been upgraded and are thus unable to operate with management platforms.

Platforms help corporations rein in network management applications. Because all the applications run on one platform, troubleshooters no longer need to work on three or four different terminals simulta-

neously to pinpoint problems.

Because of such improvements, sales of network management platforms have swelled. International Data, a Framingham, Massachusetts, market-research firm, estimates there will be over 20,000 central management platform installations by the end of 1994 (see the figure "Installed Base of Network Management Platforms").

The Main Players

At present, the platform arena includes three major players: SunNet Manager from SunSoft, a division of Sun Microsystems (Mountain View, CA); OpenView from Hewlett-Packard (Cupertino, CA); and IBM's NetView for AIX. Here's a brief look at each one.

SunSoft's SunNet Manager. SunSoft introduced SunNet Manager, the first com-

gie Mellon. Currently, the university, which has 7000 computers, relies on SNMP and Telenet for network management. SNMP gathers network fault information and then relays it to central consoles. Telenet configures remote devices.

Why two different products? SNMP isn't suited to remote configuration because it supports only one error code, while Telenet works with more error codes but lacks security. Consequently, an intruder with a protocol analyzer can pick off remote-device passwords and IDs. Waldbusser would like to use SNMP 2, which includes security features and supports 15 error codes, to handle both information gathering and remote configuration.

Because of such obvious benefits, observers expect a bevy of SNMP 2-compliant gear to appear soon. Cabletron, Cisco, and SynOptics have already demonstrated such products.

Even though SNMP 2 has encountered problems, SNMP is still clearly the protocol of choice, and vendors have expanded its scope beyond physical network management. Suppliers such as Hewlett-Packard and SunSoft have delivered packages that allow network technicians to monitor PCs and workstations. Work is also under way to enhance the protocol to oversee applications software and DBMSes.

mercial network management platform, in 1989. It's still the top-selling Unix network management platform. Being first helped SunSoft in the marketplace, and its track record is important in luring customers.

Three years ago, the Cobb County government in Atlanta, Georgia, realized that, at 4000 users, its network had become unmanageable. The county determined that a network management platform was called for. SunNet Manager was selected because, according to Gene Estensen, information services manager for Cobb County, "it was the only platform that ran on Unix and was stable." The county purchased the platform along with SynOptics' Optivity to manage its Cisco Systems (Menlo Park, CA) routers and SynOptics wiring hubs.

HP's OpenView. But SunSoft did not have the market to itself for long. In 1990,

HP entered the platform arena with OpenView. HP has been successful in courting third parties; Data General, Groupe Bull, and Hitachi resell the package, and this has helped OpenView gain market share.

In 1992, Martin Marietta, based in Orlando, Florida, wanted to move from proprietary management tools to open systems. Frank Mellard, a Martin Marietta senior communications consultant, says the company was more comfortable with HP's long-term direction: "We felt that HP had a better grasp of the problems of managing large, complex networks than Sun."

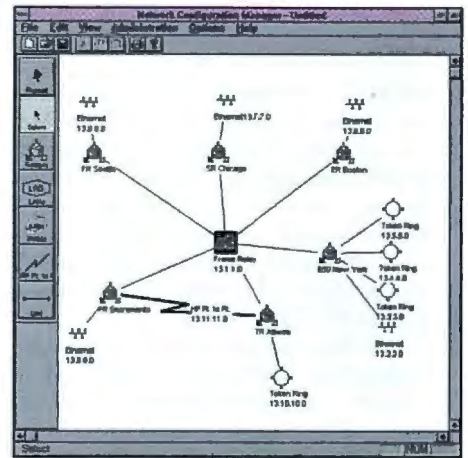
Martin Marietta's corporate network is quite large—100,000 users—and it is also complex. Its computers support AppleTalk, DECnet, SNA (Systems Network Architecture), Novell's Integrated Packet Exchange, and TCP/IP. The company currently uses OpenView along with Remedy, Inc.'s, Remedy trouble-ticketing package to control its TCP/IP connections. The company has plans to tie OpenView to DECnet with software from Isicad and to SNA with Peregrine's OpenSNA.

IBM's NetView for AIX. In 1992, IBM decided to develop a Unix network management system. Rather than write it from scratch, the company licensed HP's OpenView to incorporate into NetView for AIX. To further convolute the mix, DEC dumped its proprietary network management platform, DECmcc, in 1993 and became a NetView for AIX reseller. Because of its late entry into the market, IBM lags behind SunSoft and HP, but it has been steadily gaining ground.

For example, in 1992, the University of Florida in Gainesville searched for a platform for its 3000-user network. Because it had relied on the mainframe version of NetView for 10 years, the university chose NetView for AIX to manage wiring hubs from Cabletron and IBM as well as routers from Cisco, Proteon, and Wellfleet. Jerry Wetherington, systems coordinator, notes that a major advantage of using NetView is that a technician can view network devices on a central map and get a quick picture of how the network is functioning.

Integrated or Not? Users Tell All

Map support is one of many ways in which a third-party vendor can integrate its application into a network management platform. But third-party applications differ in the way they work with major platforms. "Some third-party applications run on Unix fine without the network management platforms," notes L. Dave Passmore, a princi-

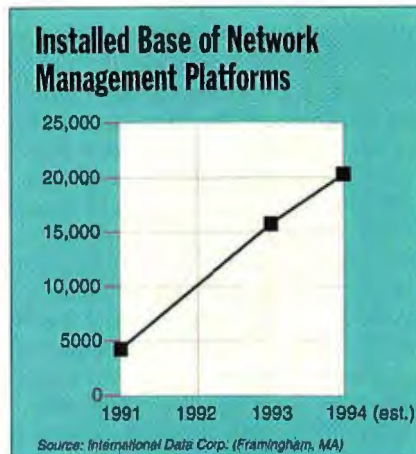


Health Care System in Dallas, Texas, relies on Optivity and its add-on modules. Mel Lively, network manager at Presbyterian Health Care, says the company uses FaultMan to control its wiring hubs, RouterMan to oversee its routers, PathMan to determine network connections, PolicyMan to set network thresholds, and FactMan for trouble-ticketing.

But most networks rely on multiple management applications. For example, a company may have Chipcom (Southborough, MA) wiring hubs and Proteon routers. In these cases, all sorts of problems arise because of user-interface issues.

Data Integration: Tying It All Together

Data integration presents other vexing problems. "Currently, different management applications store information in distinct databases," notes Passmore at Decisis. "So, a company can't take wiring-hub information and correlate it to work with its router network." Another data-compatibility problem arises because different network management applications employ different



DBMSes to store and analyze data. For example, a router application might store its information using Sybase, while a platform relies on Ingres. What's an organization that uses both network management products to do? Use both DBMSes?

Here's a case in point. The Travelers (Hartford, CT) operates an IBM SNA network with 25,000 devices, and a LAN-interconnected network with approximately

15,000 nodes. Because it has traditionally relied on IBM for much of its networking equipment, the company began working with NetView for AIX in January.

Eric Mirer, an engineer/consultant at The Travelers, says "there is literally no integration among the data generated with our various management packages." Data about the company's IBM RS/6000 servers is stored in one database, router information is housed in a second, PC LAN information is monitored with an OS/2-based package, and mainframe data is overseen by IBM's NetView. The Travelers wants tools that consolidate all that information. "Data integration represents the big kahuna for network management suppliers," notes David Abbajay, software development manager for network management products at Cisco Systems.

SNMP specs include a MIB standard so that management tools can access database information. With a MIB browser, for example, HP's OpenView can examine information generated by Cisco routers. However, there's no standard for translat-

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ing that information so it can be stored in one location. Thus, problems arise when two vendors rely on different DBMSes.

Even with a common DBMS, there are limitations. "Two vendors can rely on the same DBMS, but if they use different rows and tables, then their applications cannot share common information," explains Ab-bajay. Thus, platform vendors have to add a layer of software that identifies database differences and translates them. These features constitute a *data schema*, a technique outlining how to store data in a consistent fashion in a central repository.

Platform vendors are at different stages in the search for solutions. The first step is incorporating support for RDBMSes (relational DBMSes) in their products. Next, they must outline a central repository model.

Market leader SunSoft has been the quietest about its plans. SunNet Manager now relies on a flat-file system to store network management information, but the company plans to support RDBMSes. Yet SunSoft has been silent on the repository issue. "Sun will have to say something soon to

keep pace with competitors," says Passmore at Decisis.

HP has been gradually improving OpenView's DBMS capabilities. Initially, the product stored information in flat files, but HP now uses DBMSes and plans to support a wide range of them in the future.

In August, HP unveiled its plans for building a network data repository: OpenView Meta Schema. This document specifies object attributes, topology, and trend information. In the first iteration, each vendor will own a slice of the DBMS, which will be accessible to third-party tools.

HP plans to eventually allow all information to be stored in one database. How long that will take, however, is unclear. HP has invited third parties to comment on the working draft of its schema.

One might think that IBM would work with HP on the repository issue, but no. In fact, the two companies have been moving away from each other during the past few years. The first release of NetView/6000 relied on OpenView for about 75 percent of its functions. However, "the lat-

est release of NetView for AIX might be 10 percent OpenView code, and the rest is IBM-developed," states John Byzek, director of enterprise management development at IBM's Network Systems Division in Research Triangle Park, North Carolina.

IBM says that HP didn't offer a sufficiently robust product. "We found a lot of problems with the source code, so we felt we had to develop the work ourselves to ensure that our customers would have robust software," says Byzek.

HP's MacKinney scoffs at this. "IBM may not like to admit it, but NetView for AIX is based on OpenView," he counters, concluding that IBM has been taking heat from third parties for forcing them to use another API. "So, IBM needs to justify its actions."

In August, IBM unveiled its Karat project, which relies on objects to integrate disparate database information. The software is based on the CORBA (Common Object Request Broker Architecture) standards as well as on IBM's SOM (System Object Model), an operating environment

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With the primary suppliers moving in different directions, which one has the best chance for success? SunSoft has the leading market share and many third-party supporters. HP is gaining ground and widening its distribution channels. IBM can tap into the base of companies already working with its mainframe and LAN management systems. Third-party support is crucial, so all three are courting third parties.

"Dis-Integration": Competition's Dark Side

While the move to platforms has been a blessing for network suppliers, it also has its downside. Passmore at Decisis notes that "a package like Ciscoworks was designed for SunNet Manager. Because Cisco relied so much on the Sun platform, the company has been slow to deliver versions of its software for other platforms."

Cisco planned to deliver versions for HP's OpenView in the fall, and for IBM's NetView for AIX shortly thereafter. Cisco's Abbajay admits that the different versions took longer to deliver than anticipated, but he says porting was only one of several reasons why the software was late.

Whatever the reasons for Cisco's delays, most third parties do not want to align themselves too closely with a single platform because it takes extra time to move their software to another. They would clearly prefer a common set of APIs.

For their part, platform vendors want to differentiate their wares and have no desire to standardize APIs. In May, a group of third-party organizations formed the MIC (Management Integration Consortium) in an attempt to wrest control of the APIs from platform vendors. The group plans to outline a schema for storing information in DBMSes, for developing a simple API for access to common data, and for integrating multiprotocol events.

"Vendors face two choices: Deliver something simple that works, or bring something comprehensive," notes James Herman, a principal at Northeast Consulting Group, a Boston-based consulting firm. "MIC is working on something simple, so it has a good chance for success."

Joseph Diamond, a marketing manager at Peregrine Systems (Carlsbad, CA), says that MIC membership has swelled to 30 suppliers and that all three platform vendors are vying to have their work adopted by the group. MIC has begun working on the first draft of its data schema, plans to complete it by early 1995, and expects con-

forming products to arrive during 1995.

But users should be cautious; previous integration tries have failed. IBM was the first vendor to step up to the chore with its mainframe NetView products. In 1989, it announced its SystemView initiative to provide a common repository. But when it announced the Karat project, IBM was throwing in the towel on SystemView.

In the early 1990s, the OSF (Open Software Foundation), a vendor consortium in Cambridge, Massachusetts, was charged with creating common network management standards. The group outlined a complex set of standards dubbed DME (Distributed Management Environment). HP and IBM were early backers. The OSF missed shipment dates, however, and eventually DME also went the way of the dinosaur. "DME was ahead of its time, and that's why it failed," notes IBM's Byzek.

A principal reason for failure to achieve integration is vendors' constant attempts to differentiate their products. Martin Marietta's Mellard notes that adherence to MIB specifications would eliminate many current incompatibility problems. "Problems arise because vendors always add proprietary extensions to existing standards," he says. "Whenever that occurs, the level of interoperability drops significantly."

Vendors admit this without remorse. Cisco's Abbajay says that "a vendor has to differentiate its products in order to sell them. Whenever you add value, the level of interoperability diminishes."

Is there hope for integrated network management? "The fact that HP and IBM are now supporting only the lowest common denominator in their management systems, rather than working together, does not bode well," states The Travelers' Mirer.

Cisco's Abbajay counters that the MIC will enable users to mask the distinctions. And, although current products may be flawed, they do offer more integration than yesterday's alternatives.

Observers expect the level of integration to continue to improve. Northeast Consulting's Herman concludes that "everyone knows what the current problems are, but how to fix them is not as clear. Solutions will eventually emerge, but users shouldn't get their hopes up. There is no short-term fix to this problem, and years will pass before it is fully addressed." ■

Paul Korzeniowski is a freelance writer specializing in communications and networking issues. He can be reached on the Internet at 6841944@mcimail.com or on BIX c/o "editors."

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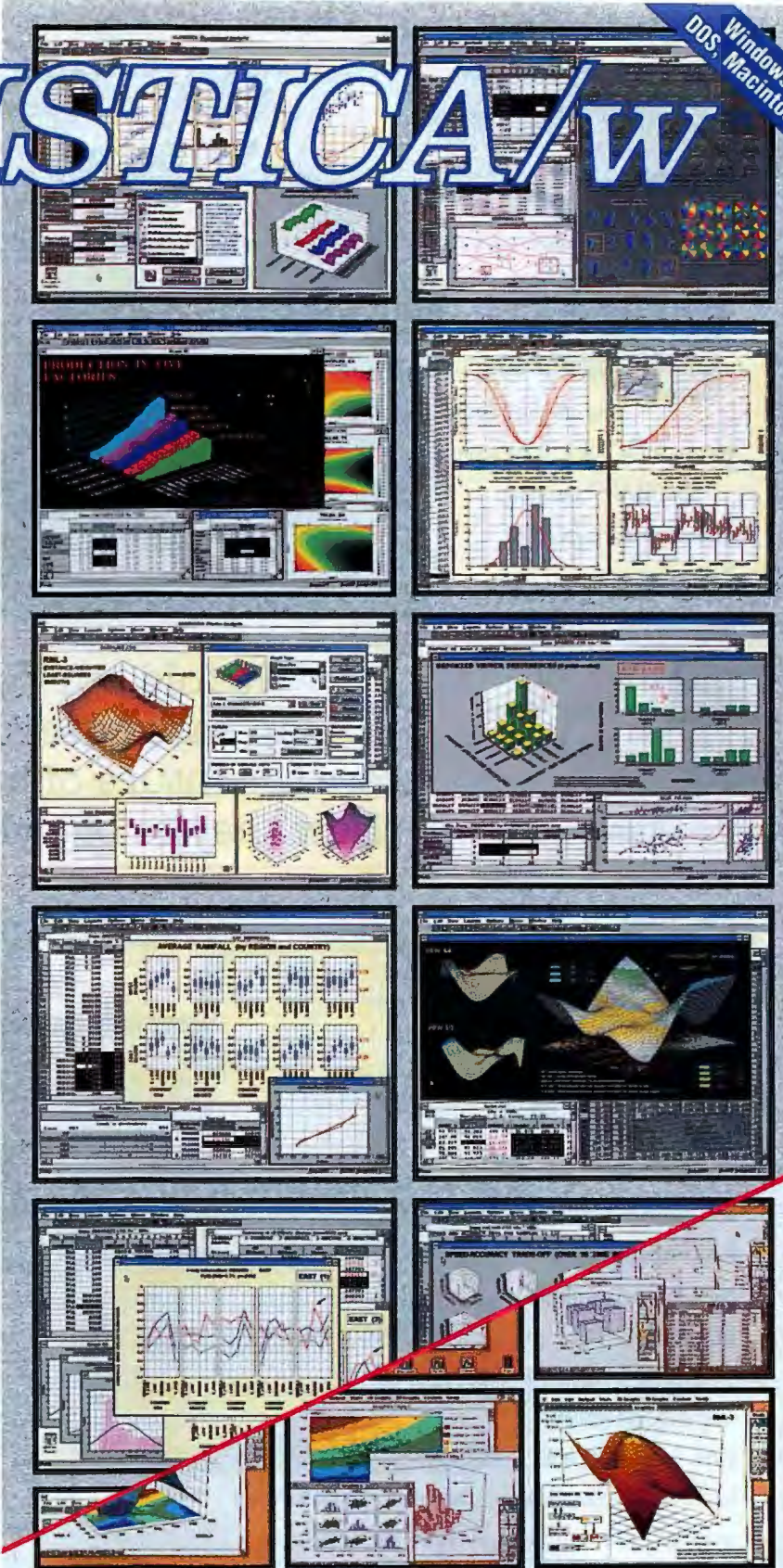
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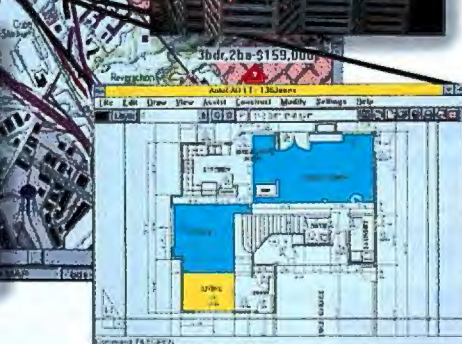
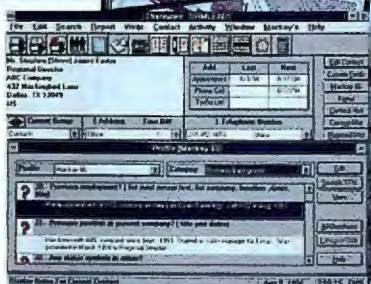
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- E. Anderson	\$95	\$89	\$95	\$279
- P. Batters	\$64	\$64	\$76	\$204
- M. Carter	\$54	\$57	\$60	\$171
- C. Davis (A)	\$36	\$176	\$296	\$708
Hardware				
- E. Jones	\$65	\$60	\$62	\$187
- E. Anderson	\$45	\$40	\$40	\$125
- P. Batters	\$30	\$30	\$30	\$90
- J. Martin	\$40	\$39	\$40	\$119
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Too many people have been conditioned by marketing hype and misleading information into believing that bandwidth is the true measure of performance. Adding bandwidth to a poorly performing network is like raising the speed limit of a congested highway—neither solution buys much.

When you measure in terms of bandwidth, you are measuring in the frequency domain. The frequency domain is ruled by terms like *megahertz* and *megabits per second*. These terms are applied to measure the theoretical capacity of a communications channel. In a LAN, the channel is the Ethernet, Token Ring, or other topological segment to which your servers and workstations are connected. That channel is often called the *media*.

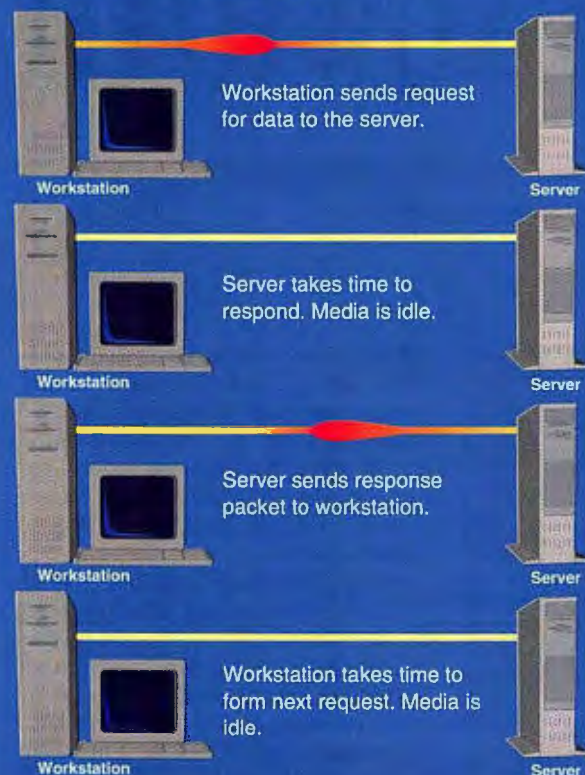
When you use the frequency domain to describe the capacity of a communications channel, you consider only the channel and not necessarily what is happening at its end points. You assume that the end points are both capable of sustaining the maximum information rate of the channel. If you are talking about a synchronous point-to-point channel, like a WAN link, your choice of the frequency domain is appropriate. In a LAN scenario, however, other factors make the choice of the frequency domain inappropriate.

For instance, a LAN may have many nodes, all competing for simultaneous access to the media. Because only one node can transmit at any given instant, all other nodes must wait.

In addition, information flow on a LAN is not synchronous. Rather, information is transmitted in small bursts called *packets*. As it turns out, these packets require a fairly significant amount of time to form and decipher. Here, the word *significant* is relative, meaning that the time to service a packet at a given node on the network will often be longer than the time it

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Common Network Read Cycle



Network read cycles commonly have four stages.

takes to transmit it.

For this reason, a LAN should be considered and measured in the time domain. In the time domain, people typically use terms like *milliseconds* to measure performance. It is better to describe a LAN's behavior by the time it takes to move information rather than by the rate at which information moves along the wire. By studying where the time is spent, you can locate and eliminate bottlenecks—bottlenecks that you would never find using bandwidth techniques.

LAN Read Cycles

The most common cycle seen on a LAN is the read cycle, where information is moved from a file server to a workstation. Why? LANs are generally used to serve applications from a common server. Even when that application is a large database application, more data is read from its files than written. Commonly 75 percent to 95 percent of all transactions are reads.

Data is generated only as fast as people can work, yet it can be sifted through and moved from the server to the work-

station as fast as the system will allow. Therefore, focusing on the read cycle is necessary to gain a fairly accurate understanding of network performance.

The read cycle shown in the figure "Common Network Read Cycle" is composed of four distinct phases. It begins with the workstation forming a request packet and forwarding it to the server. The server requires time to decode the packet, obtain the requested information either from disk or from cache memory, move that information internally, form a response packet, and then wait for access to the media. Once access has been granted, the server transmits the response. The workstation then has to perform many of the same internal processes as the server, including waiting for access to the media. The cycle repeats itself until the file, or required portion of the file, is transferred.

Which Parameters Matter?

When you study the characteristics of a LAN, you need to know the parameters that affect performance. Although there are many variables to consider, there are three important variables over which you have some degree of control. The three tunable parameters include the following:

1 Packet size Different topologies support different maximum packet sizes. Ethernet supports a maximum frame size of 1518 bytes. That frame will be filled with a maximum payload of 1024 bytes of data. On the other hand, Token Ring can carry a maximum payload of 16,384 bytes of data (16-Mbps mode) and 4096 bytes of data (4-Mbps mode). FDDI (Fiber Distributed Data Interface) frames can carry a maximum payload of 4096 bytes of data.

2 Media-access time This is a critical parameter influenced by many factors. First is the nominal access delay inherent in the chosen access methodology of the media. Token Ring uses a token-passing scheme to

control and grant access to the media. On the other hand, Ethernet uses a methodology known as CSMA/CD. CSMA/CD access times are typically on the order of five to 10 times faster than token-passing access times. As you will see, this can greatly influence overall performance.

In addition to delays inherent in the different access methodologies employed, media-access time is also influenced by the amount of competition on the segment. The higher the competition, the longer the average access time.

3 Signaling speed (typically called bandwidth) This is the speed at which individual bits of information are transmitted on the media. This is the least influential of the tunable parameters.

Modeling Network Performance

To best understand network performance, you need an appropriate model. A model will let you change each of the tunable parameters, crank the change through the model, and see the impact. Such a model is expressed in the following equation:

$$\frac{t'_{rd}}{t_{rd}} = \frac{f t_{rq} + 2a t_m + (1+x[y+p(1-y)])t_c + p f t_{rs}}{(1+x)t_c + 2t_m + t_{rq} + t_{rs}}$$

Where:

a=media-access time factor

f=signaling (frequency) factor

p=packet-size (payload) factor

t_c=total client service time

t_m=time required to access media

t_{rq}=time required to transmit a request packet

t_{rs}=time required to transmit a response packet

t_c=total time required for baseline read cycle

t'_{rd}=total time required for modified read cycle

x=file server to workstation service time factor

y=percent fixed-to-total service time

The equation considers all elements of time contained in one network read cycle. It takes into account all three tunable network parameters. The influence each tunable parameter has on each of the time elements is considered, and a ratio is formed between a known case and a case that is created by changing one or more of the tunable parameters. This equation represents a way of calculating an expected performance gain or loss from a known situation. By changing one or more parameters, the equation calculates the expected change in performance.

Although it has been validated through several practical throughput tests, the equation is just one tool for understanding network behavior. It yields results that should be taken as upper bounds of expected



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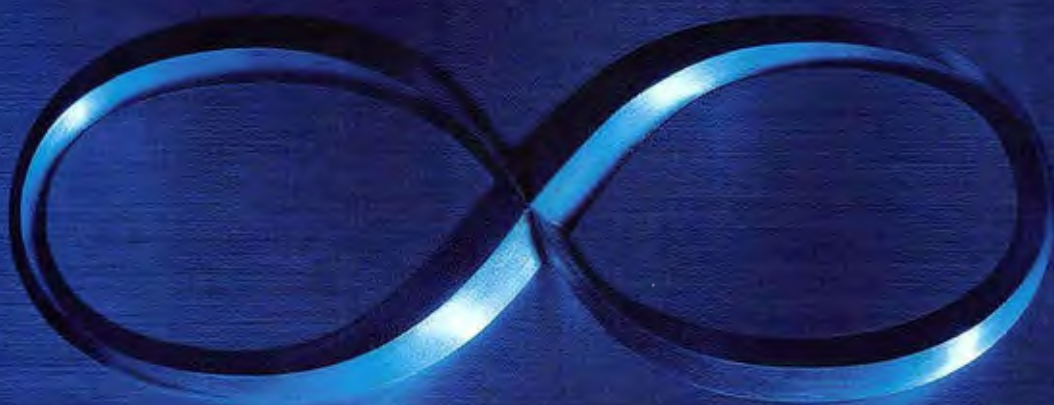
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State of the Art (Mis)using Bandwidth

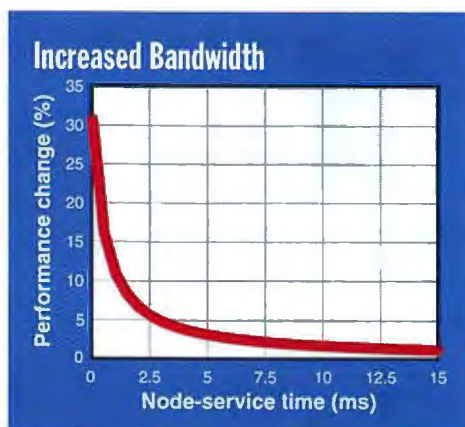
performance changes, yet its predictions will be in the same ballpark as actual measured performance changes.

Using the Model

You apply the model by choosing a baseline scenario and then changing one or more of the tunable parameters. The results can be displayed as a graph showing the expected change in performance versus the average service time of the network nodes.

The first case compares 10-Mbps Ethernet with 16-Mbps Token Ring to determine the effect increased bandwidth has on performance. In this case, the bandwidth is raised by a factor of 1.6, while all other factors are held constant.

The figure "Increased Bandwidth" illustrates why the performance change is plotted versus the network-node service time. As service time increases, performance gain due to bandwidth decreases. This stands to reason because more and more of the time required to perform a read cycle is spent at the nodes and not in

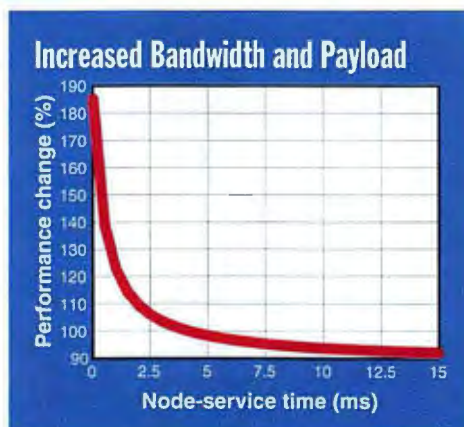


Ethernet vs. Token Ring assuming bandwidth increases from 10 to 16 Mbps.

transmitting on the media. This is why you can experience poor performance on your network, yet the network monitor reports low bandwidth utilization.

If a node requires 5 ms of service time or more, the expected performance increase is less than 5 percent. So if you are planning to move from Ethernet to Token Ring because of the increase in available bandwidth, you may be about to pay 100 percent more for less than a 5 percent gain.

The second case again compares Ethernet and Token Ring, but this time the bandwidth and payload are changed (see the figure "Increased Bandwidth and Payload").



Ethernet vs. Token Ring assuming bandwidth increases from 10 to 16 Mbps, and payload goes from 1024 to 4096 bytes.

capacity is modeled with the payload size of 4096 bytes. Ethernet can carry a maximum of 1024 bytes of payload per packet.

The results of this analysis are clear: Payload capacity is a significant performance factor. If you have large volumes of data to move, you need to maximize packet size. No single factor influences performance more than payload. It dominates all other tunable parameters. Thus, if you are considering moving from Ethernet to Token Ring for the additional payload capacity, and your application can take advantage of that extra capacity, then you are about to pay 100 percent more for roughly a 100 percent gain in performance.

The next case again compares Ethernet to Token Ring, but here Ethernet is modeled as having five times faster average access to the media. To isolate the effects of faster access time on performance, Ethernet and Token Ring are held to 1024-byte payloads.

The figure "Increased Bandwidth and Media-Access Time" shows that performance change for moving to 16-Mbps Token Ring is negative for all points on the curve. This striking result means that under this scenario Ethernet actually outperforms Token Ring, even though the Token Ring is operating at 1.6 times the bandwidth. Media-access time is a more significant factor than bandwidth, yet a less significant factor than payload. This analysis suggests that for environments that require packets of 1024 bytes and less, you can expect higher performance from the lower-cost Ethernet. Such environments would include host access, some database applica-

tions, and possibly client/server applications.

Some database applications tend to move information based on the record size of the table being accessed. Although a 2-GB table is being accessed, the database engine running on the client will request only a record at a time from the table. For example, if the record size is 256 bytes, then Ethernet will be a better performer for that database application.

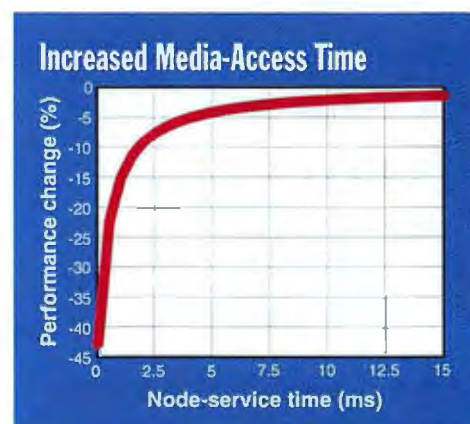
The final case compares 100-Mbps FDDI with 16-Mbps Token Ring (see the figure "Token Ring vs. FDDI"). Token Ring is modeled at its maximum 16,384 bytes of payload per packet, while FDDI is modeled at its maximum 4096 bytes of payload per packet. Media-access time is held constant between the two.

Notice how dominant payload size is in network performance and how little influence bandwidth has. Although FDDI offers 6.25 times the bandwidth of 16-Mbps Token Ring, at 2.5 ms of node-service time the move to FDDI becomes a wash. From that point forward, you can actually expect to see a decrease in performance. Even at zero service time, the expected performance increase is only 10 percent.

Interpreting the Model

When interpreting the information presented in this article, remember that the model used was derived considering a homogeneous network of only one transaction type and packet size—the read transaction with full packet.

A larger packet size will increase data transfer performance. How much depends



Ethernet vs. Token Ring assuming bandwidth increases from 10 to 16 Mbps and media-access time increases fivefold.



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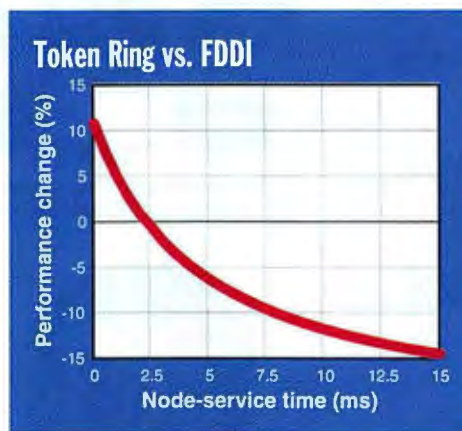
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Token Ring vs. FDDI assuming bandwidth increases from 16 to 100 Mbps, but Token Ring uses maximum payload (16,384 bytes) vs. FDDI (4096 bytes).

on how contiguous the data to be moved is. That is, you will get much better performance moving 5 MB stored in one file than moving 5 MB stored in 50 files. This is because of the overhead of small packets required in opening a file.

Some argue that increasing average packet size on a network will increase competition, because each packet transmitted holds the media longer. You must keep in mind, however, that the increased packet size will tend to decrease the number of transmissions on the media since fewer are required to move the same volume of data. This means that while there may be some increase in segment competition, the bottom line is that there is no reason not to increase average packet size on your media.

Also remember that the model presented considers only two nodes on a LAN—the workstation and server. It remains valid in the presence of other nodes and transactions, however. The presence of other nodes and transactions does nothing more than increase the time to access the media. Therefore, you can predict performance during periods of higher network use by simply selecting a higher node-service-time point on the graph, since increased time to access the media also increases average time spent at the nodes.

Improving Network Performance

There are several steps you can take to optimize performance on your LAN. The first is to check that your packet size is maximized. Many older Token Ring drivers default to 1-KB packets. The packet size must be set at all decision points on the network, including workstations, routers, and servers. The best way to tell if your

packet size is maximized is to use a network monitoring device.

After tweaking packet size, carefully choose the NIC (network interface card) and driver solution for your workstations. Remember, network performance includes service time at all nodes, not just the server. Poor performance at the workstation can yield poor overall network performance, regardless of the capabilities of the server. Do not make the decision lightly.

Be aware that most performance problems in NICs tend to be due to their drivers. Choose a manufacturer that has a strong background in the particular media you are using.

In addition, educate yourself about network competition and segmentation. High levels of competition can cause drastically reduced throughput due to increased media-access times. Competition must be controlled to achieve a high degree of performance on your LAN.

If you have done everything you can and still have poor network performance, don't just throw bandwidth at the problem. Chances are high that you won't solve the problem with that approach and will waste time and money. Perform a detailed network analysis to determine where the bottlenecks are and then draft a plan of action. In almost all cases, this will be a less costly, more-effective and timely solution.

The Best Network for You

There are three important factors over which you have some degree of control when trying to improve the performance of your network: packet size, time to access the media, and bandwidth. Packet size has the most impact, followed by media-access time. Of the three, bandwidth has the least impact.

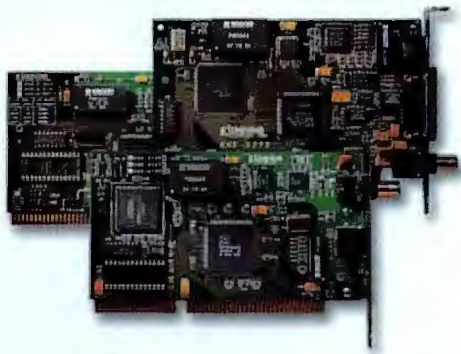
At 16 Mbps, Token Ring offers the highest available packet size and thus the highest performance in an environment where large volumes of data must be moved. But where packet size is of less importance, such as host access and some client/server applications, Ethernet offers the lowest-cost, highest-performance solution.

The one you choose is dependent on your specific application and environment. The model presented here is a tool to help you make that decision. ■

Brett Husselbaugh is president of Tobek Computer Systems, a LAN consulting firm in Dallas, Texas. He can be reached on the Internet at wbretth@aol.com or on BIX c/o "editors."



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ATM TRAFFIC CONTROL

Networks today cope with multimedia traffic and can run out of bandwidth quickly. ATM networks increase data flow by intelligently controlling traffic and allocating different-size channels to different connections.

MARK JULIANO



Networks grow in two ways: The number of attached devices increases, and the applications it supports become more diverse. The network administrator must maintain performance as traffic builds.

A shared-media LAN does not perform well under heavy traffic conditions or with a wide variety of traffic types. But ATM (Asynchronous Transfer Mode) overcomes these limitations by providing a connection-oriented approach to linking devices and by supporting a variety of traffic types, including audio and video. (See Peter Wayner's article "On the Road to ATM," September BYTE.)

ATM divides all traffic into fixed-length cells, each containing 48 bytes of user data and 5 bytes of overhead. Monitoring and organizing the flow of these cells through the network is called traffic management. How well it is done can be crucial, especially for time-sensitive data such as video.

My Dinner with ATM

To understand how to improve traffic flow in an ATM network, I'll compare the interaction of attached devices on a shared-medium LAN with the behavior of guests at a dinner party.

At the party, several people want to talk with one another; on a LAN, users want to send each other files and E-mail. For a dinner party to run smoothly, guests must behave according to a social protocol. Devices on a LAN must conform to a protocol so that they can communicate with each other. As the number of guests at a party increases, it becomes more difficult for an individual to speak with any other individual. So it is with LANs; as traffic increases, contention for access to the shared transmission medium also increases.

Contention is the delay encountered while waiting for access to a shared resource, such as the Ethernet cable. *Congestion* occurs when network devices

ATM with a French Accent

JEAN LE MÉZEC AND
MANUEL BARBERO

In many areas of telecommunications, France has pointed the way for the rest of the world. A couple of months ago, commercial ATM service was introduced in France as a nationwide service—just as ISDN and (some years back) Minitel terminals have been made universally available throughout the country. French businesses, researchers, and even some home users will be able to access France Telecom's CBDS (Connectionless Broadband Data Service), which is quite similar to the U.S.'s SMDS (Switched Multi-megabit Data Service) but offers the high speeds possible only over an ATM network.

France Telecom is one of the first major communications carriers to incorporate ATM throughout its core network. CBDS was available in beta testing since July in Paris, Lyons, and the region around Nice. Commercial beta testers included Hewlett-Packard, Dassault, Thomson-CSF, the research group Inria, and France's highest-rated TV network, TF1. For the beta users, CBDS offered virtual private networks at speeds ranging from 2 to 25 Mbps. The service offers multiple protocols, with interfaces to the Internet,

Token Ring, and FDDI (Fiber Distributed Data Interface).

Although France may be a bit ahead of the U.S. in ATM use, both countries are following similar paths. As in the U.S., the France Telecom project began with a government-supported "information superhighway," connecting the research community first and then spreading out to commercial users. ATM, which was developed at France Telecom in the early 1980s, is widely seen in both Europe and the U.S. as the best way to provide many options for interconnecting LANs and WANs. The U.S. has given the Internet to the world, and a fully ATM-connected Internet is a common dream.

Renater, which is France's broadband extension of the Internet, was begun only in 1991, and it is now being given an ATM backbone with 34-Mbps E-3 connections to subscribing networks. Renater is a cooperative venture of universities and government agencies; the network is built and managed by France Telecom, and it has been the test-bed for ATM networking in France.

European networking experiments have often been international in scope. For example, an early ATM link between

the Swiss CERN (European Laboratory for Particle Physics) and CEA (France's atomic energy commission) allowed nuclear experiments to be controlled at points located hundreds of miles away from the actual laboratory. Similarly, a 1993 demonstration of CBDS was the first transatlantic ATM linkup. Over a 2-Mbps dedicated line, groups in Paris and New York were able to simultane-

ously use InSoft's Communiqué groupware running on Sun Microsystems' SparcStations equipped with Parallax Graphics video boards. Also involved in that transatlantic linkup were Cisco Systems' AGS+ Ethernet router and Thomson-CSF's Thomflex ATM network concentrator. Much of the technology, of course, is American; the goal was to create an international network that was compatible with commonly used U.S. networks and multimedia products.

Upgrading to ATM is a project that involves widespread European and international cooperation. France Telecom is just one of 18 telecommunications providers working together in Europe's ATM pilot initiative. In addition, the company has formed the Atlas joint venture with Deutsche Telekom and is plan-



buffer their data until they can transmit it over a communications link.

Most LAN technologies share the physical transmission medium (e.g., copper wire and optical-fiber cable) among all the devices attached to the LAN. A protocol, or access method, organizes the sharing process that lets them use the medium. On Ethernet LANs, the access method is called CSMA/CD. The English translation is, "Listen first, and if no one else is talking, one person may talk." Each network device first makes sure that no other device is transmitting and then sends its message. This type of LAN protocol is analogous to a small dinner party where four people are sitting and talking together. Only one person speaks at a time. As long as the number of people is small and no one talks all the time, everyone can take part.

Things Can Change

As a business grows, its LANs expand. The more devices that are attached, however, the greater the transmission delays. Imagine a crowded restaurant trying to operate using the same rules as the small dinner party. Any person who wished to talk, whether it was with someone at their table or at the other end of the room, would have to wait until every other person in the restaurant was quiet before speaking.

This is why LAN performance often degrades as the number of attached devices increases; too many devices try to access the medium at the same time. Shared-media access methods are probabilistic; access is not guaranteed. There's no problem when the amount of LAN traffic is light (imagine a restaurant with customers at only one table), but a serious

problem arises when traffic is heavy.

An Ethernet LAN addresses this problem by dividing the LAN into smaller, interconnected segments. (By analogy, the restaurant owner could build a separate room for each table.) While this reduces contention, it makes the LAN much more difficult to manage. (Imagine the manager of such a restaurant having to maneuver around—not to mention pay for—all those walls.)

ATM: An Alternative

ATM networks are connection-oriented and use a deterministic method to allocate network resources. *Deterministic* is the opposite of *probabilistic*; it guarantees access regardless of the number of devices attached to the network. The network is determined to get you access.

ning a partnership with Sprint in the U.S. Because of its joint venture with ATM-switch supplier Alcatel, Sprint already has a working knowledge of the ATM switches that France Telecom is using. There is a considerable amount of transatlantic capacity right now, so intercontinental ATM and CBDS will soon be just as feasible as ATM in Europe.

What does this mean for BYTE readers, most of whom are in the U.S.? For the average user, ATM and CBDS mean full Ethernet or Ethernet-like connectivity at high speed to remote databases, and the use of groupware with coworkers located almost anywhere else, all with protocol-independent file transfers and messaging.

The more remote the locations that must interact, the more vital become high-speed communications links. CBDS and ATM provide better ways to not only connect U.S. and international offices and provide easier access to more remote databases but also provide virtually instantaneous electronic travel to Paris, at rates that are considerably less expensive than taking a hop on the Concorde. ■

Jean Le Mézec is vice president of science and technology, and Manuel Barbero is vice president of North American marketing for France Telecom. They can be reached on the Internet or BIX at editors@bix.com.

As each connection is established, the network allocates capacity to ensure that sufficient resources are available. ATM networks package traffic into cells of uniform length and manage the flow of these cells through the network.

Different types of traffic require different levels of service—referred to as QOS (quality of service). An ATM network provides different QOS levels to different traffic types. Indeed, different traffic types may call for different traffic management techniques.

Types of ATM Traffic

We can classify the types of traffic supported by an ATM network according to three characteristics: bandwidth, latency, and cell-delay variation. *Bandwidth* is the amount of network capacity required to

support a connection. *Latency* is the amount of delay associated with a connection. Requesting low latency in the QOS profile means that the cells need to travel quickly from one point in the network to another. *Cell-delay variation* is the range of the delays experienced by each group of associated cells. Low cell-delay variation means a group of cells must travel through the network without getting too far apart from one another.

ATM networks carry three types of traffic: CBR (constant bit rate), VBR (variable bit rate), and ABR (available bit rate). CBR traffic includes voice and video. To handle this traffic, the ATM network can act as a dedicated circuit. It provides a sustained amount of bandwidth, low latency, and low cell-delay variation.

VBR traffic is handled similarly to CBR except that the bandwidth requirement varies. An ATM network supporting a videoconferencing application guarantees that a certain amount of bandwidth will always be available during a conference, but the actual bandwidth used can vary.

ABR traffic requires no specific bandwidth or delay parameters and is acceptable for many data applications. ABR connections support LAN traffic such as E-mail and file transfers. TCP/IP and NetWare will also use ABR connections.

The table "Network Traffic Types and Their Requirements" shows how link capacity is allocated to each traffic type. While CBR reserves a constant amount of the total available bandwidth, VBR requires that a large amount of spare capacity be available. ABR defines a way to use this valuable spare capacity. It can provide service that is no worse, and is in many cases better, than most of today's networks, but it doesn't require a constant bandwidth.

Making the ATM Connection

The ATM end station (the calling party) asks the ATM network for a connection to another ATM end station (the destination) by initiating a connection request that leads to a negotiation with the ATM network. This process is called the connection establishment procedure. The parameters that must be negotiated are specified by the ATM Forum UNI (User-to-Network Interface) 3.0 standard and include traffic type, sustained and peak bandwidth, burst length, and QOS class.

This process secures a "contract" between the ATM network and the end station. The network promises to deliver a QOS, and the ATM end station promises not to send more traffic than it requested during the connection procedure. Such contracts must be enforced, and it is the job of traffic management functions to ensure that users receive the QOS they were guaranteed.

When congestion occurs, traffic management provides the mechanisms that allow the network to recover. ATM networks use three techniques: traffic policing, traffic shaping, and congestion control.

Traffic Policing

ATM networks ensure that traffic on each connection remains within the negotiated parameters. ATM switches use a "leaky-bucket" algorithm to police traffic. Imagine a wooden bucket with a hole in the bottom. Water leaks (traffic flows) out of a bucket (buffer) at a constant rate (the negotiated rate), regardless of how fast it comes in.

The need for police action occurs when traffic flow exceeds the negotiated rate and the buffer overflows. Each ATM cell header has a CLP (Cell Loss Priority) bit used to identify cells as either conforming (to the contract) or nonconforming. If cells are nonconforming—for example, more cells than the contract allows—the ATM switch sets the CLP bit to one. This cell can now be transferred through the network only if there is sufficient network capacity. If there is not enough bandwidth available, the nonconforming cell is discarded and may need to be retransmitted.

CBR traffic needs a single leaky bucket because it uses a sustained rate parameter in its network contract. VBR traffic uses dual leaky buckets to monitor both the sustained rate over a discrete time period and the maximum (peak) bandwidth used during the connection. If either value exceeds the contract parameters, the ATM switch polices the VBR traffic by manipulating the CLP bit.

continued

NETWORK TRAFFIC TYPES AND THEIR REQUIREMENTS

TRAFFIC TYPE	EXAMPLE	BANDWIDTH REQUIRED	CELL-DELAY VARIATION	LATENCY
Constant	Voice, circuit emulation	Guaranteed	Minimal	Low
Variable	Compressed video	Guaranteed	Variable	Low
Available	Data	Not guaranteed	Widely variable	Variable

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Traffic Shaping

Similar to traffic policing, traffic shaping is performed at the user-network interface. Traffic is manipulated so that flow rates obey the contract using a mechanism such as the dual-leaky-buckets algorithm. Devices that implement traffic shaping are typically ATM network adapters in PCs or workstations, hubs, bridges, routers, and DSUs (digital service units).

Congestion Control

Congestion can occur in any network, whether it uses shared media or ATM, whenever an application sends more data than the network can transmit with the available bandwidth. Also, as more applications send data over the same network, the bandwidth available to any one application changes over time.

Most networks fail to tell applications how much bandwidth is available at any given instant. As a result, applications have no basis on which to control the amount of data they send. When applications send more data than the network can handle, the network buffers fill up and can overflow. The application must then retransmit the data, which adds more traffic and further congests the network.

An ATM network performs congestion control so that ABR traffic can efficiently use the bandwidth that has not been guaranteed to CBR and VBR traffic. Effective congestion control reduces the need to retransmit data due to congestion.

While the problem of congestion control is still under discussion in the ATM Forum, it is expected that the final solution will use a variety of techniques, including end-to-end, link-by-link, rate-based, and credit-based traffic-flow control.

End-to-End vs. Link-by-Link. A network can control congestion over an entire connection path or by sublinks. With end-to-end control, the network measures the minimum available bandwidth along the connection and communicates the amount of bandwidth to the application, which then transmits at the appropriate rate. Each link in the network simply forwards the data as fast as it receives it.

Under the link-to-link technique, each link along the network connection controls its traffic flow independently. Each link buffers data as needed to adjust the incoming speed to the outgoing speed.

Rate-Based vs. Credit-Based. The rate-based traffic-flow technique constantly tells the application what transmission rate (the currently allowed rate) the sending device

BY1294

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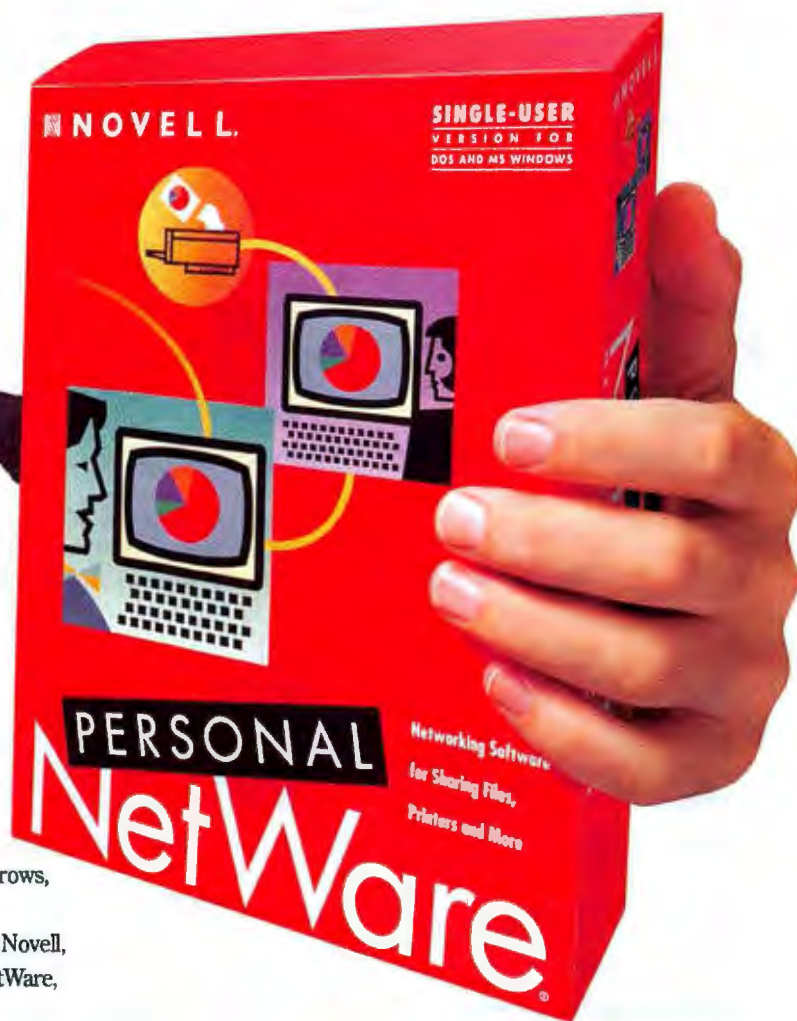
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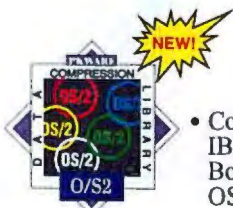
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should use. For example, the network can tell an application that it can send 1000 cells per second. If the network becomes congested, it reduces this rate and notifies the application; when the network is no longer congested, the rate is increased.

The credit-based technique is slightly different. Here, the network indicates to the sending device the amount of buffer space (credits) available in the network. For example, the application may be allowed to transmit 100 cells, after which it must wait. The network periodically replenishes the application's credits. If the network becomes congested, the application gets fewer credits and they're replenished less often. This forces the application to slow the sending of data. When the congestion clears, the number of credits is increased and replenished fast enough that the application can transmit at full speed.

Integrated Congestion Control. The integrated proposal currently under consideration by the ATM Forum provides for an end-to-end, rate-based scheme as the default method, with the link-by-link scheme as an option where more precise control is needed. Because most existing ATM equipment already offers the default method, users should soon have a standards-based ABR congestion-control scheme.

If the network requires a more precise congestion management scheme, the link-by-link option can be used to control ABR traffic. When a connection is made from an end-to-end device, the link-by-link device would simply perform the end-to-end flow control when talking to that device. This would preserve existing equipment, while providing for future growth.

Time to Switch?

No matter how carefully you plan a shared-medium LAN—whether Token Ring, FDDI (Fiber Distributed Data Interface), or Ethernet—the day will come when your network outgrows the capabilities of the technology on which it is based. ATM expands the network's ability to support a variety of applications that will help network administrators. Using ATM technology as a foundation ensures a widely accepted interface to the WAN and high-performance LAN, with traffic management designed to ensure that users get the quality of service they require. ■

Mark Juliano is vice president of marketing at Fore Systems, Inc., a supplier of ATM switches located in Warrendale, Pennsylvania. He can be reached on the Internet or BIX at editors@bix.com.

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Dear Steve,

I would like to meet with you on Monday, December 5, in my office to discuss the Marketing Plan. Can you make it? Press 'yes' or 'no' to let me know.


Sincerely,
Frank



 

to: Steve Fisher
from: Frank Shuford
about: meeting Mon. 12/5

 tap for details

*Kelly,
The plane's leaving
on time (surprise,
surprise) I'll be
in at 3:00 to go
over your (shocking)
ideas. Let me know
if that's ok.*

Frank 


 

to: Kelly Tobin
from: Frank Shuford
about: Meeting

Dear Patrick,

Hey, I know you're tied up on that project, but you gotta come up for air sometime! Like maybe for the hockey game of the century—tonight, 8pm, two tx, center ice, on the glass? Get back to me, okay?

