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Contents by Platform

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intel inside

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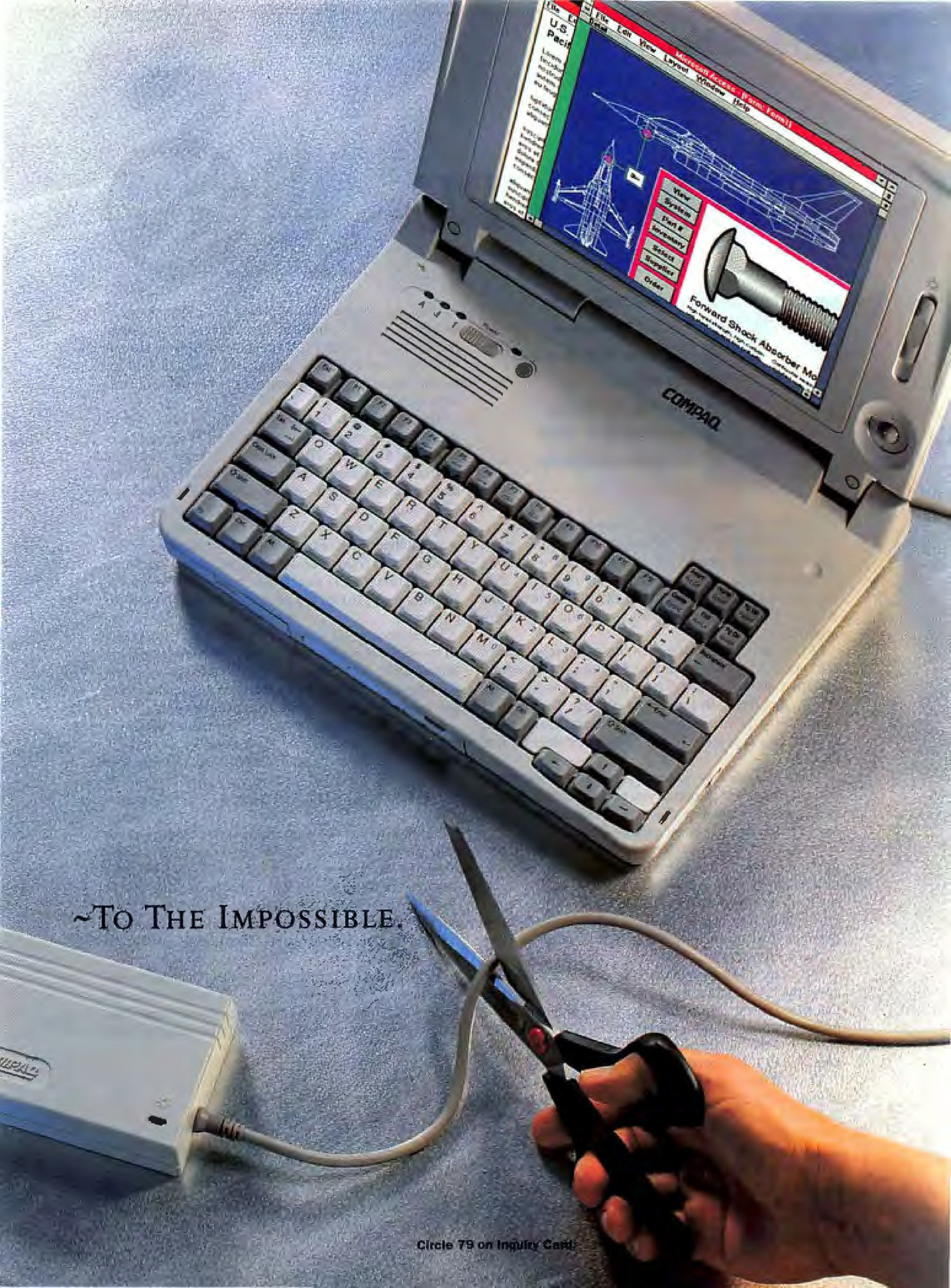
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The New CPUs

Even though Intel is now getting a great deal of competition, CPUs are not commodities

It happens with every giant. You become the most obvious target for all your competition. So, before we get into a discussion about CPU makers who are squaring off against Intel, let's make something perfectly clear: As the present leader for desktop CPUs, Intel is not just a big target for CPU competitors—it's the *only* meaningful target.

If you've been following the business press, you've read about AMD's big win with Compaq. In a nutshell, Compaq announced that it will use CPUs made by AMD—not Intel—in some of its systems. Compaq was by no means the first manufacturer to make such a move, but Compaq appears to be the biggest customer of Intel CPUs.

Think of it this way: Compaq is in effect saying that it doesn't matter which engine you put in your car, as long as the car gets you where you're going. OK, maybe that's oversimplifying it, but you get the idea.

Meanwhile, all the industry pundits and gurus are trying to read between the lines to determine the *real* objective of Compaq in forsaking Intel for AMD. Some say it was a strong-arm tactic to gain better pricing from Intel. Others say it was simply a smart business move based on lower costs. Still others have as many theories as one can imagine.

But as they say down in Arkansas, it don't make no never mind. As technology experts, what matters to us is that in making a commitment to AMD, the leading PC maker endorsed—in no uncertain terms—a non-Intel CPU. And that, my friends, is the opening of the floodgates for all Intel's rivals.

That's both good news and bad news. The good news is that competition is good for everyone, particularly, end users. The move by Compaq gives a certain market credibility to AMD that will let it move beyond building so-called 486 clones. It will likely change the perspective of nearly everyone involved in buying and recommending computer systems, and it will open a lot of minds as to whether a computer has to have Intel inside.

Until now, most folks expected that systems had to be based on Intel's chips. So no matter what technological advantages another CPU might have had, the concept of using a non-Intel CPU was next to impossible to sell to your organization. Now, that mind-set hurdle will probably vanish.

The bad news is that those same folks who once insisted that a computer had to have Intel inside may now think that CPUs are all the same—that they are commodities, and the only difference is clock speeds. Well, that's just not so. If you take a close look at the new CPUs from AMD, Cyrix, IBM and Motorola, and Mips, you'll see what I mean. We're not talking clones here. By using multiple pipelines, nonreordered instructions, CISC-to-RISC conversions, or wholly RISC architectures, for example, each CPU clearly has its own technological advantage. Frankly, we're pretty excited about the prospects.

It's obvious to you as a BYTE reader that CPUs are not all the same. However, many people will simply not understand that. Unfortunately, some of them may be people who will exercise their ignorance and champion or buy inappropriate systems for your organization.

An education process is needed, and as a technical expert, you should lead it. Yes, non-Intel CPUs are credible. No, CPUs are not commodities. The debate should not be about whether a system has Intel inside, but it should be one of whether a system uses the best CPU for a particular job.

The time to start the education is now. Don't wait for other people to set the agenda. Remember just a few years ago when some folks got the crazy idea that PCs were commodities and that you just bought the lowest-cost equipment and plugged it in? Boy, were they wrong, and a lot of money was spent to correct that mistake. For the most part, businesses learned their lesson—at least for a while.

We're on the verge of a recurring phenomenon. I guarantee that a lot of otherwise intelligent people will make the leap of faith that since Compaq endorsed a non-Intel CPU, CPUs are now commodities. Let's stop that from happening.

Dennis Allen, Editor in Chief
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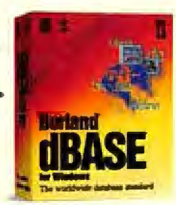

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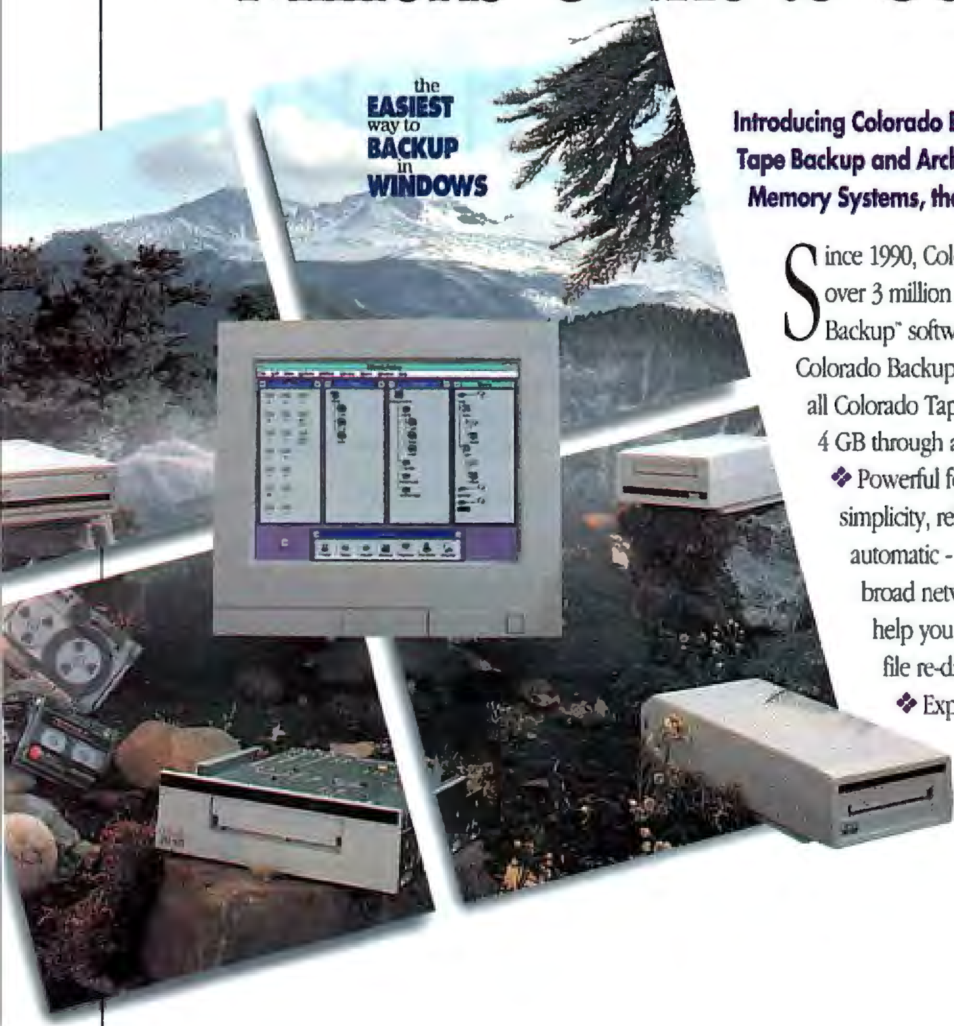

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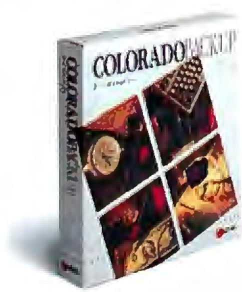

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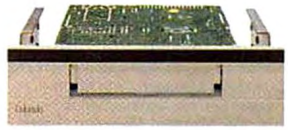

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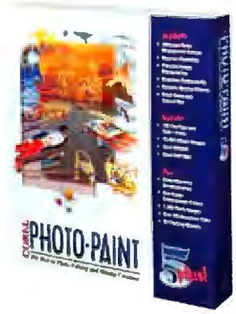

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Plug and Play Not Exactly New

Dennis Allen's September editorial quotes Tom R. Halfhill's description of Plug and Play for PCs as "won't be painless, won't come cheap, and will likely take years." However, I can tell you one *major* platform where Plug and Play has been the accepted norm for a decade: Apple's Macintosh. Even when the Mac II came out in 1987, with its NuBus expansion slots, users had only to insert a board and (at most) drop an extension into their system folder. I guess I'm just disappointed that the Mac wasn't even mentioned in the editorial.

Chris Hanson
chanson@mcs.com
Pittsburgh, PA

Plug and Play in Hindsight

Choice article on Plug and Play (September). However, you omitted one important part: how a trivial hardware botch in the original PC has made this all much worse than it had to be.

Many machines have fewer interrupt levels than the PC but aren't hurt nearly as badly by it. Why? Because on the other machines, I/O boards can *share* an interrupt line. For instance, there is no reason COM ports need distinct IRQs (interrupt requests), except that I/O cards cannot share the same one and have it work.

There are boards with multiple UARTs (universal asynchronous receiver/transmitter) on a card, all of which internally share one IRQ for the whole card, but the problem is that the original PC bus didn't arrange for IRQ sharing between cards. This only would have cost a pull-up resistor per line (and possibly an inverter), and the IRQ line could have been driven low by open-collector TTL drivers, instead of the single totem-pole outputs specified. With this trivial fix, we would have been able to share the IRQs just fine. It would have all been a lot easier.

Michael O'Dell
mo@uunet.uu.net

If I had listed everything wrong with the PC system architecture, my story would have been twice as long! You're right about the PC's limited ability to share interrupts, of course, but keep in mind that those kinds of compromises were not nearly as obvious when IBM was designing the PC in 1980 and 1981. Many of the devices we plug into our computers today didn't even exist then. Also, component costs were much higher in the early 1980s, so what seems like a trivial expense now would have been more significant in those days. In fact, IBM chose the slower 8088 processor with its 8-bit bus instead of the full 16-bit 8086 just to reduce the cost of peripheral parts.—Tom Halfhill

I work on the technical-support staff for the *New England Journal of Medicine*, supporting PCs, Macs, and Novell servers. I actually understand IRQs (interrupt requests), cascading, memory ports, and even segmented addressing, but that did me little good when I bought a CD-ROM drive. It took me 14 hours with three different brand units before I could get one installed and working properly in my 386. During the same week, my boss bought a CD-ROM for my Mac at the office, and it honestly took me less than five minutes from opening the box to viewing a sample CD.

The PC as we know it will *never* be PnP (Plug and Play). The ISA bus is not intelligent and cannot be made so; the DOS/Windows combination is even more pathetic. The only hope for PnP on non-Macs is a system that uses Windows NT or OS/2 with a PCMCIA or SCSI primary bus. PnP is just another case of Bill Gates "inventing a vision" of something that the Macintosh has been doing for seven years. Your article seemed to lead to the conclusion that PnP is a kludge that doesn't have a snowball's chance in Hades of success, but you never actually said so. I'd be curious to know why.

Don Leamy
New England Journal of Medicine
Waltham, MA

Yes, PnP is a kludge, and yes, it is merely a stepping stone to the real solution—and I made both points in my story. But I disagree that it doesn't have a chance for success or won't make life easier for millions of people. What's the alternative? Are PC users suddenly going to junk all their machines and buy systems based on an entirely new architecture? Or will they migrate in droves to the Macintosh? Not likely. For the vast majority of people, PnP will seem like wondrous technology. Why burst their bubble?—Tom Halfhill

Asking for WAN Trouble

In Jeffrey Fritz's article "Digital Remote Access" (September), he illustrates an example of split routing from Washington, D.C., to New York City. Many implementations of TCP/IP would render this scenario deadly. To improve throughput, NFS (Network File System) mounts typically use the UDP packet, leaving reordering or retransmission requests to the higher levels of the protocol stack. If the vendor also eliminates the out-of-order checking (as is frequently the case), then the described link would lock up the workstation, cause it to spontaneously reboot, or present lots of nasty messages to the user.

Robert Gammon
rgammon@rgam.micro.ti.com
Houston, TX

The fact that split routes can and do occur in ISDN multichannel connections was exactly the point I was trying to make. Split routing can cause packets to arrive out of order causing grief for a number of protocols. Generally, TCP/IP can reorder out-of-sequence packets. However, if TCPs that leave resequencing to higher levels (e.g., UDP) are used, things can get interesting. Fortunately, most ISDN remote-access vendors include packet resequencing in their products, and the network protocols are not required to deal with out-of-sequence packets. At worst, they will see short delays occasionally; these are typical and should not cause any major problems.

—Jeffrey Fritz

IBM Should License Win32

As a long time OS/2 user, I definitely do not want IBM wasting its time downgrading OS/2 to make you happy. Microsoft is

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

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losing. Windows NT is selling like fruit cake in January. Chicago is going to be the biggest mongrel kludge on the planet. Big can be a bad thing, particularly when you got big selling an operating system that *cannot* be moved slowly to a serious system without major pain and changes. OS/2 is coming on just like Windows did when it got started. The third time is the charm; the next release of OS/2 is looking good. But it doesn't just *look* good, it *is* good down to its foundations. And it is more compatible with more software than anything on the planet.

Dean Roddey
72170.1614@compuserve.com

I usually resist the temptation to add to the clutter in authors' mailboxes, but I have to say something about your September Commentary: Bravo! Bravo! This is what I've thought ever since I became an OS/2 fan a while back (right after I was disappointed with the final release of Windows NT). Why is it that Big Business, up in the Ivory Towers, can never see as clearly as we can down here in the trenches?

Robin P. Dunn, *Software Engineer*
robind@code3.com
Santa Clara, CA

Object-Oriented? Buzzzzz

In his September review of Access 2.0, Jim Carls states, "Access 2.0, like 1.x, is an object-oriented RDBMS (relational database management system)." He goes on to explain that "an object is any item in the system that you can manipulate as a unit." This definition or description of an object is probably the weakest I have seen. Using this classification, Excel, Lotus 1-2-3, and Word could all be considered "object-oriented" by the very fact that you can manipulate cells, columns, charts, and pages as a unit. This sort of watered-down "object-orientation" causes people to think everything is "object-oriented."

Chris Cuilla
ccuilla@ccdd.com
Boulder, CO

This Unix Is Free, but the Support Is Free-Form

I just finished reading J. Bruce Dawson's short review of Fintronic's distribution of Linux ("Power of Cooperation," September). While his review is quite accurate and fair, he failed to mention that there is excellent support for Linux from a number of sources: The best and most up-to-date documentation is at an FTP site: sunsite.unc.edu, in the /pub/Linux/docs/LDP directory. There you will find a number of Linux manuals developed and maintained by the Linux Documentation Project group.

For information on the different Linux distributions, the DOS emulator, and networking, look in the /pub/Linux/docs/HOWTO directory of the sunsite.unc.edu ftp site. Also, Linux System Labs and Yggdrasil Computing publish a book called *The Linux Bible, The Gnu Testament*. I highly recommend it! Besides internet newsgroups and Fido echoes that discuss Linux issues, Specialized Systems Consultants publishes monthly an excellent magazine called the *Linux Journal*.

Nick Busigin
74075.1501@compuserve.com
Stratford, Ontario, Canada

From: Sincerely Appalled

Whipping with a cat-o'-nine tails is too mild a punishment. Whoever approved the cover graphic for the September BYTE should be flogged with a frayed SCSI cable. ⊘ A circle with a diagonal line from upper right to lower left is a "Ghost Busters" advertising joke. ⃠ A circle with a diagonal line from upper left to lower right is the real thing. Come on you guys, stop making the editors of my favorite magazine look like a bunch of reversed DIPs.

Dick Heath
Rio Nido, CA

FIXES

In the August state of the art on Fibre Channel ("Fibre Channel Speeds Up"), the EISA-based adapter card mentioned as Ancor's first product will actually be sold only by Hewlett-Packard and include an HP-written driver for Series 700 workstations.

Larry Stein is president of FarPoint Communications (Lancaster, CA), not of FarPoint Systems (Jersey City, NJ), as stated in our text box on parallel-port technology (August, page 118). For more information on IEEE 1284, EPP, ECP, or on FarPoint's 1284 parallel ports, type GO EET:STDFRM to access the 1284 Parallel Port Forum on CompuServe.

In Jerry Pournelle's October column (page 222), the number for the Journal of Biological Chemistry is incorrect. The correct number is (301) 530-7145. ■

COMING UP IN DECEMBER

- **COMPUTER-BASED TRAINING**
  Arthur Andersen's system of multimedia-based, computer-aided training tools keeps its staff of management consultants and its worldwide customer base up-to-date in hundreds of areas; developing the system was not an easy task, and evaluating its effectiveness is an on-going process.
- **PENTIUMS**
  December's Product Report evaluates the hottest segment of the Intel-based PC market: 90-MHz Pentiums. We'll use custom low-level and applications benchmarks to find today's price and performance leaders.
- **WINSOCK**
  How to create network services for applications on Windows NT.
- **PEER-TO-PEER NETWORK OPERATING SYSTEMS**
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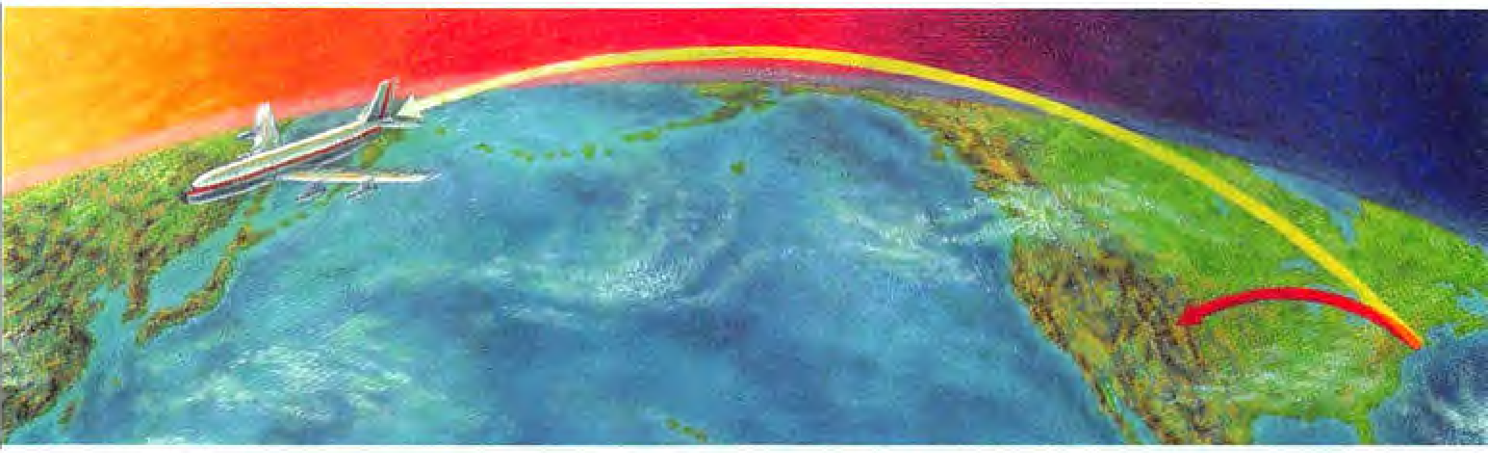

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News & Views

THE INTERNET

The Web Means Business

Companies are increasingly turning to the World Wide Web to spread the word on their products and services

STEVEN J. VAUGHAN-NICHOLS

A year ago, only a seasoned Internet surfer could tell you that WWW stood for the World Wide Web, an Internet-borne distributed collection of documents that you can navigate via hypertext. Today, the Internet's popularity is booming, and it's being partly driven by the WWW's red-hot popularity.

The Internet has a rich assortment of information resources and retrieval tools, such as Archie, gopher, and WAIS (Wide Area Information Service). The WWW, based on the HTML (hypertext markup language), is proving more successful than its predecessors because of its flexibility and its easy-to-use and colorful front ends, such as the NCSA's (National Center for Supercomputing Applications) Mosaic.

NCSA Mosaic is, and will continue to be, a freeware program; however, NCSA recently turned over Mosaic's commercial development to Spyglass (Savoy, IL). Companies wishing to use Mosaic in their products must go to Spyglass for its Enhanced NCSA Mosaic, which requires less memory than NCSA Mosaic and is more consistent across its Mac, Windows, and Unix versions.

Enhanced Mosaic 2.0, which will add support for security and authentication for business transactions, is slated to ship by the end of this year. Spyglass already has agreements in place to supply Enhanced Mosaic to DEC, FTP Software, IBM, and book and online publisher O'Reilly & Associates. And NEC (Tokyo, Japan) will develop and distribute a Japanese-language version of Spyglass's Enhanced NCSA Mosaic.

The freeware version of Mosaic will incorporate some Spyglass improvements. Other improvements, such as secure transaction processing, will be limited to Spyglass commercial versions. Before the Spyglass deal, NCSA already had contracts for Mosaic's commercial development in place with such companies as Quarterdeck Office Systems and Spry. According to Joseph Hardin, associate director of NCSA's Software Development Group, NCSA will honor these agreements, which means that these companies will have access to the source code for improved freeware versions in the future. In addition, these companies can form new agreements with Spyglass.

But not all companies are

Air Mosaic from Spry ((206) 447-0300) gives networked users access to the WWW with new features like user-definable hot lists, a full-screen kiosk mode, a search function, and enhanced stability.

What's Wrong with the Web

The WWW (World Wide Web), and the browsers that support it, is a remarkable fabric of information threads that span the world. The WWW is not without shortcomings:

- **High-speed data connections are a requirement. Connections at 14,400 bps are a bare minimum.**
- **WWW browsers are not universal Internet/Usenet interfaces. Mail support is limited, and there's no real support for Usenet news.**
- **Connections made over normal phone lines using SLIP and PPP can be difficult to install.**
- **The WWW data is not organized. There is no Dewey Decimal or Library of Congress system for organizing information on the WWW, and finding specific information can be frustrating.**
- **Support for WAIS (Wide Area Information Service) databases is still limited.** **—SJVN**

turning to Spyglass for commercial versions of Mosaic. Mosaic Communications (Mountain View, CA, (800) 638-7483, http://mosaic.mcom.com) plans to follow its intended October release of Mosaic NetSite Communications Server, for delivering nonsecure content, with a commerce server in November. The latter version of Mosaic's Unix server version incorporates RSA Data Security technology to enable secure commerce over the Internet. The company also rewrote the Mac, X Window System, and Windows NCSA Mosaic clients to support smooth operation over 14.4-Kbps and higher modems.

Businesses that have been baffled by how to establish a presence on the Internet, which has traditionally been hostile toward advertising, are rushing to set up the WWW servers. These servers provide everything from customer support, such as Novell's WWW server (http://www.novell.com:80/./), to marketing. Companies are also turning to secure transaction servers to boost their sales.

For example, a company called Quote.Com is selling a service that provides Standard & Poor Reports, Business Wire, Hoover Company Profiles, and time-delayed stock quotes from its WWW server, (http://www.quote.com). Such information is already available on-line from major services, such as CompuServe. But the Internet and a WWW server let a small company compete with corporate giants in the on-line information game. Similarly, a start-up called Infoseek (Santa Clara, CA) will introduce this fall a low-cost information service accessible via the Internet that could compete with proprietary systems such as Mead Data Central and Dialog.

The WWW is not limited to traditional on-line information resources. Seattle-based Dealer Internet Services Corp. is providing "virtual showrooms" for car dealers. The DISC WWW servers provide electronic car brochures and photographs. For example, the WWW address http:/www/freerange.com/rood/disc.html shows you the wares of a Seattle Volvo dealership.

For businesses that don't know how to spin their way into the WWW, enterprises like MecklerMedia's (Westport, CT) MecklerWeb will partner with other companies that want to become WWW players. Paul Gudelis, director of Internet development, says his company will set up special-interest domains and help businesses establish their own WWW virtual storefront. On-line service provider CompuServe says that by the second quarter of 1995, it, too, will establish WWW servers for commercial clients and provide Internet access via an international X.25 network.

The commercialization of the Internet is well under way, but it's happening in ways beyond the imagination of the networks' founders.

—SJVN (sjvn@access.digex.net)

SOLUTIONS TO INTERNET TRAFFIC JAMS

During one week in July, users on the Internet downloaded more than 300,000 files, many of them megabyte-size images, from the Comet Shoemaker-Levy 9 server at NASA's NSSDC (National Space Science Data Center) in Greenbelt, Maryland. In the past year, the total number of bytes transferred on the Internet has doubled. Such levels of network traffic, both in number of users and amount of information transferred, have many Internet observers concerned about "traffic jams" on the network. Others are busy working to prevent network overloads in the future.

From a user's point of view, the symptoms of a traffic jam are obvious: The desired network service is either unavailable or painfully slow. This symptom masks various possible problems, including failure of network components and limitations of the server computers, as well as network congestion.

Several traffic jams are caused by the popularity of a particular service. During the collision of Comet Shoemaker-Levy with Jupiter in July, NASA's NSSDC supplied images and other information to the Internet community. During the peak hour, the NASA server handled nearly 6000 requests. "The load on our primary server was sufficiently high for us to consider closing down the service," says Syed Towheed, a systems programmer with NASA. Instead, engineers brought additional systems on-line to handle the load. By the end of the week, the traffic jam was over.

Service providers can often eliminate overloads when they expect a service to be popular. For example, release 6 of the X Window System software from the X Consortium was available earlier this year on dozens of servers around the world. As a result, the X Consortium computers and network were not overwhelmed, as they have been in earlier releases.

New services on the Internet often experience heavy traffic intermittently, much as a stadium parking lot gets jammed after a football game. But what about the underlying networks? Can the wires that make up the Internet handle the traffic? Rick Adams, founder and chief technology officer of UUNet Technologies (Falls Church, VA), thinks they can. UUNet operates AlterNet, one of the largest private Internet providers. Adams says that AlterNet's networks are engineered with plenty of capacity for high-load times. However, he notes, "It's like the telephone system. If everyone picks up the phone at the same time, you won't get a dial tone."

To stay ahead of the load, AlterNet has invested in expanding the capacity of its network. So far, according to Adams, AlterNet has been able to keep up with its part of the rapid growth in Internet traffic.

One change that has some Internet observers concerned is the increase in multimedia applications. The past year has seen dramatic growth in the use of images, audio, and video across the Internet. The Multicast Backbone, or MBone, is one way of sending audio and video to many receivers on the network at once. As more users install the hardware and software needed to use audio and video, the demand for network resources will increase. To meet the near-real-time requirements of multimedia applications, researchers and network vendors have been working to develop new network protocols, such as the RSVP (a bandwidth reservation protocol), to share the available network bandwidth among competing applications. **—Win Treese**

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PROCESSORS

NexGen's Come-from-Behind Strategy

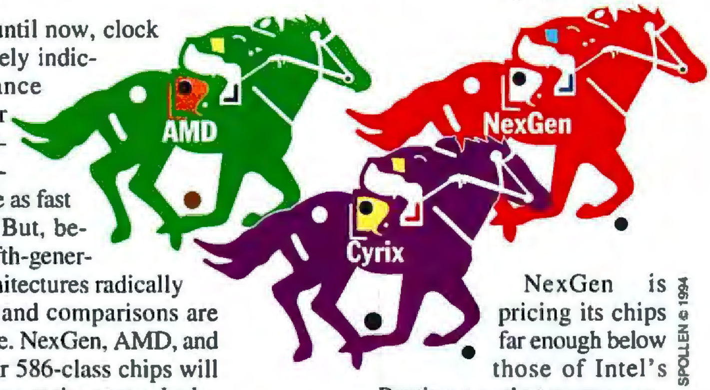
When you're number four, you try harder—or at least try something different. That's the idea behind NexGen's strategy for competing with AMD and Cyrix in the high-stakes challenge to Intel's domination of fifth-generation x86 processors.

NexGen (Milpitas, CA) was founded in 1986, and until now, it had not sold a single chip. Plagued by engineering problems, NexGen labored for eight years to design a processor that could compete in the big leagues. Now NexGen finds itself ahead of AMD and Cyrix, whose 586-class chips won't appear in systems until 1995. Alaris (Fremont, CA), previously a motherboard manufacturer, introduced the first PCs with NexGen's Nx586 processors in September. Retail prices are about 10 percent less than those for comparable Pentium systems.

That's the key to NexGen's strategy: By offering processors that almost exactly match the Pentium's performance at lower prices, it hopes to carve out a niche in the huge x86 market. But the most interesting aspects of this strategy are that NexGen's chips run at unusual clock speeds, and those clock speeds won't be advertised. Instead, NexGen is assigning numerical designations to its chips that relate to the performance of Pentium systems.

NexGen's reasoning is that clock speeds are a poor measure of comparative performance—and a measure that will become even poorer as the microarchitectures of x86 chips continue to diverge. This is borne out by benchmark tests and simulations, which show that 586-class processors from AMD, Cyrix, Intel, and NexGen do not necessarily deliver equivalent performance at the same clock speeds. As future designs evolve along different paths, the disparities will become even greater.

Of course, clock rates have always been a confusing way to compare CPUs. A 33-MHz 486, for example, easily outruns a 33-MHz 386. But until now, clock speeds *were* relatively indicative of performance within a particular x86 generation; a 50-MHz 486 does indeed run about twice as fast as a 25-MHz 486. But, because the various fifth-generation x86 microarchitectures radically differ, these shorthand comparisons are less valid than before. NexGen, AMD, and Cyrix all claim their 586-class chips will outperform a Pentium at the same clock.



CHRIS SPOLLEN © 1994

That's why NexGen has decided to de-emphasize clock speeds as a marketing tool. The result: a line of four processors, named the Nx586-P100, Nx586-P90, Nx586-P80, and Nx586-P75. By controlling the internal clock with a PLL (phase-locked loop) circuit, the Nx586 chips can operate at virtually any clock speed (within their design limits, of course). Thus, the Nx586-P100 runs at 93 MHz; the P90, at 84 MHz; the P80, at 75 MHz; and the P75, at 70 MHz. NexGen arrived at these odd clocks by running many application-level benchmarks and comparing the results to those of Pentium systems. NexGen says the P100 matches the performance of a 100-MHz Pentium, and the P90 matches that of a 90-MHz Pentium.

Because those odd clock speeds are much too fast for economical PC motherboards, the Nx586 chips—like most of Intel's Pentiums—run the CPU bus at a slower pace. Every Nx586 processor has a half-speed bus. Thus, the P100 runs at 93 MHz internally and 46.5 MHz externally; the P75 runs at 75 and 37.5 MHz, respectively. In turn, Alaris motherboards have an oscillator that matches the system clock to the CPU bus. (Alaris systems that have a PCI [Peripheral Component Interconnect] bus always run it asynchronously at its top speed of 33 MHz.)

NexGen is pricing its chips far enough below those of Intel's Pentiums so that system vendors can make Nx586-based PCs that sell for hundreds of dollars less than comparable Pentium PCs. An Nx586-P75 system with 8 MB of RAM, a 340-MB hard drive, and a 14-inch color monitor is expected to retail for $1645 to $1850, depending on dealer discounts. A comparable Pentium system would cost more than $2000.

Another departure in NexGen's strategy is to play down the importance of floating-point performance. Unlike other 586-class processors, the Nx586 chips do not have an on-board FPU. Originally, NexGen planned to offer a separate FPU, similar to Intel's FPUs for the 286 and 386. Instead, NexGen is working on new versions of its processors that will use the CPU and FPU on a multichip module. These variants are scheduled for production in early 1995.

To maintain compatibility with motherboards designed for current Nx586 chips, the multichip module will have the same pin-out. Unfortunately, this means about 100 pins—originally reserved to connect the CPU and FPU—will be redundant, because the two dies will be interfaced on the module. Those useless pins will inflate the cost of the modules. NexGen hopes to eliminate them by introducing a redesigned die later in 1995.

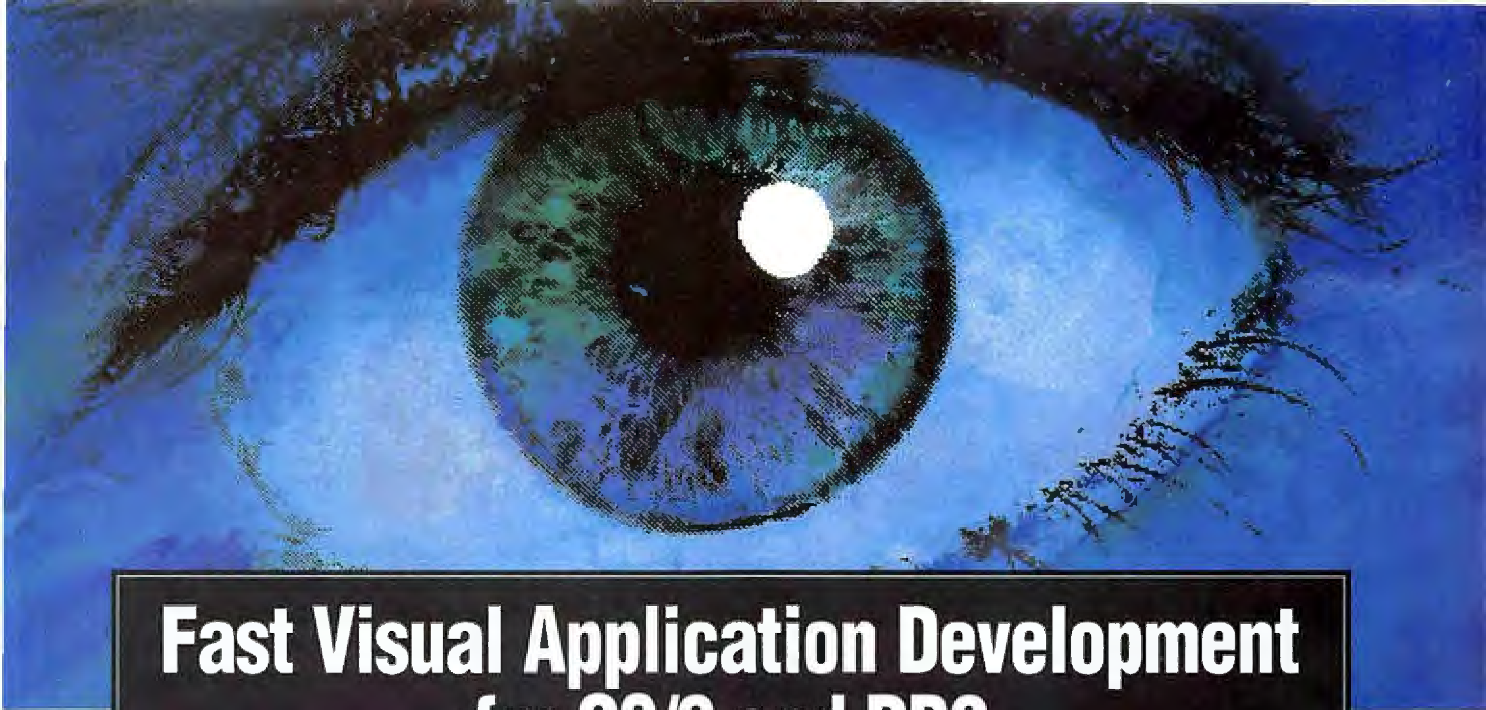
By the end of next year, NexGen also promises to debut the Nx686, a sixth-generation processor. NexGen predicts that its performance will be two to four times that of a 586-class chip. Although it took NexGen eight years to finish the Nx586, the company claims it has mastered the art of x86 design and can produce new generations with relatively little effort. But even if that claim seems a trifle optimistic, NexGen definitely has arrived and is a credible contender. **—Tom R. Halfhill**

Alaris's Pentium-Class NX586 VL

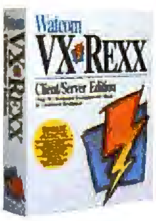
Benchmarks of Alaris's Nx586 VL show an improvement of about 1.7 times over that of a 66-MHz 486 for integer performance running BYTE's Portable Benchmarks. Integer performance is comparable to that of a Gateway 2000 P5-90. The price quoted for the Alaris includes a 420-MB hard drive and no monitor. Floating-point performance of the Nx586 was predictably poor, due to the lack of an on-board FPU.

Integer index*	1.74
CPU/speed (MHz)	84
Secondary cache (KB)	256
RAM (as tested, MB)	16
Floating-point index	N/A
System price	$2589

* Benchmark results are indexed against a 486/66 PC, which equals 1. Higher numbers mean better performance.



Fast Visual Application Development for OS/2 and DB2



If you're looking for fast and easy application development for OS/2, then take a look at the award-winning Watcom VX•REXX visual development environment. VX•REXX lets you build applications to exploit the graphical user interface, multi-threading, and multi-processing power of OS/2. VX•REXX Client/Server Edition gives you the added power to access DB2 or other database systems, manipulate the data, and chart the results at lightning speed.

"We like VX•REXX. Using it for development feels like driving a Porsche: it's fast, it's compact, everything's in the right place, and it makes us look good, too." Peter Coffee, PC WEEK

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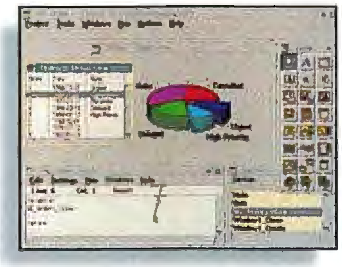
"Drag-and-drop nirvana." Nicholas Petreley, InfoWorld



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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!"

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News & Views

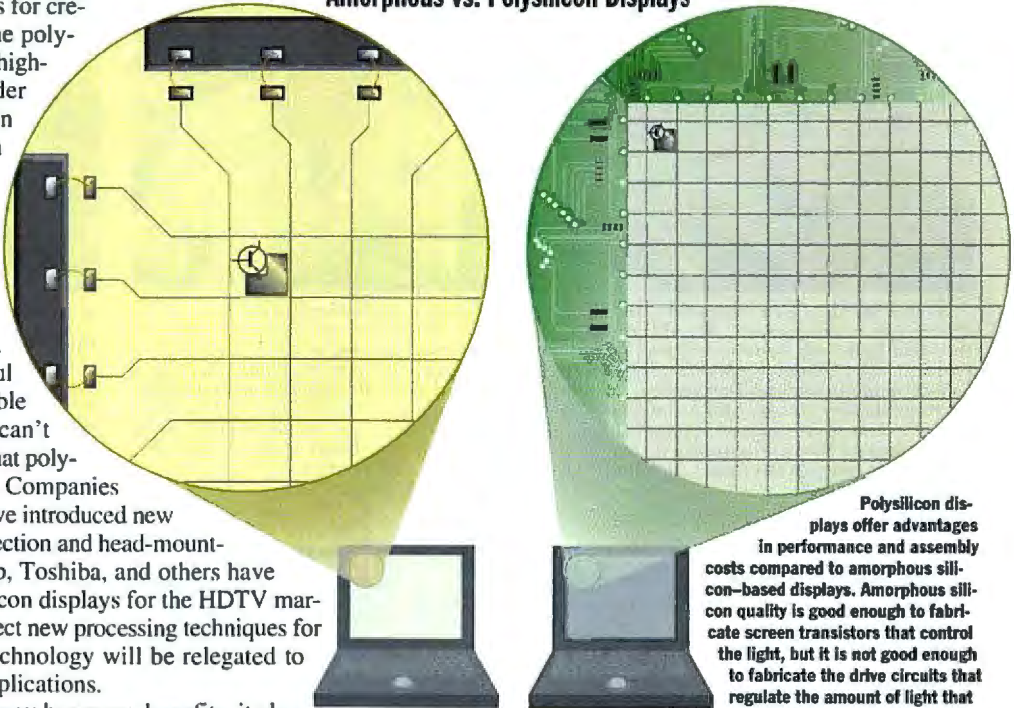
DISPLAY TECHNOLOGY

Polysilicon: The Path to Better Displays?

New fabrication techniques for creating screens based on the polysilicon technology that's used in high-resolution, diminutive camcorder viewing screens could result in higher-resolution LCDs than those now found on laptop computers. But researchers must overcome several obstacles before this technology is suitable for notebook displays.

Most LCD transistors are made with amorphous silicon. Although suitable for the colorful screens found in high-end portable computers, amorphous silicon can't deliver the high-pixel densities that polysilicon fabrication can achieve. Companies like Hitachi and Seiko-Epson have introduced new polysilicon products for the projection and head-mounted display markets. NEC, Sharp, Toshiba, and others have demonstrated prototype polysilicon displays for the HDTV market. But until manufacturers perfect new processing techniques for large format polysilicon, the technology will be relegated to virtual reality and projection applications.

Amorphous vs. Polysilicon Displays



Polysilicon displays offer advantages in performance and assembly costs compared to amorphous silicon–based displays. Amorphous silicon quality is good enough to fabricate screen transistors that control the light, but it is not good enough to fabricate the drive circuits that regulate the amount of light that passes through each display pixel—the driver circuits must be fabricated separately and connected to the LCD glass using standard interconnect methods. Polysilicon quality is good enough to support the simultaneous fabrication of LCD transistors and drive circuits on the same substrate. Because driver ICs are now integral to the design, pixel density is not limited by interconnect technology, as it is with amorphous silicon. Thus, polysilicon delivers screens with much higher resolution than amorphous technology.

Although polysilicon technology has many benefits, it also has its challenges. The high-temperature fabrication process that is the most mature for creating polysilicon transistors requires the use of quartz substrates, because glass substrates would melt. In addition to being more expensive to produce than glass substrates, quartz substrates are limited to 6 to 8 inches in diameter, which also limits the size of the resulting display. Companies in Japan and the U.S. are investigating low-temperature processes, but researchers don't expect larger-format polysilicon displays until the next century.

Another obstacle to polysilicon is the demand for active-matrix displays, which is driving manufacturers to expand amorphous capacity, overpowering consideration of polysilicon. "Virtual reality hasn't taken off yet, so there isn't a market for these [polysilicon] displays," says Joel Pollack, display product-marketing manager at Sharp Microelectronics (Camas, WA). "The projector market is experiencing steady growth, but it is still minuscule compared to the notebook or small TV market."

Tim Patton, business planning manager at Hitachi America's Electron Tube and Devices Division (Norcross, GA), acknowledges the risk in developing polysilicon technology: "We know there is a need in the projection market, and there is an unknown, but potentially large, market in virtual reality and head-mounted displays. We want to learn how to make polysilicon displays and position ourselves for the development of a large-format polysilicon process." Until that happens, high-resolution polysilicon displays will be relegated to the small screen.

—Chris Chinnock

Silicon Technologies at a Glance

Single-crystal silicon, which is the typical wafer on which ICs are fabricated, represents the high end of silicon performance. It is grown from a seed crystal and sawed into wafers. Kopin (see the April News & Views) fabricates the grid of liquid-crystal transistors and the drive circuitry on a single-crystal piece of silicon. The circuit is then transferred to a glass substrate for assembly into a complete LCD well-suited for small, high-resolution displays.

Polysilicon is made from amorphous silicon through an annealing, or thermal treatment, process. The annealing helps to organize the silicon crystal structure. High-temperature, low-temperature, and laser-annealing methods are all possible for this conversion, with performance dependent on each process.

Amorphous silicon has the lowest electrical performance characteristics of the silicon family. Composed of a disorderly array of miniature silicon crystals, it is deposited on the substrate by chemical vapor deposition and is commonly used to fabricate solar cells and LCDs. **—C.C.**

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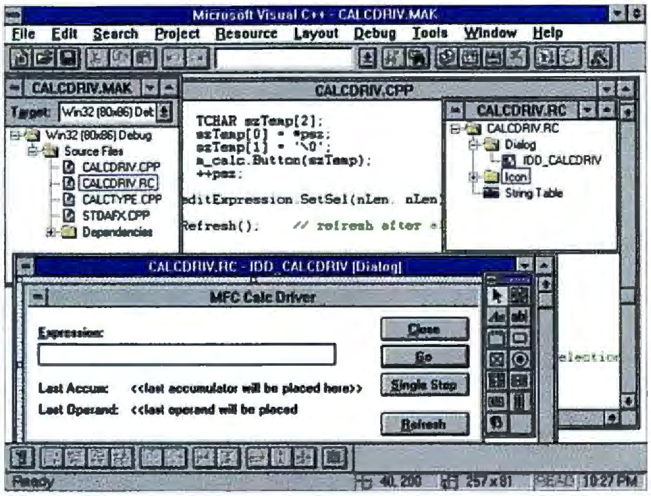
News & Views

C++ PROGRAMMING

Borland's and Microsoft's Latest Reflect Different Priorities



Visual C++ 2.0 features a seamlessly integrated development environment that minimizes the number of steps needed to create visual interface elements and link them to handle code. Pictured is the new project window, which opens the appropriate editor when you click on a filename in the project tree.

With their newest C++ products, Borland and Microsoft have taken two fundamentally different foci: Microsoft emphasizes cross-platform coverage and the ability to create OLE custom controls, while Borland introduces a highly modular set of OLE 2.0 tools. Both products should ship this fall.

In a major strategy reversal, Borland is ceding the battle for definition of a de facto C++ Windows API to Microsoft's MFC (Microsoft Foundation Classes) while taking the lead in OLE 2.0 applications development tools with Borland C++ 4.5. BC++ 4.5 delivers OLE 2.0 component support that is independent of a specific applications framework, tools that retrofit existing code with OLE functionality, and support for fast, DLL-based OLE servers.

Borland's new OCF (Object Component Framework) lets you write OLE-enabled applications that plug cleanly into OWL (Object Windows Library), MFC, straight C++, and even ordinary C Windows programs—thus offering the first incremental path for investing older code with OLE features. OCF essentially makes the model of OLE communications fit an ordinary Windows messaging model. Its normalizing mechanism allows older applications to benefit from OLE components without undergoing redesign.

A unique and complementary strength of BC++ 4.5's OCF tool set is its AppExpert source code generator. AppExpert can automatically update previously generated code with OLE support. By contrast, Microsoft's AppWizard source code generator is a single-pass utility that establishes for all time the class library support built into the application templates it creates.

BC++ 4.5's compiler will reportedly include an MFC compatibility layer. The precise extent of MFC support has not been defined, but Borland says it will be thorough. "We will give developers a path that makes MFC relatively easy to use with our compiler," says Michael Hyman, languages business-unit manager at Borland. Borland has not abandoned its OWL class libraries; it's made incremental improvements in them, the compiler back end, and some IDE tools. But the recurrent harmonic of the BC++ 4.5 theme is OLE 2.0.