Frank



to: Patrick Vogt
from: Frank Shuford
about: Time-out



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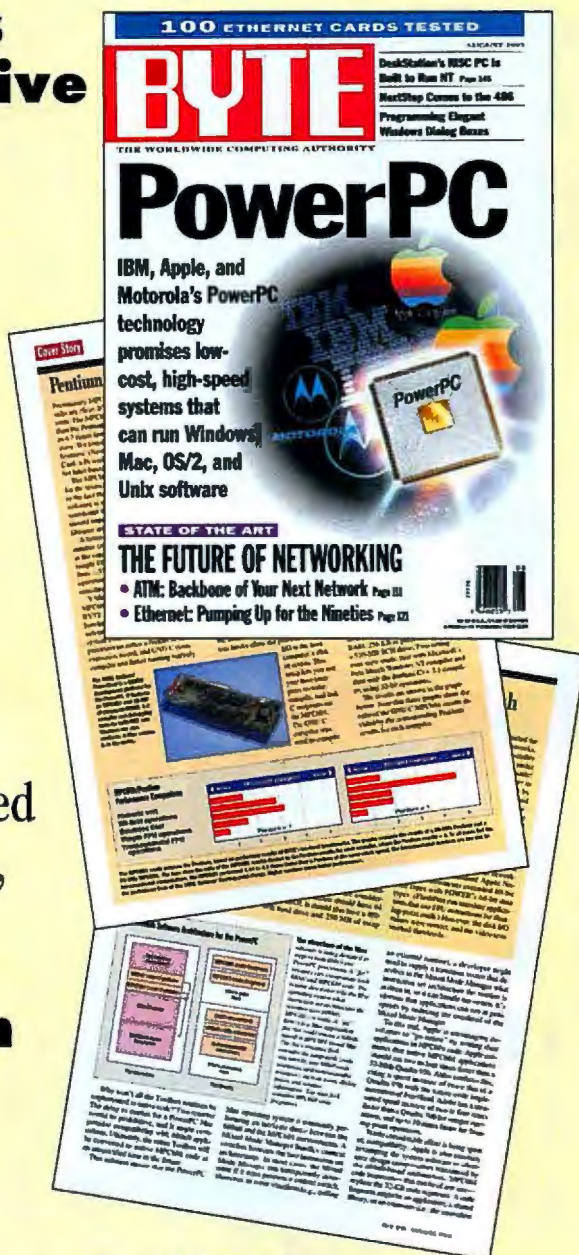
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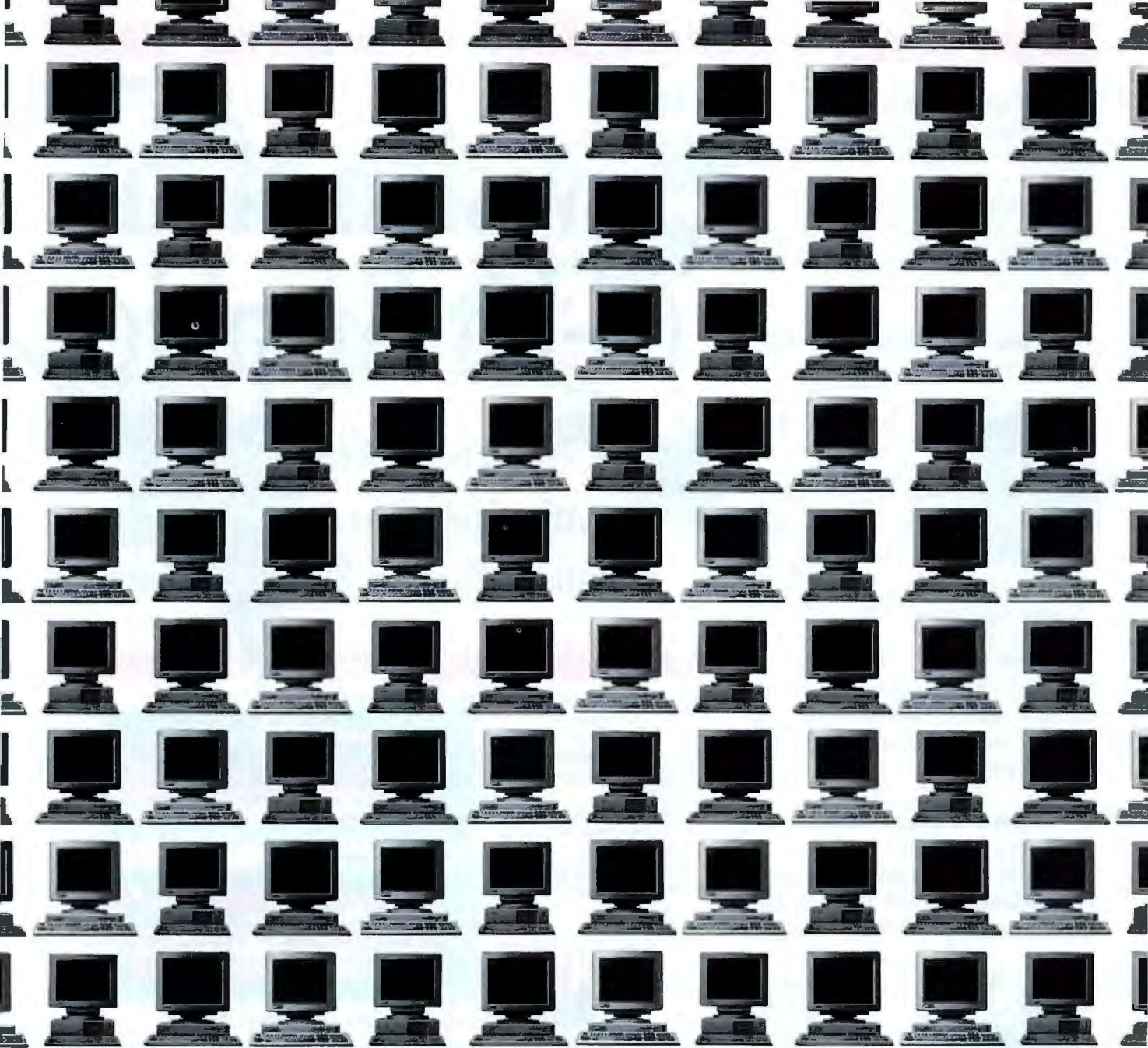
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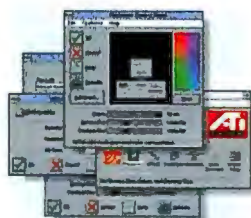
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The squadron of 64-bit graphics accelerators from ATI — the GRAPHICS PRO TURBO, WINTURBO and GRAPHICS XPRESSON — has landed. Affordably priced from only \$179, they're attacking computers with rocket-like performance, laser sharp graphics and galactic true colors.

Hi-res, True Color Galaxies

Resistance is futile. High resolutions of up to 1280x1024 and 16.7 million true colors will overwhelm you. These advanced accelerators propel applications faster in true color than other cards using just 256 colors. And the superior performance, up to 42 million Winmarks*, will conquer even the most complex applications. Plus, the flicker-free display — at up to 100Hz — reduces eye-strain over prolonged periods of attack.

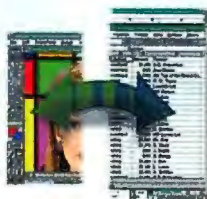


FlexDesk+

For enhanced operation and complete control of Windows options

Propelling Windows

Armed with an arsenal of utilities to enhance Windows, the mach64 graphics accelerators breeze through Windows applications quickly and effortlessly. The unique WinSwitch feature allows color and resolution to be changed - without restarting Windows. A stellar range of software drivers enable popular operating systems to be explored — OS/2, UNIX, Windows NT, CAD, DOS and others.



WinSwitch

Change resolution and color without exiting Windows

Beam up an ATI 64-bit graphics accelerator today. There's one to meet every application, budget and bus type. They're light years ahead of other accelerators.

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* WinBench 4.0 and PC Bench 8.0 performance tests done on a Pentium 90MHz, 16MB RAM, 256K cache, 420 MB HD, using 2MB and 4MB PCI graphics cards. WinBench 4.0 at 1024x768/256 colors (large fonts) and 800x600 in 16.7M colors (small fonts) at 70Hz refresh rate.

**Suggested US retail price, dealers may sell for less.

Invasion of the 64-bit Graphics

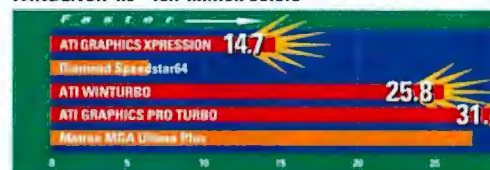
- Fast 64-bit Acceleration
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- Instant Windows Mode Switching

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WINBENCH 4.0 - 16.7 million colors



WINBENCH 4.0 - 256 colors



Outperforms other accelerators in Windows.

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WINTURBO

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- VRAM offers better performance at higher refresh and color depths

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Low-Cost Color Lasers

Three color laser printers make fast color printing almost affordable

TOM THOMPSON

At first, laser printers dealt with matters simply in black and white. Color laser printers arrived but commanded prices of \$50,000 or more, unaffordable to all but those who made their business working with color. QMS changed this situation dramatically last year by introducing the ColorScript Laser 1000 (see "QMS Strikes with Color Laser Printer," July 1993 BYTE). Using a new, 300-dots-per-inch Hitachi print engine to lay down colored toners on plain paper, and costing just \$12,499, the ColorScript Laser 1000 started the affordable desktop color laser-printer business.

Not resting on its laurels, QMS introduced this June its second-generation 600-dpi color laser printer, the QMS Magicolor Laser Printer, with a price starting at \$9999. With sufficient memory, it can generate 600- by 600-dpi output. QMS reduced the ColorScript Laser 1000 price to \$7999. However, two other vendors also launched color laser printers with prices starting under \$10,000. Also in June, Xerox introduced its 4900 Color Laser Printer, starting at \$8495. Its controller modulates the imaging laser, so that the output can be 300, 600, or 1200 dpi along the horizontal axis (and 300 dpi vertically). And in September, Hewlett-Packard announced its HP Color LaserJet printer. Its output is only 300 dpi, but pricing starts at \$7295, and the HP entry features a simplified print engine that improves color print quality.

Thus, the opening shots in the war for the nascent desktop color laser-printer market have been fired. These printers offer quality and per-page costs competitive with the best ink-jet printers but with laser-printer speed and networking capabilities. The battle will heat up as other vendors, such as Tektronix (see the text box "Tektronix Threatens a Show Stealer"), enter the fray and trade blows on features and price. For this review, I evaluate the new printers from the current combatants in this market: HP, QMS, and Xerox.

Color Laser Basics

As a group, color laser printers are big and heavy. Initial setup is more complex than

that of a typical laser printer, because there are now four colors of toner (cyan, magenta, yellow, and black) rather than one.

For the QMS and Xerox printers, you have to add four toner cartridges plus four developer modules, a waste box, and a small oil bottle. The HP printer combines the color developers into one unit, minimizing the number of items that you install to two (the black toner has a separate developer unit). However, you must still add toner power to four hoppers inside the printer.

The QMS Magicolor and the Xerox 4900 use versions of the same Hitachi print engine, although each company had the engine designed to its own specifications. This engine uses a rotating OPC (organic photoconductor) belt to receive a page image and transfer it to the print drum one hue at a time. The amount of electrostatic charge on the belt, which is controlled by the laser beam, determines how much one of the four process colors adheres to the OPC belt on each rotation.

After four belt rotations, the print drum holds the complete four-color image. This composite image is then transferred to a sheet of paper or transparency. It's important to note that the QMS Magicolor and its predecessor use the same Hitachi print engine. This allows QMS to offer a \$2499 controller board swap that brings the ColorScript 1000 up to Magicolor capabilities.

The Konica print engine used in the HP Color LaserJet forgoes the OPC belt and lays the toners down directly on the print drum. This improves color registration, because it eliminates a belt that can stretch or contract during the printing process. It also rids the printer of one more consumable item, because the OPC belt wears out over time and must be replaced. However, the print drum still must rotate four times to assemble a complete page image, so the Konica engine operates at about the same speed as the Hitachi engine.



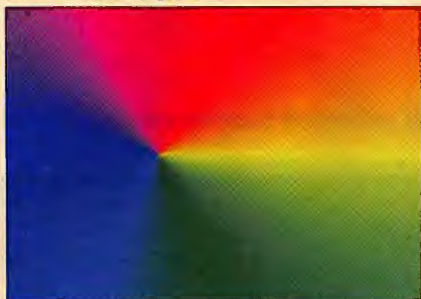
The new breed of color laser printers, from left to right: the Xerox 4900, the QMS Magicolor, and the HP Color LaserJet.

Considering the four-step printing process, you'll find engine speed impressive for all three units. Speed ratings are given in pages per minute, rather than the minutes per page you expect from other color-printing technologies. According to their respective vendors, the QMS Magicolor is rated at 2 ppm for color and 8 ppm for black and white, the Xerox 4900 is rated at 3 ppm for color and 12 ppm for black and white, and the HP Color LaserJet is rated at 2 ppm for color and 10 ppm for black and white.

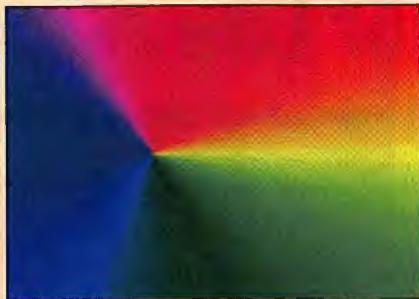
QMS Magicolor Laser Printer

The \$8495 QMS list price nets you a printer with a basic configuration of 12 MB of RAM and enough memory to produce black-and-white output at 600 dpi and color output at 300 dpi. By a sophisticated modulation of the laser beam that creates the image, QMS has coerced true 600-dpi resolution out of a 300-dpi mechanism. A \$10,999 version with 28 MB of RAM can produce both color and black-and-white output at 600 dpi. You can expand RAM up to 64 MB using SIMMs. An Intel 80960CF processor running at 33 MHz handles the printer's rasterizer

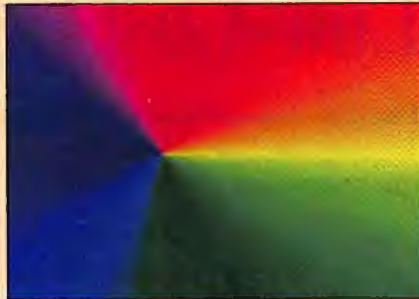
BYTE PostScript Color Wheel



HP Color LaserJet



QMS Magicolor



Xerox 4900

All three printers produced handsome output with the BYTE PostScript color-wheel image (part of the image shown here full size). Each output sample was generated at the printer's highest resolution: 300 dpi for the HP Color LaserJet, 600 dpi for the QMS Magicolor, and 300 by 1200 dpi for the Xerox 4900. The HP printer showed little banding at 300 dpi, compared with the 600-dpi QMS unit, but had a more noticeable dithering pattern. The Xerox 4900 produced no detectable banding, due to the dithering pattern its Quad Dot Technology created.

and operating system.

The QMS Magicolor has one unique feature: the QMS Crown operating system, a multitasking operating system that scans all ports for incoming data and identifies the network protocol and PDL (page-description language) for each print job. The operating system boots from an internal 80-MB hard drive (upgradable to 120 MB), and it can spool multiple jobs to this drive. This setup enables the QMS Crown operating system to manage and process several print jobs at once, minimizing bottlenecks in receiving jobs from the network. Because the printer's intelligence is stored on the hard drive, it allows field upgrades of the operating system and the PDL emulations.

The QMS Magicolor provides an RS-232 serial port and a parallel port that supports the IEEE 1284 bidirectional protocol. A DB-25 SCSI port lets you connect up to six external hard drives that can cache frequently used typefaces or act as spool buffers. For networking, a mini-DIN-8 LocalTalk port is standard, but you can add an optional Ethernet interface card (\$650) that supports a single Ethernet connection (\$149)—either thin, thick, or 10Base-T. A Token Ring interface (\$999) is also available. A daughterboard installed on the controller board determines the Ethernet protocols supported. The review unit could handle NetWare, EtherTalk (AppleTalk), TCP/IP, and LAN Manager/LAN Server simultaneously.

The QMS Magicolor supports PostScript level 2 plus HP's PCL5 (Printer Control Language) and GL/2. It uses its own PostScript clone interpreter and has 65 resident PostScript typefaces. Two external cartridge slots let you add extra typefaces or another PDL.

Xerox 4900 Color Laser Printer

The Xerox 4900 and the QMS Magicolor use the same print engine. The basic Xerox 4900 has 12 MB of RAM, letting the printer produce 300- by 1200-dpi output for black-and-white pages. Color output at 300 by 1200 dpi requires 24 MB of RAM. Memory is expandable to 48 MB. The printer's controller uses an AMD 29030 RISC processor operating at 25 MHz.

The controller can boost the engine's horizontal resolution to 1200 dpi through laser modulation. The printer uses a Xerox patented digital halftoning technology called Quad Dot. By using the 1200-dpi resolution to split halftone cells into quadrants and selectively applying pixels to each quadrant during the halftoning process, the resulting patterns trick the eye into seeing more gray levels. This translates into more apparent colors on the page, while minimizing halftoning artifacts.

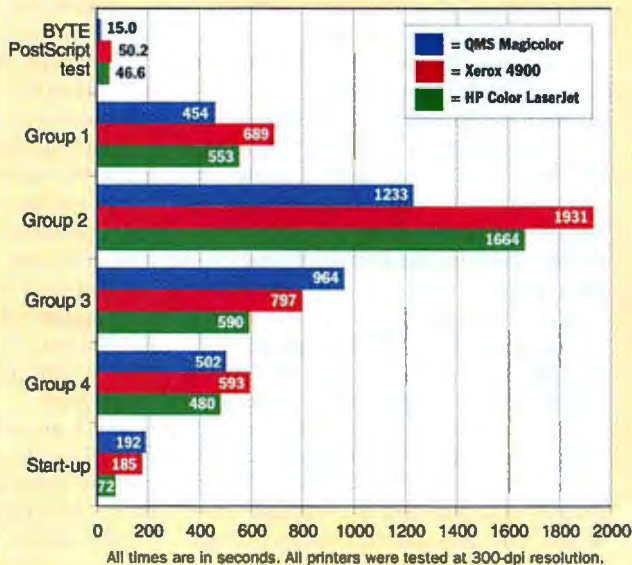
The 4900 has a DB-9 serial port, a Centronics parallel port, and a LocalTalk port. An optional Ethernet interface costs \$649 and provides thinnet and 10Base-T connectors. A Token Ring interface is also available for \$849. The Ethernet interface supports NetWare, EtherTalk, and TCP/IP. The Xerox 4900 doesn't have a SCSI port.

The printer provides Adobe's PostScript level 2 interpreter (version 2013.115) and HP's PCL5 and GL/2. It has 55 resident fonts (35 PostScript, 13 Intellifonts, and seven bit-mapped). The controller automatically scans the I/O ports and senses the PDL of incoming print jobs.

HP Color LaserJet Printer

The basic HP Color LaserJet configuration has 8 MB of RAM. For PostScript work, you'll need a minimum of 12 MB of RAM. Memory is expandable to a maximum of 72

Performance Results



The QMS Magicolor, with its 33-MHz processor, easily came in first on most tests. Oddly, the HP Color LaserJet, with a 20-MHz AMD 29030, generally bested the Xerox 4900, which uses the same processor but clocked at 25 MHz. The BYTE PostScript test measures general PostScript processing capability. The four Genoa Technology test suites test performance with actual application output: Group 1, spreadsheet; Group 2, CAD, desktop publishing, and drawing; Group 3, word processing and database; and Group 4, scanned images. Start-up time is how long it takes each printer to boot and warm up.

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ranks first in reliability, overall quality, and technical support. In fact, BEST won 12 of the 14 survey categories. And if you need power protection systems for more than small LANs or individual PCs, BEST has a full product line up to 18 KVA.

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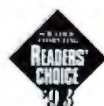
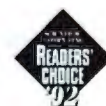
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Circle 67 on Inquiry Card (RESELLERS: 68).

MB by adding extra RAM SIMMs. The HP Color LaserJet controller uses an AMD 29030 RISC processor operating at 20 MHz. HP's Resolution Enhancement Technology smoothes the edges of black text and graphics but not with color images.

A quick glance at the back of the HP Color LaserJet reveals one of HP's cost compromises: A Centronics bidirectional parallel port is the only interface. Obtaining any other type requires the purchase of an HP JetDirect board for the printer's MIO (Modular I/O) slot. Several versions are available—a LocalTalk and Ethernet version (\$429), an Ethernet-only version (\$369), and a Token Ring version (\$619). Two cartridge slots let you add extra typefaces.

The only native PDL supported in the HP Color LaserJet printer is HP's PCL5. An Adobe PostScript level 2 interpreter (version 2013.114) is available as an option for \$795. The interpreter is stored on a ROM SIMM that mounts in one of the RAM SIMM sockets. Because the PostScript SIMM occupies a memory socket, you can expand printer RAM to only 56 MB with PostScript.

The HP Color LaserJet has 45 resident typefaces (35 Intellifont and 10 TrueType) plus another 35 PostScript typefaces when using the PostScript option. The printer also has a built-in TrueType rasterizer within the PCL5 and PostScript emulations. Like the other printers, the HP Color LaserJet's controller scans the I/O ports and switches PDLs automatically (if PostScript is present).

Blazing Colors

I gave all three printers a workout on BYTE's network and experienced no problems. Each ran the BYTE PostScript test without a hitch, also. This test rates the speed of a printer's PostScript interpreter (see the table "Performance Results").

To gauge performance with applications, I used Genoa Technology's PostScript printer tests. Genoa creates tests to evaluate PDL emulation compatibility, and, in fact, QMS uses these suites to test

Tektronix Threatens a Show Stealer

During this review, Tektronix showed me a prototype of its Phaser 540, a color laser printer with features and pricing that will compete directly with the three printers I review here. The base configuration comes with 20 MB of RAM and a 32-MHz RISC processor. It supports Adobe PostScript level 2 and HP PCL5 (Printer Control Language). The unspecified print engine uses a direct-to-drum technology, as does the engine used by HP. Tektronix claims a rate of 3.5 pages per minute for 300-dots-per-inch color and 14 ppm for black-and-white pages.

The Phaser 540 features imaging in both 300-dpi continuous-tone color and 600-dpi dithered color. Extra RAM raises continuous-tone color resolution to 600 dpi. Tektronix achieves continuous tone by modulating the intensity of the laser beam, not just its duration, which is the usual trick for boosting image resolution. You add toner by sliding four color-coded cartridges into the printer.

Sample continuous-tone output at 300 dpi was remarkable (see the figure above): I strained my eyes to see just pixels, because the usual clumping of pixels in halftone patterns was absent. Tektronix expects the Phaser 540 price to be under \$9000. Based on this price point and the quality of preliminary output from this printer, expect Tektronix's Phaser 540 to grab a chunk of the color laser desktop market when it ships sometime this month.



Tektronix Phaser 540

the compatibility of its PostScript clone. Genoa generously loaned me a set of color ATSeS (application test suites) for evaluation with these printers. The tests consist of captured PostScript output from a variety of real-world applications, such as Microsoft Excel, Adobe Illustrator and Photoshop, Lotus 1-2-3, QuarkXPress, Aldus PageMaker, Frame's FrameMaker, and others. Because the test suites are captured PostScript, you can download them directly to a test printer without incurring overhead from a graphical operating system or an imaging engine.

The Genoa tests consisted of four groups, each representing a specific application category. Group 1 consisted of 13 pages of spreadsheet output composed of charts and graphs. Group 2 consisted of 26 pages of CAD, desktop publishing, and drawing-application output with a mixture of bit maps,

text, graphics, and shaded surfaces. Group 3 consisted of 14 pages of word processing and database output composed mostly of text, with a smattering of graphics. Group 4 consisted of two pages of scanned images. Although the QMS and Xerox printers support higher resolution modes, I set both to operate at 300 dpi to make valid comparisons with the 300-dpi HP printer.

The printers' output speed averaged around 1 ppm, which is not bad, considering that the tests closely resembled real-world output and made heavy use of color. However, for scanned images, the output performance plummeted to about 4 minutes per page, due to the mass of data that has to be processed in a scanned image.

The QMS, with its 33-MHz processor, usually came in first. Oddly, the HP, with a 20-MHz AMD 29030, generally bested the Xerox 4900, which uses the same processor

About the Products

HP Color LaserJet\$8832
(as reviewed, with 12 MB of RAM, PostScript, and Ethernet/LocalTalk capabilities)

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Santa Clara, CA 95051
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fax: (800) 333-1917
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QMS Magicolor Laser Printer\$11,798
(as reviewed, with 28 MB of RAM and an Ethernet setup)

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Mobile, AL 36618
(800) 523-2696
(205) 633-4300
fax: (205) 633-4866
Circle 1011 on Inquiry Card.

Xerox 4900 Color Laser Printer\$10,093
(as reviewed, with 24 MB of RAM and an Ethernet setup)

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but clocked at 25 MHz. As expected, the HP and Xerox printers, which use genuine Adobe PostScript, had no difficulty printing the Genoa application test files. Neither did the QMS Magicolor. It speaks well of the QMS PostScript clone that it printed the complex and varied images in the Genoa tests without a hitch.

All three printers produced handsome output. There were imperfections, however. The color wheel generated by the BYTE PostScript test (see the figure "BYTE PostScript Color Wheel") showed noticeable banding on the QMS Magicolor, even at 600 dpi, and slight banding on the HP Color LaserJet at 300 dpi. The dithering patterns on the QMS output, however, were much less obvious. No banding was detectable on the color wheel produced by the Xerox 4900, due to the dithering pattern its Quad Dot Technology created. On the QMS and Xerox printers, transitions from colored regions to black regions showed darker colored bands, an artifact of the Hitachi engine. Be aware that the BYTE PostScript test deliberately stresses a print engine's color gamut with wide color variations and color extremes, so you won't normally see these transition bands.

The QMS Magicolor and Xerox 4900 showed their best on this test when allowed to operate at the highest resolution. At 300 dpi, the HP Color LaserJet showed clean, crisp images, due to its direct-to-drum Konica print engine. However, when it came to scanned images, the QMS Magicolor and Xerox 4900, operating at higher resolutions, prevailed. When I set Photoshop to do no

half-toning and to use the printer's default half-toning screens instead, I obtained gorgeous image output on these two printers.

Cost Conscious

Although color graphics output isn't as striking as that of comparably priced dye-sublimation printers, price per page is an order of magnitude lower. All three printers feature smart use of consumables: The less color you use in a document, the lower the cost per page. Comparisons of the cost per page for these printers are difficult, because the vendors tally up the costs of consumables differently. Estimates range from about 11 cents per page to 26 cents per page for a document with 15 percent color coverage (equivalent to a company cover letter embellished with a pie chart), and from about 48 cents per page to \$1.37 per page for 100 percent page coverage.

The cost is more than that for black-and-white output, but its not so steep that you can't mass-print attractive color brochures and snazzy reports for special jobs. In fact, the cost of black-and-white output for these printers is close enough to conventional laser printing (estimates are from 2.5 cents per page to just over 4 cents per page) that the vendors claim they can stand in for black-and-white laser printers. This isn't exactly true, with the cost per page for black-and-white printing on most lasers at around 2 cents, but you won't break your department's budget if you accidentally print a report on one.

The printer you should get depends on the work you do. The HP Color LaserJet

sports the lowest price, but be aware that this was achieved by shaving certain features from the printer. If you agree with HP on these design decisions, this is the printer for you. If your work consists of text mixed with graphics, and you don't need PostScript, the HP fits the bill admirably. However, if you're using page-layout applications that speak only PostScript, you'll have to add the PostScript option to the HP or look at one of the other printers.

Recall that the basic QMS Magicolor and Xerox 4900 provide minimalist network support through 230.4-Kbps LocalTalk. Nevertheless, adding similar features to the HP Color LaserJet still makes it the lowest-priced printer by the time you tally up the memory and network options the other printers require. However, if your work has lots of scanned images (perhaps real estate brochures), the superior image-handling capabilities of the QMS Magicolor and the Xerox 4900 are well worth considering. If your work requires resolutions higher than 300 dpi, the QMS Magicolor and the Xerox 4900 are the only game in town. Any company doing heavy-duty color production with lots of jobs and different typefaces should consider the QMS Magicolor because of its SCSI hard drive option and the QMS Crown operating system. ■

Tom Thompson is a BYTE senior technical editor at large with a B.S.E.E. degree from Memphis State University. He is an Associate Apple Developer and author of Power Macintosh Programming Starter Kit (Hayden Books, 1994). You can contact him on AppleLink as T.THOMPSON or on the Internet or BIX at tom_thompson@bix.com.

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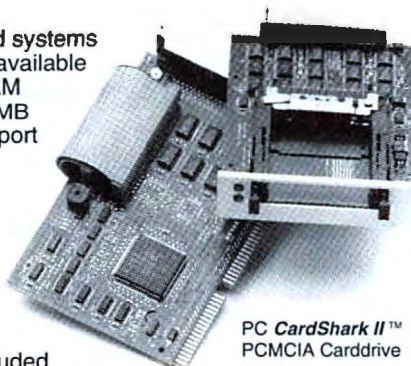
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Simonizing the PDA

BellSouth's communicative Simon is a milestone in the evolution of the PDA

CHRIS O'MALLEY

When computer makers say, "PDA" (personal digital assistant), they're referring to a small, pen-operated computer that *might* be able to wirelessly send or receive data, but not voice calls. But telephone companies, understandably, are apt to take a different view, which is why Simon says, "Talk."

Simon is BellSouth Cellular's intriguing new so-called personal communicator. Developed largely by IBM, Simon is essentially a cellular phone with the electronic innards and LCD face of a PDA. As such, Simon can not only serve as your portable phone, but it can also ply the cellular airwaves with data. Simon can send and receive E-mail, faxes, and pages. And while each of these avenues has its limits, Simon is easily the most communicative PDA to appear thus far.

Simon may also be one of the most expensive PDAs to appear thus far—or one of the least costly, depending on your point of view. Simon lists for \$899 with cellular-service activation from authorized dealers (in a BellSouth Cellular market) or \$1099 without service direct from BellSouth. In an age when cellular phones are sometimes given away to lure customers, and they rarely sell for more than \$500 in any case, that's a lot to pay for a phone. But Simon is more than a phone, and rigging a PDA (or any portable PC) with two-way wireless data features costs a lot more—and still doesn't give you voice capability.

Vintage Hardware

At first glance, Simon appears to be a throw-back rather than a trendsetter. Its brick-like shape (8 by 2½ by 1½ inches) and heft (18 ounces with battery) give it the look and feel of a vintage cellular phone from the 1980s. But instead of a dial pad, Simon has a narrow, backlit LCD screen—the only visual clue that it may be something other than a cellular phone (see the photo).



Simon looks like a large cellular phone except for its replacement of the dialing keypad with an LCD look-alike (right inset). Through the touchscreen, you operate the phone functions and a group of small PDA applications, such as the E-mail program shown (a small-screen version of Lotus cc:Mail).



But this is merely a clue at first, since the opening screen depicts a dial pad, a signal-strength gauge, and familiar cellular "buttons," such as Send and Quick Dial. Once you begin to peruse its menus and peer into its cavities, it finally becomes apparent that this is as much a PDA-like organizer and data communicator as it is a phone. This mild deception may be Simon's most striking quality: It looks and feels like a product you already know how to use, rather than a new religion you must immerse yourself in.

There is familiarity in Simon's components, too. Inside, Simon is basically a miniaturized DOS computer joined with a modem and a cellular transmitter/receiver. The CPU is a 16-bit x86-compatible processor running at 16 MHz, a single-chip design manufactured by Vadem. Simon runs a version of DOS called ROM-DOS, from Data-light, and has 32 KB of ROM dedicated to the system's BIOS. There's 2 MB of flash memory that stores Simon's built-in applications (from 1 MB, using Stackcr compression), and another 1 MB of pseudo-static RAM for running the programs and storing user data. Roughly 640 KB of this

memory is actually available for your use.

Many of the unit's hardware features are less than exotic, too. There's a 2400-bps Hayes-compatible modem inside that uses the MNP 5 protocol to help stream data through the often-turbulent cellular airwaves. Simon also has 9600-bps send-and-receive fax functions. At 4½ inches tall by a mere 1.4 inches wide, its backlit monochrome LCD is small; it has an all-points-addressable touch overlay that you can electronically write on with either the included stylus or your finger. The display is otherwise unremarkable, although the very fact that it's backlit makes it stand out among PDAs and palmtops. Even Simon's expansion port is in the form of the now-commonplace Type II PCMCIA slot.

IBM didn't reinvent the cellular wheel, either; Simon's cellular functions come via the same Mitsubishi RF transceiver that's used in several hand-held phones. As with all portable cellular phones, transmitting power is limited to 0.6 W. Externally, the unit has a retractable antenna on top, and

a 33-pin connector at the bottom for an RJ-11 land-line adapter or a (as yet unannounced) serial cable for linking Simon to a PC.

Simon uses a rechargeable nickel-cadmium battery pack that slides onto the back of the unit. The included slim battery pack provides about 1 hour of talk time (for conversation or data transmission) and 8 to 12 hours of standby time (i.e., the amount of time you can leave the phone on so it can receive calls).

A thicker, high-capacity pack can deliver roughly double these figures. But battery life varies, depending on how much you are using Simon to do other things, such as entering names and appointments into its organizing utilities. A lithium coin battery inside the unit provides up to 2½ days of backup power for your data if the main battery is drained or removed.

Simon's Software

Although Simon's hardware is largely a condensed compilation of proven performers, its software is another story. The user interface and applications were designed from scratch by IBM to fit Simon's narrow screen and make good use of its phone functions. Only one of its applications, cc:Mail, exists outside the Simon. (BellSouth says it intends to select third-party publishers to develop additional applications for Simon, but none had been announced by the time this went to press.)

The software is broken down into two main areas: phone (i.e., voice) functions, and what BellSouth calls "mobile-office" functions. You access the phone functions through the simulated dial-pad screen and a handful of accompanying menus, such as a list of one-button Quick Dial numbers or a list of direct-dial buttons showing the last 10 numbers you've called. It's as simple to use as any cellular phone, and a telephone icon at the bottom of the screen lets you get to the dial pad quickly, regardless of which application you're in.

Simon has a few features that you don't find in every cellular phone. It simplifies calling while out of your home area (known as *roaming*) by reducing the necessary steps to just pressing a few preference buttons. It also supports multiple cellular phone numbers, or *NAMs* (numerical assignment numbers), and it can answer your calls automatically.

But perhaps Simon's biggest phone perk is that it can act like a pager. When a call comes in and goes unanswered, the caller can leave a phone number, which is recorded in Simon's pager menu. Simon then beeps

Selected Simon Features

ADDRESS BOOK

- Auto-dialing
- Search

APPOINTMENT CALENDAR

- Alarms
- Periodic meetings
- One- or three-month view

CALCULATOR

- Standard
- Financial
- Metric conversion
- Programmer

CELLULAR NUMERIC PAGER

- Stores nine numbers

CELLULAR PHONE

- Last 10 numbers
- Quick-dial list (16 numbers)
- Call timing
- Vox (voice-activated transmitter)

DIAGNOSTICS

E-MAIL

- Lotus cc:Mail Remote
- Can limit to short messages

FAX (9600-BPS GROUP 3)

- Viewing with zoom
- Busy retries
- Fax storage

FILER

- System memory or PC Card storage (optional)
- Copy, rename, delete, back up, and restore

HELP (SCREEN-SPECIFIC)

NOTEPAD

SKETCHPAD

SYSTEM SETUP

- Password locking
- Power management settings

TO-DO LIST

WORLD CLOCK

- World-map view
- Alarm

and darkens the Phone Pager button. It can store up to nine numbers, which you call back with a one-touch selection.

The mobile-office functions consist largely of the usual PDA/organizer fare (see the box above): address book, appointment calendar, notepad, sketchpad, calculator, and to-do programs, plus utilities for setting system preferences and a password, managing data files, and changing the time and date. But because Simon has built-in communications gear, it adds fax and E-mail functions to the mix. The fax program allows you to use either the notepad or the sketchpad to create faxes, and you can view and annotate (as well as resend) the faxes you receive. The E-mail program is based on cc:Mail Remote and works with any cc:Mail host that supports remote users.

All these programs share a clean design and are so easy to use that you'll rarely need to poke your nose inside Simon's skinny user's manual. They are also fairly well integrated. You can call, fax, or send E-mail to someone from the address book, for example. You can also dial a number con-

tained in an E-mail message and forward an E-mail message as a fax.

The Bad with the Good

Even with all its good points, there's no shortage of frustrations with using Simon; many of them are minor, but a few are major. While you can operate Simon with a pen, it doesn't do handwriting recognition. Thus, you're left to enter data with either a tiny on-screen QWERTY keyboard or the PredictaKey keyboard, which automatically displays the next six characters most likely to be used (and lets you page through the alphabet six letters at a time according to this probability formula). You can also flip to a numeric keypad.

The PredictaKey works better than I expected it would. It seems to get the correct next letter among its first six about 75 percent of the time. But entering names into the address book or tapping out fax and E-mail messages are tedious chores. Simon needs either an adjunct keyboard (a palm-top-style one would do) for data-entry sessions or a desktop-linking kit that would enable you to transfer data from your PC. BellSouth says it intends to provide the latter soon; there's already a Link PC button for this function in the file-managing program.

Faxing with a device of this small size can be frustrating, too. You can scribble handwritten messages for creating quick faxes, but Simon's narrow screen and relatively poor pen tracking ensure that the results are usually quite atrocious. Simon is best at simply letting you view faxes (while holding the unit sideways) and then perhaps forward them after doing a quick markup. Likewise, long E-mail messages can be a real drag to read through, although you can limit incoming mail to about a paragraph if you wish. You can't receive files attached to E-mail messages, either.

Simon Does

As cellular phones go, Simon doesn't have much staying power. Even the smallest flip phones typically have more talk and standby time than Simon, and portable phones that approach Simon's size give you *much* more. That's not necessarily a fair comparison, but realistically, Simon's competition will include cellular phones as well as PDAs. Another power peeve: There's no battery gauge, either on the unit or in the software, so you're never sure when Simon is going to quit (although you won't lose data when it does, thanks to the backup battery).

Merging a phone and a PDA has another bad side effect: You can't take notes or use Simon's other features while conversing,

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Reviews

since the screen is up next to your ear. The more you depend on Simon, the more irksome that drawback becomes, since you'll want to enter all your appointments, phone numbers, and the like into it.

Regardless, Simon has a full range of communications options, and, most important, they work. Simon is no less fickle than other cellular phones for voice calls; it's clearer in some areas than others, depending on local signal strength, and it usually works better outdoors. But it completed reasonably clear calls made from inside airports between West Palm Beach and San Diego on one recent trip I took, and it also consistently performed well in my car.

But data transmissions are dicier, with Simon dropping the cellular connection 10 percent to 20 percent of the time in my experience. But an 80 percent to 90 percent success rate is nothing to complain about for sending data in analog fashion over the cellular system (Simon doesn't support the emerging CDPD [Cellular Digital Packet Data] digital cellular service).

PDA Progress

In addition to the high-capacity battery (\$78) and RJ-11 phone connector (\$119), Simon's other options include 1-MB and 1.8-MB PCMCIA memory cards (\$224 and \$279, respectively) and a travel charger (no price had been set at press time) that lets you recharge Simon's batteries directly from an AC outlet so you don't have to carry the recharger base with you. In addition, BellSouth has plans to offer a cigarette lighter adapter as well as an alphanumeric paging card similar to the one that the company's MobileComm division offers for Apple's Newton. The paging card will let you receive pager messages and E-mail from public services.

Whether or not Simon is your idea of the ultimate (for now) personal communicator depends on how appealing you find the combination of voice calls and E-mail—and maybe on how little you need a laptop. Clearly, Simon won't replace portable PCs, but it's equally clear that it represents a milestone in the evolution of the PDA. ■

Chris O'Malley is a Florida-based freelance writer who covers telecommunications, among other topics. You can contact him on the Internet or BIX at editors@bix.com.

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At your request, we also designed it to be easily expanded. The LTE Elite gives you a choice of fast 486 processors (up to 75MHz) and a removable hard disk. It also has PCMCIA slots that let you use over 140 Compaq-tested cards. And almost every key component is upgradeable: the memory, the display and the processor itself.

We even designed the LTE Elite to make things easier in the office – with the SmartStation and MiniStation expansion bases. Both of these

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Conceptual design by Robert P. Humenik and Jerry D. Flynn of McDonnell Douglas Space Systems

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Collecting Facts from Fax

Teleform 3.0 is powerful software for automatically converting customized paper forms to computer data

STAN MIASTKOWSKI

The fabled "paperless office" has become one of the running jokes of the PC revolution. PCs were supposed to eliminate paper; but, if anything, they've perpetuated it. According to market research firm BIS Strategic Decisions, most Fortune 500 firms use more than 10,000 different forms. Add the many and varied forms from the tens of thousands of small businesses, and the numbers quickly become mind-boggling.

Most of that information on paper must eventually be transformed into data that computers can use. Currently, that's largely done by legions of data-entry people, most of whom spend endless dreary days on this mind-numbing exercise. What's needed is a way to automatically take forms, read the information, and transform it into computer-readable data. Cardiff Teleform for Windows is a unique package designed specifically to do that—to directly transform hand-entered data on forms into standard database formats.

Teleform is in version 3 and has added some features, including toolbars and customizable grids, that make it easier to use than its predecessors. More to the point, its character-recognition abilities have been honed to make them impressively fast and accurate. What sets Teleform apart from stand-alone OCR programs are its forms-centric design and its direct export into database formats.

Teleform uses a *constrained* design for forms, which increases the odds of error-free recognition. As with all OCR programs, however, Teleform's success rate is still far from perfect—many forms require "cleaning up" before they can be

entered in the database, as we found in our tests. The range of potential uses for Teleform is wide indeed, although the software seems to have found its biggest proponents in organizations that gather data by fax (or mail) from large groups

(for a typical example, see the text box "The BYTE Hardware Poll").

Serious Hardware for Serious Software

Teleform is a large and complex application that requires serious hardware

Teleform Verifier - [Correct - BytePoll]

File Correct View Utilities Window Help

New Value: NEC 3NURSEZ7R CD TRON RFADER
KOSS SMAK7FRS

Field: Disk Size, Disk Type, Peripherals

Attached Peripherals: ☐ Other, ☐ 101-250 MB, ☐ 251-500 MB, ☐ > 500 MB

OPINIONS: (5=Very Happy 1=Very Unhappy)

Teleform Verifier - [Correct - BytePoll]

File Correct View Utilities Window Help

New Value: GATEWAY 2000

Field: Brand, CPU, Speed

Computer Brand Name: GATEWAY 2000

Processor (286/386/486/Pentium): 486

Processor Speed: 33

Total RAM (in MB): 4

Hard Disk Type: ☐ IDE, ☐ SCSI

Hard Disk Size: ☐ 20-40 MB, ☐ 41-100 MB

Unconstrained text entry (top) and careless handprinting that ignores example text (bottom) can create problems for Teleform (note the best guess in the New Value box at the upper left corner of each screen). Recognition accuracy can be improved by creating a custom dictionary or database lookup.

The BYTE Hardware Poll

To test Teleform's capabilities, the BYTE Reviews department created a hypothetical poll in Teleform Designer, printed a master on a laser printer, made 93 copies, and distributed them to the members of the BYTE staff in Peterborough, New Hampshire. We faxed the 55 returned and completed forms to a test system (a generic clone with 16 MB of RAM and a 75-MHz IBM Blue Lightning processor) running Teleform. Later, the data from the same forms was also scanned in to the system.

The form that we designed used virtually all of Teleform's objects, something that's unlikely in the real world. We did, however, learn some valuable lessons about using Teleform.

For example, we did not create either a dictionary or a database lookup for the constrained or unconstrained handwritten text entry, and that caused problems in text recognition, especially when respondents did not pay attention to the printing examples (a predefined Teleform object) included at the top of the form. Because the uni-

verse of computer brand names and possible peripherals is relatively limited, giving Teleform a custom lookup table would have eliminated many manual corrections. Vir-

tually every form needed some degree of manual correction, but that may have been a shortcoming of the form design.

On the other hand, Teleform was dead-

accurate at recognizing "fill in the box" optical marks, including circles that were x-ed or checked instead of filled in. Also, recognition percentages went up when respondents followed the handprinting examples in the "Example" object model. Surprisingly, there was no discernible difference in accuracy between faxed and scanned forms.

Performance was unexpectedly fast on our test system, even taking into account that the machine was equipped with above the recommended minimum hardware. Once it received each form via fax or scanning, the Teleform Reader averaged 15 seconds to process and recognize the entered data, pausing occasionally when it encountered extensive unconstrained text in the Attached Peripherals box. The result of our test was a file in Paradox format, which we were then able to open in Paradox for Windows and use with no problems.

The "Content" of a Form

The tested form contained three types of recognition objects and a predefined "Example" object. Handprint is generally recognized less reliably than optical marks, though recognition improves when printed characters are constrained to boxes. Recognition also improves when users follow the model in the "Example" object.

resources. This is especially true when it's running at full tilt, because Teleform multitasks several programs concurrently. Installation is easy, but, practically speaking, you'll need at least a 486 with 8 MB of RAM and about 40 MB of hard disk space to get started (more if you'll be storing many forms and responses). For high-volume forms processing, a multiuser version is available that does workload balancing by spreading the forms-processing chores among multiple networked PCs (I used the single-user version for this review).

Processing faxed-in forms is the heart of Teleform's functionality, and instead of reinventing the wheel, Cardiff has included SoftNet's popular FaxWorks program. FaxWorks links directly to the Teleform modules and also gives you an excellent fax program for other faxing chores. FaxWorks supports most fax modems, and the installation utility automatically senses, identifies, and tests your fax modem.

Teleform also includes extensive scanner support, and I had no problems interfacing it to a Hewlett-Packard ILC flatbed

unit. Cardiff offers optional drivers for high-speed scanners with automatic paper feeding. You will, however, need to make sure your PC hardware is compatible. I wasn't able to get a high-end Fujitsu scanner to work, because the Teleform driver required an Adaptec SCSI adapter and wouldn't work with the Future Domain SCSI board in my test system.

Form Design

Teleform's Form Designer is well designed and easy to use. If you've used a desktop



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SCEPTRE

publishing program, most of Form Designer's components will be familiar. If you haven't, creating a form won't require extensive expertise. You just need to plan ahead to design efficient and useful forms.

All Teleform forms include large "cornerstones" in each corner. The program uses these, along with an automatically created Form ID block, to identify received images (faxed or scanned) as Teleform-created and to tie them to form parameters that you create during the design stage.

Form Designer gives you almost unlimited control over type fonts, sizes, and attributes. One thing it lacks, however, is an easy way to import graphics, such as company logos. You can't just import a PCX file, for example, although you can cut and paste from any Windows program that creates BMP, TIFF, and WMF files. Instead, you must open your graphic in a separate application (e.g., Windows Paint-Brush), copy it to the Clipboard, press Alt-Tab to open Form Designer, and paste it in.

Object Objectives

Teleform offers a variety of objects, each designed for capturing different types of

data (see the figure "The 'Content' of a Form"):

- Optical Mark Recognition (OMR)—"Color the dots" entry.
- Optical Character Recognition (OCR)—Recognition of preprinted text (e.g., a form ID number or serial number).
- Constrained Handprint Recognition—Handprinted entry of alphanumeric characters; only one character per box is allowed.
- Unconstrained Handprint Recognition—Handprinted entry without the one-character-per-box constraint, usually compared against a user-defined dictionary or database.
- Complex BasicScript Validations—Teleform contains its own BASIC-like language that lets you perform complex operations on received data.
- Image Capture—TIFF images (e.g., signatures).

Choosing objects for your particular application is crucial to form design. Which objects are best for which types of data is well covered in the Teleform manual. The more constraints you place on the data, the more accurate its recognition will be.

Once you choose an object, all you need to do is drop it on the form. Then you fill out a dialog box that gives the data a field ID (for database entry) and check boxes for other attributes. Although it looks complex at first, Teleform makes the process easy, especially with a preview box that shows you what an object looks like before you paste it into a form. Teleform also has a library of predefined objects (such as name and address fields) that you can drop into any form.

Dictionaries and Databases

It quickly becomes apparent that most fields in a form have a limited universe of possible entries. Thus, one way to increase recognition accuracy is to provide Teleform with a list of possible values. There are two ways to do this: dictionaries and databases. A dictionary is simply a list of possible words. You can enter your own or



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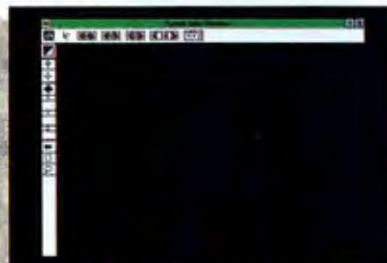
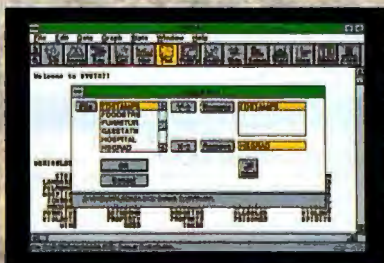
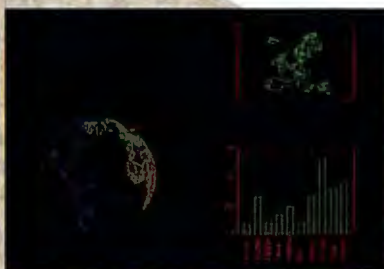
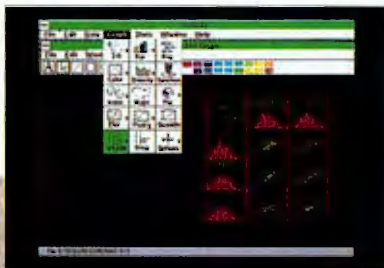
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import any text file. Database validations are more complex to set up, but they operate on fields instead of individual words.

Once you have created your form, you have only a couple more steps before you can distribute it. First you must choose the database format that the forms will be exported to after they are recognized. Teleform supports a wide range of formats, including dBase, Paradox, Access, Excel, and ODBC (Open Database Connectivity), the "middleware" that con-

nects to large client/server database systems. Finally, you have to "activate" the form, notifying Teleform that the form is finished and ready to be received.

The Shock of Recognition

Once you've distributed the forms (e.g., via fax or mail), you're ready for the reception/recognition phase, which is largely automatic. With FaxWorks up and running, it receives forms and feeds them to the Reader, the real brains of Teleform

(you can also scan forms directly into the Reader). The Reader identifies, recognizes, and passes each form to the Verifier, which flags forms that need additional correction. You can manually correct them or choose to have errors ignored and the data fed directly to the database.

This approach, used with forms that are highly constrained to increase accuracy, is often necessary in high-volume operations. The Verifier's configuration menu also offers extensive options for fine-tuning, such as the Confidence Threshold, which tells Teleform how much effort to make in creating substitutions for characters it's not sure about.

True to Form

Ultimately, most of Teleform's shortcomings are the same as in all recognition software—no one has yet figured out how to reliably spot the patterns in handwriting and unconstrained handprinting. But Teleform lets you minimize its weaknesses and exploit its strengths by using constrained objects as much as possible. As a rule, forms with no handprinting objects will be recognized close to 100 percent of the time, and they can handle most people's information-gathering needs. If you must use handprinted entry, the lower recognition rate isn't likely to wipe out the still-substantial savings in time and labor.

At first glance, Teleform's \$1495 price tag may seem high, but the program is an eminently useful, cutting-edge application that pushes the edge of technology. Despite its underlying complexity, Teleform is rock solid and surprisingly easy to set up and use. Careful planning during form design is crucial to achieving the highest accuracy. But if you need to gather data from paper forms and convert that data for computer analysis, the bottom line is that Teleform can pay for itself in no time flat. ■

Stan Miastkowski is a BYTE consulting editor who has been writing about networking and communications technology for over 16 years. He is co-author of Windows for Workgroups Bible (Addison-Wesley, 1993). You can contact him on the Internet or BIX at stanm@bix.com.

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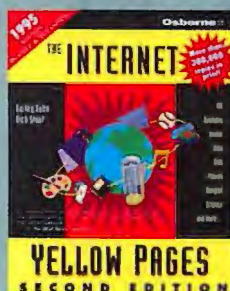
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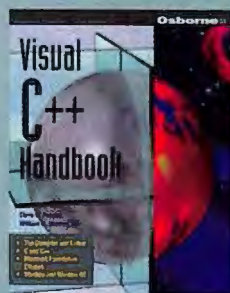
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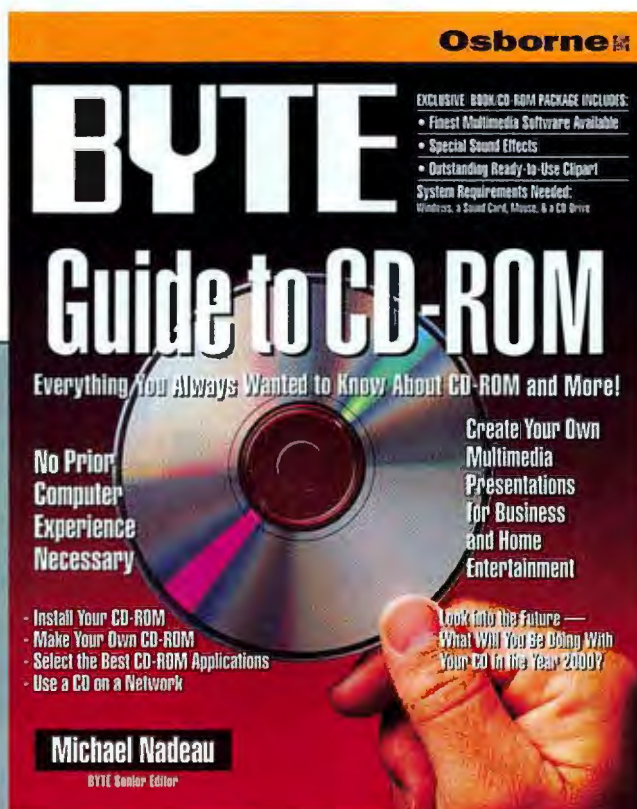
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SCSI Rides High on PCI

PCI-based SCSI host adapters combine state-of-the-art speed with (almost) Plug and Play simplicity

STEVE APIKI

Among PC technologies, PCI (Peripheral Component Interconnect) and SCSI-2 are about as natural a match as you're likely to find. PCI's two key attributes—a 132-MBps top transfer rate and Plug and Play potential—make it an ideal foil to SCSI-2, which has notorious needs for both system bandwidth and configuration tweaking. High-speed PCI SCSI host adapters take advantage of PCI's strengths to provide both simple setup and high SCSI throughput.

PCI SCSI adapters will make their biggest contribution to networked environments where many users access multiple drives. SCSI-2 performance features like SCSI disconnect and tagged command queues maximize overall data throughput with multiple drives by allowing target drives to fetch and store data while not holding the bus, essentially sharing the bus more effectively. Although single-user systems will benefit from the increased throughput, multitasking, multiuser systems are more likely to exploit simultaneous access to several SCSI drives. With this type of use, PCI opens the bottleneck typically created by ISA-bus host adapters and moves that bottleneck from the host adapter to the SCSI bus itself.

In this review, I compare three PCI 2.0-compliant SCSI-2 cards: Adaptec's AHA-2940, Future Domain's TMC-3260, and BusLogic's BT-946C. I focus mainly on performance, but I also look at ease of configuration. With a total of two jumpers among them, these three adapters are at least as different from ISA SCSI cards in ease-of-setup as they are in throughput.

Testing and Results

I tested the three cards on a NetWare 3.12 server, where the performance features of SCSI-2 and PCI make sense. I used the NetFrame DX test and the BYTE NetWare File I/O test, both of which generate disk traffic from the server itself and measure aggregate disk I/O in kilobytes per second. Both tests avoid NetWare's software caching, so that performance differences between adapter cards are emphasized. The NetFrame test runs under NetWare

and writes to free space on all drives simultaneously, bypassing the NetWare file system. It shows the performance of each host adapter under maximum load.

BYTE's NetWare File I/O test NLM (NetWare loadable module) performs sequential reads, writes, and random I/O to files residing on NetWare volumes on each attached device. BYTE's File I/O results use NetWare's Direct File System NLM to bypass the NetWare system cache to ensure that each access gets all the way out to the SCSI target. For comparison, I also ran each board with a DOS-based file I/O benchmark that uses a variety of access patterns. In addition to the three PCI adapters being tested, the test results figures (starting on page 164) also show comparison results for an Adaptec AHA-1542B (a popular ISA SCSI card).

The test bed was a 486DX2/66 system built around an Opti reference design motherboard. Opti's PCI chip set fully supports PCI 2.0 and enables posted writes on the PCI bus, a feature that's not found in older PCI designs. For all the NetWare tests, I ran each host adapter with one to four drives. The first three drives were Micropolis 4110s, and the fourth was a Micropolis 2217. All these drives support synchronous transfers up to 10 MBps as well as tagged commands. The test system was fast enough to minimize the impact of the system and drives on the tests and to place the host adapters in the bottleneck position.

While the Future Domain card depends on CPU-intensive PIO (programmed I/O) to move data between itself and system memory buffers, the more expensive Adaptec and BusLogic cards use bus mastering to off-load data transfer work from the CPU. In addition to SCSI throughput, the NetFrame DX test provides a crude measurement of CPU utilization. I used



Bridging fast to faster: Adaptec's AHA-2940, Future Domain's TMC-3260, and BusLogic's BT-946C (front to back) hitch 10-MBps Fast SCSI-2 to 132-MBps PCI. Local-bus host adapters have sufficient bandwidth to keep SCSI peripherals operating at near-maximum speeds.

this result to gauge how each card might affect a server running CPU-intensive applications.

Adaptec's AHA-2940

Adaptec's latest SCSI design was a consistent top performer on all our tests. Built around Adaptec's 10-MIPS PhaseEngine RISC microprocessor, the AHA-2940 has considerably more processing horsepower than either BusLogic's or Future Domain's PCI cards. In my testing, the advantage of the faster processor was most evident for small block sizes and for small numbers of drives, where the overhead of in-system processing time is greatest compared with the overhead of the drives. Since 4-KB blocks are probably more representative of typical transfer sizes than 32-KB blocks, the AHA-2940 should prove the best performer for running NetWare with one or two drives.

Some AHA-2940 performance features don't work quite as well. The Adaptec card supports tagged command queuing, but I had to leave the queue setting low in order to get effective performance. If I set the queue size too high, the NetWare server would simply lock up and crash when it used multiple drives. An Adaptec engineer explained that when queues get too

large and several SCSI devices wait to return data, competition for the SCSI bus becomes critical. Since SCSI awards control to the device with the highest ID, device 0 (the first drive) never gets control and starves until NetWare fails the drive, deciding it will never return. This problem was by no means unique to the AHA-2940; BusLogic's board showed similar results, and I've seen this behavior with a VL-Bus SCSI card, too.

One performance measure that isn't in the performance charts is CPU utilization by the host adapter. The AHA-2940 kept CPU utilization to a minimum, and throughput was split evenly from device to device, meaning the NetWare server was still capable of servicing every request even at the highest throughput levels.

Board configuration and setup is sim-

ple. You access SCSI and device parameters via a ROM-based SCSISelect Utility that you invoke at boot time with a hot-key combination (Ctrl-A). I had no problems with the firmware configuration after installing the board.