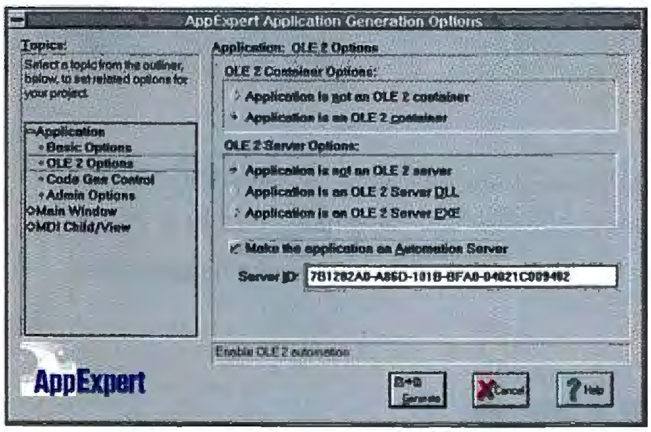
In another daring move, Borland will introduce a 32-bit portability layer that lets 32-bit Windows applications use 16-bit Visual Basic controls under Chicago and Windows NT. This is good news to the developers of Windows 3.1 applications that rely on VBXes (Visual Basic custom controls), an inherently 16-bit technology; this support is not forthcoming from Microsoft.

A novel feature of BC++ 4.5 is internationalization of the VBX property list, which eliminates the need for developers to supply separate DLLs for each international language that they want to support. A VBX can map its property list to alias tables that translate the property names to various languages so that a VBX can change languages dynamically.

With Visual C++ 2.0, Microsoft has crafted a masterful product by improving its IDE, expanding its class library, and targeting multiple hardware platforms. Visual C++ 2.0's 32-bit MFC library is source code–portable across the Intel, Mips RISC 4000, DEC Alpha, and Mac platforms. The new 32-bit MFC libraries are thread safe, exploiting one of the more sophisticated operating-system features of NT. MFC functions can be called from multiple threads, with the library offering a CWinThread class for creating new threads.

Visual C++ 2.0's most dramatic technical achievement is the OLE Custom Control Development Kit. The OLE Custom Control Development Kit does for custom controls what the Visual Workbench did for MFC: It leads developers through a set of choices and generates extensive skeleton code, leaving the programmer to add only the application-specific behavior. This is an enabling technology, and one that BC++ 4.5 OLE tools don't address.

—Nancy Nicolaisen



Using the Borland C++ AppExpert, you can create an OLE 2.0–enabled application by simply choosing the OLE 2.0 options provided. Borland's OLE 2.0 support also make it easy to OLE-enable existing applications.

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Whatever Happened to...?

QuickRing (see "Fast Transit," October 1992 BYTE)

When BYTE first covered QuickRing, it was as a potential local-bus architecture that could compete with PCI and VL-Bus. PCI has since gained momentum as a system bus; however, expect a number of vendors to announce QuickRing products this fall that complement today's PC architectures by moving large amounts of data over the top of the system bus via card-to-card interconnects or between computers using copper cable.

QuickRing supports sustained data transfer of 150 to 180 MBps. Companies such as Ariel (Highland Park, NJ) and CSPI (Billerica, MA) say they will use QuickRing as a high-speed data highway to interconnect DSP-based boards. Other companies like Matrox (Dorval, Quebec, Canada) will use QuickRing as a backbone to interconnect the company's PC-based Ethernet switching cards.

PERSONAL FINANCE/CD-ROM

Plan Ahead with Quicken

The CD-ROM version of Quicken Deluxe 4 for Windows includes a financial suite in which experts Jane Bryant Quinn and Marshall Loeb answer your questions regarding investment options and other topics pertaining to personal finance.

Over the past two years, sales of personal finance software has been growing at an estimated rate of 50 percent, according to the Software Publishers Association, and Intuit's Quicken has about 80 percent of that market. With a program that popular, Intuit's developers faced a challenge: how to add features that improve the program without drowning users in a sea of bells and whistles. To do this, they had to make Quicken even easier to use while leveraging CD-ROM to deliver historical data on mutual funds and stocks, as well as interactive personal finance advice on video.

Intuit (Menlo Park, CA, (415) 322-0573) announced new versions of Quicken for all the major platforms: Quicken 4 and Quicken Deluxe 4 for Windows, Quicken 8 for DOS, and Quicken 5 for the Mac. Each version has features that make learning Quicken easier for first-time users and features for more experienced users.

Only the Quicken Deluxe 4 for Windows CD-ROM has the Quicken Financial Suite, which lets you "stroll" through a virtual conference room, home office, and library to access information such as which mutual funds to select given your financial profile. This CD-ROM also features an interactive visual interface that offers access to all Quicken's features, as well as advice from financial experts Jane Bryant Quinn, author and *Newsweek* columnist, and Marshall Loeb, former managing editor of *Fortune* and *Money*.

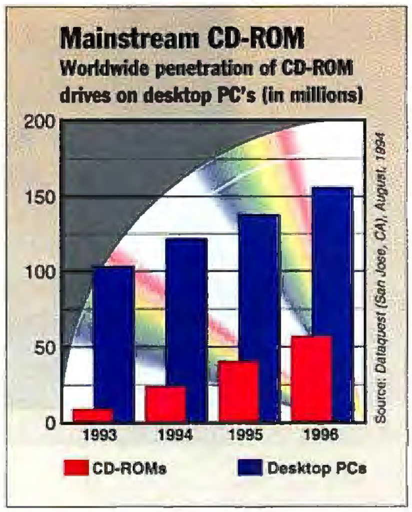
—Ken Sheldon

CD-ROM TRENDS

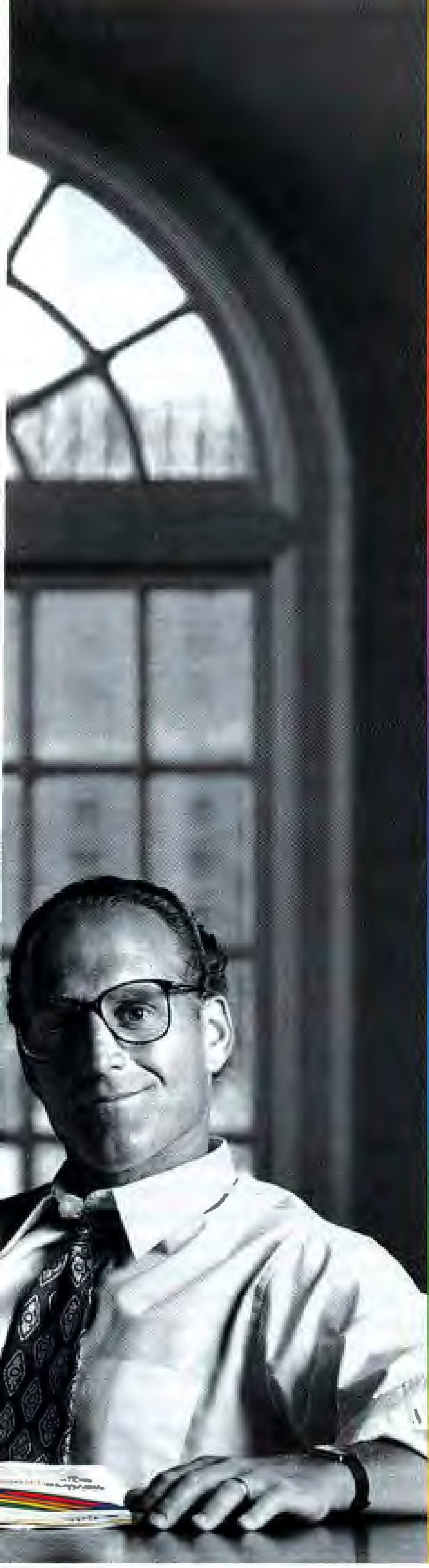
CD-ROM Drive Prices Drop

Strong competition and new technology should force already low prices for CD-ROM readers to drop even further this fall. The demand for CD-ROM drives is high, but manufacturers are finding many competitors in the retail channel. At the same time, computer vendors, who are also facing strong competition, are pressuring drive vendors (CD-ROM and magnetic) to lower their prices. "The market is cutthroat and aggressive," says John Antonchick, director of marketing at Mitsumi (Irving, TX), noting that the company's Double Speed Drive kit, which has an interface card, a cable, and software, sells for as little as $120.

New PCs that support the enhanced IDE interface on the motherboard should drive CD-ROM drive prices even lower. The direct connection eliminates the need for a CD-ROM interface card, further reducing cost. Patty Chang, principal analyst at market-research firm Dataquest (San Jose, CA), notes that an increase in demand for CD-ROM software in the home market, improved software, and falling prices of both CD-ROM drives and PCs will continue to pace demand for CD-ROM readers. She also says that in the second half of 1995, prices for quad-speed drives could be in the same range as current double-speed drive prices.



For now, drive vendors feel the high demand for CD-ROM readers will help offset the low profit margins endemic to the double-speed category. In fact, NEC (Wood Dale, IL), known for its top-of-the-line MultiSpin 4X Pro that lists for $1120, recently reentered the double-speed market with its MultiSpin 2V for value-conscious consumers.



NOTEBOOK PROCESSORS

New Chips Arrive, But DX4/75 Sticks Around

Notebooks based on Intel's 75-MHz 486DX4 CPU are popular with users who require multimedia capabilities on the road for presentations or light teleconferencing. But if you heed the hoopla over 100-MHz DX4s and even Intel's brand-new 75-MHz, 3.3-V Pentiums, you might be tempted to skip the DX4/75.

That may not be wise. If you're in the market for a feature-rich notebook, you'll find that 100-MHz DX4-based notebooks are just arriving from a few top-tier vendors due to a relative scarcity of the processor. The lack of 100-MHz DX4s is an issue of priorities—in Intel's 0.6-micron manufacturing process, the higher-priced Pentiums have priority. "DX4s are losing out to Pentiums in [Intel's assembly] lines," says Steve Andler, director of mobile-computing products marketing for AST Research.

At press time, AST had decided not to introduce a 100-MHz DX4 notebooks because it wasn't sure it would receive enough chips to meet its demand. IBM, however, planned to debut four DX4/100 models in early October.

But although Pentiums are edging out DX4s on the production line, Pentiums have typically been found in desktops, not portables. The first notebooks based on 5-V Pentiums suffered from short battery life and required fans or liquid cooling techniques to prevent overheating.

When 3.3-V P54C chips are readily available for notebooks (90- and 100-MHz versions should ship in volume this year), some notebook vendors say that they will design systems that are ventilated well enough not to subject users to fan droning.

According to Toshiba, its 3.3-V, 75-MHz P54C-based T4900CT, which is slated to ship in mid-November, won't need a fan to disperse heat, thanks to the company's experience with tab bonding. Toshiba says that Intel has implemented tape-carrier packaging that reduces the volume of the CPU packaging. When the packaging is tab-bonded to the motherboard, the chip dissipates heat quickly.

Even when the Pentium chips are available, top-tier notebook vendors may still wait to introduce systems. One reason is that vendors haven't yet tapped all the potential buyers of the DX4/100. Price is another consideration.

Prior to Intel's planned pricing changes this fall, DX4/75s cost $429 each (in quantities of 1000), DX4/100s $516, and P54C/90 $707. At press time, Intel hadn't released prices for the P54C/75, but the DX4 notebooks may look more attractive than the first notebooks based on the 75-MHz Pentium if battery life is more important than performance. When vendors design Pentium systems to improve power management and ventilation and incorporate PCI (Peripheral Component Interconnect), users needing full-motion video or other compute-intensive tasks from their notebooks may never look back. Or at least, they'd better not have to. "If you're willing to pay a premium for a Pentium notebook," says Altounian, "you don't want marginal differences in performance."

—Ed Perratore

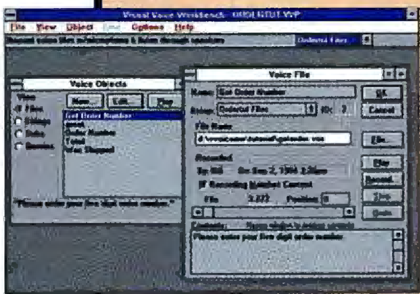
CODE TALK

RICK GREHAN

Create Voice Response Applications Visually

Visual Voice from Stylus Innovations is, at its core, just another Visual Basic custom control. Harness that, however, to the Visual Voice Workbench, and you've got a GUI-based applications development program that guides you through the creation of a complete Visual Basic–based telephony application. And when I say complete, I mean an application that can answer the phone, play audio files, record audio to disk, receive a fax, send a fax, decode Touch-Tones, hang up the phone, and probably more things that I haven't yet discovered.

Swimming about inside the Visual Voice VBX, you'll find actions and properties that allow your computer (via the proper hardware—I tested the Mwave version of the package) to perform all the audio magic mentioned above. The Workbench corrals all these together into three kinds of voice objects: voice files, voice strings, and voice queries. Voice files are simply digitized sound files (.WAV or .VOX files) that usually carry recordings like "Press the star key for more information." A voice string is the concatenation of a number of voice files. A voice query is a series of actions that, in a nutshell, let the computer ask you a question and get an answer (usually from someone's Touch-Tone response).



The Visual Voice Workbench's recording facilities let you speak into a microphone and record a message that will play back to someone at the other end of a voice-response session.

When you get down to it, working with Visual Voice involves properly mixing the right sound files, Visual Voice VBX routines, and Visual Basic code. That's where the Workbench comes in.

For example, suppose your application is one of those "here's what's playing" recordings for a movie theater; only you want to let the caller select either matinee or evening shows via a Touch-Tone entry. Using the Visual Voice workbench, you would build a query consisting first of a voice file of you telling the caller something like "...for matinee shows, press 1." The Workbench's recording facilities let you sit at your machine with a microphone and "build" the file yourself. You then tell the query builder that, after playing the prompt message, the program should wait for and then receive a single DTMF digit tone. Finally, you instruct the query builder that the digit is to be converted to its numeric equivalent and stored into a variable to be used to route program flow to the proper routine.

Once you've pointed and clicked your way through the above steps, the Workbench will pour the appropriate BASIC code (complete with proper connections to the VBX) into the clipboard for you, and you can skip over to your Visual Basic application and paste it into the correct routine. About the only BASIC code you'll have to type in is `End Sub`.

Stylus Innovations (Cambridge, MA, (617) 621-9545) sells the Mwave version of Visual Voice for $495. For $200 more, you get an ACE (Advanced Communication Enhancement) board, which is a DSP-based (digital signal processor) 16-bit board that produces just about every kind of audio signal there is, such as fax, modem (V.32 and V.42 bis), voice, and sound.

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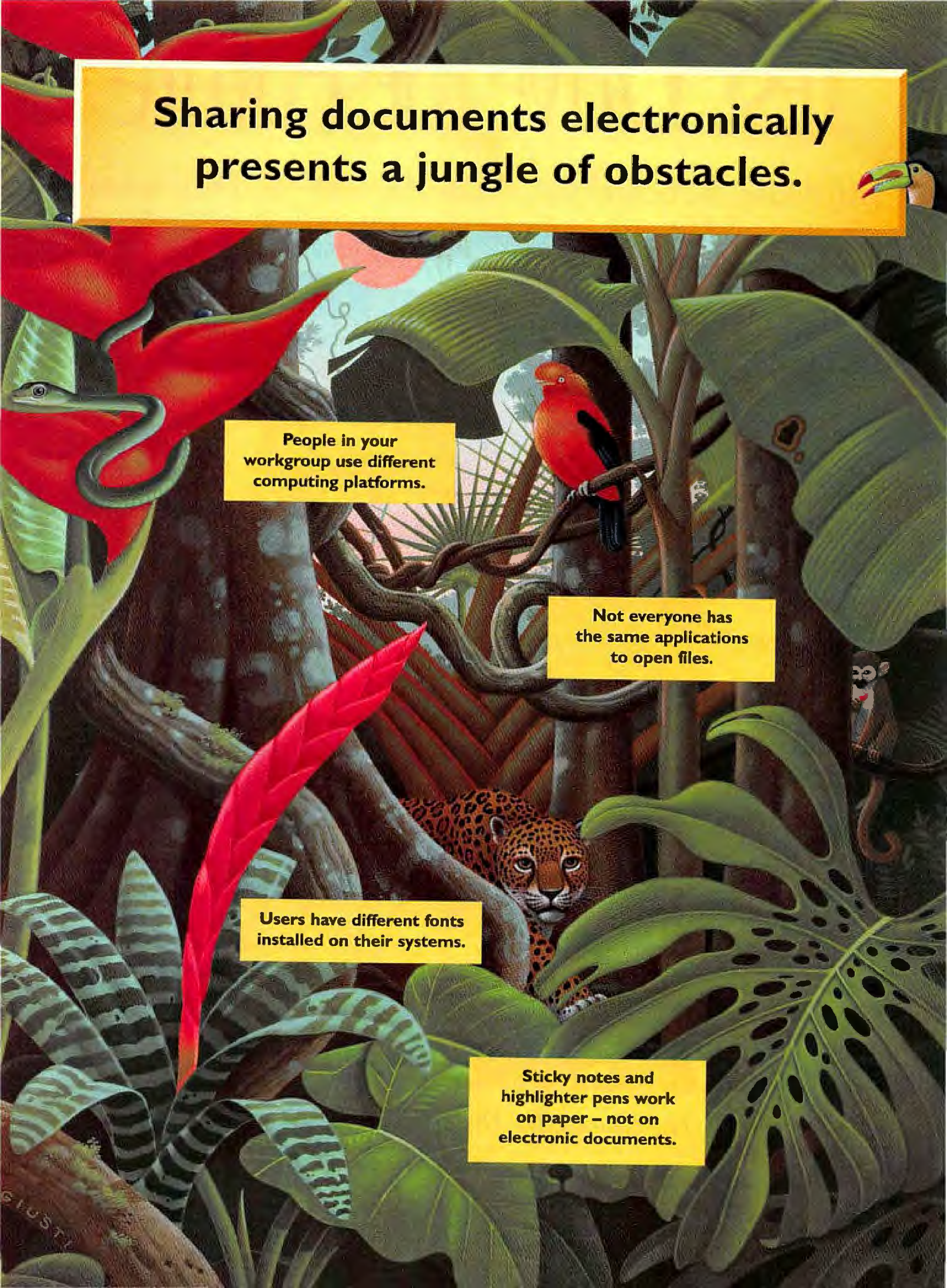


WINDOWS TRENDS

WinG Addresses Windows' Weakness in Games

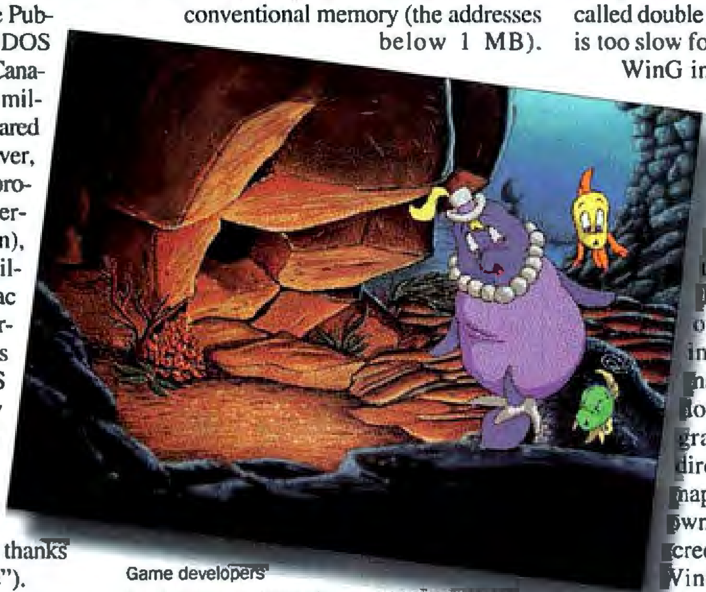
Sales of DOS-based applications continue to decline, but one area where DOS still rules is in entertainment and games, thanks to performance advantages over Windows' GDI (Graphical Device Interface). The trade group Software Publishers Association says overall DOS applications sales in the U.S. and Canada declined 47.5 percent to $235 million for second quarter 1994 compared to the same period in 1993. However, in entertainment software, DOS programs accounted for about 50 percent of retail sales ($41.6 million), compared to 33 percent ($27.4 million) for Windows, with the Mac commanding the remaining 21 percent ($18 million). As long as game developers stick with DOS for superior performance, they will impede Microsoft's efforts to move the industry to Chicago, Windows NT, and Win32. But many games developers see DOS's games domination ending thanks to WinG (pronounced "Win Gee").

WinG is a new library of graphics routines from Microsoft that lets developers significantly boost the performance of graphics-intensive Windows applications. Distributed free with new Windows software and built into Chicago and NT 3.5, WinG accelerates screen updates and delivers almost as much speed as custom graphics routines in MS-DOS programs do. Although it won't make existing Windows applications run faster, new software (and updates of current software) designed to take advantage of WinG should begin appearing late this year.

Microsoft unveiled WinG at the Computer Game Developers Conference in Silicon Valley last April. To show off the library's capabilities, Microsoft demonstrated a prototype Windows version of Doom, a popular DOS-based game from Id Software. Soon afterward, Microsoft posted beta versions of WinG in a developer's forum on CompuServe.

Any Windows program that needs fast screen updates or smooth panning can benefit from WinG. But Microsoft's primary target is the game market. Most game developers have been forced to write for DOS, because the Windows GDI is notoriously slow. DOS programmers can write optimized routines that directly access the computer's graphics hardware.

Unfortunately, the higher performance of DOS comes at a price. Without a DOS extender, DOS programs are limited to conventional memory (the addresses below 1 MB).



Game developers like Humongous Entertainment ((206) 485-1212) plan on releasing WinG-based entertainment programs for Windows in time for the holiday season. Freddi Fish and the Case of the Missing Kelp Seeds, a story adventure game capable of full-screen animation at 10 to 12 fps (frames per second) in 640- by 480-pixel resolution with 256 colors.

They also lack the device independence of well-behaved Windows programs and often require users to modify their CONFIG.SYS and AUTOEXEC.BAT files during installation, which results in more customer-support calls. Game developers are weary of these headaches but were unwilling to sacrifice performance.

For the most part, WinG works by circumventing some limitations of the GDI, which was designed for static displays rather than animation. To achieve device independence, the GDI shields Windows programmers from hardware-specific details of output devices (including graphics cards and printers) by interposing a logical drawing surface known as a DC (device context). In other words, instead of drawing directly into the physical frame buffer (screen memory) of the graphics card, Windows programmers use the device-independent display DC. The GDI and Windows device drivers handle the details of translating those logical graphics into physical graphics in the frame buffer.

Drawing graphics on the fly with GDI routines is not practical for animation, so many Windows programs use a technique called double buffering. But this technique is too slow for smooth animation.

WinG introduces a streamlined approach. First, it lets programmers create a new type of DC, called a WinGDC, that accepts DIBs (Device Independent Bitmaps) directly. That eliminates the time-consuming steps of shuttling the DIBs through a memory DC and converting them into Device Dependent Bitmaps, which developers had to do prior to WinG. Also, programmers can draw graphics directly onto the WinGDC bit map with GDI routines or their own custom routines. When the screen is ready to be displayed, WinG provides two new calls (`WinGBitBlt` and `WinGStretchBlt`) that can copy the WinGDC into the display DC much faster than the GDI's `BitBlt` and `StretchBlt` can.

As a final bonus, WinG also tests the system it's installed on to determine which combination of GDI and WinG calls yields the fastest performance, because there is some variation among graphics cards from different vendors. It then saves this profile for future reference. There can even be different profiles for each screen mode. For example, a 640- by 480-pixel resolution screen with 16-bit RGB color may require different techniques than a 320- by 200-pixel resolution screen with 8-bit indexed color. WinG handles this automatically.

Nels Bruckner, a software engineer at Dynamix (Eugene, OR), says he's using WinG for future projects. He says WinG isn't quite as fast as full-screen page flipping in the frame buffer via DOS, but it's definitely faster than the GDI at updating smaller windows and is particularly useful for simulating sprites. "Microsoft's claim is that WinG will be as fast as writing directly to the video hardware in DOS, and from what I've seen, they're coming pretty close, especially if you've got a machine with local-bus video." **—Tom R. Halfhill**

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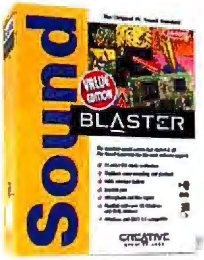

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WINDOWS TRENDS

ODBC 2.0 Further Establishes Cross-Product Data Sharing Standard

With all the attention focused on Chicago, Daytona, OLE 2.0, and Cairo, it's easy to forget another critical Microsoft-driven technology just now coming into its own, the ODBC (Open Database Connectivity) standard. With the widespread release of ODBC 2.0–compliant products this fall, this standard should see acceptance from a wide variety of database vendors and applications developers for interproduct data sharing.

ODBC 2.0 offers full compliance with the standard released in November 1992 by the SAG (SQL Access Group), an organization of leading hardware and software developers committed to universal database access. Developers report that ODBC 2.0 drivers will provide faster, more robust performance than ODBC 1.0 drivers thanks to code tuning and support for standard SAG features like SQL primary keys and data arrays.

ODBC allows database programs to share data, and in some cases application code, among differing database products—such as Oracle, Microsoft's Access, IBM's IMS, dBase, or Sybase—while those programs run on different operating systems. The ODBC standard provides interoperability and flexibility that, in turn, translates to more integrated business data at the desktop and better information for decision making.

ODBC not only refers to a SAG-compliant standard but also to ODBC-compliant driver software. The ODBC standard is an open, vendor-independent interface that requires that the data source hears *Apples* when the application program says *Apples*. The standard ensures that the minimum level of communication between application programs and data sources conforms to the levels set by the SAG.

ODBC drivers and driver managers control the interpretation and implementation of data access and manipulation at the data source level. It falls to the drivers to actually translate and execute the data source–specific commands issued by the application program via the API, while complying with the SAG standards for data access and SQL Grammar. What's more, the ODBC driver must comply with conformance levels within the SAG standard: levels 0, 1, and 2 for the API; minimum, core, and extended for the SQL Grammar. The conformance levels for the API and the SQL Grammar are independent; therefore, it is possible for a driver to provide level 2 API support while supplying extended-level SQL Grammar support.

ODBC inserts a middleware layer (the driver software) between an application program and a data source. This middleware layer handles all data access using the ODBC standard for both the call-level interface and the SQL Grammar. ODBC 2.0 drivers offer full level 2 API-compliance and, if the connecting database products support it, all the extended SQL features of SAG 92.

For developers, Microsoft's ODBC SDK (Software Developer's Kit) 2 adds support for the Win32 API, a cursor library for more consistent support of cursors through the API and in extended SQL Grammar, new sample code, improved testing and debugging tools, and all the data source drivers from their ODBC Desktop Database Driver Pack. PageAhead Software (Seattle, WA) also provides a line of products for ODBC 2.0 driver development.

On the driver side, Microsoft's ODBC Desktop Database Driver Pack 2 includes a driver manager and data source drivers for many of the popular desktop database products. Borland has integrated an ODBC 2.0–compliant "socket" into its core database engine, which dBase for Windows and Paradox for Windows use. This allows other programs to access dBase and Paradox data through any ODBC driver. What's more, a number of applications software vendors provide ODBC drivers for their respective database products.

As for recent reports that Microsoft will abandon ODBC in favor of OLE, Greg Norman, senior product marketing manager for ODBC at Microsoft, says that is not true. "ODBC is still healthy and growing," he says. "Microsoft will continue to advance the definition of ODBC while supporting our ISVs [independent software vendors] and making the development of ODBC drivers and applications a profitable business."

Brian Reed, product manager at Intersolv, agrees. "ODBC is not going away," he says. "It's the market standard, and more than 170 application programs are ODBC-compliant."

Reed notes that reports of a future version of OLE supplanting ODBC are premature at best. "Microsoft, in terms of [the next OLE] API or specification, hasn't published anything formal. But Microsoft can't expect everyone to drop what they're doing and go a different route."

—Jane Richter

ODBC 2.0 DRIVER SOURCES

- **Information Builders' EDA/Extender for ODBC: drivers for retrieving data stored in databases ranging from IBM's DB2 to Hewlett-Packard's Allbase, (800) 969-4636 or (212) 736-4433.**
- **Cross Access's Cross Access ODBC Drivers: drivers for accessing data in Unix databases and all MVS databases, (708) 954-0500.**
- **Intersolv Data Direct ODBC Pack (formerly called Q+E SQL ODBC Pack; Intersolv and Raleigh, North Carolina-based Q+E Software recently merged): over 30 drivers, including those for most of the popular desktop and SQL DBMSes, (800) 876-3101.**
- **TechGnosis's SequeLink: drivers for Informix, Oracle, and DB2 (617) 229-6100.**
- **Microsoft's ODBC Desktop Database Driver Pack: includes a driver manager and data source drivers for Microsoft Access and FoxPro, Btrieve Technologies' Btrieve, and Borland's dBase and Paradox, (206) 882-8080.**

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MAC OPERATING-SYSTEM TRENDS

Apple Redefines the Macintosh

Apple (Cupertino, CA) is embarking on a two- to three-year project that will redefine the Macintosh's proprietary hardware/software architecture to accommodate industry standards and eventually merge with IBM's PReP (PowerPC Reference Platform). Apple's goals are to slash the manufacturing costs of Macintosh hardware, encourage licensed vendors to produce Macintosh clones, allow Macs to boot rival operating systems, and expand the market for Mac-compatible hardware and software.

When the process is complete, the Mac will still be a Mac, says Apple, but it will look different from the Macs of today. Some users will bypass the Mac OS in favor of alternative operating systems, such as IBM's OS/2, Microsoft's Windows NT, Taligent's TOS, or PowerOpen-compliant Unix. And future Macs will abandon such Mac-specific features as the ADB (Apple Desktop Bus) and NuBus slots.

But the transition won't happen overnight, cautions Don Strickland, vice president for Apple licensing. It will take at least two years for Apple to eliminate the dependencies between its tightly integrated system software and hardware—a traditional strength of the Mac that nevertheless blocks Apple's path toward a more open platform, Strickland explained.

The sweeping changes are a key part of Apple's new strategy to license its closely guarded system software and hardware to carefully selected vendors. To make that strategy succeed, Apple has realized it must redesign the Mac to work more easily with standard I/O buses, peripherals, and components. Some of the latest Macs already incorporate a few of these changes, such as internal IDE hard drives, optional PCMCIA slots, and 72-pin SIMM connectors. Apple has also stated its intention to replace NuBus with PCI, but until now, it wasn't clear how far Apple was willing to go to conform with IBM's PReP.

Apple views the transition as a three-phase process that began with the introduction of the Power Macs and System 7.5, the latest version of the Mac OS that runs on 680x0- and PowerPC-based Macs. The next phase will further minimize the hardware dependencies in the Mac OS while overhauling the Mac's 11-year-old system architecture.

The new foundation is called the MRA (Macintosh Reference Architecture), which will jettison some long-familiar features peculiar to the Mac. For instance, the Command key that distinguishes Mac keyboards from PC keyboards may even disappear. MRA-based Macs will also be able to cold-boot a little-endian operating system, such as NT or OS/2, says Strickland. Today's Power Macs can't do this; the only way to launch a little-endian operating system is to first boot the machine with System 7, which means two operating systems are running (that's how Power Macs currently launch MS-DOS and SoftWindows).

In the final phase, Apple sees the MRA platform eventually merging with PReP—although Apple expects that PReP, too, will have evolved by then. The whole process will take two or three years not only because of the technical hurdles but also to protect the hardware investment of current Mac owners and avoid breaking the existing software base. Ultimate success depends on how fast Apple can resolve the compatibility issues and on how PReP continues to evolve in the meantime.

Changes to the Mac OS will be phased in over the same period, with new features appearing in the next two versions, code-named Copland and Gershwin. Copland is scheduled for release in late 1995, and Gershwin in 1996. Apple outlined its future plans for the Mac architecture while announcing that it has licensed several PC vendors to sell the Mac OS or Mac clones. Apple declined to name the vendors, leaving that up to the vendors themselves. However, Apple expects the first announcements could come as early as fall Comdex, and that the first products could hit the market by next spring or summer.

Contrary to previous statements, Apple says its licenses will not necessarily prevent clone makers from competing directly against Apple in U.S. retail channels. But that scenario is unlikely, Strickland says, because Apple is licensing vendors who will concentrate on markets where Apple has little or no presence. Examples might include Japanese schools or other relatively vertical markets that Apple lacks the resources to pursue. The objective, says Strickland, is to recruit vendors who have a shot at dominating those specialized markets, even against competition from PC compatibles.

The licenses cover not only the Mac OS but also some elements of the Mac hardware architecture—such as proprietary ASICs required to manufacture Mac clones, and Verilog models of the ASICs (application-specific ICs) for those who prefer to design their own chips. Apple is also extending its volume discounts on ASICs and other Mac-specific components to licensees.

In addition, the licensing package includes technical data, marketing information, sales materials, and customer-service training. This level of support will probably limit Apple's ability to license more than six vendors in the near future, Strickland said. **—TRH**

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OLD RECORD FOR 486 MONO:	12:07
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IBM ThinkPad 500 (486/slc) mono	6:30
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intel inside

*[‡] So you've come down here to find out about this Steeplechase thing. Well, it's not a horse race, but a thorough test of battery life. The Steeplechase test includes mechanical typing, pausing, task switching and printing in MS Windows v3.1, MS Word for Windows v6.0 and MS Excel v5.0. All numbers represent an average of at least two trials with power management function enabled. Test simulates executive usage, i.e. carrying notebook between meetings and intermittent use. Competitors' times are published in Portable Computing Magazine. For a complete copy of the VeriTest results, call our TechFax℠ line at 800-950-1329. Latitude XP is powered by one Lithium Ion battery. Latitude is powered by a NiMH battery, with the option of replacing the floppy drive with a second NiMH battery (required for 8 hrs. of battery life), which will increase the weight of the Latitude by 0.5 lbs. [†] This 3 year Limited Warranty consists of Dell's standard return-to-depot warranty during the first year, plus a 2-year parts only contract for years 2 & 3. Also included with these systems is 1 year of next-business-day on-site service. On site service provided by BancTec Service Corp. may not be available in certain remote locations. [*] Guarantees available in the USA only for registered owners of Dell systems. For a complete copy of our Guarantees or Limited Warranties, please call our TechFax℠ line at 1-800-950-1329, or write Dell USA L.P., 9505 Arboretum Blvd., Austin, TX 78759-7299, Attention Guarantees. *Prices valid in the U.S. only. Some products and promotions available in the U.S. only. Prices and specifications subject to change without notice. [⁰] Business leasing arranged by Leasing Group, Inc. The Intel Inside logo is a registered trademark and IntelDX2 and IntelDX4 are trademarks of Intel Corporation. Dell disclaims proprietary interest in the marks and names of others.*

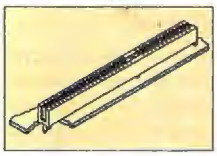
Blasts from the Past

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

EISA arrived, and we heralded it as "the new 32-bit bus standard." This enthusiasm was based on the technical details of the bus specification rather than on any hard test results. Hewlett-Packard's Vectra 486 was the first EISA system we could get our hands on; it used a preproduction 486 CPU (which was brand new) and had no EISA add-in cards, because EISA add-in cards weren't shipping.

> "By 1991, a new generation of RISC chips will be doubling the performance of current implementations, and CISC will have to play catch-up again (probably in 1992) with the 68050 and the 80586."
>
> — Michael Slater and John Wharton, "Revenge of the CISCs"

EISA was controversial, but it's hard now to see why. It aimed to replace the ISA bus, yet EISA connectors could accommodate ISA cards (unlike IBM's Micro Channel). It's fast, up to 33 MBps. And it was developed by a reputable Gang of Nine that included Compaq, HP, NEC, and AST. A wait-and-see attitude that Brett Glass noted in his "Under the Hood" column about the new bus was persistent. EISA has been a big hit in the tony turf of servers, but PC makers never did adopt it for their low-cost desktops.



EISA Connector

Before that could happen, along came local-bus technologies like PCI (Peripheral Component Interconnect). But you can't call EISA a dog, either. According to Computer Intelligence InfoCorp (La Jolla, CA), there are about 4 million EISA machines out there.

A "cheap" 486, like ALR 's PowerFlex 40, sold for $4490. It was a 286 system with a 486 on a plug-in board. That sounds pricey now, but you could also spend as much dough for a 386; AST's Premium/386C, for example, sold for $4395, and that was without a monitor or hard drive.

OS/2's future as a mainstream operating system looked so bright. Microsoft was about to release Excel for OS/2 (we found it "substantially slower" than the Windows version in file loading and screen movement). And Bill Gates himself, in an ad for Digitalk's Smalltalk/V PM, called OS/2 "a tremendously rich environment."

"This is the first [truly portable and fully functional] machine that is as useful as the computer on your office desk," we wrote. It was a 10-pound, battery-powered, IBM-compatible PC, and it came from Data General. The $2895 DG/One showed that a minicomputer maker could downsize and make a portable PC. But subsequent months showed they couldn't sell it.

Back in the days before PDAs, we called them pocket computers. The Psion Organiser was sort of like an electronic address book, sort of like a calculator. For storage, it used write-once PROM cartridges, called Datapaks, that plugged into the side of the machine and could hold 16 KB, or 300 phonebook entries. Mini applications also came on Datapaks.

Psion Organiser

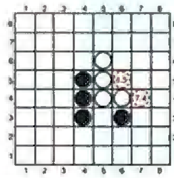
In the News

A California start-up called Ferix introduced a novel thin-film magnetic printing technology. It embedded the print-head array in a flexible strip, which slid across a rotating drum and deposited a magnetic image. Ferix expected its technology to cut sales of laser printers.... Kaypro announced the New Kaypro 2. The $995 transportable came with WordStar and MBASIC.... Finding demand less than delirious, Apple cut the price of its new IIc by $100 to $1195.

What Was Hot, November 1984

- Intel's 286
- Motorola's 68020
- Software Publishing's pfs:Plan spreadsheet
- Samna Word III
- HP's 150 touchscreen computer
- Multimate and Leading Edge word processors
- PC/FORTH

The Fun and Games issue. Fun and games didn't mean Myst and Mortal Kombat. It meant using a microcomputer to program a game of Reversi, solve SOMA cubes, write animated games in 8080 assembly language, design a spacecraft simulator, and play chess. We published code for a baseball simulation, but in all those lines of North Star BASIC is no accounting for a players' strike.



Reversi

Steve Ciarcia used Intel's System Design Kit to build a PC around the new 8086 chip. "Running up to 8 MHz, the 29,000-transistor 8086 is the fastest single-chip central processor currently available." For $780, you could buy the SDK-86 and build a 16-bit computer with 2 KB of RAM, 8 KB of ROM, serial and parallel I/O, and an eight-digit LCD.

Price Quotes: November 1979

Commodore PET 16N computer	$995
Dual floppy drive for the PET 16N	$1295
11-MB 8-inch Winchester drive, from International Memories	$1775
Microsoft BASIC interpreter for the 8086, from Seattle Computer Products	$350
Subscription to BYTE	$18

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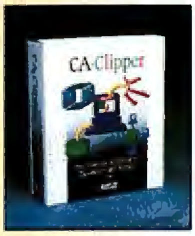
CA-Clipper 5.2 for DOS
by Computer Associates

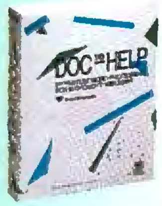


The CA-Clipper Application Development System includes a high-performance compiler, an efficient linker, and a flexible preprocessor to support a robust language! And you also get an editor, debugger and make utility to round out the complete package. Professional developers, CA-Clipper 5.2 has everything you need for developing PC- and LAN-based applications.

List: $795 Ours: $499 FAX*cetera* #: 5400-0001

key 01NV94

Doc-To-Help
by WexTech Systems



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RoboHELP® 2.6
by Blue Sky® Software

RoboHELP 2.6, the ultimate Help Authoring Tool for Windows & Windows NT, offers full document to Help system conversion and vice versa. Turns both Microsoft Word 6.0 & Word 2.0 for Windows into fully functional hypertext authoring systems capable of producing Windows Help files as easily as plain text. Just fill in the actual Help text when prompted. RoboHELP takes care of generating the RTF, HPJ and H files. Link tester allows you to simulate your design before you compile. Full support of all features in the Windows Help Engine, such as macros, secondary windows, and multiple hotspot graphics. Includes Help Compilers.

List: $499 Ours: $439 FAX*cetera* #: 2602-0005

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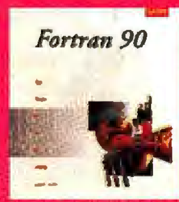
PRODUCT OF THE MONTH

Lahey Fortran 90
by Lahey Computer Systems



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Network C Library
by Automation Software Consultants, Inc.

The most comprehensive library available for NetWare software development, supporting all versions of advanced NetWare. Over 450 C functions; include any features from the NetWare command line utilities and menu utilities in your C or BASIC programs for Windows or DOS. No licensing hassles. C library source code available.

List: $395 Ours: $380 FAX*cetera* #: 1004-9201

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Controls for Btrieve
by Smithware, Inc.

Controls for Btrieve is a set of VBX controls linking Visual Basic with the Btrieve database engine. It's the easiest, fastest way to develop using Btrieve data in Visual Basic. Includes everything you need: WBTRCALL.DLL, DDF Builder for Windows, and *The Illustrated Guide to Btrieve*.

List: $249 Ours: $199 FAX*cetera* #: 2743-0003

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Visual Developer's Suite Deal
by VisualTools, Inc.

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Multi-Edit Professional
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Richly featured, completely reconfigurable and extremely easy to use, Multi-Edit will increase your productivity, right out of the box! It contains all the sophisticated features you'd expect in a high-end professional editor, plus...: new to version 7.0: fully interactive file compare; Windows clipboard interface; session manager (save/restore everything from previous session), much more! Free demo disk available.

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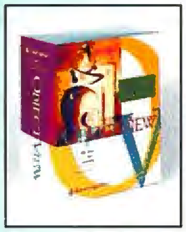
ObjectView Desktop
by KnowledgeWare



ObjectView Desktop is a powerful, Windows-based visual development tool for building rugged, high performance Client/Server applications. Tests prove ObjectView is easier to use and builds faster, more efficient applications than the competition. ObjectView Desktop includes a free Gupta SQLBase, accesses over 75 databases including dBASE, FoxPro, Btrieve, Paradox and more through ODBC and Q+E, and also includes native drivers for SQL databases such as Sybase and Oracle at no additional cost. A great value!

List: $199 **Ours: $189** **FAX*cetera* #: 0001-4801**

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by MicroEdge Inc.

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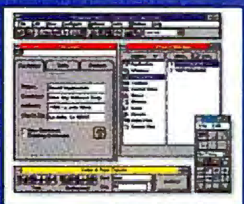
NEW THIS MONTH

WinMAKER™ Pro 6.0
by Blue Sky® Software

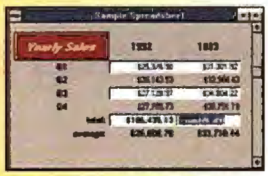


WinMAKER™ Pro 6.0, Prototyper & C/C++ Code Generator for Windows, & Windows NT, is as easy-to-use as Visual Basic—and it provides you with industrial strength C/C++ code. Visually design your application & attach functionality to any object without writing a single line of code. QuickRun™ lets you edit & test your application before compiling. Included SIMs generate ANSI C, MFC C++, OWL C++ code and more. WinMAKER Pro preserves user code 100% upon code-regenerati[illegible] Multimedia support.

List: $995 **Ours: $895** **FAX*cetera* #: 2602-0003**

key 13NV94

WinWidgets 3.0
by Lifeboat Publishing



WinWidgets simplifies the task of creating Windows programs by incorporating pre-built objects into your design. This one package provides support for standard interface elements along with a variety of high level "must have" objects such as spreadsheets, grids and tab controls. WinWidgets is available in VBX and DLL form for Visual Basic, Visual C++ and other popular compilers. In both 16-bit and 32-bit environments.

WinWidgets/VBX	**List: $199**	**Ours: $149**
WinWidgets++	**List: $299**	**Ours: $249**
WinWidgets 32	**List: $399**	**Ours: $349**

FAX*cetera* #: 2089-0023

key 14NV94

Watcom™ SQL Network Server for Windows
by Watcom

Watcom SQL Network Server for Windows is a non-dedicated multi-user Client/Server SQL database server supporting concurrent Windows, DOS and OS/2 clients in popular workgroup environments such as Windows for Workgroups, LANtastic and Personal NetWare. Watcom SQL advanced features include ODBC Level 2 drivers, bi-directional scrollable cursors, referential integrity, row-level locking, symmetric multithreading of requests plus on-line backup.

6-User	**List: $795**	**Ours: $599**

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The Joy of the Internet

CRAIG NOVA

As far as I'm concerned, there has always been a certain amount of illusion involved in thinking that a guide can solve all your problems. This illusion is great enough with, say, a guide to sex, but when it comes to something really complicated, like the Internet, it is almost complete. As far as the Internet is concerned (and sex, too, I guess), no book is going to compensate for some long, hot, sweaty hours coming to grips with actual experience. However, a good guide, like some of those mentioned below, can certainly give you a few new ideas. There were times during my Internet explorations, I must admit, when this left me contemplating the details of some extremely peculiar embraces.

Also, I'd like to say that it is unfair to compare some of these guides against others. Some are meant to be concise; others have a larger scale. Sometimes, the sheer bulk of information tends to make one guide more successful than another.

Methodology should be mentioned here, too. I went about trying to evaluate these guides by (1) making a pile of them and (2) getting on-line and trying to figure out how, say, to use gopher. When I ran up against a problem (which was almost instantly), I (3) started going through the pile until I found the answer. You do not have to be a rocket scientist (or a computer programmer) to decide that the guide that gave the most answers with the least amount of looking for them is the superior one. Also, speaking of methodology, simple reference compilations (e.g., *The Internet Yellow Pages*) are included in a separate category.

The guides are arranged in increasing order of value.

Least useful was *Internet: Getting Started*. The difficulties here are language, lack of organization, confusion as to whom this guide is for, and lack of vision (which comes, I guess, from the committee of authors/editors). The language here is so bureaucratic as to seem like guidelines for disposing of a particularly rare variety of toxic waste. What information that does exist in the first couple of hundred pages is unconnected to any particular task, and the language in which it is given does not tend to invite curiosity as to the correlatives in a guide to sex.

For instance, there are 205 pages of prose like the following before you learn anything about what you can actually do with the Internet. "When using an RFC as a reference for a protocol specification, it is important to verify that you have the most recent RFC on that protocol. The RFC titled IAB Official Protocol Standards, currently RFC 13600 (but often updated with a new RFC number under the same title), is the reference for determining the correct RFC to refer to for current specification of each protocol." Well, if you don't know how to send E-mail yet, just what are you going to make of that? When *Internet: Getting Started* comes to practical information, there is a page and a half, for instance, on WAIS (Wide Area Information Service) and a note to contact Thinking Machines if you want more information. Really.

A DOS User's Guide to the Internet is a step up on the food chain, but not a large one. The difference between it and *Internet: Getting Started* is the same as that between a spotted newt and a fish egg. Essentially, the guide is limited by giving information only about E-mail, Netnews, and `ftp` by E-mail and `uucp` software. Frankly, this is a very slender part of what the Internet can do, and `uucp` seems awkward to learn for such a small access. There is nothing about WWW (World Wide Web), archie, veronica, or other search utilities. Surely, a DOS user might want to know about some of these.

Hands-On Internet Guide is better. It gets you to do something

LEARN TO MORPH

MORPHOLOGY 101 FOR WINDOWS Andover Advanced Technologies, 239 Littleton Rd., Suite 2A, Westford, MA 01886, (508) 392-1362, $39.95

Few CD-ROMs classify as bargains, but at $40, Morphology 101 for Windows is an exception. This is a good starter kit for anyone with the itch to morph, which is the fluid transformation of one static image into another. Morphology 101 provides both a tutorial to get you started and North Coast Software's PhotoMorph Lite program, a stripped-down version of its popular PhotoMorph. You also get 75 morphing samples and several hundred static images, all royalty-free. But wait, there's more! You can use the bundled Matinee program from Access Softek to turn the morphs you create into custom screen savers. All that's missing are the Ginsu knives.

The CD is complete, but it's not perfect. The user interface is minimalist, with no direct link from one component to another. To run PhotoMorph Lite while reading the tutorial, for example, you must load each of them separately and toggle back and forth via Windows.

Although the "How the Pros Morph" tutorial is interactive as advertised, its implementation is crude by today's multimedia standards. It is simply a Windows Write file with live embedded morphing examples. There are no hypertext links from, say, the table of contents to the corresponding section of text.

The content, however, is good. The text has the voice of experience, and the organization is done logically. The morphing examples are well chosen, too. Andover Advanced Technologies should pay greater attention to the quality of the writing in the next release, however. In some cases, the wording was awkward enough to obscure the meaning.

PhotoMorph Lite provides only the bare minimum of morphing features. In fact, you will get more out of the tutorial if you have the full-blown version of the program. Nonetheless, Morphology 101 will get you morphing in fairly short order. It is a good value and a lot of fun as well.

—Michael Nadeau

with the Internet very quickly, and it also has the advantage of being arranged as a series of lessons. However, it does have a fault common to a lot of Internet books, which is that it seems to imply that the commands it lists here are the ones that are universal, when in fact, depending on your software or how you are hooked up to the Internet, your experience might be entirely different (as mine has been many times). However, *Hands-On Internet Guide* is particularly good with rules for Usenet, and it is good, too, with `telnet` and `ftp`.

The Instant Internet Guide is distinguished by being concise. In fact, it is something like a short guide to DOS commands. If it suffers from anything, it is a lack of scale. But, in many ways, its precision is a strength, and it has a no-nonsense approach that, when you are having a problem, comes in handy. What is here is good, solid information, arranged with an eye toward the practical. Still, it is short, and you will be left with some unanswered questions if you rely on this book alone.

At this point in ranking these books, we are entering a realm where it is a little harder to put one guide ahead of another. The last four are all competent and useful, and they are written in a clear, easily understandable manner. At this point, judging these competent guides is extremely subjective, because one procedure, correctly described in different guides, will seem more clear in one than another. This, I am afraid, is a matter of tone, or of the authors putting themselves in the shoes of someone who knows nothing and wants to learn fast.

There isn't much one can say against *The Whole Internet*. It is clearly written. It is precise, and it has a vision of how to use the Internet. This is another way of saying that this book was written by someone for whom the Internet makes perfect sense. This may seem like a small point, but in fact it is a very large one. This vision is what gives this book its authority. Recommended.

Everybody's Guide to the Internet is also good. It has a lively history of the Internet (and having read *many* of these before looking at this one, I want to point out that this is saying something). Also, the book has a very definite idea of the practical, and it shows up in such details as a section called "Seven Unix Commands You Can't Live Without."

It also is unafraid to admit that things will go wrong, as, of course, they do. Many Internet guides take the attitude that if you just follow the easy directions, you can't make a mistake. Well, let me tell you, you can make a lot of mistakes. If you believe a guide that implies otherwise, you have been sold a bill of goods, particularly since, under these circumstances, you will spend a lot of time wondering what is wrong with you, rather than what is wrong with the guide. Finally, this book lists a number of `telnet` and `ftp` sites. As such, it gives proof to the saying that god is in the details. Recommended.

Finding It on the Internet is distinguished by its tone, its organization, and its ability to convey, in a friendly and clear manner, how one can go about *learning* about the Internet. The truth is that a good guide needs, ah, a bedside manner. ("I understand. Sure. Here. Get comfortable.") This is a long way around of saying that this guide (which confronts the basics: gopher, E-mail, archie, veronica, `ftp`) has a way of being empathetic with what it is like to be sitting in front of a monitor, sweating bullets, and using the escape character to no effect at all.

The following is a commonsense comment, typical of those that occur throughout *Finding It on the Internet*, many times in a "Hint" section. "Don't be alarmed if a Gopher search doesn't come off as planned. Network usage may be heavy or a node on

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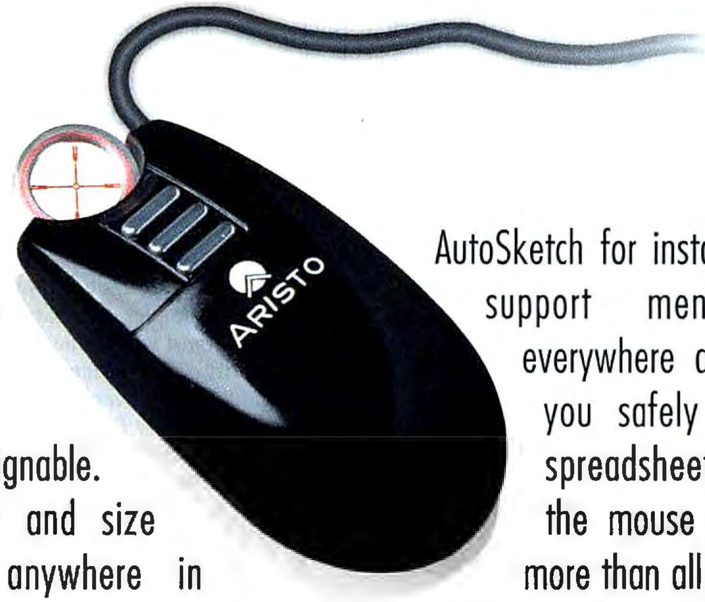

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INTERNET: GETTING STARTED
April Marine et al.
PTR Prentice-Hall
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A DOS USER'S GUIDE TO THE INTERNET
James Gardner
PTR Prentice-Hall
ISDN 0-13-106873-3
$34.95

HANDS-ON INTERNET GUIDE
David Sachs and Henry Stair
PTR Prentice-Hall
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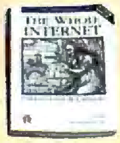

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the net may fail; if that occurs, Gopher may simply leave you hanging. The best advice in such circumstances is to wait and try again, when usage is less heavy." Highly recommended.

My favorite is *The Internet Complete Reference*. This guide has those things I was looking for right from the beginning: scale (818 pages of solid, down-to-earth information), clarity, and good examples. It admits that things will go wrong, has a definite idea of just who the audience for this book is, and has a voice you can trust. For instance, one day I downloaded a .tar file. Other guides didn't even have it listed in the index (aside from *The Instant Internet Guide*, which gets points for it, although the description was a little brief), but *The Internet Complete Reference* didn't let me down. This was typical of my experience. If you're going to buy only one guide to the Internet, this is it.

Finally, *The Internet Yellow Pages* and *Internet: Mailing Lists* are quite useful, if not essential. Of the two, I like *The Internet Yellow Pages* better, if only because the format is so readable and the book is well organized (in a domain, hierarchy kind of way). It is also one of the few telephone books, or telephone book–like books, I have actually sat down and started reading, saying out loud, "I'll be damned. I didn't know you could get a list of E-mail addresses for Ukrainian businesses." It has other information, too, I might add, that is closer to home.

Internet: Mailing Lists seems to be a little more high-minded, if not more academic, than *The Internet Yellow Pages*. One of its difficulties is that it is organized by mailing-list address, most of which make little, if any, sense. Perhaps a listing by subject would be more useful. There is an index, and a good one, although finding information here is a little harder than in *The Internet Yellow Pages*. Still, it is authoritative, comprehensive, and simply filled with information. ■

Craig Nova is the author of eight novels and the recipient of many awards and prizes, including an Award in Literature from the American Academy and Institute of Arts and Letters. You can reach him on the Internet at sextans@delphi.com or on BIX c/o "editors."

PCMCIA: Past, Present, and Promise


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JOHN BRYAN

Without a doubt, the term *PCMCIA* is one of the most widely misunderstood acronyms in the computer industry today. The usual quip is that it stands for "people can't remember computer-industry acronyms," but in reality it stands for Personal Computer Memory Card International Association, the group responsible for setting the standards for the cards so many of us refer to as PCMCIA devices. The correct name for the technology—for right now, at least—is PC Card.

But further points of confusion exist. The standards aren't just for personal computers; they apply to many other devices as well. The standards support not only flash memory, RAM, and ROM, but also such devices as modems and fax modems, LAN adapters, cellular communications, and rotating and solid-state storage. As you read this, the association is working to effect changes in both the technology and the products that are referred to as PCMCIA devices, including a change in the name of the standard itself.

Originally conceived and developed to provide memory for the Poquet computer, PCMCIA was the brainchild of Neil Chandra of Poquet (which is now a division of Fujitsu), who brought together diverse industry interests to forge a specification that provides plug-in access to memory resources that are external to a given platform. Chandra sat on the board of directors of the association for many years and is still actively involved in the development of standards.

In short, PCMCIA has grown to encompass much more than access to a memory card. And therein lie the problems. Because PCMCIA is used to access so many types of devices, each with its own electrical and logical interface and timing considerations, conflicts frequently arise among cards, platforms, operating systems, applications, and driver software.

PCMCIA may make dynamic resource management a reality

Although not sanctioned by an official standards body such as the IEEE or ANSI, the PCMCIA specifications nonetheless provide a series of recommended guidelines for the physical specification of cards; the physical and electrical specification of sockets; and the interaction among platforms, system software, and cards. Because so many firms are actively involved in the PCMCIA (the group has between 450 and 500 member companies), its guidelines carry the weight of a standard.

The PCMCIA group defines three types of cards and sockets for device support. All the cards have the same length and width (85.6 by 54 mm, roughly the size of a credit card), and each plugs into the same 68-pin connector. But differences exist in the thickness of the cards, and, correspondingly, the size of the socket openings.

A Type I card can be up to 3.3 mm thick. This form factor is used primarily for RAM and ROM cards, on which all the ICs are surface-mounted so that they are nearly flush with the printed circuit board itself. A Type II card can be up to 5.5 mm thick; it is into this category that most modem and fax modem cards, LAN adapters, and other types of purely electronic devices fall. Connectors, generally the RJ-11 phone jacks used for modems and 10Base-T, are usually attached via a flexible connector on the end of the card facing away from the bus interface. Finally, Type III cards, which can be up to 10.5 mm thick, are used mostly for rotating storage and other specialized products.

Socket sizes are also classified by type. Type I sockets support only Type I cards, Type II sockets support Type I and II cards, and Type III sockets support all three card thicknesses. Many of today's better portable systems come with two Type II sockets positioned in a piggyback fashion, so the system can use two Type I cards, a Type I and a Type II card, two Type II cards, or a single Type III card.

Type specifications refer mainly to the dimensions of the hardware; users also must contend with release specifications, which have implications for both hardware and software and are not related specifically to a type of card. PCMCIA release 1.0 cards, the first-generation products, were for memory only and did not support I/O operations. PCMCIA release 2.x introduced I/O capabilities into the standard, but it didn't modify the hardware in any visible way. Release 1.0 cards work in release 2.x sockets, but the reverse is not true. Fortunately, most systems on the market today include a release 2.x socket. The current release is 2.1.

PCMCIA releases also govern Card and Socket Services, the software elements that determine how the cards themselves operate. Socket Services is a set of BIOS-

PCMCIA Players and Products

With the PCMCIA group now some 450 to 500 members strong, it is impossible in this limited space to mention even a significant percentage of the participants who are making a contribution to improving the PC Card standard. But a number of products and companies stand out, and they deserve special mention.

One of the more important aspects of the new vistas available to PCMCIA is the move to desktop computers and other digital devices. At this point, only a few desktop vendors offer card slots as a standard on their systems, and a few more offer it as an option. IBM has the PS/2 E (the company's so-called green machine), which has four slots, and NCR has a system with two slots in front and two in back.

But if your desktop system doesn't have a slot, and a new computer isn't in your budget, don't despair. CNF (Morgan Hill, CA) and SCM Microsystems (Los Gatos, CA) provide desktop access to PCMCIA with their reader/writer products. Both vendors provide ISA-compatible (SCM also ofers PCI-compatible [Peripheral Component Interconnect]) cards that support a 3½-inch Type III slot mounted on the drive bay (front access) and a card slot mounted directly on the ISA card itself (rear access). Over the next year or two, expect to see this arrangement as a standard feature of desktop PCs. Many will probably be produced by one of these two vendors as an OEM.

In fact, SCM has just released a product that features a Type III slot and a 3½-inch floppy drive in the same unit. Jack Peterson, director of marketing at SCM, says that "the manufacturer has to provide the floppy drive anyway. If they can add PCMCIA capability for $20 to $30, there is real value added for the customer."

Very few, if any, system vendors write their own Card and Socket Services software, which is essentially an extension of the system BIOS. Like BIOS, it is frequently written by a third party, with collaboration from—and modifications made by—the host-platform vendor. Award, Phoenix, SystemSoft, and Ventura Microsystems are among the companies that provide this vital link between PC Cards and host platforms. SystemSoft currently has the lion's share of the market, providing software for Acer, AST, AT&T, Compaq, Dell, Gateway, Hewlett-Packard, NEC, NCR, and others.

On the card side, SyQuest (Fremont, CA), the removable hard disk company, has a 1.8-inch product that fits in a Type III slot. Each formatted cartridge (1.97 inches wide by 2.03 inches long by 0.193 inches high) will hold 80 MB of native (uncompressed) data. This unit offers all the benefits of a hard drive (5400 rpm, 16-millisecond seek time, and 1.3-MBps sustained data transfer rate) coupled with the cost savings of a removable drive.

The price of this unit is expected to be under $500, with additional cartridges priced at or just under $1 per MB. Chandran Cheriyan, product marketing manager for SyQuest's 1.8-inch product line, says that "this puts the break-even cost point between the second and third cartridge, compared to adding equivalent storage capacity in a noncartridge Winchester. And we plan to increase the capacity of our cartridges."

High-speed communications has also come to PCMCIA. In June, Microcom (Norwood, MA) began shipping a 28.8-Kbps fax modem in the PC Card form factor. Suggested retail price of the unit, called the TravelCard Fast 28.8, is $599—not inexpensive, but reasonable when you consider that two systems can share it. In addition, its high data transfer rate should significantly reduce phone-line charges. The TravelCard Fast 28.8 overcomes a Windows data transfer rate bottleneck by using Microcom's APT (Advanced Parallel Technology) software, which, as the name indicates, enables a modem to operate as a parallel device.

Dave Lawrence, president of Ventura Microsystems and a firm believer in the standard, thinks the PC Card standard is at the stage where developers are beginning to understand both the technology and the scope of the market. "The biggest problem they [members of the PCMCIA group] have today is people with existing products who are breaking the rules," he says. "The great thing about PCMCIA is that the technology, except for the dynamic insertion part, is not new. It's basically just a question of putting standard devices in smaller form factors."

Steve Magidson of the PCMCIA group sums up the situation pretty well: "An awful lot of the credit goes to the vendors themselves, who have taken it upon themselves to ensure that their products work together. With as many different interests represented as there are in this organization, it is somewhat amazing that we have accomplished anything at all."

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level drivers that handle the physical operation of the sockets. PCMCIA is a *bridge* bus technology, which means that it can be run from any of a platform's I/O buses. In the PC world, this is most often the ISA bus, but PCI (Peripheral Component Interconnect), SBus, and NuBus implementations also exist.

While the PCMCIA standard is platform independent, Socket Services is platform specific. It determines the number of sockets available, notifies the hardware drivers when cards are inserted or removed, makes cards accessible to system software drivers, and handles several other functions. But although the Socket Services software is platform-specific, very few vendors write the requisite code entirely on their own. Most rely on a third party to supply some of the software, as well as the other half of the PCMCIA software equation: Card Services.

Besides providing access to cards and sockets, Card Services coordinates system interrupts and memory activities; it also handles power management tasks. When correctly implemented, Card Services prevents direct interaction between a card's drivers and the system or system services. Card Services software is specific to the operating system of the host platform; in fact, it acts as an operating-system extension that deals with a specific bus structure and the peripherals on that bus.

These peripherals are PC Cards. The functions and parameters of a PC Card are contained in data sets (called *tuples*) in the CIS (Card Information Structure). CIS data is stored in ROM on the PC Card itself, and Card Services queries this data structure for information on the inserted card. These details are passed to the host system, which uses them to interface correctly with the PC Card.

The Problems with PCMCIA

PCMCIA is the original plug-and-play interface. It was designed to provide resources that users could add to and remove from a system at will, ideally without rebooting or turning off the host. In reality, however, PCMCIA did not immediately live up to anyone's expectations (as is often the case with new technologies). Many factors contributed to the disappointing showing of the early implementations of PCMCIA, but the most widespread problem was the failure of card makers to adhere to any kind of industry standard.

PCMCIA's first standard, release 1.0, was published in September 1990. In the first generation of products, Card and Socket Services did not exist. Instead, vendors supplied their own product-specific drivers, which in turn needed to be verified on each host platform. Platform vendors provided lists of tested, or *certified*, cards that they knew worked on their systems. However, each revision of the host, the operating system, or the card—no matter how small—stood a significant chance of causing compatibility problems.

The net result was that, for any given system, PC Cards worked neither as often as they should have nor in the way they should have. Changing cards, using two cards at once, and even changing applications frequently caused some sort of system failure. Users were confused by—and dissatisfied with—the technology.

The introduction in September 1991 of release 2.x, with its Card and Socket Services, provided a standard API and should have leveled the playing field. But 2.x also brought I/O into the picture. Although this release opened the door for the products that have made PCMCIA the versatile tool it is today, it also opened a Pandora's box.

For example, an operating system does not see a hard disk or a memory card as being the same type of device as a fax modem. But the vendors of these peripherals, anxious to bring their products to market, often failed to take this into account and provided only the minimum software necessary for a device's operation. As a result, each card had to be tested in a system to ensure that it worked, and users generally had to either install a card before the system was booted or reboot after installation so that the system would recognize it.

To some extent, this problem persists. Today, most PC Cards work in most systems, generally without a reboot, but there are no guarantees. Most of today's operating systems are designed to work with the resources that are present when the operating system is booted; the dynamic nature of PCMCIA runs against the grain.

The Way We Are

Many vendors of host platforms now offer some form of Card and Socket Services software. But although most host-system vendors supply them, vendors of PC Cards don't assume that Card and Socket Services will be present wherever their cards are installed. Instead, they generally supply some installation software that loads a

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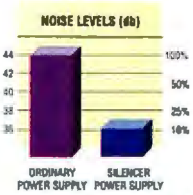

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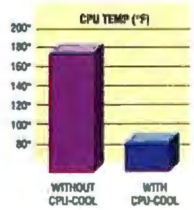

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simple driver or provide the services software themselves.

This leads to another potential problem. If users who already have Card and Socket Services on their systems use their PC Cards' installation software (which you'd expect them to do), that software may overwrite or otherwise corrupt the existing services software. When this happens, users may be left with only one card that works: the one they've just installed.

During the past six months or so, things have taken a distinct turn for the better. Because vendors are finally embracing the services software, many have upgraded their installation software so that it doesn't overwrite the existing services software during setup. Users who have recently purchased systems, especially those produced in 1994, will find that most of their new cards work perfectly, both on their own and with other cards.

The Promise of Plug and Play

By the time this article sees print, the PCMCIA group should have released its newest version of the PC Card standard. One interesting development on the hardware side of this new standard is a technology called CardBus, which adds many significant features to the current standard but is completely backward-compatible with products that conform to the existing standard. Among CardBus's more significant features are a 32-bit data path, bus-mastering capability, support for multifunction PC cards, and support for low-voltage (i.e., 3.3-V or less) products.

One of nicest features of the CardBus interface is its performance. It supports multiplexed 32-bit data and addresses and runs at speeds as high as 20 MHz. This means that the CardBus interface is capable of peak data transfers in the 80-MBps range, approximately 20 times faster than what the current 16-bit interface can achieve. Of course, host systems that attach CardBus to a 16-bit bus structure will realize little or no performance increase, but many vendors plan to release systems with CardBus/PCMCIA bridged off the PCI bus.

CardBus is designed for use in a high-performance environment, and bus-mastering capability is a part of that picture. It enables the central processor to off-load control of the bus and move on to other processes. This provides a significant performance boost, especially in a multitasking environment.

In a CardBus implementation, adapters must support either PCMCIA release 2.x cards or CardBus cards. A detection algorithm uses the adapter to determine which type of card is installed, and this informa-

tion is passed to Card Services. Card Services then uses Socket Services to determine whether the PC Card is supportable and to decide which interface protocol to activate. To prevent damage to the card, Vcc is supplied to the card only after its needs are analyzed. If the card requires 3.3 V, for instance, and the system can supply only 5 V Vcc, the system software sends a message, via the user interface, that the card cannot be supported.

All CardBus PC Cards are designed for 3.3-V (or lower) operation; for a host system to be CardBus-compatible, it must be capable of supplying that voltage. CardBus also supports power management functions, such as clock-rate control and remote wake-up. In a CardBus implementation, a socket is turned off until a card is inserted into it.

CardBus also supports multifunction cards; each CardBus card can include as many as eight functions. This means that your LAN adapter might also act as your cellular fax modem, sound card, and digital-encryption processor (see the text box "PCMCIA Players and Products" on page 66).

One of the obstacles preventing PC Card and PCMCIA technology from even more widespread use is the lack of built-in support for it at the operating-system level. Only IBM includes Card Services with its operating systems, and only in OS/2 2.1 and PC-DOS 6.1 and higher. Because today's operating systems are so closely tied to their host platforms (especially in the portable market), to get native support for PCMCIA you need an IBM system.

But this situation will soon change. Microsoft's Chicago has been designed, from the ground up, as the world's first plug-and-play operating system. It will have a superset of all Card and Socket Services functions and will provide the features that PCMCIA needs to achieve its goals: dynamic resource management, dynamic driver loading and unloading, and dynamic event messaging.

Chicago will use Microsoft's Bus Enumerator to access the PCMCIA adapter and handle all the functions that Card Services currently handles (see the figure "Chicago and PCMCIA"). Under this type of setup, the PCMCIA adapter is just another plug-and-play device. Configuration of PC Cards and CardBus cards is handled by the Configuration Manager, which allocates resources as needed.

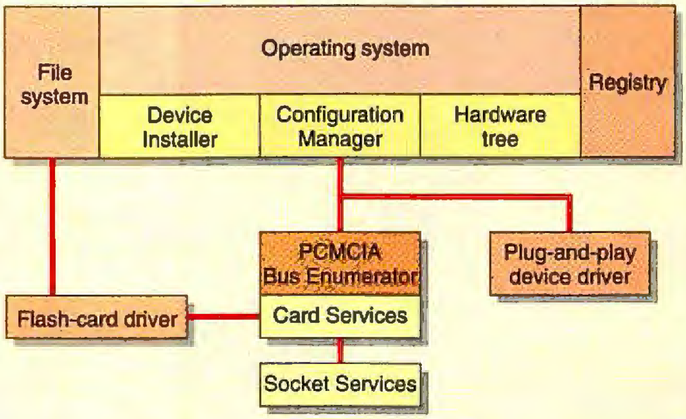
Because of its dynamic resource management, Chicago demands that each device have a unique identifier, which is created by the Bus Enumerator. In addition, each device's unique setup requirements are stored in an INF file, which Chicago's Device Installer accesses when an insertion triggers a request for identification.

After a device is identified and its INF file is created, the information is kept in the operating system's registry, and hot swapping becomes user-transparent. To permit configuration of any device, Chicago still requires the PC Card CIS to contain tuples; however, the coupling of mainstream operating systems, such as Windows, with a requirement for a standard tuple structure should help keep peripheral vendors within standards guidelines.

Chicago has a standard API for the development of plug-and-play DLVxDs (dynamically loadable virtual device drivers). All resource management for the device drivers is handled by the Configuration Manager. Actual configuration is handled by the Bus Enumerator through a Card Services interface. Because of this setup, the same device driver could conceivably manage its specific device over an EISA, ISA, PCI, or PCMCIA bus.

Microsoft seems to be treating PCMCIA as a priority. On its Redmond, Washington, site, the company maintains a building dedicated to helping developers port their device drivers and applications to Windows environments and operating systems. A major porting program for Windows' Chicago plug-and-play device drivers for PCMCIA is currently under way.

Chicago and PCMCIA



Microsoft's Chicago operating system has integrated support for PCMCIA via its Configuration Manager, which is responsible for all resource allocation and deallocation. This central control eliminates the possibility of conflict between devices.

The Possible Dream

Although up to now the driving force behind PCMCIA has been the portable industry, that's changing. A few vendors have come out with desktop systems that have PCMCIA slots, and more are sure to follow. Most of us work in a relatively dynamic environment; our system needs frequently change, and we don't want to keep taking our hardware apart to accommodate these changes.

But the simple convenience of being able to add more memory or additional capabilities to a machine isn't the only reason users will want PCMCIA capability in their desktops. Another advantage is the possibility of sharing resources among systems. This is especially important for someone who works with both a portable and a desktop system. Such a user's chances of needing a sound card or a LAN adapter in both machines at the same time are slim. If the sound card and LAN adapter are on the same card as the user's fax modem, so much the better.

PCMCIA also offers a way to improve system security. The use of data-encryption cards and the practice of storing work on a removable disk both offer protection against disaster or dishonesty. And for road warriors returning to their desks, downloading information stored on a PCMCIA hard disk is faster than just about any other data transfer method.

Finally, PCMCIA isn't just about portable and desktop PCs. The proliferation of PDAs (personal digital assistants) is opening up another market for these cards. And the time isn't too far off when we'll all be carrying our medical or credit information—or both—on a credit-card-size printed circuit board equipped with ICs.

But even if information-laden credit cards are a long way down the road, the future of PCMCIA looks bright. As standardization efforts improve and sales of new systems shift ever more toward the portable market, PCMCIA comes closer to reaching its original goals of providing seamless operation, incredible flexibility, and significant market penetration. ■

John Bryan is a freelance technology writer and consultant based in San Jose, California. You can contact him on the Internet or BIX at editors@bix.com.


All He Does Anymore Is Tie Me Up In The Backyard...
Dr. K. Ni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POWERPOINT

Yes, Dr. Nine, the power of Gateway's Pentium™-based PCs has been unleashed! It's an epidemic that's spreading from one member of my family to another. Now *she* even has a Pentium-based system from Gateway. I can see why Dataquest,® Inc. reported that Gateway 2000® is the leading supplier of Pentium PCs in the nation — they're everywhere!

She's a freelance writer, and ever since she got her P5-90 Best Buy from Gateway 2000 all she does is rave about its amazing features that increase her productivity — like its 540MB hard drive, 8MB of RAM and a super-fast double-speed CD-ROM. I have to admit, she pumps out tons of work now, and it keeps her out of the doghouse because she never misses a deadline.

She especially digs Microsoft® Bookshelf® 1994 that's part of MS Office Professional. It makes research a snap! Bookshelf includes seven best-selling reference books including *The American Heritage Dictionary, The Original Roget's Thesaurus, The Columbia Dictionary of Quotations, The Concise Columbia Encyclopedia, Hammond Intermediate World Atlas, The People's Chronology, and The World Almanac® and Book of Facts 1994.*

Of course, MS Word, the most popular word processor for Windows, has cool features like spelling and grammar check (she can spell check in 20 languages!), thesaurus and word count. She can even use Word and Bookshelf simultaneously!

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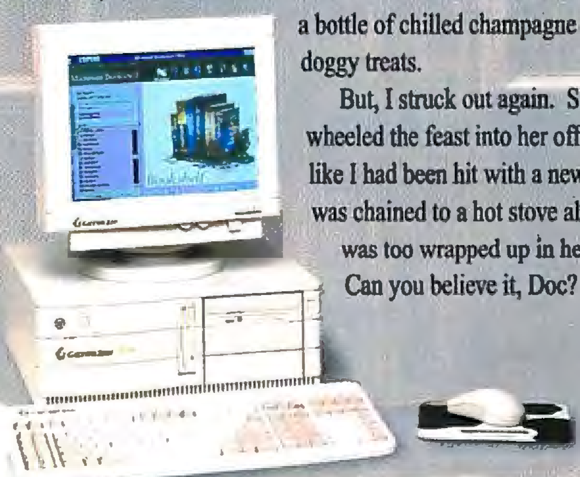
I'm glad she loves her Gateway PC and all of its awesome software, but now *she's* ignoring me too! She's so engrossed with her P5-90 Best Buy she hardly stops to eat.

One day I prepared her a lunch fit for a queen. An elaborate feast really — Belgian endive salad, savory herbed croissants, wild rice pilaf, grilled apricot-ginger chicken breasts, and white chocolate cheesecake with luscious strawberry glaze. I threw in a bottle of chilled champagne and a few of my favorite doggy treats.



But, I struck out again. She didn't bat an eye when I wheeled the feast into her office. I was stunned — I felt like I had been hit with a newspaper! How could she? I was chained to a hot stove all day. But as usual, she was too wrapped up in her Gateway PC to notice me. Can you believe it, Doc?

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Starting with a Clean Sheet

DICK POUNTAIN

CHRIS LOCKWOOD © 1994

Objects are the future of computing, we're told. But few of us can easily imagine how applications built from reusable components will look. However, after using CleanSheet from Working Title (Yarnton, U.K.), I have a pretty good picture, and I like what I see.

CleanSheet is hard to describe, although if I sat you in front of a PC screen, I could show you what it does in about 5 seconds. Basically, it's a constructor set for grown-ups; it allows you to combine ready-made objects by "wiring" them together visually onscreen. Without writing any code (not even the token number of lines that Visual Basic requires), you can create customized calculation applications as varied as financial spreadsheets and visualizations of scientific data.

A few existing products use a visual programming metaphor; the most successful of them is probably National Instrument's (Austin, TX) LabView data-logging package. But CleanSheet is a more general-purpose package than any other system I've used. Currently, it is available only for Microsoft Windows 3.1.

Imagine a constructor set that lets you use ready-made objects to create customized calculation applications—fast

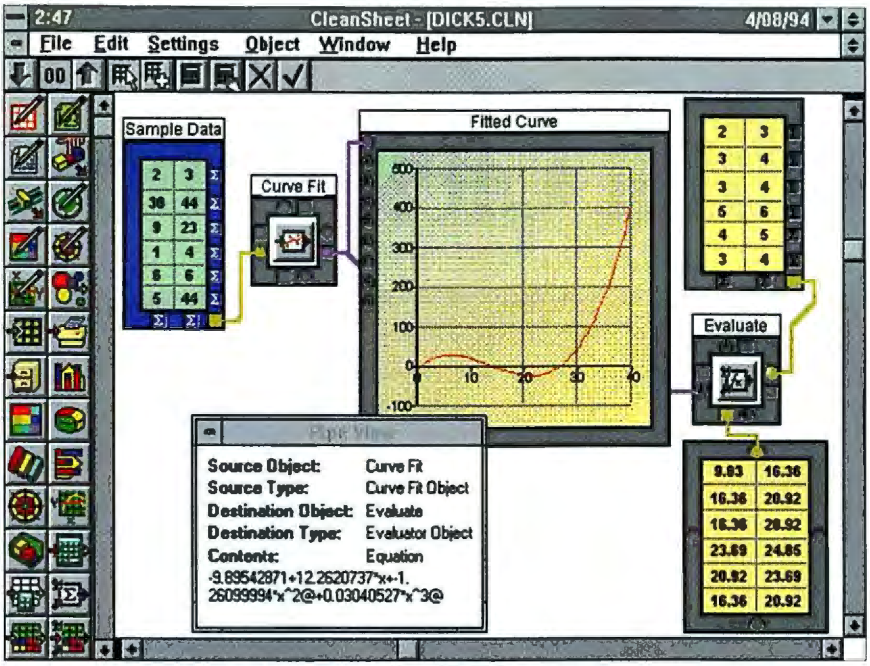
Using CleanSheet

When you build a new application in CleanSheet, you literally start with a clean sheet—a blank screen onto which you drag objects from a palette that resembles Visual Basic's toolbox. The palette has 58 predefined objects that cover every aspect of data input, manipulation, storage, and display.

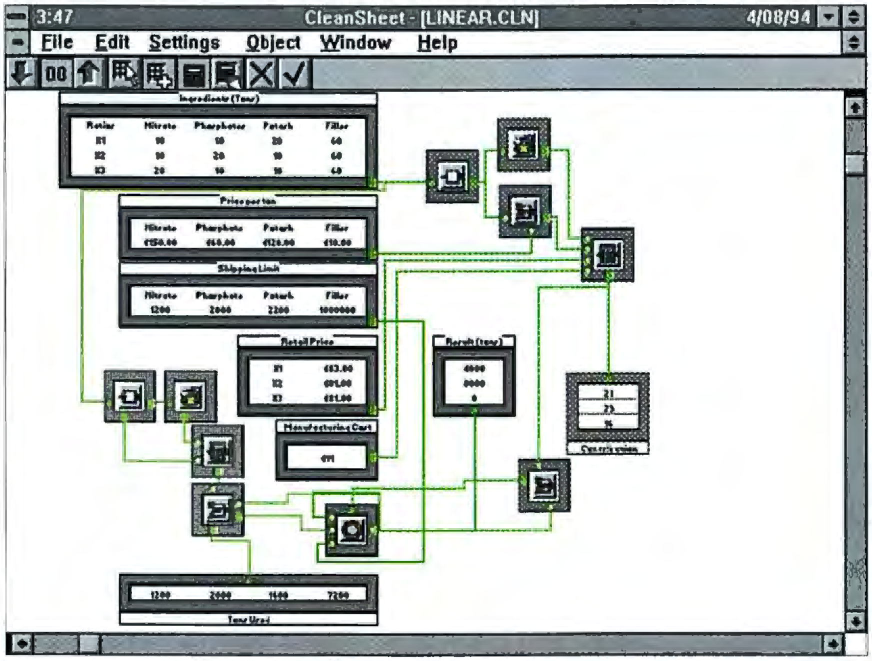
When dragged onto a sheet, CleanSheet objects appear as squares or rectangles with a very thick gray border, often with an identifying icon in the center. Scattered around the borders of these objects are small circles, which represent input ports, and squares, which represent outputs. To connect two objects, you simply click the mouse on, say, an output square and "stretch a pipe" to the desired input. If you try to do something silly like connecting an input to another input, the pipe refuses to take hold.

CleanSheet applications look like industrial process diagrams, with lots of boxes connected by pipes. Once you develop an application and get it working, you can hide the objects' thick borders. The program automatically aligns objects and reroutes pipes to produce a good-looking application.

Most CleanSheet applications rapidly expand beyond a single screen, and the program offers several ways for getting around large sheets. Obviously, you can scroll around to look at other parts of a sheet. You can also split each screen into two or four subwindows, each showing a different part of the same sheet, or open a new window on the same sheet. As with a drawing program, you can zoom and shrink your view of the application to various scales; the sheet remains editable at all scales. As a result, CleanSheet is an application that cries out to be run at a resolution of 1024 by 768 pixels or higher. *continued*



A typical CleanSheet application contains input objects (e.g., Sample Data), output objects (e.g., the *x,y* graph), and computing objects. This sample application derives an equation from the input data and then both plots it and uses it to transform a further data set (the tables with yellow backgrounds). I've opened a Pipe View window to show the actual cubic equation that was derived from the data contained in the magenta-colored pipe.



For larger CleanSheet applications like this linear programming problem, you can place objects on separate layers to make the sheet more manageable. In this half-scale view, the grayness of certain objects indicates they are on lower layers. This example is based on the Solution Search object that appears at bottom center.

Like a drawing package, CleanSheet supports as many as 100 separate layers, which permits large-scale structuring of your application. You use a mouse to run pipes between layers, in the same way that you run pipes between objects. If you view all layers at once, the program uses a fading depth effect to help you distinguish among the layers.

You can also group several objects in a single higher-level object, which lets you produce hierarchically structured applications. You can lock such structured groups with a password, so they provide a handy format in which to distribute application templates. The program's system of style tagging lets you color or size a group of related objects in a single operation.

In most cases, when you click on a CleanSheet object, a dialog box appears, and you can set the object's vital parameters. For example, in a filter object, you might want to set the filtering condition; for a calculator object, you could supply the expression the calculator will compute; and for an array-dissection object, you might define the areas it will work on. Clicking on any pipe opens a Pipe View window that shows you the source and destination types and current contents of the pipe. These views are updated dynamically at run time so that you can trace program execution.

After wiring up all the objects you need, including at least one that displays the final result, you switch CleanSheet from edit to run mode, and the sheet is recalculated. Actually, it is the pipes—the repositories of data—that get recalculated, rather than the objects themselves. You can choose manual recalculation or have automatic recalculation triggered whenever the data in an input object is changed. Another option permits circular references between objects, although you must specify a maximum number of iterations to avoid heap overflow.

Pass the Data

What makes CleanSheet work so smoothly is the ingenious protocol it uses to pass data from one object into another. Variable-size, multidimensional arrays are the fundamental data structure. Object inputs and outputs (as well as internal function arguments) accept or return only a single value, but that value can be an array holding as many as 10 dimensions; its elements can be a mixture of any of CleanSheet's data types—integers, real numbers, strings, Boolean expressions, dates, times, complex numbers, equations, errors, and null objects. So an entire spreadsheet can travel around the system as a single object, while a stream of data (e.g., the first 1000 prime numbers) is passed as a one-dimensional vector. This avoids at a stroke the nasty synchronization issues that arise with variable-length data flow, and you can think of the recalculation of a sheet as a single clock tick in which single objects of varying sizes pass through the pipes.

For obvious reasons, spreadsheet-like 2-D arrays have special importance in CleanSheet. You input most data in this form, and many CleanSheet objects are concerned with 2-D array manipulation: dissecting them, sticking them back together, and merging, transposing, filtering, multiplying, and summing rows and columns. In fact, it is tempting to describe CleanSheet as a visual APL for the 1990s.

continued

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It employs a bracketed array syntax that permits you to write, for example, a 2-D array constant such as `{{1,2,3}{"cat","dog","bat"}}`. You often need to split an array into several parts and send them into different objects; CleanSheet always offers you the choice of specifying the subarrays by writing code or by interactively pointing and clicking on a grid.

Cesk code for generating primes using the Sieve of Eratosthenes.

```
main { pmax := a;           /* taken from input a */
       width := 1;
       pnum := 0;           /* initialize prime counter */

       flags := makearray{true,pmax};  /* set all flags true */

       for (i := 0; i <= pmax; i+=1;)
       {if (flags[i])                  /* found a prime */
         {prime := i + i + 3;
          for (k := i + prime; k <= pmax; k += prime;)
            flags[k] := false;         /* kill multiples */
          pr[pnum ? width][pnum / width] := prime;
          pnum +=1;                    /* primes found */
         };
        };
        return(pr)
    };
```

Because it provides objects with different levels of generality, CleanSheet typically offers many ways to achieve a particular effect. For example, to process every element of a 2-D spreadsheet, you might use the Calculator object, which applies the same formula to an entire array; a COG (Corresponding Objects Grid) object, which contains rules on how to process by rows and columns; or pairs of Announcer and Reporter objects, which split the array into its elements, pipe them to an intermediate calculating object, and recombine the results into a single array.

Using Objects

CleanSheet's 58 object types fall into three main groups: 13 for data input, 11 for data display, and over 30 for processing data. CleanSheet offers a handful of control objects, such as switches, junctions, and lookup tables.

The simplest input device is an input table, into which you enter data just as you would in a spreadsheet. You cannot enter formulas, however, so to build the equivalent of a spreadsheet, you have to pipe the data to a calculating object and then pipe it to a display table. An input table does have built-in computational ability. Each row and column total is available via an output square marked with a sigma. You output the entire spreadsheet by connecting to the square in the lower-right corner of the input table.

There are other simple input devices, such as a text box that lets you type in text without surrounding it with quotes. But CleanSheet also offers eye-catching gadgets, like button bars for entering restricted sets of values, tumblers (i.e., rotating knobs), and sliders for entering floating-point numbers or integers. Most advanced of all are the polar, *x,y*-scatter, and density-graph inputs, which let you interactively "paint" data onto a graph scale. For example, to complete a density graph, you fill a grid with blobs whose areas are proportional to the data value.

For output, CleanSheet provides tables (for creating a conventional spreadsheet display), bar charts, pie charts, 3-D graphs, segment charts, and polar, *x,y*-scatter, and density graphs. These objects give you sophisticated control over color and scaling, and the graph objects let you produce professional presentations by incorporating on surfaces and backgrounds elements like user-supplied bit maps (e.g., a map of the U.S.). The one feature I miss is a surface plot for mathematical visualizations.

You can also output to the Hard Copy object, which sends data to the printer in various forms, or to the Filing Clerk object, which writes data to a file. Input tables can import data files directly from applications such as Lotus 1-2-3 and dBase into a variety of formats, including comma-delimited, DIF, SYLK, and DBF.

Between input and output, you set up processing objects to do the work. As I mentioned earlier, CleanSheet provides a calculator object, into which you enter a mathematical expression relating the inputs (*A* through *Z*) to the output, and a COG object, into which you enter multiple expressions and the rules defining which area of the sheet they apply to. As with other operations, you can generate these rules by pointing and clicking.

The General, Financial, and Statistical Toolbox objects are more specialized calculators containing large numbers of preprogrammed functions useful in their respective domains. More specialized still, the Savings and Loan object is devoted to compound-interest calculations. Other specialized objects include the Random Generator object, the Chi-Square object for statistics, and the Sum, Product, and SumProduct objects for matrix manipulation.

Finally, if none of CleanSheet's other objects will do the trick, you can use the Computer object, into which you enter your own programs written in a C-like language called Cesk. I managed to translate the C source code for the old BYTE Sieve of Eratosthenes benchmark into Cesk in about 5 minutes. My efforts produced a handy new prime-numbers object, and the benchmark results that I got demonstrate that Cesk runs at around the speed of interpreted GWBASIC.

Cesk has subtle syntactic differences from C that may cause seasoned C programmers some grief at first. For example, function parameters must be surrounded by curly, rather than round, brackets (they are actually arrays), and the use of terminating semicolons is slightly different (see the listing). I also found it too easy to provoke UAEs (unrecoverable applications errors) from misbehaved Cesk programs, often due to heap overflow.

When you need goal-seeking and solver functions like those provided in Excel, you can use CleanSheet's powerful Solution Search object. It can maximize or minimize a variable by repeatedly varying other selected parameters. It automatically deploys three alternative algorithms—Linear Programming, DFP (Davidson Fletcher Powell) unconstrained optimization, and Constrained Boundary Traversal—to find a reasonable solution.

CleanSheet's equation data type is the basis for other powerful objects. The Curve Fit object takes a table of *x,y* values and fits a curve to them—linear, exponential, square, or polynomial (up to the fourteenth order). The output is not a data array but an equation that you can feed into the Equation Evaluator object, which in turn applies the equation to a list of *x* values and outputs the *y* values.

You can feed equations into *x,y*-scatter or polar-graph objects, which will plot them for you, as these polymorphic objects are equally happy with a table of points or an equation. This feature alone makes CleanSheet a wonderful mathematical teaching tool. Also, *x,y*-scatter and polar-graph objects let you draw a graph and output the corresponding equation, so you can design your own empirical functions

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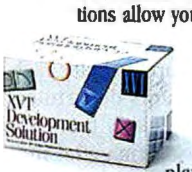

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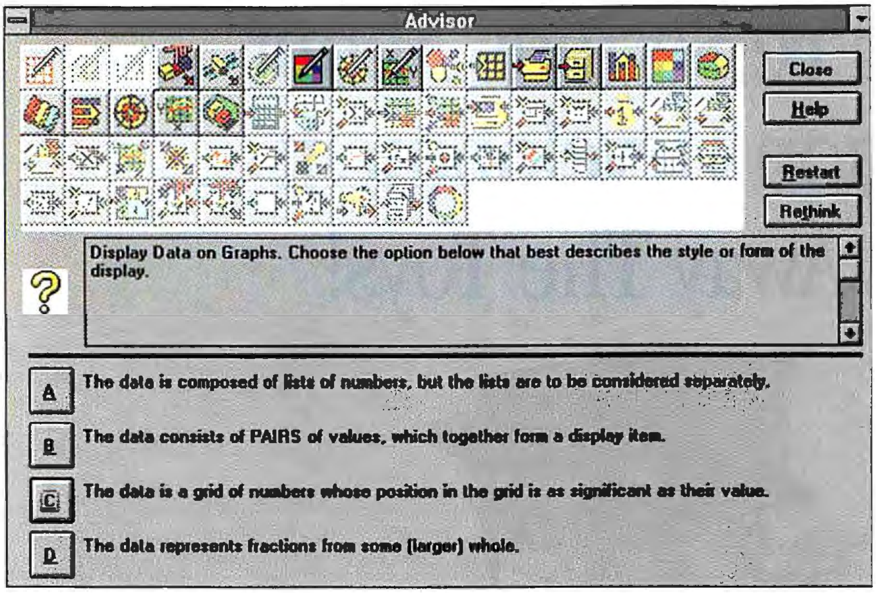

Advisor, an interactive help system, guides you through the process of choosing the proper object, presenting you with all 58 choices and posing questions that help you narrow down your selection.

by eye. I know audio and automotive engineers who'd kill for this feature.

It's hard to do justice in this short space to the ingenuity of many of CleanSheet's math functions. Consider one example, the Mag function, which returns the magnitude of an object. For a numeric object, Mag returns its absolute value; for a string object, its length; for Boolean operations, a 1 or 0. For a date object, it returns the number of days from January 1, 1900; for a time object, the number of seconds since midnight. For a complex number of the form `a+bi`, Mag returns `sqrt(a*a+b*b)`; and when applied to a square 2-D array (a maximum of 16 by 16 elements is permitted), Mag returns its determinant. The equally polymorphic Extrapolate function can identify common series types (e.g., the third Monday of each month) and guess the next item in the sequence.

Vague logic, CleanSheet's implementation of fuzzy logic, is available within any object that makes comparisons. The syntax for vague comparisons involves duplicating the operator, so `A << B` means *A* is less than *B* by at least 5 percent, while `A <<< B` means a difference of less than 10 percent, `A <<<< B` means a difference of less than 25 percent, and `A <<<<< B` means a difference of less than 50 percent. Similarly, `A >=< B` means *A* equals *B* with a 10 percent margin. In addition, CleanSheet offers several vague lookup functions, such as Nearest, that let you find the closest match in an array of numbers.

Advisor

As anyone who has studied Smalltalk or C++ knows, the downside of object-oriented systems is that you must learn the semantics of possibly hundreds of object classes. With just 58 object types, CleanSheet is modest in size compared to, say, MFC (Microsoft Foundation Classes), but its palette still looks somewhat intimidating when you start. To help you get acclimated quickly, Working Title provides a help system that goes beyond what Windows programs commonly offer.

You can get help on any object in the palette, or any instance of it in a sheet, by clicking the right mouse button on that object. This presents you with the reference manual page that defines the object's functions and interface.

The extra help, Advisor, is unusual (see the screen). This interactive system tells you which objects are suitable for a given task. Its opening window displays all object icons in dimmed form; above and below them is a multiple-choice questionnaire, which you answer by clicking on buttons. For example, the first four choices are as follows:

```
A  I wish to present data to the user
B  I wish to obtain data from the user
C  I wish to process data within the
   sheet
D  None of the above matches any part
   of my requirements
```

When you click on one of these, the appropriate related icons light up, and a new set of choices appears. Advisor continues to guide you, helping you refine your requirements until only a few icons are lit. Then you can consult the normal help by clicking on each remaining object.

Advisor's search system is quite sophisticated; the Restart and Rethink buttons let you backtrack if you take a wrong turn. I used Advisor extensively when learning CleanSheet and found it excellent.

For More Information

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129 Woodstock Rd.
Yarnton, Kidlington OX5 1PT
U.K.
+44 0865 370175
fax: +44 0865 370515
Circle 1075 on Inquiry Card.

An Object Future

I've said that CleanSheet offers a glimpse of the object-oriented future, but I need to qualify this. Strictly speaking, CleanSheet is an ordinary Windows 3.1 application, and its world of objects extends no farther than its own screen window.

The real future of objects lies in operating-system support for object communication across different applications, and in the case of Microsoft's operating systems, this means that it lies in OLE 2. The current version of CleanSheet, version 1.4, doesn't support OLE 2. Author Nigel Johnstone says he will support OLE 2 only when Chicago becomes available (perhaps in CleanSheet 2.5), and then only in the form of OLE input and output objects that will send or return arrays of data from the outside world. Unfortunately, CleanSheet's elegant object-communication protocol cannot be mixed with the baroque complexities of OLE Automation. Nevertheless, I stick by my judgment that the way CleanSheet works—by permitting end users to program visually—points to the way that future OOP (object-oriented programming) applications will work.

Of course, not every user wants to perform even this degree of programming. Johnstone says that version 2.0 will add a complete working spreadsheet object to flatten the learning curve for conventional spreadsheet users.