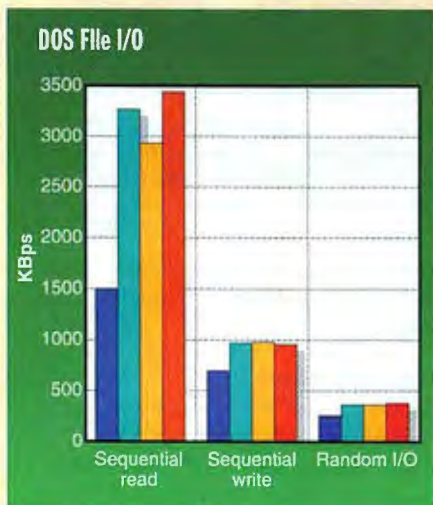
Adaptec sells the AHA-2940 only as part of its PCI SCSI Master kit. The \$399 kit includes drivers for most operating systems, a cable, and Adaptec's EZ-SCSI utility package. Adaptec also sells a wide-SCSI version of this board called the AHA-2940W.

BusLogic's BT-946C

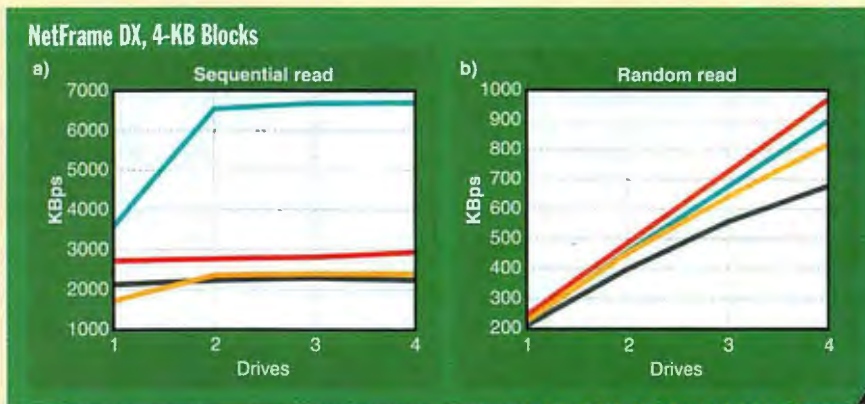
Despite a high-performance bus-mastering ASIC (application-specific IC) that's been tested in the field, BusLogic's BT-946C turned in performance results that were generally disappointing. The BT-

946C supports advanced SCSI performance features such as command queues of up to 255 commands. (Adaptec's card is limited to 32 queued commands with the firmware I tested.) In my tests, however, BusLogic's board rarely matched the performance of either Future Domain's or Adaptec's host adapters. In fact, the BT-946C lagged behind the other boards on every test.

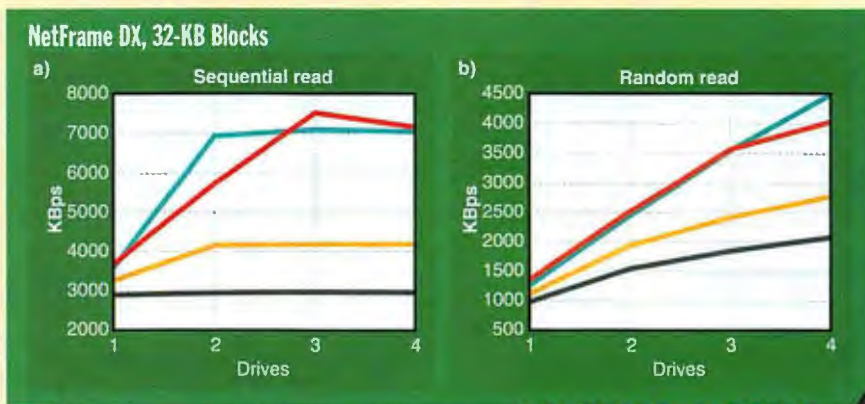
You set most performance parameters in firmware. Once I found the optimal firmware settings, the only tweaking that was necessary was to set command-queue sizes using the NetWare driver. The BT-946C had the same problems as Adaptec's card in using large queue sizes. A BusLogic engineer was surprised by my test results and explained that BusLogic had achieved throughputs of over 7 MBps from the BT-



Adapter performance under the DOS test, running file I/O operations on a single drive. Results from an Adaptec AHA-1542B ISA host adapter are provided for comparison. Although there's only slight variation among the boards being tested, sequential read tests show a dramatic difference between the ISA and PCI boards; random tests show a small but noticeable difference. Note that the DOS file I/O tests include a mixture of block sizes to provide "realistic" performance numbers; higher throughputs could be attained with consistently large block sizes.



Results for NetFrame's DX benchmark using small (4-KB) block sizes for one, two, three, and four drives under NetWare 3.12. Adaptec's AHA-2940 completely outpaces the other adapters on sequential reads (a) on the strength of its more powerful controller, but random reads (b) show only a small differentiation.



Because the DX benchmark sidesteps the NetWare file system (and with the large, 32-KB block size), it yields the highest throughputs tested for all the host adapters (a). Future Domain's TMC-3260 appears to lose performance going from three to four drives, but the card's PIO design bogs down the CPU at this level, making measurements erratic. As the number of drives goes up, the random test (b) begins to approach each host adapter's performance ceiling as the access speed of the drive puts less of a constraint on system performance.

946C board using the NetFrame DX test on a Pentium system with three Seagate Barracuda drives. However, we were unable to come up with any settings that improved performance on my test setup.

The BT-946C has the distinction of being the only board to provide jumpers for configuration; however, the jumpers are required only for nonconforming PCI motherboards, and I didn't need to use them. I had some problems setting up the board initially; the system wouldn't boot until I set the PCI IRQ (interrupt request) to the BT-946C's default of IRQ 11.

BusLogic sells both kit (\$399) and stand-alone (\$369) versions of the BT-946C. In addition to operating system drivers, the kit contains an internal cable and a copy of CorelSCSI, Corel's SCSI utilities package.

About the Products

AHA-2940\$399
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BT-946C.....\$369
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TMC-3260\$139
TMC-3260SVP kit (with cable
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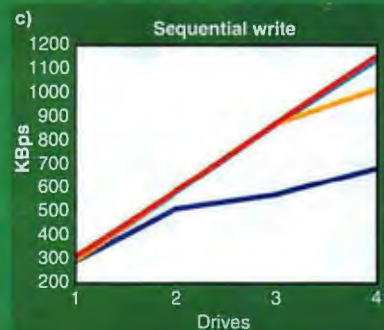
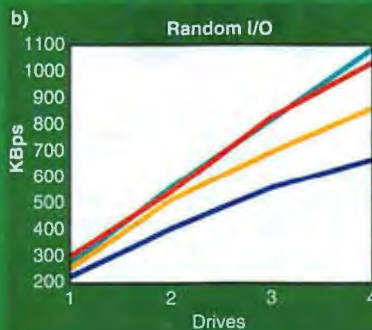
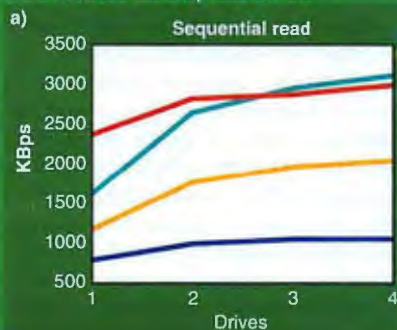
Future Domain's TMC-3260

Future Domain's recent price cutting makes the TMC-3260 a real bargain at \$139 for the stand-alone version and \$195

for the kit, which includes SCSI ribbon cable and drivers for DOS/Windows and NetWare. According to Future Domain, most other operating systems come with support for its host adapter products. If you are looking for a solid, high-performance, low-cost card, this is it. But even if cost isn't your top priority, the TMC-3260 flaunts both performance and convenience advantages.

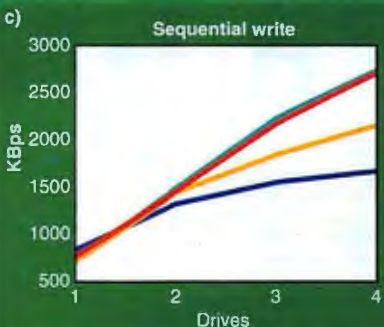
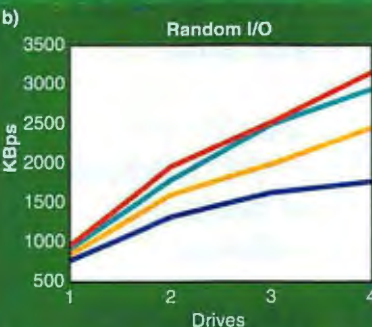
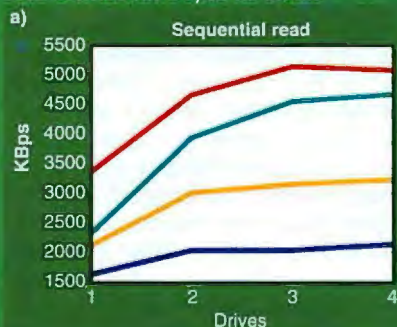
Although the other two reviewed cards come with straight ASPI (advanced SCSI programming interface) drivers, Future

BYTE NetWare File I/O, 4-KB Blocks



BYTE's NetWare-based File I/O tests demonstrate performance running on top of the NetWare file system. There is considerable overhead to this test compared with DX. For small block sizes, this overhead tends to wash out the differences between host adapters. Sequential tests (a) put Future Domain's TMC-3260 and Adaptec's AHA-2940 at similar performance levels, with BusLogic's BT-946C somewhat behind. As in the figure "NetFrame DX, 4-KB Blocks," random tests (b) show little difference between adapters. Sequential-write performance (c), mostly dependent on drive speed, is fairly insensitive to which host adapter is used.

BYTE NetWare File I/O, 32-KB Blocks



Sequential-read (a), random-I/O (b), and sequential-write (c) results for file I/O through the NetWare file system using large block sizes. Despite using PIO, Future Domain's TMC-3260 performed best in this high-overhead environment, while BusLogic's BT-946C consistently lags.



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Reviews

Domain supports ASPI by conversion through its CAM (common access method) drivers. Either way, ASPI support makes it more likely that you can attach multiple devices to one card or several host adapters in one system without compatibility problems.

The TMC-3260 is the only one of these cards to qualify as Plug and Play-compliant. Like the other boards, the TMC-3260 is fully software configurable. The deciding factor is the TMC-3260's automatic termination, a requirement for Plug and Play (and a handy feature). Auto-termination handles all card termination without any user action, enabling termination whenever the card is at an end of the SCSI chain and disabling it when the card is in the middle of the chain with both external and internal devices attached. This lets you, for instance, swap external devices between systems without worrying about card termination (after powering down all systems and SCSI devices concerned).

Although performance results were good, they were somewhat deceiving. The TMC-3260 shared the top spot on most tests with Adaptec's host adapter and exceeded its performance on the BYTE NetWare File I/O tests with large blocks. However, the PIO-based card used up so much CPU time that the test runs became erratic at high usage levels and drive utilization was extremely uneven. The high CPU requirements mean lower response time for actual network applications. Real-world performance is, thus, somewhat hard to gauge—the TMC-3260 did well on the BYTE NetWare File I/O tests, where CPU overhead appears to limit all cards—but I expect real performance to be somewhat lower than the tests indicate.

Card Comparisons

Going by the performance results, you have a choice between Adaptec's AHA-2940 and Future Domain's TMC-3260. It comes down to the lower price and somewhat greater convenience of Future Domain's card versus the performance advantage that bus mastering should give Adaptec's card with processor-intensive applications. Despite the TMC-3260's automatic bus termination, I would recommend the AHA-2940 for server applications, unless price is a critical concern. ■

Steve Apiki is a BYTE contributing editor and senior developer at Appropriate Solutions, Inc., a Peterborough, New Hampshire-based consulting firm. You can reach him on BIX or the Internet at apiki@bix.com.

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Four Peer Operating Systems

Peer LANs have matured into trustworthy tools. Here's how the top players—LANtastic, Microsoft Windows for Workgroups, Personal NetWare, and PowerLan—stack up.

BARRY NANCE

DOS-based peer-to-peer LANs have gotten a bad reputation among LAN administrators. Peer LANs can be fragile, because they use DOS as their underlying file-access mechanism. Furthermore, administrators view the indiscriminate sharing of workstation hard disks and directories with repugnance, because it lessens their control of system resources. Fortunately for administrators, peer LAN vendors are developing new OS/2- and Windows 95-based products that will eliminate the first objection (see the text box "Peer into the Future"). And current versions of peer LAN products address the resource-sharing problem in different ways.

I tested four peer-to-peer NOSes (network operating systems): Artisoft's LANtastic 6.0, Microsoft Windows for Workgroups 3.11, Novell's Personal NetWare 1.0, and Performance Technology's PowerLan 3.11. I evaluated each for reliability, memory consumption, ease of use, price, security features, overall number and quality of features, and performance. The table "Performance Benchmarks" reports on file I/O benchmarks, while the table "Features Comparison" summarizes and contrasts product features.

A Jury of Peers

On a peer-to-peer LAN, my workstation can be your file server, your workstation can be my file server, and I can share your printer. The most significant practical limit for a collection of PCs sharing each other's hard disks is the lack of available drive letters for more than about 25 connections—the alphabet just isn't big enough. But peer LAN vendors encourage you to dedicate one or more PCs as servers when you grow to have more than 20 or 25 PCs attached to a LAN. For smaller LANs, you can use the peer LAN product in a strictly peer arrangement. You and I can share files without having to think of the file server as an intermediary. As the LAN grows, an unattended PC acts as a file server. You simply run the server component of the peer LAN product on that one PC

and then connect only to the shared resources of the unattended PC. By not running the server component at the other (interactive) workstations, you regain some conventional memory.

I ran each of the peer NOSes under review through test suites that evaluate reliability, application compatibility, performance, and peer-to-peer communications. The reliability test concurrently copies 1000 files totaling 200 MB between several peer machines to test for file errors under peak-load conditions. All products passed this test without incident.

The compatibility tests check for compliance with DOS file-sharing conventions. All DOS applications issue DOS function calls to perform LAN file I/O. Certain functions (e.g., create file, change directory, and delete file) behave the same on a LAN as they do on a local disk. Other functions (e.g., open file, read file, write file, and lock record) operate differently on a file server. If you open a file, and I try to open the same file for exclusive access, my operation should fail. Likewise, the LAN should allow two workstations to simultaneously open the same file if both specify shared access. The LAN should also let a workstation identify itself through the DOS function Get Machine Name. A NOS that passes these tests implements LAN specifications correctly and will work with Paradox, dBase, FoxPro, Lotus 1-2-3, Excel, Access, WordPerfect Office, and Microsoft Word, as well as any other application that uses LAN-aware DOS file I/O functions. All the peer LAN products reviewed satisfactorily implement these LAN characteristics.

The performance suite determines the LAN operating system's network file I/O per-

formance by reading and writing files of random sizes. With elapsed times of about half those of LANtastic and Personal NetWare, PowerLan easily outdistanced the competition. The final suite tests PC-to-PC communications using NetBIOS programming techniques; this test is significant because third-party LAN utilities, remote-control programs, and some E-mail packages talk PC-to-PC via NetBIOS. Again, all the products offer excellent NetBIOS connectivity.

I tested these NOSes on PCs equipped with SMC EtherCard Plus network adapters. The eight PC workstations and one unattended file server ranged from a 486/25 IBM PS/Valuepoint to a 486/66 Zenith Z-Station 500. For the benchmarks, I set up each product in its recommended optimum configuration. To measure the responsiveness of these peer network products, I used BYTE's low-level DOS benchmark program running concurrently on the eight workstations. The BYTE test measures file read and write operations at the DOS function-call level.

Artisoft's LANtastic

LANtastic has been a popular NOS for several years; version 6.0, released in March 1994, adds many new features. LANtastic has offered Windows support



LANtastic's toolbars let you single-click on icons to perform network tasks. The included Artisoft Exchange E-mail is similarly icon-driven.

since version 4.0, and the current incarnation supplies a network DDE function called Linkbook. Working between DDE clients and servers running on separate PCs, Linkbook does a good job of enabling applications to automate the sharing of document sections, spreadsheet rows, and other data. LANtastic's Windows interface makes print queue management, network management, E-mail, and other tasks as simple as pointing and clicking.

LANtastic offers a universal client feature that lets you connect LANtastic workstations to NetWare, LAN Server, and other server-based NOSes. In version 6.0, LANtastic is again adapter-independent. Beginning with version 4.0, you needed to buy a special version of the software at \$99 per workstation if you wanted to use non-Artisoft network adapters. But in version 6.0, Artisoft reverts to a per-node pricing scheme that lets you use NDIS, ODI (Open Data-Link Interface), or Artisoft's own drivers to access a network adapter not manufactured by Artisoft. A separate product from Artisoft lets Macintosh computers participate as workstations (but not servers) on the LAN. In addition, LANtastic's NetBIOS uses an IPX format for its LAN packets, letting you use popular IPX routers if you need to connect multiple LANs into a WAN.

Memory-wise, LANtastic 6.0 isn't as frugal as earlier versions were. But version 6.0 still needs only 45 KB in a workstation: 21 KB for NetBIOS, 6 KB for SHARE, and 18 KB for the Redirector module. The Server module adds 60 KB, for a total of 105 KB. All but the Server module can load high on a computer equipped with a 386 or better CPU, leaving 545 KB available for running DOS programs. Artisoft's ALONE program can turn a peer server into a dedicated resource, and the LANcache utility does a good job of caching both read and write operations for multiple drives. Neither the fastest nor the slowest NOS I tested, LANtastic came in third in the benchmarks.

Like PowerLan, LANtastic can recognize UPS (uninterruptible power supply) signals and shut down during power outages. It also comes with an easy-to-use E-mail application, Artisoft Exchange, that integrates post office names and addresses with the roster of LAN accounts, so you don't have to enter user names twice. You also get fax and pager communications, as well as a group scheduler.

PERFORMANCE BENCHMARKS

On the same hardware platforms, and with each product optimized according to the manufacturer's recommendations, the peer LAN operating systems showed markedly different times in tests measuring file I/O speed. Performance Technology's PowerLan, with its 32-bit PowerServe module, was the fastest of the four.

	LANTASTIC 6.0	MICROSOFT WINDOWS FOR WORKGROUPS 3.11	PERSONAL NETWORK 1.0	POWERLAN 3.11
Seek	1.2	0.3	1.8	0.7
Read	17.3	12.1	19.5	9.5
Write	27.0	6.4	10.7	4.8

Times are in milliseconds. The network consisted of nine mixed-brand 486-based PCs of varying clock speeds, each equipped with an SMC EtherCard Plus network adapter. One machine was dedicated as the file server.

You can set up as much security on a LANtastic network as you need. After creating each network user, you point and click to grant permissions and rights. You can password-protect disk drives, directories, or individual files. LANtastic can produce audit trails that track network activity. A server that is low on disk space or that is experiencing high CPU use can send warning messages to network administrators.

Artisoft hasn't forgotten LANtastic's simple-is-best roots. If you don't need the rich set of features LANtastic offers, you might want to investigate Artisoft's Simply LANtastic product. Simply LANtastic forgoes many features of the full LANtastic product to give you a basic, no-frills network environment for sharing files and printers. At the other end of the spectrum, Artisoft offers CorStream Server, a combination of LANtastic workstation software and NetWare 4.0 file server software.

Microsoft Windows for Workgroups

Performance enhancements make version 3.11 of Microsoft Windows for Workgroups a noteworthy upgrade of version 3.1, but the software continues to suffer from security shortcomings that keep it from being seriously considered by large organizations. Version 3.11 also improves greatly on the product's multi-protocol support. WFW installs easily, and you can connect WFW PCs to a NetWare network or

an SMB-based network such as IBM's LAN Server.

WFW is a combination of Windows 3.1, a peer-to-peer NOS, an E-mail application, and an appointment book. The E-mail software is Microsoft Mail, and the appointment-book software is Microsoft Schedule+.

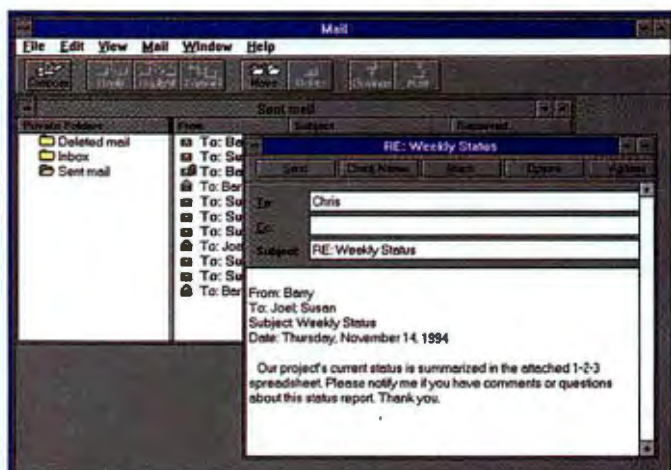
WFW runs best on a 386-, 486-, or Pentium-based computer with at least 8 MB of RAM. On a lesser CPU chip or without sufficient memory, the software executes in Standard mode instead of 386 Enhanced mode. You can share files only if Windows is running in Enhanced mode.

Conventional RAM use isn't a meaningful measurement in the WFW environment, because the software shares files only when Windows is running, and Windows loads some of the WFW drivers in extended memory.

An optional Workgroup Connection for DOS package consists of DOS-only software. Workgroup Connection for DOS lets PCs that can't or don't run Windows access resources shared by computers that are running WFW.

You use the regular Windows File Manager to share a directory on a PC running WFW in 386 Enhanced mode. You can let other team members access an entire hard drive, a directory, or (through Print Manager) a printer.

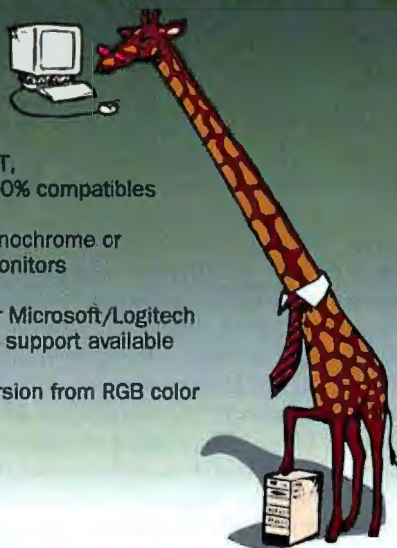
You have three options for setting up security for a shared resource: Read-Only, Full, and Depends on Password. Read-only access grants people at other workstations the right to view files but not to delete or change them. Read-only access also prevents anyone from creating



Windows for Workgroups includes a version of the popular Microsoft Mail, which offers one of the best E-mail interfaces available.

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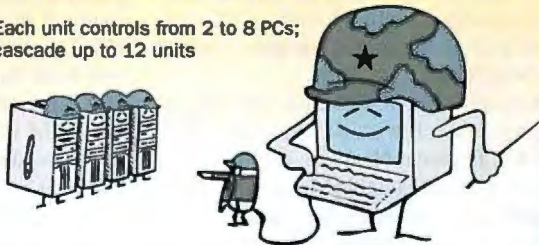


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directories below the shared-resource directory name. Full access lets other people view, edit, and delete files and create or remove directories. With the Depends on Password option, you can give read-only access to some people and full access to others. A person at another computer on the LAN obtains the appropriate level of access by entering a password matching the read-only or full-access password you designate.

Unfortunately, WFW does not maintain a network-wide roster of log-on accounts. Thus, when you use any workstation for the first time, the NOS asks you to register as a new user, even though you've logged on from other machines in the past. The same happens if you mistype your log-on account name.

In addition, you can't prevent someone from adding or removing directories, using more than a designated amount of disk space, modifying file attributes, or logging in from multiple workstations. You can't use WFW to force people to use or change passwords, nor does it support a user-groups concept to help distinguish security levels.

The bundled Schedule+ software lets you share your appointment book across the LAN, so you can coordinate meeting times with coworkers. Unlike PowerLan and LANtastic, WFW doesn't recognize power-is-fading signals from a UPS.

Novell's Personal NetWare

Personal NetWare, introduced in fall 1993, is a redesign of Novell's first peer LAN operating system, NetWare Lite. Novell continues to sell NetWare Lite to companies that already use Lite and need to add more PCs. But the company doesn't plan to enhance NetWare Lite with additional functions; instead, it will focus on Personal NetWare. Novell supplies several network adapter drivers with Personal NetWare, and the NOS works with any driver that complies with Novell's ODI standard, just as the client for server-based NetWare does.

As you'd expect, Personal NetWare interoperates well with NetWare 2.2, 3.12, and 4.0. Personal NetWare uses Novell's VLM (Virtual Loadable Module) software technology to manage the loading of the ODI drivers and redirector functions. The latest version of Novell's client kit for the company's server-based NetWare products supports TCP/IP as a substitute for IPX, but Novell hasn't yet updated Personal NetWare to offer TCP/IP connectivity. (You

Peer into the Future



Virtually all peer LAN products use DOS to access files on the server's hard disk, but DOS won't be with us forever. Microsoft has even hinted that it may not develop new versions of DOS in the future. Although the products reviewed here add peer networking to a DOS or DOS-and-Windows environment, the future of peer LANs may rise or fall with the success or failure of OS/2 and Windows 95 (formerly known as Chicago).

IBM includes a peer-to-peer feature in its new OS/2-based LAN Server 4.0 product, Microsoft promises peer networking in Windows 95, and Artisoft should soon release LANtastic for OS/2. (Windows NT offers peer-to-peer support, and a combination of Unix and NFS (Network File System) can be used to create a peer arrangement. But Windows NT and Unix remain too large and resource-hungry to be considered desktop operating systems.)

The peer-to-peer feature of LAN Server 4.0 lets OS/2 workstations easily access each other's hard disks and printers with just a click of the mouse on the Workplace Shell-aware LAN Server icons. Similarly, Windows 95 offers GUI-driven resource sharing, but it emphasizes the ability to browse the LAN to find a resource to which to connect. LAN Server, with an attitude that's a bit more conservative and staid than Windows 95's, is based on the principle that you should connect to the LAN resources when you first log on to the LAN—browsing is discouraged. Windows 95 will be able to network right out of the box, but you must buy both OS/2 and LAN Server to achieve IBM peer networking.

LANtastic for OS/2 was in beta test as I wrote this article. Code-named Sidewinder, the LANtastic for OS/2 product will enable DOS, DOS-and-Windows, Macintosh, and OS/2-based workstations to connect to a file server that's running OS/2. You'll be able to add LANtastic for OS/2 to an existing LANtastic LAN, as long as the workstations use version 5.0 or later of LANtastic. The combination of LANtastic and OS/2 should let you create interesting and useful client/server environments.

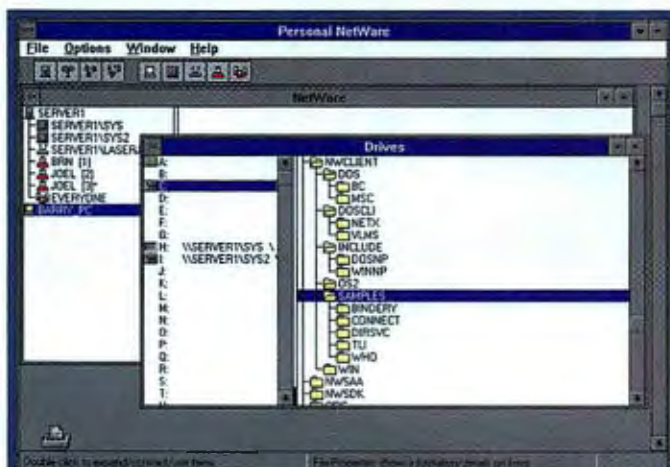
can manually graft TCP/IP into a Personal NetWare environment but only with some difficulty.) Personal NetWare integrates well in a Windows environment and can even install successfully over WFW.

Personal NetWare's components consume 110 KB on a server—16 KB for IPX, 45 KB of server software, and 49 KB of VLM and requester software. On a client-only machine, Personal NetWare uses 65 KB of RAM. Depending on the upper memory that's available in your PC, you can load the 16-KB IPX and 10 KB of the VLM module in upper memory. NW-Cache is an optional module for boosting server performance, and you can install optional security and SNMP modules.

Personal NetWare supports up to 240

users—fewer than the other peer LAN products. However, Novell suggests you switch to server-based NetWare 3.12 or 4.0 when your LAN grows beyond 25 workstations.

Like WFW, Personal NetWare does not understand UPS signals. Novell makes a Personal NetWare patch available on



Personal NetWare makes connecting to NetWare servers or other Personal NetWare PCs easy, because its VLM technology is basically the same one that Novell offers in its client kit for server-based products.

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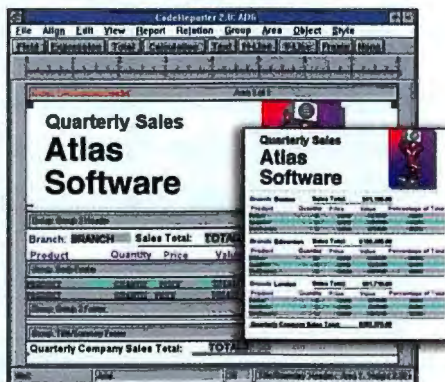
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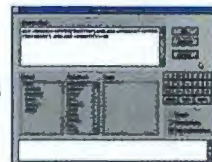
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Installing and connecting Personal NetWare PCs is fairly simple. However, when I rebooted an active workstation/server PC, simulating a power failure, the other Personal NetWare machines sometimes had trouble reconnecting. No other product had this problem.

Your data is as secure with Personal NetWare as with regular NetWare. For each user, you can enable or disable the account, grant or revoke supervisor (management) privileges, require passwords, set the minimum number of characters and expiration date of the password, and delete accounts. For each directory, you can specify default access rights and single out those users who should have nondefault access rights. In a Personal NetWare environment, you can choose to have no security at all by changing the STARTNET.BAT file so that it doesn't load the security module. You save some workstation memory by not loading the security module, but then all workstations have full access to the shared resources of that server.

Performance Technology's PowerLan

The fastest peer-to-peer NOS tested, PowerLan comes with a five-user version of DaVinci eMail for DOS and Windows. (Performance Technology bundled Lotus's cc:Mail product with early versions of PowerLan.) The company also sells remote-control and Epoch groupware calendaring software.

PowerLan's Windows interface uses a plug metaphor to depict shared-resource connections; you drag a plug icon from a drive letter or printer port to a network volume or print queue. Alternatively, network administrators can set up permanent drive mappings that everyone on a LAN can use. Even the administrative functions of PowerLan are enabled for drag and drop. You can add a user to a named group by dragging that person's log-on account icon from the nonmember side of a window to the member side.

PowerLan achieves its high performance through well-written software—the NetBIOS implementation is one of the best on the market. Another PowerLan component, a 32-bit, multithreaded dedicated server module called PowerServe, contributed to PowerLan's fast benchmark times. In fact, PowerLan proved to be nearly as fast as NetWare 3.11, beating the other peer LAN products to the finish line and even out-

pacing Windows NT-Advanced Server 3.5.

PowerLan supports packet drivers, ODI, and NDIS. In addition, it offers monolithic implementations of NetBIOS for most network cards, which cuts the protocol stack's RAM needs and raises its performance, because the monolithic NetBIOS drivers talk directly to particular brands of adapters, making ODI and NDIS unnecessary. PowerLan easily networks DOS and DOS-and-Windows workstations with other SMB NOSes, such as IBM's



PowerLan sports both a toolbar and a PowerLan menu option in File Manager, making it easy to access PowerLan functions in the Windows environment.

LAN Server. PowerLan 3.11 also integrates well into a server-based NetWare environment. With Performance Technology's optional Powerfusion product,

FEATURES COMPARISON

	LANTASTIC 6.0	MICROSOFT WINDOWS FOR WORKGROUPS 3.11	PERSONAL NETWARE 1.0	POWERLAN 3.11
Network software				
Server memory use	105 KB	16 KB ¹	110 KB	84 KB
Client memory use	45 KB	16 KB ¹	65 KB	45 KB
Loadable in upper memory	●	●	●	●
Server disk cache	●	●	●	●
Maximum nodes	Unlimited	Unlimited	240	Unlimited
Recognizes UPS	●	○	○	●
Can share CD-ROM	●	●	●	●
Supports NDIS	●	●	○ ²	●
Supports ODI	●	●	●	●
Interfaces to SMB LANs (LAN Server, NT)	●	●	○	●
Interfaces to NetWare	●	●	●	●
Macintosh connectivity ³	Optional	○	○	○
Offers network DDE	●	●	○	○
User interface				
Command line	●	●	●	●
Text-mode menu	●	●	●	●
Windows interface	●	●	●	●
Printing				
View print queue	●	●	●	●
Modify queue	●	●	●	●
Security				
Log-in time restrictions	●	●	●	●
Expiration dates	●	○	○	●
User groups	●	○	●	●
File-level passwords	●	○	○	○
Other features				
E-mail	●	●	○	●
Group scheduling	●	●	○	●
Fax software	●	●	○	○
SNMP agent	○	○	●	○
Remote access	●	●	○	Optional
Price per node	\$119	\$219.95 ⁴	\$99	\$99

¹ Windows automatically loads some drivers in extended memory.

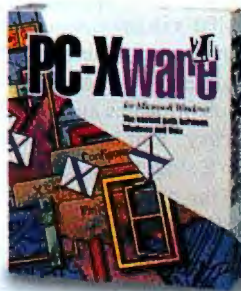
² Through an ODI-to-NDIS converter (shim).

³ Also available in Miramar Systems' Personal MacLAN Connect.

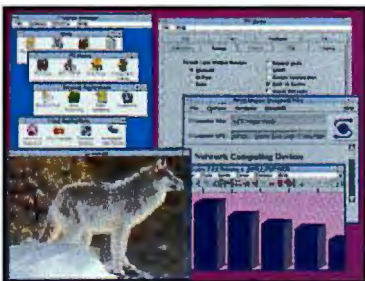
⁴ \$69.95, if upgrading from Windows 3.1.

● = yes; ○ = no

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A PowerLan workstation typically loads the NetBIOS, Redirector, and Server modules, along with the DOS SHARE program. You select other modules at installation time for printer sharing, disk caching, NetWare integration, and workstation remote control.

Without loading PowerLan into high memory, I had 537 KB of conventional RAM free. The SHARE program took 6 KB, the PowerLan NetBIOS took 42 KB, the Redirector took 15 KB, and the optional Server module took 21 KB—a total of 84 KB. (You don't need to load the Server module on a PC that won't act as a server on the LAN.) On a 386 or higher CPU, all of PowerLan can be loaded into high memory; I had 621 KB free for DOS applications in this configuration. Also, PowerServe, the dedicated server software, can use all the RAM in a computer to cache disk reads and writes.

I tested the ability of all four NOSes to recognize and respond to signals from a UPS. The PowerLan file server recognized such signals and performed a graceful shutdown before the UPS batteries ran out.

PowerLan's print queue manager lets you see what's in the queue and tells you when the printer is off-line or out of paper. Queue maintenance tasks, such as changing print job priorities and canceling print jobs, are easy. You can connect multiple printers to a single queue and make print jobs go to the printer that becomes available first. PowerLan can even display the target printer on a map of your office, so

that you don't have to remember where printer "HPIVsi" is located.

PowerLan offers a range of security options. You can assign passwords to shared printers, grant users read/write/create rights for disk drives and directories (but not individual files), dole out privileges to users that allow or restrict multiple concurrent server log-ins, and otherwise protect your data. Overall, PowerLan's security features are comparable to those of LANtastic and Personal NetWare, and superior to those of FWF.

The Final Judgment

Where peer access makes sense—in small, cost-conscious groups that need to share disks equally—peer LAN products provide good value. If you want performance, PowerLan is your likely choice. For tight Windows integration on machines that can run in 386 Enhanced mode, Windows for Workgroups is for you. Personal NetWare is especially good at providing peer access in a NetWare server-based environment. And you'd buy LANtastic if you wanted a full-featured peer LAN.

What's the best peer LAN operating system overall? For its combination of features, excellent Windows and NetWare integration, and small RAM footprint on client machines, LANtastic is the best of the four. ■

Barry Nance is a BYTE contributing editor and the author of Using OS/2 Warp 3.0 (Que, 1994) and Client/Server LAN Programming (Que, 1994). You can reach him on the Internet or BIX at barryn@bix.com.

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Visual Programming for Lotus Notes

Notes ViP adds significant new features to Lotus Notes, including visual programming, reporting and charting tools, and enhanced connectivity

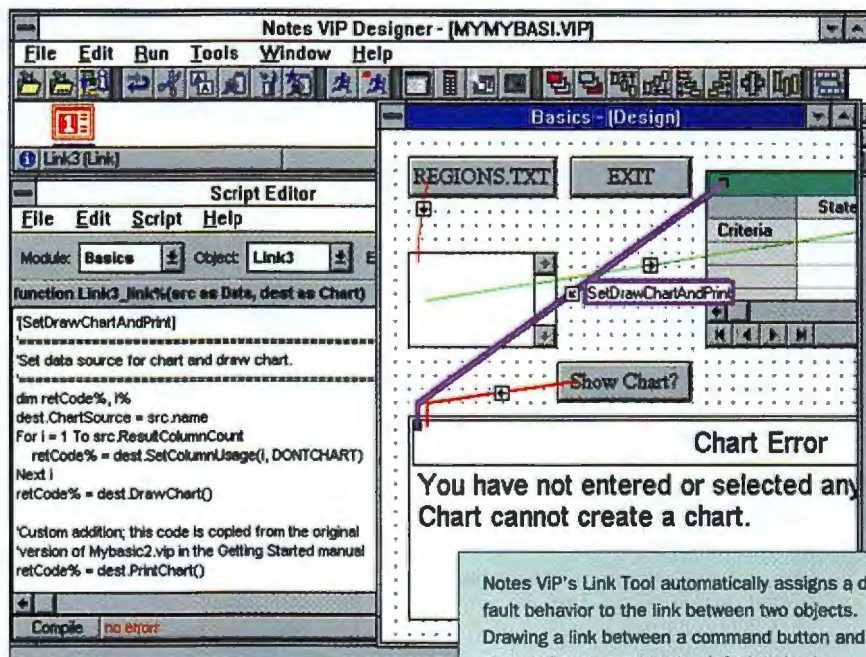
RICK DOBSON

Without a doubt, Lotus Notes has become a huge player in the groupware market. The extensibility of Lotus Notes makes it much more than simple conferencing and information-sharing software. In fact, the word *simple* is rarely used in the same sentence with Lotus Notes. Complexity, especially development complexity, has long been a common complaint about Notes. The lack of strong reporting and charting tools has been another perceived weakness. Lotus Development has addressed these specific problems with the release of Lotus Notes ViP (Visual Programmer). Similar in design and ease of use to Microsoft's Visual Basic, Notes ViP is differentiated by several distinctive touches that promote ease of use, programmability, and Notes compatibility.

Notes ViP delivers some essential capabilities sorely lacking in Lotus Notes. It more fully integrates Notes with corporate data sources, including legacy databases. It provides a BASIC-compatible visual programming environment and visual linking tools to speed and simplify applications development. And it includes reporting and charting components that provide richer output.

Essential ViP

Applications built with Notes ViP integrate seamlessly with Notes, inheriting all of Notes's rich groupware functionality, including full-text searching, replication, remote access to data, encryption support, and mail-enablement. Notes ViP links to Notes databases through the Notes API. The Notes ViP data object permits the reading of Notes forms and views. Notes ViP applications can also update Notes databases. The same data object that links Notes ViP to Notes database objects also ties it to legacy relational databases, such as Oracle, IBM DB2, IBM AS/400, SQL Server, dBase, and Paradox. Notes ViP readily links and joins Notes databases with tables from these products and other databases and spreadsheets. Notes ViP interfaces with non-Notes databases through Datalens and ODBC (Open Database Connectivity) drivers.



Notes ViP includes the Toolbox—just like Visual Basic—so applications developers can draw objects on a form or application window. A unique Link Tool makes it an easy matter to assign any of 85 precoded behaviors to pairs of objects in an application window. The updated LotusScript version 2, a BASIC-like language that will become Lotus's standard scripting language, lets developers customize precoded behaviors, as well as create new behaviors without a prior model. LotusScript even empowers visual programmers to create their own custom object classes instead of creating them in C++.

The Link Tool is one of Notes ViP's most distinctive features. Tying two objects together can be as simple as choosing the Link Tool in the Toolbox and then drawing a line from a source to a destination object. The Link Tool automatically assigns a default behavior to the link between the two objects. If you prefer to have a different precoded behavior between the two objects, you can select one from a list. As you highlight different behaviors, the Description text changes and new LotusScript code shows in the Script text box.

For example, if you draw a link between a command button and a chart object, Notes ViP automatically selects Draw-

Notes ViP's Link Tool automatically assigns a default behavior to the link between two objects. Drawing a link between a command button and a chart object generates the default behavior DrawChart. This precoded script redraws the chart whenever you click the button in the Run view. As you highlight different behaviors, the Description text changes and new LotusScript code shows in the Script text box.

Chart, its default behavior for the pair of objects. This precoded script redraws the chart whenever you click the button in the Run view.

If none of the precoded behaviors meet your requirements, you may be able to develop the needed code by slightly editing one of the standard links. You select the link, click the right mouse button, and choose Script Editor from the menu that appears. From here, you can edit the LotusScript code that controls the link's behavior.

The Link Tool offers benefits to both beginning and experienced applications developers. Novice developers will find it easy to automate applications by choosing precoded scripts from a list. Advanced developers will find the Link Tool a help in building rough prototypes during visits to clients.

Developing with LotusScript 2

LotusScript, which Lotus originally introduced with Improv, was extended with the

Building Notes ViP Objects

Code illustrating how to define classes with LotusScript. The code also reveals how to create and use objects that put the class definition to work in an application. The CLASS...END statement defines the class. DIM or SET statements in association with the NEW keyword create objects from class definitions. After an application creates an object for a class, it can use the object, manipulate its properties, and perform tasks with its methods.

```
CLASS Customer
  PUBLIC Name AS STRING
  PUBLIC Address AS STRING
  PUBLIC Balance AS CURRENCY
  SUB CheckOverdue
    'Send an overdue letter
    IF Balance > 0 THEN
      PRINT "Overdue balance:"
    END IF
  END SUB
END CLASS

DIM X AS NEW Customer
'This is a legal statement,
'because Name is PUBLIC.
X.Name = "McGraw-Hill, Inc."
'Balance is PUBLIC.
X.Balance = 2000.00

DIM B AS CURRENCY
'Assigns the value of the PUBLIC data
'member Balance to the variable B
B = X.Balance
'Prints Overdue balance:
X.CheckOverdue
'Prints amount of balance for object X
PRINT B
```

Class Inheritance

Classes can inherit properties and methods from each other. The AS keyword on the CLASS line references the base class. Here, the AS keyword references the Customer class (from the listing "Building Notes ViP Objects") when it starts the definition of NewCustomer. The DIM...AS NEW combination passes the properties and methods from the base class through to the object as long as the derived class definition does not override them.

```
CLASS NewCustomer AS Customer
  SUB CheckOverdue
    IF Balance > 25000 THEN
      PRINT "No further shipments"
      PRINT "until a payment of:"
    ELSE
      PRINT "Please pay your bill of:"
    ENDIF
  END SUB
END CLASS

DIM X AS NEW NewCustomer
X.Name = "McGraw-Hill, Inc."
X.Balance = 2000.00
'Prints Please pay your bill of:
X.CheckOverdue
PRINT X.Balance
X.Balance = 25001.00
'Prints No further shipments until a payment of:
X.CheckOverdue
PRINT X.Balance
```

plications by creating instances of them. These instances are called *objects*. Data members function

the CheckOverdue method of the X object. The Notes ViP code segment's final line prints X's Balance property.

release of Notes ViP. Lotus plans to further refine and enhance LotusScript as it becomes the common macro programming language for its SmartSuite in 1995 and beyond. In release 2 of LotusScript, Lotus adds new features that are not available with other visual programmers, such as Visual Basic.

One of the most innovative features in LotusScript is its ability to code custom classes and then create objects based on these class definitions. Other visual programmers reserve this functionality for C++ coders. Classes created with LotusScript function exactly as those defined with C++.

Notes ViP allows you to define classes with the Class...End Class statement. Classes can contain data and subroutine members. You use Public and Private statements to declare data members. A Public declaration makes a data item available outside the class definition. Data members are private by default. You define subroutine members with Sub...End Sub statements.

Notes ViP developers use classes in ap-

like object properties. Sub members operate like object methods. Classes and objects are contained within the module in which you define them.

Use the DIM or SET statements in association with the NEW keyword to create objects from class definitions. After an application creates an object for a class, it can use the object, manipulate its properties, and perform tasks with its methods.

The LotusScript example (see the listing "Building Notes ViP Objects") demonstrates how to use an object's methods and properties to print a message about the object. The script starts by creating a class named Customer, containing three Public data members plus a Sub member. The DIM statement with NEW keyword creates an instance of the class as the object named X. The next line sets the Name data member to McGraw-Hill. Then, X's Balance data member is set to 2000. Both Name and Balance function as properties of X. The next two lines of code reserve memory for a variable named B and store X's Balance property in it. The next-to-last line invokes

Class Inheritance

Classes can inherit properties and methods from each other. Notes ViP calls the class inheriting properties and methods a *derived* class. Base classes serve as models for one or more other derived classes. Properties and methods in the derived classes can override definitions in their base classes. Add the AS keyword to the CLASS line in the derived class definition to reference a base class.

The second LotusScript example (see the listing "Class Inheritance") overrides the CheckOverdue method in Customer with a new method defined in NewCustomer. Notice how the AS keyword references the Customer class (from the listing "Building Notes ViP Objects") when it starts the definition of NewCustomer. However, the Name, Address, and Balance properties carry over as is from Customer to NewCustomer.

Notes ViP creates objects from derived classes in the same way that it does from base classes. For example, when you use the DIM...AS NEW combination with the derived class name, properties and methods from the base class pass to the object as

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Visual Programming for Notes

Lotus	Microsoft	Advantage
Tightest possible integration with Notes	Good integration with Notes	Lotus
Link Tool	No linking tool	Lotus
Has Notes in product category	Does not have Notes-style product yet; Microsoft Exchange is in development	Lotus
No VBXes or OCXes; plan future support for VBXes and OCXes	Many VBXes; OCXes on the way	Microsoft
Developers must learn a variant of Visual Basic	Large pool of experienced Visual Basic programmers	Microsoft
20 objects	Hundreds of objects from Visual Basic, Visual Basic for Applications, and Access Basic	Microsoft
Single-company support	Requires support from more than one company	Lotus
Must distribute run-time version for rollouts	Can distribute .EXE files for rollouts	Microsoft
Custom class and object definition	C++ required for class definitions	Lotus
Designer tools	No designer tools	Lotus

long as the derived class definition does not override them.

The listing "Class Inheritance" uses the Name and Balance properties from Customer when working with an object based on NewCustomer. The CheckOverdue method from NewCustomer will print one of two messages depending on the value of the Balance property. The code segment generates both messages by invoking the

method with a value less than \$25,000 and then a second time with a value greater than \$25,000. The original CheckOverdue method in Customer would have printed the same message in both cases.

Notes Programming Alternatives

Although Notes VIP represents a powerful, full-featured way to develop graphical access to Notes databases and legacy data-

bases, a growing number of alternatives include Lotus's own Notes ODBC driver. In addition, Lotus publishes the Notes API so third-party firms can develop other integration tools.

Edge Research (a Portsmouth, New Hampshire, company that was recently purchased by Lotus and is now a wholly owned subsidiary) offers a rich set of tools for linking to Notes databases via the Notes API. These include the HiTest API, htVisual, and htGlue. The HiTest API is a C-language API that radically simplifies use of the Notes API. The other two tools rely on the HiTest

API to provide access to Notes databases from Visual Basic, Visual Basic for Applications, and LotusScript. (Edge Research posted a free sample application on CompuServe that allows Excel 5 users to link to Notes databases. It is in the Lotus Communications forum under the name XLSAMP.ZIP.)

Among the most widely known alternatives to Notes VIP is VB/Link for Lotus

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Notes from Brainstorm Technologies (Cambridge, MA). VB/Link relies on Notes API calls for the most part, but it also has additional linking techniques. Release 1.0 offers a VBX (Visual Basic custom control) that lets Visual Basic programmers link to Notes databases and develop a results set query. You can also link the results set to Visual Basic 3 data dynasets. Release 2.0 of VB/Link adds two new controls for processing rich text fields and hierarchical views.

The Lotus ODBC driver for Notes is important, because nearly all the major database managers support ODBC linking to other databases. You just add the Notes driver, set up a data source, and then attach and import Notes views and forms from the database designated in the ODBC link.

Lotus's database manager, Approach 3, uses Notes API calls rather than the

ODBC driver to connect to Notes databases. This provides a richer interface with Notes databases than is possible with the ODBC driver.

With solutions already available for accessing Notes data, developers may concentrate on OCXes (OLE custom controls) that will link to Lotus Notes. This strategy will give them a portable-component architecture and a mechanism for linking to both Lotus Notes and Microsoft Exchange, Microsoft's planned solution for group communication and information management.

About the Product

Lotus Notes ViP\$995
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A Leap Forward for Notes

Lotus offers a free run-time version of Notes ViP to all licensed Notes clients. The run-time version lets Notes clients run Notes ViP applications without letting them edit the applications. The only other way that you can run applications devel-

oped with Notes ViP is to purchase the full developer's version. If you use this version, code can be distributed in a locked file with a .VIL file extension, instead of the standard NOTES VIP. Because you cannot edit locked files, developers need to preserve unlocked versions of locked applications for maintenance.

With the release of Lotus Notes ViP and other products that link to Notes, developers have exciting, new opportunities to enrich their applications. The gaps in the Lotus groupware strategy are now being filled by Lotus and by solutions coming from third parties. It is now a straightforward process to mix Notes data with that of other database managers, which represents real progress in the world of Notes development. ■

Rick Dobson, Ph.D., is a consultant and writer who lives in Louisville, Kentucky. He has authored titles for Que Books on subjects that include macro programming and optimization techniques for Lotus 1-2-3, as well as numerous articles for the computer press. You can reach him on CompuServe at 71172,57 or on the Internet at 71172.57@compuserve.com.

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Speedy Data Delivery

Micropolis's high-capacity AV drives deliver uninterrupted data transfer to match the needs of serious audio and video developers

STAN MIASTKOWSKI

The worlds of computers and serious audio/video are fast converging, and the range of applications is wide. Computers are being used to produce corporate videos, audiotapes, and computer-specific multimedia applications and presentations on CD-ROMs. With the emergence and predominance of ever more powerful RISC and CISC processors, that trend will continue to grow.

But there's a problem on the way to this multimedia nirvana. Many of today's hard drives just aren't designed for the stringent requirements of audio and video processing. Micropolis has an answer to these and other problems: a line of SCSI-2 drives specifically designed for the needs of digital media production.

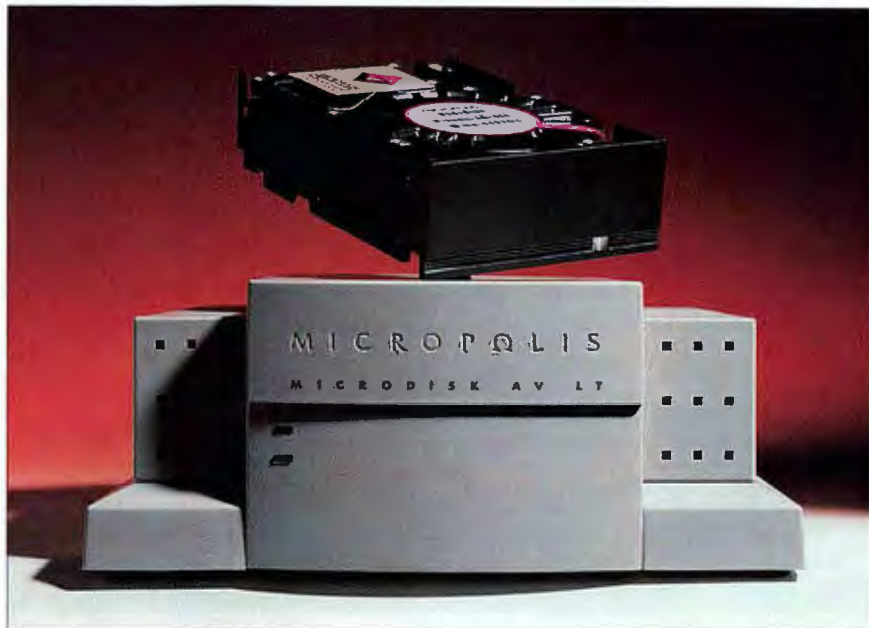
The Micropolis AV drive line is available in both internal and external versions, in three sizes ranging from 1.69 to 9 GB. The external versions feature a clever stackable design that lets you fabricate arrays of many gigabytes. I tested the LT 1700AV, the external version of the 1.69-GB 2217AV drive.

Certainly high-capacity, quick-access, and fast-throughput SCSI hard drives offer many advantages, but most are designed for the requirements of data processing (e.g., word processing, database management, and networking). Applications of these types read and write small chunks of data that tend to be scattered randomly across a disk. Consequently, most drives are optimized for this type of data handling.

Various housekeeping functions, such as error recovery, thermal calibration, and head degaussing, are going on while data is being transferred to and from the disk. These cause regular pauses in the data flow, ranging anywhere from 10 to nearly 1000 ms. That's no problem for garden-variety applications, but it won't do for digital multimedia—it causes dropped video frames, audible pauses, or even full-fledged application crashes.

Like Tape

To understand the hard drive requirements of multimedia, it's helpful to use a tape



Micropolis's AV drives come in both internal and external versions, with capacities ranging from 1.69 to 9 GB. External modules can be stacked to create larger arrays.

analogy. Files on both audiotape and videotape (either analog or digital) are organized as large and continuous blocks of data. The tape-recording and playback process delivers large amounts of data as a continuous flow. The structure of multimedia files is much the same.

There are three interrelated parts to multimedia hard drive requirements: storage capacity, data throughput, and lack of data-flow interruptions. The first is the reason that the AV drives start at capacities of 1.69 GB and go upward from there. Storage requirements for video vary depending on the compression method used and the resolution. For example, at the bottom end, an AVI (Audio Video Interleave) file uses about 8 MB per minute of running time; MPEG compression uses about 12 MB per minute. At the other end of the spectrum, full-frame, uncompressed, interlaced NTSC video gobbles 1.6 GB per minute. (This causes other problems: SCSI-2 can't handle that type of throughput.)

The audio side has similar problems, especially since professional audio is usually stored uncompressed. CD-quality stereo sound (16 bits, 44.1-kHz sampling rate) requires about 9 MB per minute of

storage. Specialized 24-track hard disk recorders, used by some professional recording studios, use nearly 2 MB of storage space per second.

Data throughput is, of course, directly related to storage requirements. If 1 second of high-quality compressed video requires, for example, 2 MB of storage, it needs to be delivered through the pipeline (either reading or writing) at exactly the same rate. That's not a problem for SCSI-2, which theoretically maxes out at 10 MBps (Fast 8-bit SCSI). But the bus that your SCSI adapter is connected to is also a factor. ISA certainly won't cut it, but PCI (Peripheral Component Interconnect) and the new Power Macs can hit full SCSI-2 speed.

The final, and crucial, part of making a drive truly multimedia-compatible is making sure the flow of data from the drive is completely uninterrupted. As mentioned above, when laying down a finished video to tape, dropped frames or even short-duration pauses in audio are unforgivable in a professional production environment. It's also a problem in CD-ROM recording, where any data pause makes the disc useless (and costs money). *continued*

No Interruptions, Please

For professional audio and video work, any gaps in data flowing from the hard drive can cause dropped video frames, jerky motion, annoying sound pauses, or even software crashes. A pause in writing a recordable CD-ROM renders the disc useless. In its AV line, Micropolis uses a variety of tricks and technologies—some proprietary, some not—to guarantee an uninterrupted data flow. Most recent hard drives use some of these techniques for performance reasons. All are necessary for smooth, fast data flow.

• Caching

Micropolis AV drives have an unusually large (512-KB) on-board cache for buffering data.

• Error Correction

Many hard drives attempt to reread misread data, causing pauses of up to 850 ms. Micropolis AV drives couple a large cache with intelligent error-correcting firmware that attempts error correction on the fly. It eliminates extra revolutions other drives use in the error-correction process. The company says hardware-based error correction will be incorporated in future versions of AV drives.

• Thermal Calibration

All hard drive platters expand and contract with temperature changes depending on how heavily they're used and how much the ambient air temperatures vary. Thermal calibration (TCal) adjusts the read/write heads using servo information. Non-AV drives typically do this as a timed event, usually every 10 minutes or so. This can take up to 40 ms.

Micropolis AV drives calibrate only one head at a time and never while a read or write is in progress. In addition, Micropolis AV TCal attempts to wait until the internal cache is full.

• Rotational Speed

Micropolis AV drives spin at 5400 rpm, versus 3600 rpm for older hard drives. The faster the platters spin, the faster the data can be retrieved (although this requires sophisticated electronics).

• Head Degaussing

The thin-film head technology used in the AV drives (and used by other manufacturers in some drives) has a tendency to become randomly magnetized. This increases the signal-to-noise ratio of the data and requires extra error correction. Degaussing the heads requires writing to dedicated areas of the disk that aren't used for normal data storage. Non-AV drives put this area on the edge of the platters. Micropolis scatters these areas throughout the platters for minimum overhead.

bit recording) scheme, where outer data tracks hold more data sectors than inner tracks; this is also true of the Micropolis AV drives. As Avitest moves from the outer tracks, where more data is accessed with each revolution, to the inner tracks, the maximum response time increases.

BYTE tested the 2217AV in a Zeos 60-MHz Pentium system using Adaptec's AHA-2940, a PCI-bus SCSI-2 card with a maximum SCSI throughput of 10 MBps (Fast 8-bit SCSI). The drive did not meet the expectations created by Micropolis's marketing material. With a large block size of 230 KB, the maximum guaranteed throughput after a single read-through of the drive was around 2.1 MBps. During that test, maximum response time rose from 98 ms at the start to 112 ms at the end—a surprisingly modest climb. Tested throughput dropped, as expected, with smaller block sizes. A block size of 87 KB reduced guaranteed throughput to 1.8 MBps.

To see how well a drive handles soft errors, Avitest can run repeatedly for several hours. Extending the test time to 5 hours with the 2217AV turned up occasional response times that decreased guaranteed throughput to 1.6 MBps with 230-KB blocks. In other words, a 230-KB block would occasionally take as long as 145 ms to read, probably due to soft errors.

Avitest also gives an average throughput for reading the whole drive. It measured average sustained throughput for the 2217AV at a respectable 2.7 MBps. This is a conservative measure derived by dividing the amount of storage on the drive by the time it takes to read the drive from beginning to end. Talks with the vendor indicated that Micropolis's testing worked more closely with the hardware than did BYTE's testing. The Avitest approach is, however, reasonable from an application's point of view.

While the 2217AV didn't meet its maker's claims, according to BYTE's throughput testing, it should come close with the drive caching provided by most operating systems and by many multimedia applications. Even the drive's longest delays are not very long. With reasonable caching, the 2.7-MBps average throughput measured by Avitest is probably a better measure of throughput for multimedia applications. ■

Stan Miaszkowski is a BYTE consulting editor based in Peterborough, New Hampshire. He has been writing about computer technology for over 16 years. You can contact him on MCI Mail at 530-9979 or on the Internet or BIX at stannm@bix.com.

Psyched Out

Some psychological factors come into play here, too. Your eye can "forgive" an occasional dropped frame (common when playing AVI files off a CD-ROM), though pauses in the action or jerky motion are plain annoying. Audio has more severe problems. Human ears can detect even the smallest pause or dropout in audio.

Most hard drives have a cache that buffers the data flow, but it's usually small because of the small files that data-processing drives normally handle and because of cost. You can help it along with a sizable RAM cache (using Microsoft SmartDrive or a third-party product), but even the largest cache isn't much help with multimedia files that can be hundreds of megabytes in size. To keep the data flowing, Micropolis uses a combination of methods (see the text box "No Interruptions, Please").

Micropolis claims that, thanks to these

performance enhancements, its 2217AV drive can deliver a guaranteed 2.9 MBps of uninterrupted data flow and, from the outer zones of the drive, sustained throughput as high as 4.3 MBps. A 2.9-MBps throughput rate is enough to smoothly supply 24-

bit, 640- by 480-pixel video compressed at a relatively conservative 10-to-1 ratio.

Measuring Results

BYTE's Avitest benchmark was written specifically to test guaranteed data rate. It reads a SCSI drive sequentially from the first data block to the last, measuring how long it takes to deliver each chunk of data and keeping track of the maximum response time. Avitest controls the SCSI drive fairly directly using ASPI (advanced SCSI

programming interface) calls. You can set the block size for the reads. Dividing that read block size by the maximum response time yields the maximum guaranteed data rate. Most modern drives use a ZBR (zone-

About the Product

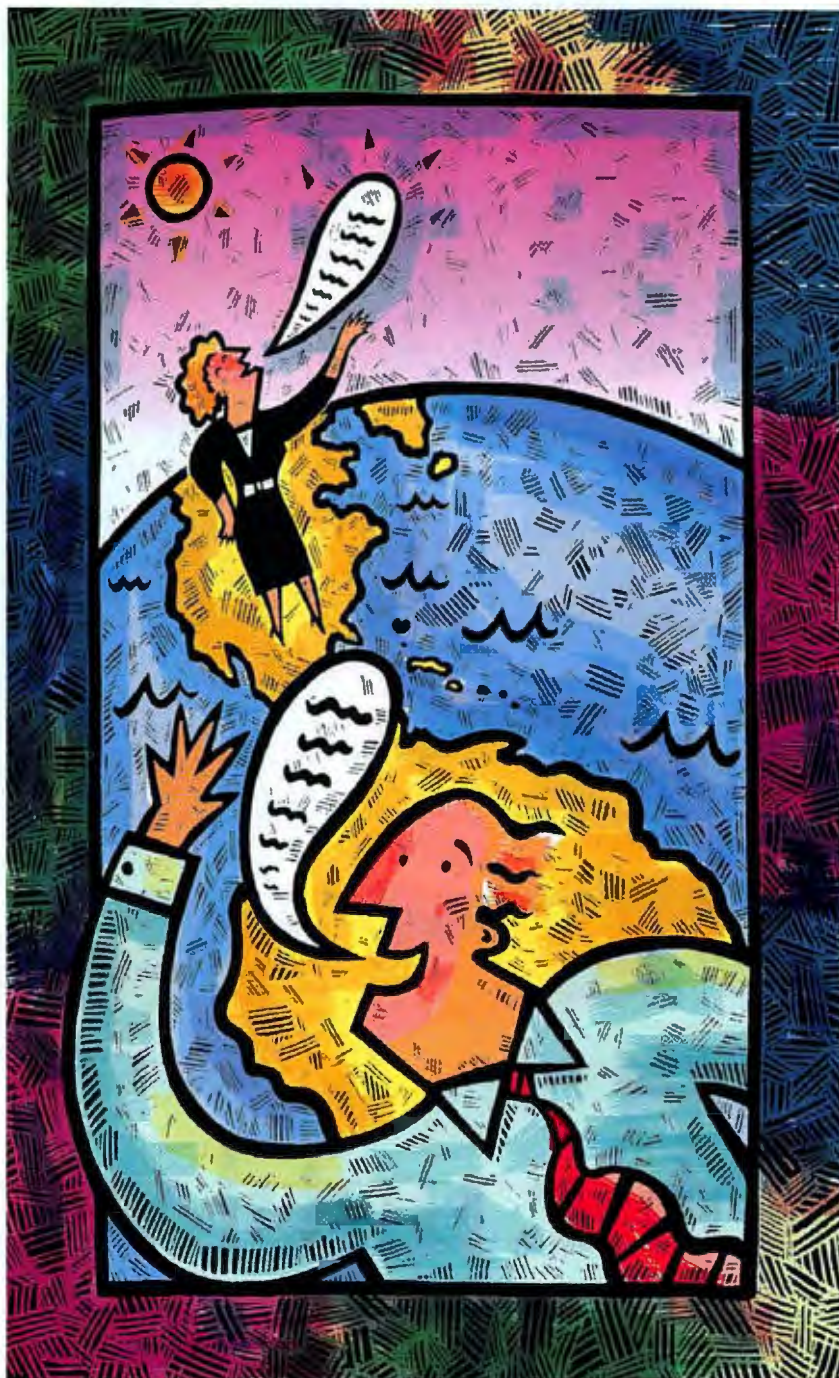
Micropolis AV Drives

Internal: 4110AV (3 $\frac{1}{2}$ -inch, 1-inch high, 1.01-GB), \$1110;
2217AV (3 $\frac{1}{2}$ -inch, 1.69-GB), \$1590;
4221AV (3 $\frac{1}{2}$ -inch, 2.1-GB), \$2410;
3243AV (3 $\frac{1}{2}$ -inch, 4.3-GB), \$3895;
1936AV (5 $\frac{1}{4}$ -inch, 3-GB), \$3410;
1991AV (5 $\frac{1}{4}$ -inch, 9-GB), \$5845.
External: LT 1700AV (1.69-GB), \$2075; LT 2100AV (2.1-GB), \$2865; LS 3020AV (3.02-GB), \$3955; LT 4300AV (4.3-GB), \$4350; LS 9100AV (9-GB), \$6295.

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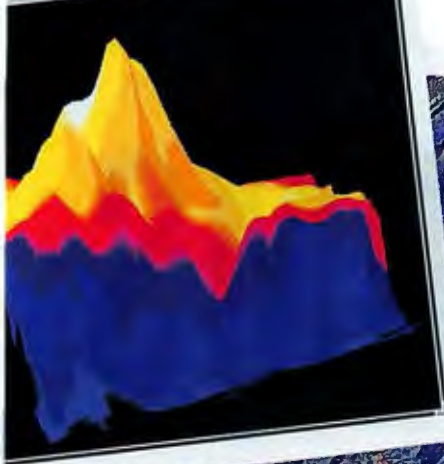


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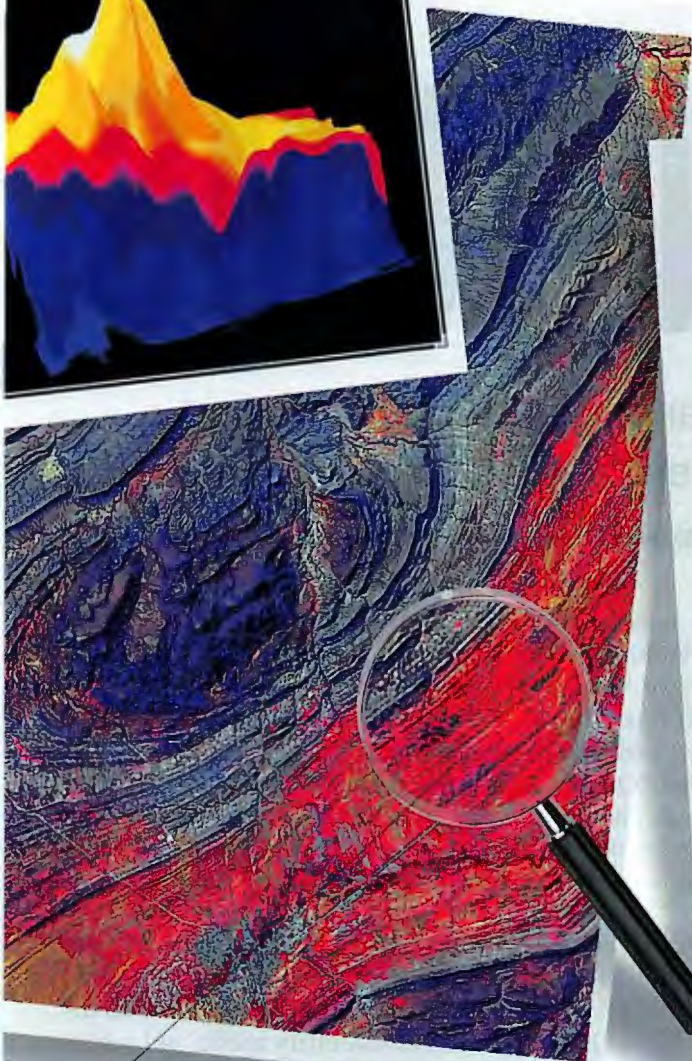


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19 PENTIUMS

We evaluate 19 high-performance Pentiums for speed, usability, expandability, features, and price

CHANDRIKA MYSORE AND JOHN MCDONOUGH

The market for 90-MHz Pentium systems is becoming extremely competitive as power users clamor for more speed, especially for server-based applications. This month, we evaluate 19 systems equipped with Intel's Pentium processor. One system from Xi Computer arrived with dual processors, ready for testing (see the text box "The Dual-Processor Pentium" on page 204).

The systems flew through the Windows and DOS application tests. But the bad news is that we ran into a few problems running Unix and SQL Server-based benchmarks. Our attempts to run Unix sometimes ended in frustration, because three new systems had state-of-the-art video cards that did not yet offer Unix drivers for SCO Unix (see the report on the best Pentiums for Unix on page 203). Only nine of the 19 systems we tested completed our SQL Server workout, due to disk I/O errors (see "90-MHz Pentiums as SQL Servers" on page 194).

Since last summer, prices have dropped over a thousand dollars on these high-end Intel systems, thanks in part, to competition from Motorola's PowerPC and to Intel's own triple-speed DX4 chip. All the systems in this review offer more than just a fast processor. We asked for 32 MB of memory, large hard drives from 1 to 2.5 GB, high-end video cards with at least 1 MB of RAM, 256 KB of secondary cache, and a double-speed or faster CD-ROM drive. They each have at least one PCI (Peripheral Component Interconnect) or VL-Bus slot and at least one shared local-bus slot with either an ISA or EISA bus design. And for those systems that are not sold through mail-order businesses, street prices are considerably lower than those listed here. In addition, although we standardized on a high-end configuration, for many purposes, half

How to use this guide

To find the best Pentium system for your needs, follow the main headings until you come to the category that most closely matches yours. Then look at the descriptions of the


winners and runners-up in Best Overall, Most Expandable, or Low Cost categories to find an appropriate system.

List prices are for the as-tested configuration. All the systems had 32 MB of RAM and a hard drive with a minimum capacity of 1 GB, a double-speed or faster CD-ROM drive, and a 15-inch color monitor.

Speed scores are based on tests appropriate to each rating category. Higher scores indicate faster performance.

BEST OVERALL AST Computer Premium GX P/90

At \$6200, AST's Premium GX P/90 is the second most costly Pentium system, and it performs near the top in both the DOS and Windows benchmarks. It also displays an interesting spin on superstation design: this desktop system (along with Zenith Data Systems' Z-Station EX) provides expansion slots on a card positioned perpendicular to the motherboard; when installed, the expansion cards are parallel to the motherboard. The desktop Pentium has a SCSI hard drive and six available expansion slots, and it comes with a three-year warranty. On the downside, it performed poorly in the Unix tests but we did not consider Unix scores in judging this category. It also has an integrated Ethernet port.



SYSTEM	PRICE (\$1000)	PRICE (\$1000)	PERFORMANCE (WIN95)	PERFORMANCE (DOS)	SCORE OF 100	PERFORMANCE (DOS)	SCORE OF 100	SCORE (DOS/UNIX)	SCORE (DOS/UNIX)	SCORE (DOS/UNIX)	SCORE (DOS/UNIX)
AST Premium GX P/90	\$6200	92.00	9.25	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA
AST Premium GX P/90	\$4777	10.00	9.27	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA
Digital DC Cpc XL100	\$5672	9.47	9.92	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA
AT&T Globalnet 600	\$6214	9.70	9.71	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA
Cine Design Desktop 200	\$5045	9.71	9.88	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA
Zenith Data Systems EX	\$3995	9.72	9.93	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA

Ease-of-use scores indicate how easy it is to configure and upgrade a system, as well as the quality of the documentation.

Features scores reflect the presence of key elements for expandability, flexibility, and reliability. Higher scores indicate greater capabilities.

AT 90 MHz

Inside a High-End Pentium System

POWER SUPPLY

Many of today's power supplies accept variable AC input, from 90 to 240 V, a convenient feature for international use. Having the proper combination of components and power is something a reputable system manufacturer should provide. As a consumer, you may need to take that on faith; Typical ratings for power supplies are between 200 and 300 W.

PCI SLOTS

At 33 MHz, a PCI local bus is more than four times faster than an ISA or EISA bus. It also offers high bandwidth and auto-configuration, and it is processor-independent.

VL-BUS SLOTS

Adapters using the 32-bit VL-Bus can run at speeds of up to 40 MHz. Systems that offer ISA, VL-Bus, and PCI buses are not typical. If you have an investment in VL-Bus and want to capitalize on PCI as well, a system with both types of slots is highly desirable.

DRIVE BAYS

Empty drive bays accessible from the outside are necessary for adding any type of removable media. This system has five accessible full-height drive bays and four inaccessible ones that are suitable for hard drives.

SIMM BANKS

If you plan to run intense graphics or multimedia, you'll need plenty of RAM. All the systems tested accept at least 128 MB of RAM.

CPU

Pentium chips are usually hidden by large heat sinks and fans, which are necessary to keep the CPU running at a cool temperature. Some CPUs even have thermostats connected to alarms. In most cases, if the system is designed to house a Pentium chip, secondary fans and alarms are not needed.



the RAM and disk space would suffice, increasing your savings even more.

To identify today's top Pentium performers, we rank systems in three categories: General Business, where we consider Pentiums for general-purpose DOS and Windows applications; CAD and Graphics, for ranking systems based on Windows, X Window System, and graphics components of various test suites; and Unix,

where we run those systems that support SCO Unix through SPEC tests, BYTE's Unix tests, and NSTL's Intermark test suite. In each category, we use an array of low-level and application tests that give a real-world basis for comparing the performance differences among the systems. In addition, to arrive at winners, we combine these numerical test results with hands-on evaluation of features and ease of use.

GENERAL BUSINESS (DOS AND WINDOWS)

AST Computer Premmia GX P/90

This EISA-based desktop performed near the top in both the DOS and Windows benchmarks, and it registered the best features score of all the Pentiums we tested. The Premmia GX P/90 has a SCSI hard drive, six available expansion slots, and comes with a three-year warranty.

PAGE 195

CAD AND GRAPHICS

Digital Equipment DECpc XL590

Several factors make the DECpc XL590 a strong CAD/graphics workstation. It ranked third in DOS performance and scored above average in Windows and X Window System tests. Digital's \$5672 PCI Pentium posted an excellent score for its ease of use and feature set. The standard Diamond Stealth 64-bit video card delivers snappy graphics performance.

PAGE 201

UNIX

Digital Equipment DECpc XL590

The DECpc XL590 completed all the Unix tests admirably, but its design is what really set it apart in this category. The mini-tower stocks three ISA slots, three PCI slots (one shared), five drive bays, six SIMM slots (for a maximum of 192 MB of RAM), as well as on-board SCSI and I/O ports. Because the CPU is on a card, upgrading the processor is easy.

PAGE 203

GENERAL BUSINESS

You might think that buying a 90-MHz Pentium for everyday business tasks such as spreadsheet calculations or word processing is overkill. But the prices of 90-MHz P54C Pentiums are dropping so fast that you might consider getting one to scream through your Windows and DOS applications.

Most vendors chose a tower chassis design for their 90-MHz Pentiums, an intelligent approach that provides room for expansion and better ventilation and heat dissipation. In all, we tested 11 tower systems, three mini-towers, and five desktop systems. Some of the tower systems, such as the Zeos International Pantera 90 and the Austin Power System 90, have exceptionally good internal design: The power supply, drive bays, and CD-ROM drive are in the top half of the tower, and the CPU and expansion slots occupy the bottom half. These systems make it easy to install and remove expansion cards. Other designs (e.g., the Xi Computer XiP90 MTower SP and Gateway 2000 P5-90 XL) have congestion problems, because drive bays and SIMM banks block the expansion slots. These blocked slots cannot be used for full-length adapters. Several systems are dual-processor-ready, with an

empty socket available for a second Pentium chip.

The vast majority of systems include PCI video cards; the most widely used video card was the PCI Diamond Stealth 64, and it performed extremely well in accelerating Windows performance. Two systems (the AT&T Globalyst 600 and the Zenith Data Systems Z-Station EX) have on-board video. The High Definition Systems Victoria PCI 90MHZ was the only system to ship with an ISA-based video card. Predictably, this system finished last in our graphics-dominated Windows tests.

The PCI bus runs at 33 MHz, significantly faster than the 8-MHz speed of the EISA or ISA bus. The PCI local bus not only provides a speed advantage over EISA and ISA, but it has the flexibility to permit enabling or disabling components from the CMOS setup. It also supports 32- and 64-bit data paths, as well as bus mastering. The Dyna Micro Dyna System 590, the Hertz P90, and the Mitsuba VIP System-90MHZ supported both VL-Bus and PCI local bus. Only two systems utilize the EISA bus architecture (the AST Computer Premia GX P/90 and the dual-processor Xi Computer XiP90 NTower DP). The others are ISA-based.

90-MHZ PENTIUMS AS SQL SERVERS

Harnessing the power of a 90-MHz Pentium for SQL Server applications seems like a good idea, but during testing, we were plagued with incompatibility problems—both when installing Windows NT 3.1 and building the SQL Server for NT 4.21 database. Only nine of the 19 Pentiums we tested as NT-based database servers successfully completed our SQL Server testing.

Installing NT successfully sometimes took two or three attempts, and one system could not install NT at all, because of BIOS incompatibilities between the Pentium's firmware and the operating system. After clearing the NT hurdle, three systems failed to build the SQL Server database, and six systems could not complete the tests after successfully building the database.

We tested the survivors

in a network of 16 workstations connected via an ISA Ethernet network card from 3Com. We began the tests with four workstations, and after 20 minutes, we added four more workstation clients, working until reaching a total of 16 clients. Of the six systems that could not complete the tests, some failed with four and others with 12 or 16 workstations (table scores indicate transactions per second). We used a Microsoft hard-

ware-stress utility to help identify where and why the systems failed.

These Pentiums show promise as SQL Servers, but the inherent incompatibilities of new technologies make a move in this direction premature. We advise waiting a few months until incompatibility problems disappear before jumping on the 90-MHz SQL Server bandwagon. Otherwise, you could spend many hours on the phone with technical support.

PERFORMANCE OF SQL SERVER TESTS

VENDOR	MODEL	PRICE (AS TESTED)	NUMBER OF WORKSTATIONS				HARD DRIVE	
			4	8	12	16	MANUFACTURER	INTERFACE
AT&T GIS	AT&T Globalyst 600	\$6214	0.78	1.04	1.03	1.05	Quantum	SCSI
Cornell Computer Systems	PCI Power Workstation	\$4075	0.74	0.98	0.91	0.93	Micropolis	SCSI
Data Storage Marketing, Inc.	DataStor P590	\$5845	0.88	1.23	1.21	1.21	Seagate	SCSI
Digital Equipment Corp.	DECpc XL590	\$5672	0.79	1.01	1.02	0.98	Digital	SCSI
Duracom Computer Systems, Inc.	FilePro 586/90P-32	\$5499	0.75	0.93	0.87	0.93	Micropolis	SCSI
Dyna Micro, Inc.	Dyna System 590	\$4075	0.71	0.87	0.89	0.84	Seagate	SCSI
Mitsuba Corp.	VIP System-90MHZ	\$3990	0.69	0.82	0.81	0.80	Quantum	SCSI
Xi Computer Corp.	XiP90 MTower SP	\$3999	0.76	1.05	1.03	1.03	Conner	IDE
Xi Computer Corp.	XiP90 NTower DP	\$4549	0.76	0.92	0.98	0.93	Quantum	SCSI

Our 1-GB storage requirement prompted 11 of the vendors to supply a fast SCSI hard drive. The remaining were equipped with IDE drives. The enhanced IDE standard expands capacities beyond its traditional 528-MB limit and when combined with a local-bus interface, boosts the data throughput rate to 11.1 MBps.

Although the AST Computer Premmia GX P/90 took top honors in our Best Overall ranking, other Pentiums made strong showings. Priced at \$3995, the Zeos International Pantera 90 deserves to be mentioned (it costs about \$2300 less than the Premmia) because it is relatively affordable and comes with a Diamond Stealth video card and five 16-bit slots, supporting 384 MB of system RAM. The lower price, however, reflects the lack of a SCSI hard drive and a one-year warranty. The overall performance of the Austin Power System 90 came closest to the Best Overall winner, because of its excellent Windows score.

To arrive at features and expandability scores, we considered the maximum amount of RAM the system will hold, flash

ROM, system and video ROM BIOS, the number of available expansion slots, the presence of available drive bays and SCSI ports, diagnostics, security locks, the warranty, and support and service.

These features were weighted equally for all the systems. Other features, including software and the UART (universal asynchronous receiver/transmitter) type, were weighted slightly higher. For ease-of-use rankings, we evaluated the documentation, technical support, and descriptions of the hardware specifications.



KEY	
Excellent ▲▲▲▲	Good ▲▲▲
Fair ▲▲	Poor ▲
Tower ■	Mini-tower □ Desktop ▢

BYTE BEST

GENERAL BUSINESS

The best Pentium for business applications...

BEST OVERALL

AST Computer Premmia GX P/90



At \$6288, AST's Premmia GX P/90 is the second most costly Pentium system, and it performs near the top in both the DOS and Windows benchmarks. It also displays an interesting spin on expansion-slot design;

this desktop system (along with Zenith Data Systems' Z-Station EX) provides expansion slots on a card positioned perpendicular to the motherboard; when installed, the expansion cards are parallel to the motherboard. The desktop Pentium has a SCSI hard drive and six available expansion slots, and it comes with a three-year warranty. On the downside, it performed poorly in the Unix tests but we did not consider Unix scores in judging this category. It also has an integrated Ethernet port.



		PRICE (AS TESTED)	CASE TYPE	PERFORMANCE WINDOWS DOS	EASE OF USE	FEATURES	BUSES	RAM (STD./MAX.)	DRIVE CONTROLLER	WARRANTY (YEARS)
BEST	AST Premmia GX P/90	\$6288	■	9.28 9.85	▲▲▲	▲▲▲▲	EISA, PCI	8/192	SCSI	3
RUNNER-UP	Austin Power System 90	\$4777	■	10.00 9.87	▲▲▲	▲▲▲	ISA, PCI	16/128	IDE	3
RUNNER-UP	Digital DECpc XL590	\$5672	□	9.47 9.92	▲▲▲▲	▲▲▲▲	ISA, PCI	0/192	SCSI	3
RUNNER-UP	AT&T Globalyst 600	\$6214	■	9.70 9.71	▲▲▲	▲▲▲▲	ISA, PCI	8/128	SCSI	3
RUNNER-UP	Data Storage DataStor P590	\$5845	■	9.71 9.88	▲▲▲	▲▲▲	ISA, PCI	16/128	PCI-SCSI	3
RUNNER-UP	Zeos Pantera 90	\$3995	■	9.72 9.93	▲▲▲	▲▲▲	ISA, PCI	1/384	IDE	1

When expandability is your primary concern...

MOST EXPANDABLE

Austin Direct Austin Power System 90



The Austin Power System 90 offers some of the best expandability features we have seen. The ISA system has a SCSI port, three 16-bit expansion slots, three PCI local-bus slots, and eight drive bays. The system we tested came with a Diamond Stealth 64 video card with 2 MB of VRAM and a 1-GB Micropolis IDE hard drive. It is also the best Windows performer of all the Pentiums that we put through their paces and finished near the top in both the Unix and DOS benchmarks. An additional bonus is free on-site service and a three-year warranty.

		PRICE (AS TESTED)	CASE TYPE	PERFORMANCE WINDOWS DOS	EASE OF USE	FEATURES	BUSES	TOTAL BAYS (3 1/2"/5 1/4")	ETHERNET/ SCSI PORT	RAM (STD./MAX.)
BEST	Austin Power System 90	\$4777	■	10.00 9.87	▲▲▲	▲▲▲	ISA, PCI	4/4	No/Yes	16/128
RUNNER-UP	Zeos Pantera 90	\$3995	■	9.72 9.93	▲▲▲	▲▲▲	ISA, PCI	4/6	No/No	1/384
RUNNER-UP	XIP90 NTower DP	\$4549	■	9.32 10.00	▲▲▲▲	▲▲▲	EISA, PCI	4/5	No/Yes	8/512
RUNNER-UP	Insight PCI P90 CD	\$4299	■	8.55 9.74	▲▲▲▲	▲▲▲	ISA, PCI	9/4	No/No	16/128
RUNNER-UP	Data Storage DataStor P590	\$5845	■	9.71 9.88	▲▲▲	▲▲▲	ISA, PCI	3/4	No/No	16/128

Need a 90-MHz Pentium at a reasonable price?

LOW COST

Hertz Computer Hertz P90



As testament that prices are dropping drastically, last August's winner, the 66-MHz Cornell Pentium Power Pak, won this category with a price of \$4295. This month's winner is the \$2830 Hertz P90. This was certainly not the fastest system we tested, but the price is remarkable. If faster Windows and DOS speed is essential, try the Zeos International Pantera 90 or the Gateway 2000 P5-90 XL.

		PRICE (AS TESTED)	CASE TYPE	PERFORMANCE WINDOWS DOS	EASE OF USE	FEATURES	BUSES	RAM (STD./MAX.)	DRIVE CONTROLLER	WARRANTY (YEARS)
BEST	Hertz P90	\$2830	■	8.01 8.54	▲▲	▲▲▲	ISA, PCI	8/128	PCI-SCSI	1
RUNNER-UP	Gateway P5-90 XL	\$3699	■	9.38 9.72	▲▲▲▲	▲▲▲	ISA, PCI	16/128	IDE	3
RUNNER-UP	Zeos Pantera 90	\$3995	■	9.72 9.93	▲▲▲	▲▲▲	ISA, PCI	1/384	IDE	1
RUNNER-UP	Insight PCI P90 CD	\$4299	■	8.55 9.74	▲▲▲▲	▲▲▲	ISA, PCI	16/128	IDE	1
RUNNER-UP	Cornell PCI Power Workstation	\$4075	■	9.24 9.71	▲▲	▲▲▲	ISA, PCI	32/128	PCI-SCSI	3

The ZEOS® Pantera™... "This Is As Good As It Gets."

—PC World Best Buy, August 1994

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There's no desktop system that comes close to the ZEOS Pantera in performance, reliability, and value. As *PC/Computing* said: "Rocket-fast performance and a great price make this our favorite Pentium of the lot."

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The ZEOS Pantera, based on Intel's 486 and Pentium processors, is breaking record after record with its supreme power and awesome performance.

"Mark a new high on the performance chart!" *PC World* said the

The ZEOS Pantera 66MHz and 90MHz also received the highest scores in all benchmark tests run by *Windows Sources*, and earned two Experts' Pick awards.

What makes the Pantera blow all others away? Superior engineering—starting with a ZEOS designed motherboard, created specifically to take full advantage of the latest technological advancements. The motherboard is stocked with exceptional features such as an on-board PCI Local Bus IDE Controller supporting up to four IDE devices. For the fastest video performance, we give you a Diamond Stealth 64-bit PCI video card with 1MB DRAM *standard*.

Valuable Extras

The Pantera is a first-rate example of ZEOS' commitment to provide you with an excellent value on an award-winning machine. With all the extras, options, and 100% compatibility with all major operating systems, you can't go wrong.

Many of our most popular money-saving Pantera packages are ready to ship *the same day you order*. We also give you the option to custom-design a system to your exact computing needs.

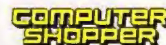
Either way, you can buy with confidence because of our on-going dedication to offer you high-quality features and state-of-the-art technology at an affordable price. As *PC/Computing* said: "...this is a deal you simply can't pass up."

Unequalled in performance, reliability and value, the ZEOS Pantera "is the ultimate Power Desktop." *PC World* added: "It's lightning fast, beautifully configured, and priced right." To get your best buy, call a ZEOS Systems Consultant today at 800-554-5226.

Pentium-66 and Pentium-90 Pantera PCs were "the fastest system(s) ever tested." *PC World* also awarded the Pantera DX4-100 a Power Best Buy in October after it outperformed all other DX4 machines, *and* was as fast as many Pentium PCs!



April 12, 1994
Pentium-66
June 28, 1994
DX4-100



April 1994
Pentium-60
August 1994
Pentium-90



January 1994
486DX2-66
February 1994
486DX2-66
March 1994
486DX2-66
June 1994
486DX2-66
June 1994
Pentium-66
July 1994
Pentium-66
August 1994
Pentium-66
August 1994
Pentium-90
September 1994
Pentium-66
September 1994
Pentium-90
October 1994
DX4-100
October 1994
Pentium-90
November 1994
DX4-100
November 1994
Pentium-90



May 1994
Pentium-66



June 1994
Pentium-66
August 1994
Pentium-90



March 1994
486DX2-66



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486 Extras:

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Additional processors available. Call today for details.

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486DX-33	\$1495	486DX-33	\$1795	486DX-33	\$2295	486DX-33	\$2795
486DX2-50	\$1495	486DX2-50	\$1795	486DX2-50	\$2295	486DX2-50	\$2795
486DX2-66	\$1545	486DX2-66	\$1845	486DX2-66	\$2345	486DX2-66	\$2845
Pentium-60	\$1845	Pentium-60	\$2145	Pentium-60	\$2645	Pentium-60	\$3145
Pentium-66	\$1995	Pentium-66	\$2295	Pentium-66	\$2795	Pentium-66	\$3295
Pentium-90	\$2145	Pentium-90	\$2445	Pentium-90	\$2945	Pentium-90	\$3445
<ul style="list-style-type: none"> ➤ 4MB RAM ➤ 214MB local bus IDE hard drive with 32K cache ➤ 3.5" 1.44MB floppy disk drive ➤ Diamond Stealth 64-bit PCI local bus SVGA color graphics card with 1MB DRAM ➤ ZEOS 14" 1024 x 768 non-interlaced SVGA color monitor, .28mm dot pitch ➤ Six-bay desktop case with two cooling fans ➤ Microsoft Mouse ➤ MS-DOS 6.2, Windows for Workgroups 3.11 		<ul style="list-style-type: none"> ➤ 8MB RAM ➤ 528MB local bus IDE hard drive with 256K cache ➤ 2X CD-ROM drive, 3.5" 1.44MB floppy drive ➤ Diamond Stealth 64-bit PCI local bus SVGA color graphics card with 1MB DRAM ➤ ZEOS 14" 1024 x 768 non-interlaced SVGA color monitor, .28mm dot pitch ➤ Six-bay desktop case with two cooling fans ➤ Microsoft Mouse ➤ MS-DOS 6.2, Windows for Workgroups 3.11 		<ul style="list-style-type: none"> ➤ 16MB RAM ➤ 720MB local bus IDE hard drive with 128K cache ➤ 2X CD-ROM drive, 3.5" 1.44MB floppy drive ➤ Diamond Stealth 64-bit PCI local bus SVGA color graphics card with 1MB DRAM ➤ ZEOS 15" 1024 x 768 non-interlaced SVGA color monitor, .28mm dot pitch ➤ Six-bay desktop case with two cooling fans ➤ Microsoft Mouse ➤ MS-DOS 6.2, Windows for Workgroups 3.11 ➤ Lotus SmartSuite 		<ul style="list-style-type: none"> ➤ 24MB RAM ➤ 1GB local bus IDE hard drive with 256K cache ➤ 2X CD-ROM drive, 3.5" 1.44MB floppy drive ➤ Diamond Stealth 64-bit PCI local bus SVGA color graphics card with 1MB DRAM ➤ ZEOS 15" 1024 x 768 non-interlaced SVGA color monitor, .28mm dot pitch ➤ Six-bay desktop case with two cooling fans ➤ Microsoft Mouse ➤ MS-DOS 6.2, Windows for Workgroups 3.11 ➤ Lotus SmartSuite 	

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How We Tested

PERFORMANCE

We tested each system under Windows 3.1, DOS 6.0, and SCO Unix 3.2.4. The DOS and Windows test suites consist of a combination of BYTE low-level tests and NSTL application tests.

The application tests use actual business applications to represent a real-world measure of system performance. The DOS performance suite includes WordPerfect 6.0, Lotus 1-2-3 release 2.4, and FoxPro 2.5. The Windows suite uses Microsoft Excel 5.0, Microsoft Word 6.0, WordPerfect 6.0, FoxPro 2.6, AutoCAD 12.0, and PhotoShop 2.5. All applications execute macros that exercise common functions of each application. For instance, the Word for Windows test includes subtests that measure file I/O, search-and-replace functions, changing fonts, scrolling by page and line, checking spelling, print previewing, and printing to a file. We ran Windows tests in 1024- by 768-pixel resolution and DOS tests in 640- by 480-pixel resolution.

The DOS low-level tests isolate performance of specific subsystems, such as CPU, FPU, memory, video, and hard disk. These tests provide important data for analyzing the results of the application-level tests. The BYTE Windows low-level tests predominantly exercise the Windows GDI (Graphical Device Interface) to determine how well a system can execute basic Windows graphics tasks: drawing a line, displaying text, and executing BitBlt operations.

For the Unix tests, we loaded SCO Unix 3.2.4 on each system and ran a test suite consisting of BYTE's low-level Unix tests and SPEC92 integer and floating-point tests. The Unix tests cover a spectrum of typical scientific and engineering tasks, such as electronic-circuit analysis, architectural analysis, and compilation, as well as typical Unix operating-system commands. These tests primarily stress the CPU/cache/memory architecture of the system. Thus, the Unix test suite evaluates each system as a generalized workstation.

The SPEC92 suite we use covers a variety of application-based and low-level benchmarks representative of engineering and scientific activities. The integer test (SPECint) contains six CPU integer-intensive benchmarks, mostly written in C. Floating-point benchmarks

TRANSACTIONS/SECOND	5.690
Horizontal Resolution	1024
Vertical Resolution	768
Bits per Pixel	16
Display type	VGA
Windows Text	12.426
Windows Picture	6.815
Windows Bitmap	73.939

(SPECfp) contain 14 CPU-intensive floating-point benchmarks, mostly written in FORTRAN. These tests primarily measure the performance characteristics of the processor, the processor cache, and main memory units in processor-intensive applications. They do not attempt to measure display, network, or drive performance. SPEC results are indexed to the performance of a DEC VAX 11/780 computer. A score of 42.3 means that the system ran the test 42.3 times faster than the VAX.

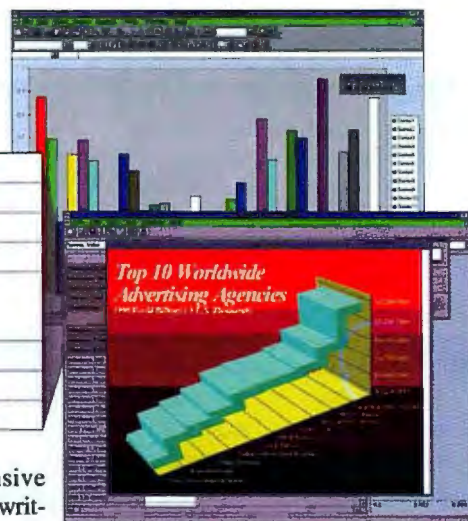
This month, we introduce Unix testing based on XMARK93, an industry-standard benchmark to test performance of X Windows server systems. XMARK93 measures how well a workstation's X server executes primary operations; these operations are weighted according to frequency of use and relative complexity. Results are indexed on a Sun Microsystems SparcStation1 running X11R5 under SunOS 4.1.2 and using a CG3 Color Frame Buffer.

To arrive at overall scores, we scale the results of the DOS and Windows application test scores from one to 10, using the best system's results as a 10. We produce three different performance indexes for each system—one each for DOS, Windows, and Unix.

EASE OF USE

In addition to running performance tests, we examined each system for usability by focusing on two areas: system design and documentation. In looking at system design, we rated each system on how easy it is to insert or extract adapter cards; the presence of labels; whether slots are obstructed or easily accessible; and whether you can disable any integrated components to use their IRQ (interrupt request) settings or to swap to another disk, video, SCSI, or networking arrangement.

We gave top ratings to systems that provided well-integrated manuals with



The top-right screen shows Excel in the Windows 3.1 application benchmark suite, generating different types of charts from one set of data. This test measures screen I/O speed. The lower screen shows a typical Microsoft PowerPoint slide from the video component of the Windows NT 3.5-based Intermark tests. This test script paints these and other graphics, including Corel clip art and simple lines and circles, in several different sizes. When the tests finish, each system's results appear in columns on the main interface (see the detail at left).

comprehensive indexes. Systems that didn't have manuals for video, disk, and SCSI subsystems were penalized. Relevant jumper and DIP-switch settings had to be detailed for a system to rate highly.

FEATURES

We considered the following features most important for Pentium systems:

- a flash ROM BIOS for vendor upgrades or bug fixes
- the number of available adapter slots and drive bays
- the maximum RAM capacity
- a parts-and-labor warranty of at least one year
- a high-performance disk subsystem
- local-bus graphics

Contributors

Chandrika Mysore, Project Manager/NSTL, has tested peripherals and systems for NSTL since 1989.

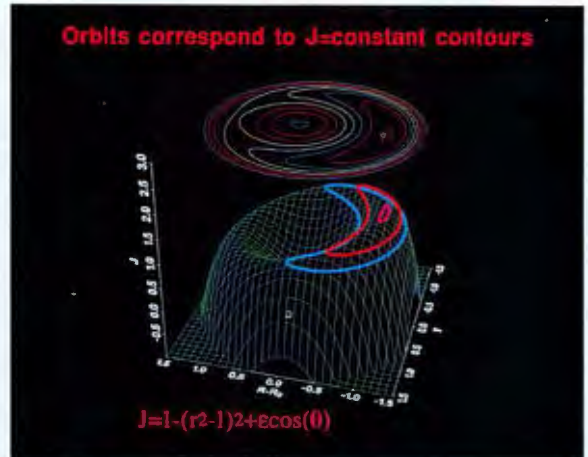
John McDonough, Technical Editor/NSTL, has been writing for high-tech publications for the past five years. He can be reached on the Internet at editors@nstl.com.

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@blx.com or at (603) 924-9281.

UNLEASH Your Pentium/486

The Pentium is the first x86 product in the last few years that bucks the trend away from faster PC numerics. It achieves improved speed by combining a CISC front end with an execution unit that uses RISC principles. This makes the Pentium sensitive to instruction scheduling. The Intel i860, which is the current leader in the embedded numerics field, can do up to two operations per cycle. While the Pentium can only do an operation every other cycle, this is much better than the 487, which can often take many cycles per operation. To help overcome the small 8 deep x87 numeric stack size, the Pentium makes it possible to exchange stack values at no cost. The machine code that results is difficult to read, but helps the Pentium run on a par with chips that have true numeric registers.

Microway's Pentium compilers take full advantage of the Pentium's dual numeric units using the same techniques we employ for the i860's dual units. Unlike integer programs, which benefit from the Pentium's Superscalar features, numeric-bound applications require a combination of instruction scheduling and loop unrolling to hit full speed. The Pentium code we produce for routines like DAXPY is virtually identical to the code recommended by Intel and better than the code we have seen in articles on the subject. The resulting programs run over a factor of two faster than older 16 and 32-bit compilers that do not feature register caching or loop unrolling. Call for our Pentium White Paper which compares the NDP family with other x86 Fortran and C/C++ compilers.



MGX™ is a 32-bit scientific plotting and graphics package currently available for DOS and OS/2. It does 2-D and 3-D plots, graphics, text, supports color separations and dozens of display adapters, printers and export formats. A screen only version is included with NDP Fortran and C/C++ . Printer/Export Extensions..\$145 Binary/C Source library..\$395/695

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Microway's NDP family of 32-bit compilers generate globally optimized mainframe quality code that runs on the 386, 486, Pentium and i860. They run on 32-bit operating systems such as OS/2, UNIX, Solaris, Coherent, and DPMI/VCPI DOS Extenders.

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DOS versions include a VCPI/MM DOS Extender, DPMI interface layer, support for x87 and Weitek coprocessors, NDPLink, NDPLib and **GREX** - our DOS graphics library. The Pentium release adds new code generation, royalty free DPMI and VCPI plus symbolic debugging.

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DOS Pentium version.....\$995

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IMSL Microway compiled and validated version of the IMSL mainframe libraries, available for the 386/486 or i860, Complete Package.....\$2,000

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KUCK & ASSOCIATES hand coded i860 libraries. DSP library does 1024 real FFT in 500 microseconds!

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LAPACK and **BLAS**, sources included, 386/486.....\$195 i860.....\$295

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Great performance and an excellent design

BEST OVERALL Digital Equipment DECpc XL590



Several factors make the DECpc XL590 a strong CAD/graphics workstation. It posted above-average scores in Windows and X Window system testing, as well as the third-highest DOS performance results. It comes with three ISA slots, two stand-alone and one shared PCI slot, and five drive bays, and it holds up to 192 MB of RAM. Digital incorporates the Diamond Stealth 64 PCI graphics card, a double-speed Toshiba CD-ROM drive, and a SCSI hard drive into the XL590's mini-tower design. A SCSI port is standard on this system. The processor is easily upgradable, and the ventilation is carefully designed so that air blows on the CPU through a plastic pipe connected to the panel in front of the system.



The CAD/CAM market is one of the healthiest segments in the computer industry. Revenues for the market in general were up 8.4 percent last year. After running the 90-MHz Pentiums through our AutoCAD for Windows release 12 and PhotoShop for Windows 2.5 application benchmarks, we discovered that the scores did not vary much. The majority of the ranked systems use the 64-bit PCI Diamond Stealth video card. There were, however, a few exceptions: The Dyna Micro Dyna System 590 and Mitsuba's VIP System-90MHZ: both use a variant of Tseng Lab's ET4000/w32 video chip set and had some of the worst Windows performance scores. But the Dyna System 590 performed the second fastest in the X Window System tests.

Among the runners-up, the AT&T Globalyst 600 costs \$542 more than our Best Overall winner for this category, but it had the highest scores in the



PhotoShop, AutoCAD, and Excel tests. The AT&T system also excelled in the X tests (the Unix graphics tests). If you require powerful graphics, you could easily justify paying a high price to get the performance this system offers.

Performance rankings for CAD and Graphics are based on Windows scores, with an emphasis on AutoCAD for Windows 12 tests, X graphics tests, and the Intermark low-level tests.

KEY			
Excellent ▲▲▲▲	Good ▲▲▲		
Fair ▲▲	Poor ▲		
Tower ■	Mini-tower □	Desktop ▢	

		PRICE (AS TESTED)	CASE TYPE	PERFORMANCE			FEATURES	RAM (STD./MAX.)	VIDEO ADAPTER	DISPLAY RAM
				WINDOWS	DOS	X WINDOW				
BEST	Digital DECpc XL590	\$5672	□	9.47	9.92	9.82	▲▲▲▲	0/192	Diamond Stealth 64	2 MB DRAM
RUNNER-UP	Mitsuba VIP System-90MHZ	\$3990	■	7.69	8.48	9.55	▲▲▲▲	8/128	Mitsuba P6-PCI	2 MB VRAM
RUNNER-UP	Austin Power System 90	\$4777	■	10.00	9.87	9.60	▲▲▲	16/128	Diamond Stealth 64	2 MB VRAM
RUNNER-UP	AT&T Globalyst 600	\$6214	■	9.70	9.71	9.12	▲▲▲▲	8/128	ATI mach64 GX	2 MB VRAM
RUNNER-UP	Data Storage DataStor P590	\$5845	■	9.71	9.88	9.42	▲▲▲	16/128	Diamond Stealth 64	2 MB VRAM

Need to upgrade your graphics workstation?

MOST EXPANDABLE Austin Direct Austin Power System 90

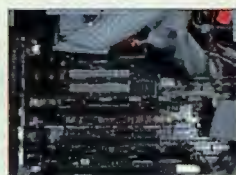


The Austin Power System 90 offers outstanding expandability features. Housed in a tower configuration, this ISA system has three 16-bit expansion slots, three PCI slots, and eight drive bays for adding components. On top of that, the System 90 was the best Windows performer of all Pentiums we tested this month.

		PRICE (AS TESTED)	CASE TYPE	PERFORMANCE			FEATURES	RAM (STD./MAX.)	TOTAL BAYS (3 1/2"/5 1/4")	VIDEO ADAPTER
				WINDOWS	DOS	X WINDOW				
BEST	Austin Power System 90	\$4777	■	10.00	9.87	9.60	▲▲▲	16/128	4/4	Diamond Stealth 64
RUNNER-UP	XIP90 MTower SP	\$3999	□	9.45	9.78	9.46	▲▲▲	8/128	6/4	Diamond Stealth 64
RUNNER-UP	Zeos Pantera 90	\$3995	■	9.72	9.93	9.35	▲▲▲	1/384	4/6	Diamond Stealth 64
RUNNER-UP	Insight PCI P90 CD	\$4299	■	8.55	9.74	9.45	▲▲▲	16/128	9/4	Diamond Stealth 64
RUNNER-UP	Mitsuba VIP System-90MHZ	\$3990	■	7.69	8.48	9.55	▲▲▲▲	8/128	5/2	Mitsuba P6-PCI

A Pentium system priced to sell

LOW COST Hertz Computer Hertz P90



This desktop unit is the only system in our review under \$3000. It took second-place honors in our SPECfp scores, which indicates its suitability for handling the CPU-intensive applications required for CAD/graphics. One reason for its excellent rating might be that it is packed with 512 KB of secondary cache memory. For this review, it was also loaded with a SCSI hard drive from Micropolis with a PCI-based SCSI Adaptec controller. It sports a triple-speed NEC CD-ROM drive and a Diamond Stealth 64 video card.

		PRICE (AS TESTED)	CASE TYPE	PERFORMANCE			FEATURES	RAM (STD./MAX.)	VIDEO ADAPTER	DISPLAY RAM
				WINDOWS	DOS	X WINDOW				
BEST	Hertz P90	\$2830	■	8.01	8.54	10.00	▲▲▲	8/128	Diamond Stealth 64	2 MB VRAM
RUNNER-UP	Gateway P5-90 XL	\$3699	■	9.38	9.72	9.31	▲▲▲	16/128	ATI mach64 GX	1 MB DRAM
RUNNER-UP	Mitsuba VIP System-90MHZ	\$3990	■	7.69	8.48	9.55	▲▲▲▲	8/128	Mitsuba P6-PCI	2 MB VRAM
RUNNER-UP	Insight PCI P90 CD	\$4299	■	8.55	9.74	9.45	▲▲▲	16/128	Diamond Stealth 64	1 MB DRAM
RUNNER-UP	Zeos Pantera 90	\$3995	■	9.72	9.93	9.35	▲▲▲	1/384	Diamond Stealth 64	2 MB VRAM



MP90 System Featuring

- INTEL Pentium 90Mhz CPU
- 8 MB RAM
- 540 MB Hard Disk Drive
- 1.44 MB 3.5" Floppy Diskette Drive
- PCI VGA Card with 1 MB RAM
- Double -Speed CD ROM Drive
- Sound Blaster Sound Card
- 2 Speakers
- 15" Non-Interlaced SVGA Monitor
- Serial Mouse
- 101 Keyboard
- MS Dos & MS Windows
- FREE Gift: CD Titles Package

* Favorite Option: BOSE Speakers

MP60 System Featuring

- INTEL Pentium 60Mhz CPU
- 8 MB RAM
- 540 MB Hard Disk Drive
- 1.44 MB 3.5" Floppy Diskette Drive
- PCI VGA Card with 1 MB RAM
- Double -Speed CD ROM Drive
- Sound Blaster Sound Card
- 2 Speakers
- 15" Non-Interlaced SVGA Monitor
- Serial Mouse
- 101 Keyboard
- MS Dos & MS Windows
- FREE Gift: CD Titles Package

* Favorite Option: BOSE Speakers

MP66 System Featuring

- INTEL Pentium 66Mhz CPU
- 8 MB RAM
- 540 MB Hard Disk Drive
- 1.44 MB 3.5" Floppy Diskette Drive
- PCI VGA Card with 1 MB RAM
- Double -Speed CD ROM Drive
- Sound Blaster Sound Card
- 2 Speakers
- 15" Non-Interlaced SVGA Monitor
- Serial Mouse
- 101 Keyboard
- MS Dos & MS Windows
- FREE Gift: CD Titles Package

* Favorite Option: BOSE Speakers



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Note: INTEL and Pentium are registered trade mark of INTEL Corporation. All other names are properties of their respective owners.

Circle 290 on Inquiry Card (RESELLERS: 291).

The 90-MHz Pentium market has matured since our last systems Lab Report, but not remarkably so for Unix implementations. The SPEC92 benchmark we use requires the video resolution to be 1024 by 768 pixels by 256 colors, so the shortage of drivers for high-end video cards and this operating system was made markedly clear to us. For this reason, we could not run SCO Unix on three of the 19 systems.

Having 1 GB of storage space might tempt you to install multiple operating systems. To avoid operating-system conflicts, SCO recommends that you install Unix and its root file system in the first 1024 cylinders and add other operating systems in the extended partition.

Among the systems that performed well under Unix but didn't merit the Best Overall ranking, the AT&T Globalyst 600 deserves mention, because it excelled in our Unix SPECint

test. Data Storage's DataStor P590 also performed well in the Unix drive tests.

The Unix test scores are based on the Pentiums' performance in disk tests, processor-intensive floating-point and integer tests using complex applications, as well as in X graphics tests using the new XMARK93 tests. In contrast, we considered only the performance of DOS, Windows, and low-level Intermark tests in the General Business category.



KEY	
Excellent ▲▲▲▲	Good ▲▲▲
Fair ▲▲	Poor ▲
Tower ■	Mini-tower □ Desktop ▬

Digital delivers the best overall Unix box

BEST OVERALL Digital Equipment DECpc XL590



The DECpc XL590 didn't burn up the track in Unix performance testing, but it had excellent ease-of-use and features scores. The system offers a SCSI hard drive with the controller located on the motherboard, 256 KB of secondary cache memory, a Toshiba Model 4101 CD-ROM drive, and a three-year warranty. Although it didn't qualify as a runner-up, the Insight PCI P90 CD posted high Unix scores, and it is an attractive alternative to Digital's Pentium—it has excellent ease-of-use features, and it costs \$1373 less than our Best Overall winner.



		PRICE (AS TESTED)	CASE TYPE	PERFORMANCE			EASE OF USE	FEATURES	RAM (STD./MAX.)	DRIVE CONTROLLER	WARRANTY (YEARS)
				SPECINT	SPECFP	BYTE UNIX					
BEST	Digital DECpc XL590	\$5672	□	65.12	56.55	4.64	▲▲▲▲	▲▲▲▲	0/192	SCSI	3
RUNNER-UP	Mitsuba VIP System-90MHZ	\$3990	■	55.33	46.72	3.84	▲▲	▲▲▲▲	8/128	PCI-SCSI	2
RUNNER-UP	Data Storage DataStor P590	\$5845	■	66.54	57.92	4.72	▲▲▲	▲▲▲▲	16/128	PCI-SCSI	3
RUNNER-UP	AT&T Globalyst 600	\$6214	■	66.74	58.22	4.61	▲▲▲	▲▲▲▲	8/128	SCSI	3
RUNNER-UP	Austin Power System 90	\$4777	■	65.64	56.67	4.84	▲▲▲	▲▲▲	16/128	IDE	3

10 drive bays and slots galore...

MOST EXPANDABLE Xi Computer XiP90 MTower SP



This \$3999 system doesn't have exceptional overall Unix performance results, but it had high Intermark and above-average X Window System scores, due in part to its fast graphics subsystem. The XiP90 MTower SP utilizes a mini-tower design that houses seven expansion slots (four 16-bit and three PCI local bus), as well as 10 drive bays (six 3½-inch and four 5¼-inch). On the downside, the XiP90 MTower SP may frustrate some users because its drive bays and SIMM banks block several expansion slots. These blocked slots cannot be used for full-length adapters but are fine for daughterboards.

		PRICE (AS TESTED)	CASE TYPE	PERFORMANCE			EASE OF USE	FEATURES	RAM (STD./MAX.)	TOTAL BAYS (3½"/5¼")	DRIVE CONTROLLER
				SPECINT	SPECFP	BYTE UNIX					
BEST	XiP90 MTower SP	\$3999	□	65.15	57.00	4.59	▲▲▲▲	▲▲▲	8/128	6/4	IDE
RUNNER-UP	Austin Power System 90	\$4777	■	65.64	56.67	4.84	▲▲▲	▲▲▲	16/128	4/4	IDE
RUNNER-UP	XiP90 NTower DP	\$4549	■	69.34	58.54	4.95	▲▲▲▲	▲▲▲	8/512	4/5	PCI-SCSI
RUNNER-UP	Insight PCI P90 CD	\$4299	■	65.50	57.75	4.93	▲▲▲▲	▲▲▲	16/128	9/4	IDE
RUNNER-UP	Mitsuba VIP System-90MHZ	\$3990	■	55.33	46.72	3.84	▲▲	▲▲▲▲	8/128	5/2	PCI-SCSI

Hertz scales the price/performance curve

LOW COST Hertz Computer Hertz P90



In this category, where we rank systems selling for less than \$4800, the Hertz P90 provides unspectacular, yet respectable, Unix performance. If you need better performance and have a larger budget, try Gateway 2000's P5-90 XL, which had the highest Unix scores in this group and a relatively affordable price of \$3699. Gateway's price includes a 17-inch monitor (all other prices reflect a system configured with a 15-inch monitor).