Even with this feature, CleanSheet will probably not displace Excel for totting up the petty cash in the accounts department. It is more likely that engineers, laboratory scientists, financial modelers, teachers, and mathematicians will be the first to appreciate the program, creating in minutes customized and highly interactive user interfaces that are tedious or impossible to achieve in a conventional spreadsheet. CleanSheet will undoubtedly have other devotees as well: people like me, who find it enormously entertaining to play with constructor sets. ■

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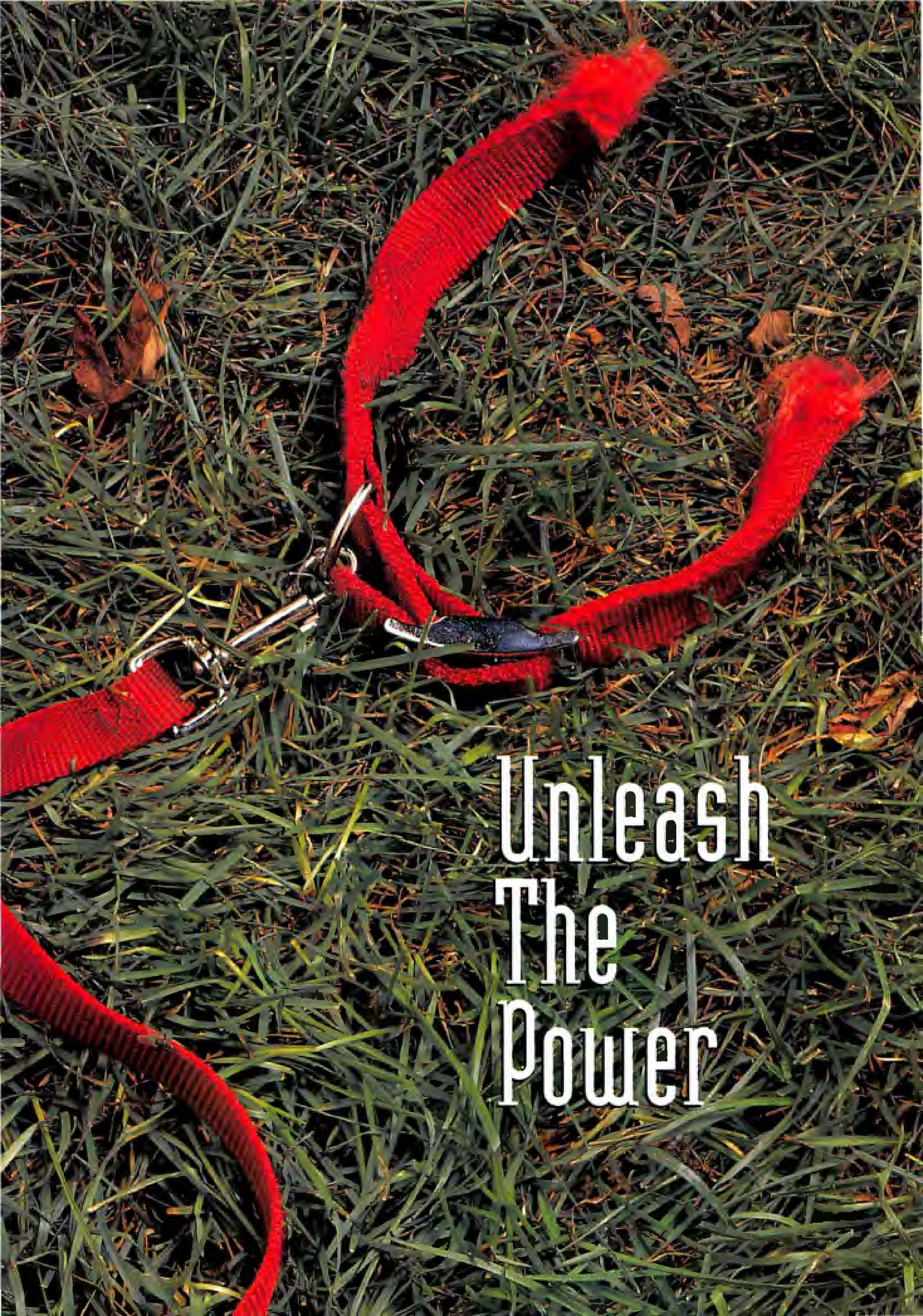
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Smarter Copiers, Printers, and Fax Devices Are Coming

ANDY REINHARDT

Already dominant on the desktop, Microsoft appears bent on extending its reach into office equipment and hand-held computers with a new operating system called Microsoft At Work. At Work lets vendors create intelligent peripherals, such as printers, fax machines, and copiers, that fit easily into a Windows world.

At Work is not based on MS-DOS nor on the Chicago core used in the impending release of Windows; instead, it uses a new real-time kernel surrounded with communications protocols, Windows-like APIs, and a user interface tailored to touchscreen or stylus devices. Microsoft isn't alone, however, in its quest to manage office integration: Novell has released a set of technologies called NEST, or Novell Embedded Systems Technology, that extends NetWare Core Protocols to devices such as printers and copiers. NEST offers a simpler alternative to building a complete copy of NetWare into a device such as a network-ready printer. It may also be used in industrial and other settings, where it could provide an easy means of linking factory data or field data to corporate information systems.

Microsoft and Novell believe that peripherals need their own operating system

Both At Work and NEST are consistent with the respective strategies of their sponsors. At Work springs from a Windows-centric world view. Although its user interface and API aren't exactly the same as the Windows GUI and Win16, it's designed to play in Microsoft's "Windows everywhere" framework and to take advantage of development tools for and programmer knowledge of Windows. NEST, in contrast, builds on NetWare services and protocols, emphasizing openness and cross-platform portability, but it lacks a user interface. In other words, NEST is about attaching peripheral devices to a NetWare LAN, whereas At Work is about controlling peripheral devices from a Windows desktop.

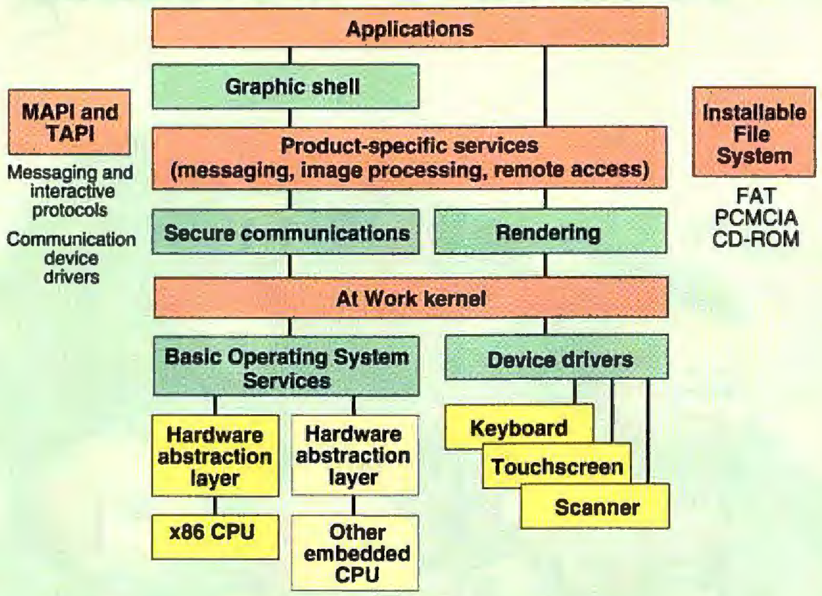
In typical Microsoft fashion, At Work takes a "from the ground up" approach. Using it requires new client software, new applications, and, most importantly, new peripherals. Having once made these investments, Microsoft says, users will enjoy powerful new capabilities and improved productivity. NEST's portable libraries, on the other hand, provide a way to make any embedded system NetWare-compatible. It doesn't matter whether that system is based on the Intel x86 or another chip, or whether it runs FlexOS, which Novell recently sold to Integrated Systems (Santa Clara, California), or another real-time embedded operating system. According to Novell, 80 percent of embedded systems now use custom-written software, but by employing NEST libraries, programmers can add these devices to a NetWare LAN and bring them under centralized control.

These differences mean, ultimately, that At Work and NEST aren't mutually exclusive, nor even necessarily incompatible. In fact, Microsoft and Novell are seeking rapprochement regarding their respective embedded operating-system initiatives. But each

ILLUSTRATION: KERRY GAVIN © 1994

still faults the other's solution. Novell says that At Work is too tied to Windows and Intel chips and that it does not go far enough in networking, whereas NEST encompasses security, directory services, and network management. Microsoft counters that users need more than just the NetWare environment, and they also require a consistent user interface for configuring and monitoring peripherals. As has happened in the battle between Microsoft's TAPI (Telephony API) and Novell's Telephone Services API, both solutions may end up coexisting in a single network, with NEST and At Work devices attached to NetWare LANs and fronted by Windows clients.

The Architecture of Microsoft At Work Software



At Work uses a layered architecture that lets it work on a variety of hardware; at present, the operating system is designed to run on x86 processors, but it may be ported to others in the future. Above the kernel, At Work is tailored to different uses on printers, hand-held devices, and so on. Communications services—interfaced via MAPI and TAPI—and the Installable File System are available to all applications. Some programs use the graphical interface, and others do not.

Getting to Work

At Work is designed to handle four types of equipment: printers, fax machines, copiers, and hand-held devices. The core operating system consists of a kernel, an Installable File System, a graphics system, and communication protocols. Wrapped around these elements are other technologies: fax extensions, RSA security (public-key encryption and authentication), user interface components, and a compressed document-rendering technology called At Work Printing.

The kernel, roughly 85 KB in size, is 16-bit, offers preemptive multitasking, and runs in protected mode on Intel-compatible CPUs. Although it benefits from the higher performance of 386 processors, the kernel will run on 286 and later CPUs, because it does not use 386-specific instructions. Its basic responsibilities include task management, memory management, and interprocess communications, although not through channels such as DDE or OLE.

At Work uses preemptive multitasking to better accommodate real-time activities, such as communications between hosts and peripherals. To provide backward compatibility with Win16, however, it also lets programs cooperatively multitask, or relinquish control to another task. The At Work API is both a subset and superset of Win16; it does not support certain Win16 calls and uses others not in Win16, such as Win32 scheduling, semaphores, signals, pipes, and certain file system calls.

Its Installable File System lets developers support a variety of storage media. To preserve backward compatibility, the default choice is the MS-DOS FAT (file allocation table), but At Work will also support the PCMCIA Flash File System and the CD-ROM file system. The Installable File System creates an abstraction of file system behavior, which means that applications developers do not need to know what is on the other side of the API.

Graphics services let developers provide At Work devices with three levels of user interface. The simplest is a one- or two-line LCD, comparable to those now found on many laser printers and fax machines. This simple interface is adequate for devices controlled by a desktop PC with a full-size, Windows-based GUI. In non-GUI devices such as these, the software doesn't call Windows' GDI (Graphical Device Interface) or User (the windowing system), so memory requirements are minimal, roughly 1 MB.

For medium-size LCDs, the type that might be used on a fax machine or low-end copier, At Work offers a set of graphics components (a subset of the GDI), including single windows, tabs, dialog boxes, 3-D buttons, scrolling lists, bit maps, and text display. These LCDs, which typically support pen-based or touchscreen input, do not have room for multiple windows or small icons. Memory requirements are somewhat higher than those for one- and two-line LCDs; for instance, At Work software requires 2 MB of memory in the new Ricoh IFS66, an At Work fax machine expected to ship this quarter.

Full-size LCDs use the whole Windows GDI plus some Win32 calls. Such interfaces would be used for WinPad hand-held devices, which are not discussed here.

At Work includes two communications protocols: message-based and interactive. Both are device- and media-independent, which permits them to work over serial or parallel lines and with LANs, modems, and fax transports. (Device independence is achieved through use of Windows Sockets.) The store-and-forward message-based protocol lets you send editable or noneditable documents from one process to another and also supports At Work's encryption capabilities. The protocol writes through Microsoft's MAPI (Messaging API) to DLLs that arbitrate between messaging clients and back ends. As a result, MAPI-compliant applications (E-mail clients, mail-enabled word processors, and so on) can talk to At Work devices. (At Work will also support Common Mail Calls, or CMCs, a stripped-down set of standard mail APIs promulgated by the multivendor XAPIA [X.400 API Association].) The interactive real-time protocol is used for two-way communication between devices and the host. It will also play a vital role in TAPI. (See the figure "The Architecture of Microsoft At Work Software.")

Outside the At Work operating system are several important new technologies. The first is a set of extensions to the

international T.30 fax standard, primarily BFT (Binary File Transfer), a technique for sending editable files between fax machines (discussed later). The second is AWP (At Work Printing), a scheme to turn the Windows GDI into a kind of page-description language. AWP greatly reduces the size of rasterized files—to roughly one-quarter the size of a typical Group 3 fax, Microsoft says—which plays a crucial role in improving printer performance and reducing fax transmission time.

AWP is also known as Resource-Based Architecture, because instead of sending a complete bit map of a page from host to printer or from one fax to another, AWP compresses documents by reducing them to component parts, or resources. All the text is extracted, and only one instance of each character is sent across the wire. It is cached on the other side and subsequent occurrences are merely referenced. The same applies to other primitives and patterns, which are extracted and re-created on the target device by reference. Of course, free-form bit maps must still be transmitted, and At Work compresses them using standard Group 3 algorithms. AWP resides on the client system as a printer driver, and its output is a resolution-dependent, noneditable image.

Windows Printers

Microsoft says that adding At Work to printers will provide improved control and feedback, faster performance, and perhaps lower prices. The management features derive from At Work's bidirectional communications protocol, which is supported by desktop drivers and dialog boxes. The dialog boxes offer a standard, graphical means to remotely set up printers and configure options (e.g., paper tray, resolution, and half-tone settings), as compared with setting options directly on the printer through a membrane pad or using generic Windows dialog boxes that may not support unique features. At Work also defines a way to report—via visual and audio feedback—printer status or error conditions (e.g., paper jams, a low-toner warning, job-completion status) on the PC to which the printer is attached.

Speed improvements and potential cost reduction go hand in hand. Some performance gain derives from At Work's support for the Extended Capabilities Port, a high-speed parallel interface jointly designed by Microsoft and Hewlett-Packard. The highly compressed AWP format also boosts throughput by reducing the amount of data sent across the wire. But the big architectural difference is At Work's load balancing, a technique for sharing work between a printer and host PC by rasterizing in either or both places, depending on available CPU resources. Load balancing improves performance, because while the printer's controller is rasterizing one band of an image, the host can rasterize the next band and then blast a bit map down the wire.

The prospects for price reduction are less certain. Microsoft asserts that printer vendors can save costs by eliminating local displays and keypads; more importantly, because of load balancing, they can design printers with less expensive processors (x86-based chips, for example, instead of powerful RISC engines) and less memory. Vendors can also design "sleek" printers that have no local intelligence and instead rely on the host PC for rasterization. This "dumb engine" approach has floated around for many years—Ricoh, for instance, aggressively promoted such a device in 1988—but it has never gained significant market acceptance. Unfortunately, the cost savings are partly offset by At Work software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licensing fees and the expense of new firmware and interfaces. On top of that, the printer market is performance-sensitive, and printer makers may decide not to strip out powerful processors or shift the workload back to the host. Instead, they may add At Work support and charge more for it.

At present, only Lexmark and NEC have made a public commitment to supporting At Work printing. The Lexmark WinWriter 600 is available in the U.S. for $1399, and NEC has released a Kanji At Work laser printer in Japan. (NEC also sells the Silentwriter SuperScript 610 in the U.S., a $600 Windows GDI laser printer that uses only the host's processor and RAM. However, it is not yet an At Work product.)

Just the Fax

Ironically, fax machines could represent At Work's area of greatest innovation. Fax machines exploded on the scene in the 1980s, partly because of the failings of E-mail. But now that people are used to exchanging electronic mail instantaneously, they want to exchange editable fax documents, as well. Because fax is among the most pervasive of all "transports," Microsoft is retrofitting it to handle binary files, which is somewhat like using horse-drawn carriages to ship airplane parts.

At Work allows fax machines to become intelligent network nodes controlled from the desktop, with advanced features such as built-in hard drives for storing incoming and outgoing faxes. As with today's fax servers, you may select a document on your desktop, choose the recipient from a local or centralized address book, and send the file across the network and out through the fax.

You can even send a document via fax from within certain programs. Software built into the At Work fax machine can log usage and track costs for billing. And the graphical desktop client makes it easy to employ such advanced features as delayed transmission or broadcast fax, which often exist in today's fax machines but are too hard to use.

At Work Fax surpasses contemporary products in two areas: BFT and support for fax via E-mail interface standards. BFT is simply a faster way to send faxes and an easier way to send editable files, such as Microsoft Word documents or 1-2-3 worksheets, from one compliant machine to another. As such, BFT is no different from E-mail attachments, BBS uploads/downloads, or direct modem-to-modem transmissions, except that it's simple enough that a novice who knows nothing about modems can use it.

At Work follows a defined procedure for establishing optimal communications between machines. When you specify the recipient, At Work checks its database to see if the capabilities of that person's fax machine are already known. If so, and if the target supports BFT, At Work defaults to that as the fastest method, unless you choose to transmit only an image, in which case the file is rendered using bandwidth-saving AWP and sent out.

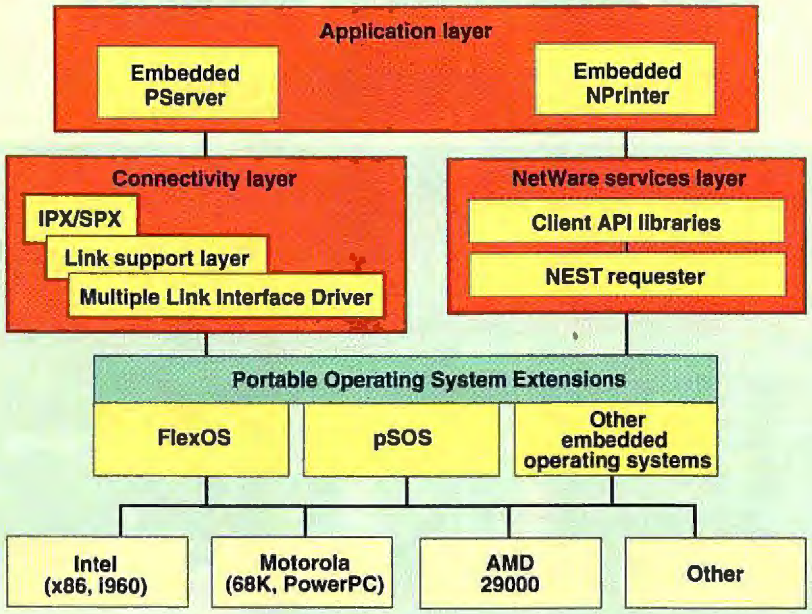
One benefit of AWP: Its image quality is higher than that of a normal fax, and the received image can be printed on an At Work printer or fax machine using the same AWP rendering model. If the recipient has a conventional fax, At Work rasterizes and sends the file using Group 3 standards. If the recipient is unknown, At Work dials the target machine and tries to send BFT; if that fails, At Work uses Group 3. Results of the interaction are filed

in the database for future reference. BFT also supports encryption as a means of ensuring secure fax transmissions.

The second major breakthrough is an E-mail interface for fax. Chicago will include fax as a MAPI transport, so applications that write to MAPI can now handle faxes as well as E-mail. As a result, users don't need to know what transport is being used; they merely dispatch a document, which reaches its destination by the best available means. Workgroup tasks, such as forms routing, benefit enormously, because they are no longer limited to running over LANs; some users may be reached permanently or temporarily by fax, but the sender never knows.

The first At Work fax, and one of the first At Work devices of any kind, is the IFS66 from Ricoh, a high-end product whose price has not yet been announced. It comes with 2 to 8 MB of RAM (2 MB is used for the At Work software alone), built-in floppy and hard drives, and a touchscreen interface. It's also a complete network device, supporting both a direct network connection and built-in services. It runs over Novell's IPX/SPX now but will work on TCP/IP, AppleTalk, and others as needed in the future. The local hard drive lets the IFS66 spool fax jobs by itself. Other companies that have announced support of At Work Fax include Castelle, Delrina, GammaLink, Minolta, Mita, Murata, Oki, Toshiba, and Xerox.

The Architecture of NetWare Embedded Systems Technology Software



Like Microsoft's At Work, Novell's NEST uses a layered architecture, but it is intended to run on multiple operating-system and processor platforms through the abstraction of the POSE. Higher levels of the stack are drawn directly from NetWare, and Novell will provide implementations of its print services for easy porting to new NEST printers.

Hornet's NEST

The approach that Novell is taking with NEST is different from At Work's in several ways. First, NEST libraries may be linked into any commercial or proprietary embedded operating system that supports preemptive multitasking. NEST may also be used on different processors, an essential requirement given the wide range of embedded chips now in use (of which x86 CPUs are a small percentage). Novell used to offer its own embedded operating system (FlexOS, which came from Digital Research when Novell acquired it) but has now sold that product to underscore its operating-system independence.

In some cases, NEST is smaller than At Work, requiring on the order of 75 to 100 KB. Also, given the preponderance of custom-embedded solutions, it could provide a better choice than At Work for existing designs or devices with limited resources; potential uses might include point-of-sale terminals and factory-floor, security, or environmental-control systems. In office devices, such as printers and faxes, At Works' greater memory and processing needs are less of a handicap, because they play a proportionally smaller role in overall system cost.

Because its layered architecture separates media and transport from higher levels of the protocol stack, NEST is completely network-independent. One of its most intriguing aspects is that, in the future, communication between devices and systems will occur via an object request broker based on CORBA (Common Object Request Broker Architecture) standards. As a result, Novell says that NEST will make it possible for work to be shared among networked devices and hosts. (See the figure "The Architecture of NetWare Embedded Systems Technology Software.")

The point of NEST is to take advantage of the features already in NetWare, such as file and print services, directory, security, queuing, and messaging. NEST offers a way to add a protocol stack and NetWare client services to a device. For instance, instead of relying on an external print server or supporting a full, native copy of NetWare inside each device, vendors can create true network printers by embedding reduced versions of core NetWare services (i.e., PServer and NPrinter).

In contrast to At Work, however, NEST doesn't provide assistance when it comes to managing and configuring a device or interpreting its error conditions. Instead, NEST leaves it to a device's maker to create client-side Windows or Mac drivers and dialog boxes.

Future Tense

At Work and NEST are important to their proponents because they represent a logical next step in the evolution of personal computing. With NEST, Novell is asserting its dominance over the world of networking and expanding into areas such as office equipment and process control. But Novell's inability to control the user interface means that other companies—Microsoft, Apple, Sun, and various ISVs (Independent Software Vendors)—will always provide users with the dashboard for driving those networked devices.

With At Work, Microsoft is making a critical bid to expand the domain of its operating systems beyond the desktop, an effort by no means assured of success. At Work suffers a bit from "not invented here" syndrome; it requires partners to buy into the scenario and stake their futures on Microsoft. But if anybody can pull that off, Microsoft can. It would be in the best interest of users, however, if both Microsoft and Novell continue to seek ways to make their solutions interoperate. ■

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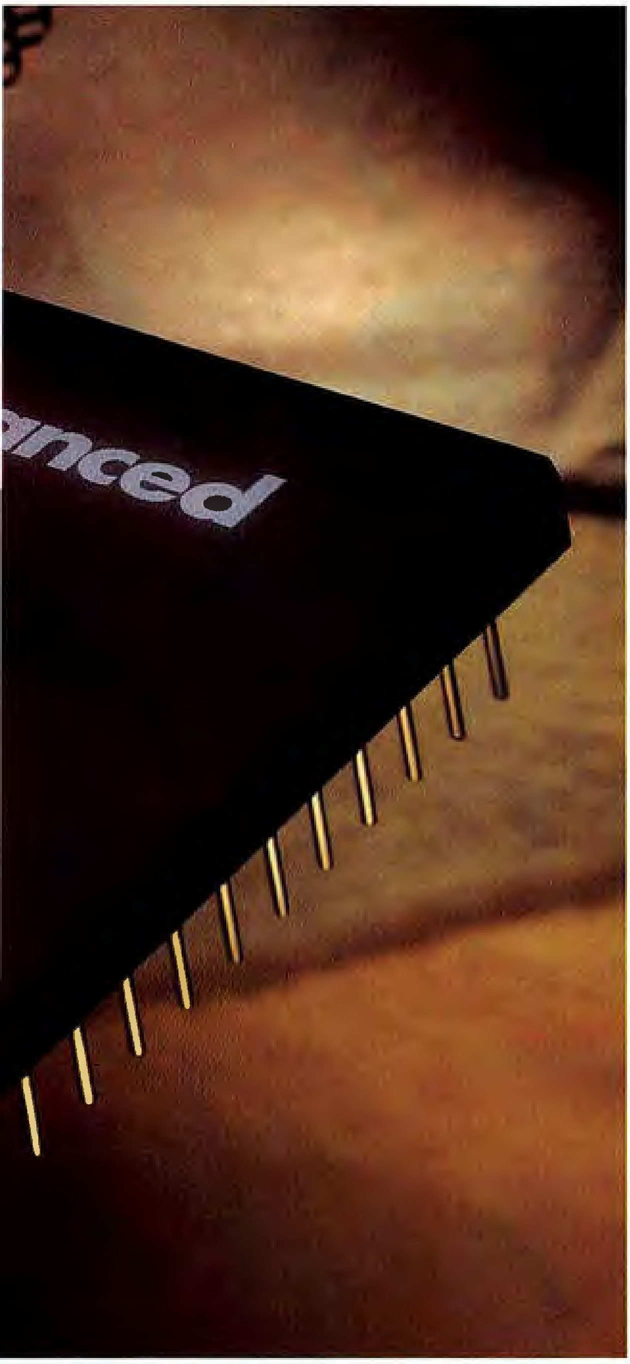

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Every year, in mid-October, the best and the brightest in the world of microprocessor design converge on the San Francisco Airport Marriott for the Microprocessor Forum. In an event orchestrated by Michael Slater, editor/publisher of the *Microprocessor Report*, they reveal to the world and each other just what they've cooked up in the way of new microprocessors. Here you will find the chip that will power your system next year or the year after.

This year, the microprocessors announced at the forum make up a most interesting group. Collectively, they represent the current state of the art in microprocessors. Individually, they carry the hopes, dreams, and fortunes of some of the biggest companies in the industry.

Knockin' on Intel's Door

For the past few years, AMD has enjoyed a fair measure of success in the x86 market. In the face of never-ending litigation with Intel over the terms of a technology-sharing agreement gone sour, the company has carved out a significant portion of the 486 market.

Despite its successes in the courtroom and in the marketplace, AMD has been beset by a serious problem: Because its designs are derived from Intel's, it has lagged at least a generation behind Intel in getting processors to market. It always plays catch up, never reaping the substantial financial benefits that accrue when you are the sole source of the fastest x86 processors.

The K5 is AMD's declaration of independence. The only thing it shares with Intel's processors is the x86 architecture. Thus, to a programmer—or to any software a programmer produces—the K5 is indistinguishable from a Pentium or a 486.

Where K5 differs is in its microarchitecture. It processes x86 instructions in a different way from a 486 or Pentium. It is the latest in a series of fifth-generation x86 processors—NexGen's Nx586 and Cyrix's M1 are the others—that operate differently from the Pentium, yet achieve the same results. In "AMD vs. Superman," Tom Halfhill describes the technology of the K5 and discusses its implications in the marketplace.

New Beginnings

An early commercial pioneer of RISC technology, Sun Microsystems rode the performance advantage of its SPARC architecture to the top of the workstation world, leaving its competitors scrambling to catch up. Well, the scramble is over, and Sun is now in a tight spot.

On the high end, SPARC has been unable to compete with newer RISC architectures: DEC's Alpha, Hewlett-Packard's PA-RISC, and Mips Computer Systems' Mips—just about every architecture regularly surpasses the performance of SPARC. On the low end, where Sun has long enjoyed a price/performance advantage, PCs based on the Intel Pentium (and soon the K5, M1, and Nx586) often outperform SparcStations. What's a company to do?

Sun's solution is to regain the technology high ground that first propelled it to prominence. The visible manifestation of this solution is UltraSparc, a 64-bit SPARC implementation. In "SPARC Strikes Back," Peter Wayner examines how UltraSparc stacks up against the competition.

Moving Forward

Another major announcement out of the Microprocessor Forum comes from Mips. Like Sun, Mips has not often been on the leading edge of performance, but this seems more by design than anything else. Recently, with its many partners, Mips has devoted much time and energy to derivatives such as the ultra-low-power R4200, the floating-point-intensive R8000/8010, and the low-cost R4600 Orion. In doing so, however, Mips has seen its mainline R4000 and R4400 processors slip further behind the leading edge.

The T5 changes all that and gives Mips a needed boost in performance. Tom Halfhill reports on the ins and outs of the T5 in "T5: Brute Force."

End of an Era?

Back in 1991, when Apple, IBM, and Motorola announced their intention to create a new processor architecture, and IBM and Motorola agreed to jointly design the first four implementations of that architecture, most observers were skeptical that they could pull it off. The PowerPC 620, the high-performance member of the PowerPC family, is the visible capstone of the PowerPC alliance. With the 620, IBM and Motorola have moved the PowerPC to 64 bits. Tom Thompson describes its workings in "PowerPC 620 Soars."

The 620 is the last processor that IBM and Motorola are committed to designing together. Whatever the future of the PowerPC architecture, the first four members of the line will always stand as landmarks of creative technical collaboration.

Offstage Lights

Among the companies without major CPU announcements at the forum was DEC, which jumped the gun by announcing the 21164, the world's fastest MPU (microprocessor unit) last month.

HP and Intel are busy jointly developing a "post-RISC" architecture (reportedly based on Very Long Instruction Word technology—see this month's Core Technologies CPU column) that will run PA-RISC and x86 software. When they are ready sometime in 1997 or 1998 to announce the fruits of their labors, they will probably do it at the Microprocessor Forum.

—Bob Ryan, Senior Editor

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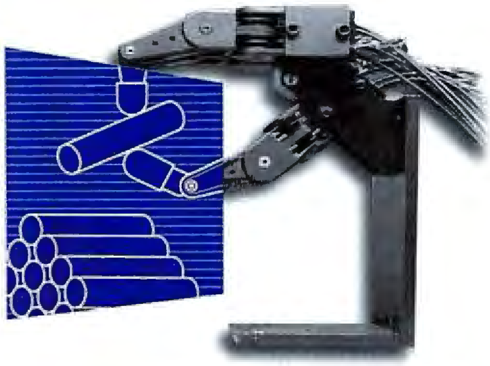

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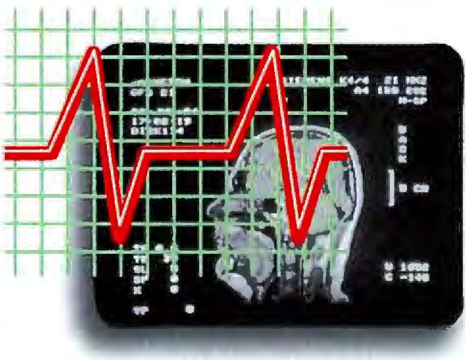

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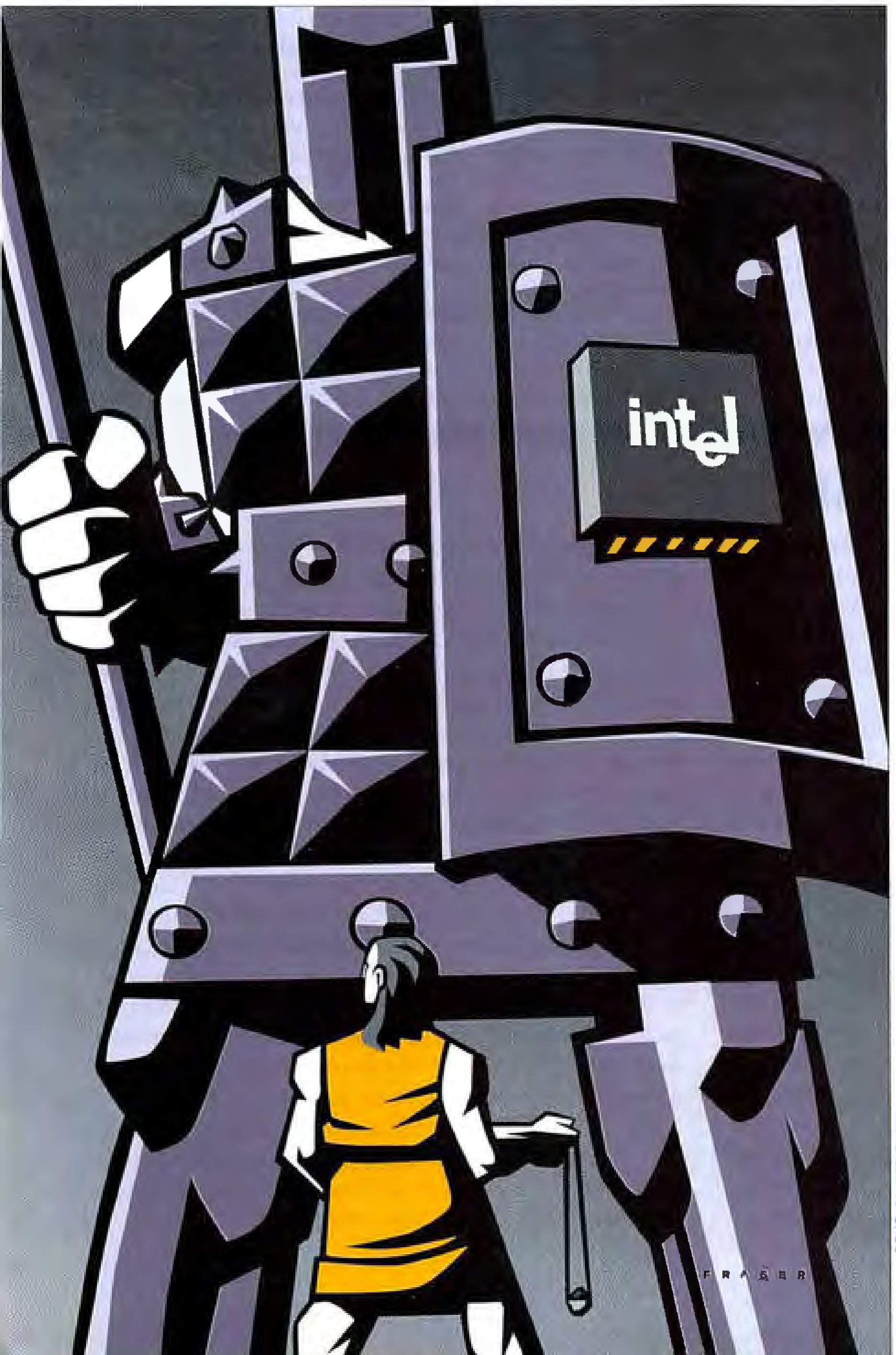
AMD VS. SUPERMAN

The quad-issue K5 series is AMD's long-awaited answer to Intel's Pentiums. Its RISC-like core and innovative approach to x86 decoding may propel it past the Pentiums of today, but Intel isn't standing still.

TOM R. HALFHILL



DOUG FRASER © 1994

Originally it stood for Kryptonite, the mythical substance that could destroy Superman. But to avoid legal hassles with D.C. Comics, AMD changed the code name of its fifth-generation x86 chip to Krypton-5, or K5. That compromise is symbolic of AMD's long quest to challenge Intel's supremacy in microprocessors—a quest that has been dogged with legal obstructions and technical hurdles at every turn.

Since 1990, lawyers for AMD and Intel have been fighting tedious battles over contractual language and microcode in federal court. By 1994, it seemed that AMD was gaining the upper hand. But lawsuits were only part of AMD's troubles. For years, AMD has lagged at least a full generation behind Intel in x86 evolution, relying heavily on licensed technology and minor variations of Intel chips to carve out a pittance of market share. Intel's 1993 introduction of the Pentium—the first superscalar x86 processor—threatened to widen the gap and knock AMD out of the contest altogether (see "80x86 Wars," June BYTE).

But at AMD's labs in Austin, Texas, engineers had begun work on a new x86-compatible microprocessor family. Their goal was to create a series of chips that would leapfrog Intel's Pentiums and put an end to AMD's perennial follow-the-leader status. To reach that goal, they had to start working on the K5 before they knew any significant details about the Pentium. This ensured that the K5 would not be a derivative design, but it also put enormous pressure on the engineers to devise a superior microarchitecture without sacrificing software compatibility.

There was honor at stake, too, after Intel CEO Andy Grove denounced AMD as "the Milli Vanilli of semiconductors," a reference to the pop singers who were stripped of a Grammy award for lip-synching their songs. Grove dismissed AMD as a clone company: "Their last original idea was to copy Intel."

AMD CEO Jerry Sanders, visiting Austin for a quarterly strategy meeting in late 1993, declared that an independently designed fifth-generation x86 chip was AMD's top priority. Work had already started in July 1992, but incredibly, the team consisted of only two engineers: Mike Johnson, director of advanced processor engineering, who also fathered AMD's 29000 embedded RISC chip, and Dave Christie, who began modeling various design alternatives on a software simulator written by Johnson. Later, they were joined by Dave Witt, who became the design manager. But several months passed before the number of K5 engineers in the lab exceeded the number of lawyers in the courtroom.

After two years of effort, the result is a truly creative design that makes AMD's promise to catch Intel at least credible, though by no means assured. AMD says the K5 is its first x86-compatible CPU family that discards all vestiges of Intel's intellectual property (including microcode) while delivering better-than-Intel performance. According to AMD's simulations, the first K5-series chip will run real-world applications (e.g., Microsoft Word, Excel, and CorelDraw) about 30 percent faster than a Pentium at the same clock speed. AMD says it could do even better with artificial benchmarks such as SPEC and Dhrystone—and without optimized compilation.

Johnson credits the K5's performance to larger primary caches and a more aggressive superscalar design. Instead of the Pentium's twin integer pipelines, with their many restrictions on parallel execution, the K5 has a five-unit, four-issue superscalar architecture that unites a RISC-like core with a unique x86 instruction decoder.

The decoder, by far the most complex and fascinating part of the chip, strives to minimize the liabilities of the x86 instruction set by splitting the long CISC instructions into smaller RISC-like components called R-ops (RISC operations). These R-ops, in turn, are dispatched four at a time to a core that borrows heavily from RISC. Dynamic register renaming, branch prediction, speculative execution, and out-of-order execution—it's all there. The K5 implements a hybrid CISC/RISC technology that is also evident in the Nx586 chip from NexGen and will almost certainly be a larger feature of Intel's next-generation x86, code-named P6.

The K5's design had better be forward-thinking, because the competition isn't standing still. The P6 is expected to debut next year, when AMD will just be ramping up production of the K5. At the same time, NexGen will be shipping the Nx586 and Cyrix will introduce yet another fifth-generation x86, the M1 (see the text box "x86 Wars Update").

AMD claims the K5's microarchitecture has enough performance headroom to compete with all these processors, and that faster versions will soon follow. There's already talk about a K6 that could debut late next year or early in 1996. The K6 might depart even further from its Intel ancestry by abandoning pin-compatibility with Intel's x86 chips. (In contrast, the K5 is pin-compatible with the P54C-series Pentiums.) As with most wars of independence, AMD's struggle with Intel will not be won easily or cheaply.

CISC/RISC Fusion

Intel's public commitment to CISC notwithstanding, it is generally recognized that future gains in x86 performance will

x86 Wars Update

It appears 1995 will be the year when fifth-generation x86 microprocessors come into their own. Although volumes of 486-class chips are expected to remain strong, the proliferation of 586-class CPUs will give system makers and users many options, forcing system prices well below $2000 by the end of 1995.

Intel (Santa Clara, CA) will continue introducing new variations of the Pentium. This December, Intel is promising to release the P24T, the long-awaited Pentium OverDrive chip for systems with special upgrade sockets. To address the heat problems known to afflict this CPU in some systems, the P24T will run at 3.3 V and include a tiny fan and a piggybacked voltage transformer for compatibility with 5-V motherboards. Another Pentium variant, code-named P55C, is expected to shrink the die to a 0.4-micron process and perhaps add more cache. Intel will also introduce a 75-MHz version of the P54C-series Pentium this fall.

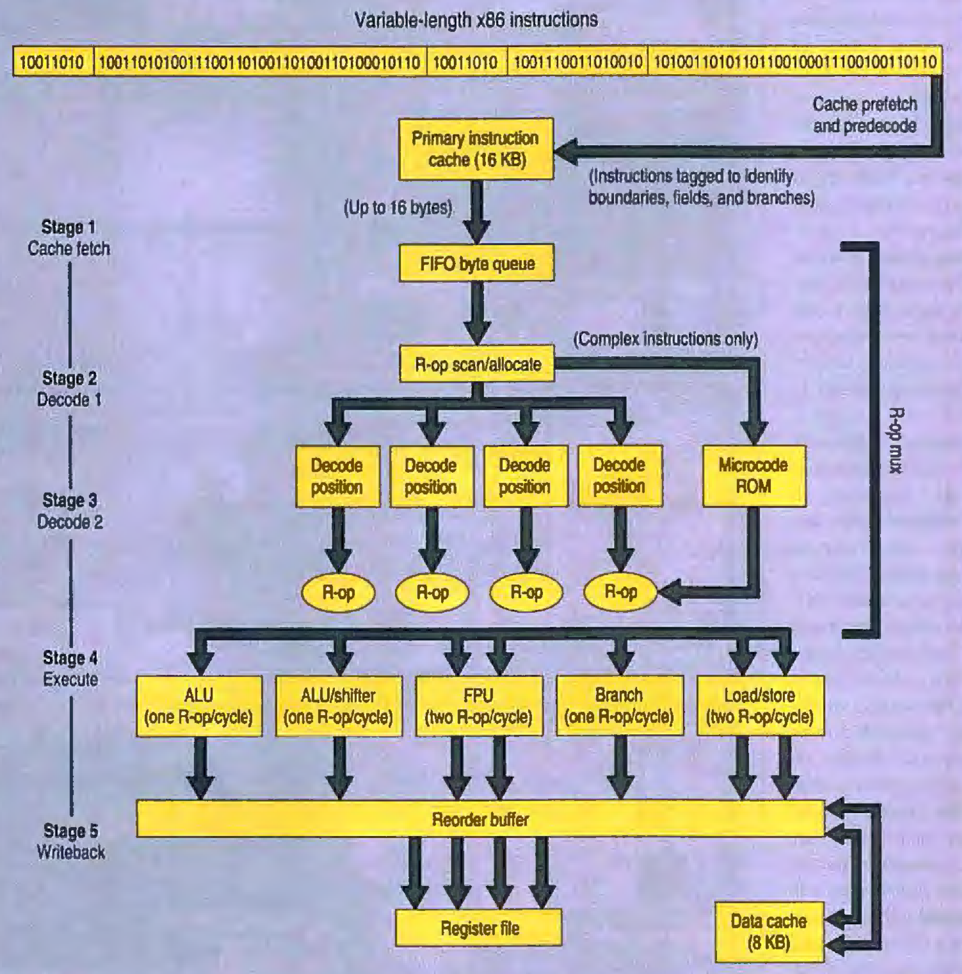
Sometime in 1995, Intel plans to announce the P6, the first sixth-generation x86 processor. Virtually nothing has been publicly disclosed about this CPU, but it's expected to be a multichip module that modestly improves on the Pentium's superscalar core. There's also a rumor that the P6 uses some patented technology that will make it legally difficult for vendors of other x86 processors to use the same supporting chip sets. Appreciable volumes of the P6 probably won't reach the market until 1996.

NexGen (Milpitas, CA) recently saw Alaris (Fremont, CA) ship the first systems using its Nx586 processor. (For more information on that system and how well it performs, including the first benchmark report, see News & Views, page 30.) It will be interesting to see how well this newest entry fares in the chip wars. Although the Nx586 will be its first product, NexGen has been working on the design since 1986. (For more on the company's history, see "NexGen Nx586 Straddles the RISC/CISC Divide," June BYTE, page 76.) NexGen has some strong financial backers, and the Nx586 is being manufactured by IBM Microelectronics.

Cyrix (Richardson, TX) says it will deliver samples of its M1 processor this year and begin volume production in 1995. Like AMD and NexGen, Cyrix has designed a superscalar microarchitecture that is more flexible than the Pentium's and has enough potential to compete with all the new Pentium variations now appearing (see "M1 Challenges Pentium," January BYTE). Also like its fellow x86 competitors, Cyrix has perennially lagged at least a year behind Intel, and its efforts to close that gap will depend on whether the P6 is a radical leap beyond the Pentium.

IBM Microelectronics is manufacturing the M1 and has also acquired the right to sell the chip under its own name. Such an endorsement from IBM could go a long way toward establishing the credibility of Cyrix in the high-end x86 market.

K5 Pipeline: Melding CISC and RISC



As the K5 prefetches variable-length x86 instructions into its primary cache, it tags them with predecode information that will assist full decoding later. Every cycle, the chip fetches up to 16 bytes' worth of tagged instructions from the instruction cache into a byte queue. The byte queue stores the x86 bytes and predecode information from a stream of speculative cache lines and merges them with the currently accessed cache line. From there, a two-stage decoder converts the x86 instructions into relatively simple, fast-executing R-ops and then dispatches them to five independent functional units. These units can execute as many as five instructions per cycle in any order. Before retiring the results, a reorder buffer holds the speculative instructions in original program order to forward intermediate results and recover from mispredicted branches and exceptions.

be achieved by working around the inherited limitations of the x86 instruction set. CISC was a good idea when Intel conceived the original 8086 in the 1970s and was trying to cram a rich instruction set onto a 29,000-transistor chip. But a processor like the K5, which incorporates 4.1 million transistors, has different priorities. It is bound by how fast it can fetch, decode, and execute instructions, not by the computational wealth of its instruction set.

The pure RISC approach would be to dump the x86 instructions altogether and replace them with modern, streamlined instructions. However, the x86's greatest liability is also its greatest asset: an instruction set that runs more software than any other architecture in the world.

The approach now being explored by all x86 engineers—including those at Intel, AMD, Cyrix, and NexGen—is to integrate CISC and RISC technologies without abandoning backward compatibility. Special attention is being focused on the x86 instructions themselves, which are troublesome because of their complexity and variable lengths. After evaluating several different solutions, AMD finally settled on a sophisticated decoder that turns complex x86 instructions into relatively simple and fast-executing R-ops.

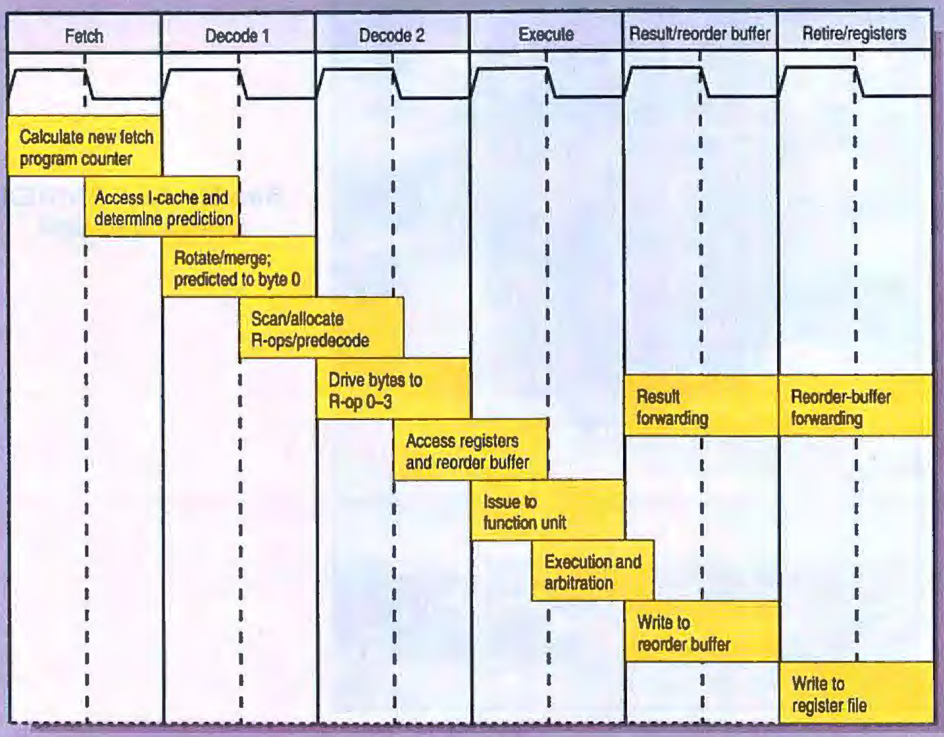
R-ops bear a strong resemblance to the microcode instructions that are inherent in all x86 processors. Every x86 chip executes its most complex instructions as a sequence of microinstructions fetched from an internal microcode ROM, though the most recent x86 chips minimize the use of microcode by hard-wiring the simpler instructions. But the K5's R-ops are subtly different: The vast majority of them are generated on the fly by the decoder, not from microcode.

But microcode still handles the most complex and infrequently encountered x86 instructions, such as string operations and transcendentals. Even in those cases, however, the result is a stream of R-ops identical to those generated by the decoder. The R-ops have so much in common with RISC instructions that AMD used an assembler for its 29000 RISC processor during early phases of the K5's development.

The transition from x86 instructions to R-ops begins even before the K5 fetches from its primary I-cache (instruction cache). During I-cache loading, instructions are predecoded—every byte is tagged with additional bits of information. These tags mark the instruction boundaries, identify the various fields within each instruction, and (in the case of branch instructions) predict where the branch will be taken.

The purpose of this predecoding is to reduce the amount of work required later when the instructions enter the execution pipeline for final decoding. Just marking the instruction boundaries saves time, because x86 instructions can vary in length from 8 to 120 bits, so the processor has to figure out where one instruction ends before fetching the next. (RISC chips avoid this problem by using instructions that are always 32 bits long.) By marking the instruction boundaries during predecode, the K5 resolves these serial dependencies be-

Stage Timing in the K5 Pipeline



The stages of the K5 pipeline provide more evidence of its RISC-like nature. Unlike traditional 486/Pentium pipelines, which have a separate address-generate stage, the K5 uses an execution unit—the load/store unit—to handle external memory accesses. Also, the K5 adds a retire stage in which results are finally allowed to update the architectural state of the processor. As with the 486 and Pentium, instructions are said to complete after the fifth stage, with the retirement stage needed to reorder instructions that execute out of order.

fore the instructions even reach the cache.

Identifying the fields in each instruction helps, too. Later, when the processor fully decodes the instructions, it can quickly distinguish between op codes and their various operands.

All this predecoding happens in the same cycle as the cache prefetch, before the instructions enter the execution pipeline, so it doesn't add a stage to the pipeline or delay execution. It is also supervised by a coherency mechanism that watches for self-modifying code, another bane of x86 design.