		PRICE (AS TESTED)	CASE TYPE	PERFORMANCE			EASE OF USE	FEATURES	RAM (STD./MAX.)	DRIVE CONTROLLER	WARRANTY (YEARS)
				SPECINT	SPECFP	BYTE UNIX					
BEST	Hertz P90	\$2830	■	60.71	63.84	3.84	▲▲	▲▲▲	8/128	PCI-SCSI	1
RUNNER-UP	Gateway P5-90 XL	\$3699	■	65.39	57.36	4.95	▲▲▲▲	▲▲▲	16/128	IDE	3
RUNNER-UP	Mitsuba VIP System-90MHZ	\$3990	■	55.33	46.72	3.84	▲▲	▲▲▲▲	8/128	PCI-SCSI	2
RUNNER-UP	Insight PCI P90 CD	\$4299	■	65.50	57.75	4.93	▲▲▲▲	▲▲▲	16/128	IDE	1
RUNNER-UP	XiP90 NTower DP	\$4549	■	69.34	58.54	4.95	▲▲▲▲	▲▲▲	8/512	PCI-SCSI	1

The Dual-Processor Pentium

The latest incarnation of Intel's Pentium processor does more than simply run faster than the older 60- and 66-MHz versions. In fact, along with the availability of Windows NT 3.5, the latest Pentium should make dual-processor architectures a cost-effective option in the desktop workstation market. The P54C Pentium runs faster, comes in a smaller package, operates at 3.3 V, and adds special support for dual-processor designs.

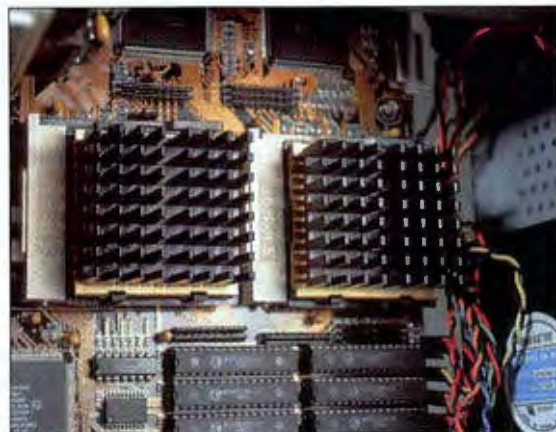
High-end multi-processor systems implement a dedicated cache for each processor, but sharing a single-processor cache between two processors enables a simpler, less-expensive dual-processor architecture. The system requires only one SRAM (static RAM) cache and a single cache controller.

However, additional logic is also needed to arbitrate access to the shared bus and ensure cache coherency. The P54C Pen-

tium has built-in hardware features to support cache coherency and bus arbitration (see "Pentium's Dual Personality" on page 211). Vendors can now implement a dual-processor architecture without worrying about designing additional logic to arbitrate a shared cache.

Xi Computer's XiP90 NTower DP came to us with an extra processor installed (right). Other units came with open slots for dual-processor upgrades. As the XiP90 proves, you can now buy a surprisingly low-cost dual-processor system. Or you can buy an upgradable model and pop in the second processor if your needs demand it. Of course, your software applications must support dual processing. Our standard low-level and application-level benchmarks do not exercise a second processor, so any performance enhancement effected by a dual-processor design will not show up.

This brings us to the second development that should boost the market ac-



Xi Computer's XiP90 NTower DP has dual processors with heat sinks.

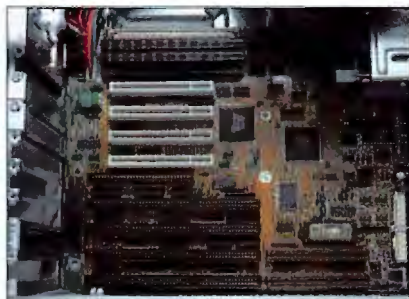
ceptance of dual-processor systems: Windows NT. NT was built from the ground up to support multiple processors. The NT kernel will spawn threads to each available processor. It simply allocates a dedicated processor to the next-highest-priority thread. New multi-threaded NT applications, such as Picture Publisher, do not have to do anything special to take advantage of a dual processor. You run different threads for complex operations (e.g., applying a special-effects filter), and NT will do the rest.



The Xi Computer XiP90 NTower DP.

HONORABLE MENTIONS

Mitsuba's VIP System-90MHZ, the Hertz P90, and Dyna Micro's Dyna System 590 offer the flexibility of VL-Bus and PCI local-bus expansion slots in ISA-based designs. These were the only systems that provided both these local-bus options. The VIP System-90MHZ has two VL-Bus and two PCI slots and one shared PCI/8-bit ISA slot (a total of five local-bus slots); it also has two 16-bit ISA slots. The Dyna System 590 is designed with two VL-Bus and three PCI slots and one shared PCI slot (a total of six local-bus slots). These systems would be ex-



The Dyna System 590 motherboard.

cellent choices for anyone who has already invested in VL-Bus adapter cards and wishes to migrate to PCI.

Tower systems dominate our Pentium roundup, yet we loved the internal design of Zenith Data Systems' Z-Station EX desktop Pentium. The Z-Station EX has integrated video and Ethernet. It achieves expandability by locating expansion slots on a card positioned perpendicular to the motherboard. When installed, the expansion cards are parallel to the motherboard. The AST Premia GX P/90 (our Best Overall winner for General Business) also put an interesting spin on expansion-slot designs using a similar system architecture.





"ALR put a lot of time and effort in the design of this system from the major components all the way to the little details that other manufacturers overlook."

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Circle 63 on Inquiry Card (RESELLERS: 64).

ROLL CALL OF PENTIUMS TESTED

VENDOR	MODEL	PRICE (AS TESTED)	PERFORMANCE					EASE-OF- USE SCORE
			WINDOWS	DOS	SPECINT	SPECFP	BYTE UNIX	
 AST Computer	Premmia GX P/90	\$6288	9.28	9.85	Failed¹	Failed¹	1.17	▲▲▲
AT&T GIS	AT&T Globalyst 600	\$6214	9.70	9.71	66.74	58.22	4.61	▲▲▲
Austin Direct	Austin Power System 90	\$4777	10.00	9.87	65.64	56.67	4.84	▲▲▲
Cornell Computer Systems	PCI Power Workstation	\$4075	9.24	9.71	Failed ²	Failed ²	Failed ²	▲▲
Data Storage Marketing, Inc.	DataStor P590	\$5845	9.71	9.88	66.54	57.92	4.72	▲▲▲
Dell Computer Corp.	Dimension XPS P90	\$3949	9.06	9.79	N/A ³	N/A ³	N/A ³	▲▲▲▲
 Digital Equipment Corp.	DECpc XL590	\$5672	9.47	9.92	65.12	56.55	4.64	▲▲▲▲
Duracom Computer Systems, Inc.	FilePro 586/90P-32	\$5499	8.54	9.67	N/A ³	N/A ³	N/A ³	▲▲▲
Dyna Micro, Inc.	Dyna System 590	\$4075	7.42	6.74	56.05	46.01	3.65	▲▲
Gateway 2000, Inc.	P5-90 XL	\$3699	9.38	9.72	65.39	57.36	4.95	▲▲▲▲
High Definition Systems, Inc.	Victoria PCI 90MHZ	\$4905	7.36	9.88	72.19	64.63	4.88	▲▲▲
Hertz Computer Corp.	Hertz P90	\$2830	8.01	8.54	60.71	63.84	3.84	▲▲
Hewlett-Packard Co.	HP Vectra XU 5/90C	\$8207	9.21	9.00	N/A ³	N/A ³	N/A ³	▲▲▲▲
Insight Direct, Inc.	Insight PCI P90 CD	\$4299	8.55	9.74	65.50	57.75	4.93	▲▲▲▲
Mitsuba Corp.	VIP System-90MHZ	\$3990	7.69	8.48	55.33	46.72	3.84	▲▲
Xi Computer Corp.	XiP90 MTower SP	\$3999	9.45	9.78	65.15	57.00	4.59	▲▲▲▲
Xi Computer Corp.	XiP90 NTower DP ⁴	\$4549	9.32	10.00	69.34	58.54	4.95	▲▲▲▲
Zenith Data Systems	Z-Station EX	\$4778	9.39	9.66	67.66	58.20	4.84	▲▲▲
Zeos International	Pantera 90	\$3995	9.72	9.93	Failed	Failed	4.83	▲▲▲

BYTE = BYTE Best.

Excellent ▲▲▲▲ Good ▲▲▲ Fair ▲▲ Poor ▲

N/A = not applicable.

¹ AST Premmia could not complete the SPECint, SPECfp, or XMARK93 tests in Unix.

² We were unable to install SCO Unix on the Cornell system during the testing time frame.

³ The Dell, Duracom, and Hewlett-Packard systems could not complete the Unix tests because video drivers for Unix were not available at the time of testing.

⁴ The Xi Computer XiP90 NTower DP is a dual-processor system.

FEATURES SCORE	EXPANSION BUS	CASE TYPE	MAXIMUM RAM (MB) (ALL TESTED WITH 32 MB)	SECONDARY CACHE (KB)		ETHERNET PORT	TOTAL SLOTS			DRIVE BAYS		
				AS TESTED	MAXIMUM		16-BIT*	32-BIT (NONLOCAL BUS)	LOCAL BUS	TOTAL		5¼-INCH FLOPPY (ALL HAVE 3½-INCH)
										3½-INCH	5¼-INCH	
▲▲▲▲	EISA	■	192	256	512	✓	0	4	2	3	2	
▲▲▲▲	ISA	■	128	256	256		6	2	1	3	2	
▲▲▲	ISA	■	128	256	256		3	0	3	4	4	
▲▲▲▲	ISA	■	128	256	256		5	0	3	4	6	
▲▲▲	ISA	■	128	256	256		5	0	3	3	4	✓
▲▲▲	ISA	□	128	256	256		4	0	2	2	3	
▲▲▲▲	ISA	□	192	256	256		3	0	3	2	3	
▲▲▲	ISA	■	128	256	256		4	0	2	3	4	
▲▲▲▲	ISA	■	128	512	512		2	0	6	2	6	
▲▲▲	ISA	■	128	256	256		4	0	2	5	4	
▲▲▲	ISA	■	128	256	256		4	0	3	5	3	✓
▲▲▲	ISA	■	128	512	512		3	0	2	4	3	
▲▲▲	ISA	■	256	512	512	✓	3	0	2	2	2	
▲▲▲	ISA	■	128	256	256		4	0	3	9	4	
▲▲▲▲	VIP ^a	■	128	256	1024		2	0	5	5	2	✓
▲▲▲	ISA	□	128	256	256		4	0	3	6	4	
▲▲▲	EISA	■	512	512	512		0	4	4	4	5	
▲▲▲	ISA	■	128	256	256	✓	3	0	2	1	2	
▲▲▲	ISA	■	384	512	512		5	0	2	4	6	

Case type: Tower ■ Desktop ■ Min-tower □

✓ = yes.

* The Mitsuba VIP System-90MHZ has one shared PCI/8-bit slot, two 16-bit ISA slots, two 32-bit VL-Bus slots, and two 32-bit PCI local-bus slots.

^a Not shared slots. PCI/ISA-shared slots are counted as PCI.

Notes: All systems include a PCI local bus; all were priced with 15-inch monitors except for the Gateway, which was priced with a 17-inch monitor.

ROLL CALL OF PENTIUMS TESTED

VENDOR	MODEL	SIZE (GB)	INTERFACE	HARD DRIVE		ADAPTER	GRAPHICS	
				CONTROLLER LOCATION	VENDOR		VIDEO CHIP SET	MB OF VRAM/DRAM
AST Computer	Premia GX P/90	1	SCSI	Motherboard	Quantum	ATI Graphics Pro Turbo	ATI mach64 88800GX	2 MB VRAM
AT&T GIS	AT&T Globalyst 600	1	SCSI	Motherboard	Quantum	Integrated	ATI mach64 88800GX	2 MB VRAM
Austin Direct	Austin Power System 90	1	IDE	Integrated	Micropolis	Diamond Stealth 64	S3 Vision964	2 MB VRAM
Cornell Computer Systems	PCI Power Workstation	1.05	SCSI	PCI bus	Micropolis	Orchid Kelvin 64	Cirrus Logic GD5434	2 MB DRAM
Data Storage Marketing, Inc.	DataStor P590	2.5	SCSI	PCI bus	Seagate	Diamond Stealth 64	S3 Vision964	2 MB VRAM
Dell Computer Corp.	Dimension XPS P90	1	IDE	PCI bus	Western Digital	Number Nine GXE64Pro	S3 Vision964	2 MB VRAM
Digital Equipment Corp. DECpc XL590		1	SCSI	Motherboard	Digital	Diamond Stealth 64	S3 Vision964	2 MB DRAM
Duracom Computer Systems, Inc.	FilePro 586/90P-32	1.75	SCSI	PCI bus	Micropolis	Number Nine GXE64-P	S3 Vision864	1 MB DRAM
Dyna Micro, Inc.	Dyna System 590	1	SCSI	PCI bus	Seagate	Genoa Phantom 32i	Tseng Labs ET4000/w32i	2 MB VRAM
Gateway 2000, Inc.	P5-90 XL	1	IDE	Integrated	Western Digital	ATI WinTurbo	ATI mach64 88800GX	1 MB DRAM
High Definition Systems, Inc.	Victoria PCI 90MHZ	2	SCSI	PCI bus	Seagate	ATI Graphics Wonder	ATI mach32 68800	2 MB VRAM
Hertz Computer Corp.	Hertz P90	1	SCSI	PCI bus	Micropolis	Diamond Stealth 64	S3 Vision864	2 MB VRAM
Hewlett-Packard Co.	HP Vectra XU 5/90C	1	IDE	Integrated	Quantum	Matrox MGA Ultima Plus	Matrox MGA	4 MB VRAM
Insight Direct, Inc.	Insight PCI P90 CD	1	IDE	Integrated	Western Digital	Diamond Stealth 64	S3 Vision964	1 MB DRAM
Mitsuba Corp.	VIP System-90MHZ	1.08	SCSI	PCI bus	Quantum	Mitsuba P6-PCI	Tseng Labs ET4000/w32p	2 MB VRAM
Xi Computer Corp.	XiP90 MTower SP	1.05	IDE	Integrated	Conner	Diamond Stealth 64	S3 Vision964	2 MB VRAM
Xi Computer Corp.	XiP90 NTower DP ¹	1.08	SCSI	PCI bus	Quantum	Diamond Stealth 64	S3 Vision864	2 MB VRAM
Zenith Data Systems	Z-Station EX	1	IDE	Integrated	Western Digital	Integrated	ATI mach64 88800GX	2 MB VRAM
Zeos International	Pantera 90	1	IDE	Integrated	Micropolis	Diamond Stealth 64	S3 Vision964	2 MB VRAM

ATI = BYTE Best.

¹ The XiP90 NTower DP is a dual-processor system.

Notes: All systems tested had 32 MB of RAM and a PCI local bus; all were priced with 15-inch monitors except for the Gateway, which was priced with a 17-inch monitor.

MONITOR		CD-ROM		MODEL	POWER SUPPLY				SCSI PORT	TOLL-FREE PHONE	INQUIRY NUMBER
VENDOR	MODEL	DOT PITCH (MM)	VENDOR		FCC RATING	WARRANTY (YEARS)	OUTPUT (W)	AC INPUT (V)	SWITCHABLE VOLTAGE	PHONE	
ATI	Vidion 5L	.28	Toshiba	Sanyo CDR-400I	B	3	230	110 ^a	✓	✓ (714) 727-4141	(800) 876-4278 1105
AT&T	SuperVGA	.28	NEC	CDU 561	B	3	180	110 ^a	✓	(513) 445-5000	(800) 225-5627 1106
KFC	MN2408	.28	Toshiba	3401A	A	3	250	110	✓	✓ (512) 339-3500	(800) 752-1577 1107
ADI	4GP	.28	NEC	CR510 ^a	P	3	300	110	✓	(909) 594-5848	(800) 886-7200 1108
Data Storage	Spectra 14ni	.28	Toshiba	3401B	P	3	300	110	✓	(303) 442-4747	(800) 543-8098 1109
Dell	UltraScan VS15	.28	Panasonic	CR563	B	1	200	110 ^a	✓	(512) 338-4400	(800) 613-3355 1110
Philips	PCXBV-PC	.28	Toshiba	XM-4101	B	3	300	120	✓	✓ (603) 884-4304	(800) 722-9332 1111
ADI	DM2950	.28	Plextor	DM3028	B	1	250	120 ^a	✓	✓ (214) 518-1200	(800) 551-9000 1112
Addonics	MON-152GLR	.28	Sony	CD33A	P	1	230	110	✓	✓ (408) 943-0100	(800) 362-3962 1113
Sony	Gateway 2000 Vivitron	.28	NEC	260 CDR	B	3	300	N/A	✓	(605) 232-2000	(800) 846-2000 1114
AMAX	Impression 5	.28	NEC	NEC-500 ^a	P	1	250	110	✓	(408) 720-0493	(800) 347-0493 1115
MAG Innovision	DX15F	.28	NEC	CDR-5N ^a	A	1	250	115	✓	✓ (212) 684-4141	(800) 232-8737 1116
HP	HP Ergo Ultra VGA	.28	Toshiba	XM-4101	B	3	160	110 ^a	✓	✓ (303) 635-1000	(800) 752-0900 1117
MAG Innovision	DX15F-1	.28	Plextor	DM3028	B	1	230	110	✓	(602) 902-1176	(800) 998-8045 1118
Mitsuba	M15VS	.26	Mitsumi	FX001D	P	2	230	110	✓	✓ (909) 392-2000	(800) 648-7822 1119
KFC	Xi1528NI	.28	Toshiba	XM-4101B	A	1	300	110	✓	✓ (714) 498-0858	(800) 432-0486 1120
Xi OEM KFC	Xi1528NI	.28	Toshiba	XM-4101B	A	1	300	110	✓	✓ (714) 498-0858	(800) 432-0486 1121
Nokia	44BS	.28	Mitsumi	CRMC- FX00IDE	B	3	145	110	✓	(708) 808-5000	(800) 582-0524 1122
CTX	1561 ES	.28	Mitsumi	FX200	B	1	200	120	✓	(612) 362-1234	(800) 554-5226 1123

P = pending.

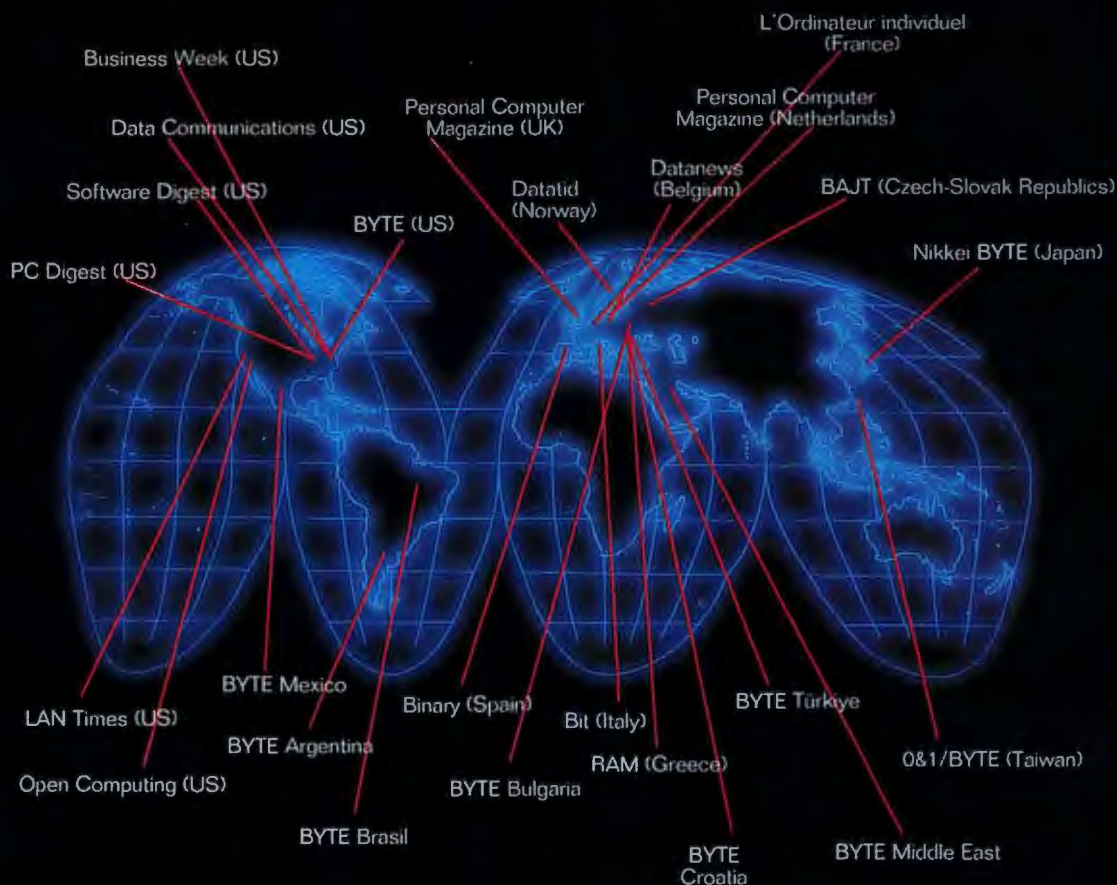
N/A = not applicable.

✓ = yes.

^a Triple-speed CD-ROM drives. All others are double speed.

^a Auto-sensing/auto-switching.

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Pentium Chip's Dual Personality

The latest processors offer built-in support for dual-processor systems

ROELAND VAN KRIEKEN

Early in 1994, Intel announced two new versions of the Pentium processor: one that runs at 90 MHz and another that runs at 100 MHz. Collectively code-named the P54C, these CPUs use a 0.6-micron BiCMOS process that reduces their die size by 45 percent. They have improved performance due to higher core frequencies and lower power dissipation, because they operate at 3.3 V. Although the low-power, high-performance features of these processors have garnered much attention, this column focuses on another important feature in the Pentium 90-MHz (or 735\90) and Pentium 100-MHz (or 815\100) design: Both possess architectural enhancements that support efficient dual-processor systems.

Some background information is in order on Pentium system designs that use two or more processors. One design, which I term *multiprocessor*, uses dedicated caches for each Pentium processor. The advantage of a multiprocessor design is that it has efficient bus utilization, because each processor communicates freely with its own cache. This bus efficiency yields high performance that scales effectively for two or more processors. Adding a second processor to a multiprocessor system design boosts its performance by more than 90 percent. The disadvantage of this design is its cost and complexity. Each dedicated cache requires an additional cache controller and SRAMs, as well as data-path, memory-bus, and interrupt-control circuitry. Because performance, scalability, and cost of a multiprocessor system are all greater than those of a single-processor system, this design is ideally suited for OLTP (on-line transaction processing) applications.

Another design, called *dual-processor*, uses two Pentium processors that share a single secondary cache. The advantage of the dual-processor design is that it is simpler and less costly, because only one cache controller and some SRAM is necessary to implement it. However, because

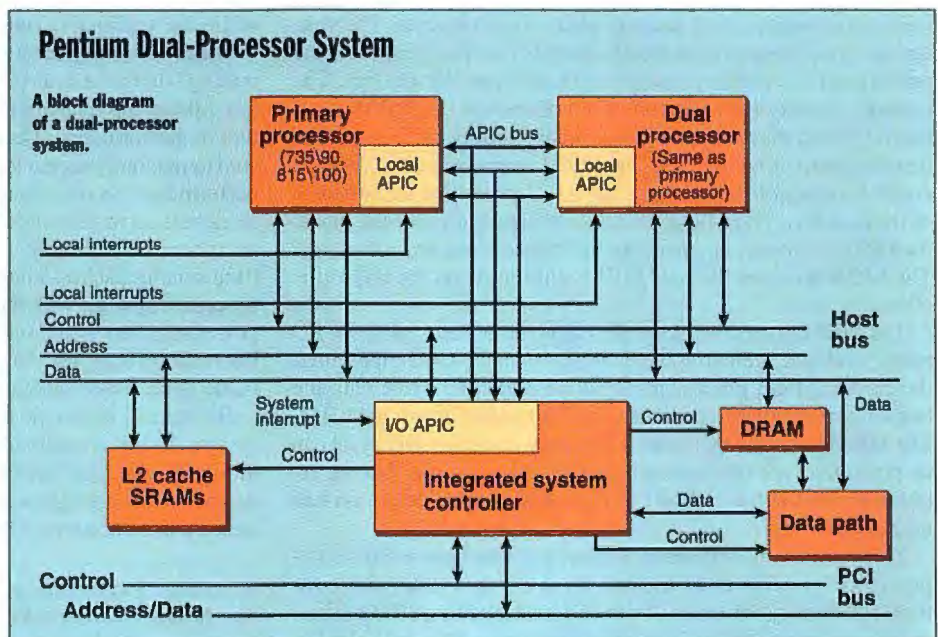
each processor shares the bus with the secondary cache, bus efficiency is limited. The performance of a dual-processor system design typically improves by 50 percent to 80 percent with a secondary processor installed. The price/performance of this implementation makes it suitable for high-end desktop systems or workstations.

Dual Details

The 90- and 100-MHz versions of the Pentium processor provide three key hardware features to support a dual-processor design: cache coherency, multiprocessing interrupt control, and bus arbitration. The Pentium's bus interface implements the MESI (modified, exclusive, shared, invalid) protocol, which helps manage cache consistency. The bus also integrates multiprocessor interrupt-control logic and bus-arbitration logic. The interrupt-control logic is based on the APIC (advanced programmable interrupt controller) architecture, which supports the re-direction of interrupts to multiple processors. The bus-arbitration logic lets the two processors arbitrate access for the common bus to the shared cache.

With these on-chip logic blocks, a system designer can develop a "glueless" interface for a dual-processor system. It simplifies the overall system design, but some support logic is required to flesh out the implementation. The support hardware consists of an external I/O APIC that obtains the system interrupts and distributes them to the appropriate processor, and some data-path control logic to optimize access to the host bus.

The Pentium dual-processor design uses a private APIC



bus to maintain cache coherency and to coordinate the operations of the two processors. The APIC bus consists of three lines, as shown in the figure "Pentium Dual-Processor System." The first line is the APIC enable. It signals the presence of a dual-processor setup, enabling the on-chip (local) APIC logic. This allows another processor to be inserted into a second socket without special consideration to the system hardware or software. The second line selects the processor. The external I/O APIC uses this line to select the processor that is the recipient of a system interrupt. The third line is the APIC bus clock, which operates the APIC bus independently of the processor bus.

As mentioned earlier, both the primary and the secondary processor contain integrated local APIC modules. This APIC logic handles directed interrupts and interprocessor interrupts. As interrupts arrive from the system, they are routed through the external I/O APIC logic. This I/O APIC is similar to the original 8259 interrupt controller found in all PCs today. However, the I/O APIC captures all system interrupts and directs them to separate processors through various programmable distribution schemes. The local APIC logic in the primary and secondary processors receives interrupts from the I/O APIC via the three-wire private APIC bus, locally via the local interrupt pins, or from the other processor via the APIC bus.

The Pentium processor incorporates a private arbitration mechanism that allows the primary and secondary processors to arbitrate for the shared processor bus without assistance from a bus controller. The arbitration architecture is structured in such a way that the dual-processor pair appears as a single processor to the system. The arbitration logic uses a fair arbitration scheme, and the arbitration state machine was designed to efficiently use the processor bus bandwidth.

The arbitration mechanism requires that the Pentium check the second socket for a processor every time it is reset. The voltage on a processor type pin indicates whether the Pentium is the primary or the secondary processor in a dual-processor design. The primary processor always comes out of reset as the MRM (most recently used master) and the secondary processor as the LRM (least recently used master). The MRM controls the bus. Via the control signals of the host bus, the LRM processor requests use of the host bus. The MRM processor grants control of the bus to the LRM as soon as any pending bus transactions are completed. The LRM becomes the new MRM, until it yields the bus to the other processor.

The MRM grants the bus to the LRM immediately if that CPU has a pipelined cycle to issue. During this inter-CPU pipelining, the current MRM processor may drive one more cycle onto the bus, or it may grant the address and the control bus to the LRM. The MRM gives the bus to the LRM only if another bus cycle can be pipelined onto the current bus cycle. The result is that the arbitration for the bus doesn't introduce any dead clocks on bus transactions.

To improve the efficiency of the host bus bandwidth, dual-processor systems must include an integrated data-path controller. Memory writes go from the host bus to a FIFO (first-in/first-out) write buffer. The data flows through the FIFO and to

DRAM. The result is that memory writes require significantly fewer host bus cycles during write-intensive applications.

It's important to note that the dual-processor design provides for future growth through its support of OverDrive processors. This is accomplished by using a CPUID instruction. With this instruction, system software can establish the processor type in the primary and secondary processor sockets and the features they support. CPUID assigns bits 12 and 13 of the EAX register with values that indicate the processor type. For upgradability with future Pentium OverDrive processors, the system software must allow the EAX register to contain CPU type values following a CPUID instruction.

Software Issues

Adding a second processor to a computer doesn't make the system run any faster if the operating system fails to make use of the second processor. A smart multitasking system allots certain tasks to each processor, distributing the workload. Furthermore, application code can be written

so that it's subdivided into threads. A *thread* is a portion of application code that runs in parallel with, or independent of, other parts of the application. For example, a spreadsheet application might have a print thread generating the output for a chart while an interface thread accepts new data from the user.

In a multiprocessing system, the application's threads can run on different processors. Thus, a threaded application can use the capabilities of a dual-processor system more efficiently than a non-threaded application can. For example, the table "Single-Processor and Dual-Processor Mode Performance" shows that a threaded version of Adobe Photoshop achieved better performance by running its filtering operations on the secondary processor of a dual-processor Pentium system. However, nonthreaded applications can still benefit from a dual-processor system: The multiprocessing operating system would run on one processor while the application runs on the other.

Other software factors must also be considered when determining whether a dual-processor design is the best solution for a job. Specifically, an application's memory-usage pattern can affect its performance. Database applications (OLTP workloads) tend to randomly access large areas of memory. These applications perform best on machines with large cache memories and, thus, work best on multiprocessor machines. Workstation applications are more calculation-intensive, tending to execute tight loops that fit in smaller caches. These applications can benefit from a dual-processor system, with its smaller cache and additional compute power supplied by the secondary processor. For example, Adobe Photoshop filters ran 50 percent to 80 percent faster, as shown in the table. Your mileage will vary.

Because of its simple design and low cost, the dual-processor system design is well-suited to advanced desktop systems. Although its reduced bus efficiency means it achieves lower performance than multiprocessor systems for some applications, the added cost to accommodate the second processor is minimal. ■

SINGLE-PROCESSOR AND DUAL-PROCESSOR MODE PERFORMANCE

Intel evaluated multiple image files filtered by Adobe Photoshop 3.0 running under Daytona on a dual-processor system that uses 90-MHz Pentiums. The data shows the improved performance of the multithreaded functions.

FILTER	DUAL-PROCESSOR/ UNIPROCESSOR RATIO
Despeckle	1.64
Dust & Scratch	1.51
Find edges	1.70
HighPass	1.68
Median	1.64
Radial blur	1.73
Unsharp mask	1.79

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CTOS Revealed

Unisys' best-kept secret is an operating system built for distributed business applications

DIRK S. FAEGRE AND JON UDELL

Operating systems all seem to be headed in the same direction. OS/2, Windows NT, Solaris, NextStep, and the Mac OS, among others, are converging on a microkernel-based, message-passing architecture. Operating systems lacking these or other desired features—including preemptive multitasking, modularity, virtual memory, long file names, built-in networking, and memory protection—are scrambling to provide them.

It's ironic, then, that CTOS (Convergent Technologies Operating System), which does all this and more, remains virtually unknown. If you've never heard of it, don't be surprised. CTOS is the invisible operating system. Its vendor, Unisys, doesn't advertise CTOS and does little to market it. But when you want to field business applications that are distributed and yet manageable, CTOS is hard to beat, as the U.S. Coast Guard, Nationwide Insurance, U-Haul, and Hong Kong Bank will attest.

CTOS was conceived and designed by a small cadre of engineers from Intel and Xerox PARC (Palo Alto Research Center). The group formed Convergent Technologies in 1979 (a time before PCs and LANs, when multitasking was the sole province of Unix and mainframes). Part of the team looked to the future with a mainframe slant. The engineers in this group gave their product the ability to multitask, address large memory, spool printed output, and dynamically recognize system resources. The other half of the team, those with Intel's vision, made sure that the system would be networked and exploit emerging microprocessor technology. Together these groups developed a product that, when it shipped in 1980 on Convergent's x86-based clustered workstations, was years ahead of its time.

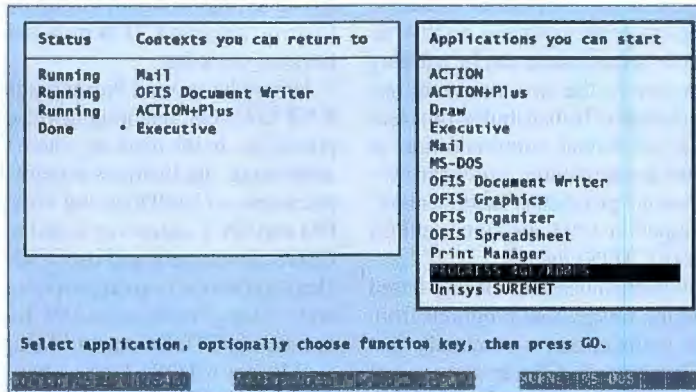
The CTOS Message-Passing Microkernel

The tiny 4-Kb CTOS microkernel deals only with process scheduling and dispatch, as well as message-based

IPC (interprocess communications). Because no other services are bound into the microkernel, it passes messages quickly—on a real-time basis, in effect. Other system and user processes invoke each others' services by passing requests (specially formatted messages) through the microkernel. The kernel reads a message, identifies its source, interprets the request, and forwards it to a resource that can respond to it. The response can come from the user's own workstation, from a local server, or from a remote server located across a WAN. In all these cases, the user is unaware of which machine responds or how it does so, because CTOS routes and responds without assistance. Likewise, the programmer doesn't need to know how to accomplish message-based IPC—it's just intrinsic to CTOS. When CTOS returns a response, the microkernel channels it to the program or utility that originally made the request.

Each CTOS workstation manages a resource table. When a program makes a disk request, for example, the microkernel checks the resource table to determine if it has a disk. If so, the local disk service handles the I/O request. But if it is a diskless client (as cluster workstations often are), the microkernel forwards the

request to the cluster server for a response. In the case of a communications gateway, the server may in turn forward the request to another server in the WAN. This simple, elegant design is the foundation of a networking architecture that works, is simple to manage, and is built in. It also enables CTOS to exploit multiprocessor hardware.



Prosaic by today's GUI standards, Context Manager's display of active and runnable tasks serves the needs of the vertical markets in which CTOS remains strong.

On a dual-processor machine, for example, CTOS can dedicate a database server or a communications gateway to one CPU, freeing the second CPU to handle all remaining chores.

CTOS System Services

Services external to the microkernel do most of the work in CTOS. This approach ensures that unused services don't eat up RAM, that each workstation can run an appropriate mix of services, and that CTOS can cleanly integrate new technologies. Services added to CTOS over the years include Posix, NFS (Network File System), SNA (Systems Network Architecture), TCP/IP, Token Ring, Ethernet, IPX/SPX, LAN Manager, NetWare, 3270 gateway, and more.

A CTOS system service, such as a GUI event loop,

waits for and responds to messages. Scheduling of services is also event-driven in the sense that a waiting service moves onto the run queue only when it receives a message. Its position in the run queue depends on its priority. CTOS itself owns the highest range of priorities, followed by layered system services, and, finally, applications. Note that while CTOS does time-slice applications, the event-driven scheduling of system services means that they can yield the CPU only to same- or lower-priority processes when waiting for messages. In other words, CTOS system services multitask cooperatively. As with NetWare and its NLMs (NetWare loadable modules), it's the programmer's job to make sure that a CTOS system service uses the CPU responsibly.

Filters are special system services that can replace, monitor, or modify the behavior of existing system services. Filters that monitor existing services typically do so to collect statistics for network management or auditing purposes. Filters that modify existing services can preserve most of their functionality while altering only specific behaviors. This form of inheritance is one of the keys to the powerful extensibility of CTOS. It lends itself particularly well to various kinds of redirection. Filters can be used by a remote-access program to redirect screen writes and keyboard reads or by a router to strip the node name from an address and redirect a network message to a cluster.

CTOS Networking

CTOS first appeared and for years ran only on proprietary x86-based workstation clusters connected with twisted-pair wire. Small clusters were simply daisy-chained; larger clusters communicated through a hub called TeleCluster. The wire-level protocol, operating at 3.68 Mbps, resembles SNA's multidrop poll-select scheme. It's highly efficient for individual clusters, although, as with SNA, the polling can create problems on WANs.

For departmental computing, this arrangement can be a highly convenient and effective alternative to the two dominant approaches: LANs and multiuser systems. It distributes processing power as does a LAN, yet it centralizes administration as would an AS/400, Unix, or other departmental multiuser system. More recently, CTOS has shed the proprietary label. Unisys' SuperGen workstations, first shipped in 1993, are standard PCs that use ISA adapters to connect to CTOS clusters.

While a CTOS cluster looks and feels much like a server-based LAN (the workstations boot from the server, load programs from it, and share files stored on it), the entire cluster is potentially just one node in a multicluster CTOS network. Cluster servers can connect to form such networks over a variety of media, including Ethernet, Token Ring, and X.25. Only in this larger network environment must users and applications use node names to address resources. Within a cluster, the server's resources are automatically available to all workstations. Utilities for sharing workstation resources in a peer-to-peer fashion are also available.

When NetWare LANs spring up around existing CTOS clusters, as often happens nowadays, the CTOS users invariably wonder what all the fuss is about. On a PC network, misconfiguration of the server or of any workstation can cause failure, and installation of new or updated software can be a daunting task. CTOS works much more simply, in part because all workstations synchronize on a common configuration file.

Applications use CTOS's networking strengths automatically, with little or no user or developer intervention. Consider Progress, the client/server database that the Concord Group (Concord, NH) deploys in small insurance offices. On CTOS, the Progress engine runs on the cluster server as a system service. To the Progress

client, which loads from the server and runs on workstations as an application, the Progress engine is indistinguishable from any other standard CTOS system service. Connectivity between the client and server pieces of a distributed application, often a stumbling block in PC LAN environments, is automatic in the CTOS cluster environment.

CTOS at Work

The solution that the Concord Group offers to the independent insurance agent running his or her own business is typically a cluster of about eight CTOS workstations. The application mix includes a CTOS-based Progress application that handles accounting, claims and policy tracking, forms printing, and marketing, as well as Unisys' CTOS-based mail and word processing programs. Because agents use a variety of rating applications from other companies, several concurrent DOS or Windows sessions may also be running—something the CTOS emulator handles reliably. There is also typically a heavy communications load—perhaps a 3270 session and one or more asynchronous communications sessions.

Nowadays, 8-MB 486 boxes are typical, with 12-MB 486s or Pentiums as servers (much less RAM would be needed to support CTOS applications only; DOS and Windows exact a substantial penalty). These systems multitask the required mix of CTOS, DOS, and Windows applications with ease. Equally important, CTOS clusters run virtually trouble-free once installed. Unisys offers a powerful management tool called CTOS InControl that enables a central site to monitor and manage branch offices. It uses CTOS messaging to relay alerts to the central office, which can then correct problems at the branch offices by remote control. However, the Concord Group has never found a need to use InControl, because CTOS installations by and large just work, and keep on working.

Unisys has ported Presentation Manager and XVT Software's XVT to CTOS, enabling development of native CTOS GUI applications. In the markets where CTOS is strong, however, character-mode applications remain dominant. While such GUI applications as CorelDraw and Wingz were ported to CTOS, Unisys' PM and XVT initiatives failed to generate much interest among CTOS developers and users who, for the most part, think that character mode is an appropriate technology and can be forgiven for seeing the Windows 95 Taskbar as a reinterpretation of the decade-old CTOS Context Manager (see the screen on page 213).

Whither CTOS? Unisys has announced a plan to integrate CTOS with NT at the server, running NT on one or more main CPUs and CTOS on a bus-mastering I/O processor board. The idea is to protect investment in distributed CTOS applications while embracing the scalable power and broad appeal of NT. Unisys calls this coexistence, but many CTOS faithful worry that it implies migration and will be watching closely to see what happens. They know how simply and reliably CTOS can work, and they don't want to abandon ship. ■

ACKNOWLEDGMENT

Thanks to Tony Lavinio, a longtime CTOS and Progress developer, for supplying valuable technical information.

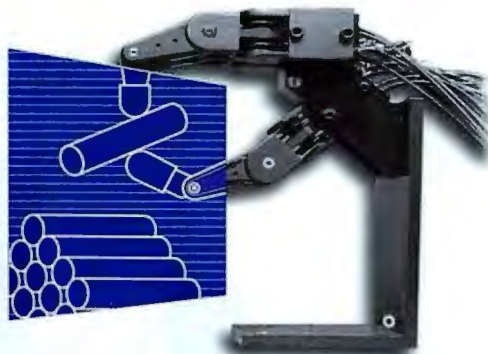
Dirk S. Faegre directs microcomputer functions for the Concord Group (Concord, NH), which deploys CTOS clusters at 40 sites in Maine, Vermont, and New Hampshire. He can be reached on CompuServe at 72322,3545 or on BIX c/o "editors." Jon Udell is a BYTE senior technical editor at large. He can be reached on the Internet or BIX at judell@bix.com.

THE REAL TEST OF A REALTIME OS...



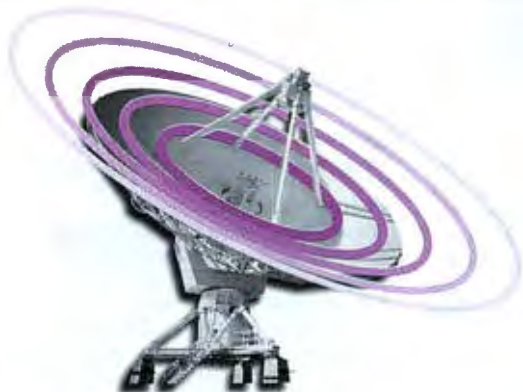
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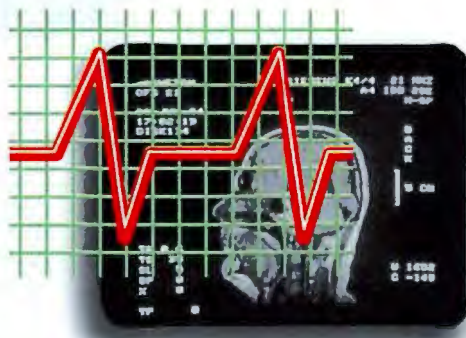
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Programming in Tight Spaces

In the realm of the ultrasmall, inexpensive memory and fast processors can't compensate for inelegant code

RICK GREHAN

In the brave new world of OOP (object-oriented programming), where huge development systems fit only on CD-ROMs and cross-platform API libraries take up most of your disk space, the solutions to many programming problems lie in hardware: more memory, a faster processor, and a disk cache. Today's computer science students are taught that the future lies in writing structured, reusable code. However, there are places where none of this works.

The programming techniques of the large-scale microcomputer world collapse if you apply them in the world of the ultrasmall microcontroller or IBP (itty-bitty processor). In this fascinating realm, there are no Pentium processors with 16 MB of RAM. Instead, you find designs with 4 KB of RAM paired with 8-bit Zilog Z8s, Motorola HC05s, and Microchip Technology PICs. (For details about these processors, see "Processors Proliferate," September BYTE.)

The Arena

Programmers working with IBPs create embedded components for automobiles, cordless and cellular communications equipment, medical instrumentation, and entertainment products. Programming battlegrounds exist on a few fronts. First, there's chip count and size. Because a number of microcontroller-based products are hand-held devices, toys, and consumer items, smaller chip real estate (or fewer chips) translates directly to reduced cost. This is especially important for consumer electronics because a manufacturer's production run may be in the hundreds of thousands, and the full-run price difference between adding an additional 20-cent chip or not can be significant. For the programmer, this

means he or she has to work with reduced resources, such as less memory, or use software instead of hardware to solve some problems.

The second battleground is performance. Programs on microcontrollers are always managing interfaces to the real world, an activity that is governed by precise timing constraints. For example, the microcontroller in a little Santa Claus doll has to make the eyes blink rhythmically and play Christmas-carol tones at the proper pitch. The processor must do this using only 8 bits, and you're lucky if you can run it at anything over 10 MHz. It's a classic conflict of space versus speed. And when you're working with routines that must fit in tens of bytes, you don't have the luxury of clicking on a compiler's dialog box to pick "optimize for speed" over "optimize for space." You have to optimize for both (I'll present an example of how you do this in a moment).

The last battleground is the sheer claustrophobia programmers face. An IBP is usually a one-chip device, with CPU, RAM, and ROM all in one package. Registers and RAM are typically the same thing, and there's often no more than 32 bytes of RAM. As I mentioned before, programmers may get 4 KB of RAM if they're lucky, which means the code may have room for only 512 instructions.

Case in Point

Because of its size, a microspace program cannot be a collection of independent, separate routines. Instead, routines are interdependent and interlocking. One programmer of IBPs described his work as being similar to assembling a jigsaw puzzle. Programmers working in these tight spaces are more like artists than they are like factory workers cranking out objects for some software foundry.

Chip Gracey, a software engineer with Parallax, wrote the on-chip code for the company's BASIC Stamp, an elegantly designed PIC 16C56 development system that consists of two ICs, a 4-MHz oscillator circuit, a voltage regulator, and some passive electronics that are all powered by a 9-V transistor battery (for more details, see the text box "The Taming Power of the Small," September BYTE, page 68). You can program the board in BASIC by downloading code from a PC-compatible machine.

continued

Sine Wave in Six Steps

Super-simple Microchip Technology PIC 16C5x code for generating a sine wave. Note that the heart of the routine is composed of only six instructions. On a 20-MHz PIC microcontroller, those instructions execute in only 1 μ .

```
sine = 08h           ;Declare sine reg.
velo = 09h           ;Declare velocity reg.

init    mov sine,#32   ;Set init. value
        clr velo       ;Reset velocity
loop    mov w,-velo     ;Get decr'd val. of velocity
        snb sine,7     ;Skip next instr. if sine>=0
        mov w,++velo    ;Get incr'd val. of velocity
        add sine,w      ;Add velocity to sine
        mov velo,w      ;Store new velocity
        code to use sine goes here...
        jmp loop
```


Building the Stamp meant working on a processor with 1 KB of code space—about one-thousandth the memory space of most personal computers.

Gracey took four days to locate and fix the last bug on the BASIC Stamp. The time was needed not because the bug was hard to find, but because its correction required adding an instruction to the code. Unfortunately, there was no room, because Gracey had stuffed so much functionality into the Stamp the on-chip ROM was full. So he spent those four days figuring out how to rewrite code to free up the one word of instruction space he needed to make the fix. This was not just an editing job; he had to figure out how to make one routine one instruction shorter, and so much looping and code interdependence was at play that changing any given instruction sequence might have affected the performance of several routines. He had no choice but to write spaghetti code.

Other Considerations

What about reusability, a cornerstone of object-oriented technology? Is there any place for it in the environment of microcontrollers? Not much, according to Dave Hampton, an independent consultant who has been writing microcontroller programs for nearly a decade.

He admits to keeping a toolbox of routines that he uses often, but there's danger in starting a project by simply grabbing an off-the-shelf routine, he says. A generic routine might not make use of memory-saving or performance-boosting features of the processor, so blindly using such a routine as the starting point might take him down a wrong path. Consequently, Hampton finds that most of his projects consist of about 25 percent reused code and 75 percent custom code.

When programming for IBPs, intimate knowledge of the hardware is unquestionably a key requirement for a successful design. The upshot is that while many of us are clamoring for portability, IBP programmers thrive on the precise opposite.

A Taste

Programmers in the world of the small must become algorithm innovators. The famous sourcebooks of computer algorithms, such as *The Art of Computer Programming* series (Addison-Wesley) by Donald Knuth and *Numerical Recipes* editions (Cambridge University Press) by William Press, et al., have a place on the IBP programmer's shelf, but when you're counting every byte of code space, you've got to do some trailblazing. You can't simply go after an existing algorithm with a mental paring knife and shave away layers until you've reduced the code to its essentials. Instead, you often have to devise a completely new routine for solving your specific programming problem.

Gracey offers the following example: The routine shown in the

listing "Sine Wave in Six Steps" on page 217 acts as a sine function generator: Each time you call the routine, it produces the next "step" in the waveform. You could send the output of the routine to a DAC (D/A converter) and have a minimum-overhead function generator.

The listing shows the algorithm as it's implemented in PIC 16C5x instructions. As you can see, the entire sine algorithm consumes six instructions. If this seems like unnecessary

masochism, consider the code's destination processor. The Microchip PIC 16C5x 8-bit processors are complete 1-chip microcontrollers ideal for super-small applications (some members fit in 18-pin packages). Each 16C5x-family member features an on-chip ROM that can hold from 512- to 2-KB of instructions. However, there are no provisions for external memory, so code space is at a premium.

You'll notice that the algorithm performs its magic without series approximation or table-lookup; either would be impractical in most IBP applications. A series approximation would have taken precious space for both the routine and the coefficients, and it would have involved time-consuming multiplication instructions. A table-lookup approach would have meant using up storage to hold the table.

The listing "QuickBasic Sine Wave" is a short QuickBasic-compatible program that graphically demonstrates how well the sine-wave function in the listing on page 217 performs. To use it, type in this listing and alter the initial values of *sine* and *velocity* that appear near the beginning of the program. Watch the resulting waveform as you do.

Get Small

As memory cost-per-megabyte continues to descend, processor performance-per-dollar continues to ascend, and system needs continue to expand to consume system resources, we'll see bigger and bigger programs. I can't help but believe this will create fertile ground for sloppy programming. The day draws near when it will no longer be an embarrassment to use a bubble sort instead of a heap sort: Who's going to care if the list gets alphabetized in one-tenth of a second instead of one-hundredth of a second?

Nevertheless, it's good to know that one sharp edge of the programming community is still alive and well. IBP programmers are still scrounging to free up that 1 byte, and they are still counting cycles. In the end, it's reassuring to know there are still assembly language programmers. ■

Rick Grehan is technical director of the BYTE Lab. He has a B.S. in physics and applied mathematics and an M.S. in mathematics/computer science. He can be reached on the Internet or BIX at rick_g@bix.com.

QuickBasic Sine Wave

*QuickBasic source code demonstrating how the algorithm in "Sine Wave in Six Steps" on page 217 generates a sine wave. Note: You can type in and run the source code to see the waveform. Alter initial values of *sine* and *velocity* that appear near the beginning of the program to change the waveform.*

```
REM Simple method for sequentially computing a
REM sine wave.
SCREEN 9: x=639: y=175
REM Initialize sine and velocity
sine=128: velocity=0
REM Draw axes and initial offsets
COLOR 12
LINE (0,y)-(x,y)
LINE (0,y-sine)-(x,y-sine)
LINE (0,y+sine)-(x,y+sine)
COLOR 15
REM Draw pattern
FOR i=0 TO x
IF sine>=0 THEN velocity=velocity-1
ELSE velocity=velocity+1
sine=sine+velocity
PSET (i,y+sine)
NEXT i
```


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Network Spoofing

Is your WAN on the wane? LAN spoofing may help solve some of your woes.

JEFFREY FRITZ

Network protocols love to talk. They are constantly sending packets to and fro filled with all kinds of information. Not all the chatter contains user data, however. Although most users aren't aware of it, a significant amount of behind-the-scenes LAN traffic is dedicated to the protocol's management functions.

Nearly all network protocols spend time sending and receiving packets for management purposes. The nature of the packets varies from protocol to protocol. Many protocols send out keep-alive messages to various network devices, which ensure that all devices are present and accounted for. Network protocols also keep track of topologies, maintaining information about where devices are located and how they can be reached. This information is shared by exchanging routing tables across the network and by updating them on a regular basis.

How often keep-alive messages and routing updates are sent across a network depends on the LAN protocol. Some protocols send updates infrequently, every few minutes or several times an hour. Others are much more aggressive, sending out updates every few seconds. For example, the AppleTalk NOS (network operating system) sends out RTMP (Routing Table Maintenance Protocol) updates every 10 to 15 seconds. Users tend to see this traffic as overhead; network engineers see it as essential. Either way, management packets are busy running the network, representing traffic that an end user never sees but depends on for reliable connectivity.

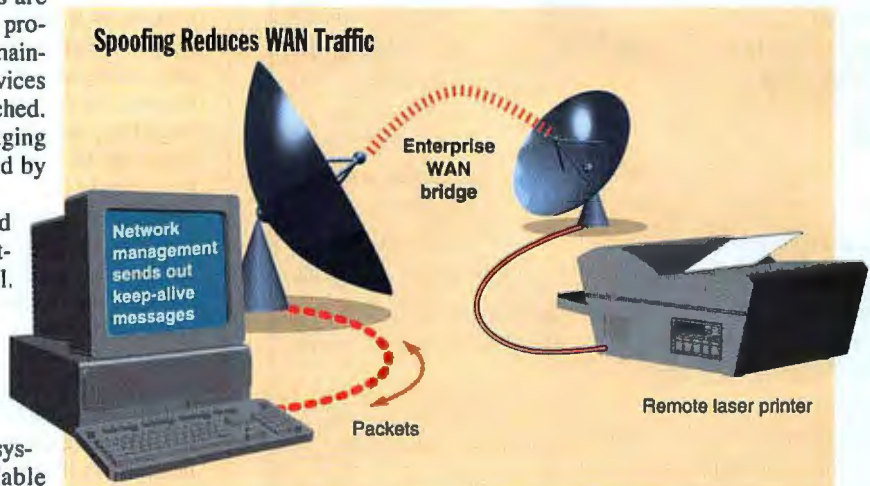
When running on a LAN, protocol management packets simply place more traffic on the network. LAN bandwidths are wide enough that the extra management packets are seldom noticed. WANs, however, are an entirely different matter. When protocol overhead is added to normal user traffic, it can contribute to link saturation and slow-downs, particularly for slower speed WAN links.

However, there is an even worse culprit. Unlike LANs, which operate on a connectionless service, WAN links are, more often than not, connection-oriented services. Connections are physically made and, for switched digi-

tal services, charged on a usage basis. Because of this, WAN links are often configured to bring up the connection only when there is traffic destined for the remote network. They drop the connection when there is no traffic passing over the link.

The Theory

In theory, traffic-based switched WAN connections save money because the connection is not billed unless user traffic is present. The savings can be significant. In the case of a user who has taken a break from a workstation or PC, dead time can be from minutes to hours. Because there is no user traffic, the connection can be kept down during that time and the billing reduced to zero. In reality, the protocol makes a call every time it sends out network routing updates or keep-alive messages, and it incurs charges, even though no user is involved. WAN devices add to the traffic and the expense by regularly exchanging their own internal routing or bridging tables.



The enterprise bridge responds to the keep-alive message rather than sending it to the actual device, reducing WAN traffic.

A potential solution to this problem is a process called *LAN spoofing*, and *spoofing* aptly describes the technology. According to Webster's, the term *spoof* means "to delude by underhanded methods." LAN spoofing places the WAN in a stealth mode, where the WAN network devices, such as bridges or routers, answer for the remote devices.

For instance, if a Novell file server sends out a SAP (service advertising protocol) packet, the enterprise-side WAN device will not place a call to the remote side to pass the SAP (see the figure "Spoofing Reduces WAN Traffic."). Instead, it will acknowledge the SAP for the remote LAN. This fools the server into believing that the remote LAN is still connected, although the connection is down and the user is disconnected.

continued

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Core Technologies Networks

A Hot Topic

Implementing LAN spoofing is a hot topic among WAN vendors. Although it is a recent concept for WAN networking, it is not new to other services. A form of spoofing has been in use for some time with IBM's SNA (Systems Network Architecture). The SNA protocol is used primarily for communications between IBM mainframes and remote synchronous terminals.

One of SNA's characteristics is a continuous handshaking between devices. On dedicated or switched lines, a master/slave relationship exists between the communications controller and the remote unit, resulting in constant polling between devices. Some vendors took this into account in designing their SNA communications devices.

To spoof SNA, the controller-side device automatically answers the status inquiries (polls) intended for the terminal. Similarly, the remote-side communications device answers for the controller. Both sides are happy, even though there is no actual response from the far side. Also, traffic over the serial connection is minimized, giving improved throughput to user data.

Interestingly, SNA uses a different tactic over LANs. It sends out a keep-alive or an "are you still there" message every 5 or 10 seconds. Therefore, it qualifies for the same treatment as other LAN protocols.

It's Not Nice to Fool Mother Nature

Spoofing attempts to fool a network into thinking that disconnected remote devices are really connected. Therefore, the technique defeats a network's native ability to assure itself that everything is as it should be. A NOS is designed this way for good reason. Vendors need to learn how to accomplish spoofing without causing serious grief to a user or a network. A network can be spoofed for only so long before management traffic must be allowed to pass. This may be a maximum of a few minutes, or it could be 24 hours. No one is sure just how long the spoofing time should last.

There are other serious spoofing issues. Network protocols send out keep-alive messages to validate that devices are present and accounted for. What if something really happens to a remote device while the connection is down? The device may crash, be rebooted, power off, or hang. Whatever the case, it is likely to come up in a different state than it was in. However, the spoofed network doesn't realize that the workstation was down. The fact that it has reconnected in a different manner than the network expects leads to a myriad of potential problems, particularly for file servers where reconnected users may wind up being logged in multiple times.