One drawback of predecoding is that it makes the long x86 instructions even longer. To compensate, the K5's primary I-cache is twice as large as the Pentium's: 16 KB versus 8 KB. (Actually, the K5's I-cache has about 24 KB of array space, but AMD quotes it as having 16 KB because it's equivalent to a conventional 16-KB cache filled with untagged instructions.) Both the I-cache and the separate 8-KB data cache are linearly addressed and four-way set-associative, which is more efficient than the Pentium's two-way set-associative caches.

Instruction Fission

Final decoding is a two-cycle process that begins by fetching the tagged instructions from the I-cache into the decoder. *Decoder* is something of an understatement. This is really the heart of the chip, where x86 instructions are converted into R-ops and dispatched to the five functional units (two integer, one FPU, one branch, and one load/store). AMD refers to the decoder as the R-op mux (R-op multiplexer).

If you picture the CISC instructions as heavy atoms, the R-op mux is like a nuclear reactor that splits them into elemental RISC particles. Among other things, this fission allows the K5 more flexibility in arranging out-of-order execution. A single x86 instruction might break down into multiple R-ops that are dispatched to different functional units, executed separately, and then completed out of order. (Eventually, of course, to preserve software compatibility, the results are restored to their original program order.)

To start the fission process, up to 16 bytes are fetched from the I-cache in a single cycle. The bytes enter a special FIFO (first-in/first-out) queue called the byte queue. This queue is scanned for enough bytes of predecoded instructions to generate four R-ops. It is possible for a single byte in the queue to contain enough information to generate four R-ops, but more likely several bytes will be consumed. As bytes exit the queue, more are fetched from the I-cache. These bytes don't have to originate from the same cache block; indeed, they often represent different speculative threads of execution that are scattered throughout the cache.

Next come the two decode stages. From the byte queue, the four R-ops' worth of instruction information are transferred to four identical decode positions and then are converted into R-ops. The four R-ops don't necessarily bear a direct relationship to their antecedent x86 instructions. They may represent a single instruction, multiple instructions, or fragments of an x86 instruction. It all depends on the original instruction's complexity.

The simplest x86 instructions (e.g., a register-to-register add) map directly to single R-ops, but most instructions yield two or three R-ops. For example, a stack-relative memory-to-register add is broken up into a pair of R-ops: one to load the register and another to add the registers. A stack-relative register-to-memory add would yield three R-ops: one to load the register, one to add the registers, and one to store the result. Instructions that divide into three or fewer R-ops are called *fast instructions*.

If a complex x86 instruction (e.g., a string operation) requires more than three R-ops, it traps into the microcode ROM. This can produce hundreds of R-ops. However, the microcode sequencer generates these R-ops in clusters of four per cycle, so they're issued to the functional units in parallel, just like the fast-instruction R-ops. The sequencing continues until the complex instruction is finished. Then the byte queue resumes processing fast in-

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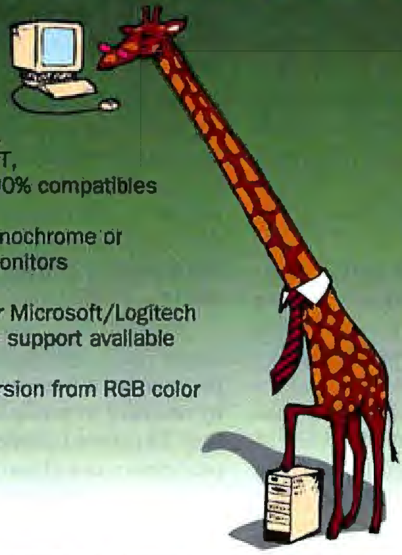

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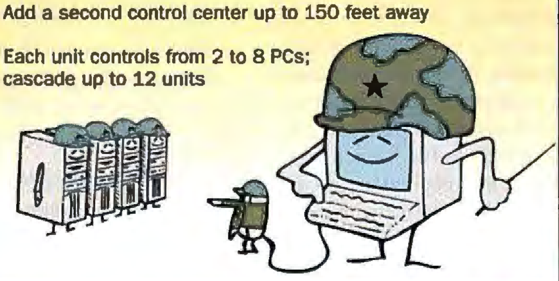

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structions. In practice, this microcode detour rarely happens, because today's smart programmers and compilers avoid the worst x86 instructions.

At this point, the fission is complete: The CISC instructions have been converted into quartets of fully decoded R-ops that, on average, are 59 bits long. Even though that is longer than true RISC instructions, they carry decode information and operand fields that get separated later. What's important is that R-ops are much more manageable than x86 instructions, and the vast majority will execute in a single cycle.

Under optimal circumstances, the K5 can convert four x86 instructions into four corresponding R-ops in a single cycle, making it four-issue superscalar on both the x86 and RISC sides. In practice, it will attain optimal issue rates far more often on the RISC side than on the CISC side.

Point of Order

During the next stage, the R-ops are dispatched in parallel to a set of reservation stations, which act as queues for the functional units. Because the load/store unit is deemed the most vital, it has six stations. Other units have as few as two. Each integer unit (an ALU and an ALU/shifter) has two stations, making a total of four stations that can handle integer-type R-ops.

The functional units execute the R-ops at a peak rate of five per cycle, although the K5 can retire only four per cycle. The units are completely independent, so they are free to complete their instructions out of order if there are no dependencies (i.e., as long as the completion of one instruction does not depend on the result of a previous instruction).

Without some kind of reorder mechanism, of course, the K5 would play havoc with existing software. To ensure that results are retired in program order, each R-op gets an entry in a 16-slot reorder buffer, which keeps track of the original instruction sequence. When the reorder buffer gives the green light, the R-ops are retired in program order by writing their results to the architectural registers and the 8-KB dual-ported data cache. The K5 completion mechanism is analogous to the one used in the PowerPC 604.

In addition, the reorder buffer makes sure instructions are completed in their entirety before yielding to an exception. Otherwise, an instruction might be left partially completed if it was split into multiple R-ops that were executing out of order when the exception occurred. (In cases where the x86 lets some complex instructions be interrupted by an exception, the K5 allows this, too.)

In addition, the reorder buffer is responsible for register renaming, another RISC retrofit for the x86. A well-known limitation of the x86 architecture is its eight GPRs (general-purpose registers), a rather sparse register file by today's standards. The K5 has 16 logical GPRs, any of which can be renamed to represent the eight physical registers that x86 software expects to see.

Branch prediction is handled a little differently than in other advanced microprocessors. Instead of maintaining a separate branch target buffer to hold the addresses of predicted branches, the K5 appends the predicted address to the branch instruction during predecode. This 10-bit tag, called a *successor index*, points to a target within the I-cache.

At first, all predecoded branch instructions are predicted *not taken*. Later, if speculative execution reveals that the prediction was wrong, the prediction is reversed by writing a new successor index that points to the correct cache block. That prediction remains in effect until it's wrong again. In other words, the prediction is reversed every time it's wrong.

This is one reason why the cache blocks are only 16 bytes in size. The K5 can predict only one taken branch per block, so a smaller block reduces the chance that an instruction will branch to another branch in the same block. A 32-byte cache block would reduce performance, according to AMD's simulations.

Although the branch prediction is "dynamic" in the sense that it adapts to wrong predictions at run time, it does so merely by reversing its predictions in a binary flip-flop. In contrast, some of the latest RISC processors use algorithms that dynamically predict the outcome of branches by keeping track of how often a particular branch is actually taken. But RISC chips don't have to bother with complicated x86 decoding. By adopting a somewhat simpler form of branch prediction, the K5 keeps an already complicated decoder from becoming even more labyrinthine.

There is another advantage to the K5's approach: In effect, it predicts branches over a larger sample of the program than other methods. Branch target buffers have a limited number of entries, usually a few dozen. However, the K5 can theoretically predict a branch in every cache block. Since the block size is 16 bytes and the I-cache is 16 KB, that's potentially 1024 branches. This larger sample—coupled with the K5's flexible cache fetching—partly offsets its less sophisticated predictions. Of course, when the cache is flushed, all the prediction states are lost, too, because they're tagged to the instructions instead of being held in a branch target buffer.

To make this whole mechanism complete, the K5's byte queue can trigger a special signal called *BQ confused*. It waves this flag when the predecoded instructions don't appear to make sense because of a mispredicted branch or some other anomaly. The signal wipes out the incoherent cache blocks and reloads them with freshly predecoded instructions. Johnson says this rarely happens, but it is so reliable that it once masked a

AMD'S K5: WHAT'S NEW

- **Fifth-generation x86-compatible microprocessor family**
- **Four-way issue superscalar architecture**
- **Five-stage pipeline**
- **Five parallel-functional units: ALU, ALU/shifter, FPU, branch, and load/store**
- **16-KB instruction cache, 8-KB dual-ported data cache, linear addressing, four-way set-associative**
- **Out-of-order execution, branch prediction, and speculative execution**
- **AMD's first completely non-Intel microcode**
- **Claimed performance: 30 percent faster than the Pentium at the same clock speed. SPEC ratings not yet available**
- **Initial clock speed: 100 to 120 MHz—up to 150 MHz in 1996**
- **Internal/external clock ratios: 1x, 1.5x, 2x, and 3x**
- **4.1 million transistors**
- **3.3-V, three-layer metal, fully static CMOS**
- **Initial version on 0.5-micron process, moving to 0.35 micron in 1996**
- **Pin-compatible with Intel P54C Pentium**
- **Samples this year, volume production in 1995**
- **Price: not announced but expected to be the same as P54C Pentium**

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bug in the K5's critical logic path during the chip's early development. Even though not even AMD would claim the K5 is a fault-tolerant processor, it's comforting to know there's a mechanism of last resort that is robust enough to handle a logic glitch and confused code.

RISC to the Core

We've paid relatively little attention to the K5's core because once the x86 instructions are fully decoded into R-ops and dispatched to the functional units, the K5 core is basically a conventional RISC chip. The K5 core was closely patterned after an upcoming superscalar version of the 29000. Indeed, both the K5 and the new 29000 implement the theories expounded in Johnson's book, *Superscalar Microprocessor Design* (Prentice Hall, 1990). Johnson and Christie modeled early designs of the K5 with a simulator called T-Sim that Johnson wrote for his book. It's interesting to note the resulting architectural differences between the K5 and the Pentium.

The biggest difference is that the K5 has five parallel-functional units instead of two parallel-integer pipelines. Like the Pentium, it can execute two integer operations simultaneously; but unlike the Pentium, it can also execute a floating-point instruction, a load/store, or a branch at the same time. The larger register file and a load/store unit that can perform two operations per cycle keep memory fetches to a minimum.

Another key difference is that the K5 allows out-of-order execution, while the Pentium does not. Overall, the K5 takes a broader approach to superscalar issue than Intel's fifth-generation chip.

One place where AMD cut corners was the FPU. Although the K5's FPU is adequate by x86 standards, it's not as fast as the Pentium's, which has more dedicated logic to make it more competitive with RISC chips. But even Intel says floating point is not particularly important for real-world PC software, so AMD's trade-off is reasonable.

AMD says the K5 was designed to deliver more performance headroom than the Pentium. According to AMD's simulations, adding cache to the K5 yields relatively more performance than adding cache to the Pentium, because the K5 isn't as close to its limit of core saturation. Adding cache is much easier than designing a faster core, so AMD hopes the K5 will remain competitive even when Intel debuts the P6 next year. Of course, this assumes the P6 won't introduce a significantly better architecture. If it does, AMD might not be any closer to catching Intel than it is now.

Nevertheless, the K5 proves that AMD can design a competitive x86-compatible CPU that isn't merely an Intel clone. From its unique R-op mux to its quad-issue superscalar pipeline, the K5 boasts a clearly innovative microarchitecture that inherits only what it must to remain compatible. Indeed, it's possible that Intel's P6 will more closely resemble the K5 than the K5 resembles the Pentium. If nothing else, the K5 will stand as AMD's declaration of independence. ■

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SPARC STRIKES BACK

UltraSparc moves SPARC to 64 bits while providing a host of video and graphics capabilities

PETER WAYNER

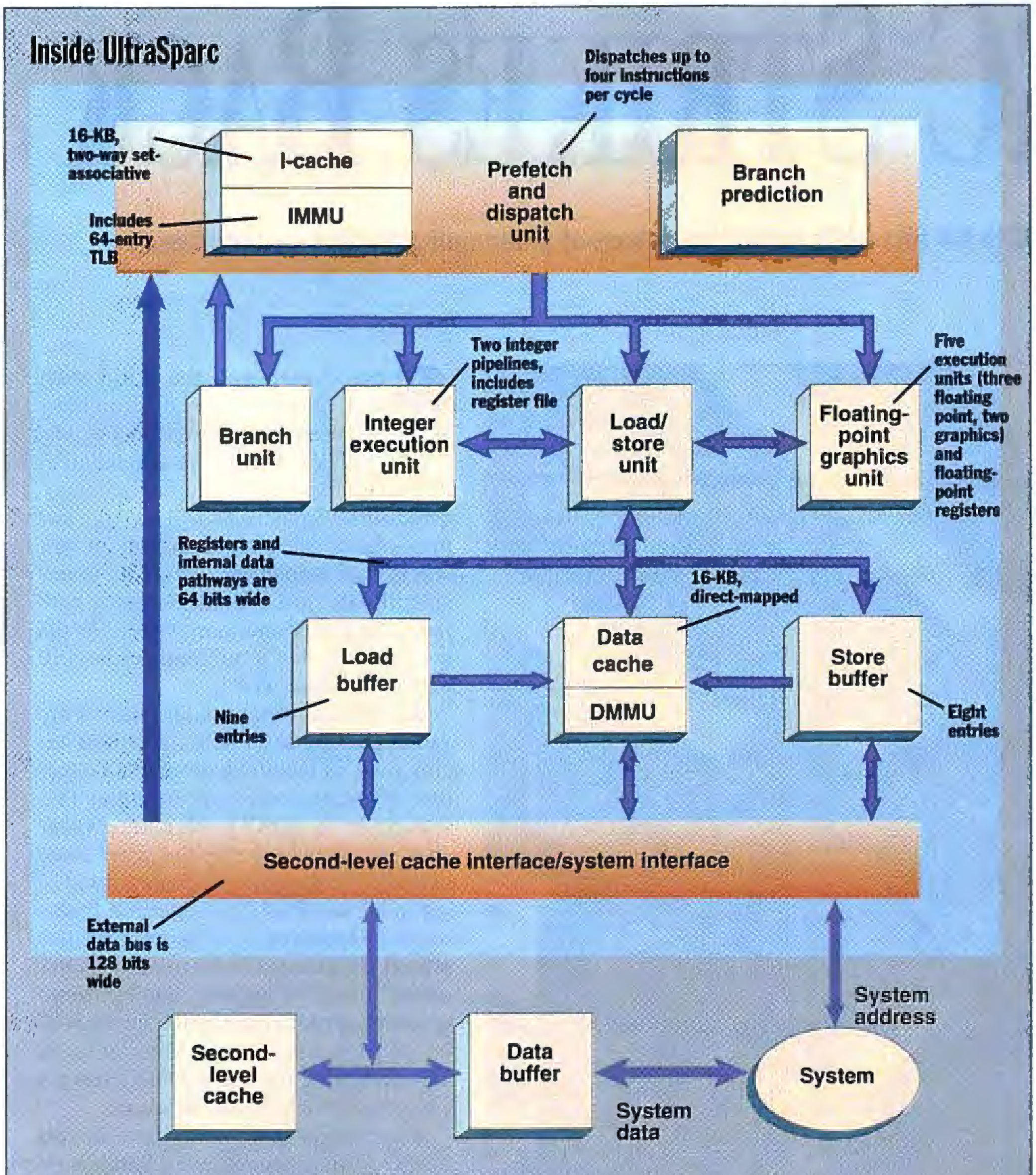
DOUG FRASER © 1994

Several years ago, the world order was very regimented: computers were computers, phones were phones, and TVs were TVs. Today, the coherency of that structure is rapidly blurring as microprocessors wiggle their way into more and more places. The next version of Sun Microsystems' (Mountain View, CA) venerable SPARC line is aimed at being both faster than ever and more suited for the diverse rolls that a microprocessor will play in the video world.

Sun made substantial and incredibly varied changes to SPARC. The most exciting one is including on-chip a collection of image-processing functions that can operate on up to 8 pixels at once. Other changes are where the designers have tweaked the structure of context switching to allow SPARC to better run multithreaded operating systems and have improved the instruction set to allow better optimization by compilers. Some changes are necessary to bring SPARC into the 64-bit world that Alpha and Mips, at least, have inhabited for years. Other changes are more specialized and detailed.

The changes to SPARC come in two forms: At the abstract level, Sun has issued the SPARC-V9 revisions to the SPARC architecture that spell out in detail what constitutes a SPARC-compatible chip. This permits companies such as Fujitsu to produce their own versions of the latest definition of SPARC. SPARC-V9 is the first major set of revisions to emerge since the commercial SPARC architecture was announced in the 1980s as the SPARC-V7. SPARC-V8 contained relatively minor revisions to the original architecture.

On the more concrete level, Sun has announced UltraSparc, the first implementation of the SPARC-V9 architecture. This chip will be produced in a partnership with Texas Instruments. Although the final numbers are not available at this writing, Sun hopes to produce a product that runs between 250 to 300 SPECint92 using a



The UltraSparc is unusual in that it devotes so many internal resources to graphics and video processing. In addition to the two pixel processing engines in the FPU, the UltraSparc also can handle block moves of up to 600 MBps that bypass the caches. Sun is pointing squarely at a multimedia future with this chip.

chip that runs about 200 MHz. Sun expects the processing ability to scale linearly with the clock speed. This chip should be available in samples by early 1995 and in quantity by the end of 1995.

Pieces of Eight

The built-in instructions for handling video tasks are perhaps the most novel addition to the architecture. Digital manipulation of graphics and video data in computing environments is growing exponentially, and many companies are developing specialized chips to handle these tasks. UltraSparc represents one of the first general-purpose processors to integrate these functions. It has specialized hardware to process image data packed in the typical RGB and alpha format. Each of these components can be represented with either 8, 16, or 32 bits. The instruction set includes new instructions that will load and manipulate data in 64-bit blocks. The pixels in one 64-bit block can be either added to or multiplied by the pixels in another 64-bit block in a single operation.

The image manipulation is performed in the FPU, which normally operates on 64-bit floating-point quantities. In the case of pixel addition, the chip simply forgets to carry a bit every 8, 16, or 32 bits. The process is more complicated for pixel multiplication and relies heavily on shifters that are used extensively in floating-point arithmetic.

The pixel operations can also be split to increase processing parallelism. For example, one of the new instructions can multiply four 16-bit numbers by four 8-bit numbers without choking the pipeline. If you want to do 16-by 16-bit multiplies, then you use two of these instructions and combine the results with an addition.

The ability to perform up to eight operations at once in parallel is useful when compressing and decompressing video images. The most time-consuming part of the MPEG algorithm is trying to analyze the motion of the image by comparing each part of the current frame against the previous frame. The UltraSparc comes with a special instruction that will do the eight subtractions, eight absolute values, and eight additions this comparison takes—as well as the final work of aligning the information—all in a single graphics-unit operation. A special memory system automatically loads pixels in 8-byte blocks without a separate instruction. When these specialized instructions are pipelined, the chip will sustain one operation per cycle.

The benefit of these special instructions is enormous. Sun hopes that the UltraSparc will be able to deliver performance that is up to 80 times faster than other RISC processors on pixel manipulation operations. Sun estimates that the chip will be able to decompress two MPEG-2 video streams and perform video processing in real time. On the other end, the chip should be able to provide real-time MPEG-2 compression.

It is not clear whether these instructions will provide similar gains to other applications. Several more specialized scientific applications may be able to use the parallelism to speed up the work substantially. The ones that will benefit will be

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ULTRASPARC HIGHLIGHTS

- Multimedia instructions can process up to 8 pixels at once for MPEG decompression.
- Upgrades SPARC to 64-bit architecture.
- Single-cycle branch prediction integrated into first-level cache.
- Fabricated on Texas Instruments' 0.5-micron CMOS, 3.3-V four-layer metalization process.
- Sun claims 250 to 300 SPECint92 at 200 MHz.
- Samples in the first quarter of 1995; ships in 1995.
- Integrated second-level cache support.
- Speculative loads allow a load that might fail because of a nil pointer to be done without testing.
- Up to 600-MBps block data transfer without affecting caches.
- Nested traps.
- Logic units: two integer, two floating-point/graphics addition, two floating-point/graphics multiplication, one floating-point division/square root, one branch, and one load/store.
- 16-KB instruction cache; 16-KB data cache.

those that can operate with low-precision, fixed-point values.

Memory Improvements

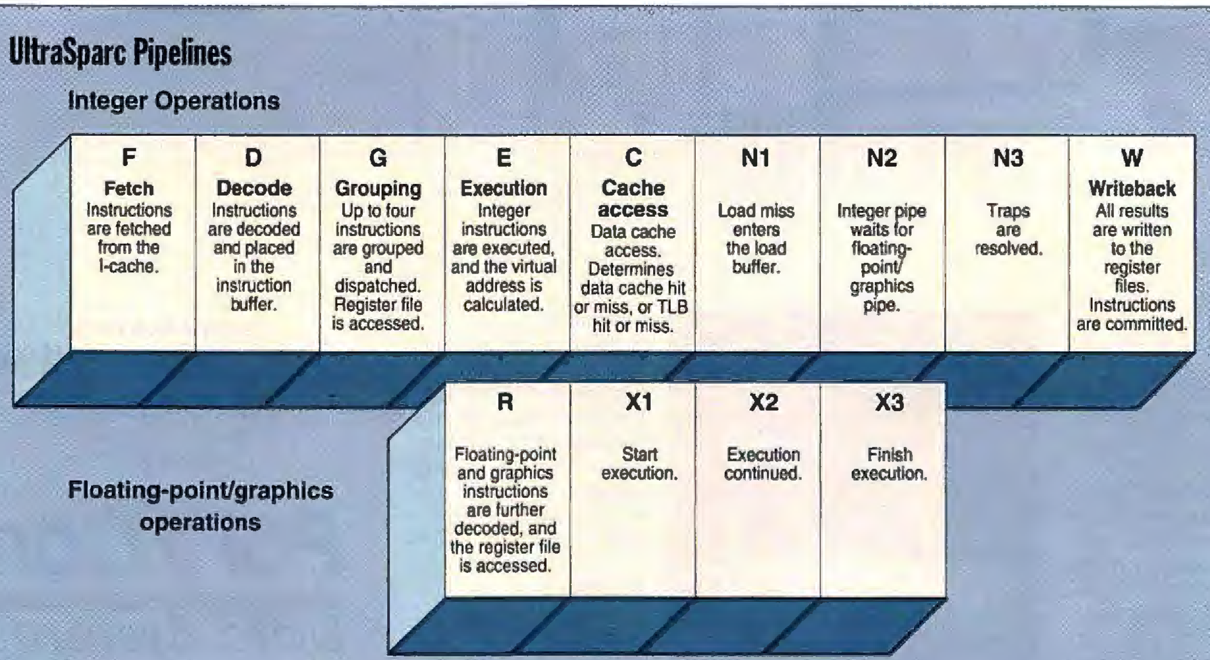
The greatest headache for any modern processor designer is getting data on and off the chip. The UltraSparc has several features that should significantly improve the memory performance of the chip. Some of these changes will boost multimedia performance, and others are aimed at helping average system tasks.

The biggest change, at least in the volume of bits moved, is a new block move instruction that circumvents the normal cache structure. Using this instruction, you can move up to 600 MBps across the processor/memory bus. This lets the main processor act as the video processor by blitting data on and off the screen. This block move also comes in handy in other applications that shuffle memory. Sun's system architects say that they've watched the TCP/IP networking software move packets of data up to eight times before it reaches its final destination. Given that most UltraSparc machines will be networked, the block move instruction can help hold down networking overhead.

The other parts of the memory interface are fairly standard. The UltraSparc has split primary caches. The data cache is 16 KB and direct-mapped, while the instruction cache also holds 16 KB, though it is two-way set-associative. Both caches have their own TLB (translation look-aside buffer). The UltraSparc also comes with an on-chip cache manager for an off-chip second-level cache. You only need to add SRAM (static RAM) to have a fully functioning second-level cache.

Instruction fetching is tightly integrated with the first-level instruction cache. The instructions stored in the cache are predecoded to speed their processing when they enter the execution pipeline. Every two instructions in the cache are associated with 2 bits that are used to predict branches taken by the instructions. The 2 bits keep track of four different states that encode the last two paths taken by these instructions.

The prefetching mechanism uses the



The SPARC pipeline breaks into two paths for integer and floating-point instructions. The key work is done in the third stage that groups together up to four instructions that can be executed simultaneously. Although the instructions must start in order, they can finish out of order without stalling the pipeline. The long tail of the integer pipeline is needed to handle memory access to data not found in the cache. Integer results don't have to wait until writeback, however; a bypass mechanism makes them available immediately after their execution stage.

bits to dynamically predict branches. Sun's preliminary studies show that the UltraSparc is able to predict the right path in 88 percent of the branches taken in the SPECint92 test suite and 94 percent of the time in the SPECfp92 set.

Into the Pipeline

The execution pipeline is the backbone of a modern chip, and its structure defines the performance limits. The UltraSparc comes with a nine-stage pipeline that can issue up to four instructions per cycle. The first two stages are standard: The instructions are fetched and then decoded.

The third stage groups together any possible instructions that are available for issue to the execution units. The chip will not issue the instructions out of order, and Sun is confident that its compilers will be able to do a good job scheduling the instructions to maximize throughput. There are particular rules about which instructions may be bundled together. There is a limit of two integer operations, two floating-point or graphics operations, one load/store memory access, and one branch that can be issued each tick of the clock. Even though this adds up to six possible instructions, only four can go at once.

In addition, this stage is responsible for getting the information from the registers. If the information is not ready, it will stall any instruction that depends on it until it is ready. Sun says that it is closing in on the magical one-instruction-per-cycle average.

After issue, the pipeline splits into two parts. One fork handles the integer and memory instructions and the other handles the floating-point and graphics instructions. The floating-point instructions travel down a three-stage pipeline that is tuned to handle everything except floating-point division and square roots. A separate functional unit attacks these without stalling the pipeline. The chip issues instructions in order, but they don't need to finish in the same order.

Basic integer instructions execute in one cycle. Others such as integer multiplication and division have variable latencies. For example, the UltraSparc executes 2 bits of the multiplicand or 1 bit of the divisor per cycle (the chip is thus very human in its performance: Bigger numbers take longer). Once an integer instruction executes, a bypass mechanism makes its results available immediately, rather than after the writeback stage.

The rest of the integer/memory pipeline is devoted to handling the loads and stores. These can occasionally take a long time if the data is not available in the on-chip cache. Sun worked to keep these stages in the integer pipeline the same size as the floating-point pipeline so that the results from the two can be rejoined in the final stage when the information is written back to memory or registers. These loads and stores do not have to finish in their programmed order, which significantly adds to pipeline throughput.

Context Switching

The pipeline structure governs how well a chip will do on a straight-line segment of code, but it says little about how a chip will perform on a desktop when it is often forced to handle a number of different programs. The ability to switch quickly

between different blocks of code (i.e., context-switching) is becoming more important than ever because both modern multithreaded operating systems and OOP (object-oriented programming) are slicing the programs into smaller bits or contexts.

The SPARC architecture is the only RISC processor on the market that uses register windows. Instead of 32 basic registers, the chip offers eight overlapping windows of 24 registers each. The theory behind these windows is that when a new procedure or thread begins, the windows would obviate the need to write the old information out to memory; the new context would simply be a new "window" of registers. In practice, many compiler writers found that they would quickly exhaust the supply of windows, so they needed to pause and write the information to memory anyway.

Register windows have caused Sun some grief. Other RISC designers were able to produce nice small sets of 32 registers with a much simpler design that would run faster. Also, other compiler designers found they didn't need many of the advantages of the overlapping nature of the registers because they could simply compile short procedures in-line. Sun couldn't abandon windows without losing backward-compatibility with the old SPARC software. For this reason, with UltraSparc, it concentrated on adding several different improvements for handling context switches.

One of the neater solutions is providing another fresh window of registers everytime a trap, an interrupt, or an MMU (memory management unit) trap is sprung. Anyone writing a software routine implemented as a trap must ordinarily save all the information in the registers so that the routine does not destroy the results of the process that was interrupted. The UltraSparc provides eight fresh registers that can be used without worry in these cases. This should significantly improve the speed at which the UltraSparc handles code of multithreaded operating systems that use many traps and interrupts.

Onward, Upward

In its early years, Sun recognized that the main demands on a desktop Unix box were to do simple integer pointer arithmetic and move the data around. So it produced a RISC instruction set that did just this and nothing more. Now that the system demands on a desktop machine are no longer as significant, Sun is changing the instruction mix to supply what they hope desktop users will want: hot graphics and video processing.

The graphics instructions and the fast block data transfers should let Sun build low-cost desktop systems that offer stunning video processing. The graphics-processing instructions will be able to speed up video processing and graphics generation. This should become a tantalizing addition to the desktop and may even let Sun make substantial inroads in the potential market for set-top computers. ■

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PowerPC 620 Soars

Its faster logic, shorter pipelines, and high-speed interface endow it with processing power that raises it to workstation and server caliber

TOM THOMPSON AND BOB RYAN

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In 1991, Apple, IBM, and Motorola formed an alliance whose goal was to create a new hardware and software standard for personal computing. The hardware portion of the standard is centered around the PowerPC architecture, a 64-bit machine environment that uses a single-chip RISC processor. This architecture serves as a template for a growing family of PowerPC processors, each with a design carefully tailored to address the computing needs of a different market.

The IBM/Motorola Somerset facility, located in Austin, Texas, is the work site of the engineers responsible for creating the various processor designs. Since 1991, Somerset design teams working in parallel have introduced new versions of the PowerPC processor with relentless regularity. The PowerPC 601, a low-cost 32-bit implementation of the PowerPC architecture, was introduced in early 1993. Fall of that year saw first silicon on the PowerPC 603, a low-power 32-bit processor suitable for notebook computers. Early this year, the PowerPC 604, a high-performance 32-bit processor designed for high-end desktop systems, made its debut.

At the Microprocessor Forum in October, IBM and Motorola jointly announced first silicon on the PowerPC 620, the first 64-bit implementation of the PowerPC architecture in a processor. While the previous members of the PowerPC family were targeted for desktop PCs, the 620 is instead crafted for workstations and high-speed servers.

Based on simulations at 133 MHz with 4 MB of secondary level-2 cache clocked at 66.5 MHz, the PowerPC 620 posts performance marks of 225 SPECint92 and 300 SPECfp92. Key design features, such as 64-bit internal data paths, 64 KB of on-chip cache, six independent execution units, and a high-speed bus interface, provide the high level of performance required by simulations and transaction processing. The 620 is code-compatible with earlier PowerPC processors and can execute existing 32-bit PowerPC programs, as well as new 64-bit programs written specifically to exploit features on the 620.

Sampling of the PowerPC 620 begins in the second quarter of 1995, and the chip should be available in limited quantities by the second half of 1995. Pricing was not set at press time, but it was expected to follow the competitive pricing set by other members of the PowerPC family.

Processor Basics

The PowerPC 620 uses the 0.5-micron CMOS four-metal layer-fabrication technology, which is similar to that used in the PowerPC 604. However, the 620 fabrication process also uses an improved transistor design that switches faster, thereby improving overall performance. The PowerPC 620 operates at 3.3 V, the same as the PowerPC 603 and 604.

As with these other two processors, an on-chip PLL (phase-locked loop) on the PowerPC 620 acquires the processor clock, and the processor's bus interface can operate at one half, one third, or one fourth the speed of the processor clock to support slower memory or devices. At 133 MHz, the PowerPC 620 dissipates 30 W in a worst-case scenario. The PowerPC 620 also sports the same power management features as the 603 and 604, which can be used to reduce power consumption and build an energy-efficient computer.

However, the PowerPC 620's resemblance to other members of the PowerPC family ends here. The chip's design uses 7 million transistors—nearly double the number in the 604 design. To house that many circuits requires a large (for a PowerPC) 311-mm² die.

These extra transistors implement several key features. First, because the 620 is a 64-bit processor, additional hardware is required to support 64-bit data types and 64-bit addressing. This means that many of the processor's internal data buses and buffers, as well as the GPRs (general-purpose registers) and FPRs (floating-point registers), must be 64 bits wide.

The second original feature of the 620 is the presence of two massive, 32-KB on-chip caches. The 620, like the 603 and 604, implements a Harvard architecture with separate code and data paths. One cache handles the code path, and the other handles the data. Each cache has its own MMU (memory management unit) and functions independently of the other.

Third, the 620 employs an aggressive branch-prediction mechanism that requires prediction logic plus 64-bit rename buffers and reservation stations to store speculated branch results. This, in turn, uses more transistors.

Finally, the processor's bus interface has been beefed up: The data bus is 128 bits wide, and direct support for a level-2 cache is built in. All these new features work in concert to boost the 620's performance.

Features of the PowerPC 620

- **133-MHz processor clock**
- **Half-, third-, or quarter-speed bus-interface clock**
- **128-bit data bus**
- **40-bit address bus**
- **64-bit GPRs and FPRs**
- **3.3-V operation**
- **7 million transistors**
- **331-mm² die**
- **Six execution units**
- **Split 32-KB caches**
- **Built-in level-2 cache interface**

The PowerPC 620 uses an improved, faster-switching transistor design.

620 Interiors

At first glance, the heart of the PowerPC 620 looks identical to that of the 604. Both have the same six independent execution units: a load/store unit, a branch unit, an FPU, and three integer units. This enables up to four instructions to be fetched and dispatched at each tick of the processor clock. Because this and other 620 features resemble those of the 604, some comparisons to the 604 are necessary.

While the 620 uses a superscalar RISC core similar to that of the 604, specific design enhancements endow the 620 with its workstation-caliber performance. The major difference between the 620 and the 604 is that the 620 uses an improved bus-interface unit and memory subsystem to pump data into and out of the processor faster. The 620 also has a 128-bit data interface, so it fetches two longwords (64 bits each) of data during every bus access. The bus interface has 40 address lines,

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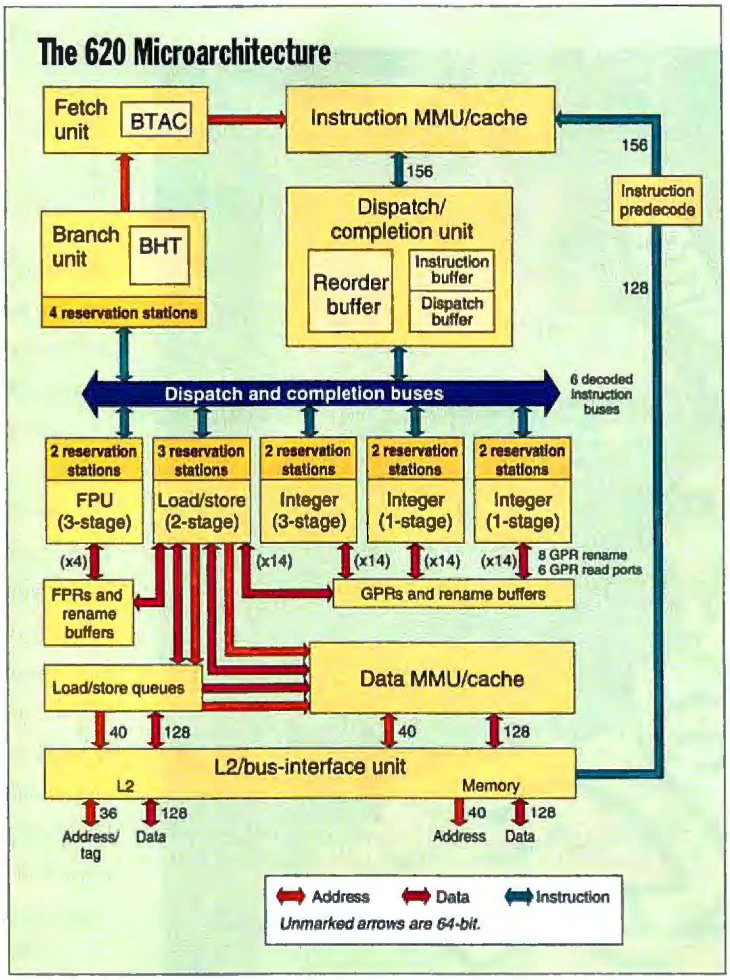
which enables the processor to access 1 TB of physical memory.

Note that although the 620 uses only 40 bits of address, internally it uses 64-bit effective addressing and thus supports 80-bit virtual addresses. Needless to say, the wide data path and additional address lines mean that the 620 is decidedly *not* pin-compatible with the 604: It has 482 pins, versus the 604's 304 pins. The 620 uses a BGA (ball grid array) package.

The PowerPC 620's bus interface includes integral support for a unified (i.e., both code and data) level-2 cache, whose size is configurable from 1 to 128 MB. The cache-interface signals can run at the same speed as the processor clock rates or at one half or one quarter their speed, which allows the construction of a level-2 cache from slower RAM. This on-chip cache interface eliminates the extra clock cycles normally required to drive any external level-2 cache logic.



A block diagram of the PowerPC 620. Although it closely resembles the PowerPC 604 in structure, the GPR, FPR, and internal buses are 64 bits wide. The predecoder unit sits in front of the code cache and helps shorten the processor pipeline by one stage.

For a single-processor system, the level-2 cache interface improves performance by moving the data through the processor faster. In a multiprocessor system, the level-2 cache interface minimizes bus traffic. It does so by using a bus protocol that's designed to be tightly coupled with snoop-response pipelining. This improves the rate at which addresses issue onto the bus, without the latency of bus-snooping activity. The result is faster shared-memory access, which is vital in an environment where two or more processors exchange data or access shared semaphores and flags.

Inside the PowerPC 620, fetched code and data land in the internal 32-KB caches. The data cache supports both write-through and write-back modes and uses the MESI (Modified, Exclusive, Shared, Invalid) protocol to maintain cache coherency. On the code side of the street, instructions pass through a predecoder on their way to the internal code cache (see the figure "The 620 Microarchitecture"). The predecoded instructions reside in the code cache until the dispatch/completion unit fetches them.

Because of this up-front predecoding, the remaining decoder logic is merged into the dispatch stage of the processor pipelines. This effectively shortens the 620's pipelines from six stages to five (fetch, decode/dispatch, execute, complete, and writeback). The shorter pipelines mean that each instruction completes in fewer clock cycles, resulting in faster overall code execution.

Once fetched by the decode/dispatch unit, instructions are assigned a rename buffer that temporarily holds any instruction results, such as write to another register. The rename buffers make possible the speculative execution of instructions based on branch prediction, since an operation's results remain in this buffer until the outcome of a branch instruction is resolved. If the branch prediction is correct, the rename-buffer contents are written to the architectural registers. If not, the rename-buffer contents are discarded.

As with the 604, a 16-entry reorder buffer in the 620 tracks the status of an instruction from dispatch to completion. Significantly, the 620 can release up to four rename buffers per cycle, versus just two for the 604. This makes the existing rename buffers more readily available to other instructions in the pipeline. Furthermore, the shorter pipelines process instructions faster. The combination of these two features means fewer rename buffers are needed to store the intermediate results of speculative executions. Therefore, the 620 has only 16 rename buffers (eight GPRs and eight FPRs) total, versus a total of 20 (12 GPRs and eight FPRs) for the 604.

Next, the decode/dispatch unit issues instructions to the six execution units. Up to four instructions are dispatched per cycle to the execution units. Each unit has two or more *reservation stations*, which act as temporary storage for those dispatched instructions that depend on the results of other instructions. The reservation stations thus keep the instruction-dispatch bus clear so that the dispatch unit can continue to issue instructions to other execution units. If there are sufficient reservation stations available, an execution unit that stalls because of code dependencies won't impede the instruction dispatch or the operation of those execution units (e.g., the integer units) that can execute instructions out of order.

To this end, the PowerPC 620 has several more reservation stations than the 604: The 620's branch unit has four (versus two on the 604), and the 620's load/store unit has three, as opposed to the 604's two. The 620 provides in-order instruction dispatch and out-of-order execution. The reorder buffer weaves the instruction results together so that instructions ultimately complete in program order. *continued*

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State of the Art

Like the PowerPC 604, the 620 implements dynamic branch prediction. But the 620 has a more aggressive branch-prediction logic that can speculatively execute up to four unresolved branch instructions, versus only two on the 604. To accomplish this, the 620 uses a larger 2048-entry BHT (branch history table) that records and tracks the usage history of each branch instruction encountered. Also, the 620 has a larger, 256-entry BTAC (branch-target address cache) in which it caches the instruction and target addresses. By contrast, the 604's BHT holds 512 entries, and its BTAC has only 64 entries.

Simulations run by the PowerPC's designers show that the branch-prediction logic is 90 percent accurate, which translates to little or no execution delays on program branches most of the time. In those cases where a bad branch prediction occurs, the penalty for recovering the thread of execution is typically four clock cycles. On the first cycle, the PowerPC 620 completes all instructions up to and including the branch and calculates the address of the correct branch path. (This operation sometimes takes more than one cycle.) The second cycle flushes the pipelines and fetches the correct instructions. The third cycle dispatches the instructions; the fourth cycle executes them.

Fast Floating-Point Performance and Modes

The 604's PC-based design emphasizes integer performance, as dictated by the needs of its applications. But workstation applications anticipated to run on the 620—such as data capture and visualization, scientific simulations, and real-time analysis of market trends—make heavy use of exotic equations to compute thousands of results per second. Thus, they require rip-roaring floating-point performance.

As the SPECmarks mentioned at the beginning of this article indicate, the 620 easily serves up floating-point performance that's much better than its integer performance. The PowerPC's designers achieved this by implementing key improvements in certain execution units and by fine-tuning the RISC core's throughput.

In the 620's FPU, the engineers worked to improve the speed of the divide (`fdiv`) and square-root instructions (`fsqrt`). The divide instruction is a computationally expensive instruction and is used frequently, so any enhancement in its execution speed has an impact on all floating-point computations. The engineers decided to also speed up the square-root instruction be-

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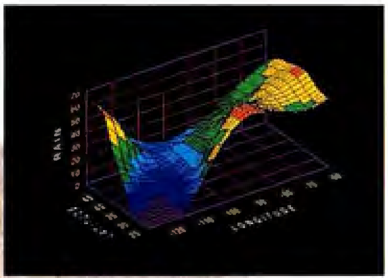

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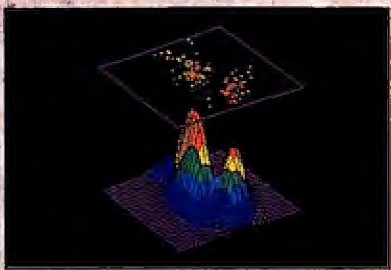

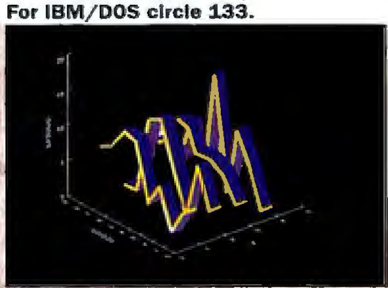

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cause of its high frequency of use. The `fdiv` instruction, which takes 32 clock cycles on the 604, takes just 18 on the 620. The `fsqrt` instruction, which was emulated in software on the 604, now executes in 22 clock cycles. For the load/store unit, one clock cycle was shaved off floating-point data accesses.

All these improvements add up to better floating-point throughput. However, the designers obtained the most significant performance gains by engineering the processor to get data through the RISC core faster. The PowerPC 620's wider data paths, shorter pipelines, on-chip caches, and level-2 cache support all contribute to shipping large amounts of floating-point data in, through, and out of the FPU.

Over time, 64-bit applications will be written to take advantage of the huge address space the 620 offers. To this end, the 620 implements 38 new instructions as part of the 64-bit PowerPC architecture. Specific 64-bit instructions that such applications might use are load/store instructions that access longwords of data, such as load doubleword (`ld`) and store doubleword (`std`). For compatibility with the existing base of 32-bit PowerPC applications (such as it is now), the 620 can execute them without modification.

A mode bit in the processor's MSR (machine state register) indicates which mode the PowerPC 620 operates in (32- or 64-bit). There's no penalty for running the processor in either mode; in 32-bit mode, the bits in the lower half of the 620's 64-bit registers are guaranteed to correspond to those in a 32-bit PowerPC processor. Furthermore, the mode bit in the MSR is under software control, so it's possible for a 64-bit operating system to change the processor environment on-the-fly to execute 32-bit applications. There would be some overhead on the part of the operating system to manage the mode switch.

One unique feature found in all PowerPC processors—but which the 620 should be able to put to good use—is the ability to assume either big-endian (Motorola) or litttle-endian (Intel) address modes under software control. One bit in the MSR determines the addressing mode; another bit indicates the addressing mode of an interrupt handler. This lets a big-endian operating system run little-endian applications. When a hardware interrupt occurs for an operating-system service, the addressing mode can be switched to big-endian for the duration of the interrupt handler's execution. A 620-based workstation could thus host application code from different operating systems (say, a Unix operating system running Windows applications) with respectable performance.

Future Directions

The PowerPC 620 is a promising addition to the PowerPC family of processors, offering workstation-class throughput and paying special attention to floating-point performance. Its speed and power consumption are comparable to those of other RISC processors. However, processing speed is always a moving target in this fast-paced business: By the time the first 620-based system appears in the latter half of 1995, we'll be witnessing the first silicon on a new generation of faster chips from other RISC vendors.

While the 620 is the last of the publicly announced processors, the Somerset engineers are busily working on next-generation processors and enhancements to existing designs. The PowerPC alliance is understandably quiet about information on future processors, but its efforts to enhance existing designs are already well known, as is evidenced by the 601+.

In the 601+ processor, a 0.5-micron, five-metal-layer, local-interconnect process shrinks the die size from the original 121 mm² to 74 mm². It also reduces the operating voltage from 3.6 V to 2.5 V, so the 601+ dissipates 4 W at 100 MHz. This is half the power consumption of the original PowerPC 601 operating at 66 MHz, and close to the maximum output of the PowerPC 603 (3 W at 80 MHz). Expect similar improvements to appear in the PowerPC 603, 604, and 620 designs.