Another frightening possibility could occur when two LANs are remotely connected but not currently on-line with each other. During the time when user traffic is not present and the link is down, the topology of one of the LANs may change. Perhaps a user will turn off a workstation or move a device from one LAN segment to another. The LAN being spoofed is unaware of these changes. Its routing table still contains entries for old topology.

Now suppose user data causes the remote LAN to reconnect. During the next routing-table update, the two networks suddenly realize that their routing tables are different. The network has a decision to make: Which routing table reflects the real network topology, and which is out of date?

Rewriting NOS

Instead of spoofing, some LAN NOS vendors are reevaluating how they handle keep-alive messages and routing updates. Most

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Core Technologies Networks

LAN protocols were written when interconnections of LANs were relatively rare. The designers could count on all the devices on a network being attached to the same physical wire. About the worst thing they had to worry about was repeater delays.

Today, WAN connections are much more prevalent. It may be time for major rewrites of LAN protocols into WAN protocols, taking into account switched digital connections. Although this is easier said than done, there has been some recent activity in this area. Apple, Novell, Microsoft, and other companies have been working to integrate WAN technologies into their network protocols. However, this complex process is going to take some time. A start has been made, but much more work still needs to be done.

ISDN D-Packet Solution

There may be another way to solve the management problem. ISDN D-packet connections may be well suited to handle management functions. The D channel is an ISDN packet service that provides 9600-bps bandwidth in addition to the 64-Kbps circuit-switched B channels. ISDN network devices can take advantage of the D channel for control and management of WAN devices.

Using the D channel, it would no longer be necessary to bring up a circuit-switched call just to transmit a keep-alive message or to update a routing table. Because D packet is a connectionless service, packets are routed through the packet handlers in the central office switch and sent out to their destinations, with no circuit-switched connection to bring up.

Interestingly, the D channel's primary function is control and management of ISDN devices and connections. It was designed from the ground up for exactly this purpose. Therefore, it lends itself well to control and management of ISDN WAN devices. Users are charged on a per-kilopacket basis for D-channel connections. Because management packet size tends to be small compared with user data packets, these charges should be nominal and reasonable.

Unfortunately, the down side to D packet is that it's not widely deployed in North America. A number of ISDN exchanges offer no D-packet service, and D channels are not always connected to the national PDNs (public data networks). When D-packet service is available, it is often restricted to connections within the local switch, making it difficult, if not impossible, for vendors to implement cross-the-board D-channel management. Users could access the D channel for local device management but not for devices outside the local switch.

Despite this limitation, many vendors believe that D-channel management is viable, and they plan to implement it once telephone service providers support it. Unfortunately, the carriers do not seem to be in any hurry to improve deployment of D-packet service.

The ultimate solution for dealing with management protocol traffic is still somewhat elusive, with many options to choose from. One thing is sure: With the ever-increasing number of telecommuters and remote-office WAN connections, it won't be long before users have a solution that is both efficient and cost effective. ■

Jeffrey Fritz is a telecommunications engineer for West Virginia University. He is the author of *Sensible ISDN Data Applications* (WVU Press, 1992). He can be reached on the Internet at jfritz@wvnm.wvnet.edu or on BIX c/o "editors."

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JERRY POURNELLE

Can You Say Network?

Last month I tried to look into the future. Unfortunately, as soon as I did, everything changed. Well, maybe not everything, but a lot did. Several things happened at about the same time. Novell dropped out of the OpenDoc consortium and began making dark hints about abandoning DOS 7 (aka DR DOS). Microsoft announced that Chicago, renamed Windows 95, won't ship until at least next spring. IBM learned that they won't make the year-end deadline for OS/2 on the PowerPC chip. There were probably some other announcements I missed.

All this is annoying, but it doesn't have to change your life. IBM is going on with OpenDoc and swears that it will be compatible with OLE 2.0—but better. The important point for developers is that you can get on with OLE 2.0 projects. The important point for users is that you don't have to know what OpenDoc and OLE 2.0 are.

Users also don't have to worry about Windows 95, or Daytona, or choosing an operating system. Windows for Workgroups 3.11 is quite stable, if irritating

to NetWare users—see below—while any version of DOS from 5.0 up (except for MS-DOS 6, but you know about that) will work. If you need to run both Windows and DOS programs—and almost everyone does—you'll want a better memory manager than DOS provides. Several are good enough, but we like Quarterdeck's QEMM.

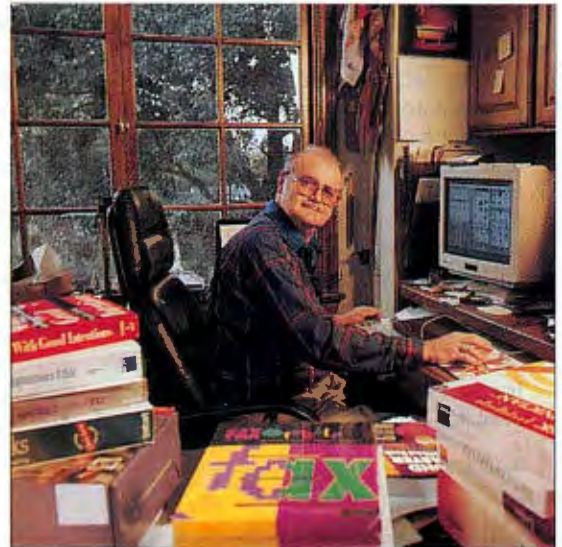
If you run mostly DOS but still want to use Windows occasionally, IBM's OS/2 WARP, sometimes known as Personal OS/2, knows about all presently extant forms of Windows. OS/2 is very good for running multiple DOS applications. Get Windows running first, and then install OS/2 WARP, keeping the capability to boot up with DOS. Once you get things set up and running, OS/2 is extremely reliable and does multitasking, including communications, quite well. Of course, it's not always so simple to get things set up.

We recently got an Iomega Tape250 Parallel Port II tape backup unit. It uses the same DC-2120 tape cartridges and apparently the same format—QIC-80 (quarter-inch cartridge)—as the

Colorado Memory Systems Jumbo 250 I mentioned in my November column. The Iomega Tape250 came bundled with DOS and Windows software from Arcada Software of San Luis Obispo, California. Arcada wrote the backup software that comes with MS-DOS 6, and we suspect they wrote the Norton backup software; it certainly has the same look and feel.

Installing the Windows version on the parallel port of Pentafluge, our fire-breathing Pentium computer, was trivially easy, and the backup ran quite well in the background. Actually, we really stressed it, because while the backup was running in the background, Alex put up Caligari TrueSpace (which is discussed later). Manipulating 3-D graphics really eats up CPU cycles. We were running the backup program in full-compression mode, and while time-sharing with Caligari TrueSpace slowed it down somewhat, nothing crashed.

Better yet, Word 6.0 for Windows runs fine with the Iomega Tape250 doing backup in the background. You can edit, write, load, and save without noticeable degradation of your system's



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Jerry's campaign into computerdom proceeds on all fronts, with particularly heavy activity in networking

performance. Word processing is about the only thing I tend to do in multiprocessing mode anyway.

The Iomega Tape250 is much smaller than the Colorado Jumbo 250, partly because the Jumbo has its power supply built into its case and plugs directly into the wall socket. The Iomega Tape250 has a brick that plugs into the wall. Incidentally, it's only a minor quibble, but I greatly prefer the other kind of brick, with a short power cord. Too often, when you have to plug the power-supply box into the wall, you find it covers more than one outlet.

Along with the Iomega Tape250 being smaller than the Jumbo 250, it's a great deal quieter. You don't hear it running at all except for a few clicks when it changes tracks. I haven't done speed-comparison tests—and I'm not likely to—but it's certainly fast enough for a tape drive. All told, the Iomega Tape250 Parallel Port II is easy to install and use, and it runs nicely in the background, which is, after all, what you want a backup unit to do.

Note that both Colorado and Iomega offer units that will install internally and hang off your floppy drive train, but I don't have that kind. People who have used them

say they work much the same as the parallel-port systems but are faster. Parallel-port systems let you back up more than one machine as well as transfer files between machines.

I still prefer DAT (digital audiotape) for backup because it's faster, the tapes are cheaper, and you get 2 GB on each tape. Of course, the DAT drive is a lot more expensive. If your work is worth anything at all, you need a reliable backup system. The Iomega Tape250 Parallel Port II is plenty good enough. Recommended.

DOS and Windows backup software comes bundled with the Iomega Tape250. They also sent software to let us use it with OS/2, and that's what we tried first. Alas, we never got it to work. We kept getting messages about IRQ (interrupt request) conflicts. Three attempts to get help through Iomega's FAXback help system (which is offered with the software) produced no response whatever.

Eventually I called in the daytime. I got an exceedingly complex telephone tree, a 28-minute wait, and then a technician who didn't know OS/2. Finally, I got someone who said my problem wasn't OS/2 but the

computer I was running it on: the current version won't work with an IBM PS/2 (i.e., Micro Channel architecture) machine. With a machine that has a more conventional bus, it works fine under OS/2.

They're working on the Micro Channel architecture version and ought to have it done before you read this. They didn't reply to my request for FAXback help because they were hoping to get a fix for the PS/2 before replying. The 28-minute delay in getting to a human being was unusual.

Do note that we didn't need any help installing the Iomega Tape250 Parallel Port II on Pentafluge, which is about as advanced a system as you'll find, and we'd not have needed any help with OS/2 if we'd used a different platform for testing.

So, this time the problem wasn't OS/2 at all. On the other hand, I wasn't terribly surprised when we had difficulties. As I said earlier, OS/2 is very stable and reliable once you get things set up and running, but getting things working in the first place can be nontrivial.

IBM is working on that. They've been adding drivers like mad. They also hired my friend Rich Heimlich to show them



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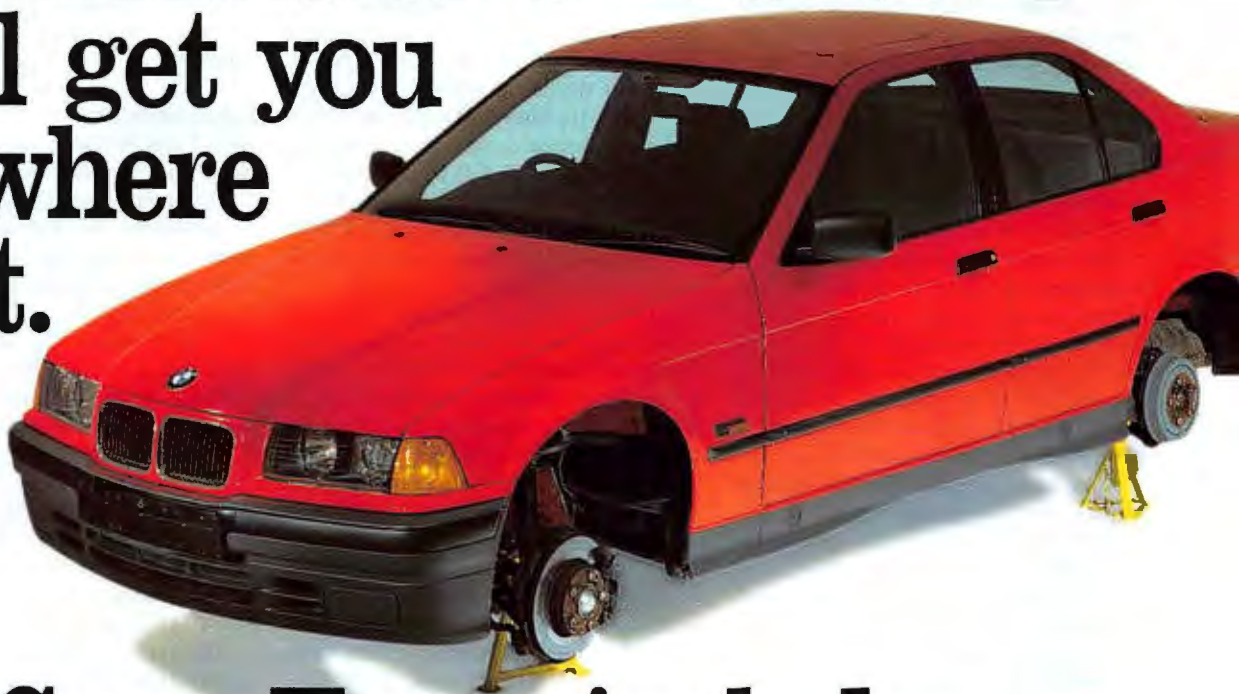
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how to get the 100 best-selling games running with the most popular CD-ROM and sound cards under OS/2. That will, coincidentally, take care of almost all multimedia software. Games always test the limits of what you can do; if it runs major games, it will probably run anything.

The delay in shipping Chicago, or Windows 95, gives IBM yet more time to get OS/2 out there as the true 32-bit system of the future. That's far more important than OpenDoc. IBM thinks that OS/2 is the answer to Chicago, and now they're working on the answer to Windows NT and Daytona. If Microsoft had gotten Chicago out on schedule, the operating-system wars would be over; but just now, IBM is still hanging in there.

Novell dropping DR DOS is no great surprise. It's likely they bought Digital Research mostly as a hedge against the possibility that Microsoft would engage in all-out war. Some of us remember when the slogan in Redmond was, "The job's not done until Novell won't run."

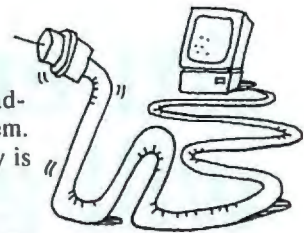
Owning DR DOS gave Novell the ability to ship a NetWare-compatible operating system that users were already familiar with. If it came down to war to the knife,

Novell could simply put DR DOS in the public domain, letting clone makers ship systems without paying for the operating system. That wouldn't destroy Microsoft, but it sure would cut into their cash flow. Because of the history of CP/M and DOS, and the settlement made with the late Gary Kildall (who wrote CP/M and founded Digital Research), neither Microsoft nor IBM can ever sue the owner of DR DOS over look-and-feel issues, another form of insurance for Novell.

DR DOS has fanatical and probably justified support from a small group of users, but Novell hasn't put in the effort to keep it out ahead of current versions of DOS, much less move it toward Chicago and 32-bit operations. It will therefore slowly and quietly vanish. Of course, a few will continue to use it.

The fact is that our hardware has long since run away from the clunky, old DOS architecture. It's high time we had a new generation of software that can take advantage of high-speed video, wave-table sound, enormous hard drives, CD-ROMs, and memory to burn. A lot of the new programs are fat and lazy and need all the new capabilities, yet they can hardly be

said to take advantage of them. But a new day is coming.



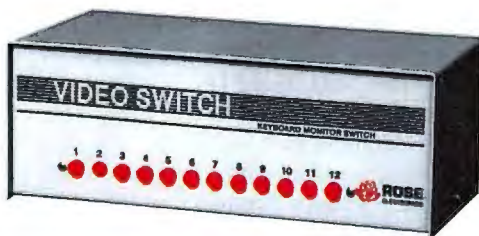
In last month's column, I said that we'd managed to get NetWare and Windows for Workgroups networks working together. That turns out to be not strictly true. I've now learned more about networks than I really wanted to know, and it's still not enough.

Start with the basics. A network consists of two parts: the hardware connections that physically carry messages from machine to machine and the network software. There are many kinds of network hardware. In CP/M days, we used serial ports connected by RS-232 cables to link machines. Then we graduated to parallel-port connectors. Even today, Traveling Software bundles thin, blue serial-port cables and fatter, yellow parallel-port cables to use with LapLink.

The Mac has always had built-in communications. PCs come with serial and parallel ports, but you still need LapLink or some other software to let machines talk to each other. Other companies developed

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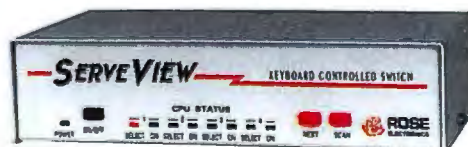
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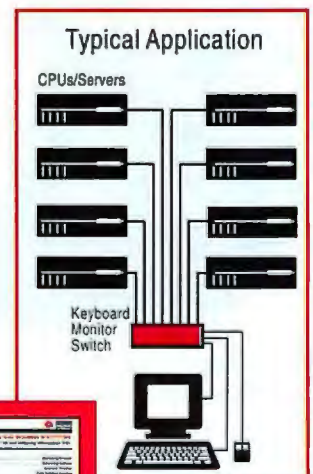
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Pournelle

special chip sets and communications boards for PCs. One of the earliest systems was ARCnet, which had a big play for a while but is now vanishing.

Another early system was Ethernet. Everyone liked Ethernet. For a long time, the chips were very expensive, but now they're not. While other network hardware systems are available, Ethernet is by far the most common. Ethernet chip sets and boards are made by a variety of manufacturers. Two major sources of Ethernet boards are Intel and Artisoft.

There are two major ways to connect systems with Ethernet. One is called thin-wire, or thin-coax, which runs in a great daisy chain connecting all your machines in a single line. Machines are connected to the network cable with T connectors, which attach to the back of the computer. It's possible to disconnect a machine from the chain and still have it work; but if the chain is broken at any point, the entire network collapses.

The other connection system is called 10Base-T (sometimes known as twisted-pair). It allows more flexible configurations (e.g., star and hub) but also requires more equipment. We plan to convert to 10Base-T, but just now we're still using thin-wire Ethernet, which makes it easy to add stations as long as they're close to the cable line. If we want to add one at any great distance, however, we have to string two coax lines. Those usually run behind bookcases, up walls, and across ceilings. Roberta says that network installations are definitely not decorator-friendly.

Once you have the hardware set up, you still don't have a network until you choose and install software. There are two kinds of networks: client/server and peer-to-peer. Windows for Workgroups, LANtastic, and Traveling Software's LapLink and DeskLink are peer-to-peer systems. NetWare is the best-known client/server network. The network setups are not determined by your hardware configuration. NetWare runs just fine on a thin-wire Ethernet daisy chain, and you can hook up a peer-to-peer system using a 10Base-T hookup.

Peer-to-peer networks are exactly what the name implies: each station on the network has equal access to all the others. In a W4WG network, for example, I may decide to share one of Big Cheetah's drives. If I do, that drive will be available for access from every other workstation on the network. I can go to another machine and

access the shared drive as if it were present on the machine I'm using.

In our peer-to-peer network, we have in practice dedicated one machine to be a "server" in the sense that it has a few large hard drives, a Pioneer New Media Technologies' DRM-604X CD-ROM drive, and a DE-UH7101 WORM/rewritable optical drive. All those are shared and thus are available as assets to any machine on the network.

I use those assets a lot. I archive stuff off to the optical drive. I keep CD-ROMs I use often, such as Microsoft Bookshelf, on the DRM-604X and reserve the local CD-ROM drive for whatever I'm working on at the moment.

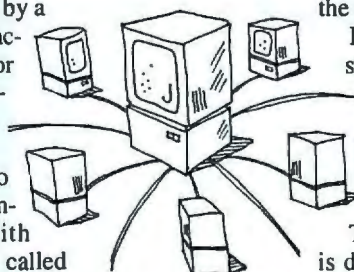
The NetWare client/server network is different. You designate one machine as a network server, which means that you don't use it for anything else. The other machines are workstations. Each has access to the server, but not to the other workstations. Thus, if the Pioneer optical and CD-ROM drives are physically attached to the server, they'll be available across the network; but if they're not—if they're attached to a workstation (i.e., a client) rather than to the server—other clients can't get at them.

In my case, in addition to the DRM-604X attached to the old Cheetah 386, I have a Maximum Storage WORM drive attached to the SuperCow 486/66, a DAT drive attached to the Cheetah 486/33, and yet other assets attached to other machines. Each of those is connected to the Ethernet, and each can run W4WG. As long as the W4WG network is up, I can get at nearly any asset from any workstation. Given how I work, that's convenient.

Alas, W4WG peer-to-peer file transfer is slow. NetWare has been tuned over the years and is really speedy. Quite often, access over the network is as fast or faster than access from a local drive.

There are other advantages to a NetWare network. Backups are simpler because you're storing your most important work on the network server. The best archiving and backup software, such as Palindrome's Network Archivist, is designed to work with NetWare. For instance, you can set rules that say if you haven't accessed a file in six months, Network Archivist will archive it on tape and remove it from your server drive. Next time you need to access it, Network Archivist will find the file in the archives. W4WG has no way of knowing when you last accessed a file (unless you wrote to it), but NetWare does.

Also, NetWare offers far better and



more flexible security than any peer-to-peer network. W4WG does have some capability for requiring a password before you can remotely access a given drive or directory, but it's a lot easier to defeat than NetWare's system, which allows different levels of access to server files and services. Security isn't a big problem at Chaos Manor, but for some places, it's the most important consideration of all.

NetWare is very flexible. It can network old DOS systems without Windows, Macs, and OS/2 systems. All those can be clients and use network assets. Roberta has several Macs that can talk to each other, but she has refused to take the time to use Windows. Her PC system runs DOS, QEMM, and Desqview. She's not on the network, so backing up her stuff is a pain. I want to get her on the network, and the only practical way to do that is to run NetWare.

Finally, there are many third-party programs (such as Fax<HQ, which I wrote about last month) that are designed to work with NetWare. There are hardware boxes designed to increase the capability of NetWare installations. One, for instance, attaches to your LaserJet printer and makes it available to any network machine. When you print under NetWare, your job is "printed" to a file on the NetWare server, which takes over supervision until the printing is finished. One of Pournelle's laws is "one user, at least one CPU"; another is "no one really wants to share his CPU with anyone, including himself." We're not quite to "one task, at least one CPU," but we're getting there.

I wanted NetWare for the increased file access speed, but adding network services was the deciding factor for installing NetWare alongside W4WG. I really like Fax<HQ, and I love talking to my printer at Ethernet speeds. I've got a lot of programs I need but don't use often that may as well be over on a network server rather than local. On the other hand, I need the peer-to-peer assets I get with W4WG.

For a while, it seemed we had managed to have both. There were problems. NetWare grabs drive letters from Z backward, but W4WG starts at the top and works down. Because I have a lot of shared drives—the DRM-604X uses six right off the bat—I need as many as I can get, which means we have to do tricks with the Last Drive statement on start-up.

All that was awkward but endurable; but then other mysterious things happened. The NetWare network didn't seem to have problems, but W4WG connections would mysteriously disappear. Sometimes we could get them back by disconnecting and reconnecting. Sometimes we couldn't.

continued

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David B. Egan
Publisher

The worst moment came when I attempted to connect the Zenith Z-Noteflex color notebook to the system. My usual system is to attach a yellow parallel-port cable to one of the systems on the W4WG network and run LapLink Pro on both the laptop and the desktop. LapLink Pro then sees every network drive that the desktop can see. After we installed NetWare, that didn't work anymore.

The problems weren't consistent, and I had deadlines. Finally, I told Alex to shut down the NetWare network and restore W4WG. He thought he'd done that, but things still weren't working right everywhere. On some machines, all was as before; but on Big Cheetah, I'd ask for the list of network connections and get an error message. Drive connections would vanish. Inspection of the AUTOEXEC.BAT file showed we were still running some of the NetWare start-up routine. Remarkably those out fixed the problem.

There's one moral to this story. Before you install NetWare, or attach your system to a NetWare network, be sure you keep copies of CONFIG.SYS, AUTOEXEC.BAT, WIN.INI, and SYS.INI.

Now that the deadlines are over, we're

going to rethink the situation and try again. I still want both NetWare and a good peer-to-peer system. We'll try to tweak NetWare and W4WG once more, but I haven't found anyone who's really happy running both, so we'll probably try other combinations. LapLink V allows peer-to-peer file transfer over a NetWare network, but it doesn't seem to allow programs to access drives that way. There are third-party software packages said to let me access the Pioneer CD-ROM and optical drives even though they're on a workstation. For that matter, maybe I'll just install the Pioneer assets on the Gateway 2000 machine we use as the NetWare server.

For now, this advice: if all you need to do is share assets from one computer to another, W4WG is a good beginner's network. It's easy to set up, and it works fine if you leave it alone. NetWare is harder to install, but it's fast and flexible and speeds up Windows printing. If you get both working before I do, please let me know.

Bill Gates long ago pointed out that computing power per buck was doubling every year and a half, a trend that hasn't slackened off yet. Everyone knows that the average

person now has computing power not available to anyone, including the government, a few decades ago. There are also powerful simulation programs to run on desktop computers. Some of these, like PowerSim for the PC and Extend for the Mac (and now for Windows), have non-linear system-modeling capabilities far greater than were available to Jay Forrester and his World Dynamics projects, made famous in the Carter era.

With all these tools available for the desktop, it would be natural to assume that more powerful modeling tools are available to the professionals, that institutions with big computers can make reliable predictions about nearly anything. Those familiar with Forrester's World Dynamics models, which were discussed in books with titles like *The Limits to Growth* and *Models of Doom*, know that the Forrester world model made some pretty gloomy forecasts and contributed to President Carter's apprehension of a "national malaise." Now anyone with a Pentium machine and PowerSim can build models more complex than Forrester's—surely the government can do much better?

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small computers have become extremely powerful in comparison to what we had in the early 1970s, and supercomputers can certainly do things that were impossible in those days, we still don't have the computing power to reliably model something as complex as the atmosphere. Of course, that doesn't stop people from playing with such models and publishing their conclusions. The results of that playing are about to cost us some \$135 billion, and estimates range up to \$2 trillion.

These costs are associated with changes in air-conditioning, fire fighting, and refrigeration, as we rapidly move to ban chlorofluorocarbons, said to cause the destruction of ozone in the upper atmosphere. Clearly, something like ozone destruction is not lightly to be risked. On the other hand, a trillion dollars is no small thing either, not to be risked until you're pretty sure of what you're doing. I mean, a trillion here, a trillion there, and pretty soon it adds up to real money.

I don't think the policymakers know what they're doing. Worse, I think it's the astounding success of our little machines that has the public ready to believe they do. Those interested in the subject should write to the George C. Marshall Institute (1730 M Street NW, Suite 502, Washington, DC 20036) and get a copy of "The Ozone Crisis," a short—20 pages—paper by a friend of mine, Sallie Baliunas. Sallie has studied the ozone-depletion theory and concludes that "there is no scientific reason for our current policy, and there is no economic reason to have a policy that is inflexible and irreversible." Her reasons are given in this paper.

I've no suspicion that I'm infallible or that Sallie can't be wrong; but I do believe this is a matter of considerable economic importance that has an impact on every one of us. It's certainly important enough to bring to your attention.

I don't suppose I'm any more vain than the next man (although I suppose that can depend mightily on who the next man is), but I confess I'm rather proud of a picture taken in the White House. It shows me, General Graham, and Max Hunter in the act of convincing Vice President Dan Quayle that we ought to build a single-stage-to-orbit spaceship. Quayle took us seriously, listened to our opposition, got opinions from two other groups, and caused the Air Force to build the DC/X, which I've written about before.

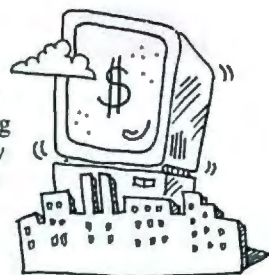
In a couple of hours, I'm catching a plane to Atlanta for a computer show. I'll go from there to Washington, where I'm sitting in on a roundtable discussion con-

vened by the Administrator of NASA. Participants include the CEOs of Martin Marietta, Lockheed, and Boeing; the NASA Administrator; the Deputy Secretary of Defense; a couple of senators and representatives; General Graham; and me. The subject is the future of NASA. Meetings of this sort don't usually accomplish much, but there's a chance this one will. At least we can all trade ideas.

I was putting together some materials for the meeting, and David Mitchell suggested that we scan in the White House

picture and include that in my briefing packet. I don't know what the next man would do, but I thought it was a good idea.

The scanned image ended up as a 2-MB TIFF file. David says he also got a 14-MB high-resolution file, which I figured was a bit much. The next question was how to display the scanned image.



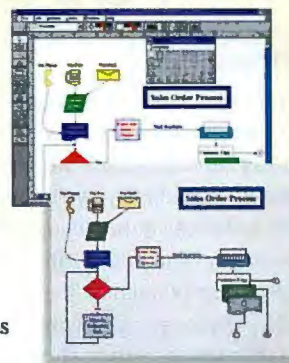
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I had CorelDraw 3.0 installed on my network, but we recently received CorelDraw 5.0, and this seemed like a good time to install it on Pentafluge. This is our Pentium machine that boasts ATI Technologies' Graphics Pro Turbo Mach 64 graphics card and an NEC MultiSync 5FGp monitor. CorelDraw 5.0 comes on a plethora of disks; fortunately, there's also a CD-ROM shrink-wrapped into the instruction manual. Installation from CD-ROM is absurdly simple and goes swiftly. Once I had that done, I opened CorelDraw PhotoPaint and read in the scanned image.

It was gorgeous. This was the smaller file with lower resolution than the original, but it looked fine to me. Now would it print? I saved it as a .BMP file, opened Word 6.0 for Windows, and did Insert Object. The system trundled for a minute or so, and there was the color image pasted into a Word document. I hit the print icon to send it over to the LaserJet III.

The result was an acceptable black-and-white copy of the original color photo. I'm sure I can tweak it to adjust gray scales and make it sharper, but I probably won't bother.

The next step didn't work as well. The

Z-Noteflex notebook I mentioned earlier is what I'll be taking on the trip. I installed Word 6.0 for Windows, using the "minimum" or laptop installation choices, and tested it out by reading in a novel. It worked just fine. Alas, when I tried to read in the saved document containing my photograph, I locked up Word. Ctl-Alt-Del got me back to Program Manager, and a test of Word on text documents showed no problems.

It's late at night. I don't know if I didn't install all of what Word needs to read that or if there's a problem because the Z-Noteflex is in 640- by 480-pixel resolution instead of the 1064- by 760-pixel resolution I used on my desktop or if the 8 MB of RAM in the Z-Noteflex just isn't enough memory or if I didn't hold my mouth right. Before I make my presentation, I'll have PowerPoint installed on the Z-Noteflex, and maybe I can get it to display my picture. The Z-Noteflex has a 200-MB hard drive, and I've got another 150 MB on the BSE Flashdrive I carry in checked luggage. If I get a chance, I'll copy CorelDraw PhotoPaint over to the system. And it's not the end of the world if I can't manage to get any of it to work.

I think I'm going to like the Z-Noteflex. I stuck with a monochrome Zenith Mastersport as my portable of choice for the last couple of years because it's a rugged and reliable machine. The Z-Noteflex looks to be as sturdy. We'll see. I'm hard on portables.

Many of the images in Roberta's Literacy Connection reading-instruction program have been taken from the T-Maker collection of ClickArt. You've probably seen a lot of T-Maker's ClickArt images in presentations and newsletters. There's a huge variety of images covering every conceivable subject—religion, business, animals and vegetables, funny beasts, sports, children, and everything else. T-Maker also supplies tools for converting the images to nearly any format your publishing program wants.

The latest ClickArt is called Holiday Seasonings, images suitable for holiday greeting cards and suchlike.

These collections make it easy for somebody who's not an artist to decorate publications and presentations. If you get stuck with doing the club newsletter or the company party invitations, you ought to know

URGENT —YOUR INPUT NEEDED

On: DATA REFINING and DATA MINING

Dear Reader:

To improve BYTE's coverage of technology in the State of the Art section, we'd like to get *your* feedback about what topics, areas, and products we should be considering, and in what ways. Specifically, we're planning to cover data refining, or what some call data mining. This will involve looking at not only the manipulation and presentation of data through SQL or other products but also at the process of examining your data carefully, discovering new relationships, and extracting the most *information* from that data. So we need to know what your requirements in this area are, what products and services you'd like to see available, and maybe even some tips on people we should be talking to—users, vendors, researchers—you tell us!

Also, we're using a new method to capture your comments and suggestions so that we can use them more easily in the future, not just as a one-shot item. To let us know what you think, please use the following as a template to send us, via E-mail, an ASCII text file with your comments. Please be sure to include the "<FIELDNAMES>" with their angle brackets, followed by your information and comments. And thanks very much for your help.

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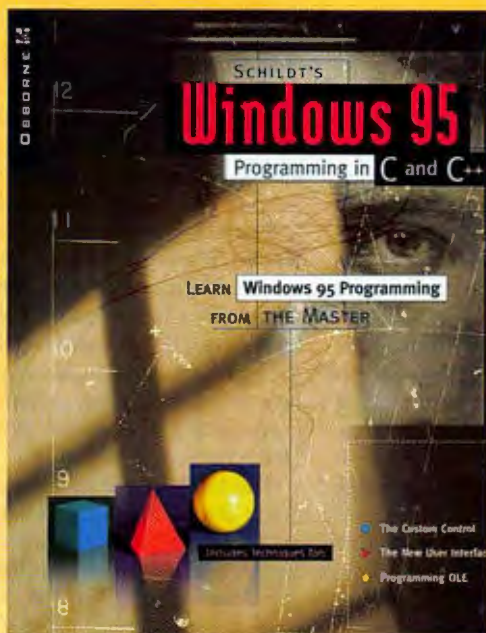
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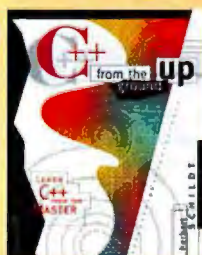
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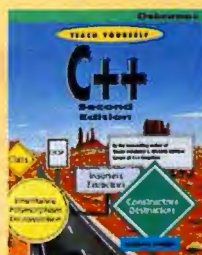


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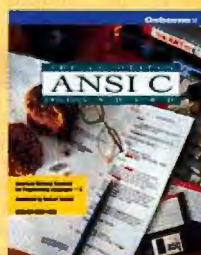


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about T-Maker and ClickArt. You'll like this stuff. Highly recommended.

Jim Baen of Baen Books uses Ventura Publisher to set type and make camera-ready copy for many—maybe all—of the books he publishes. I try to meet deadlines, but sometimes I cut things pretty close. Once I delivered the final copy of a novel to Jim about three weeks before it was to ship.

The book didn't need much copy editing, and by using Ventura and doing the work in-house, Jim got the masters to the printer on time. Ventura has since been acquired by Corel, which is likely to make a good product better. I won't pretend to be an expert on making books look good, but Jim is a bit of a fanatic on the subject. While he's got some quibbles with Corel Ventura, it's what he uses.

I have fooled around with some lower-cost publishing programs, and Roberta, who uses a Mac for her publications, is quite fond of Aldus PageMaker. I have concluded, however, that if I were stuck with the job of publishing newsletters or books or much of anything else, I'd get the biggest and fastest system I could afford. Final-draft desktop publishing can eat computer resources like mad. You can do page layouts with small systems, but you won't be happy doing it.

After I got fire-breathing hardware, I'd get Corel Ventura, T-Maker's ClipArt, as well as the Corel CD-ROMs, and then I'd get to work. Learning the fine points of Corel Ventura will take time, but it's no

harder than any of the other desktop publishing programs I've seen. Once you've learned it, you'll be ready for anything. Why fool around with half measures?

For weeks my friend Larry Aldridge has been urging me to look at Caligari TrueSpace, so the package sat accusingly on top of Pentafluge. Alex finally got around to installing it two nights ago. Wow!

I'm not all that familiar with 3-D design programs, but I'm sure impressed with this one. It's fast—at least on Pentafluge it's fast—and you can do incredible things with it. Even the demonstration program is impressive.

There's a huge selection of tools. Start with a shape, distort that, spin it, lathe off some, extrude it to be a solid, lathe away at the solid, change colors, change lighting, turn it into a wireframe and move it around, animate it, and squeeze it through a funnel—all that and more.

It's pretty easy to get started, too, and so far everything has been intuitive. I have no doubt that you can spend a lot of time learning to use all the tools and it helps to have some artistic talent; but if anything can get you going in 3-D design, this is it. Highly recommended.

The game of the month is still MicroProse Software's XCOM: UFO Defense, which continues to absorb far more time than I ought to give it. Another one I like is Sierra On-Line's Alien Legacy, which is similar to the better-known Outpost. Ex-

plore another solar system and found a human colony. This game was created by Joe Ybarra, designer of Starflight (the Chaos Manor game of the year nearly a decade ago), and it's pretty neat. Having said that, I confess I've left my human colony half complete to go back to XCOM.

The fun product of the month is Kitty Hawk Software's The Greatest Paper Airplanes, more than you want to know about how to design and fold paper airplanes. It would make a great stocking stuffer.

The computer book of the month is Robert Waring's *Doom: Totally Unauthorized Tips and Secrets* (Brady Books, 1994). This has more than you need to know about Doom, including maps, where the monsters and treasures are hiding, and how to get Doom enhancements. If you crave using a chain saw on the creatures of Hell, you need this book.

The book of the month is Andy McNab's *Bravo Two Zero* (Dell, 1994), the autobiographical story of a sergeant of the British Special Air Services Regiment during Desert Storm. Wow! ■

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 jerryrpbix.com.

For More Information

One game I like is **Alien Legacy** (\$49.95), which is similar to the better-known Outpost, and it is pretty neat. Contact **Sierra On-Line**, Oakhurst, CA, (800) 757-7707 or (206) 649-9800; fax (206) 562-4223. **Circle 1146 on Inquiry Card.**

If anything can get you going in 3-D design, **Caligari TrueSpace** (\$795) will do it. Contact **Caligari Corp.**, Mountain View, CA, (800) 351-7620 or (415) 390-9600; fax (415) 390-9755. **Circle 1147.**

Installation of **CorelDraw 5.0** (disk and CD-ROM, \$895; CD-ROM only, \$695) from CD-ROM is absurdly simple and goes swiftly. In addition, it made my scanned image of the White House picture look gorgeous. Learning the fine points of **Corel Ventura** (disk and CD-ROM, \$595; CD-ROM only, \$495) will take time, but once you've learned it, you'll be ready for anything. Contact **Corel Corp.**, Ottawa, Ontario, Canada, (800) 772-6735 or (613) 761-9176; fax (613) 728-9790. **Circle 1148.**

A range of simulation programs, **Extend** (Mac or Windows version, \$695 each), **Extend+BPR** (Mac or Windows version, \$990 each), and **Extend+Manufacturing** (Mac or Windows version, \$990 each), have powerful nonlinear system-modeling capabilities. Contact **Imagine That, Inc.**, San Jose, CA, (408) 365-0305; fax (408) 629-1251. **Circle 1149.**

The fun product of the month is **The Greatest Paper Airplanes** (\$29.95), which would make a great stocking stuffer. Contact **Kitty Hawk Software, Inc.**, Tucson, AZ, (800) 777-5745 or (602) 622-2200; fax (602) 622-3700. **Circle 1150.**

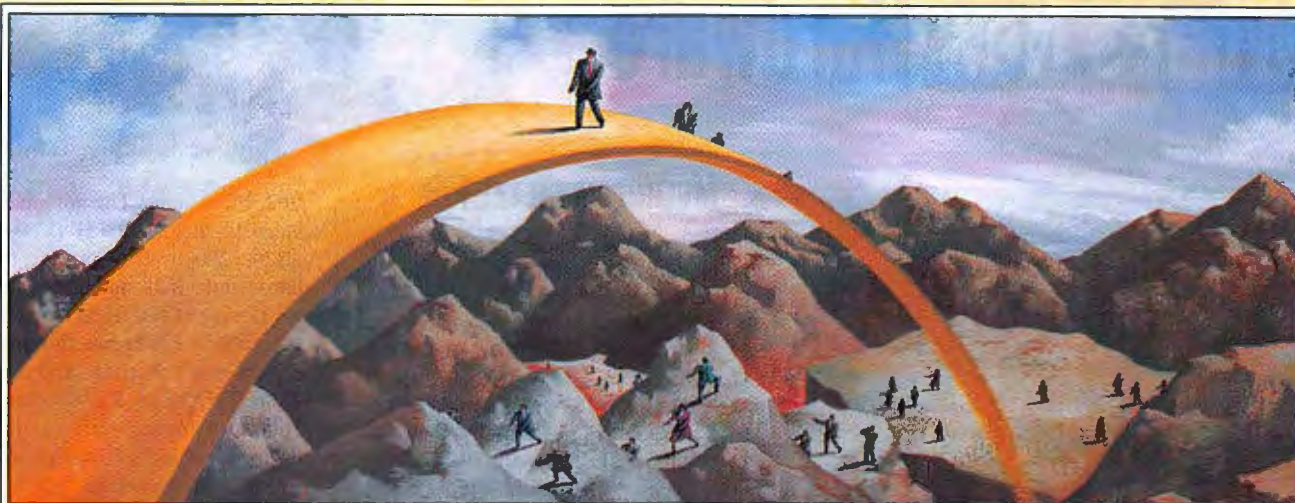
The latest ClickArt is called **Holiday Seasonings** (\$24.95), images suitable for holiday greeting cards and suchlike. The T-Maker collections of **ClickArt** (\$27.95 to \$339.95) make it easy for somebody who's not an artist to decorate publications and presentations. You'll really like this stuff. Contact **T-Maker Co.**, Mountain View, CA, (800) 533-0331 or (415) 962-0195; fax (415) 962-0201. **Circle 1151.**

If your work is worth anything at all, you need a reliable backup system. The **Iomega Tape250 Parallel Port II** (\$385) is plenty good enough. Contact **Iomega Corp.**, Roy, UT, (800) 777-6654 or (801) 778-1000; fax (801) 778-3450. **Circle 1152.**

Simulation programs like **PowerSim 2.0** (\$640) have powerful nonlinear system-modeling capabilities. Contact **MicroWorlds, Inc.**, Cambridge, MA, (617) 225-0025; fax (617) 225-0028. **Circle 1153.**

The game of the month is still **XCOM: UFO Defense** (call for price), which continues to absorb far more time than I ought to give it. Contact **MicroProse Software**, Hunt Valley, MD, (800) 879-7529 or (410) 771-1151; fax (410) 771-1174. **Circle 1154.**

I think I'm going to like the **Z-Noteflex** (\$3222). I stuck with a monochrome Zenith Mastersport as my portable of choice for the last couple of years because it's rugged and reliable. The Z-Noteflex looks to be as sturdy. Contact **Zenith Data Systems Corp.**, Buffalo Grove, IL, (800) 533-0331 or (708) 808-5000; fax (708) 808-4483. **Circle 1155.**



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What's New Hardware



MULTIMEDIA ON THE RUN

Beneath the keyboard of the V41 line of multimedia notebooks is a full-size, double-speed CD-ROM drive that plays 16-bit stereo sound and accepts 8- and 12-cm 540-MB CDs. A PCMCIA slot accommodates Type II and III cards; a 10.4-inch TFT color screen offers 65,536 colors and 640- by 480-pixel resolution. Prices start at \$3999 for the 8.4-pound, 50-MHz 486DX2 model with 4 MB of RAM, a floppy drive, and a 260-MB hard drive. Pentium models are under development.

Contact: Panasonic Personal Computer Co., Secaucus, NJ, (800) 742-8086 or (201) 271-3182.
Circle 1313 on Inquiry Card.

FAST, WRITABLE CD-ROM

Pinnacle Micro's (Irvine, CA) recordable CD-ROM system, the RCD-1000, offers double-speed writing capability and a 1-MB cache buffer that lets you write data to a disc without interruptions. It can create ISO 9660, HFS, CD-Image, multisession, or audio-format discs; each disc (\$39) holds 680 MB of data or 74 minutes of audio. The Mac system costs \$2995; the PC version costs \$3195. Both versions include backup software for performing random-access data retrieval.

Phone: (800) 553-7070 or (714) 727-3300.

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VIDEO TELECONFERENCING

From Alpha Systems Lab (Irvine, CA), the PC-based MegaConference package (\$1100) provides a MegaMotion multimedia video card, a 28.8-Kbps modem, and software for doing video teleconferencing over standard telephone lines. You can view full-motion video images (one live and one compressed) on two Tru-Color subscreens and share a two-way whiteboard workspace. The MegaMotion card can handle 30-fps video captures at resolutions as high as 320 by 240 pixels.

Phone: (800) 576-4275 or (714) 622-0688.

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HIGH CAPACITY IN A SMALL PACKAGE

Integral Peripherals (Boulder, CO) has added a high-capacity hard drive, the PocketFile 260 (\$499), to its family of 1.8-inch PCMCIA Type III devices. Built for ultralow-power consumption and to withstand rugged handling, the drive offers an average seek time of 12 ms and an MTBF rating of 250,000 hours. The unit has a capacity of 260 MB.

Phone: (303) 449-8009.

Circle 1320 on Inquiry Card.

FLEXIBLE UNIX STORAGE

The SuperFlex series of uninterrupted data-access systems from Storage Dimensions (Milpitas, CA) now support Unix systems. All the SuperFlex disk, tape, and RAID systems provide 16-bit SCSI performance; a backplane design accommodates interchangeable I/O modules, which will provide an easy upgrade path as new technology emerges. SuperFlex ESP technology permits multiple versions of Unix to run on several hosts, which

fosters enterprise-wide storage solutions based on common service procedures. An entry-level, 1-GB SuperFlex for RS/6000 system costs \$6185. Products for Sun and HP 9000 systems, as well as other Unix versions, are under development.

Phone: (408) 954-0710.

Circle 1321 on Inquiry Card.

WATCH THIS

Audio 15, a 15-inch monitor from Tatung Co. of America (Long Beach, CA), conserves desk space by incorporating two internal speakers into the unit's case. Positioned at the sides of the monitor, the speakers have a frequency range of 100 Hz to 20 kHz. The noninterlaced flat-screen monitor (\$499) offers a 0.28-mm dot pitch, 1024- by 768-pixel resolution, and a 75-Hz refresh rate. Tatung also offers two large-screen monitors, the 17-inch CM17MKR (\$995) and the 20-inch CM20MKR (\$1799). Both have flat screens and offer a refresh rate of 120 Hz and resolutions as high as 1600 by 1280 pixels.

Phone: (800) 829-2850 or (310) 637-2105.

Circle 1318 on Inquiry Card.

The Elite series of flat-screen monitors, from MAG InnoVision (Santa Ana, CA), are compatible with PCs, Apple systems, and Sun

SPARC systems. The noninterlaced 15-inch MXE15F (\$749) offers 1280- by 1024-pixel resolution and a 0.28-mm dot pitch, the 17-inch MXP17F (\$1299) offers 1600 by 1280 resolution and a 0.26-mm dot pitch, and the 21-inch MXP21S (\$2499) offers 1600 by 1280 resolution and a 0.28-mm dot pitch. All models are Energy Star-compliant.

Phone: (800) 827-3998 or (714) 751-2008.

Circle 1319 on Inquiry Card.

A JACK OF TWO TRADES

The Jack of Diamonds Trumpcard from Ositech Communications (Guelph, Ontario, Canada) bundles an Ethernet network adapter and a high-speed cellular data/fax modem into a Type II PCMCIA card. All hookups are achieved through direct cable connections to a wall socket or a cellular phone. The \$549 model comes with a 14.4-Kbps data/fax modem and a 10Base-T adapter (or a 10Base-2 adapter and a 10Base-2 adapter); with a 28.8-Kbps data/fax modem, the product costs \$749.

Phone: (519) 836-8063.

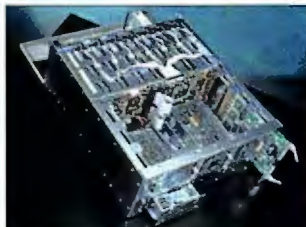
Circle 1322 on Inquiry Card.

FOUR-CHANNEL MULTIPLEXING

A four-channel multiplexer, The Fox provides high-speed, full-duplex communication among eight devices over a pair of fiber-optic cables. Each channel operates at speeds as high as 64 Kbps. The Fox includes a wall-mounted transformer, a test switch, and an internal jumper for switching from a four-port multiplexer to a three-port multiplexer whose fourth channel supports full-duplex, 128-Kbps operation. From Telebyte Technology (Greenlawn, NY), The Fox costs \$450 and comes with four 25-foot RJ-11 interconnecting cables and eight adapters.

Phone: (800) 835-3298 or (516) 423-3232.

Circle 1323 on Inquiry Card.



RIDING ON AIR

AirLink Bridge, a remote Ethernet wireless bridge, has a range of 15 miles when it's operating at maximum capacity: 1872 64-byte packets per second. From Cylink (Sunnyvale, CA), the full-duplex unit costs \$7995 and supports all network operating systems and protocols. It meets all IEEE 802.3 LAN standards and is FCC certified as a spread-spectrum transmitter. No license is required for operation in the U.S. and many other countries.

Phone: (408) 735-5800.

Circle 1324 on Inquiry Card.

LOOK—NO CORD ▼

The teardrop-shaped Remote-Point cordless mouse (\$199), from Interlink Electronics (Camarillo, CA), lets you work as far as 40 feet from your desktop. The device relies on an infrared transmitter and a receiver; it has a sleep mode to extend the life of its two AAA batteries. The PC version of the receiver plugs into a serial port or a PS/2 mouse port; the Mac version uses the Apple Desktop Bus interface. Neither model requires any special software.

Phone: (805) 484-1331.

Circle 1325 on Inquiry Card.



GETTING A FIX ON BOARD TROUBLE

Designed to troubleshoot malfunctioning or dead boards, the New Single Step Debug Board from International Debug Tools (Houston, TX) allows you to single-step through BIOS instructions, trap user-defined addresses, capture data at user-defined addresses, and intercept POST codes. By providing an overview of how the entire data bus and the address and control buses are

FREEDOM OF SPEECH

When attached to the parallel port of any Windows PC, the small SounText adapter can read numbers, letters, and text in eight languages: English, French, German, Italian, Spanish, Mandarin, Russian, and Dutch. Working in any Windows program, you highlight the desired information and click on the appropriate language icon. A package with English-to-Spanish translation software (other translators are under development), a high-quality external speaker, an internal battery holder, an AC/DC adapter, and a parallel port connector costs \$99.

Contact: Fortress Systems, San Jose, CA, (408) 955-9888.

Circle 1314 on Inquiry Card.



functioning, it lets you pinpoint the source of a problem. The ISA model is \$299; the EISA model costs \$499.

Phone: (800) 843-3284 or (713) 873-6834.

Circle 1326 on Inquiry Card.

MULTIMEDIA MIXERS

Working in tandem, the 32-bit Pixellock overlay card (\$499) and the 32-bit PixelMaker VGA card (\$299) enable you to integrate PC graphics and video images. Pixellock converts 24-bit VGA images into TV images and overlays them onto live video, using 8-bit alpha-channel compositing. You can view the output on TV or record it on videotape. PixelMaker supports 1280- by 1024-pixel resolution, displays 16.7 million colors, and comes with 1 MB of DRAM, upgradable to 2 MB. Both products are from Power Pixel Technologies (Santa Clara, CA).

Phone: (408) 748-0246.

Circle 1327 on Inquiry Card.

NETWORK PRINTING WHERE YOU LIKE IT

Extended Systems* (Boise, ID) ESI-2849A PocketPrintServer transfers data at speeds as high



as 120 Kbps and is designed to allow NetWare network administrators to connect a parallel printer anywhere on a token-ring network. Because the unit's firmware is stored in flash memory, you can easily update it to work with new releases of NetWare as they become available. The \$659 ESI-2849A supports standard parallel and bidirectional printers, handles as many as eight file servers and 32 print queues, and comes with STP and UTP connectors.

Phone: (800) 235-7576 or (208) 322-7575.

Circle 1328 on Inquiry Card.

NEW PRINTERS ON THE BLOCK

Designed to offer optimal performance for Windows printing, Lexmark International's (Lexington, KY) WinWriter 100 (\$349), WinWriter 200 (\$579), and WinWriter 400 (\$899) are all compatible with current and future releases of Windows. A compact ink-jet unit, the WinWriter 100 produces 600- by 300-dpi output at a rate of 3 ppm. The WinWriter 200 produces four pages of 300-dpi laser output per minute and comes with 512 KB of memory and 22 TrueType fonts. Using LED technology, the WinWriter 400 prints 5 ppm at 600 dpi; it has 2 MB of RAM and 44 TrueType fonts.

Phone: (800) 358-5835 or (606) 232-2000.

Circle 1329 on Inquiry Card.

Mitsubishi Imaging Products (Somerset, NJ) offers two color printers that employ different technologies. The wax-thermal G2700-10U (\$1499) prints a full-color page of 300-dpi output in 1 minute. It comes with a Windows 3.1 driver and prints on plain or coated paper or on transparency film, using a monochrome, three-color, or four-color ribbon. Designed for use with PCs, Macs, and Unix systems, the CP-2000U (\$8995) uses dye-sublimation technology to produce a 325-dpi image in as little as 85 seconds. Compatible with the SVGA standard, it can produce images of up to 1280 dots by 1024 lines from an analog RGB source.

Phone: (908) 563-9889.

Circle 1330 on Inquiry Card.

THE SOUND OF STEREO MUSIC

Two new sets of speakers from Jazz (City of Industry, CA) let you improve the quality of your system's sound without upgrading your sound card. Both sets make monaural sound simulate stereo sound and make stereo sound simulate 3-D sound; they can be used with CD players, stereos, and other sound sources. The J-688S comes in a plastic cabinet and sells for \$197.95 per pair; the J-707S comes in a wooden cabinet and sells for \$379.95 per pair.

Phone: (818) 336-2689.

Circle 1332 on Inquiry Card.

What's New Hardware



SIGN HERE

The compact, pressure-sensitive Portable MP100 Writing Pad (\$459) lets you capture handwritten data and transfer it to a PC via an RS-232 connector. The device offers 1024-by-1024-pixel resolution, weighs less than 2 pounds, and can be used with paper and a ballpoint pen or with a nonelectronic stylus. Rechargeable batteries are rated for 10 hours; the device remains in operation when the AC adapter/charger is in use.

Contact: Inforite, San Mateo, CA, (800) 366-4635 or (415) 571-8766.

Circle 1315 on Inquiry Card.

REMOTE DATA MANAGEMENT

Remote StandbyServer, from Vinca (Orem, UT), connects a backup server to a primary server through a common carrier connection, letting you operate an on-line, warm standby server miles away from your company's main office. The product is compatible with standard communications hardware and media and supports common protocols, such as Frame Relay and X.25. Supported interfaces include RS-232, V.35, X.21, and RS-422; the unit's base price is \$6995.

Phone: (800) 934-9530 or (801) 223-3100.

Circle 1333 on Inquiry Card.

AVOIDING COLLISIONS

Grand Junction Networks' (Fremont, CA) CollisionFree is a full-duplex, 100-Mbps Fast Ethernet adapter. According to the company, this device can double the bandwidth between two of the company's FastSwitch Ethernet switches or between fast Ethernet ports on FastSwitch Ethernet switches and dedicated servers. Pricing for CollisionFree is \$549 for the FastNIC 100 EISA, \$8350 for the FastSwitch 10/100, and \$9350 for the FastSwitch 10/100 AG. FastSwitch 10/100 and FastSwitch 10/100 AG customers can upgrade to CollisionFree for \$400; the FastNIC 100 EISA upgrade costs \$50.

Phone: (800) 747-3278 or (510) 252-0726.

Circle 1334 on Inquiry Card.

MINIATURE REPEATERS/HUBS

About the size of a postcard, the LMR Mini Repeaters/Hubs can connect eight nodes or network segments to a backbone or can act as hubs on stand-alone networks for as many as nine users. From Lantronix (Irvine, CA), the units can be cascaded to provide more connections. The four-port models—the LMR-4T, with an AUI port for network connection; the LMR4T-2, with a BNC port; and the LMR5T, with a fifth twisted-pair connector—sell for \$175 each. The eight-port models—the LMR8T, with an AUI; the LMR8T-2, with BNC; and the LMR9T, with all twisted-pair connectors—cost \$250 each.

Phone: (800) 422-7055 or (714) 453-3990.

Circle 1335 on Inquiry Card.

AN LCD PROJECTION PANEL

Compatible with all popular PC and Mac platforms, the highly portable Ovation+ series of active-matrix LCD projection panels come with plug-in cables like a monitor's, a serial mouse offering one-button control of the panel and computer, and a LightBoard feature that allows you to draw and write directly on the unit's screen. From Proxima (San Diego, CA), the Ovation+ 840 (\$4995), the Ovation+ 842 (\$5695), and the Ovation+ 846 (\$6695) support resolutions as high as 800 by 600 pixels; an optional interactive pointer system,

the Cyclops 2050, costs \$495.

Phone: (800) 447-7694 or (619) 457-5500.

Circle 1336 on Inquiry Card.

TESTING, TESTING

The Ethertest Ethernet LAN analyzer (\$2995) lets you measure network performance and analyze traffic patterns. From Frontline Test Equipment (Oak Brook, IL), Ethertest runs on most 386-based PC-compatible desktops or notebooks, has a mouse-driven interface, and comes with an on-line tutor and a troubleshooting guide. You can choose from among three network adapters: a PCMCIA interface, a parallel-port device supporting standard and enhanced parallel ports, or an ISA-compatible half-slot card. Ethertest supports TCP/IP, IPX, NetBIOS, OSI, Banyan Vines, 3Com, 3+Open, and AppleTalk protocols.