Key to the PowerPC's future survival is its acceptance by users. Initial activity in this area, though limited, is promising. The only PowerPC-based systems on the market at this writing are Apple's line of Power Macs, which use the PowerPC 601. Apple sold over 345,000 of these systems in just four months, becoming the largest RISC-computer vendor on the planet. If this trend continues, especially when high-speed PowerPC 603–, 604–, and 620–based systems from Apple, IBM, and other vendors appear, then the alliance's hopes of creating a new standard for desktop computers might succeed after all. ■

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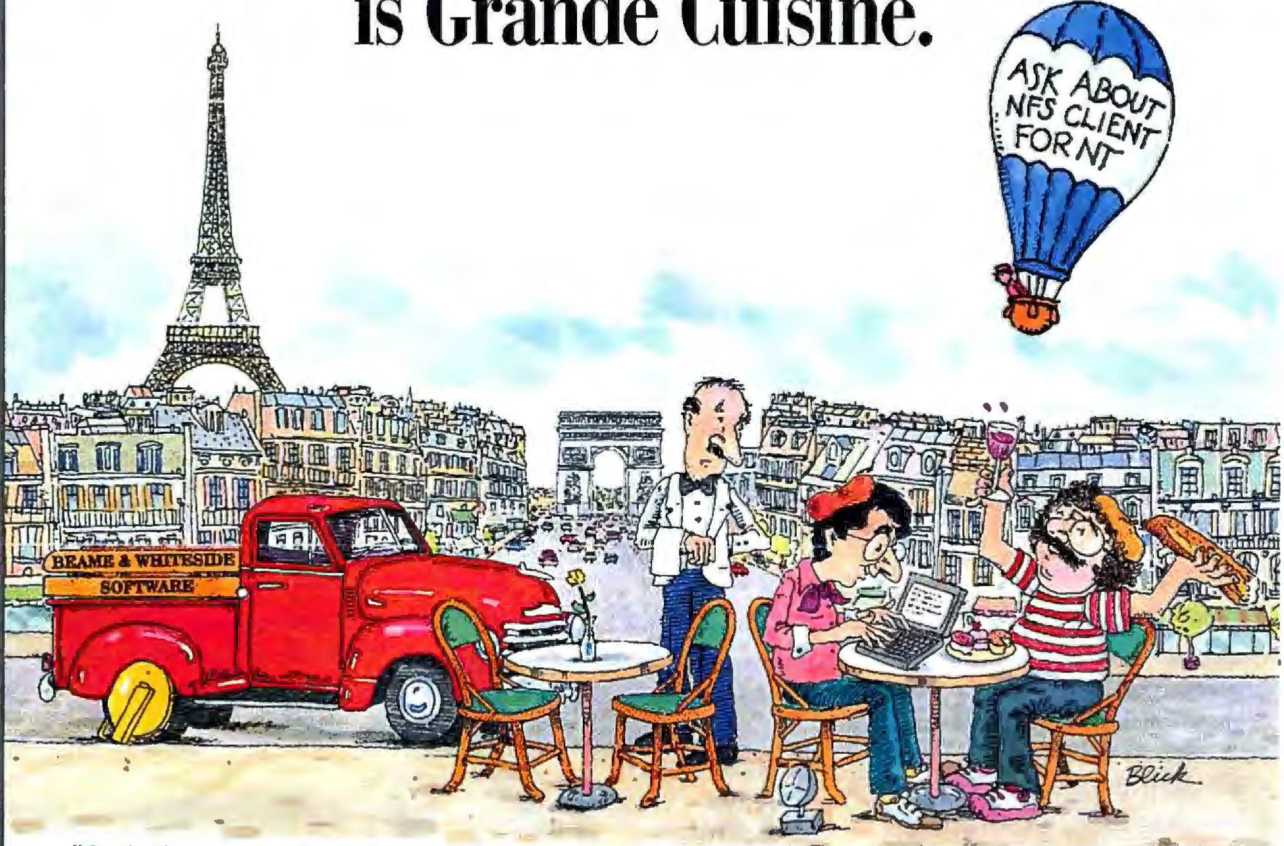

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T5: Brute Force

Mips Technologies' T5 chip takes an aggressive approach to superscalar dispatch that shows how far today's engineers must go to deliver cutting-edge performance

TOM R. HALFHILL

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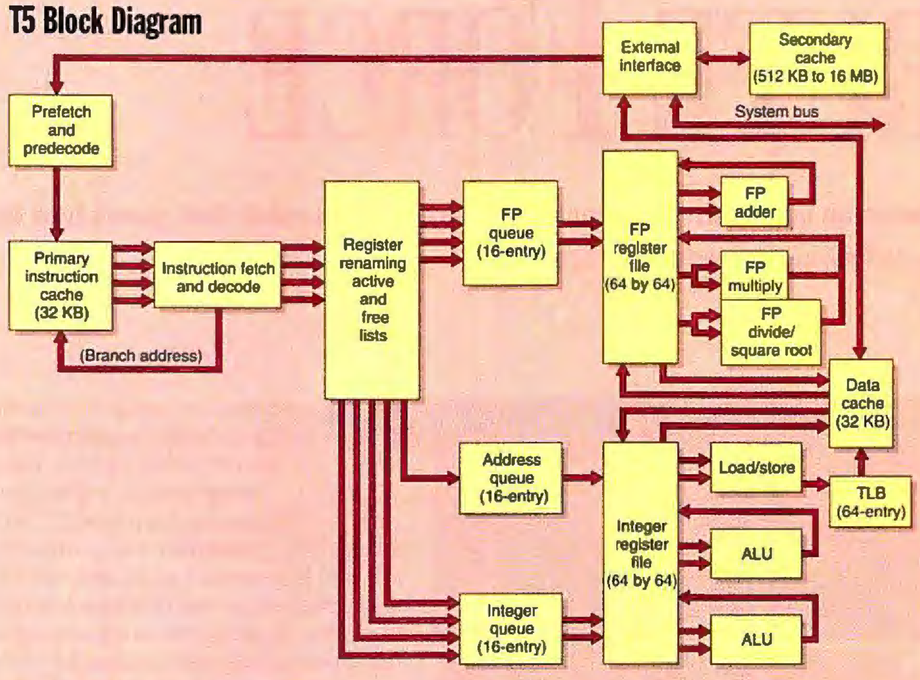
Microprocessor design is a never-ending cycle of eliminating bottlenecks and thereby creating new ones. When CPUs outran the ability of memory chips and I/O buses to keep them fed with instructions, the solution was to widen the bus, add high-speed caches, and simplify the instructions so that they took less time to process. When the resulting instruction stream surged beyond the capacity of the core, the answer was to deepen the execution pipeline and add multiple functional units with parallel pipes. Then I/O became a problem again, leading to even wider buses and larger caches. And so it goes.

This tug-of-war between bandwidth and horsepower won't end until all known techniques are exhausted or the cost of diminishing returns becomes prohibitive. Even though that wall isn't yet in sight, today's CPU architects are turning to increasingly radical architectures in their quest for leading-edge performance. Witness the new fifth-generation Rx000-series processor from Silicon Graphics, Inc./ Mips Technologies (Mountain View, CA).

The chip's code name is T5, or the Terminator—referring to the 1991 movie *Terminator 2: Judgment Day*, with its Oscar-winning special effects, which were created with Mips-powered SGI workstations. The T5 is based on the same fifth-generation superscalar RISC technology introduced earlier this year in the Mips R8000, a supercomputer processor. But while the R8000 is a multichip module optimized for high-end scientific calculations, the T5 is a general-purpose single-chip processor for desktop PCs, workstations, and servers. It offers a better balance between integer and floating-point performance than the R8000, making it more suitable for mainstream applications. The T5 is designed to be equally at home in PCs running Windows NT, workstations running Unix, or multiprocessor servers

T5 Block Diagram



The Mips T5 is a cross between a four-way and a five-way superscalar design. It can fetch up to four instructions per cycle, dispatch up to five instructions to its five execution units per cycle, and graduate four results per cycle. It supports out-of-order execution, branch prediction up to four levels deep, speculative execution, and dynamic-register renaming.

for transactional databases.

As the first single-chip superscalar processor from Mips, the T5 represents a significant step forward for the Rx000 architecture. Behind it is a strong RISC heritage—the original R2000 in 1985 was the first commercially available RISC chip, and one of Mips' founders was John L. Hennessy, a pioneer researcher in RISC technology. The T5 builds on preceding generations (R2000, R3000, R5000, and R4000) by incorporating five functional units, twice as much primary cache as the R4400, twice as many registers, dynamic-register renaming, dynamic-branch prediction, speculative execution, out-of-order execution, and multiprocessor support for up to four CPUs on a special cluster bus.

At its initial core speed of 200 MHz, the T5 is expected to deliver 250 SPECint92 and 350 SPECfp92—and that's with R4000 binaries that haven't been optimized for the T5. Although not as fast as DEC's new Alpha 21164 (see "Alpha Rides High," October BYTE), the T5 offers a distinct price/performance ratio advantage over the Alpha and the Pentium. It will keep SGI's graphics workstations competitive and maintain the price/performance advantage of Mips-based NT boxes.

Mips says the T5 is even faster than synthetic benchmarks indicate because it's more tolerant of cache misses than other processors. The T5's ability to tolerate up to four misses without stalls should make it a particularly good CPU for busy database servers, because transaction processing is I/O-intensive and requires huge secondary caches to avoid the penalty of frequent misses.

Beyond Brute Force

By far the most impressive features of the T5 are its high degree of parallelism and dynamic instruction scheduling. The goal of this design is to combine the brute force of multiple functional units with the finesse of speculative, out-of-order execution.

Previous Rx000-series chips had scalar pipelines that always executed instructions in their original program order. In contrast, the T5 has five independently pipelined functional units, each of which can execute and complete one instruction per cycle without regard to program order. Furthermore, the T5 can predict the outcome of branches and speculatively execute the code that follows. Only when all dependencies are resolved are the results of the completed instructions retired (or *graduated*, in Mips parlance) and restored to their original sequence. Up to four results can be graduated per cycle.

Out-of-order execution is an increasingly common technique for managing the growing resources of advanced microprocessors. Brute force in the form of higher clock speeds, wider buses, larger caches, and more pipelines has its place but also its limits. Soon you reach a point of diminishing returns where the functional units are stalled because they don't have enough to do. Optimized compilers try to address this problem by reordering the instructions to take advantage of a particular CPU's requirements.

In effect, out-of-order execution is a partial substitute for optimized compilation, because it shifts the burden of instruction ordering from the compiler (or the assembly language programmer) to the CPU itself. The CPU, not the compiler, rearranges instructions to match the availability of resources—and it does so dynamically at run time, not statically at compile time.

If this technique is carried far enough in future designs, optimized compilers and hand-tuned assembly language may become as obsolete as punch cards and toggle switches. The T5 doesn't go quite that far, but it does represent the state of the art, matching or exceeding the sophistication of dynamic issue in DEC's Alpha 21164, IBM/Motorola's PowerPC 620, AMD's K5, and Cyrix's M1.

Wall-to-Wall Superscalar

Mips isn't taking a tentative step toward superscalar with the T5; this chip is thoroughly parallel from front to back (see the figure "T5 Block Diagram").

Each cycle, the T5 can fetch four 32-bit instructions from its 32-KB, two-way set-associative instruction cache, or I-cache. Not only is that cache twice as large as the R4000's, but its two-way set-associativity is also an improvement over the R4000's direct mapping, yielding an effective 4× increase in cache efficiency (see "Cache Advantage," August BYTE). An on-chip controller supports a secondary cache ranging in size from 512 KB to 16 MB, which is also two-way set-associative.

continued

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Cached instructions are actually 37 bits long, because five extra bits are appended during a predecode stage when the instructions are prefetched into the cache. The extra bits assist full decoding by classifying the instructions according to various attributes and by preassigning them to execution units. This prefetch/predecode stage is not counted as one of the main pipeline stages.

After the instructions are fetched from the I-cache, they pass through a two-stage decoder. Actual decoding takes only one stage, however; the second stage is for register renaming.

Dynamic-register renaming is a way of expanding a processor's register file without jeopardizing software compatibility. While previous Rx000 processors had 32 integer and 32 floating-point registers, the T5 has 64 integer and 64 floating-point registers, all 64 bits wide. In each of these register files, any of the 64 physical registers can be dynamically renamed to represent the architectural register file of 32 logical registers. Thus, programs continue to see only 32 registers, but the processor has twice as many registers for storing internal values.

This technique is critically important for speculative and out-of-order execution, because it allows the T5 to store intermediate results and speculative results in the "invisible" registers. The results then become visible to the program when all dependencies have been resolved and the speculative paths have been validated.

To keep track of what's going on, the T5 maintains an *active list* of occupied registers and a *free list* of available registers. Registers on the active list can have two states: active (i.e., currently in use by an executing instruction) or completed (i.e., the final result of an executed instruction). Up to 32 instructions can be active at a time. After a completed result is graduated and no longer needed, the register is removed from the active list and added to the free list. Speculative execution can continue as long as free registers are available, and register renaming takes only a single cycle (see the figure "Register Renaming in the T5").

Register renaming also plays a crucial role in branch prediction. It's part of a clever mechanism that lets the T5 quickly abort a speculative path if a branch was wrongly predicted.

Here's how it works. The T5 speculates on every branch, up to four branches deep. At each of these junctures, the T5 takes a snapshot of the register states—what Mips calls a *shadow map* of the register-rename map as it existed at that moment. If it later turns out that a branch was mispredicted, the T5 doesn't have to flush any buffers or clear any registers. It merely restores the appropriate shadow map as the working register-rename map and then adds any registers holding invalid results to the free list. This takes only one cycle.

Therefore, the penalty for mispredicting a branch varies from one to four cycles, depending on when the T5 realizes it has guessed wrong. The worst case is when the T5 pursues speculative paths through four nested branches and then discovers *in reverse order* that it mispredicted each one. Usually, however, the oldest mispredicted branch in a series will be discovered first, because the CPU has had time to execute more instructions along the speculative path to which it leads. In that case, the penalty for aborting all four branches is only a single cycle. Any branches that follow an invalid branch must themselves be invalid, so the T5 just restores the shadow map for the oldest valid branch in the speculative tree.

Branch prediction is also dynamic, adapting to the program as it runs. The T5 records the history of each branch by setting a 2-bit flag that defines four possible states: strongly taken, weakly taken, weakly not taken, and strongly not taken. According to Mips, the T5 correctly predicts branches more than 90 percent of the time—a significant factor in real-world performance, because the integer code typically found in mainstream applications averages a branch every six instructions.

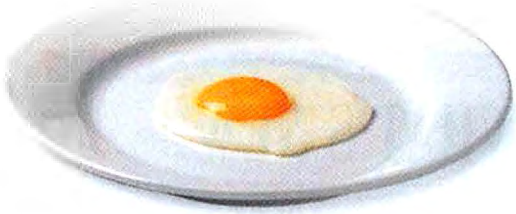
Register Renaming in the T5

Line #	Original code	Effective code	Remarks	Register mapping	Active list
1	LW R1,x	LW P36,x	LoadWord "x" into R1	Logical R1 to physical P36	P36 added
2	LW R2,y	LW P47,y	LoadWord "y" into R2	Logical R2 to physical P47	P47 added
3	ADD R3,R1,R2	ADD P48,P36,P47	Add R1+R2 into R3 Dependencies: lines 1,2	Logical R3 to physical P48	P48 added
4	BGTZ R3,Label	BGTZ P48,Label	Branch to Label if R3>0 Dependency: line 3C		
5	LW R1,z	LW P49,z	LoadWord "z" into R1	Logical R1 to physical P49	P49 added
...					
Label: 9	ADD R5,R3,R1	ADD P51,P48,P36	Add R3+R1 into R5 Depndencies: lines 1,3	Logical R5 to physical P51	P51 added

Any of the T5's 64 integer and 64 floating-point physical registers can be renamed to represent any of the 32 integer or 32 floating-point logical (architectural) registers. Whenever an instruction needs a register, a physical register from the free list is added to the active list. When all dependencies are resolved and the instruction graduates, the physical register is renamed as a logical register. In this example, lines 1 and 2 load values into a pair of registers, R1 and R2. Line 3 adds these values together and stores the result in a third register, R3. Line 4 compares the result to zero; if it is less than or equal to zero, the program continues to line 5, which loads a value into R1. If the comparison in line 4 is greater than zero, the program branches to line 9, which adds the values in R1 and R3 and stores the result in R5. Note that execution hinges on several dependencies: Line 3 cannot complete until lines 1 and 2 complete; line 4 cannot complete until after line 3; and line 9 must await completion of lines 1 and 3. Lines 1 and 2 can complete out of order, but they will always graduate in order. Line 5 or 9 could be executed speculatively before the outcome of the branch in line 4 is known. If the branch is validated, the instructions in lines 1 to 4 will graduate, physical register P36 will be renamed as logical register R1, the instruction in line 50 will not graduate, and physical register P49 will be removed from the active list and returned to the free list.

Five-Way Execution

Even though the T5 can fetch four instructions per cycle and graduate four results per cycle, it has five execution units in between. Potentially, instructions can be issued to all five units at once, and each unit can execute and complete an instruction every cycle. The T5 is therefore something of a cross between a four-way and a five-way superscalar processor, but that apparent mismatch is no



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MIPS T5: WHAT'S NEW

- **64-bit RISC microprocessor, Rx000-compatible design.**
- **Mips' first single-chip superscalar CPU.**
- **Dynamic-branch prediction and speculative execution up to four levels deep.**
- **Out-of-order execution.**
- **Five functional units: two integer, two floating point, and load/store.**
- **Executes up to five instructions per cycle, graduates (retires) up to four per cycle.**
- **64 integer registers and 64 floating-point registers, dynamically mapped to 32 integer and 32 floating-point logical registers.**
- **32-KB, two-way set-associative instruction and data caches.**
- **On-chip control for up to 16 MB of secondary cache.**
- **Multiprocessor cluster bus supports up to four CPUs.**
- **200-MHz internal clock; external clock programmable for 200, 133, 100, 80, 67, 57, or 50 MHz.**
- **64-entry TLB, 44-bit virtual addressing.**
- **Estimated performance: 250 SPECint92, 350 SPECfp92.**
- **More than six million transistors.**
- **Fully static CMOS, 3.3-V, four-layer metal, 0.35-micron process. Approximately 290mm² die.**
- **Estimated power consumption: 20 to 30 W maximum.**
- **Sampling scheduled for late this year or early 1995; volume production by late 1995.**
- **Estimated price: $1000 to $1200.**

accident. By providing more peak bandwidth in the core, the T5 can allocate its resources more efficiently and has more headroom for future growth.

Functional units include two ALUs for integer instructions, a load/store unit, and two FPUs—one for addition and another for multiply/divide/square root calculations. The latter FPU is actually a pair of subunits (a multiplier and a divider/square root) that share the same issue and completion logic. They can execute single- or double-precision division and square-root operations in parallel.

The two ALUs are nearly identical, but one can handle integer multiplication/division (in multiple cycles) and the other has some logic for verifying predicted branches that depend on integer register values. The load/store unit handles all address calculation and translation, and it can calculate one address per cycle. It translates 44-bit virtual addresses into 40-bit physical addresses using a 64-entry, fully associative TLB (translation lookaside buffer). Each TLB entry can address two pages ranging in size from 4 KB to 16 MB.

All five pipelines have the fetch-decode-rename stages described above, as well as at least one execution stage. Counting the graduation stage at the end, therefore, the minimum pipeline depth is five stages.

Instructions remain in program order as they pass through the first three stages. Then they enter a trio of queues to await issue to their appropriate execution units. Each of these queues (one for the ALUs, one for the FPU, and another for the load/store unit) has 16 entries, and they can issue from any position in the queue. In other words, this is where the instruction stream starts to deviate from original program order.

Under certain conditions, the T5 can issue up to five instructions per cycle from these queues. In most cases, however, it will issue one to four instructions, depending on the instruction mix.

As usual for a RISC chip, the vast majority of instructions execute in a single cycle. Single- or double-precision floating-point multiply, add, subtract, compare, and convert operations require two cycles, although multiplications need a third cycle to transfer the result. More complex floating-point instructions that are computed iteratively may consume numerous cycles.

Load operations require two cycles if they hit the data cache, and they can be executed speculatively and out of order. This is important because loads account for about 20 percent of all instructions, and the speculative execution of other instructions will screech to a halt if they depend on data that isn't available yet.

This also explains why Mips doubled the size of the data cache, from 16 KB in the R4000 to 32 KB in the T5. A heavily pipelined processor like the T5 can gobble data at a prodigious rate. The cycle times of memory and microprocessors were about the same 10 years ago; today, we have 60-nanosecond DRAM mated to screamers such as the T5, which at 200 MHz has a cycle time of only 5 ns. And because the T5 graduates up to four instructions per cycle, at times it's equivalent to a scalar CPU running at 800 MHz.

During the final pipeline stage, completed instructions aren't allowed to graduate until any dependencies are resolved and speculative paths are verified. The T5 also maintains precise exceptions: Any completed instructions following the instruction that caused the exception aren't permitted to graduate, either.

During graduation, physical registers are renamed as logical registers to validate their results, and the oldest completed instructions always graduate first. This restores the instruction stream to its original program order.

Mips Dynamics

As long as the T5 doesn't trigger an exception, mispredict too many branches, run out of free registers, overflow its queues, or miss the cache, it will deliver something close to its peak throughput. Although that seems like a lot of ifs, simulations indicate that the T5 is very efficient. As with all CPUs running real-world software, it spends a fair amount of time recovering from cache misses, but when everything clicks, the pipelines gush oil. Mips says that existing R4000 binaries appear to run almost like optimized code, a tribute to the effectiveness of the T5's dynamic scheduling.

"There is less need to recompile for the T5 than there is for a classic superscalar," says John R. Mashey, director of systems technology at Mips and one of the 90 engineers who designed the T5. "The hardware is doing a lot of what compilers sometimes had to do. When you're designing a compiler for a classic static-issue superscalar, you sometimes work real hard to arrange things, like moving loads and branches further apart, being careful not to have two loads in a set of a couple instructions, because you know the chip is only going to single-issue. Here, you just kind of don't care." ■

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

SPECIAL BYTE REPORT

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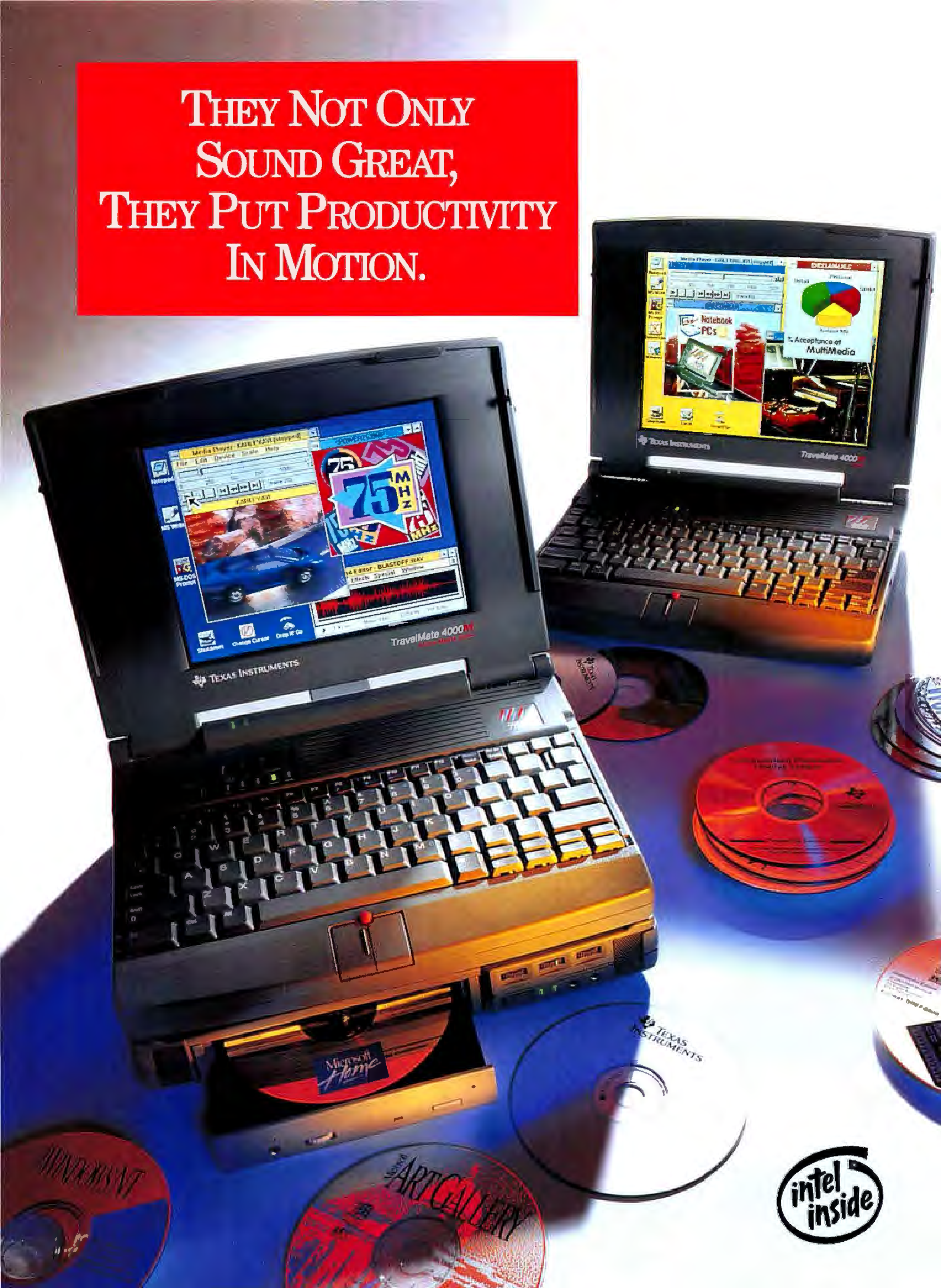
Microsoft's newest operating systems promise a whole new set of features—and complications.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Exploring Chicago

Although they share common features, the newest versions of Windows and NT have fundamental differences

JON UDELL

As summer 1994 drew to a close, beta testers were evaluating the two newest members of the Windows family of operating systems: Windows 95 (aka Chicago, due in 1995) in its first beta release, and Windows NT 3.5 (aka Daytona, due now) in its last.

The two siblings have a lot in common. They can run some of the same Win32 applications. They can work with each others' files, printers, clipboards, mailboxes, and even registries. And, of course, they can both run legacy DOS and Win16 applications.

But their differences are equally profound. Chicago is a mongrel, with preemptive multithreading and 32-bit capability grafted onto a 16-bit DOS/Windows foundation.

and Daytona

Daytona, the second generation of Windows NT, is a purebred, multithreaded and 32-bit from the ground up. To use another analogy, Chicago is like a car, designed for the average home or business user. Daytona, on the other hand, is like a Mack truck. It carries big loads for servers and serious business, scientific, and engineering users whose tasks justify powerful x86 or RISC workstations. Chicago, though built on a weaker foundation, can reach a large population of systems, so it gets first dibs on important advances, such as Plug and Play and MAPI 1.0. Although Daytona is built on a far stronger foundation, it finds a smaller group of machines to run on today, so it has to wait for some of the cutting-edge stuff.

Which to choose: Chicago or Daytona? It's increasingly clear that while both have important roles to play, they won't eradicate the deeply entrenched Windows 3.1 anytime soon. Four-MB desktop and laptop systems and 16-bit Windows applications continue to sell in huge numbers. Chicago and Daytona demand more powerful systems and applications.

The good news is that once companies start supplying users with bigger, smarter systems and Win32 applications, either Chicago or Daytona can make those users far more productive. The bad news is that during the transition period, the coexistence of Windows 3.1, Chicago, and Windows NT (not to mention other options, such as OS/2) will create headaches for software developers, systems managers, and users alike. As with all families, the Windows family of operating systems can sometimes drive you crazy.

Chicago in 4 MB

"Runs great in 4 MB!" That was the unofficial battle cry of the Chicago development team. The official claim, once Microsoft admitted that there actually *was* a Chicago, was more guarded and more carefully qualified. "If you're happy with Windows 3.1 in 4 MB," Microsoft said, "you'll be happy with Chicago in 4 MB." Even this, however, now seems unlikely, based on the (admittedly two-months stale) beta 1 release of the product.

I keep a low-end PC on hand, partly out of inertia and partly to test these kinds of claims. This system began life as a 4-MB Gateway 386/20. DoubleSpace expanded its 80-MB hard disk to a more livable 150 MB; a CPU upgrade (to a Cyrix CX486DRX2) accelerated the system nicely; and Media Vision's Memphis multimedia kit added sound, MIDI, and CD-ROM capabilities. But it's really still just a dinky PC. I won't say I'm happy with Windows 3.1's performance on this machine, but I will say that Windows 3.1 can get useful work out of it, handling easy tasks such as writing, telecommunicating, CD-ROM information retrieval, and MIDI recording/playback well enough.

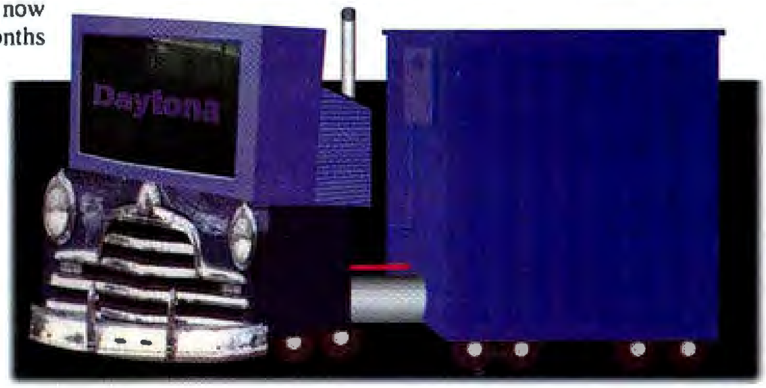
Running Windows for Workgroups on this humble Gateway is another matter entirely, however. With networking turned on so that I can remotely access the office network, WFW thrashes. I've found 6 MB to be the practical minimum for WFW with networking; it works in 4 MB only without it—in effect, you're running the equivalent of Windows 3.1 beefed up with 32-bit file access. (How *can* you work remotely with a 4-MB Windows PC? Straight Windows 3.1, the NetWare shell, and Shiva's asynchronous IPX is one lightweight combination that has worked well for me.)

Since WFW was the dress rehearsal for Chicago's 32-bit network and file I/O subsystems, you should base size expectations for Chicago on WFW rather than on straight Windows 3.1 (although Microsoft hasn't been clear about this distinction). I didn't expect Chicago to make the 4-MB Gateway a useful networked machine; I expected it to make it just a useful stand-alone machine, as both Windows 3.1 and WFW do.

Chicago found the Gateway's S3-based Orchid Fahrenheit video board and the ProAudio Spectrum sound card with its Trantor SCSI connector, migrated the Windows 3.1 program groups and desktop settings, and rebooted. Chicago came back up with the correct wallpaper and chimed to announce that the sound system was working.

Unfortunately, that's about all I could get it to do. My 4-MB Gateway was transformed, for all practical purposes, into a boat anchor. It can run the Chicago shell, but almost nothing else—not even the Control Panel, which I might otherwise have used to start jettisoning nonessentials, such as sound support.

How do you reconfigure Chicago when you can't run the Control Panel? The trusty old DOS start-up files still matter more than you think. Although you hope that Chicago's



protected-mode drivers support your hardware, installation doesn't assume that they will. Real-mode drivers that load from CONFIG.SYS and AUTOEXEC.BAT continue to load until you see that they aren't needed. For example, on my Adaptec 1742–equipped 16-MB Everex Step DX2/50, Chicago left the ASPI (advanced SCSI programming interface) and Corel SCSI drivers and MSCDEX in place. When I commented them out, the system still ran perfectly fine—even better, in fact, because its feet weren't stuck in the real-mode mud.

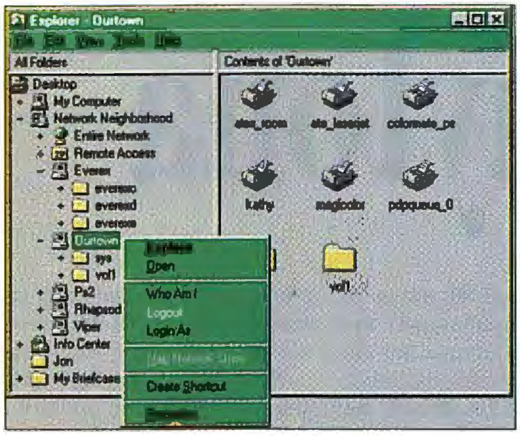
As with DOS, pressing the F8 key at boot time makes Chicago prompt before executing each line of CONFIG.SYS and AUTOEXEC.BAT. (You can also clean-boot straight into the Chicago version of DOS by pressing Alt-F5.) Using this technique, I lightened Chicago's memory load by dumping sound and CD-ROM support. DBLSPACE.BIN had to stay because its protected-mode replacement wasn't included with beta 1, although it will be available later. DoubleSpace had to run somewhere if Chicago was going to work on this machine; shifting compression to protected mode might make the system faster but isn't likely to make it much smaller.

My tweaks helped a little, but Chicago still ran out of memory trying to run its own Control Panel applets. I will be fascinated to see whether the final Chicago product can do better. Admittedly, my DoubleSpace-equipped 4-MB Gateway represents a worst-case scenario. There are, however, many such worst-case scenarios in the real world, particularly in the form of laptop PCs.

Businesses that want their road warriors to have a fighting chance should plan to outfit their troops with bigger, faster systems, and they should jump on the Plug and Play bandwagon as soon as it's feasible to do so. But the center of gravity of the installed base moves slowly. Chicago will have to get a lot smaller and faster to run acceptably on many of the PCs that are now in use or being sold in retail stores and through mail-order catalogs.

Chicago in 8 MB

On a reasonable desktop machine—an Advanced Logic Research Flyer 32LCT with 8 MB of RAM, a 486/66 CPU, and a 340-MB Maxtor IDE drive—the Chicago story is, as you'd expect, far more compelling. I ran the installation from WFW 3.11 and, lacking a local CD-ROM drive, used the WFW redirector to borrow a remote one. In 20 minutes, Chicago was up and running, enjoying the same access to all the WFW, NT, and NetWare resources that WFW had previously enjoyed, including redirected drives, printers, and file-based and client/server network applications.



The browsing of NetWare resources (e.g., servers Ourtown and Rhapsody) using Chicago's Explorer works just like the browsing of Chicago (e.g., Everex, PS/2) and Daytona (e.g., Viper) resources. Right-clicking on a NetWare icon gives direct access to NetWare commands, such as LOGIN and WHOAMI.

Moreover, Chicago made things better than before in a couple of ways. One huge win is the unification of network namespaces and browsing methods across multiple network providers. (Note that NT has always had this kind of multiprovider capability; now the NetWare client included with Daytona visibly exploits it.)

Under WFW, I redirect to an NT drive like this:

```
net use h: \\EVEREX\EVEREXCD
```

but to a NetWare drive like this:

```
map root t:=OURTOWN\VOL1:TEMP
```

In Chicago (or Daytona), it's all done with a consistent UNC (Universal Naming Convention) syntax, so the NetWare mapping becomes the following:

```
net use t: \\OURTOWN\VOL1\TEMP
```

Under WFW, GUI-based drive and printer redirection works one way for Windows network resources and another way for NetWare resources. Chicago's Explorer treats both flavors of resources identically.

Although Chicago defaulted to the real-mode ODI-based (Open Data-Link Interface) NetWare client I had been using under WFW, I then used the Networks applet in the Control Panel to switch to the protected-mode NDIS-based NetWare client that comes with Chicago. It's still unfinished, but the NetWare client is fast and very functional. Although support for protected-mode ODI isn't part of the current plan, the recent Microsoft/Novell detente raises hopes that Chicago's already-strong NetWare support will get even stronger.

Both Chicago and Daytona have the ability to run essential NetBIOS- and RPC-based (remote procedure call) networking services over any of three transport protocols: NetBEUI, IPX/SPX, and TCP/IP. I've used all of these protocols successfully. (The Chicago and Daytona remote-access services can both use PPP, which extends this protocol's flexibility to asynchronously connected systems, too.)

Since the Chicago and Daytona TCP/IP stacks support DHCP and WINS (Windows Internet Naming Service), administration of TCP/IP is a lot easier than before (see "Automating TCP/IP in NT" on page 189). I'm running DHCP on a Daytona Advanced Server system, which automatically allocates IP addresses to my Chicago and Daytona clients, as well as to my WFW 3.11 system running the new VxD-based (virtual device driver) TCP/IP stack.

What about WINS? It isn't a factor on BYTE's single-subnet LAN. It comes into play only during the mapping of NetBIOS names across TCP/IP subnets, as an automatic and dynamic substitute for the cumbersome and static LMHOSTS file that maps NetBIOS names to IP addresses.

Despite significant TCP/IP improvements, both Chicago and Daytona default to the NetWare standard, IPX/SPX. Why? It's routable, unlike NetBEUI, and works right out of the box, unlike TCP/IP, which minimally requires that you set up DHCP (and possibly WINS) servers and keep them running all the time. Since IPX/SPX is required to connect Windows to NetWare in most corporate LANs anyway, it makes great sense to accommodate Windows to it. Multiprotocol networking is neat, but not just for its own sake. Microsoft's agnostic approach to network transports is a laudable achievement.

Two important new features, user-level security keyed to NTAS (NT Advanced Server) and NetWare servers and a so-called master key authentication service, weren't quite cooked in beta 1. When you share a Chicago resource, you'll be able

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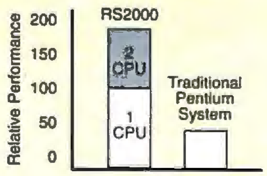

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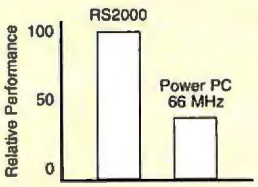

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*Multiprocessor benchmark run on the RISCstation 2000 (single and multiprocessor) and a Compaq ProLiant 66 MHz Pentium-based system with 32-bit Picture Publisher 4.0 performing a Gaussian blur on a full screen.
**MicroSoft Visual C++ Version 2.0 Development System for MIPS. ***Emulation benchmark run with 16-bit Word Perfect 5.1 on RISCstation (multiprocessor) and a 66 MHz Power Mac.

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IBM Engages Warp Drive for OS/2

STAN MIASTKOWSKI

Experience counts. That's one of the messages that IBM is continually repeating as it gets ready to roll out the next version of OS/2. The company's experience in operating-system development isn't difficult to see with the product that has gone through one of the most extensive beta tests in the history of software development.

The product I tested was named Warp. At press time, the formal name, version number, and pricing of Warp weren't available.

IBM said it would make OS/2 installation much easier through extensive built-in code for identifying the hardware on which users are installing it. The only way the company could test the hundreds of thousands of hardware combinations existing out there in the real world was to have as many users as possible test OS/2.

Although IBM declined to discuss the technical details of how Warp identifies hardware, problems with strange hardware combinations were expected, and they quickly cropped up. Three out of four PCs that I tested—starting with an ancient no-name 386/33 with a Tandy CD-ROM drive—failed to load the Warp beta version. I finally got Warp running on a genuine IBM 486/33-based PS/ValuePoint.

IBM technical support quickly released an updated installation file that solved my problems on two of the three machines that wouldn't load Warp. By the time Warp ships, IBM expects to have solved the vast majority of installation problems.

Doing More Windows

Although IBM continues to develop additional versions of OS/2 that incorporate advanced features, such as symmetrical multiprocessing, Warp is a different animal, aimed squarely at the large universe of individual Windows users who want a more advanced operating system than DOS underlying Windows 3.x. Like OS/2 for Windows 2.1, which has been available for nearly a year, Warp integrates your existing Windows installation into the OS/2 environment. This integration allows you to use Windows and its applications in the familiar manner, but with the advantage of using OS/2's preemptive multitasking and linear memory space to "wall off" applications from each other. If one crashes, the others keep running.

Unlike OS/2 for Windows 2.1, Warp now works with Windows 3.11 and Windows for Workgroups, and it is compatible with applications written for Microsoft's Win32s API. The person in charge of Warp development, Paul Giangarra, who was also the chief designer of OS/2 2.0, declined to explain how this was done, but he said it was "simply a job of polishing the code." Warp still doesn't work with applications that use Windows VxDs (virtual device drivers), but at the moment that's an extremely small part of the universe of Windows applications.

As a full-fledged 32-bit operating system, OS/2 has developed a reputation for requiring powerful processors and lots of memory. This is true enough, but in this release IBM has made an effort to produce a product that will run adequately on older processors and systems with 4 MB of RAM.

Giangarra is philosophical about this, saying the 4-MB requirement is "what the market wants but not what the industry buys." He also points out that many major Windows applications require 8 MB of RAM. Although I wasn't able to test Warp on a 4-MB system, its performance on an 8-MB PC is noticeably faster than that of its predecessor.

Giangarra adds that there's no big mystery to making Warp smaller and faster. "In first releases, you do your best. Later, you go back and shine things up," he says. IBM developed automated tools for testing and optimizing Warp code. "We produced gigabytes of traces and found the places where code wasn't efficient," says Giangarra. As a prime example, IBM completely rearranged the all-important code-paging algorithms, under the direction of the person who developed the MVS (IBM's mainframe operating system) pager.

The Workplace Shell for Warp looks similar to that for the prior version. However, in addition to the 3-D icons and LaunchPad (at the bottom of the screen), behind the shell are increased performance and additional Windows compatibility.

On a Screen Near You

At first glance, the Warp desktop looks nearly identical to that of OS/2 for Windows, but a closer exploration reveals some interesting changes and additions to its look and feel. Besides the 3-D icons (which are nice, but far from essential), IBM has done a great deal of work at making the object-oriented Workplace Shell easier to use. It still requires something of a paradigm shift to use, especially for experienced Windows users. But the more you use it, the more sense it makes.

New and useful are status-sensitive folders icons that appear opened when a folder is opened, and closed when it's closed. You can also choose to close parent folders when you open applications or folders. This makes for a desktop that's much less cluttered. And there's also a pick-up-and-drop option for moving icons, which is essentially a clipboard for icons. Finally, there's the LaunchPad, which is a handy, floating, customizable toolbar that enables you to set up your favorite folders and applications for single-click access.

Dialog boxes and settings screens hidden behind the Workplace Shell also make a lot of sense. Involved dialog boxes are split into easily accessible categories, and IBM has eliminated some of the confusing techno-speak; for example, you no longer "migrate" applications to OS/2; you "install" them.

IBM has also made an effort to make life easier for portable computer users. PlayAtWill is a new utility that IBM claims offers full plug-and-play (though not based on the Microsoft/Intel Plug and Play standard) capabilities for PCMCIA card users. Although I wasn't able to test it, IBM claims that you can associate applications with specific PCMCIA cards. For example, plugging in a fax modem card would automatically launch communications software.

Real Applications

Thankfully, IBM has tossed the wimpy and largely useless mini-applications that were shipped with previous versions of OS/2. They've been replaced by the BonusPak, which includes IBM Works (a miniature suite of 32-bit native OS/2 applications), FaxWorks for OS/2, CompuServe Information Manager for OS/2, Personal Information Manager, Person-to-Person (a simple workgroup-collaboration tool), and an advanced system configuration/testing utility.

At the bottom line, it's obvious that IBM has put a great deal of time and effort into making Warp a highly optimized, easy-to-install, and easy-to-use operating system that offers next-generation power to existing users without requiring them to invest in additional hardware.

With the delay of Windows 4.0, IBM has been handed another chance to take over a chunk of the desktop market. And, interestingly, the dearth of true 32-bit native OS/2 applications seems to have become a minor inconvenience instead of a major shortcoming, especially because of how well OS/2 integrates with existing Windows installations and applications.

Experience counts, and Warp bears all the hallmarks of an experienced operating system. But, at the bottom line, Warp's success will depend on IBM's making it widely available in the marketplace, especially through having it preinstalled on new hardware. Purchasing prior versions of OS/2, for example, required a determined effort. For Warp to be a success, that has to change.

Stan Miastkowski is a BYTE consulting editor. He is cofounder and former publisher of the OS/2 Report *newsletter and has been an OS/2 user since version 1.0. You can contact him on the Internet or BIX at stanm@bix.com or on MCI Mail at 530-9979.*

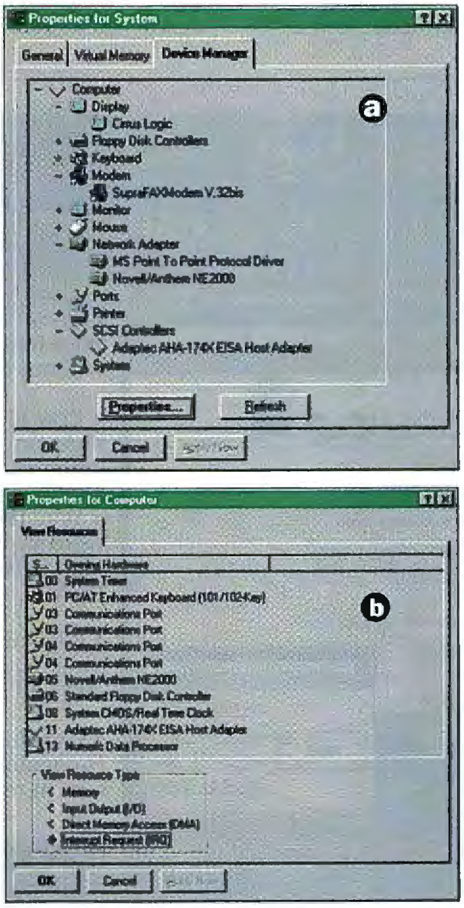
to specify share-level security, which challenges all users to unlock it with a password you assign to the resource, or user-level security, which admits only those users you select from lists authenticated by NTAS or NetWare. The latter is a great way to control the anarchy of peer networking, and I wanted to see it in action, but beta 1 Chicago couldn't find NetWare binderies and hung trying to access an NTAS user database.

Chicago's master key is another bright idea, intended to enable you to unlock a set of password-protected network, mail, and other services with a single password. In beta 1, a single password did work for both network providers and mail, but the Networks->Security->Set Passwords dialog box, where you'll administer the master key, didn't reflect that.

Managing Devices

Users' experiences with Chicago will vary wildly depending on the hardware they put it on. There's a vast difference, for example, between Chicago on a conventional system and Chicago on a Plug and Play system. Chicago can also behave very differently from one conventional system to another.

Consider the thorny problem of ISA/EISA hardware detection. Chicago tries hard, and you can read in DETLOG.TXT the record of its heroic struggle to identify motherboard, video, SCSI, network, and other devices by sniffing and poking. Results vary. When I tried it on four different machines, detection always succeeded with video, usually with SCSI, sometimes with network adapters, and, for some reason, never with modems.



Once automatically detected or manually configured, Chicago's Device Manager summarizes installed devices **(a)** and their settings **(b)**. The registration database is the configuration viewer/editor of last resort.

Of course, knowing that a Future Domain 1660 or an NE2000 is present isn't the same as knowing how that card is set. In my tests, Chicago almost always punted and took the defaults, even though my hardware often wasn't set that way. So I had to use the new Device Manager to configure boards, and in the end, detection was mostly a waste of time.

On one system, the Everex Step DX2/50, it was a disaster. Trolling for SCSI cards, Chicago kept poking I/O address 300 (used by the NE2000), hanging the system each time. Setup is restartable, but this routine gets old in a hurry: "BusLogic, are you there at 300?" Wham! "UltraStor, are you there at 300?" Wham!

Intriguingly, Daytona sailed through hardware detection on the very same Everex machine. Microsoft says that Chicago and NT share detection code and data, but it sure doesn't look that way. I've found Daytona's detection to be less ambitious than Chicago's, but more reliable. If you plan to deploy both operating systems on the same hardware, be certain to study the hardware compatibility lists carefully.

Don't assume that a Chicago machine is by definition an NT machine or vice versa. For example, I've got Daytona happily humming along on a Compaq ProLiant, giving both 66-MHz Pentium CPUs a workout. When I installed Chicago on the ProLiant, its protected-mode disk driver threw an exception and suggested that I try a real-mode substitute. In real life, you'd never waste a classy multiprocessor system like the ProLiant on Chicago. But while Chicago and NT may someday share a common pool of Win32 applications, they're further apart, in terms of device support, than Microsoft originally led us to believe.

Does Chicago's device management add any value to today's non–Plug and Play PC? Yes. Like Daytona, Chicago keeps all configuration data in the registry. Once you help it figure out what the configuration is, you can review it using the Device Manager or RegEdit (see the screen shot on page 139). And, as with Daytona, Chicago's RegEdit is RPC-enabled, so system managers can review and edit configurations on remote PCs. Furthermore, Chicago will export configuration data to system management consoles by way of DMI and SNMP agents.

Given the state of conventional hardware, your Chicago experience also depends a lot on whether your device support comes from DOS, Windows 3.x, or Chicago itself. I've tried it all different ways. Working with an unsupported SCSI controller and CD-ROM drive, it was nice to be able to fall back on DOS, but it was depressing to have to fiddle with CONFIG.SYS, AUTOEXEC.BAT, MSCDEX, SmartDrive, and more.

Working with a Future Domain 1660 cabled to a Plextor CD-ROM drive, however, life was wonderful. Using the Win32 version of Martin Heller's image3 GIF viewer, images leaped from a CD to the screen, following a 32-bit path through the SCSI driver, the disk cache, and the CD-ROM file system. All I had to do was configure the Future Domain card in Device Manager. Chicago (like Daytona) just takes care of details that DOS and Windows expect the user to handle.

Chicago won't be the only PC operating system to support Plug and Play; OS/2, PC versions of Unix, and (I hope) NetWare will, too. But with its Plug and Play–ready drivers, setup and configuration tools, and shell, Chicago currently leads the pack in readiness.

Meet the Chicago Shell

As promised, Chicago can log in to and log out from NetWare on the fly, correcting a Windows flaw that has caused endless wailing and gnashing of teeth in the corporate world. The method of access to these functions nicely demonstrates one of the principles that Chicago borrows from IBM's Workplace Shell: You right-click on shell objects to expose their properties and methods. In the case of an object that represents a NetWare server, a right-click pops up a menu from which you can directly invoke NetWare commands, such as LOGIN, LOGOUT, and WHOAMI. Right-clicking on objects that represent files reveals properties such as size and modification date, and methods such as QuickView, which invokes a viewer to show the contents of the file.

Workplace Shell users will find the Chicago shell eerily familiar. Both shells make extensive use of right-click-activated property editing and method activation, tabbed property pages, aliases (called *shadows* in OS/2, *shortcuts* in Chicago), and fully nestable folders. Both also exhibit the same fundamental design flaw: namely, failure to unify the file system with the desktop object system. In other words, the file system depends on one root (C:\), while the desktop object system depends on another (C:\DESKTOP for OS/2, or C:\WINDOWS\DESKTOP for Chicago).

What's wrong with this arrangement? It overloads the notion of a top-level folder. For example, the first thing I did with the Chicago shell was to create a top-level folder called Jon and drag some files into it. Later, browsing with the Explorer, I opened what I thought was a top-level folder called Jon and discovered those files were missing.

Where had they gone? From the shell's perspective, the top-level Jon folder was C:\WINDOWS\DESKTOP\JON, and that's where it put my files. While browsing with the Explorer, I expected to find a top-level Jon folder at the root of the C drive, where in fact I did find one: C:\JON. Which is the real top level? Either, really, depending on how you think about it. As Apple's user-interface guru Donald Norman could have told both IBM and Microsoft, this kind of conceptual overloading is a dangerous thing.

It gets worse. In some situations (e.g., the File Open dialog box), Chicago hides the desktop's root, C:\WINDOWS\DESKTOP, while in other situations (e.g., the DOS C: prompt) it doesn't. This inconsistency yields weird results. For example, I put some Visual C++ project subdirectories into the file system's top-level Jon folder, and others into the desktop's top-level Jon

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folder. All projects were accessible from Explorer, but only the C:\JON folder was accessible from the Visual C++ File Open dialog box. However, from a DOS window I was able to change directories to C:\WINDOWS\DESKTOP\JON and then load Visual C++ projects stored there by typing `start project.mak`.