Phone: (800) 359-8570 or (708) 575-8570.

Circle 1337 on Inquiry Card.

MAKING MUSIC ON A PC

Compatible with AdLib and Sound Blaster, the 16-bit Audio Forge Professional A-10 (\$255) lets you use a multimedia system as a recording studio. From Triumph Logistic Computers (Covina, CA), the device provides 128 MIDI instruments, multiple drum sets, and 317 synthesized sounds. It offers a GUI and a range of music-editing fea-

tures; it also lets you use WAV, CD, and MIDI audio to create scores for multimedia presentations. The unit has built-in connectors for all makes of CD-ROM players.

Phone: (818) 858-5700.

Circle 1338 on Inquiry Card.

MANAGING MIGRATION

Racal-Datcom's (Sunrise, FL) Excalibur Access Node 2000 is a remote-access device that permits the migration of mainframe business applications to a client/server environment. Equipped with a Motorola 68360 processor, it combines the capabilities of Racal-Datcom's Excalibur digital access product with Wellfleet Communications' Access Node, a highly integrated, fixed-configuration, multiprotocol router/bridge. A self-configuring device, the EAN 2000 supports a variety of access services (including DDS and Frame Relay), popular network and bridge protocols, and Ethernet (AUI and 10Base-T) and token-ring (UTP/STP) interfaces. Unit pricing begins at \$3995.

Phone: (800) 722-2555 or (305) 846-1601.

Circle 1339 on Inquiry Card.

SHARING WORKSTATION RESOURCES

Priced at \$2450, the SBus-SCI adapter card from Dolphin Interconnect Solutions (Westlake Village, CA) lets you exploit the high bandwidth, low latency, and shared-memory capabilities of the ANSI/IEEE Scalable Coherent Interface protocols. Designed for workstation-clustering applications, it links the resources of physically separate systems. The SBus-SCI adapter includes a Unix device driver for the SCI protocols and a TCP/IP interface for compatibility; it can be used with parallel shielded twisted-pair cabling.

Phone: (805) 371-9493.

Circle 1340 on Inquiry Card.

TRUTH IN HARDWARE

Vendors make performance claims. Compatibility claims. Support promises.

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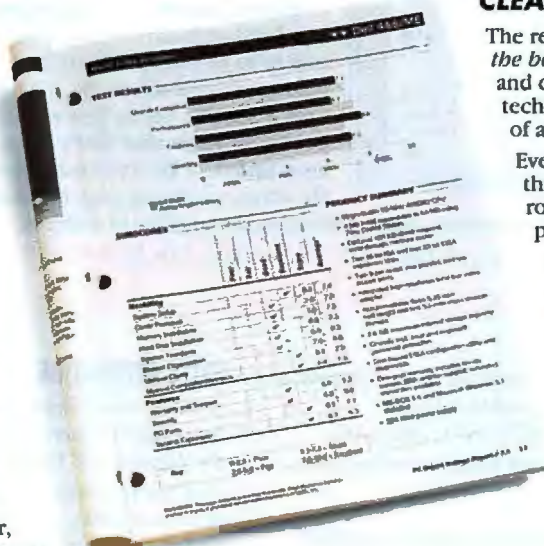
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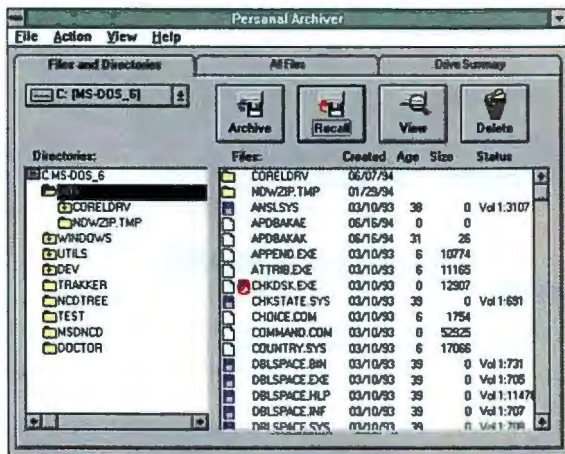
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What's New Software



MANAGE THE FILES ON YOUR HARD DRIVE

A personal storage management utility, **Personal Archiver (\$49.95)** provides complete file management for your hard drive. The tool archives files to a floppy disk on demand, usually based on frequency of use. Each archived file continues to appear to be on your local hard drive. When you access an archived file, it's recalled from a specific floppy disk without disturbing the application that's in use. Features include a Windows user interface, file aging, point-and-click file manage-

ment, file archiving to floppy disks, automatic recall, and automatic tracking of archives.

Contact: Chili Pepper Software, Atlanta, GA, (800) 395-1812 or (404) 339-1812.

Circle 1271 on Inquiry Card.

CROSS-PLATFORM DESIGN

The advanced text-handling capabilities of Adobe Illustrator 5.5 for Sun (from \$995) let you



access the program's text options through a floating character palette. In addition, the software has a

spelling checker with a user-definable dictionary, added row-and-column capabilities, and multiple undo and redo at the document level. Other features of the Adobe Systems (Mountain View, CA) software include plug-in filters, Pathfinder technology, and layers and layer management. The file format is the same as that for Adobe Illustrator software for Mac, Silicon Graphics, Sun, and Windows systems.

Phone: (800) 833-6687 or (415) 961-4400.

Circle 1275 on Inquiry Card.

A SUITE FOR THE OFFICE

Office Suite (\$149.95), from Premium Design (Troy, MI), consists of modules that are tied together via FoxPro. Major modules include Invoicing, Bulk Mailer, Report Generator, Contact Manager, Scheduling, and Word Processing. Other features include an au-

tomated ZIP code retriever and an on-line calculator.

Phone: (313) 362-4400.

Circle 1276 on Inquiry Card.

MANAGE REMOTE PRINTERS

A Unix-based software package, EasyNet (from \$995) lets you manage remote printers connected to any network that uses the TCP/IP protocol. From the EasySpooler division of Seay Systems (Dallas, TX), EasyNet lets you schedule and manage print jobs on printers attached to any remote host on the network without requiring you to log on to that host.

Phone: (214) 522-2324.

Circle 1277 on Inquiry Card.

CASE CONCEPTS

Now available for Windows, CASE Essence (\$5400) instructs teams in the conceptual basis of CASE and object-oriented system analysis. From AGPW (St. Louis, MO), the electronic book emphasizes underlying thinking skills over specific techniques or tools. The core curriculum covers domains, entities or objects, predicates, and entity types or classes.

Phone: (800) 795-7953 or (314) 721-4884.

Circle 1278 on Inquiry Card.

SALES AUTOMATION

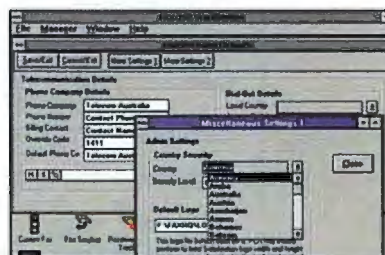
A sales-automation and inventory-control system, Orders Plus for Windows (\$795) provides an easy yet powerful way to automate your business. From Benefit Systems of America (Charlotte, NC), Orders Plus includes activity and sales tracking, quotations, sales orders, invoicing, purchasing, and inventory control. Single-user and multiuser versions are available that support Windows for Workgroups, Windows NT, NetWare, LANtastic, and other NetBIOS-compatible networks.

Phone: (704) 529-1413.

Circle 1279 on Inquiry Card.

SHARED FAXING ▼

Fax<HQ (\$1295) lets you send, receive, and manage faxes from any desktop computer connected to a network while sharing fax/modems built into a central fax server. This client/server software is designed for workgroups,



departments, and enterprises. From Headquarters Software (Jacksonville, FL), Fax<HQ features management and administrative tools, shared and private phone books, an electronic notepad on which you can type a few words while you're still on the telephone, date and time stamping, and remote faxing. The program's user-selectable macros enable you to launch Word, Ami Pro, and WordPerfect with a click of your mouse.

Phone: (904) 645-9271.

Circle 1280 on Inquiry Card.

MAC NETWORK TOOL

A tool to automatically update and install any file on a Mac network, The Frye Network Management Platform—Software Update and Distribution System for Macintosh (MacSUDS) 1.0 (from \$995) provides automated updating and distribution of files from a central location. Network managers can use the tool to easily, quickly, and uniformly distribute files across a network and ensure that everyone is using the same version of the utilities, templates, and programs. MacSUDS is from Frye Computer Systems (Boston, MA).

Phone: (617) 451-5400.

Circle 1281 on Inquiry Card.

MOLD YOUR SOFTWARE

Able to work with any AutoCAD drawings, the R12/Mold program (\$395) from E D Sales & Service (Schaumburg, IL) speeds up dimensioning and detailing in AutoCAD. To make changes, you simply rewindow your drawing using familiar AutoCAD dialog boxes. R12/Mold can count your dimensions and identify components, as well as identify all selected geometry in the window and display your requested output results.

Phone: (708) 885-3636.

Circle 1282 on Inquiry Card.

FIND FACTS FAST

The first commercial version of the Windows information manager, InfoRecall 4.0 (\$99.95) gives you instant access to records as short as a few words or as long as 25 pages. You can create free-form records and link them through hypertext to reveal relationships and patterns. Searches are done via such methods as keywords, phrases or blocks of text, phonetic matches, dates, numbers, logical operators, and across multiple files, among others. InfoRecall is from Phantech Software (Toronto, Ontario, Canada).

**Phone: (800) 208-1311 or
(416) 502-1311.**

Circle 1283 on Inquiry Card.

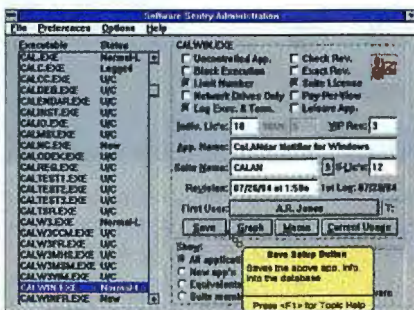
DSP TOOLKIT

Visual Numerics' (Boulder, CO) PV-Wave:Signal Processing Toolkit (from \$995) is an add-on module to the company's PV-Wave Advantage. The toolkit provides a broad selection of basic and advanced predefined and customizable DSP functions, as well as utilities and source code. Applications include speech recognition, telecommunications, acoustics, radar, sonar, seismol-

ogy, remote sensing, consumer electronics, medical analysis, and time-series analysis.

**Phone: (800) 447-7147 or
(303) 530-9000.**

Circle 1284 on Inquiry Card.



MANAGE NETWORK LICENSES ▲

Software Sentry (from \$595 per server), a license metering and network management tool from Microsystems Software (Framingham, MA), manages application license usage on the network and on users' local hard drives. Able to monitor stand-alone applications as well as applications within a software suite, Software Sentry can operate on most networks, provide version control, produce reports, and track or block application usage.

Phone: (508) 879-9000.

Circle 1286 on Inquiry Card.

TCP/IP SUPPORT

A multiprotocol groupware system from SoftArc (Markham, Ontario, Canada), the FirstClass TCP/IP Module (\$995) lets you use FirstClass client software on

Windows PCs or Macs to make TCP/IP connections to a FirstClass server. You do this by selecting TCP/IP in a connection setup pop-up box. The FirstClass server recognizes the log-in and treats the client as it would treat any other FirstClass user. *Phone: (905) 415-7000.*

Circle 1285 on Inquiry Card.

HELP FOR HELP FILES

U.K.-based Oxford Computer Consultants' Help Browser (\$89) lets you find information in Windows 3.1 help files quickly and easily. Help Browser provides an interactive map of the help file you are viewing, letting you search for any word or phrase anywhere in the help file. The utility is available in the U.S. from Cascadilla Press (Somerville, MA).

Phone: (617) 776-2370.

Circle 1287 on Inquiry Card.

Software Update

WinMaker Pro 6.0, Blue Sky Software (La Jolla, CA), adds a configurable project manager, three floating palettes, and the Multimedia Extended Functionality Module; supports Visual Basic custom controls; has an independent main window and application-design area; and provides the capability to create application templates. \$495.

**Phone: (800) 677-4946 or
(619) 459-6365.**

Circle 1299 on Inquiry Card.

T.C. Fonts 3.0, Technical Software (Cleveland, OH), adds formatting features, such as superscripts, subscripts, and small caps; a hand-lettered font and a braille font; four fill densities; kerning; continuous route-out; and 32 international characters; and 32 monospaced fonts. \$149.

**Phone: (800) 356-9050 or
(216) 765-1133.**

Circle 1300 on Inquiry Card.

PV-Wave Advantage 5.0, Visual Numerics (Boulder, CO), adds a GUI-based source code debugger for PV-Wave procedures and HDF/netCDF file support, enhances its mapping functionality, features a built-in world map database, and lets you use precoded routines to retrieve longitude and latitude data from the map. \$6995.

Phone: (303) 530-9000.

Circle 1301 on Inquiry Card.

WinSales 2.1, WinSales (Kent, WA), adds a Fulfillment Center feature, which automates gathering, analyzing, and merging of scheduled correspondence. \$495.

Phone: (206) 854-9580.

Circle 1302 on Inquiry Card.

HelpLine 2.2, Raxco
(Rockville, MD), features a
Windows client connected to
servers running Open VMS
or SunOS. From \$8250.

Phone: (301) 258-2620.

Circle 1303 on Inquiry Card.

RIDE A CAROUSEL THROUGH WINDOWS

With its intuitive rotating toolbar and ability to automate repetitive operations, SpinWizard (\$79.95) lets you access and manage 96 of your most common documents, applications, and tasks. When you install the program, it searches for popular applications and automatically loads them.

SpinWizard's 3-D carousel rotates when you click on the top or bottom row; clicking on a colored



triangle at the end of the carousel instantly takes you to the corresponding row. You can also launch applications and navigate through the Windows desktop, drag and drop icons from the Program Manager or File Manager, and at a glance see which of your applications are currently running.

**Contact: Tanisys Technol-
ogy, San Antonio, TX, (800)
460-7746 or (512) 263-1700.
Circle 1272 on Inquiry Card.**

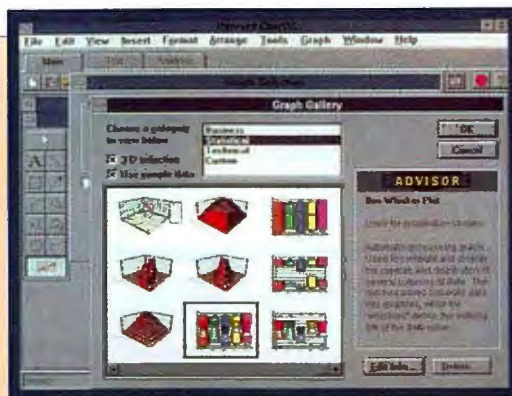
What's New Software

CHART COMPLEX DATA AND ANALYZE TRENDS VISUALLY

A Windows data-charting application, Harvard ChartXL (\$149) provides 183 2-D and 3-D business, financial, statistical, and technical chart types, as well as mathematical capabilities and what-if analysis tools. Designed to complement your existing Windows applications, Harvard ChartXL lets you generate a chart based on data from any of the leading Windows spreadsheet packages and directly supports files created in Excel or Lotus 1-2-3. Other data sources are supported through OLE and DDE. A built-in, 70-trillion-cell spreadsheet offers more than 50 mathematical calculations and statistical functions, to which you can add your own equations for instant what-if analysis of key variables.

Contact: Software Publishing, Santa Clara, CA, (800) 234-2500 or (408) 986-8000.

Circle 1273 on Inquiry Card.



well as pronunciations and English translations or equivalents. Phone: (800) 676-4021 or (617) 648-2041.

Circle 1289 on Inquiry Card.

LINK DATA WITH NOTES

DataLink for Lotus Notes (\$1495) lets you migrate and synchronize data between Notes and major relational databases. From Brainstorm Technologies (Cambridge, MA), DataLink's point-and-click interface lets you use databases, such as Access and dBase, and spreadsheets, such as Excel, to merge the data with your local and remote Notes databases. You can migrate data between Notes servers running NLMs, Windows, OS/2, and Unix, as well as integrate data between desktop or server databases and Notes servers on an ad hoc or scheduled basis.

Phone: (617) 492-3399.

Circle 1291 on Inquiry Card.

CREDIT-CARD PROCESSING

PC-Credit Developers Kit (\$395) is a utility that lets software developers integrate credit-card processing capabilities into their DOS or Windows applications. From Go Software (Savannah, GA), the utility replaces the single-function stand-alone terminals used by businesses for handling credit-card sales. Either the developer or the merchant can buy the runtime modules (\$125 each).

Phone: (800) 725-9264 or (912) 925-4048.

Circle 1292 on Inquiry Card.

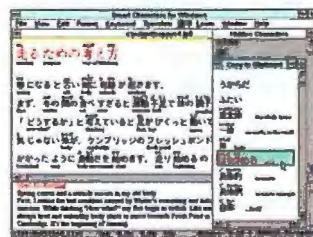
ity displays all the search criteria and results in one window, displaying multiple files as they are found while it continues to search for others. You can act on any of the files before the entire search is complete.

Phone: (800) 383-8546 or (408) 559-3838.

Circle 1290 on Inquiry Card.

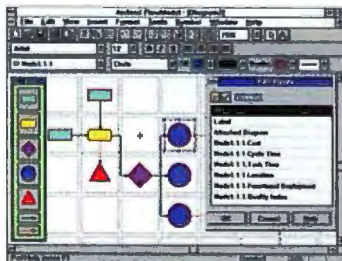
SMART LANGUAGE LEARNING ▼

A Japanese and Chinese word processor and reading, writing, translating, and learning tool, Smart Characters for Windows (\$179.95) is designed to help non-native speakers communicate in these languages. From Apropos (Arlington, MA), Smart Characters converts documents from, to, and between the various national Japanese and Chinese text formats, recognizing and preserving stylistic differences. The software has cross-referencing and annotation capabilities, as



LINK DIAGRAMS TO DATA

FlowModel (\$495), from Arcland (Berwyn, PA), allows you to rapidly create complex yet unambiguous diagrams. The 32-bit



application automatically places and aligns objects within a grid structure when you point and click on the spot where a node belongs. Connections between nodes are automatically routed, and objects and connections are prevented from overlapping. FlowModel also captures important data associated with any part of a diagram, letting you simultaneously view the diagram and the data behind it.

Phone: (610) 993-9904.

Circle 1288 on Inquiry Card.

PUT A GENIE IN YOUR MAC

File Genie (\$49), from Duet Development (Campbell, CA), lets you use one application to manage your Mac hard disk. The util-

Software Update

Myriad 2.2, Informative Graphics (Phoenix, AZ), adds redlining tools, point-to-point measure, batch printing, Group 4 output for QMS and JRL high-speed A/B-size printers, MAPI support for Microsoft Mail, and native CADkey drawing and file viewing. \$595.

Phone: (602) 971-6061.

Circle 1304 on Inquiry Card.

Face to Face 2.0, Crosswise (Santa Cruz, CA), adds a general-purpose file transfer utility, expanded support for TCP/IP networks and more than 150 modems, and support for displays as large as a full 9-inch page. \$179.

Phone: (800) 747-9060 or (408) 459-9060.

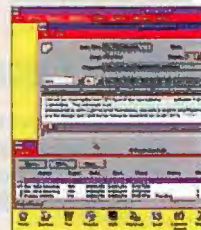
Circle 1305 on Inquiry Card.

WinBoard 1.10, Ivex Design (Beaverton, OR), provides an Advanced Design Rule Check feature, netlist on the fly, a Global Edit function, and print preview. \$995.

Phone: (503) 531-3555.

Circle 1306 on Inquiry Card.

ImageFast 2.0, ImageFast Software Systems (McLean, VA), has 114 new and improved features, including Action Icons, a Database Design Wizard, full-text indexing of ASCII



files with drag-and-drop capability, and E-mail messaging functionality. From \$4995 for five concurrent users.

Phone: (800) 899-6665 or (703) 893-1934.

Circle 1309 on Inquiry Card.

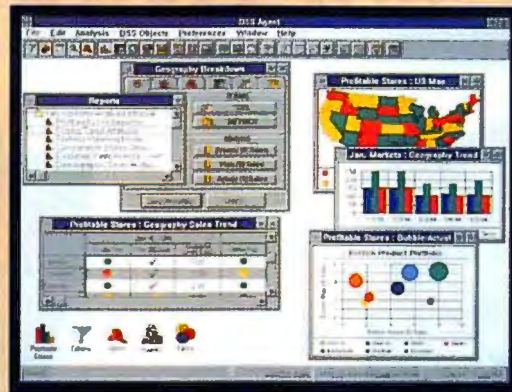
Koyn Fractal Studio 2.1, Koyn Software (St. Louis, MO), provides native execution on Power Macs. \$119.95.

Phone: (314) 878-9125.

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SCALABLE DECISION-SUPPORT TOOL

An object-based on-line analytical processing environment for enterprise-wide decision support and data-warehouse access, **DSS Agent (\$795)** is both a data-mining application and a DSS-aware development tool set. The program's client/server decision support allows corporations to implement ad hoc query and analysis, executive information systems, workflow automation, and mission-critical applications using an open-systems methodology. The server portion operates on major RDBMS platforms, and the client interface is optimized for Windows.



Contact: **MicroStrategy**, Vienna, VA, (800) 927-1868 or (703) 761-4840.

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PROJECT TRACKING

Designed for use throughout a project, **SureTrak Project Manager for Windows (\$695)** provides all the necessary analytical tools, graphics functions, and reports for planning and implementing a project from the initial idea through completion. Organization choices include a basic outline, a work-breakdown structure up to 20 levels deep, and customizable activity coding. You can cross-cut or drill down in any direction through the project information to reach the heart of an issue. The Progress Spotlight feature automatically highlights all the tasks that should have been worked on during the past week or month. From Primavera Systems (Bala Cynwyd, PA), SureTrak is ODBC compliant.

Phone: (610) 667-8600.

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SHARE A PRINTER WITH MACS

Laser Choice (\$49.95) lets Windows and DOS users share AppleTalk-compatible PostScript printers with Mac users on the same network. From DataStream Imaging Systems (Lexington, KY), Laser Choice is ODI compliant and functions concurrently with protocols such as TCP/IP and IPX/SPX.

Phone: (606) 255-6686.

Circle 1294 on Inquiry Card.

JOB SCHEDULER

The Event Control Server for Windows NT (\$1495 per job server) is designed to control the unattended execution of 16- and 32-bit Windows programs and DOS programs on Windows NT workstations or servers. The multiplatform scheduling facility from Vinzant (Hobart, IN) lets IS managers schedule programs and processes to run on PCs under Windows 3.1, NT, OS/2, and DOS and distribute scheduled tasks over many dissimilar resources.

Phone: (800) 355-3443 or (219) 942-9544.

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INSTANT PROBLEM FIXER

A TSR program that pops up when a cryptic error appears on your Windows PC screen, **First Aid for Windows (\$129.95)** analyzes the situation and offers to repair the problem on the spot. If you agree and click on the Fix button, the utility corrects the problem immediately, such as rewriting a WIN.INI file or locating and copying a DLL file. All changes are logged so that you can print them out or undo them later if you so desire. First Aid for Windows is from CyberMedia (Los Angeles, CA).

Phone: (310) 843-0800.

Circle 1296 on Inquiry Card.

ARTICLE SEARCH

TitleBank (starter database, \$29.95; weekly updates, from \$59.95; monthly updates, from \$44.95) works under Windows 3.1 to locate articles from more than 60 computer magazines. The program accesses articles that review any products or vendors you request and identifies other journals that have published articles you may want to read. From InfoOutlet (Rockville, MD), TitleBank offers weekly and monthly updates that contain articles published up to the week before the updates are shipped.

Phone: (800) 725-9668 or (301) 460-7638.

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MUSICAL BACKUP

An interactive music-accompaniment system for the Mac, **Vivace (\$2295)** instantaneously analyzes and reacts to music played by a wind or brass instrument. From Coda Music Technology (Eden Prairie, MN), Vivace speeds up and slows down as the soloist changes tempo while interpreting the music. You can customize the accompaniment to range from a piano to a full orchestra. A Windows version is in the works.

Phone: (800) 843-2066 or (612) 937-9611.

Circle 1298 on Inquiry Card.

Software Update

ArchT 12.5, Ketiv Technologies (Portland, OR), provides enhanced 2-D production drafting features, customizable reporting and scheduling capabilities, and automatic dimensioning; it also adds new door and window styles and more. \$1195.

Phone: (800) 458-0690 or (503) 252-3230.

Circle 1307 on Inquiry Card.

Quicken 4 for Windows, Intuit (Menlo Park, CA), enhances ease of use, insight, and financial planning. **Quicken 5 for Macintosh** enhances the Financial Calendar and insight, is easier to use, and adds time-savers. \$39.99 each.

Phone: (415) 322-0573.

Circle 1310 on Inquiry Card.

Filex 2.0, Durand Communications Network (Santa Barbara, CA), adds automatic sensing of an incoming call to receive a fax or file, multiline server phone support, subdirectory password security, E-mail capability, a seamless interface that lets computers continue working during file transfers, and zip and unzip. \$149.

Phone: (800) 999-7771 or (805) 961-8700.

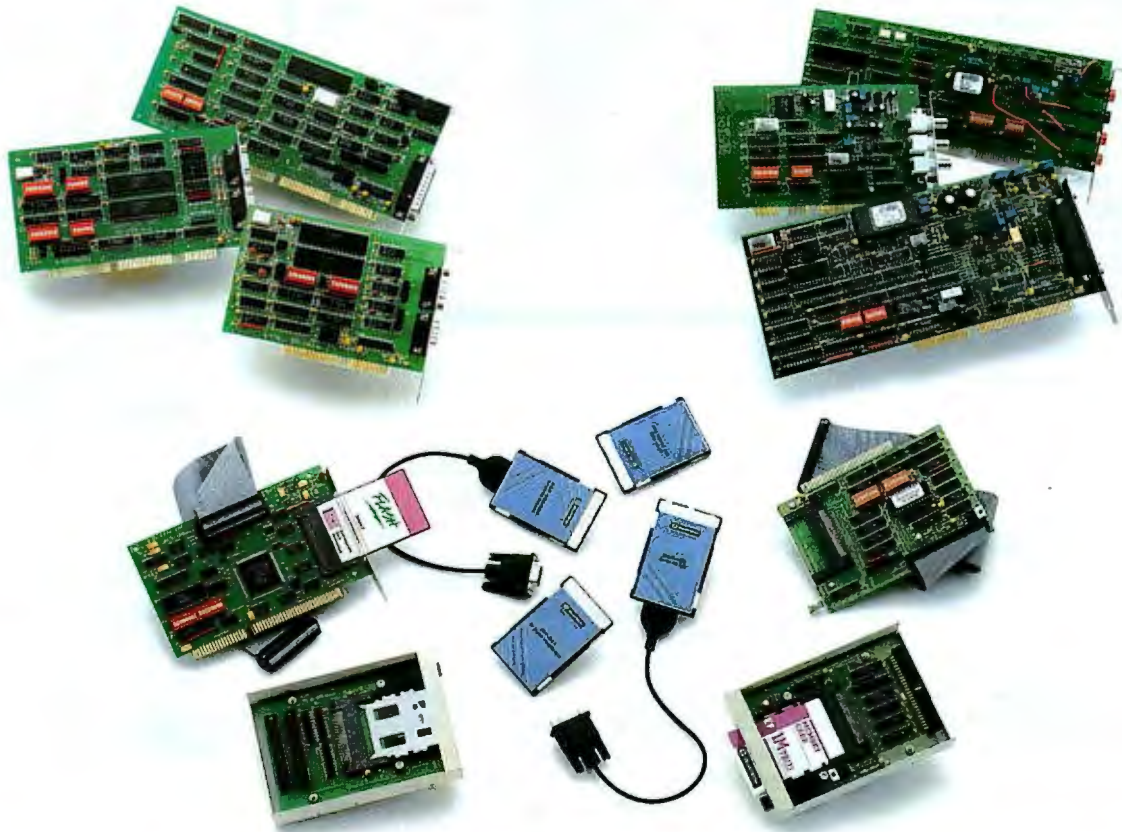
Circle 1311 on Inquiry Card.

WinView for Networks 2.3, Citrix Systems (Coral Springs, FL), adds TCP/IP support, easy replication of installation and configuration information, a user-accounting module, transparent multi-session NetWare shell support, restricted file-server log-in, log-on sequence encryption, ISDN WAN connectivity, Mac support for DOS applications, XMODEM/YMODEM file transfer support, expanded support for FDDI products, enhanced password security, and enhanced remote-workstation printing. From \$2995.

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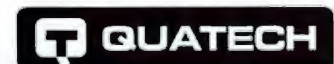
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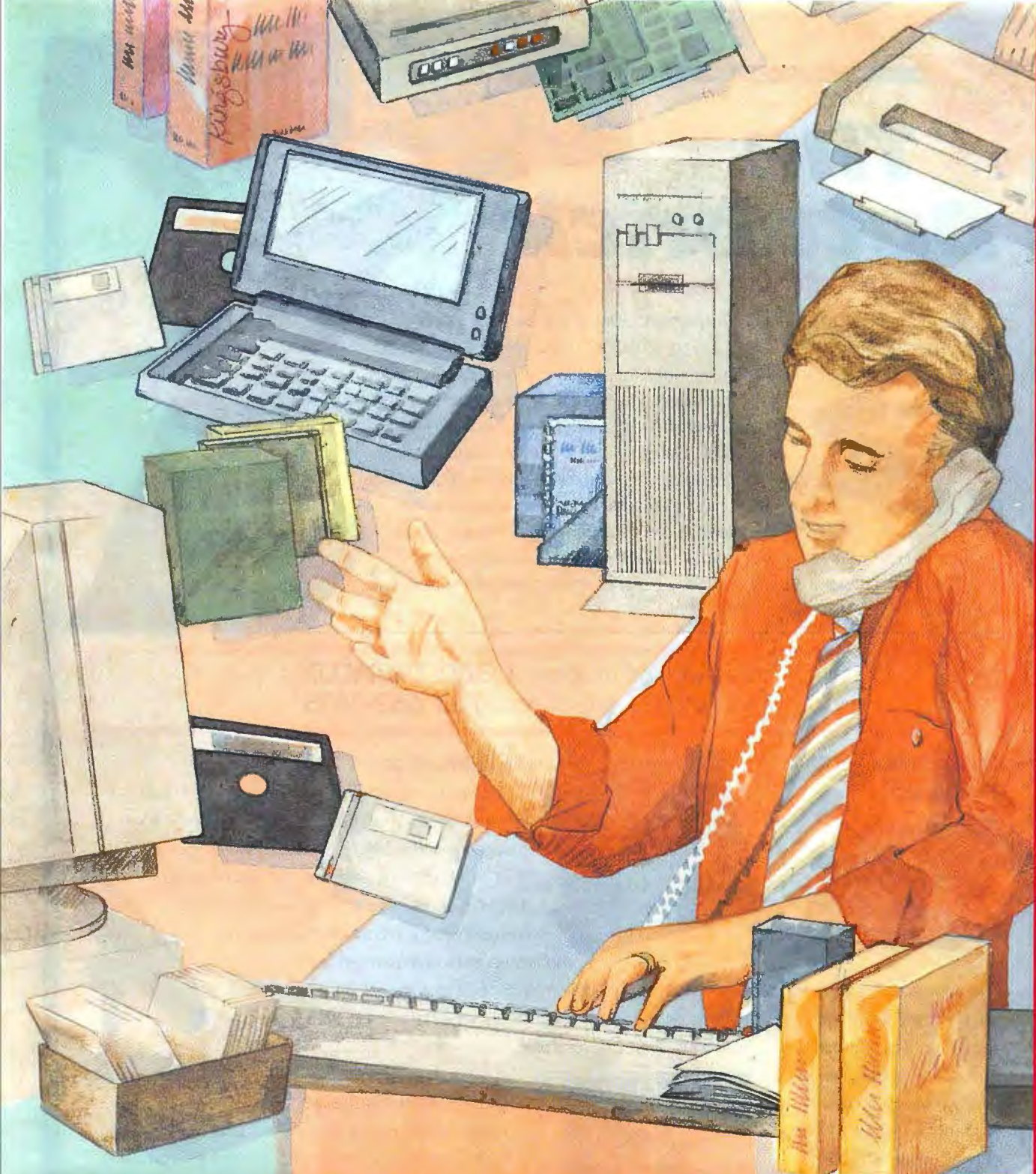
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The popular 1.0kg desk and .4kg portable flat models save 60% of the normal desk space, with full-travel, tactilly responsive keys. Footprint is only 28x16 cm (11x6"), but the 100 keys have standard left-to-right spacing. Both models are XT/AT/PS2 compatible and are available in many languages.



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Datalux stand-alone monitors are available in both 1.8 kg, desk/wall (which folds for portability) and 2.7 kg mobile/industrial, 64-grey shade, mono or 256 color DUAL SCAN versions. Both are 9.4" diagonal 640 x 480 VGA and can be fitted with optional touch screen with integrated touch controller. The mobile/industrial unit (pictured with swivel



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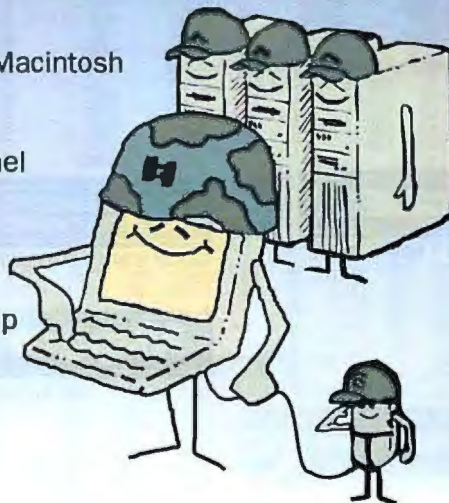
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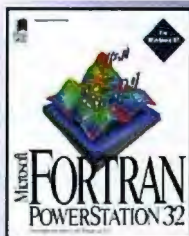
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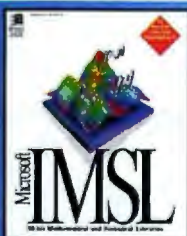


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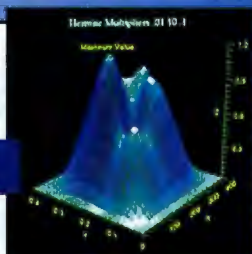
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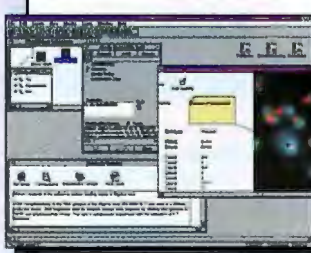
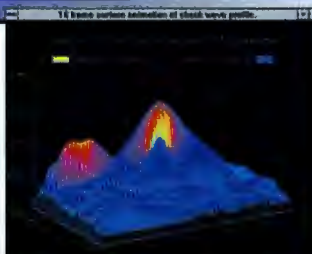
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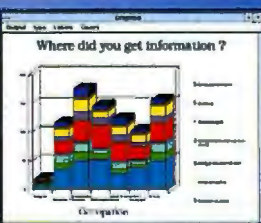


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Versa S 433S 210MB mono	1699.83
Versa S 433S 210MB pas color	1896.87
Versa S 450 260MB act color	3309.79
Versa M 475 250MB dual color	3748.78
Versa M 475 340MB act color	4839.20
Versa M 4100 340MB act color	5178.86
Versa M 4100 810MB act color	6063.62
Versa M 4100 810MB hi-res color	5939.88
Versa M 4100 540MB true color	5844.60
Ready 423S 270MB CD	1349.45
Ready 466 340MB CD	1554.81
Ready 466A 420MB 3X CD	1649.37
Ready 580A 420MB 3X CD	2229.74

PACKARD BELL

Force Multimedia 425SX 210MB	1083.82
Force14 450SX 340MB	2999.00
Force52 450SX 420MB MM	1448.17
Force54 466A 420MB MM	1448.17
Force57 466A 540MB MM	1659.84

COMPUTERS

TEXAS INSTRUMENTS

TM4000M 4/50SX 200MB dual color	2768.29
TM4000M 4/50SX 340MB act color	3139.85
TM4000M 4/75 344MB act color	4968.42
TM4000M 4/75 455MB act color	4477.96
TM4000E 4/50 200MB dual color	2587.00
TM4000E 4/50 200MB act color	2857.23
TM4000E 4/75 455MB act color	4047.35

DOT MATRIX & LASER PRINTERS

OKIDATA

184 Turbo	219.14	ML590	429.51
ML320	304.45	ML591	579.89
ML321	427.40	Pacemaker 3410	1219.49
ML380	214.85	OL400E	422.70
ML395	887.32	OL410E	467.84
ML395C	1039.74	OL410E/PS	
ML520	359.82	Agem 600dpi	818.15
ML521	495.18	OL510	985.50

*includes \$75 manufacturer rebate (ends 12/31/94)

Canon

BJ105X	244.86	BJ230	388.00
BJ200E	259.44	BJC600 color	499.00
BJC4000 720dpi color			689.43
LBP430 300dpi 4ppm laser			679.00
LBP660 600dpi 6ppm laser			988.83

EPSON

AP2250	96.59	LQ2550	898.08
AP3250	146.31	DFX5000 Plus	1354.86
AP3260	175.75	DFX8000	2259.45
LX300	165.01	Stylus 300	186.92
FX870	269.48	Stylus 400	186.92
FX1170	359.00	Stylus 800+	208.88
AP5000+	229.71	Stylus Color	509.53
LQ1070	265.35	ActionLaser 1100	479.80
LQ670	454.44	ActionLaser 1500	595.15
LQ1170	507.95	ActionLaser 1800	834.00

IBM LEXMARK LASER PRINTERS

WinWriter 100 inkjet	297.87
WinWriter 200 laser	799.92
WinWriter 400 laser	768.47
WinWriter 600 laser	999.00
ValueWriter 300 (4037 SE SPPM)	647.17
ValueWriter 600 laser	815.87
Optra R 600dpi laser	1429.97
EliteJet inkjet	327.80
4029-10 10PPM	1115.42
4039-10R 10PPM	1273.46
4039-10RD 10PPM DUPLEX	1566.46
4039-12L PLUS	1859.75
4039-12R PLUS	1394.85
4039-16L PLUS	2695.00

Digital Corporation

DECwriter 500 inkjet	357.00
Color upgrade for 500	41.00
DECwriter 1152 4 ppm	698.78
DECwriter 5100 8 ppm	1439.85

Panasonic

1150	123.40	2130*	174.40
1624	388.20	2135 Color**	187.43
2023	182.27		

after \$30* or \$50* mail-in rebate (ends 12/31/94)

after \$50* or \$100* mail-in rebate (ends 12/31/94)

TECH INSTRUMENTS

microMenc Color inkjet	378.83
microWriter basic	485.81
microWriter P250	539.85
microLaser Pro 600 PS2	1197.02
microLaser Pro 600 PS65	1524.25
microLaser Pro E	1385.48
microLaser Power Pro 600 PS65	1629.60

HEWLETT PACKARD

DeskJet Portable 310 w/CSF	367.00
DeskJet 500C	409.99
DeskJet 520	284.10
DeskJet 540	284.10
DeskJet 560C	479.75
DeskJet 1200C	1347.81
DeskJet 1200C PS	2019.22
LaserJet 4L	609.99
LaserJet 4P	999.47
LaserJet 4MP	1818.18
LaserJet 4 plus	1488.35
LaserJet 4M plus	1988.72
LaserJet 433	2998.36

COSTAR

LabelWriter XL DOS/Win	144.48
LabelWriter XL Plus DOS/Win	324.89

HARD DRIVES & CONTROLLERS

Maxtor

170MB IDE	161.73	345MB IDE	306.04
290MB IDE	163.68	345MB SCSI	236.14

MICROPOLIS

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2210 1050MB SCSI	734.97
4110 1050MB SCSI	969.65
2217 1.7GB SCSI	798.89
2210AV 1.05GB SCSI AV	798.89
2217AV 1.75GB SCSI AV	1099.22
1936 3GB SCSI	1899.99

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200MB IDE	173.14	427MB IDE	224.56
261MB IDE	177.87	1.0GB SCSI-2	658.63

WESTERN DIGITAL

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Cover 540MB IDE	270.98		

CONTROLLERS

Accugate IDE WH/PA, ZSER, 1GAME	35.06
Accugate IDE WB/OS	48.50
Accugate VLB IDE	69.76
Adaptec AHA1505 SCSI-2 CD KIT	64.95
Adaptec 1542CF SCSI-2	265.45
Adaptec 2424AT ISA SCSI-2	33.22
Adaptec 2842 VLB SCSI-2	257.23
Promise IDE ISA Cache	34.50
Promise IDE VLB Cache	115.29
Promise EIDE VLB	59.87

MODEMS & COMMUNICATIONS

Robotics

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V.34 28.8K external w/fax	244.32
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14.4K external w/fax	108.79
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COURIER MODEMS

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V.34 external w/fax	427.84

Hayes

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ACCURA 14.4 external w/fax	128.88
ACCURA 28.8 V.F.C. internal w/fax	209.02
ACCURA 28.8 V.F.C. external w/fax	256.82
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PRACTICAL PERIPHERALS

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MICROCOM

DeskPorte ES 14.4	184.56
DeskPorte Fast EP V.F.C. 28.8	179.84
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MOTOROLA

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SmartUPS 400	299.88
SmartUPS 600	343.38
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386CD (3.3V)	15.00	9.00	10.00	7.00
64Kx1	-	11.00	8.00	8.00
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1Mbit	6.50	6.50	15.00	4.50
1Mbit	24.00	55.00	24.00	-
2Mbit	24.00	22.00	24.00	-
2Mbit	24.00	22.00	24.00	-
4Mbit	24.00	22.00	24.00	-
8Mbit	24.00	22.00	24.00	-
16Mbit	24.00	22.00	24.00	-
32Mbit	24.00	22.00	24.00	-
64Mbit	24.00	22.00	24.00	-
128Mbit	24.00	22.00	24.00	-
256Mbit	24.00	22.00	24.00	-

INTEL Math Chips

8087	8087-2	8087-3	8087-4
8087	39.00	39.00	39.00
8087-2	79.00	79.00	79.00
8087-3	79.00	79.00	79.00
8087-4	79.00	79.00	79.00
8087-5	79.00	79.00	79.00
8087-6	79.00	79.00	79.00
8087-7	79.00	79.00	79.00
8087-8	79.00	79.00	79.00
8087-9	79.00	79.00	79.00
8087-10	79.00	79.00	79.00
8087-11	79.00	79.00	79.00
8087-12	79.00	79.00	79.00
8087-13	79.00	79.00	79.00
8087-14	79.00	79.00	79.00
8087-15	79.00	79.00	79.00
8087-16	79.00	79.00	79.00
8087-17	79.00	79.00	79.00
8087-18	79.00	79.00	79.00
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8087-21	79.00	79.00	79.00
8087-22	79.00	79.00	79.00
8087-23	79.00	79.00	79.00
8087-24	79.00	79.00	79.00
8087-25	79.00	79.00	79.00
8087-26	79.00	79.00	79.00
8087-27	79.00	79.00	79.00
8087-28	79.00	79.00	79.00
8087-29	79.00	79.00	79.00
8087-30	79.00	79.00	79.00
8087-31	79.00	79.00	79.00
8087-32	79.00	79.00	79.00
8087-33	79.00	79.00	79.00
8087-34	79.00	79.00	79.00
8087-35	79.00	79.00	79.00
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8087-37	79.00	79.00	79.00
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8087-39	79.00	79.00	79.00
8087-40	79.00	79.00	79.00
8087-41	79.00	79.00	79.00
8087-42	79.00	79.00	79.00
8087-43	79.00	79.00	79.00
8087-44	79.00	79.00	79.00
8087-45	79.00	79.00	79.00
8087-46	79.00	79.00	79.00
8087-47	79.00	79.00	79.00
8087-48	79.00	79.00	79.00
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8087-51	79.00	79.00	79.00
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8087-56	79.00	79.00	79.00
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8087-59	79.00	79.00	79.00
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8087-62	79.00	79.00	79.00
8087-63	79.00	79.00	79.00
8087-64	79.00	79.00	79.00
8087-65	79.00	79.00	79.00
8087-66	79.00	79.00	79.00
8087-67	79.00	79.00	79.00
8087-68	79.00	79.00	79.00
8087-69	79.00	79.00	79.00
8087-70	79.00	79.00	79.00
8087-71	79.00	79.00	79.00
8087-72	79.00	79.00	79.00
8087-73	79.00	79.00	79.00
8087-74	79.00	79.00	79.00
8087-75	79.00	79.00	79.00
8087-76	79.00	79.00	79.00
8087-77	79.00	79.00	79.00
8087-78	79.00	79.00	79.00
8087-79	79.00	79.00	79.00
8087-80	79.00	79.00	79.00
8087-81	79.00	79.00	79.00
8087-82	79.00	79.00	79.00
8087-83	79.00	79.00	79.00
8087-84	79.00	79.00	79.00
8087-85	79.00	79.00	79.00
8087-86	79.00	79.00	79.00
8087-87	79.00	79.00	79.00
8087-88	79.00	79.00	79.00
8087-89	79.00	79.00	79.00
8087-90	79.00	79.00	79.00
8087-91	79.00	79.00	79.00
8087-92	79.00	79.00	79.00
8087-93	79.00	79.00	79.00
8087-94	79.00	79.00	79.00
8087-95	79.00	79.00	79.00
8087-96	79.00	79.00	79.00
8087-97	79.00	79.00	79.00
8087-98	79.00	79.00	79.00
8087-99	79.00	79.00	79.00
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Clock doubling technology	286 to 386	386 to 486
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Compatible with DOS, Windows, 3.5, OS/2 1.3 and 2.1	286 to 386	386 to 486
Uses industry standard math chips	286 to 386	386 to 486
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-	-	-	-	-	660.00	-

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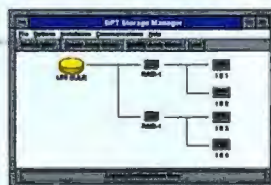
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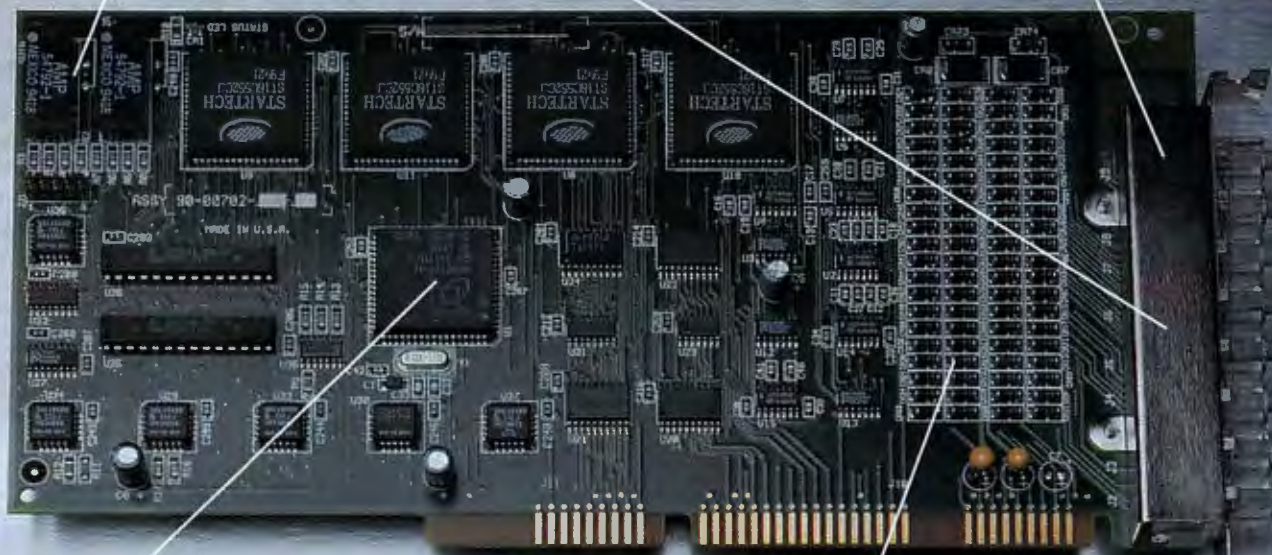


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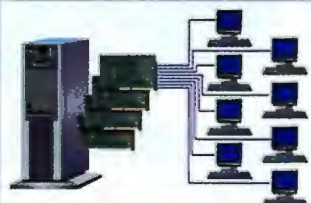
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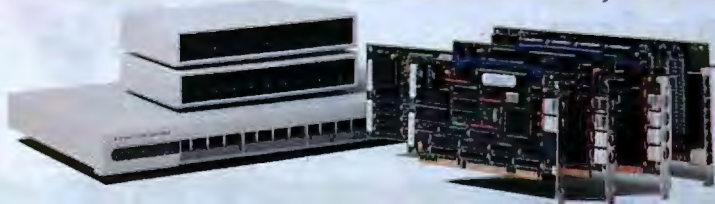
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SMART750	750VA, Line Reg., 4 Outlet, LEDs	420	IB2-6	2 Outlet, 6 ft. Cord 32
SMART900	900VA, Line Reg., 6 Outlet, LEDs RJ11 jacks	523	IB4	4 Outlet, 6 ft. Cord 43
SMART1250	1250VA, Line Reg., 6 Outlet, LEDs RJ11 jacks	654	IB6	6 Outlet, 6 ft. Cord 51
UPS Back-Ups			IB8	8 Outlet, 12 ft. Cord 61
BC-250	2 Outlet, 250 VA	\$105	MP	Econo Modem Suppressor \$14
BC-400	4 Outlet, 400VA	169	SK8-6	6 Outlet, Spike Block, 6' Cord 28
BC-500	4 Outlet, 500VA	194	STRIKER	6 Outlet, 6' Cord 12
BC-500LAN	4 Outlet, Lan Inter.	199	TERM-6	6 Outlet, Surge 38
Line Stabilizers				
LC-1200	1200 Watt	\$139		
LC-1800	1800Watt	188		
LC-2400	2400 Watt	243		



Networking

Longshine Ethernet Adapters			BOCA 10Base-T Concentrator		
LCS-8634MI	16-bit Ethernet Adapter (BNC, SGL Chip)	\$46	BEN210	Up to 8 Nodes, RG-45, can be daisy-chained	\$139
LCS-8634TBA	16-bit Ethernet Adapter (AUI, BNC, TP)	57	Ethernet Transceiver Cables		
LCS-8634L-T	16-bit Ethernet Adapter (RJ45) Jumperless	110	TXC-1M	15 Pin Male to Female, 1 Meter	\$19.39
LCS-8634P	Ethernet Pocket LAN Adapter (BNC or AUI)	113	TXC-2M	15 Pin Male to Female, 2 Meters	22.69
LCO-8834P-T	Ethernet Pocket LAN Adapter (Twisted Pair Connectors)		TXC-4M	15 Pin Male to Female, 4 Meters	29.59
BOCA Ethernet Adapters			Token Ring		
BEN1P1	Ethernet Adapter for PCI-Bus (RJ-45 & BNC)	\$83	Part # Description	1-24 25-99 100+	
BEN110	10Base-T Adapter (RJ45) Jumperless, "Plug 'N Play"	65	D-4C	4-Pin Data Connector	\$5.50 \$4.25 \$3.90
BEN120	10 Base-T Adapter (RJ45 & BNC) Jumperless, "Plug 'N Play"	70	Ethernet BNC Cables (M-M)		
BEN1VL	High Speed 10Base-T VL-Bus Ethernet Adapter	73		1-9 10 25 100	
BOCA Ethernet Hubs			58BC-10	RG-58 10 ft. \$4.59 \$3.82 \$2.86	\$2.30
BEN220	16-Port Ethernet 10Base-T Hub	\$264	58BC-25	RG-58 25 ft. 6.79 5.66 4.24	3.45
Longshine Ethernet Transceivers			58BC-50	RG-58 50 ft. 8.89 7.41 5.56	4.45
LCS-883T3	Transceiver (BNC Connector) LEDs	62			
LCS-883T-T	Transceiver 10Base-T (AUI to RJ-45)	42			

MULTI-PORT ARBITRATOR combines features of Auto Switch, Converter, and Line Extender to support up to 32 PCs sharing one printer using 4 Wire phone line and jack. Reach out 2000 ft. at a transfer rate of 256K bps. "First Come, First Served". Includes Two Parallel Receivers, 50' Line and necessary components to get started.

MB4162P	Multi-Port Arbitrator	\$119.00	MB400P	Additional Parallel Receiver	\$30.00
			MB400S	Additional Serial Receiver	\$2.00

Motherboards

MB386DX mainboard is based on a 32-bit 80386DX CPU running at your choice of 33 or 40 MHz. Mainboard is of Mini size (250mm x 196mm) with AMI BIOS, EMS support and a built-in direct-mapped cache controller with write-back scheme and variable cache memory size of 128k up to 256k (16 byte cache line size). Provided is a math co-processor socket. Configuration of RAM memory can be utilized up to 32M using 256k, 1M or 4M SIMM memory modules. Features six 16-bit I/O slots and two 8-bit I/O slots.

MB386-33C	MB386DX running at 33MHz (Intel)	\$124
MB386-40	MB386DX running at 40MHz (AMD)	\$129
MB386SX-40	MB386SX-40 running at 40 MHz	\$79

We ask that you call us for a latest price quote On INTEL 486-DX4 and Pentium processors."

MB486DX VESA Local Bus mainboard is a 32-bit 80486DX CPU with AMI BIOS, EMS support and a secondary write-back 256K cache. Four 16-bit I/O slots and three 32-bit VESA Local Bus slots, RAM expandable to 64Mb using SIMM Modules. Mini sized at 250mm x 196mm.

MB486-33	MB486DX running at 33MHz	\$339
MB486-66	MB486DX running at 66MHz	\$429
MB-ISA	MB486DX without CPU	\$139
MB486SX-33	MB486SX running at 33MHz	\$239

486DX4 VESA LOCAL BUS "GREEN" MAINBOARD features Intel ZIF socket 3, internal coprocessor, SS471 Chipset for "Green" PC, 256k cache, four 72pin SIMM sockets supporting 64Mb capacity, Award BIOS, seven expansion slots (2 VESA and 5 ISA), lithium battery and four system power modes for energy conservation.

MB486DX4	486 DX4 "Green" Mainboard without CPU	\$139
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PENTIUM PENTIUM is the next generation Intel microprocessor family with superscalar architecture, separate on-chip code and write-back caches, a 64-bit external data bus, ZIF socket for 60-66MHz processor, internal co-processor, Intel PCI chipset, 32bit PCI and 16bit ISA bus, six SIMM sockets for up to 192Mb capacity, PCI SCSI BIOS, 7 expansion slots (2 PCI, 1 PCI/ISA and 4 ISA) on a baby AT sized board.

MB-PENTIUM	PENTIUM 586 Mainboard without CPU	\$419
SUPER PENTIUM MAINBOARD was designed to work with a 90/100MHz Pentium processor and features a 64-bit data bus and 32-bit address bus, ZIF socket, internal math co-processor, 256k secondary write-back cache, SIMM sockets for 128Mb of capacity, 3 Modes of "Green" power savings, Five ISA, Four PCI and Two VESA Local Bus slots, AMI BIOS, DOS, UNIX, NOVELL, WINDOWS compatible and USA made.		
MB-PENTIUM1	Super Pentium 586 PCI "Green" Mainboard without CPU	\$409

Line Extenders & Buffers

Non-Powered Parallel Line Extender

For computer (transmitter) to printer (receiver), you can safely transmit data up to 1600 ft. over 4Pair phone line without data loss. Compact, FCC Approved.

PLE100	DB25 Male to DB25 Male with 30' cable	\$49
PLE110	DB25 Male to 36 Pin Cent. Male w/30' cable	49
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AUTO SWITCH locks onto incoming signal. "First-Come-First-Serve" Basis

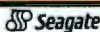
AS-251P	2 to 1 Parallel (Compact) Non-Powered	\$25
AS-451P	4 to 1 Parallel (Compact) Non-Powered	49

AUTO SWITCH/BUFFER -Powered Auto Switch with a optional Buffer Card. Takes data at full speed, cutting delays and wait time.

AS-411P	4 to 1 Parallel	\$79
AS-811P	8 to 1 Parallel	119

Add-on Buffer Memory Boards (AS-411P/811P)

AS-RAM-256K	256k Ram Card	\$59
AS-RAM-1M	1 Mb Ram Card	129
AS-RAM-2M	2 Mb RAM Card	215
IC-9V300	9V/300mA Power Adaptor	6



IDE Hard Drives	ST-3243A	212Mb @15ms	\$219
	ST-3290A	260Mb @16ms	239
	ST-3391A	344Mb @15ms	269
	ST-3491A	428Mb @ 15ms	299
	ST31220A	1.08Gb @ 9ms	739



MAXTOR Hard Drives	MXT-7171A	170Mb @ 14ms	\$179
	MXT-7345A	345Mb @ 15ms	239
	MXT-7546A	546Mb @ 12ms	349



SCSI Hard Drives	ST-3600N	525Mb @10.5ms	\$559
	ST31200N	1.05Gb @9ms	749
	ST12400N	2.1Gb @9ms	1349
	ST12550N	2.14Gb @10ms	1449
	ST42400N	2.4Gb @11ms	1799
	ST43400N	2.9Gb @10ms	2279
	ST15150N	4.6Gb @ 8ms	2649

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TRAKKER-250	250Mb Ext. Parallel Port	\$379
DJ-20	Jumbo 250Mb Internal	199
DDH-06	5 1/4" DSHD 1.2Mb	49
DDH-10	3 1/2" 1.44Mb	39
DDH-11	DDH-10 w/no mnt brkt.	36
DDH-12	Combo 3 1/2" & 5 1/4" HD	91
5.25KITFD	Mnts 3 1/2" FD-5 1/4"	9.95
5.25KITHD	Mnts 3 1/2" HD-5 1/4"	9.95

Video Boards

BOCA VESA Video "Voyager" Has Video Caching for Peak Performance! 1 MB Accelerator upgradable to 2 Mb. 5 Yr. Mfg. Warranty.

SVCXL1	VESA Accelerator, 1Mb	\$155
SVCXL2	VESA Accelerator, 2 Mb	229
IFC-46	1024 X 768 SuperVGA with 1Mb of Display Mem.	79
IFC-46L	VESA Performance VBoard (To 2Mb DRAM)	85
IFC-48	BOCA SXVGA Accelerator! 1Mb Memory	129
IFC-33	Color Graphics, Printer Port XT/AT (Mono Avail.)	25
IFC-42	BOCA VGA (800x600)	59
IFC-44	16 Color VGA w/256k Display Mem. (640x480)	45

Disk Controller Boards

LCS-6924G	VESA I/O(2FD,2IDE, 2S,1P,1G)	\$30
LCS-6941	VESA LB IDE Caching Ctrlr 16Mb (4HD, 2FD)	179
IFC-27-2	Dual AT IDE, Floppy Controller (2HD, 2FD)	19
LCS-6633F	SCSI/IDE Controller (7HD, 2FD) Novell Cert.	99
AHA-151DA	16-Bit ISA to SCSI CD	109
AHA-1542CF	16-Bit ISA Fast SCSI Controller	219
AHA-1542CFK	SCSI Master Kit (OS Drivers, Cables, Bracket)	299
AHA-2842VL	64-BitVESA SCSI Master Kit (Drivers, Cables, Bracket)	299
MIO-400KF	DFI All in One (2HD, 2FD, 2S, 1P, 1G)	33
MIO-500	All In One Card (2HD, 2FD, 2S, 1P, 1G)	25

In-Expansion Boards

I02BY4	BOCA I/O Board. (Supports 2 Par. & 4 Ser. Ports)	\$99
IFC-12	Dual Serial Board. 16C550 Upgradeable.	11
IFC-25	Serial, 1 Parallel & One 15 pin joystick port.	16
IFC-13	Parallel Board for XT/AT. (LPT2 or LPT3)	9
IFC-20	Game Card (2Ports)	9

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1MEGX9-70	\$45	4MEGX9-60	\$180	44256-70	\$6.75
1MEGX9-60	46	4MEGPS2-60	186	1MEGX1-70	7.20
1MEGPS2-70	59			256KX9-70	16
8MEGPS2-60		\$397	16MEGPS2-60		CALL

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MY28KI	28.8K Internal Modem 5 Yr Mfg Warr.	\$149
MY28KE	28.8K External Modem 5 Yr Mfg Warr.	\$179
M1440I	14.4K Internal Modem w/V.32bis Compression 5 Yr Mfg Warr.	\$89
M1440E	14.4K External Modem w/V.32bis Compression 5 Yr Mfg Warr.	\$119
VFPV32BIS	14.4K Internal Send/Receive	\$89
VFXV32VIS	14.4K External Send/Receive	\$119
VFP14.4V	14.4Kbps Internal with Voice Mail	\$129

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SONY DOUBLE-SPIN CDU33A CD-ROM equals quality and reliability with this Internal Drive featuring 350ms access, 300Kb transfer rate & 64Kb buffer. MPC/Kodak Compliant and Audio CD Playback.

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FX-001D	Mitsumi Double-Spin (250ms, 32K Buffer)	159

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9269-BEL	RG-62A/U, 22 AWG (.025), Solid, 95% Shield		
PLENUM (50 OHM) COAXIAL COMPUTER-INSTRUMENTATION CABLE			
89907-BEL	Thin Ethernet, 20AWG (19x32), 100% Shield, NEC CL2P CSA	\$0.34	\$0.27

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0.19	0.15
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Voice/Data Cable - Level 3, 4 & 5

Part #	Description	1-99'	100-999'	1000'
VDC3-2	Level 3, 2 Pair, Unshielded CL-2 PVC	\$0.06	\$0.04	\$0.29
VDC3-2P	Level 3, 2 Pair, Unshielded CL-2P Plenum	.13	.11	.71
VDC3-3	Level 3, 3 Pair, Unshielded CL-2 PVC	.07	.05	.36
VDC3-4	Level 3, 4 Pair, Unshielded CL-2 PVC	.08	.07	.44
VDC3-4P	Level 3, 4 Pair, Unshielded CL-2P Plenum	.18	.14	.94
VDC5-4	Level 5, 4 Pair, Unshielded CL-2 PVC	.12	.10	.80
VDC5-4P	Level 5, 4 Pair, Unshielded CL-2P Plenum	.25	.20	1.80

Bulk Coaxial Cable	100-999'	1000'
RG-58U 50 Ohm Ethernet	\$0.09	\$0.065
PRG-58U 50 Ohm Ethernet (Plenum)	0.33	0.233
RG-58THIN 50 Ohm Thin Net	0.18	0.115
RG-62U 93 Ohm Arcnet	0.11	0.073
PRG-62U 93 Ohm Arcnet (Plenum)	0.36	0.243

Bulk Cable 24AWG PVC INSULATED

Multi-Conductor (7/32) NEC725, CL2, 24AWG Shielded Cable	1-99'	100-999'	1000'
4304 4 Conductor	\$0.13	\$0.10	\$0.069
4306 6 Conductor	0.17	0.13	0.089
4308 8 Conductor	0.22	0.18	0.117
4310 10 Conductor	0.26	0.21	0.140
4312 12 Conductor	0.30	0.24	0.159

Stranded Twisted Pairs Individually Shielded (NEC725, CL2)

	1-99'	100-999'	1000'
3302 Two Pair	\$0.11	\$0.09	\$0.072
3303 Three Pair	0.15	0.13	0.101
3304 Four Pair	0.19	0.16	0.126

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BNC Connectors (Partial Listing Only)

Turret-On Male	1-24	25-99	100+
Part # Description			
27-9090 RG-59 & 62	\$1.17	\$1.08	\$1.90
27-9051 RG-50	1.17	1.08	1.00
27-9204 RG-58 Thin Net	2.03	1.87	1.74
27-9000 RG-59 & 62	\$1.43	\$1.32	\$1.22
27-9001 RG-58	1.43	1.32	1.22
27-9204 RG-58 Teflon	1.95	1.80	1.87
3 Piece Crimp Male			
27-9100 RG-59 & 62	\$1.28	\$1.18	\$1.09
27-9101 RG-58, 141	1.28	1.18	1.09
27-9205 RG-58 Teflon	1.73	1.59	1.48
27-9204 RG-58 Thin Net	1.95	1.80	1.87

Chassis Mounts	1-24	25-99	100+
Part # Description			
27-8400 Bulkhead	\$0.80	\$0.82	\$0.75
27-9248 RG-58 Crimp	3.15	2.91	2.70
27-9249 RG-58, 62 Crimp	3.15	2.91	2.70
27-8470 Feed thru - 1/2"	3.00	2.73	2.58
27-8468 Economy 8470 (Shorner)	2.50	2.31	2.14
Chassis Mounts 5/8" Twist-On			
27-8475 RG-58	\$3.38	\$3.12	\$2.89
27-8476 RG-58, 62	3.38	3.12	2.89

BNC Adapters	1-24	25-99	100+
Part # Description			
25-7430 Inline Splice	1.40	1.27	1.17
27-6110 Female to RCA Male	1.88	1.73	1.61
27-6100 Female to F Male	1.88	1.73	1.61
27-8140 "T" 1 Male 2 Female	2.93	2.70	2.51
27-8141 "T" 1 Female 4 Males	4.73	4.36	4.05
27-8130 Male to BNC Male	2.20	2.00	1.83
25-7510 Male to RCA Female	1.50	1.38	1.29
25-7500 Male to "F" Female	1.73	1.58	1.48

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MA9M-6		MA9F-6		9 pin D-Sub to RJ-11	\$3.00	\$2.40 \$1.90
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MA9M-8		MA9F-8		9 pin D-Sub to RJ-45	3.50	2.80 2.40
MA25M-8		MA25F-8		25 pin D-Sub to RJ-45	3.50	2.80 2.40

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MA25M-6TS	MA25F-6TS	25 pin D-Sub to RJ-11	1.99	1.89	1.39	
MA9M-8TS	MA9F-8TS	9 pin D-Sub to RJ-45	1.88	1.68	1.39	
MA25M-8TS	MA25F-8TS	25 pin D-Sub to RJ-45	1.99	1.89	1.39	
MA25M-10TS		25 pin D-Sub male to 10 conductor	2.95	2.75	2.57	

Modular Plugs

Part #	Description	1-99	100-999	1000+
MP-4M	For Handset Plugs 4x4	\$2.00	\$1.85	\$1.11
MP-4	RJ-11 Plugs 4x4	.20	.15	.11
MP-6	RJ-12 Plugs 6x6	.25	.18	.14
MP-8	8 pin RJ-45 Plug 8x8	.30	.22	.17
MP-8S	8 Pin RJ45 Plug (Solid)	.35	.26	.21
MP-10	10 x 10 Pin Modular plug	.58	.46	.40

Modular Wire

Part #	Description	Per Ft.	100 Ft.	1000 Ft.
MW-4	4 conductor	\$0.08	\$8.04	\$8.03
MW-6	6 conductor	.14	.07	.054
MW-8	8 conductor	.17	.09	.067
MW-10	10 conductor	.20	.17	.13
60-3011	Cutter and Stripper for Modular Wire		\$8.95	

Modular Wall Plates

Part #	Description	Each	25-99	100+
MWP6-1	6 conductor 1 jack	\$1.83	\$1.46	\$1.22
MWP6-2	6 conductor 2 jacks	2.75	2.20	1.83
MWP6-1	8 conductor 1 jack	1.85	1.48	1.23
MWP6-2	8 conductor 2 jacks	3.45	2.76	2.30

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Part #	Description	Each	25-99	100+
SM-6	Screw Terminal 6 Conductor Jack	\$1.83	\$1.46	\$1.22
SM-8	Screw Terminal 8 Conductor Jack	3.08	2.46	2.05
SM-4DC	4 Conductor 110 IDC type	3.87	2.80	2.32
SM-6DC	6 Conductor 110 IDC type	4.50	3.23	2.58
SM-6-2DC	6 Conductor, 110 IDC type, Dual	4.50	3.85	3.48
SM-8DC	8 Conductor 110 IDC type	4.80	3.80	2.88
SM-8-2DC	8 Conductor, 110 IDC type, Dual	4.95	4.21	3.69

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Switchboxes

Part #	Description	Each	10+
AB25-2E	2 Way, DB25 Switchbox	\$9.99	\$8.99
AB25-4E	4 Way, DB24 Switchbox	15.99	14.39
AB15HD-2E	2 Way, 15Pin High Density Switchbox	14.89	13.40
AB15HD-4E	4 Way, 15 Pin High Density Switchbox	18.89	17.00
ABRJ11-4E	4 Way, RJ11 Switchbox	13.99	12.59
ABRJ45-4E	4 Way, RJ45 Switchbox	12.99	11.69
ABMKB-2E	2 Way Keyboard (5, 9 Pin) Switchbox	14.95	13.45
ABMKB-4E	4 Way, Keyboard (5, 9 Pin) Switchbox	29.99	26.99
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CS-106 MASTER VIEW allows one console to access six computers. Supports VGA to Multisync, Built-in buffer, Daisy Chainable, AutoScan or Manual selection (3-40 sec. scan interval). Perfect for computer room access to file servers, testing or Q. C.

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10BASE-T Patch Cables (Category 3 & 5)

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* Simply fill in _____ with one of the following Color Designation:
Allux No. Length (ft.) 1-9 10-24 25+

Category 3 (10Mbps Standard) Colored Cable & Colored Boot	GT (Gray)	BK (Black)	BL (Blue)	RD (Red)
* Simply fill in _____ with one of the following Color Designation:				
10BT3-3	3 ft.	\$3.75	\$3.50	\$3.25
10BT3-6	6 ft.	4.25	4.00	3.75
10BT3-10	10 ft.	5.00	4.75	4.50
10BT3-25	25 ft.	7.25	6.75	6.00

Category 5 (100Mbps Standard) Colored Cable & Colored Boot

* Simply fill in _____ with one of the following Color Designation:	GT (Gray)	BK (Black)	BL (Blue)	RD (Red)
10T5-3	3 ft.	\$4.50	\$4.25	\$4.00
10T5-7	7 ft.	5.48	5.35	5.11
10T5-10	10 ft.	7.75	7.25	6.75
10T5-15	15 ft.	8.00	7.81	7.50
10T5-25	25 ft.	11.25	11.00	10.25
10T5-50	50 ft.	18.00	17.50	16.75
10T5-100	100 ft.	33.00	31.50	30.00

CATEGORY 5 (100Mbps Standard) Colored Cable ONLY (No Boot)

* Simply fill in _____ with one of the cable colors at right:

Allux No.	Cable Length	1-9	10-24	25+
73-65	3 ft.	\$4.10	\$3.72	\$3.56
73-66	7 ft.	5.28	4.88	4.67
73-68	15 ft.	7.60	7.26	6.93
73-69	25 ft.	10.85	10.26	9.80
73-69	50 ft.	17.60	16.98	16.22

110 Type RJ45 Jack Inserts

Part #	Description	1-9	10-24	25-99
KJ-110WH	White	\$3.50	\$3.00	\$4.58
KJ-110V	Ivory	5.50	5.00	4.58
KJ-110BK	Black	5.50	5.00	4.58
KJ-110RD	Red	5.50	5.00	4.58
KJ-110GR	Green	5.50	5.00	4.58
KJ-110YE	Yellow	5.50	5.00	4.58
KJ-110OR	Orange	5.50	5.00	4.58
KJ-110BL	Blue	5.50	5.00	4.58

Other Type Inserts

Part #	Description	\$0.30	\$0.25	\$0.20
KP-8MT	BNC Feed through Insert	3.00	2.73	2.50
KP-ST	ST Insert	6.50	5.91	5.42

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Part #	Description	\$2.50	\$2.27	\$2.08
MB-W	Ivory	3.50	2.27	2.08
MB-WH	White			

Cable Assemblies

Cable Assemblies

	8 ft	10 ft	25 ft	50 ft
PPC301-2 Parallel Printer Cable (DB25 to 36P)	\$2.99	\$3.99	\$6.99	\$18.99
DB-25 Line Cables (Wired Straight Thru, Shielded w/ TS)				
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 - > Storage subsystems
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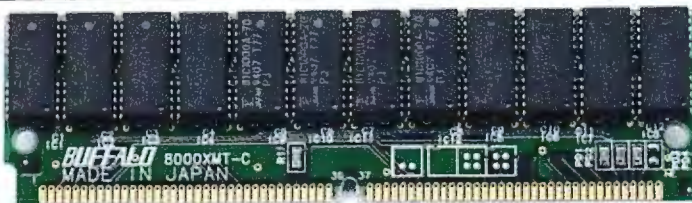
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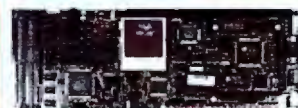
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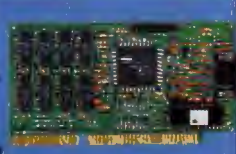
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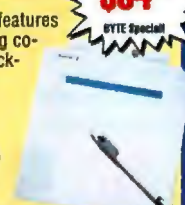
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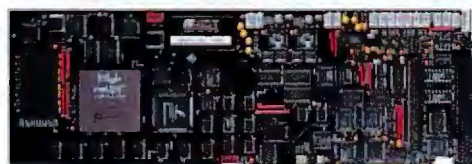
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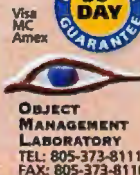
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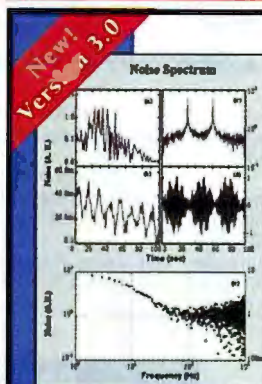
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215-216	ANTEX ELECTRONICS	270 310-532-3092	287	DESIGN TECHNOLOGY	232 619-448-2888	234	LAGUNA DATA SYSTEMS	276 800-838-TAPE
*	APPLE COMPUTER INC	2-3 800-732-3131 ext 7150	565	DIGICOM INC (INT'L)	99 +886-2-752-6670	537	LAWSOURCE	40KS 16 +44-223-237778
209	APPRO INTERNATIONAL INC	270 800-927-5464	566	DIGICOM INC (INT'L)	101 +886-2-752-6670	516	LIGATURE LTD	40KS 4 +972-2-513553
166-167	ARISTO GRAPHIC SYS (INT'L)	224 +49-40-54747-111**	553	DIGITAL NPG (ETHERWORKS) (INT'L)	119 +44(0)734-208-008	177	LIUKUVA SYSTEMS INT'L	156 916-678-0676
166-167	ARISTO GRAPHIC SYS (U.S.)	224 800-631-7846	197-198	DISTRIBUTED PROCESSING TECH	259 800-322-4378	517	LOGIC PROGRAMMING ASSOC	40KS 30 800-949-7587
547	ARTEK SRL (INT'L)	182 39 573 934745	507-508	DR HUGGLE & PARTNER GMBH	401S 6 +49-241-40317**	168	LOGICIELS ET SERVICES DUHEM	46 +33149700455
160-161	AT & T PARADYNE	54-55 800-482-3333 ext 622	279-280	DTC ELECTRONICS HUNGARY	276 +36-27-387-292**	106-107	LOGITECH INC	112-113 800-245-0000 ext 7014
66	ATI TECHNOLOGIES INC	138 905-882-2600 ext 4441	F			N		
543	ATMA TENDERING SYS SRL	40KS 28 +39-2-295-31350**	529-530	ECG (INT'L)	291 +31-4830-22716**	518	MAGIC / MSE (INT'L)	241 +972-3-751-1901**
*	AUTODESK INC	11 800-228-3601	282-283	ELMA ELECTRONIC	275 510-656-3400	283	MANCHESTER EQUIP CO	284NE 1 516-435-1199
532	AXIS COMMUNICATIONS	401S 13 +46-46136130**	264	EMATEX GMBH	277 +49-221-528866**	170-171	MARX DATENTECHNIK GMBH	224 +49-8403-1555
B			541-542	ERGOTRON EUROPE	401S 9 +31 20 696 60 65	290-291	MEDIA ON	202 800-552-7835
67-68	BEST POWER TECHNOLOGY	141 800-356-5794 ext 6989	509-510	EUTRON	401S 14 +39-35-692-829**	519	MEGADATA	40KS 30 516-589-8858**
450	BIX (N.A.)	291 800-695-4775	G			211	MICRO 2000	266 800-864-8008
190	BOOKLINK TECH - INTERNETWORKS (N.A.)	95 800-453-SURF	539-540	F & H SIMULATIONS	401S 15 +31 13 427 516**	549-550	MICRO DIRECT INT'L	40KS 10 415-325-3174
69-70	BORLAND INTERNATIONAL	CII, 1 800-336-6464 ext 9577	511-512	FAST HARDLOCK	401S 27 +49-69-539800-20	203-204	MICRO SOLUTIONS COMP PROD	253 800-295-1218
192	BUFFALO PRODUCTS	268 800-345-2356	536	FINSON	401S 29 +39-2-6898-7027	205-206	MICRO SOLUTIONS COMP PROD	255 800-295-1214
*	BYTE BACK ISSUES	40KS 12 603-924-9281	526	FIRST INT'L COMPUTER	401S 2 +886-2-717-4500**	235-236	MICROBOARDS	276 612-448-9800
*	BYTE BACK ISSUES	284MW 1 603-924-9281	199-200	FIRST SOURCE INT'L	252 714-448-7750	248-249	MICROCAL SOFTWARE, INC	279 800-969-7720
*	BYTE CARD DECK	284PC 4 603-924-2596	91	FRAME TECHNOLOGY (N.A.)	101 800-UFRAME ext 618	214	MICRO-INTERNATIONAL, INC	262 800-967-5687
*	BYTE BACK ISSUES	284SO 1 603-924-9281	89-90	FRONTIER TECHNOLOGIES	96 414-241-4555	*	MICROSOFT CORP	8-9 800-240-4782 ext 3HY
*	BYTE EDITORIAL SURVEY	234	270	FUZZICALC	278 800-472-6183	*	MICROSOFT CORP	20-21 800-434-3982 ext VNH
*	BYTE IT SERVICES '94	188 508-429-2303	H			*	MICROSTAR LABORATORIES	274 206-453-2345
*	BYTE NETWORKING	128 800-924-6621	229	GAGE APPLIED SCIENCES, INC	274 514-337-6893	109	MICROWAY	199 508-746-7341
*	BYTE ON CD ROM	186	228	GAMMA PRODUCTIONS	278 800-974-2662	151	MINICOM / CLASSNET VIDEO	98 +972-2-637578**
*	BYTE PUBLISHER'S STATEMENT	231	*	GATEWAY 2000	72A-J 800-846-2058	191	MOBILECOM / BELL SOUTH (N.A.)	119 800-505-3636
*	BYTE READER	178	*	GATEWAY 2000	72-73 800-846-2058	254-255	MYSTIC SOFTWARE	279 800-697-8426
*	BYTE REPRINTS (N.A.)	136 603-924-2618	92-93	GLENCO ENGINEERING	149 800-562-2543	O		
*	BYTE SUB MESSAGE	148	252-253	GRANITE DIGITAL	275 510-471-6442	278	OBJECT MANAGEMENT LAB	277 800-6789-OML
C			76-77	GREENVIEW DATA	69 800-458-3348	114-115	OCEAN ISLE SOFTWARE	229 800-677-6232
176	CALIFORNIA PC PRODUCTS INC	100 800-394-4122	513	GREY MATTER LTD	401S 17 +44(0)384-53071**	520-521	OCEAN ISLE SOFTWARE (INT'L)	CIV 407-770-4777
531	CARDIFF SOFTWARE	40KS 28 619-259-6445	281-282	GTEK INC	273 800-282-4835	*	OLIVETTI S.P.A.	881S 1-8 +39-1-255-24813
544	CENTRIC PMS BV	40KS 26 +31 71 323 626	I			514	OLIVETTI S.P.A. (INT'L)	120-121 +39-1-255-24813
501	CHERRY	401S 20-21 +49-9643-16-206	*	HEWLETT-PACKARD	28-29 800-821-8440 ext 8574	528	ON TIME MARKETING	40KS 22 +49-40-437472
71-72	KIKROSCHALTER GMBH	12-13 800-451-0897 ext 755	*	HEWLETT-PACKARD	39 800-533-1333 ext 8464	*	OSBORNE MCGRAW-HILL	160-161 800-822-8158
73	COMPAQ CONTURA (N.A.)	126-127 800-345-1518	*	HEWLETT-PACKARD	76-77 800-LASERJET ext 8549	*	OSBORNE MCGRAW-HILL	235 800-822-8158
293	COMPAQ DESKTOPS (N.A.)	137 800-739-4343	554	HITACHI	401S 18 +44-81-849-2092	P		
74	COMPAQ ELITE PORTABLE (N.A.)	150-151 800-345-1518	230	HIT-TECH INSTRUMENTS	275 713-980-9040	226	PACIFIC COAST MICRO	264 619-581-6040
502-503	COMPEX INC	40KS 23 714-630-7302	534-535	HOCKWARE	401S 11 919-380-0616	*	PACIFIC DATA PRODUCTS	181 619-625-3685
75	COMPUSERVE (INT'L)	177 614-529-1349	231	HOOLEON CORP	275 602-634-7515	116	PASSPORT DESIGNS INC	97 415-726-0280
*	COMPUSERVE (N.A.)	178A-B 800-848-8199	94-95	HORIZONS TECHNOLOGY	116 619-292-8331	117	PATTON & PATTON	233 800-525-0082 ext 114
78	COMPUSERVE (N.A.)	177 800-848-8199	288-289	HYPERBOLE STUDIOS	200 206-441-8334	116-119	PC POWER & COOLING	19 800-722-6555
79	COMPUTER ASSOC REALIA	147 800-434-REAL dept 26500	J			R		
80	COMPUTER ASSOC UNICTR	123 800-225-5224 dept 10500	286	IBM OS/2	16-17 800-3-IBM-OS2	S		
*	COMPUTER ASSOC VISUAL OBJECTS	36-37 800-225-5224 dept 14500	96	IBM POWER PC (N.A.)	120-121 800-IBM-6676 ext 821	T		
*	COMPUTER DISCT WREHSE	258A-P 800-959-4CDW	97	IBM SERVER	106-107 800-772-2227	U		
193	COMPUTER DISCT WREHSE	256-257 800-959-4CDW	98	IBM VISUAL AGE	57 800-IBM-CALL dept SA005	V		
*	COMPUTER EXPO '95	40KS 26	188-187	ICONOVEX INC	222 800-943-0292	W		

INDEX TO ADVERTISED PRODUCTS

For FREE product information from individual advertisers, circle the corresponding inquiry numbers on the response card!

To receive information for an entire product category, circle the category number on the response card!

Category No.
Inquiry No.

Page No.

HARDWARE

1 ACCESSORIES/SUPPLIES

188-189	AER ENERGY RESOURCES INC	59
174-175	AERONICS INC	167
215-216	ANTEX ELECTRONICS	270
259	IERC	272
256	JD INTL	272
184-185	QUARTON USA	226

2 ADD-IN BOARDS

215-216	ANTEX ELECTRONICS	270
66	ATI TECHNOLOGIES INC	138
217-218	COROLLARY	260
84-85	CURTIS INC	144
197-198	DISTRIBUTED PROCESSING TECH	259
279-280	DTC ELECTRONICS HUNGARY	276
201	JAMECO ELECTRONICS	263
265	PRACTICAL ENHANCED LOGIC	272
266	PRACTICAL ENHANCED LOGIC	272
129-130	QUATECH INC	246
271-272	SILICON WAREHOUSE	272
242	TALKING TECHNOLOGY INC	274

3 BAR CODING

243	VIDEX, INC	273
-----	------------	-----

4 COMMUNICATIONS/ NETWORKING

225	ALTA RESEARCH CORP	279
558	ALTEX ELECTRONICS	264MW 2-3
556	ALTEX ELECTRONICS	264NE 2-3
557	ALTEX ELECTRONICS	264SO 2-3
160-161	AT & T PARADYNE	54-55
532	AXIS COMMUNICATIONS	40IS 13
217-218	COROLLARY	260
276-277	CYCLADES CORP	273
*	DELL COMPUTER CORP (N.A.)	88A-D
287	DESIGN TECHNOLOGY	232
279-280	DTC ELECTRONICS HUNGARY	276
541-542	ERGOTRON EUROPE	40IS 9
281-282	GTEK INC	273
97	IBM SERVER	106-107
519	MEGADATA	40IS 30
151	MINICOM/CLASSNET VIDEO	98
191	MOBILECOMM/BELL SOUTH (N.A.)	119
182-183	POLYCON GMBH DATA SYSTEMS	183
260-261	RCI	273
240	RHETOREX, INC	273
132-133	ROSE ELECTRONICS	228
250-251	SIGMA TECH SOFTWARE	274
562-563	SOLID COMPUTER GMBH (INT'L)	137
242	TALKING TECHNOLOGY INC	274

5 COMPUTER SYSTEMS

567	ACORN COMPUTERS	40IS 5
83-84	ADVANCED LOGIC RESEARCH	205
*	APPLE COMPUTER INC	2-3
209	APPRO INTERNATIONAL INC	270
293	COMPAQ DESKTOPS (N.A.)	137
217-218	COROLLARY	260
196	DATALUX CORP	248
*	DELL COMPUTER CORP (N.A.)	CIII
*	DELL COMPUTER CORP (N.A.)	CIV
529-530	ECG (INT'L)	291
*	GATEWAY 2000	72A-J
*	GATEWAY 2000	72-73
96	IBM POWER PC (N.A.)	120-121
97	IBM SERVER	106-107
*	INTEL CORP	82-83
*	INTEL CORP (N.A.)	40A-D
100-101	INTERGRAPH	152
233	KILA	274
283	MANCHESTER EQUIPMENT CO	264NE 1

Category No.
Inquiry No.

Page No.

290-291	MEDIA ON	202
113	NSTL - PC DIGEST (N.A.)	241
*	NSTL - WORLD DOMINANCE	210
226	PACIFIC COAST MICRO	264
208	RECOTEC INC	269
*	SILICON GRAPHICS (N.A.)	158
562-563	SOLID COMPUTER GMBH (INT'L)	137
247	TRI VALLEY TECHNOLOGY INC	274
150	ZEOS INTERNATIONAL	196-197

6 DATA ACQUISITION

229	GAGE APPLIED SCIENCES INC	274
232	IO TECH	274
*	MICROSTAR LABORATORIES	274
129-130	QUATECH INC	246

7 DISK & OPTICAL DRIVES

84-85	CURTIS INC	144
252-253	GRANITE DIGITAL	275
554	HITACHI	40IS 18
203-204	MICRO SOLUTIONS COMP PROD	253
205-206	MICRO SOLUTIONS COMP PROD	255
*	PHILIPS LMS	40IS 24
545-546	PHILIPS LMS	40IS 25
122-123	PINNACLE MICRO	7
172-173	PLEXTOR	44

8 DISKETTES/DUPLICATORS

174-175	AERONICS, INC	167
---------	---------------	-----

10 GRAPHICS TABLETS/MICE/ PEN INPUT

166-167	ARISTO GRAPHIC SYSTEMS	224
230	HI-TECH INSTRUMENTS	275
106-107	LOGITECH INC	112-113
561	PRIMAX ELECTRONICS	264PC 2

11 KEYBOARDS

501	CHERRY MIKROSCHALTER GMBH	40IS 20-21
196	DATALUX CORP	248
262-263	ELMA ELECTRONIC	275
231	HOOLEON CORP	275
*	MICROSOFT CORP	20-21

12 LAN HARDWARE

502-503	COMPEX INC	40IS 23
86-87	CYBEX CORP	171
194-195	CYBEX CORP	249
.505-506	CYBEX CORP (INT'L)	CIII
553	DIGITAL NIPG (ETHERWORKS) (INT'L)	119
541-542	ERGOTRON EUROPE	40IS 9
199-200	FIRST SOURCE INT'L	252
*	OLIVETTI S.P.A.	88IS 1-8
118-119	PC POWER & COOLING	19
182-183	POLYCON GMBH DATA SYSTEMS	183
551-552	XIRCOM EUROPE NV (INT'L)	79

13 LAPTOPS & NOTEBOOKS

207	ADAPTEC	268
166-169	AER ENERGY RESOURCES INC	59
246	AMREL TECHNOLOGY, INC	275
73	COMPAQ CONTURA (N.A.)	128-127
74	COMPAQ ELITE PORTABLE (N.A.)	150-151
565	DIGICOM INC (INT'L)	99
566	DIGICOM INC (INT'L)	101
526	FIRST INTERNATIONAL COMPUTER	40IS 2
*	JDR MICRODEVICES	271
214	MICRO-INTERNATIONAL INC	262
292	SIEMENS NIXDORF INFO (EUROPE)	150-151
135	SONY	135
140-141	TEXAS INSTRUMENTS	86-87
142	TOSHIBA AMERICA INC	62-63
551-552	XIRCOM EUROPE NV (INT'L)	79
149	ZENITH DATA SYSTEMS	15

Category No.
Inquiry No.

Page No.

150	ZEOS INTERNATIONAL	196-197
-----	--------------------	---------

14 MAIL ORDER

558	ALTEX ELECTRONICS	264MW 2-3
556	ALTEX ELECTRONICS	264NE 2-3
557	ALTEX ELECTRONICS	264SO 2-3
*	COMPUTER DISCOUNT WAREHOUSE	256A-P
193	COMPUTER DISCOUNT WAREHOUSE	256-257
560	COMPUTERLANE UNLTD	264PC 1
201	JAMECO ELECTRONICS	263
549-550	MICRO DIRECT INTERNATIONAL	40IS 10
202	NEVADA COMPUTER	254
210	WORLDWIDE TECHNOLOGIES	250

15 MEMORY/CHIPS/UPGRADES

*	ADVANCED MICRO DEVICES (N.A.)	99
199-200	FIRST SOURCE INT'L	252
*	INTEL CORP	82-83
*	INTEL CORP (N.A.)	40A-D
201	JAMECO ELECTRONICS	263
104-105	KINGSTON TECHNOLOGY	125
223-224	L A TRADE	258
210	WORLDWIDE TECHNOLOGIES	250

16 MISCELLANEOUS HARDWARE

176	CALIFORNIA PC PRODUCTS INC	100
99	INTEGRAND RESEARCH	114
226	PACIFIC COAST MICRO	264
118-119	PC POWER & COOLING	19

17 MODEMS/MULTIPLEXORS

*	JDR MICRODEVICES	271
158-159	ZYXEL USA	108

18 MONITORS & TERMINALS

82-83	CTX INTERNATIONAL INC	185
196	DATALUX CORP	248
515	KUO FENG CORP	40IS 31
110-111	NANAO USA CORP (N.A.)	79
523	PHILIPS MONITORS (INT'L)	125-127
182-183	POLYCON GMBH DATA SYSTEMS	183
538	SAMTRON	40IS 7
163-164	SCEPTRE TECHNOLOGIES	155
102-103	SMILE INTERNATIONAL INC (N.A.)	162
143-144	VIEWSONIC	61

19 MULTIMEDIA/CD-ROM

215-216	ANTEX ELECTRONICS	270
154	CREATIVE LABS INC	48-49
155	CREATIVE LABS INC	71
156	CREATIVE LABS INC	81
279-280	DTC ELECTRONICS HUNGARY	276
235-236	MICROBOARDS	276
116	PASSPORT DESIGNS INC	97
*	PHILIPS LMS	40IS 24
545-546	PHILIPS LMS	40IS 25
*	SILICON GRAPHICS (N.A.)	158
241	SILICONSOFT INC	276
268-269	SOUND MINDS TECH	276

20 PRINTERS/PLOTTERS

*	HEWLETT-PACKARD	28-29
*	HEWLETT-PACKARD	39
*	HEWLETT-PACKARD	76-77
*	HEWLETT-PACKARD	92-93
283	MANCHESTER EQUIPMENT CO	264NE 1
514	OLIVETTI S.P.A. (INT'L)	120-121
*	PACIFIC DATA PRODUCTS	181
139	TEKTRONIX	190-191

21 PROGRAMMABLE HARDWARE

192	BUFFALO PRODUCTS	268
511-512	FAST HARDLOCK	40IS 27
*	JDR MICRODEVICES	271

INDEX TO ADVERTISED PRODUCTS

Category No. Inquiry No.		Page No.
170-171	MARX DATENTECHNIK GMBH	224
131	RAINBOW TECHNOLOGIES	53
245	Z-WORLD ENGINEERING	276

22	SCANNERS/OCR/DIGITIZERS	
516	LIGATURE LTD	40IS 4

23	TAPE DRIVES	
174-175	AERONICS INC	167
71-72	COLORADO MEMORY SYSTEMS	12-13
234	LAGUNA DATA SYSTEMS	276
203-204	MICRO SOLUTIONS COMP PROD	253
205-206	MICRO SOLUTIONS COMP PROD	255
*	PHILIPS LMS	40IS 24
545-546	PHILIPS LMS	40IS 25
239	OUALSTAR CORP	278
257-258	SHAFFSTALL CORP	277

24	UPS/POWER MANAGEMENT	
284	AMERICAN POWER CONVERSION	32-33
67-68	BEST POWER TECHNOLOGY	141
118-119	PC POWER & COOLING	19

52	SECURITY	
501	CHERRY MIKROSCHALTER GMBH	40IS 20-21
511-512	FAST HARDLOCK	40IS 27
170-171	MARX DATENTECHNIK GMBH	224
131	RAINBOW TECHNOLOGIES	53
241	SILICONSOFT INC	276
169	WIBU	46

SOFTWARE

25	BUSINESS	
531	CARDIFF SOFTWARE	40IS 28
544	CENTRIC PMS BV	40IS 26
94-95	HORIZONS TECHNOLOGY	116
117	PATTON & PATTON	233

26	CAD/CAM	
166-167	ARISTO GRAPHIC SYSTEMS	224
547	ARTEK SRL (INT'L)	162
*	AUTODESK INC	11
100-101	INTERGRAPH	152
244	WINTKORP	277

27	COMMUNICATIONS/ NETWORKING	
212-213	AGE LOGIC	267
160-161	AT & T PARADYNE	54-55
190	BOOKLINK TECH - INTERNETWORKS (N.A.)	95
502-503	COMPEX INC	40IS 23
199-200	FIRST SOURCE INT'L	252
89-90	FRONTIER TECHNOLOGIES	98
221-222	IGC INC	261
180-181	JSB	182
537	LANSOURCE	40IS 16
254-255	MYSTIC SOFTWARE	279
112	NOVELL INC (N.A.)	133
114-115	OCEAN ISLE SOFTWARE	229
520-521	OCEAN ISLE SOFTWARE (INT'L)	CIV
120	PERSOFT INC	223
121	PERSOFT INC	227
178-179	SMITH MICRO SYSTEMS & SOFTWARE	220
165	SOFTARC	102-103
562-563	SOLID COMPUTER GMBH (INT'L)	137
533	TRAVELING SOFTWARE (INT'L)	95
525	WALKER, RICHER & QUINN (INT'L)	133

28	DATA ACQUISITION	
237	NATIONAL INSTRUMENTS	277

29	DATABASE	
69-70	BORLAND INTERNATIONAL	CII-1
78	COMPUTER ASSOC. REALIA	147
79	COMPUTER ASSOC. UNICENTER	123
80	COMPUTER ASSOC. VISUAL OBJECTS	36-37
507-508	DR HUGGLE & PARTNER GMBH	40IS 6
94-95	HORIZONS TECHNOLOGY	116
564	INNOVATIVE SOFTWARE	136
564	INNOVATIVE SOFTWARE	136
518	MAGIC / MSE (INT'L)	241
*	MICROSOFT CORP	8-9

Category No. Inquiry No.	Page No.
30	EDUCATIONAL
61-62	ABACUS SOFTWARE
	168

31	ENGINEERING/SCIENTIFIC	
539-540	F & H SIMULATIONS	40IS 15
94-95	HORIZONS TECHNOLOGY	118
100-101	INTERGRAPH	152
548	INTERISIS AUTOMACAO	40IS 22
152-153	ITERATED SYSTEMS	184
237	NATIONAL INSTRUMENTS	277
238	PERSONAL TEX	277
219-220	SCITECH INTERNATIONAL	251

32	ENTERTAINMENT	
288-289	HYPERBOLE STUDIOS	200

33	GRAPHICS	
166-167	ARISTO GRAPHIC SYSTEMS	224
543	ATMA TENDERING SYSTEMS SRL	40IS 28
81	COREL DRAW	23
264	EMATEK GMBH	277
110-111	NANAO USA CORP (N.A.)	79
116	PASSPORT DESIGNS INC	97

34	MACINTOSH	
517	LOGIC PROGRAMMING ASSOCIATES	40IS 30

35	MAIL ORDER	
*	COMPUTER DISCOUNT WAREHOUSE	256A-P
193	COMPUTER DISCOUNT WAREHOUSE	256-257
504	COMPUTER QUICK	40IS 8
513	GREY MATTER LTD	40IS 17
108	PROGRAMMER'S PARADISE	86-87

36	MATHEMATICAL/ STATISTICAL	
539-540	F & H SIMULATIONS	40IS 15
238	PERSONAL TEX	277
138	STATSOFT	115
137-138	SYSTAT INC	157

37	MISCELLANEOUS SOFTWARE	
528	ON TIME MARKETING	40IS 22

38	ON-LINE SERVICES	
450	BIX (N.A.)	291
75	COMPUSERVE	177
88	DELPHI INTERNET SERVICES	189

39	OPERATING SYSTEMS	
274-275	ACC CORP	278
286	IBM OS/2	18-17
221-222	IGC INC	261
*	MICROSOFT CORP	42-43
*	NETWORK COMPUTING DEVICES (N.A.)	175
112	NOVELL, INC (N.A.)	133
127	QNX SOFTWARE SYSTEMS LTD	215
128	QUARTERDECK OFFICE SYSTEMS	47

40	PROGRAMMING LANGUAGES/ TOOLS	
89-70	BORLAND INTERNATIONAL	CII-1
507-508	DR HUGGLE & PARTNER GMBH	40IS 6
264	EMATEK GMBH	277
76-77	GREENVIEW DATA	69
534-535	HOCKWARE (INT'L)	40IS 11
98	IBM VISUAL AGE	57
177	LIKKUVA SYSTEMS INTERNATIONAL	156
517	LOGIC PROGRAMMING ASSOCIATES	40IS 30
518	MAGIC/MSE (INT'L)	241
109	MICROWAY	199
278	OBJECT MANAGEMENT LABORATORY	277
528	ON TIME MARKETING	40IS 22
522	PHAR LAP SOFTWARE INC (INT'L)	175
126	POPKIN S/W & SYSTEMS INC	237
108	PROGRAMMER'S PARADISE	66-67
134	SEQUITER SOFTWARE INC	173
*	TYPHOON SOFTWARE	264PC 4
273	VIMAN SOFTWARE	278
145	WATCOM C/C++ 10.0	31
148-147	XVT SOFTWARE INC	216

Category No. Inquiry No.		Page No.
41	SECURITY	
559	ALADDIN KNOWLEDGE SYSTEMS	264PC 3
65	ALADDIN KNOWLEDGE SYSTEMS	85
555	ALADDIN KNOWLEDGE SYSTEMS	264NE 4
162	DALLAS SEMICONDUCTOR	143
509-510	EUTRON	40IS 14
511-512	FAST HARDLOCK	40IS 27
92-93	GLENCO ENGINEERING	149
170-171	MARX DATENTECHNIK GMBH	224
131	RAINBOW TECHNOLOGIES	53
524	SOFTWARE SECURITY	40IS 32
169	WIBU	46

44	SPREADSHEETS	
169	WIBU	46

45	UNIX	
212-213	AGE LOGIC	267
91	FRAME TECHNOLOGY (N.A.)	101
76-77	GREENVIEW DATA	69
*	NETWORK COMPUTING DEVICES (N.A.)	175

46	UTILITIES	
65	ALADDIN KNOWLEDGE SYSTEMS	85
544	CENTRIC PMS BV	40IS 26
267	CONSOLIDATED SOFTWARE PRODUCTS	278
168	LOGICIELS ET SERVICES DUHEM	48
211	MICRO 2000	266
124	PKWARE INC	132
125	PKWARE INC	134

47	WINDOWS	
61-62	ABACUS SOFTWARE	166
544	CENTRIC PMS BV	40IS 26
507-508	DR HUGGLE & PARTNER GMBH	40IS 6
536	FINSON	40IS 29
89-90	FRONTIER TECHNOLOGIES	98
270	FUZICALC	278
228	GAMMA PRODUCTIONS	278
186-187	ICONOVEX INC	222
177	LIKKUVA SYSTEMS INTERNATIONAL	156
517	LOGIC PROGRAMMING ASSOCIATES	40IS 30
248-249	MICROCAL SOFTWARE INC	279
254-255	MYSTIC SOFTWARE	279
110-111	NANAO USA CORP (N.A.)	79
120	PERSOFT INC	223
121	PERSOFT INC	227
157	SERIF INC	159
241	SILICONSOFT INC	276
148	WORDPERFECT / NOVELL APPLICATIONS GROUP	24-25

48	WORD PROCESSING/DTP	
91	FRAME TECHNOLOGY (N.A.)	101
186-187	ICONOVEX INC	222
516	LIGATURE LTD	40IS 4
157	SERIF INC	159
148	WORDPERFECT / NOVELL APPLICATIONS GROUP	24-25

GENERAL

49	BOOKS/PUBLICATIONS	
61-62	ABACUS SOFTWARE	166
*	BYTE READER	178
*	DATAPRO (INT'L NOT EUROPE)	150-151
*	OSBORNE MCGRAW-HILL	180-181
*	OSBORNE MCGRAW-HILL	235

51	MISCELLANEOUS	
*	AMERICAN LUNG ASSOCIATION	264MW 4
*	AMERICAN LUNG ASSOCIATION	264SO 4
*	BYTE PUBLISHER'S STATEMENT	231
*	BYTE BACK ISSUES	40IS 12
*	BYTE BACK ISSUES	264MW 1
*	BYTE BACK ISSUES	264SO 1
*	BYTE CARD DECK	264PC 4
*	BYTE EDITORIAL SURVEY	234
*	BYTE IT SERVICES '94	168
*	BYTE NETWORKING	128
*	BYTE ON CD ROM	186
*	BYTE POWER PC FORUM '94	219
*	BYTE REPRINTS (N.A.)	136
*	BYTE SUB MESSAGE	148
*	COMPUTER EXPO '95	40IS 26

EDITORIAL INDEX

For more information on any of the companies covered in articles, columns, or news stories in this issue, circle the appropriate inquiry number on the response card. Each page number refers to the first page of the article or section in which the company name appears. IS pages appear only in the International edition.

Inquiry No.	Page No.	Inquiry No.	Page No.	Inquiry No.	Page No.	Inquiry No.	Page No.				
A		Data General	109	1152	Iomega	225	1293	Primavera Systems	245		
1474	Accounts II Software	40IS 28	Datapro Information	30	Isicad	30	1444	Primax Electronics	40IS 18		
1001	Adaptec	163	Services Group		1306	Ivex Design	244		Priority Call Management	26	
1471	Adept Scientific Micro Systems	40IS 30	1109	Data Storage Marketing	192	J		1467	Prisma Office	40IS 24	
1275	Adobe Systems	242	1294	DataStream Imaging Systems	245	1332	Jazz	239	1336	Proxima	240
	Advanced Micro Devices	50	1111	DEC	104, 109, 192	K		Q			
1433	Advanced RISC Machines	40IS 4		Decisis	109		Kedwell Software	40	1011	QMS	139
1278	AGPW	242	1110	Deli Computer	192	1307	Ketiv Technologies	245	R		
	A. K. Peters	35	1470	Digithurst	40IS 24	1150	Kitty Hawk Software	225	1437	R&D Technology	40IS 14
1317	Alpha Systems Lab	238	1340	Dolphin Interconnect Solutions	240	1308	Koyn Software	244	1339	Racal-Datcom	240
1460	Ambitron	40IS 19		Drew Studios	35	L		1303	Raxco	243	
	Andersen Consulting	74	1290	Duet Development	244	1335	Lantronix	240	S		
	Apple Computer 10, 50, 104, 221		1112	Duracom Computer Systems	192	1329	Lexmark International	239	1453	Savin	40IS 16
1289	Apropos	244	1311	Durand Communications Networks	245	1472	Longman Logotron	40IS 26	1277	Seay Systems	242
	Apsylog	30	1113	Dyna Micro	192	1004	Lotus Development	50, 179		SGI/Mips	50
1288	Arcland	244	E			M			Shiva	27	
1445	Arcom Control Systems	40IS 16	1282	ED Sales & Service	242		Macromedia	74	1146	Sierra On-Line	225
1005	Artisoft	169		Electronic Arts	35	1319	MAG InnoVision	238	1443	Silica	40IS 14
1105	AST Computer	192		Environmental Systems Research Institute	38	1469	Majih Software	40IS 24	1285	SoftArc	243
	AST Research	50	1328	Extended Systems	239		MapInfo	38		Software Illustrated	38
1106	AT&T	50, 109, 192	F			1421	MDi Systems	40IS 3	1273	Software Publishing	244
1456	ATDI	40IS 19	1458	Fabmaster	40IS 22	1020	MegaSoft	40IS 26		Sony	38
1107	Austin Direct	192	1429	Fast Electronic	40IS 12		Metrowerks	50	1480	Sophos	40IS 30
B			1314	Fortress Systems	239		Microchip Technology	217	1321	Storage Dimensions	238
1426	Backup Business (Computer) Services	40IS 3	1337	Frontline Test Equipment	240	1461	Microft Technology	40IS 19		Strategic Mapping	38
	Banyan Systems	109	1281	Frye Computer Systems	242	1009	Micropolis	187		Sun Microsystems	50, 109, 129
1344	BellSouth Cellular	145	1434	Fujitsu	40IS 8	1154	MicroProse Software	225		SunSoft	104, 109
1279	Benefit Systems	242	1003	Future Domain	163	1006	Microsoft	10, 40, 50, 89, 169, 221		SynOptics	109
	Berkeley Systems	35	G			1274	MicroStrategy	245	T		
1464	Blackwell Software	40IS 21	1430	Gandalf	40IS 8	1286	Microsystems Software	243		Tandy	50
1447	Blue Chip Technology	40IS 12	1114	Gateway 2000	192	1440	MicroTouch Systems	40IS 8	1272	Tanisis Technology	243
1299	Blue Sky Software	243	1292	GoSoftware	244	1153	Microworlds	225	1318	Tatung	238
	Borland International	40, 50	1334	Grand Junction Networks	240	1119	Mitsuba	192	1300	Technical Software	243
1291	Brainstorm Technologies	244		Groupe Bull	109	1330	Mitsubishi Imaging Products	239	1428	Tekdata	40IS 10
	Broderbund	34	H				MobileWare	27	1323	Telebyte Technology	238
1002	BusLogic	163	1422	Hakuto International	40IS 4		Motorola	27, 38, 41, 50, 217		Thomson-CSF	129
	Byron Preiss Multimedia	35	1280	Headquarters Software	242	1439	MRT International	40IS 12		3Com	27
C			1438	Herbert Helmstreit	40IS 16	1425	Multidata	40IS 3	1151	T-Maker	225
	Cabletron	109	1116	Hertz	192	N				Travelers	109
1147	Caligari	225	1010,	Hewlett-Packard	30, 50, 104, 109, 129, 139, 192	1427,	National Instruments	40IS 6,	1338	Triumph Logistic Computers	240
1000	Cardiff Software	153	1117			1457		40IS 21	V		
1287	Cascadilla Press	243	1115	High Definition Systems	192		NetLabs	30	1333	Vinca	240
1462	C. D. Hardware	40IS 21	1111	Hitachi	109	1459	NHC Communications	30	1295	Vinzant	245
1468	CER International	40IS 22	1431	HM Systems	40IS 10	1007	Novell	50, 89, 104, 109, 169, 221	1284,	Visual Numerics	243
1423	Cherry Mikroschalter	40IS 6	1475	HTS	40IS 30	O			1301		
1271	Chili Pepper Software	242	I				Object Design	26	W		
1463	Cimlinc	40IS 19		IBM	10, 41, 104, 109, 221		Oracle	50	1442	Wandel & Goltermann	40IS 10
	Cisco Systems	109, 129	1309	ImageFast Software	244	1322	Ositech Communications	238		Wellfleet	109
1312	Citrix Systems	245	1478	ImageShop	40IS 26	P				Wessex	38
1298	Coda Music Technology	245	1149	Imagine That	225		Panasonic	34	1302	Wildfire Communications	26
	Compaq Computer	41, 50	1297	InfoOutlet	245	1313	Panasonic Personal Computer	238		WinSales	243
	Component Integration Laboratories	50	1315	Inforite	240		Performance Technology	169	X		
	Computer Expressions	35	1304	Informative Graphics	244	1008	Phantech Software	243	1012	Xerox	50, 139, 213
1148	Corel	225	1118	Insight Direct	192	1283	Phase IV Systems	40IS 3	1120,	Xi Computer	192
1108	Cornell Computer Systems	192	1320	Integral Peripherals	238	1424	Pinnacle Micro	238	1121		
1305	Crosswise	244	1473	Integrated Measurement Systems	40IS 28	1316	Power Pixel Technologies	239	Z		
	C-T Link	26		Intel	10, 41, 50, 213	1327	PP&P	74	1122,	Zenith Data Systems	192, 225
1296	CyberMedia	245		Interlink Electronics	239	1276	Premium Design	242	1155		
1324	Cylink	239	1326	International Debug Tools	239				1123	Zeos International	192
	Cyrix	50	1310	Intuit	40, 245					Zilog	4
D											
	Daratech	38									
	Dassault	129									

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Teach Formal Methods

Safety-critical systems should require a formal methods specification

A plane from a major airline crashes, killing everybody aboard. After many months of investigation, the responsible authorities declare that the accident might have been caused by a faulty component in the plane's fly-by-wire system. Months pass; eventually the families of some of the victims sue the airline for damages. During the trial, the attorneys for the victims' families produce an analysis of the logic of the fly-by-wire system that reveals several previously undetected fault modes. These modes are shown to be directly responsible for the plane's crash. Not only does the judge award the families a substantial sum of money, but he or she also starts proceedings to have the plane's manufacturer charged under a new criminal negligence statute.

Such a scenario may occur in the near future. Several European and Canadian agencies have issued new guidelines strongly recommending—and in some cases mandating—the use of formal methods and proof in the development of hardware and software for safety-critical systems (e.g., nuclear reactor and military systems).

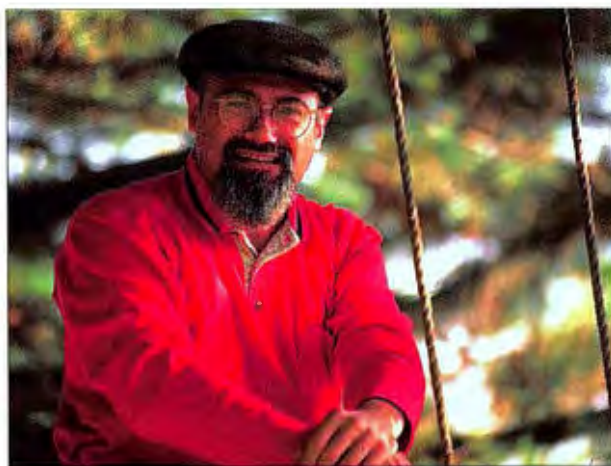
At the present time, the situation is different in the U.S. Under pressure from many manufacturers, the U.S. government has been reluctant to follow the lead of some European countries in recommending the use of formal methods in the development of safety-critical systems. These manufacturers have a misguided fear of the difficulty and the costs involved in using formal methods.

For the past 30 years, a large body of material on formal methods has been accumulating at research institutions. For over 15 years, several introductory texts have taught the use and practice of formal methods.

The main idea of a formal specification is to use a formal language to describe a set of properties that the underlying system must satisfy. This implies that there are at least two formal languages. One is used to describe the properties we are trying to specify; another (possibly the same) language describes the system about which these properties are to be verified. The languages themselves need to be formally defined.

There are many such languages and techniques, ranging from various logics to algebraic models. Many systems provide automatic tools for the composition of formal specifications and several semiautomatic theorem provers for the verification of such specifications.

Although much work remains to be done, particularly in the area of distributed systems, there is a solid core of materials available for systems developers. There is also the issue of the current set of programming languages available for the coding of what has been speci-



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fied using a formal language. Ideally, implementation languages would facilitate the verification of system properties. For example, in some Prolog-like languages, we come close to having executable specifications: The formal description of what the system is to accomplish can be written in the same underlying logic language.

The main complaint one hears from industry is that it is almost impossible to hire people who are trained in the use of these techniques. Training in the use of formal methods must become an integral part of the computer science curriculum before there is any hope of these techniques being applied in industry. These methods are not any more difficult than the differential equations and vector analysis techniques that all engineers learn in their undergraduate education. Training has to begin with the first course in computer science and continue to be used and enhanced during a scientist's professional life.

Most U.S. colleges require their students in engineering and science to take many "service" courses in mathematics. These include three semesters of calculus and one semester of differential equations. Most computer science majors won't use the majority of these techniques. It would be much more useful to teach these students the logic and algebraic methods that can be immediately applied in their chosen discipline.

In the U.S. today, there is a large pool of well-educated, mature scientists from what used to be the defense industry. Many of these individuals have advanced degrees in math, physics, electrical engineering, and other technical areas. It would be simple to teach them the formal methods approach to software and hardware development. These people could be hired and used as catalysts for the growth of formal techniques in U.S. industry. What an opportunity for some smart politician! ■

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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