True Chicago applications are supposed to call a version of File Open that respects the desktop's notion of hierarchy, not the file system's, and so will behave differently than legacy Win16 applications in this respect. Confused? I sure was.

I can hardly imagine what novice users will make of all this. On a Mac, there's no disconnection between physical and logical storage. Users know that the desktop is a view of the hard disk and that the window system and the file system are synonymous. In Windows 3.x, the File Manager/Program Manager split presents physical and logical views of storage, but Program Manager's logical view is not too ambitious and doesn't invite confusion with File Manager's overtly physical view. In OS/2, Workplace Shell, and the current Chicago shell, the logical view is very ambitious and always at war with the physical view.

A logical view of storage can be very powerful. The question is how to implement it. I think Microsoft has the right idea: Insert a high-level API between programs and their data. OLE 2.x structured storage is such an API. In Daytona's successor, Cairo, OLE-structured storage will be able to attach to, and extend, the file system. As the Explorer navigates from a file store into an object store, control will be transferred from Explorer's viewer to an object-supplied viewer. Object internals won't be stored in user-visible directory structures, so users won't trip over them.

The OLE 2.x strategy is an ingenious bridge between today's world of file-based storage and tomorrow's world of object storage. Microsoft hopes that users lured by compound documents and in situ editing will voluntarily commit more and more data to object storage. As that shift occurs, Windows will be able to sustain more comprehensive and more seamless logical views of storage.

The InfoCenter

One excellent example of how this can work is the Chicago InfoCenter, which appears as a top-level desktop folder when you install MAPI 1.0 and the Chicago mail system. There is, to be sure, a directory called C:\WINDOWS\DESKTOP\INFOCENT, which corresponds to the InfoCenter. But it's virtually empty. All you'll

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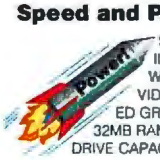

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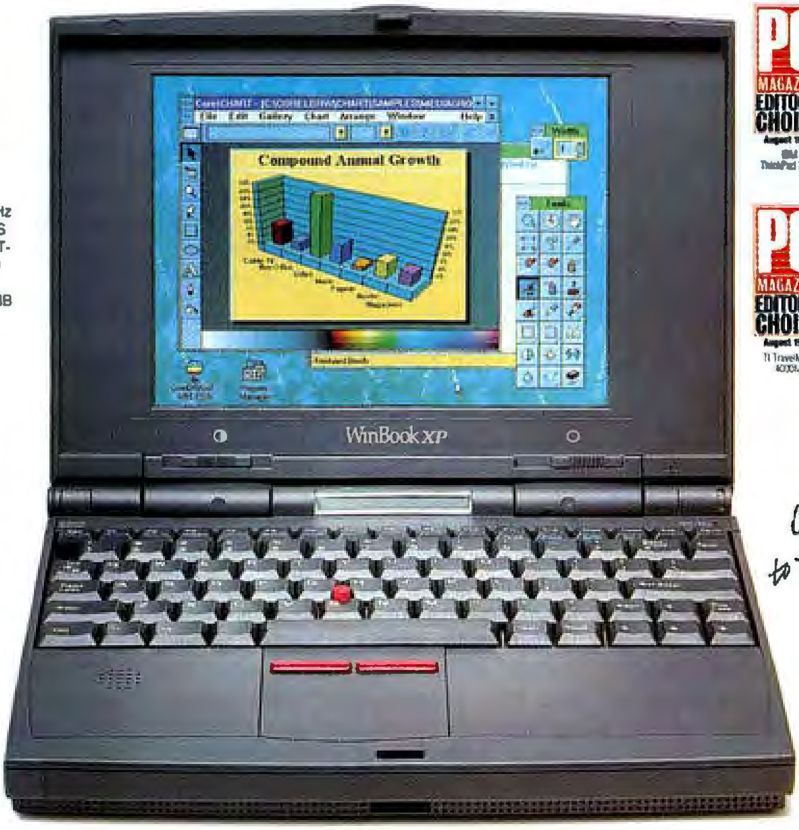

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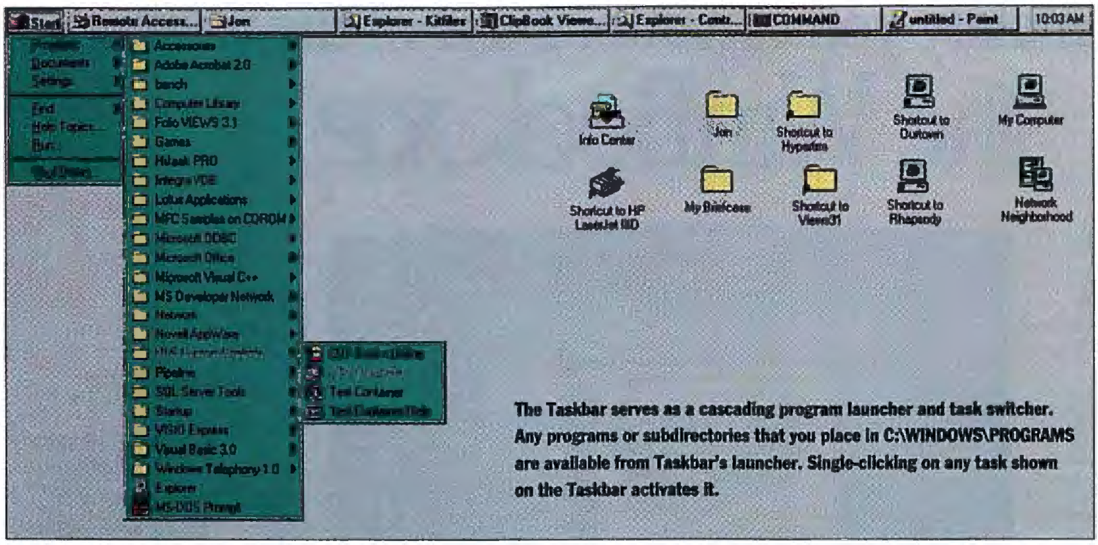


The Taskbar serves as a cascading program launcher and task switcher. Any programs or subdirectories that you place in C:\WINDOWS\PROGRAMS are available from Taskbar's launcher. Single-clicking on any task shown on the Taskbar activates it.

find is the OLE 2.x interface ID that the shell uses to invoke Chicago's mail client. It, in turn, creates a logical view of the InfoCenter as a structure of nested folders containing objects (i.e., messages) that, when right-clicked, invoke methods that are used to edit, address, send, forward, or delete messages.

This brilliant idea deserves some careful study. How can developers implement it? The mechanism is still being invented and is, like everything on the cutting edge of OLE, fairly obscure. It's not nearly as accessible as the straightforward SOM (System Object Model) hierarchy that underlies the Workplace Shell. If Microsoft follows true to form, however, a future version of MFC (Microsoft Foundation Classes) will probably encapsulate it sufficiently for the average programmer's use.

As promised, the MAPI 1.0 subsystem included with Chicago unifies message handling across multiple mail providers—a neat trick. To test it, I installed the beta CompuServe mail provider alongside the Microsoft Mail provider that's included with Chicago and configured it to share the Microsoft Mail message store and private address book. Getting things to work took some persistence because the CompuServe provider wouldn't talk to my modem at first. After much poring over its script files, I found the problem. Chicago's RAS (Remote Access Service) was listening on the same COM port that the CompuServe driver needed.

Contention for that port wasn't a problem for HyperTrm, Chicago's telecommunications tool, because HyperTrm and RAS both comply with the TAPI (Telephony API) rules for shared access. Once I shut down RAS, things worked fine. CompuServe and Microsoft Mail messages mingled happily in my inbox, and I could send a single message to users on both systems with one mouse-click.

Easier Windows?

When Microsoft user-interface researchers polled a group of Windows 3.1 users, they found that most ran one program at a time. How, then, to expose Chicago's more formidable multitasking to novice users? The shell team's answer is the Taskbar, which combines the functions of an application launcher with those of a task switcher.

Always visible unless you explicitly hide it and dockable to any edge of the screen, the Taskbar's cascading launcher puts programs and recently used documents within easy reach. Once launched, applications minimize to the Taskbar, which in turn provides a constant visual summary of what's running on the system and reactivates minimized programs with a single mouse-click. The most visible emblem of Chicago, the Taskbar serves its purpose and may help sell multitasking to the masses, but I miss the old Task Manager's handy list of running applications.

Microsoft also touts the ease-of-use benefits of Chicago's help system. Specifically, the new help system is supposed to take you to the scene of the action it describes. When you're trying to set up remote access, for example, the help topic should provide a link to the RAS configuration dialog box. That's a good idea, but not nearly the brilliant innovation that appeared in Apple's System 7.5. Because the System 7.5 Finder is Apple Event–aware, the new Mac help system can not only take the user to the scene, it can also enact the whole drama, driving the shell under script control and coaching the user along the way.

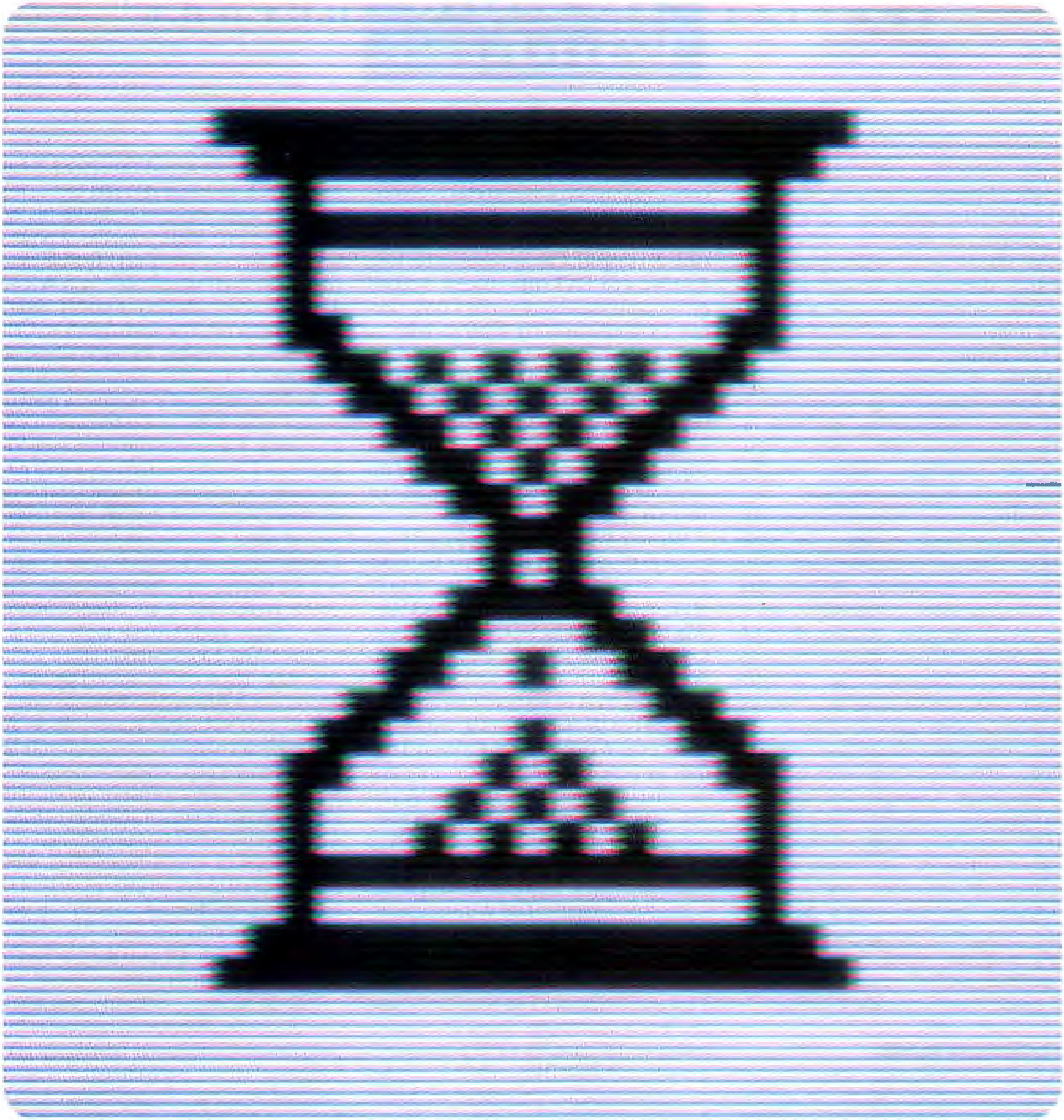
The Windows way to achieve this effect would be to OLE-automate all aspects of shell operation. Chicago will not work that way, but it should. Desktop operating systems are complicated, and no matter how you organize their knobs and levers—in dialog boxes, menus, or tabbed notebooks—there's a ton of procedural lore for users to absorb. For example, when I am configuring RAS, do I take the path Network Neighborhood->Remote Access->Connections->Dial-in Options or the path Control Panel->Network->Configuration? And which settings on which property pages found in these places do I tweak to get the results I want? Making the system the coach would be a great use of OLE 2.x automation.

Users on the Move

Chicago's so-called mobile services include single-port dial-in and dial-out remote access and a special desktop folder, called the Briefcase, that synchronizes sets of files across Chicago systems. For multiport service, you need Daytona Advanced Server, which quadruples to 264 the dial-in capacity of NT 3.1 Advanced Server.

Eventually I got both Chicago and Daytona to work as both RAS clients and servers, but fiddling with communications settings was a tedious chore. If Chicago, in particular, is going to be something that you can just hand over to a busy field-sales force, it ought to get smarter about this sort of thing. Once I was connected to the office from a Chicago PC at home, though, the view was breathtaking. For the first time as an asynchronously connected user, I could see both Windows and NetWare resources simultaneously.

In fact, there are two ways to achieve this effect. You can run multiple network clients on the remote PC, or you can run only the Windows network client and use Daytona Advanced Server on the office LAN as a gateway that republishes NetWare resources for local or remote Windows network clients. *continued*



A problem with WFW's RAS was that it tended to hog the system when communicating. Chicago's threading alleviates this problem in some cases. A file search, for example, ran nicely on a background thread. But browsing with Explorer was painfully slow in beta 1, and it monopolized the system. Click on the wrong remote folder, and you can be in for a long wait as Explorer fetches dozens—or even hundreds—of filenames. Microsoft, which has been urging Chicago developers to write network applications that work intelligently on slow links, should heed its own advice and make remote browsing incremental and more interactive.

The Briefcase is intended to help you synchronize Chicago systems using either RAS or floppies to transfer data. With RAS, you can synchronize a Briefcase that lives on your home system with a set of files back at the office, updating from office to home at the start of an evening work session, and vice versa at the end of the session. That's less useful than it sounds, though, because it requires two phone calls. I find it easier and quicker to simply drop a floppy disk into my real briefcase.

Here, though, Chicago's Briefcase metaphor failed me. I thought I could just drag it from home PC to floppy, and then from floppy to office PC. But Briefcases synchronize with sets of files, not with other Briefcases. The second step of the floppy shuffle triggered a sharing violation: You can't smash one system's Briefcase on top of the Briefcase belonging to another PC and expect them to somehow merge.

From Chicago to Daytona

Even in its current rough state, Chicago can do a lot of useful work. On my 16-MB Everex, I already prefer it to WFW 3.11. Daytona, however, now much slimmer than NT 3.1, is making a bid for dominance on this machine. The trade-offs are vexing. Chicago is snappier, especially when running demanding Win16 applications. For example, I've been building a lot of Folio Views infobases lately on this machine, and while I'd prefer to use Daytona, Chicago gets the job done quicker.

Chicago is also cleverer in some ways. For example, its new printing subsystem, which spools to an enhanced metafile that renders on a background thread, really does speed up return-to-application time. But Chicago isn't yet immune to those annoying "The system has become unstable" messages, and, given its heritage, it likely never will be. Daytona, on the other hand, has the stability I cherish. Its sophisticated performance-monitoring and event-logging services also make it inherently far more manageable than Chicago.

Other Daytona improvements include OLE 2.0 support, Chicago-compatible long filenames on FAT (file allocation table) file systems, the ability to run VDMs (virtual DOS machines) in separate address spaces, smaller and faster network transports, and OpenGL 3-D graphics. The beta version I tested ran Win16 programs somewhat faster than NT 3.1 did on x86 hardware, and dramatically faster on Mips and Alpha systems, thanks to an improved Insignia emulator and WOW (Windows on Windows) subsystem.

Because Windows 3.x is the cash cow, these extensions get built first in 16-bit form. Then they migrate to the Win32 platforms, but not necessarily in lockstep. Win16 applications on Chicago or Daytona need 16-bit services, Win32 applications need 32-bit services, and 16- and 32-bit flavors must be made to interoperate.

If you're thinking about a staged upgrade from Windows 3.x to Chicago, Daytona, or both, you will need to verify that the components you need are available and will work in the combinations you require. Is there light at the end of this tunnel? Not, I think, until Win32 becomes the preferred platform for new Windows extensions.

Daytona's multi-VDM Win16 capability works well, protecting Win16 applications from one another. Microsoft says that Daytona would ensure reliable DDE and OLE traffic across VDM boundaries, and my tests bear out that claim. This feat is easier for NT than for OS/2 because NT can use its Win32 DDE and OLE engines to route the traffic, while OS/2 has to use its own special-purpose router.

The advent of OpenGL graphics bolsters NT's claim on the scientific workstation market. The OpenGL SDK (Software Development Kit) demonstrations and the way-cool new 3-D Pipes screen saver appear very much at home running on an SGI/Mips R4400–based Magnum. Microsoft says the Daytona implementation can exploit accelerated OpenGL hardware.

Daytona does not, however, deeply integrate OpenGL with Win32. OpenGL is a separate library that owns regions of the screen bounded by Win32 frames. Win32's imaging model, which works in only two dimensions, could make excellent use of the third, but for now, Win32 applications and OpenGL applications inhabit different worlds.

The Win32 Horizon

The first beta version of Excel for NT has just arrived, for x86 and Alpha CPUs. It's a Win32 application, so it should run on Chicago, right? Well, someday it probably will, but not yet. Excel for Chicago (if it exists yet) would also be a Win32 application, so it should run on NT, right? Well, maybe not, if it binds tightly to Chicago shell services that are not available on Daytona.

At the moment, it's sometimes hard to predict what won't run where, or to explain why. Of course, the Microsoft Visual C++ 2.0 beta version that's now circulating can generate x86 Win32 binaries for both Chicago and Daytona, and its version of MFC can even render some user-interface details in a context-sensitive manner. So, there's hope from that quarter for source-compatible, if not binary-compatible, Chicago and Daytona applications.

Some Win32 applications that are available today do run on Chicago or Daytona—MicroEdge's Visual SlickEdit, for example. Even if such applications show up in significant numbers, there will still be a performance gap between Chicago and NT. A lightweight operating system will always get more out of a given set of hardware than an industrial-strength one. So, on uniprocessor x86 hardware, if you want flat-out speed above all else, run a Win32 application on Chicago—not NT—if you can. Given multiprocessor or RISC hardware, though, only NT can take that Win32 application to full throttle.

I favor security, reliability, and manageability over raw speed, as long as the performance is adequate. Daytona's performance will be good enough for more desktops than NT 3.1's performance was; however, for Win16 applications, it still likely won't match Windows 3.x, Chicago, or the latest version of OS/2 (see the text box "IBM Engages Warp Drive for OS/2" on page 138). For Win32 applications as well, Daytona likely won't outrun Chicago. On smaller systems, NT isn't even an option.

The upshot is that we'll be living with the whole Windows clan for the foreseeable future. CONFIG.SYS and SYSTEM .INI wizards can now branch out into new realms of registration-database esoterica. I guess this is progress, but could somebody please pass me the ibuprofen? ■

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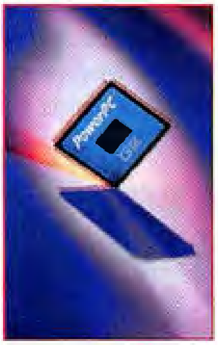

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Windows Becomes DSP-Aware

ANDREW W. DAVIS

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Chicago promises many new features and benefits, but none will have a more dramatic effect on multimedia and business communications than Chicago's new DSP (digital signal processor) architecture. Its key components are a new layer of code dubbed the DSPRM (DSP Resource Manager) and two new DSP programming interfaces. These interfaces will shield applications software from hardware details and make it more attractive for independent hardware and software vendors to offer DSP-aware products.

Users will benefit from a new class of easier-to-use, higher-performance, and multipurpose audio, telephony, and multimedia devices. While the new DSP architecture will appear for the first time with the release of Chicago, Microsoft is clearly targeting the new DSPRM for other Microsoft operating systems as well, including Windows NT.

Any future-oriented, PC-based DSP architecture is directed toward general-purpose, programmable (RAM-based) DSP chips. These chips are true multimedia coprocessors that can run their own multitasking operating systems. Using a DSP coprocessor with its own real-time operating system has obvious performance advantages when running multiple simultaneous applications under Chicago.

But the Microsoft DSP specification is also compatible with dedicated hard-wired (ROM-based) DSPs, such as modem chip sets and sound chips, as well as with signal processing done on the host processor. Host-based signal processing is likely to become more important as the new Pentium and PowerPC chips gain market share. These processors are fast enough to provide some level of real-time response for multimedia applications, or they have embedded DSP capabilities. Host-based signal processing is likely to be favored for entry-level systems where low cost is the primary design goal.

One purpose of the DSP architecture is to enable the DSP to carry out several operations simultaneously, servicing multiple concurrent processes, such as audio and fax, on the host. Because the processes on the host may be totally independent, the DSPRM must handle a wide variety of resource contention conditions. The DSP architecture does this by providing tools to handle resource allocation and prioritization of service requests.

Signal Processing, Chicago Style

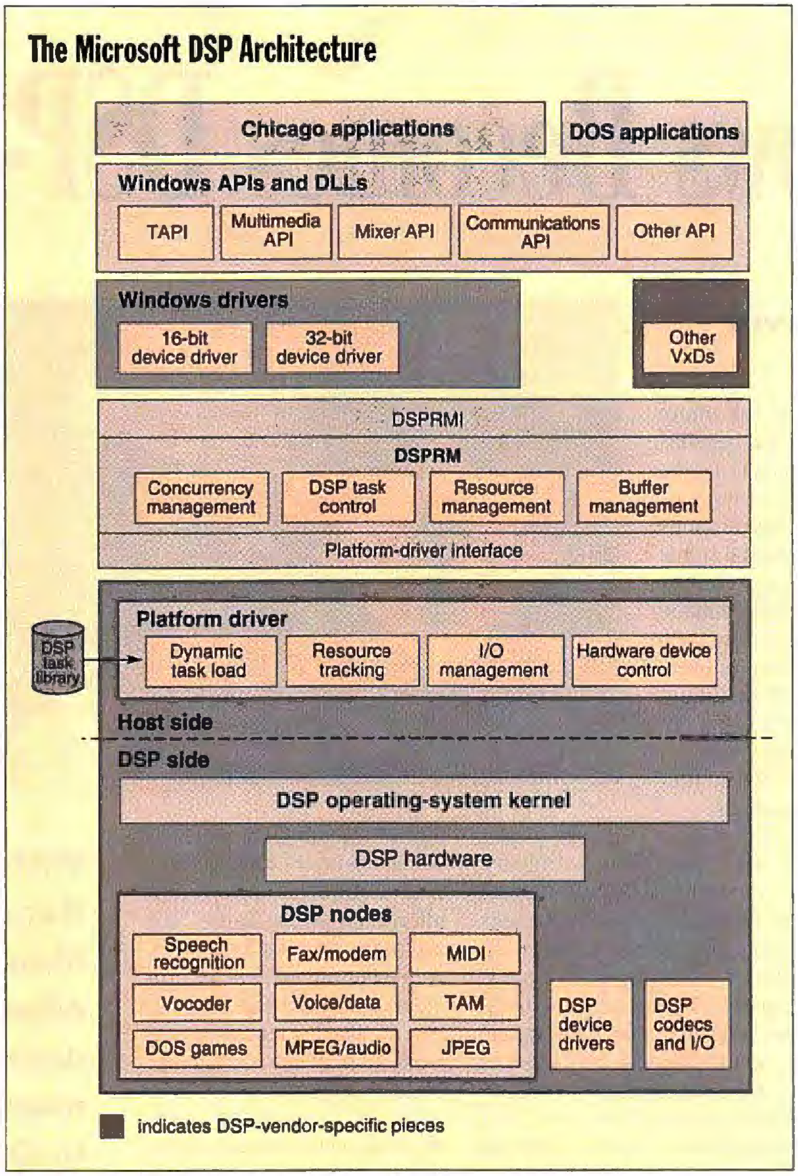
At the top layer of the Chicago DSP architecture are the applications (see the figure "The Microsoft DSP Architecture"). At the bottom are service providers, the hardware and device drivers that actually do the work. In between is a layer of middle-code, which Microsoft owns and controls. The middle-code, which creates an environment for standards, passes off commands from above to resources down below. In this case, the middle-code is the DSPRM. The interface between the middle-code and the bottom layers is known generically as an SPI (service provider interface); Microsoft calls it the platform-driver interface. The DSPRMI (DSP Resource Manager interface) is the API. The layered structure provides signal-processing services to Windows device drivers while making the low-level DSP-hardware details invisible to high-level software applications.

With the DSP Resource Manager, Chicago offers both developers and users easy entry to DSP-based devices

Windows APIs commonly abstract the hardware details from applications such as word processors or communications software. For example, TAPI (Telephony API) supports telephony devices, Wave controls waveform file I/O for speech and music applications, and a Communications API supports fax. The APIs, in turn, communicate with DLLs, which interface to Windows device drivers residing in a hardware-specific layer called the DDI (device-driver interface). A device driver operates an I/O device by mapping hardware-independent API calls to a particular hardware architecture. Hence, each board vendor needs to provide DDIs for its product.

Under Windows 3.1, DDIs communicate with add-in products over the PC bus, but for Chicago, all DDIs are supposed to go through the resource-manager layer first and then to the platform driver, which is also hardware-specific.

Under Chicago, adapting a motherboard or add-in card for signal processing will involve three steps. First, you must write a platform driver. Second, you must create a library of platform nodes or DSP nodes that the Windows device drivers can use. The DSP chip vendors typically provide these, though in many cases, they are also available from independent DSP technology houses. Finally, you must write a Windows device driver for the new platform.



Chicago's DSP architecture is centered on Microsoft's DSP Resource Manager code layer. Vendors who wish to take advantage of the architecture need to provide Windows device drivers that are compatible with the DSPRMI, a new API, and platform drivers that are compatible with the SPI (service provider interface), called the platform driver interface. High-level applications will generally use standard Windows APIs for telephony and multimedia, but for cases where the APIs do not yet exist, the applications may call the DSPRM directly.

The Platform Driver

The platform driver is a Chicago Plug and Play driver that manages the physical link between host and platform. This driver contains the details of the platform's implementation such as DSP hardware, DSP operating system, hardware interface, and I/O devices. It hides these details from the Resource Manager and Windows device drivers. The driver implements the platform-specific functions for managing hardware resources (including memory) and dynamically loading nodes, including host-DSP communications, interrupt handling, I/O techniques, and communications with the DSP system software. The extent to which a platform driver must be involved in other aspects of the DSP operation, such as node creation and control, depends on the type of DSP and DSP operating system used.

A platform driver is a dynamically loaded VxD (virtual device driver) that specifies the DSPRM as its device loader. Because Windows is a multitasking environment, platform drivers are required to be reentrant. The platform driver and not the DSPRM determines support for multiple platforms in one system. Because you can load Windows VxDs only once, platform drivers should be able to accommodate multiple platforms of the same type. Similarly, the Windows device drivers must also handle multiple platforms.

Multiple DSP implementations are likely to fall into one of two categories: single or multiple platform. A single-platform driver would present the illusion of a single powerful DSP to the DSPRM, although the hardware consists of multiple DSPs. A multiple-platform driver recognizes that different DSPs are available, such as one for audio services and a separate DSP architecture for video compression/decompression.

The platform driver runs the DSP code. The Microsoft specification does not attempt to standardize DSP code, which is typically stored in a library or database of images and information. The code is also specific to the DSP chip used. To meet Microsoft's minimum specifications, the platform driver must supply three abstract interfaces to the Resource Manager: stream I/O, message I/O (events), and node control.

Nodes

DSP nodes are the code that the DSP runs to process requests by Windows device drivers or service providers. *Node* refers to entities that can be logically interconnected to perform operations and that the client device drivers can access. A node can be a task, an I/O thread, a device (e.g., a stereo codec), or a combination of elements. The code sets for data/fax modem, wavetable synthesis, and speech compression are all nodes. Nodes can reside anywhere. The platform driver must determine if the node resides on the DSP-based hardware platform or if it will have host-based components.

Nodes are typically stored in node

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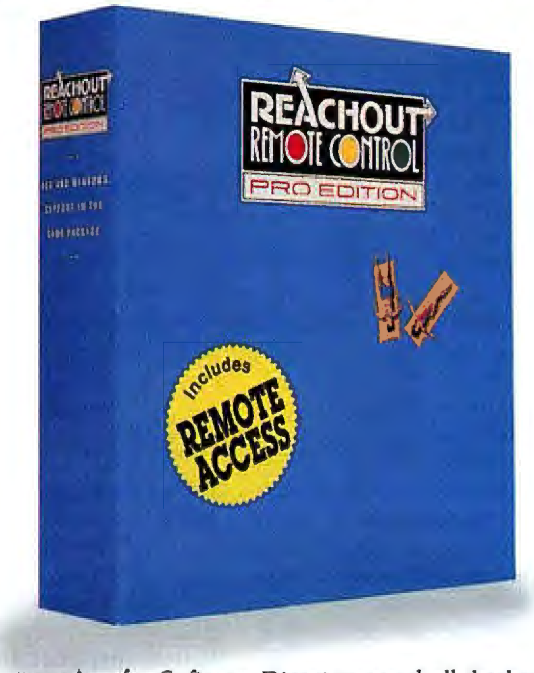

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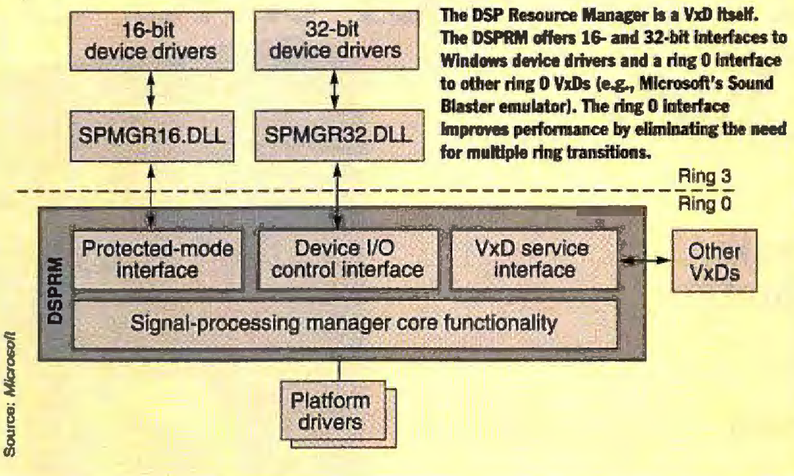
The DSP Resource Manager and Its Interfaces



The DSP Resource Manager is a VxD itself. The DSPRM offers 16- and 32-bit interfaces to Windows device drivers and a ring 0 interface to other ring 0 VxDs (e.g., Microsoft's Sound Blaster emulator). The ring 0 interface improves performance by eliminating the need for multiple ring transitions.

Source: Microsoft

libraries where the DSPRM accesses them. When a platform driver receives a request, it retrieves an image of that node's DSP machine code and downloads it to the platform for execution. The node library contains important node-specific information, including the DSP (or host) machine code and initialization data, the resource requirements for the node (i.e., memory, I/O, and processor time), and node attributes. Node images in the library are indexed by a platform global identifier and by a type so that one library can contain any number of nodes for any number of platforms. Hence, you can use the same node type on different platforms if the node has the same function, inputs, and outputs and if it understands the same message (e.g., a Hayes AT modem command set). This architecture will enable independent algorithm developers to make a standard set of nodes work on many platforms.

Each node is tagged with three attributes: real time or not real time, evictable or not evictable, and service class. All nodes in each real-time group compete with each other for DSP attention. The attributes provide a smooth way for the DSPRM to work with the platform driver and handle overload situations. Real-time nodes get priority over nonreal-time nodes. Microsoft assumes that simultaneous real-time nodes can work cooperatively if the system resources are sufficient for all nodes to perform their functions.

The evictable flag and service-class designations let the DSPRM prioritize task loading and eviction. The DSP operating system, however, actually handles the implementation. When a resource conflict occurs, the DSPRM can halt and discard a node marked *evictable*. An executing node marked *not evictable* will not be subject to prioritized eviction. Service classes, which include telephony, modem, and games, are prioritized either by default or at run time by an application such as a Control Panel. In this way, you could designate that the "receive fax" function should take precedence over audio playback but that audio playback is a higher priority than image decompression during a multimedia presentation. Only the real-time attribute flag is visible to the platform driver itself.

A platform driver has two classes of resources available to it: single items, which are typically devices either allocated or not allocated, and countable items, such as memory that can be allocated up to some fixed limit. The platform driver communicates resource capacities and usage to the DSPRM, which acts accordingly.

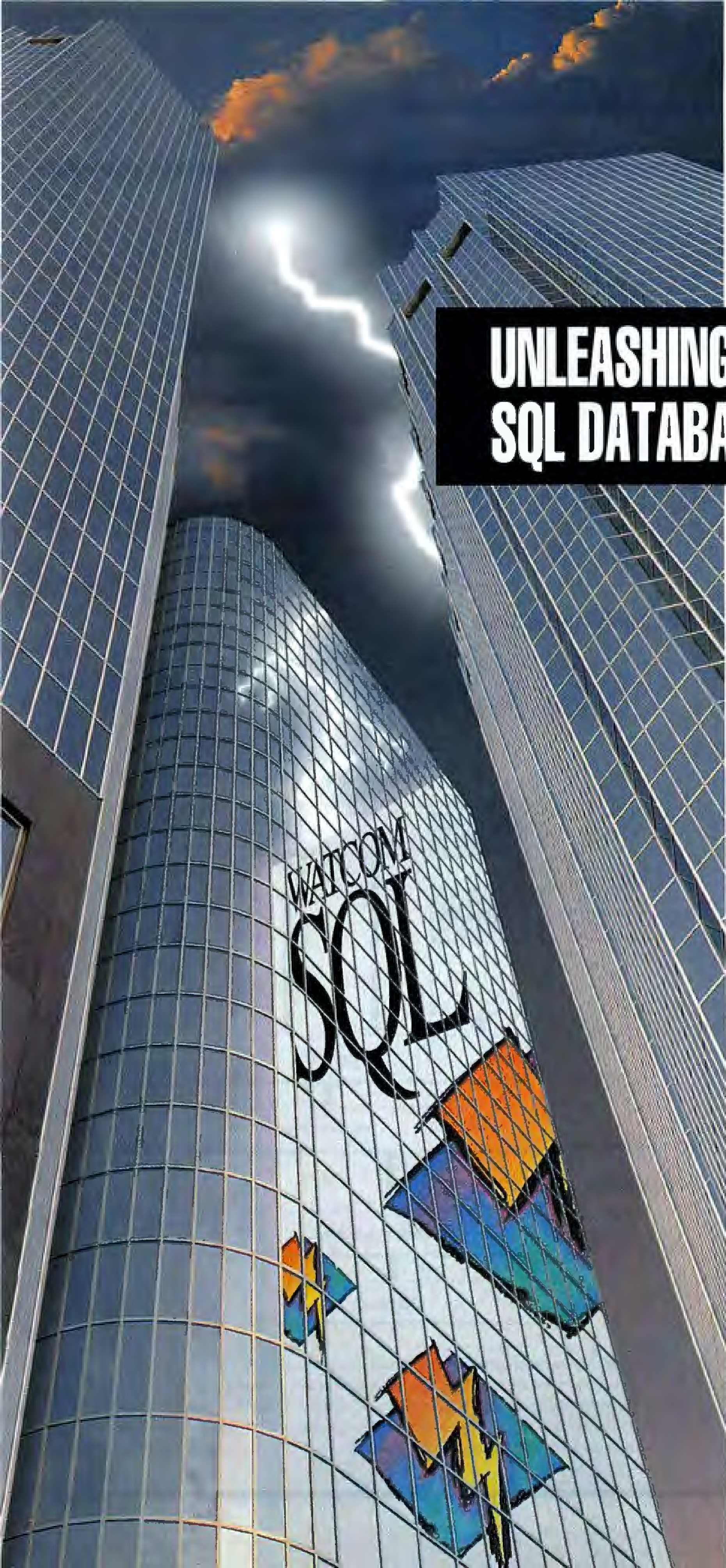
For example, when a request is made to allocate a node, the DSPRM makes the request of the platform driver. If that request fails due to insufficient resources, the DSPRM invokes prioritized node eviction. If the resource conflict includes a device that only one application can use at a time, the DSPRM identifies the nodes in conflict; if all are of equal or higher priority, it fails the allocation request. The DSPRM scans the node list, beginning with the lowest-priority service class. It then identifies and discards evictable nodes until enough resources are collected to satisfy the request. If it cannot free enough resources, the allocation request fails.

The query test for evictable nodes allows the platform driver and clients to override the eviction. More important, the query gives either the platform driver or the client an opportunity to modify tasks running on the platform to reduce resource requirements (e.g., stepping down a modem to 2400 bps).

Node eviction priorities are not always static. A node's real-

MICROSOFT'S MINIMUM AND RECOMMENDED DSP FUNCTIONALITY

	MINIMUM	RECOMMENDED
Plug and Play	Not required	Full support
Wave record and playback	11.025 and 22.05 kHz, 8-bit PCM	5.125 to 48 kHz, mono, 8-bit pulse-code stereo, and 16-bit modulation
Music synthesis	MIDI	Wavetable
Telephone interface	One line: POTS or ISDN	Two lines: POTS or ISDN
CD-ROM interface	Not required	One interface, internal or external; IDE or SCSI
Games compatibility	Not required	Compatibility with Sound Blaster, AD1848, MPU-401, and Adlib
Call types	Voice only	Voice, data, fax, and VoiceView
Telephony	DTMF generation and detection, CallerID, and popular Class features	DTMF generation and detection, CallerID, and Class features
Data communications	Not required	V.18, V.17, V.29, V.21, Channel 2, and V.27 ter
VoiceView	Not required	Full support
Multimedia devices	Telephone set (wave), telephone line (wave), audio codec (wave), line in (AUX), and mixer	Telephone set (wave), telephone line (wave), audio codec (wave), synthesis DAC (MIDI), line in (AUX), and mixer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Virtual Device Driver Services

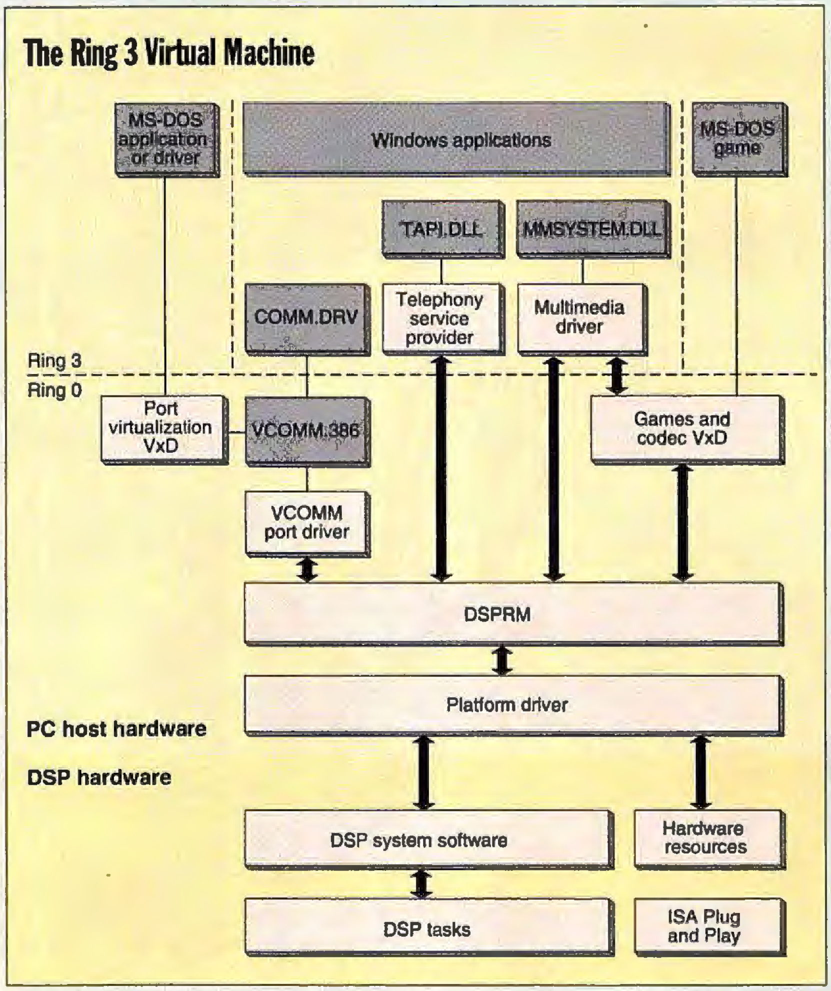
All x86 Intel processors since the 386 have had four internal protection levels, 0 to 3. Chicago uses only two of these, 0 and 3. Ring 3 is where all applications and Windows drivers reside; ring 0 is where the most privileged code resides, such as the operating-system kernel, software with full access to I/O ports, disk read/writes, and the DSPRM (digital signal processor Resource Manager). A driver at ring 0 can trap I/O port accesses and redirect them, if needed, thereby emulating a piece of hardware such as a modem or sound card.

The code that does this is called a VxD (virtual device driver). The DSPRM itself is a VxD. The DSPRM provides services for platform drivers that register the driver's control function and list the platform driver as a Plug and Play enumerator. The DSPRM also provides an interface for other client VxDs to use its COM (Common Object Model) interfaces.

In Chicago, the system can set up multiple virtual machines, all in ring 3; each DOS application and each 32-bit application is its own ring 3 VM (virtual machine), but all 16-bit Windows applications share a single VM. Windows 3.1 applications share one ring 3 VM.

The majority of the functionality of the DSPRM and platform driver is in ring 0 code. This is a shift from earlier approaches. Microsoft elected a ring 0 focus for three reasons. First, the DSPRM must present its primary interface at ring 3 to device drivers and an equivalent interface at ring 0 for VxDs. By keeping the majority of implementation in ring 3, the ring 0 interface could not have used the COM interface. Second, if implemented at ring 3 (easier to program), either the DSPRM would have to perform additional ring transitions, thereby hindering performance, or all platform drivers and client VxDs would be required to have both a ring 0 and a ring 3 component to communicate with their appropriate counterparts in the DSPRM. Finally, full services in ring 0 allow for more appropriate and efficient servicing of platform driver callbacks and VxD service requests. For example, VxDs in ring 0 have low interrupt latencies, and advisements are very fast. Note that Microsoft's VCOMM port driver and Sound Blaster implementation are already ring 0 VxDs.

Under the new DSP architecture, hardware developers will need to provide a platform driver for ring 0. This requires a new level of programming skills. VxDs are powerful but unfriendly, and they are perhaps somewhat dangerous under Chicago's loose security structure. However, Chicago will support C and C++ language-based drivers for ring 0, making the job somewhat easier. This level of code has typically been written in assembly language in the past.



The horizontal dashed line represents the divide between ring 0 and ring 3. The ring 3 VMs are separated by the dashed vertical lines. This figure illustrates a DOS application talking to code emulating a Hayes AT modem through the port virtualization VxD. The VxD then passes data to the VCOMM port driver, which is the AT command-set parser. A separate VM in the figure is a DOS game that interfaces to the games VxD (Sound Blaster emulation).

time attribute may vary. If a task requires real-time response, then all nodes that make up the task are so marked, including nodes previously marked *not real time.* In addition, while service class is a static attribute (a modem is a modem), service-class priority is a run-time attribute, and you can change class priorities to meet changing needs.

The DSPRM

The Windows device driver for any specific hardware platform supplies Windows with logical device support, such as Wave In and Wave Out, by directing the DSPRM to load the appropriate nodes for the platform and then sending the appropriate data to those nodes. In many cases, the Windows device driver is platform-specific, because the driver is responsible for knowing which algorithms and interconnections are required on the platform to provide a desired service. Long term, however, it is possible that standard node libraries will exist that will let many device drivers become device-independent.

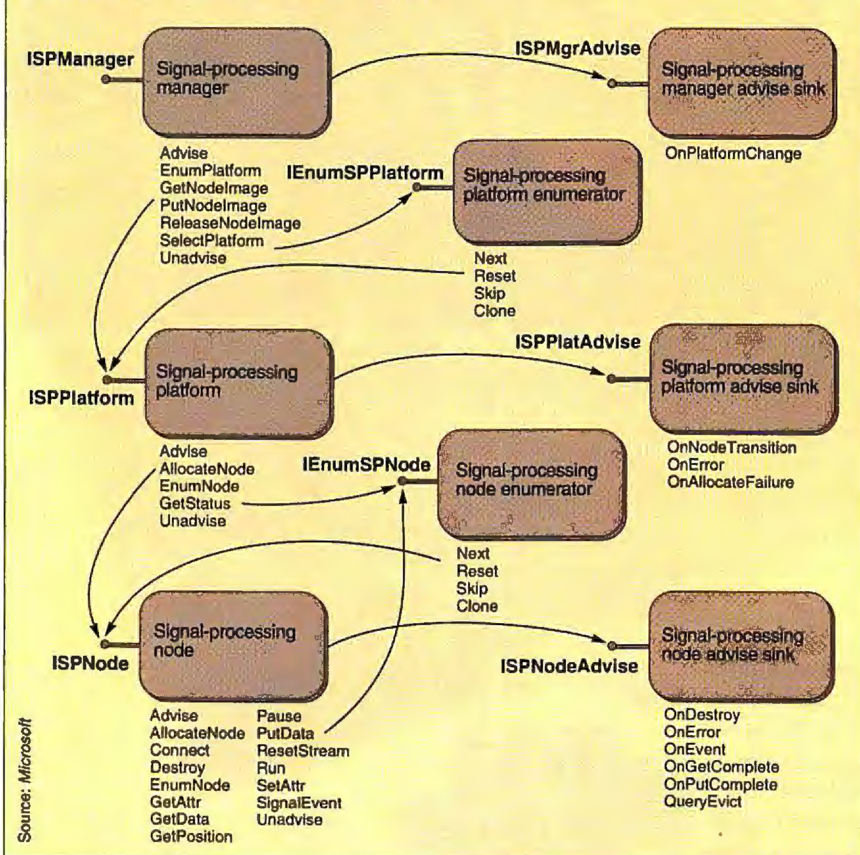
Just as Windows is a compatibility layer between applications and devices, the DSPRM is a compatibility layer between drivers and the DSP. The DSPRM resides immediately below the Windows device-driver layer and provides access to the DSP. The DSPRM standardizes the data flow and control without knowing the meaning of the data or how it is transferred. Drivers can communicate without knowing about the details of the transfers, the hardware, or the DSP software. For example, an application can request a V.32 modem and receive the appropriate services without knowing how the services are provided.

The DSPRM core code is implemented as a VxD under Chicago. The DSPRM, which is a nonreplaceable component, is a Plug and Play device loader that gets loaded when the Virtual Machine Manager starts (see the figure "The DSP Resource Manager and Its Interfaces" on page 154).

The top interface to the DSPRM is the DSPRMI, which is organized as eight OLE 2.0 Component Object Models available to 16- and 32-bit device drivers and service providers and 32-bit applications. Ring 0 access to the DSPRM is provided by a separate VxD service interface (see the text box "Virtual Device Driver Services" on page 156).

The platform driver interface contains four sets of COMs (Common Object Models) that map to comparable modules (with confusingly similar names) in the DSPRMI: `ISPPlatformDriver Interface`, `ISPPDAdvise Interface`, `ISPPDNode Interface`, and `ISPPNNodeAdvise Interface`. The DSPRM turns DSPRMI function calls over to the platform driver through the platform-driver interface. For example, a device driver does not call a platform driver directly; instead, it would use the `ISPPlatform::AllocateNode` function in the DSPRMI. This function call allocates a node on the signal-processing platform. The Resource Manager would then use the platform-driver interface `ISPPlatformDriver::AllocateNode`, which allocates all resources required to run a node. The platform driver itself retrieves the node and attempts to grab the needed CPU, memory, and I/O devices (see the figure "Interfaces to the DSP System Objects").

Interfaces to the DSP System Objects



Device drivers obtain their platform identification during load time because drivers are associated with a particular device on a specific platform. Thus, drivers may use the `ISPManager::SelectPlatform` method directly. `ISPManager` provides services to select a DSP platform, advise the system of DSP events, and make use of the node library. `ISPPlatform` is a set of routines to create nodes on the platform, perform I/O between nodes, obtain the current state of the platform, and register to receive notification about events on the platform. `ISPNode` contains the methods to send data to and from a particular node. Data movements are reported asynchronously to a calling thread so that other processing may proceed during the transfer of data to and from a physical device. `ISPNode` also contains methods for allocating nodes by groups and having them execute at once. `IEnumSPPlatform` and `IEnumSPNode` modules allow applications to find out what class of services or nodes are available and to select services based on a category level. The three object modules `ISPMgrAdvise`, `ISPPlatAdvise`, and `ISPNodeAdvise` are two-way interfaces that either the client or the caller implements; advisement interfaces provide calls to communicate platform and node status to the rest of the system asynchronously.

The DSP Platform

The bottom layers in the Chicago architecture make up the DSP hardware and chip-specific software, such as the DSP operating system (if present) and DSPs for functions such as speech compression, imaging, and modem modulations—the signal-processing services delivered to the higher levels. The DSP hardware intended

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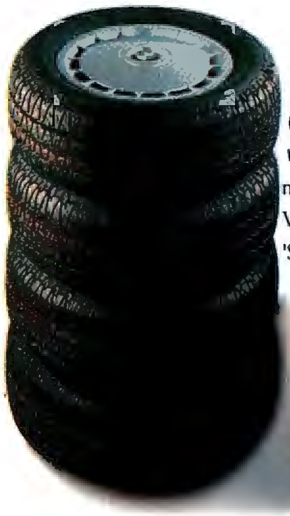

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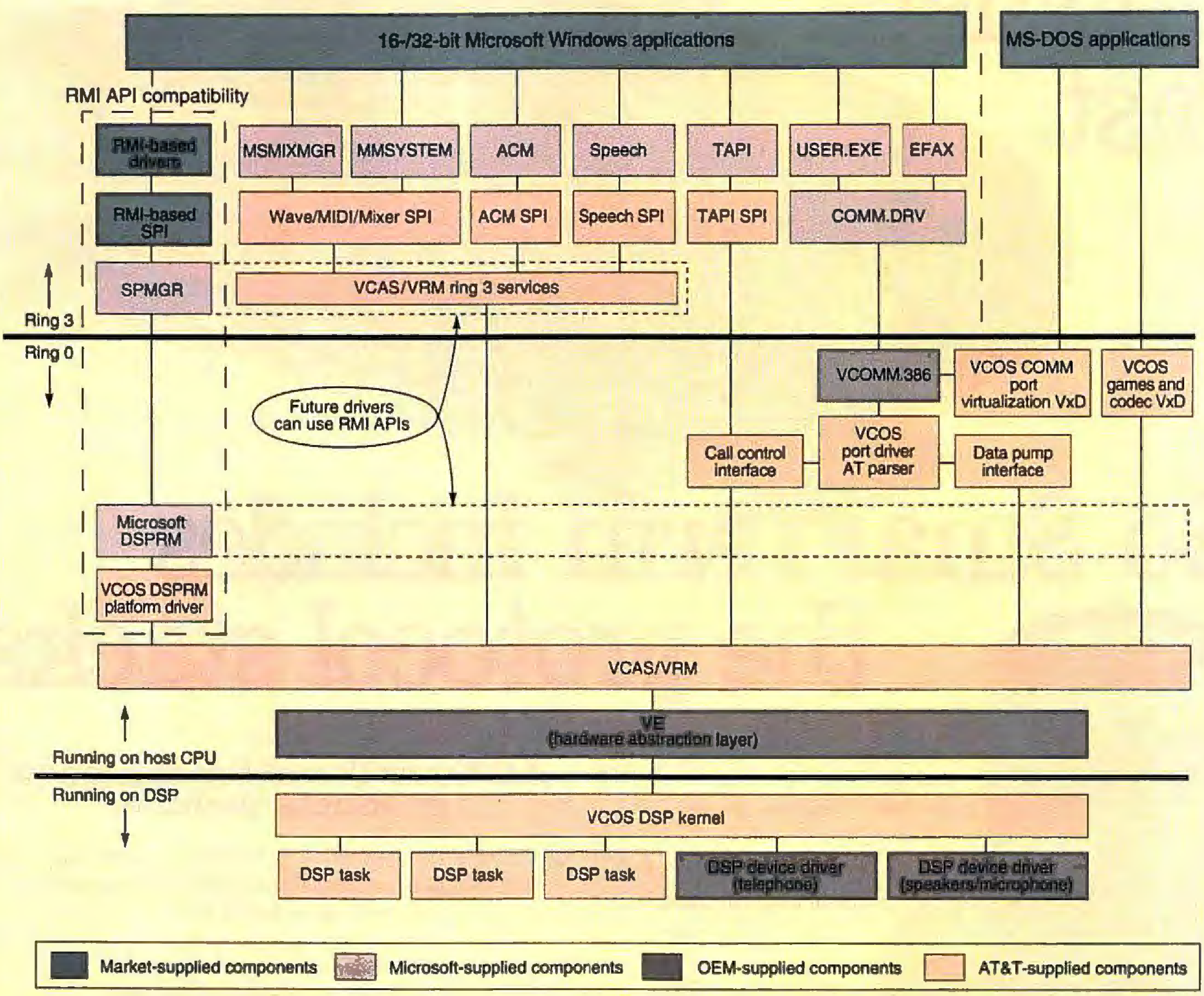
AT&T's VCOS/DSPRMI Architecture for Chicago



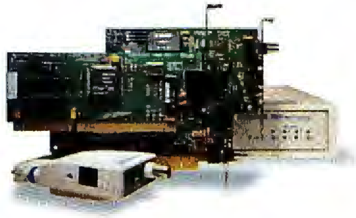
AT&T is restructuring its DSP3210/VCOS solution for the new Chicago architecture. Certain functionality has been moved from ring 3 to ring 0. The diagram shows a software structure that attaches cleanly to the Microsoft DSPRM but still provides added features. AT&T's VCAS and VRM map from Microsoft's DSPRM and a standard VCOS platform driver layer to a hardware abstraction layer that contains all the product-specific code. The VRM code running on the host keeps track of both DSP and I/O resources and usage levels and can balance loads across multiple DSPs.

for most Chicago applications includes a multipurpose, multitasking processor with its own peripherals and local memory. The DSP chip, or chips, are under the control of a real-time operating-system kernel executing on the DSP. The operating system makes calls to a variety of multimedia libraries and uses DSP device drivers for I/O functions such as telephony and audio. Suitable DSPs from Analog Devices, AT&T, IBM, Motorola, and Texas Instruments are already available.

Microsoft also calls out several desired features of the DSP operating system. These include the ability to run more than one thread of execution, which gives the system the appearance of doing many things concurrently. The DSP operating system must also provide hooks to handle real-time features, since many of the multimedia signals require real-time responses. How these features are achieved is independent of the Microsoft architecture. For example, AT&T's VCOS (frame-based), IBM's Mwave (deadline-based), and Spectron's SPOX (priority-based) all provide concurrency and real-time scheduling but use different technical approaches.

Industry Response

AT&T and IBM have been providing comprehensive DSP hardware and software solutions for Windows 3.1, and both companies have committed to making their architectures comply with the Chicago standards. AT&T's DSP solution centers around the DSP32XX chip family and VCOS; IBM has the Mwave chip and the Mwave operating system. Each company controls its own hardware and DSP software and offers a multitasking operating system with an integrated Resource Manager. For instance,



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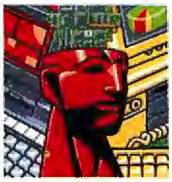

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VCOS includes the operating-system kernel for the DSP chip and a host-based applications server and Resource Manager, code that predates the DSPRM. AT&T and IBM will redesign certain pieces to move them from ring 3 (Windows 3.1) to ring 0 for Chicago and have these pieces bolt cleanly to the new architecture. Both companies already have customers with products similar to Microsoft's platform specification.

The AT&T host code centers on the VCAS/VRM (VCOS Application Server/ VCOS Resource Manager), which are constant for all AT&T's customers (see the figure "AT&T's VCOS/ DSPRMI Architecture for Chicago" on page 160). These serve as a mapping layer from Microsoft's DSPRM to a hardware abstraction layer, which AT&T calls the VE. The VE is nearly the only code that is hardware-dependent. The VCAS layer translates Microsoft's node-allocation methods to frame-based commands that the VCOS kernel can handle, while the VE understands, for example, that the hardware has one, two, or four DSP chips, each with its own I/O port, on an ISA bus board with local memory or on a PCI (Peripheral Component Interconnect) board with bus-mastering capabilities. The VRM keeps track of resource availability and allocations. For example, VRM knows that two telephone lines but only one speaker are available. It also knows that device driver YY is currently attached to the speaker and that DSP 2 is less loaded than DSP 1.

A DLL stub in ring 3 provides the transition hook to ring 0. The stub also works in reverse and offers disk I/O services to ring 0, which has no file-service capabilities. IBM Mwave has a similar structure.

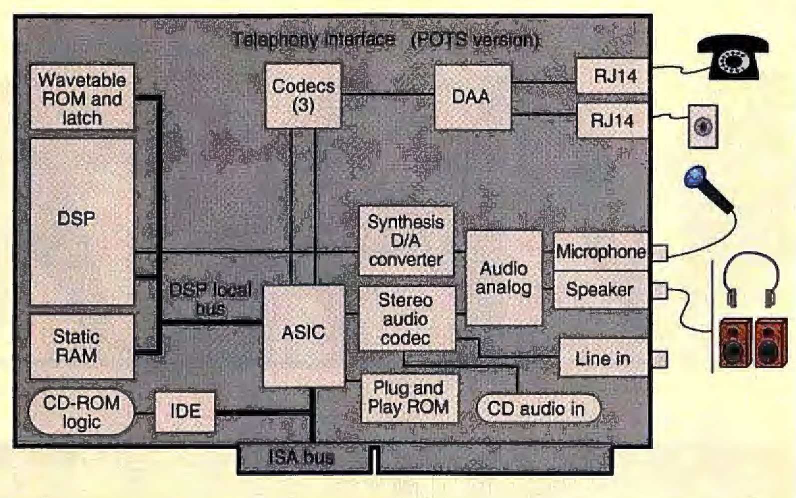
AT&T has already developed a suite of device drivers for Wave, MIDI, Mixer, and TAPI. ACM audio compression and speech are under development. Under Chicago, these drivers can continue to use the existing interfaces. They are compatible with Chicago but don't use the DSPRM services. Alternatively, in the future, if AT&T or its customers modify these drivers, the drivers can be made to go through the DSPRM layer.

Microsoft's Platform Specification

With the DSPRM, Microsoft has simultaneously published a DSP Architecture PFS (Platform Functional Specification), which describes recommended and minimum platforms and functions (see the figure "DSP ISA Adapter Architecture"). The table represents what Microsoft believes will be needed to run standard classes of applications in the areas of audio, telephony, and communications. The PFS provides a specific example of a hardware implementation that will enable Plug and Play computer telephony integration and function with standard Windows APIs, multimedia APIs, TAPI, and the new speech APIs. The PFS also provides architectural details for an example implementation of the recommended platform. Microsoft will provide design information and driver source code in the DSP platform SDK (Software Development Kit).

By publishing the PFS, Microsoft is establishing a de facto standard multimedia peripheral. It defines a playing field that includes a programmable DSP, RAM, 16-bit stereo codec, Windows Sound System–compatible mixer, wavetable synthesis ROM, two analog phone-line connections, phone head-set connection, CD-ROM interface, Plug and Play support, multichannel DMA control, and two 16-bit ISA data channels. Applications developers can write code to take advantage of the functionality described in the PDS with reasonable confidence that hardware vendors will be providing such a device.

DSP ISA Adapter Architecture



Microsoft's Platform Function Specification provides architectural details for an example implementation of the recommended Microsoft DSP architecture platform. Design information and driver source code will be provided in the DSP Architecture Platform Development Kit for this example implementation. The POTS version (analog telephone lines) is unusual in that it includes two separate phone interfaces, as well as a stereo I/O sound system with wavetable synthesis and a CD-ROM interface. Performing all these functions concurrently will be a formidable challenge to today's DSP chips.

Global Benefits

One benefit of a layered architecture is that structure and divisions of labor are well understood. In the current signal-processing market, there is no clear division between what the applications vendor and the signal-processing vendor must do. Hence, most systems are complete packaged hardware/software solutions. The Microsoft DSPRM architecture will offer structure to the market by requiring that the platform definition and base set of capabilities be well designed and meet defined programming interfaces.

If the industry adopts Microsoft's architecture as a standard, vendors will be able to build the DSP-enabled systems that customers require. DSP providers will be able to create subsystems that meet compatibility standards and that can take advantage of third-party applications. And end users will find a broad range of compatible products meeting a range of price/performance needs. Just as Microsoft Windows helped allow CAD software vendors to provide a common driver for the many different PC display systems, the DSPRM will buffer multimedia and communications software vendors from the many emerging DSP solutions. ■

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MAPI Blooms in Chicago

TOM SHELDON

ILLUSTRATION: GORDON STUDER © 1994

If the Earth is ever conquered by aliens, we may be forced to adopt their technology standards. That will be a relief for network administrators, who are trying to figure out what direction they should take with messaging systems. In the meantime, Microsoft's MAPI (Messaging API) appears poised to make Chicago a universal E-mail client, allowing potentially any Windows application to interoperate with a variety of back-end mail systems.

E-mail and messaging in general are critically important to enterprise computing. The Electronic Messaging Association predicts that the number of E-mail users will triple in 1995, with 25 million users sending 15 billion messages a year. Messaging goes well beyond the exchange of E-mail. It is a key component of groupware and work-flow applications, which allows applications to exchange information automatically. For example, the approval of a sales order by a manager might initiate a forms-routing sequence over the network. Messaging also provides a way to get information from database systems. A remote user might request information from a system with an E-mail message and receive a reply in his or her mailbox.

MAPI solves a critical problem for developers by separating the messaging requirements of applications from messaging services with an intermediary layer called the MAPI subsystem. Windows applications can use MAPI calls through the subsystem to interact with any MAPI-compliant messaging system. MAPI eliminates the need of the client application to know how a particular messaging system provides services. Companies can use MAPI to build on existing messaging systems or install new ones.

MAPI is part of Microsoft's WOSA (Windows Open Services Architecture), which Microsoft calls "a blueprint to establish Windows workstations as universal clients that fit seamlessly into heterogeneous corporate computing environments." WOSA extends the Windows API set to give desktop applications access to many types of back-end services. The other components of WOSA include ODBC (Open Database Connectivity), as well as network file services, print services, and licensing services.

By providing transport independence, MAPI lets organizations continue to use their existing messaging services while migrating users to Windows-based messaging applications. With MAPI and Chicago, you can integrate a diversity of messaging applications on the desktop. Through Chicago's Info Center, for example, you can potentially access E-mail, faxing, voice mail, BBSes, and on-line information services like CompuServe. In fact, a single inbox can serve all these applications and any underlying messaging system.

Microsoft's MAPI, with wide industry support, is set to be the desktop messaging standard

Microsoft chose a client/server approach for MAPI to help reduce bottlenecks that increased messaging generates on a LAN. A client/server architecture distributes tasks between the client side and the server side. Servers store the procedures and executable modules most commonly used by clients.

Using RPCs (remote procedure calls), clients call the procedures and servers return the results to the client. Because the executable code for the procedure is already at the server, the client just needs to send a command to invoke it. This dramatically reduces the I/O between individual users and servers and helps reduce network traffic. The store-and-forward nature of messaging complements the RPC method of client/server interaction in the network.

Management is also simplified with the client/server architectural approach when commonly used procedures and information are stored at a single server. You can upgrade these servers to high-performance systems to further boost messaging performance. When messaging services are based at a central location, they tend to be more consistent and up-to-date. For example, global directories and document-conversion routines are easier to maintain and update if they are located in one place.

What MAPI Does

- Manage message routing via a common user interface
- Manage message stores
- Manage address books for one or more messaging systems using the same user interface
- Manage different messaging transport systems
- Perform message store-and-forward functions if a message system is unavailable
- Notify of message delivery or sending

Front and Back

MAPI provides programming interfaces for two classes of software systems. Front-end applications use MAPI to access messaging services, and back-end systems make their services available to front-end applications through the MAPI functional layer. Essentially, if you create a MAPI-compliant user application, it will interface with any MAPI-compliant messaging system. Likewise, if you create back-end messaging systems, you simply make the services MAPI-compliant. In the past, the developer of a workgroup application had to create a version for each messaging system that his or her customers might use. (See the text box "Programming with MAPI" on page 168.)

MAPI does for messaging what the Windows printer system did for printing. The printer system separates the printer driver from the application, so developers don't have to write printer drivers for every printer on the market. Instead, printer drivers are included with Windows or supplied by printer manufacturers. In the same way, MAPI separates messaging applications from back-end messaging systems.

David Knight, vice president of marketing at messaging-system vendor Isocor (Brentwood, CA), uses the analogy of a stereo system. "The amplifier has all sorts of switches and can modify and route signals, but it has two sets of jacks: the RCA jacks for plugging things in, and the speaker jacks for connecting the speakers. That is very analogous to MAPI, which is a whole subsystem that sits under your client in your desktop. You carry it around with you in your PC. Applications are on one side, and an output provider module—at least one—is on the other side. The provider modules are like the speakers of the stereo. You can play any kind of music and the speakers don't care."

MAPI Architecture

MAPI is an architectural approach, not just a set of APIs. It exists as a subsystem of the entire operating system. Developers must write MAPI-compliant client applications to one of three client-side interfaces: CMC (Common Messaging Calls),

Simple MAPI, or Extended MAPI. MAPI defines four groups of services that are accessible by MAPI-compliant applications: the message store, address-book management, message transport services, and configuration management.

Both Simple MAPI and CMC were designed with simplicity in mind. This lets developers quickly and easily provide mail-enabling features in their applications. CMC is a cross-platform component that is available for Windows/DOS, Macintosh, and Unix systems.

Extended MAPI was designed to create message-intensive applications like work flow, data collection, and message management. It uses an object-oriented design and provides access to a variety of public and private message stores. Extended MAPI also supports high message volumes and complex addressing requirements. Developers can write to any of these interfaces to create applications that work with any back-end MAPI service provider.

Microsoft categorizes client applications in three general groups. First, messaging-aware applications are those that don't require messaging services. However, they let you customize the interface to include messaging options on menus. The "Send" option on the File menu in Microsoft Word for Windows is a good example of a MAPI customization. Second, messaging-enabled applications are those that require messaging services (e.g., Microsoft Mail) and that typically run over a network or on-line services.

The third category covers messaging-based workgroup applications (e.g., work-flow software), which operates over a network and makes extensive use of message stores, address books, and message-transport functions. These three categories correspond to CMC, Simple MAPI, and Extended MAPI.

Microsoft recommends that software developers use CMC when creating cross-platform, message-aware applications that don't need to support a previous version of Simple MAPI. You would use CMC or Simple MAPI to add messaging features to nonmessaging applications (e.g., a word processor or spreadsheet). Use Extended MAPI if an application is dependent on messaging and requires message stores and address books.

CMC and Simple MAPI

The X.400 API Association (XAPIA) developed CMC after work done by Microsoft on Simple MAPI. Many vendors are implementing CMC. It replaces the Simple Messaging Interface in VIM (Vendor-Independent Messaging) 2.0. Because MAPI and VIM support CMC, developers can write mail-enabled applications to a single client interface. CMC also provides a level of interoperability between MAPI and VIM.

CMC provides a basic set of 10 function calls, including send, receive, and address lookup. XAPIA is working on a new version, CMC 2.0, which will provide more complex messaging (e.g., document-attachment and directory-synchronization services). It should be available late this year. Such advanced functions were left out of the original specification to promote wide acceptance from vendors wanting to add their own custom features.

Simple MAPI is designed for Windows-only applications. Its messaging functions provide features such as send, address, and receive messages. (See the table "CMC and Simple MAPI Functions" on page 174.) Simple MAPI also supports the attachment of files and OLE objects to messages. With file-attachment capabilities, Simple MAPI can be used to create forms-routing programs. Windows' Schedule+ groupware accessory uses Simple MAPI to exchange schedules among users. Microsoft Word, Excel, and other applications also use Simple MAPI message features.

Extended MAPI Capabilities

- Access arbitrary properties in messages and recipients
- Customize messages and message formats using properties
- Develop custom features for address books
- Notify of events
- Access and search the folder hierarchy
- Perform MAPI memory management
- Substitute custom forms, such as a time sheet or calendar
- Provide "smart-form" capability, which links field information on custom forms with other applications

One of Simple MAPI's limitations is that it has a single-folder message store. In Microsoft Mail, this translates to the Inbox. Extended MAPI provides a hierarchical storage structure that allows folders within folders and the integration of message stores from different messaging systems.

Extended MAPI

Extended MAPI goes well beyond the simple mail-enabling APIs available in Simple MAPI and CMC by using object-oriented programming methods for its messaging functions. Messages, folders, and attachments are objects that you access through MAPI object structures. When a calling program opens an object, it gets a pointer to reference the object for future use.

While each object type allows different calls or operations, many calls can be made to different objects (i.e., polymorphism) to reduce the development time and code required for applications. According to Microsoft, the MAPI object model is consistent with both present and future object-oriented models for Windows, recognizing each service-provider DLL as a separate object.

Messages are stored in the hierarchical MAPI message store, which is organized into a tree of folders. Messages can have attachments, such as complete files or file pointers, OLE objects or object pointers, MAPI messages, and arbitrary binary data (e.g., sound or images). Folders, messages, and attachments are made up of properties that store data values, such as the time a message was sent, user name, subject material, and other information.

The value of the properties may be in the form of text, numbers, dates, or binary information. This use of properties simplifies message exchange with other messaging services. It also provides a way to create custom properties for workgroup applications or other special-purpose applications where messages have special significance for the application or its users.

The Messaging Subsystem

The MAPI messaging subsystem provides functions for creating a common user interface to send, receive, and save messages. It provides functions for storing messages in an outbox, forwarding messages at a later time, and providing notification of message delivery. The subsystem also provides functions for managing message stores, address books, and access to different transport providers. MAPI's services operate in the background. Because they take place when the foreground application is idle, they have little effect on system performance.

When a user logs on to a MAPI-compliant application, MAPI.DLL is loaded. It includes a message spooler that queries service providers to determine what functions and services are available for the application. MAPI.DLL receives calls from applications that use CMC, Simple MAPI, or Extended MAPI and routes messages to the appropriate message-store and address-book service providers. It places messages in message stores as they are created, and you access the address book to choose recipients for the message.

When the user or an application submits the message for delivery, the message spooler examines the message address and exposes the message to available transport providers, one of which may take on the task of delivering the message, if appropriate. The messaging subsystem can store messages and forward them when a particular messaging service becomes available. It thus operates as a clearinghouse for messages.

A security feature authorizes user access to messaging services. Users are verified (by user name/password) when they access a MAPI-related option, either the first time they make that access or every time, depending on the level of security required. For some operating systems (e.g., Windows NT), greater security is available. A unified log-on is supported, so you can access multiple workgroups with a single log-on.

Transport-Provider Responsibilities

- **Verify credentials, as the underlying messaging system requires**
- **Access outbound messages passed by the spooler**
- **Translate message formats, as the messaging system requires**
- **Generate delivery or nondelivery reports**
- **Inform the spooler of incoming messages**
- **Pass incoming data to the spooler**

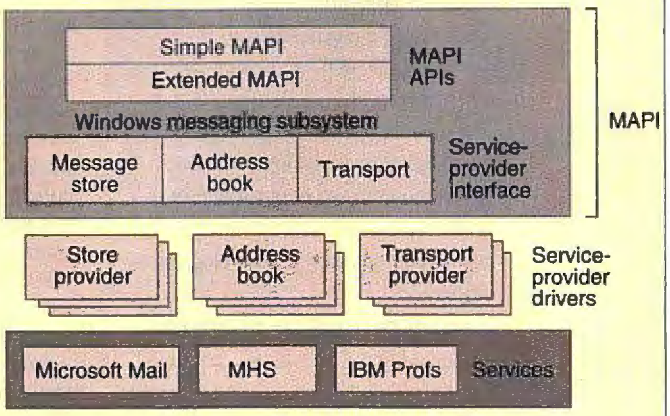
Spooler and Transport Providers

The spooler handles the sending and receiving of messages between applications and the back-end messaging services in the same way a print spooler routes jobs to each printer. The spooler interfaces with messaging-transport service providers, which are user-installable drivers that create the connection to the underlying messaging services. The spooler directs inbound messages to message stores and manages undeliverable messages.

If a messaging service is temporarily unavailable, the spooler automatically sends the message when the messaging service becomes available. The spooler performs its operations in the background, when foreground applications are idle, to minimize performance loss. Transport providers are implemented as user-installable drivers, which are installed for each messaging service that you or applications need.

In some cases, an underlying message system might not be able to accurately represent and deliver the contents of a MAPI message. In this case, the MAPI TNEF (Transport Neutral Encapsulation Format) is used to pass both text and binary message data over the system. Any unsupported MAPI properties are placed in a binary file that is attached to the message. The receiving system then decodes and restores the MAPI properties. According to Chris Williams, product manager at Microsoft, TNEF allows message transmission at "full fidelity" with no degradation, even if the message transport does not directly support MAPI capabilities.

Message-Enabled Applications



The Windows applications at the top communicate with the MAPI messaging subsystem (MAPI.DLL) using CMC, Simple MAPI, or Extended MAPI calls. The messaging subsystem responds to the calls and routes messages through an SPI (service-provider interface) to a service provider, such as the message-store SPI, the address-book SPI, or the transport-service SPI. A message spooler handles outgoing messages by passing them to the appropriate transport driver, where the matching transport service transfers the messages.

The MAPI Message Store

Extended MAPI uses message stores for all its operations. A message store is a hierarchical storage system in which folders can contain other folders and messages can be stored at any level in the hierarchy. Every message store has at least one folder that is called the root folder.

Your local message store and message stores that you may access on the network or from remote systems are stored in *collections*. As you create messages, they are placed in the message store with messages from other users. You can place copies of a single message in multiple folders, and each copy becomes an individually modifiable message. A deleted-mail folder holds messages that are marked for deletion. During a typical session, you can copy and move messages from one message store to another. Before disconnecting from a network or remote system, you can copy or move messages into their local store for later use.

Messages can have attachments (e.g., files and OLE objects). If you receive a message with an OLE object attachment such as an Excel spreadsheet, you can edit the object by activating it in the message. That message and object can be stored for later viewing or forwarded to the recipient or another user. Messages are

Programming with MAPI

All MAPI interfaces are available in both 16- and 32-bit versions to support the Windows family. You can call MAPI functions from C or C++ programs through scripting packages like Microsoft Visual Basic or by using the macro languages in Microsoft Excel or Word for Windows.

The MAPI programming architecture includes the session, the message store, and the address book. MAPI clients must establish sessions with the messaging subsystem before they can interact with the messaging stores and address books. You use the `MAPILogon` function to log clients on to the messaging system and authenticate their identity to the messaging system. You can create custom dialog boxes for the log-on process, or you can use the standard MAPI log-on dialog box.

Logging on generates a session handle that applications use to interact with the MAPI environment. A session handle is a pointer to a session object, which supports the `IMAPISession` interface. You use `IMAPISession` methods to manage and find objects in the MAPI environment.

An example is `IMAPISession::OpenAddressBook`, which opens the address book. It is possible for a single client to acquire handles to two different session objects and open two different message stores. In this way, clients can copy data between message stores in different environments.

After log-on and retrieval of a handle to a session object, the application can access message stores. You use the `IMAPISession::GetMsgStoresTable` method to get information about available message stores. The table that this method returns contains row and column information. The rows list message stores. The columns list information about the message stores, such as entry ID (i.e., unique reference), the name of the provider that handles the message store, and whether the message store is the default.

The `IMAPITable` interface is used to retrieve information from the message-stores table. For example, `IMAPITable::SetColumns` specifies a column, and `IMAPITable::QueryRows` returns the data in a specified number of rows, starting with the current column. To actually open a message store, you pass its entry ID to the `IMAPISession::OpenMsgStore` method. Once a message store is open, you use the `IMAPIMsgStore` interface to browse its folder hierarchy.

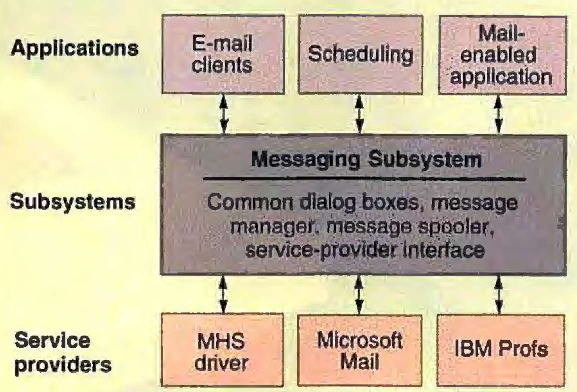
You create and manage folders with the `IFolder` interface. The functions of the interface become available when you create or open a folder object. For example, `IFolder::GetContentsTable` returns a pointer to a table of summary information. `IFolder::GetHierarchyTable` returns a table object with information about the child folders of the current folder. There are also functions for performing management on folder objects and messages in folders and for reading or setting search criteria.

objects with properties that hold information like the time the message was sent and the name of the recipient. The values of these properties are accessible by MAPI client or server applications.

Folder operations that are available in Extended MAPI include the ability of clients to examine the folder hierarchy, examine folder messages by subject or other property, search the folder hierarchy for specific information or properties, and manipulate the structure of the message store. The message store has search features that help you locate messages in folders. You can search based on the properties of message objects (e.g., user, subject, time, date, and custom properties).

A MAPI notification engine goes beyond simple polling processes that check for messages at specified time intervals. It lets clients specify various system events. When those events occur, the MAPI subsystem notifies messaging applications or service providers to take appropriate actions.

Windows Messaging System



The MAPI subsystem resides in Chicago. It provides the link between applications and back-end messaging services with a functional layer called the messaging subsystem. MAPI provides an additional number of Windows APIs that allow applications to use messaging services, including common dialog boxes, message management, and the ability to exchange messages with any back-end MAPI-compliant messaging service. Drivers are installed for each back-end messaging service you need to access.

MAPI Address-Book Providers

The MAPI address book provides message address information for all possible recipients. A typical desktop will contain your PAB (Personal Address Book) and optional address books for network or remote systems. Although a service provider typically utilizes its own addressing method, the MAPI address book hides the addressing differences by providing a unified addressing scheme for the client. You install a driver for each service provider to which you need access. Dialog boxes let you pick "human-readable" names from a list. These names are converted in the background to internally used messaging addresses.

The structure of the address book itself is organized into containers that hold recipients and recipient lists. Containers are like folders that hold other containers or recipients. They are used for organizational purposes.

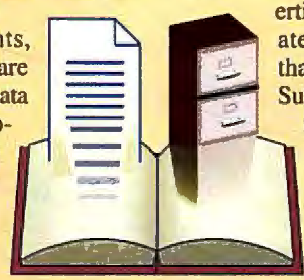
continued

Address Information

MAPI address books provide message address information and hide the differences in addressing schemes used by the different back-end messaging services. Programs can access address books without user intervention, or you give users access through the common dialog boxes provided with MAPI. The address-book dialog boxes let users pick "human-readable" names from a list, which are converted in the background to internally used messaging addresses. Address books, like MAPI message stores, are hierarchical objects. Objects in the address book (i.e., containers, mail users, and distribution lists) are accessed with unique entry IDs.

You open an address book by calling the `OpenAddressBook` method on the session object. A pointer to an address-book object is returned that supports `IAddrBook`, which is a high-level interface to the address book. It supports operations like displaying the address-book dialog box, opening containers in the address book, and resolving friendly names with E-mail names. You can view the internal organization and structure of an open address book with `IABContainer::GetHierarchyTable`. This returns a table that you can examine with the `IMAPITable` interface. MAPI provides other interfaces for creating containers in address books and adding recipients in the container.

Messages, attachments, and other MAPI objects are principally composed of data called properties. A property is a data structure that contains a unique identifier, information about the data type, and the value of the data. Applications use the `IMAPIProp` interface to read, write, and modify object properties.

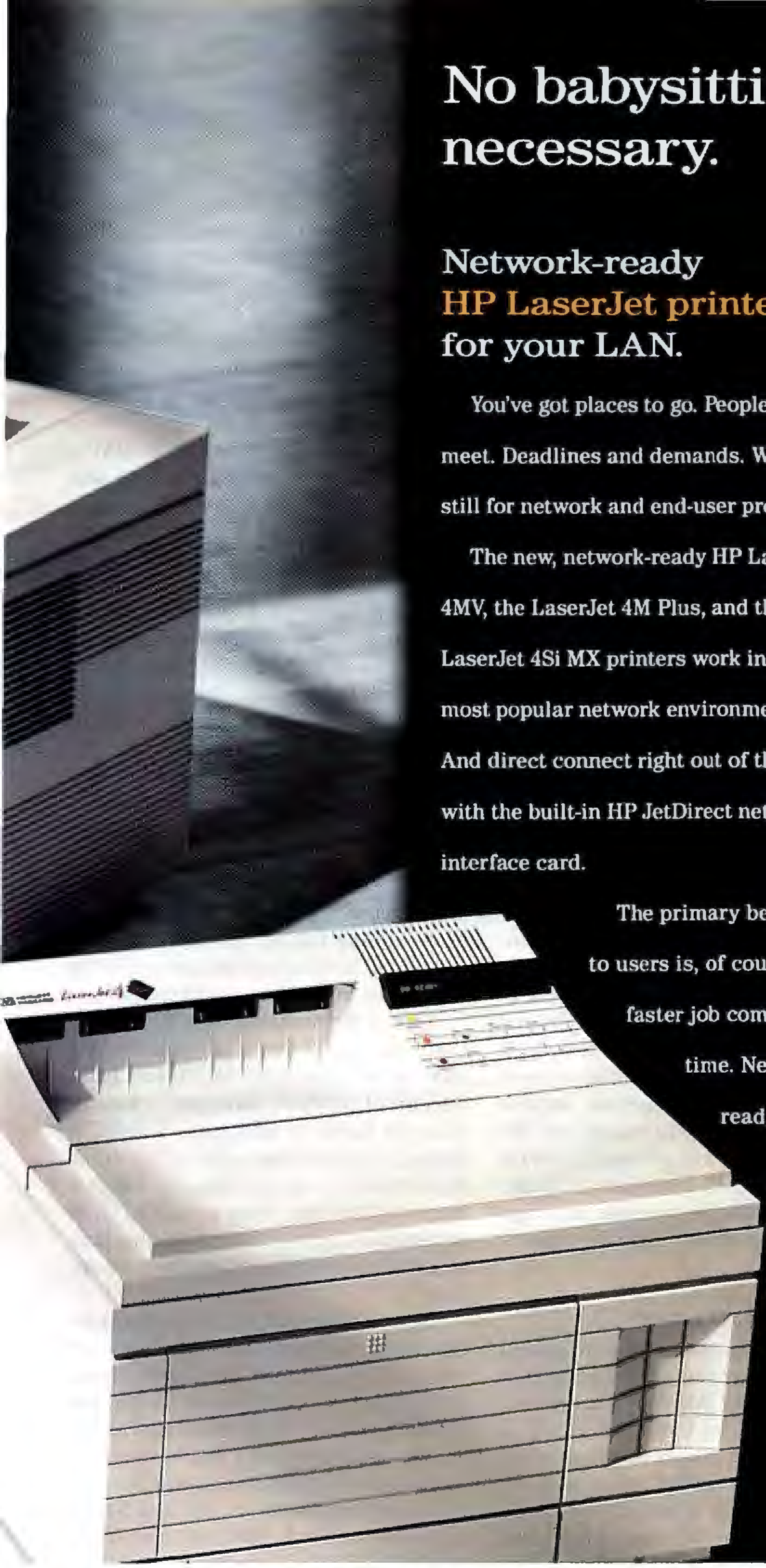


Common MAPI properties include the subject line of a message, user names, and the body of an attachment. Properties are values read by the recipient or the transport that handles the delivery of the message. Every property accessed by object methods has a unique name. For example, every MAPI object has a property called `PR_OBJECT_TYPE` that describes the type of object it is.

Finally, messages are created in folders with `IFolder::CreateMessage`. This returns a pointer to a message object. Message properties are set using `IMAPIProp::SetProps`. Message properties include the icon associated with the message, text that appears in the message's Subject field, and the text that makes up the body of the message.

So that the user can address the message, `IAddrBook::Address` is called, which returns a list of recipients that the user selected from the address-book dialog box. A pointer to this recipient list is then passed to the message object using `IMessage::Modify Recipients`. When the message is complete, it is sent with `IMessage::SubmitMessage`. This saves all changes and marks the message for sending. At this point, the underlying messaging system takes over and delivers the message.

*HP JetAdmin and similar utilities are available for NetWare, UNIX, Mac, LAN Server, LAN Manager and other popular networks. **In Canada, call 1-800-387-3867, Ext. 8549. Adobe, PostScript, and the PostScript logo



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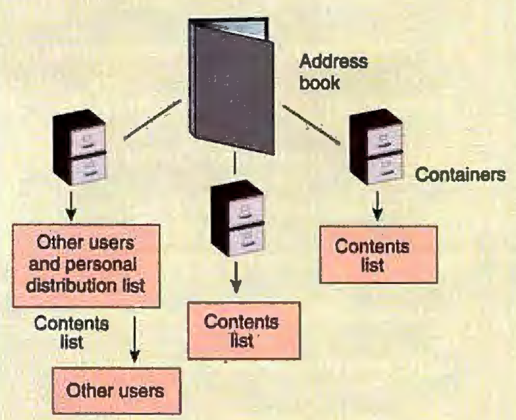
HEWLETT PACKARD

Address-Book Structure



The Extended MAPI address book gives you a view of your own PAB or the address books of other messaging systems, such as their local network. The address book is hierarchical in structure and contains lists of either users or distribution lists. A distribution list contains a group of users that will receive whatever message is addressed to the distribution list.

Distribution lists indicate recipients that are referred to by a single name. While a typical address book might use a single container to hold its list of recipients, multiple containers or hierarchies of containers are also possible. For example, an address book might have Local User and Remote User containers. Each different network messaging system will have containers that appear in the top-level address book.

You can customize a PAB, for example, to form a collection of address-book entries from other address books. If you frequently send messages to network or remote systems, you can copy the addresses to the PAB. This is not only convenient, it also places the address locally, in case the system holding a remote address book goes down. A local PAB also reduces LAN traffic.

Chicago's Info Center

MAPI's messaging-system independence is most apparent when working with Chicago's Info Center. It provides a single place where you can read and send E-mail, send and receive faxes, access workgroup servers, move messages and documents, and organize all types of information. It presents a single user interface, while providing connections to a diversity of information services (e.g., the Internet, CompuServe, and MCI Mail). At this writing, however, it is not clear which services the Info Center will support in its first release.

The Info Center is a "viewer" that works as a client to any E-mail or information system when the appropriate MAPI drivers are available. "MAPI will just call the appropriate service provider," says Isocor's Knight. "I can send the same message to 10 people, even if each one is on a different system. One can be voice-only, and it would do a text-to-speech conversion. Then it could do a fax for the next guy, MCI for the next person, and maybe France Telecom for the next."

Any information or messaging service provider can develop a MAPI driver. Chicago users will be able to access those services through the MAPI-compliant Info Center. According to Microsoft, over 60 vendors are creating MAPI drivers for their E-mail systems, voice-mail applications, workgroup applications, and information systems.

To work with the system, you log on to Chicago and choose View Inbox or Compose New Message from the Start menu. You can compose OLE 2.0–compatible messages with special fonts and styles and attach files and OLE objects. It doesn't matter if the underlying message system doesn't understand these formats, because MAPI will automatically encapsulate the special information into a binary file that is readable by a MAPI-compliant recipient. You can also access multiple message stores and address books using the same interface.

What About VIM and X.400?

Although MAPI appears to have gained industrywide acceptance, other companies have developed VIM, which is a cross-platform API. Like Extended MAPI, it simplifies the creation of messaging-reliant and mail-enabled applications by providing message-store, transport, and directory functions. Developers need only write their mail-enabled or messaging-reliant applications to one interface.

According to Ed Owens, director of technology relations at Lotus's cc:Mail division and chairman of XAPIA, over 300 software developers have obtained the new VIM toolkit. A number of applications are already on the market that use it. "In theory, VIM is independent of both the message transport and environment on which you run it, but in reality," says Owens, "the current implementation of VIM is only on Lotus messaging products like Notes and cc:Mail."

Owens notes that Lotus is developing a VIM-over-MAPI layer, so people writing to VIM will be able to run in a MAPI environment. He says that future Lotus products will provide a service-provider interface to tack up under MAPI. Third parties will have a voice on which way to go.

While the VIM camp accuses MAPI of running only under Windows, Knight claims it's only a temporary problem. Isocor is developing MAPI for Unix and similar operating systems. "We do not have customers clamoring for VIM," he says. "MAPI is already a worldwide phenomenon because it's exactly what users have been looking for: an open client/server messaging architecture that preserves the investment in backbone technology."

"One of the problems with VIM is that Lotus has stated that it is implementing VIM on the server side," says Janie Chang, director of product marketing at Infonet Software Solutions (Burnaby, British Columbia, Canada), a provider of X.400 and X.500 messaging systems. "What that means is that they want people to write applications that run over their transport, which is the cc:Mail and Lotus Notes transport."

There are three important standards for implementing back-end messaging services and backbones: the international X.400 standard, the Internet's SMTP, and Novell's MHS. A backbone minimizes the number of gateways required by clients to access a message system and provides centralized management. X.400 and SMTP are public standards. MHS is a proprietary standard. X.400 is a specification defined by the International Telecommunications

Current and Future MAPI-Supported Messaging Services

- Microsoft Mail
- Novell MHS
- Microsoft's Exchange Server
- DEC's All-In-1
- IBM Profs
- AT&T EasyLink
- CompuServe
- MCI Mail
- Hewlett-Packard
- SoftSwitch
- Banyan
- The Internet

Union that outlines how to build interoperable messaging systems. SMTP is used on the Internet and Unix networks as a store-and-forward messaging system.

While X.400 is an industry-accepted standard, SMTP has gained more popularity as a de facto standard for use with the Internet. However, Microsoft and others are developing X.400 servers that MAPI clients can plug into. Microsoft's Exchange Server implements a client/server architecture that is based on the X.400 messaging standard. It also supports X.400 message stores, which are facilities for housing data and information in the form of messages, documents, and folders.

X.400 is important because of its ability to provide interoperability and rich features. Chang notes that "the industry must mature so that certain types of information become the normal types of information that get transmitted. That is why X.400 is such a good carrier, because as a transport, it has already-defined multimedia body parts, plus very rich information when it comes to confirmations, such as receipt and delivery notification."

MAPI's Inside Track

As part of Chicago and with the support of most messaging-system vendors, MAPI has the inside track to become the solution of choice for implementing enterprise-wide messaging systems. It stands to help stabilize the messaging environment so that organizations will be more willing to undertake sophisticated messaging projects like work-flow automation.

"Architecturally, MAPI makes the most sense," says Chang. "It's probably the closest thing we have seen from a PC software vendor that actually allows the plug-and-play concept of messaging." ■

Tom Sheldon is the author of over 20 books, including Encyclopedia of Networking, *which is part of the Osborne/McGraw-Hill* LAN Times *series. He has produced educational videotapes on Windows and NetWare that are marketed by LearnKey of St. George, Utah. You can reach him on the Internet or BIX at editors@bix.com.*

CMC AND SIMPLE MAPI FUNCTIONS

Much similarity exists between CMC and Simple MAPI functions. Microsoft recommends using Simple MAPI to maintain backward compatibility with existing applications that have been written using Simple MAPI. CMC should be used by developers wanting cross-platform support.

CMC FUNCTION	MAPI FUNCTION	DESCRIPTION
CMC_Logon	MAPILogon	Establishes a session with the messaging service.
CMC_Logoff	MAPILogoff	Terminates a session with the messaging service.
CMC_Free	MAPIFree	Frees the memory allocated by the messaging service.
CMC_Send	MAPISendMail	Sends a standard mail message. Messages can be sent without any user interaction or can be prompted via a common user interface (i.e., a dialog box).
CMC_SendDocuments	MAPISendDocuments	Sends a standard mail message. This call always prompts with a dialog box for the recipient's name and other sending options. It is primarily intended for use with a scripting language such as a spreadsheet macro.
CMC_List	MAPIFindNext	Lists information about messages meeting specific criteria.
CMC_Read	MAPIReadMail	Reads a specified mail message.
CMC_ActOn	MAPISaveMail, MAPIDeleteMail	Saves or deletes a specified mail message.
CMC_LookUp	MAPIAddress, MAPIDetails, MAPIResolveName	Handles addressing chores, such as creating addresses, looking up addresses, and resolving friendly names with E-mail names.
CMC_QueryConfiguration		Determines information about the installed CMC service.

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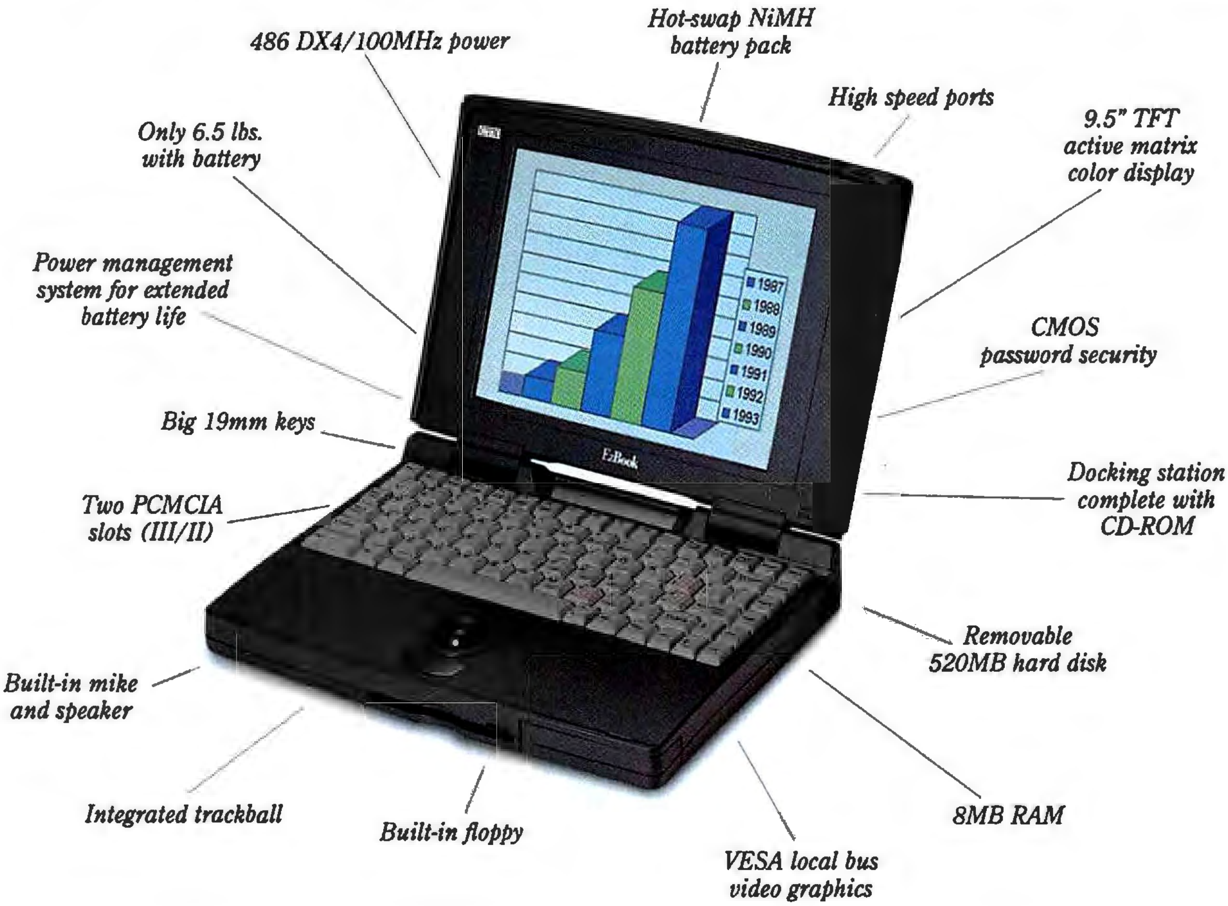

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Globalization of Windows

DEAN ABRAMSON

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Developing Windows software for the global market could be your greatest challenge. Here's how to start.

Take this pop quiz: Jane is a project manager at Really Big Airline Corp. Her group is developing the next version of its leading flight reservation software. There are $x{\times}2$ localized versions of Windows 3.1, $y{-}1$ localized versions of Windows NT, and a single, localized beta version of Chicago. How many executables should Jane's group develop if Really Big Airline Corp. plans to support facilities in 62 countries for customers and employees who work in English, German, Japanese, Russian, Greek, Hebrew, Arabic, Hindi, and Inuktitut? Who in the world *speaks* Inuktitut?

Your time's up. The correct answers are 1 and the Inuits of Alaska. If you received a perfect score, you may skip the remainder of this article and submit your résumé for Jane's job. For the rest of you, get out your highlighters and let's get started.

Globalization 101

If you are a software developer, you are likely to be involved in some facet of software localization. If you're lucky, this involves only some quick translations in your resource module, replacing the menus, dialog boxes, and stringtable. If you didn't plan ahead, you might have to build your resource module. In either case, your software is soon ready for release in 28 Latin-based languages. You tweak the code a bit, add some fonts, and presto, your software supports Russian and Greek—mostly. If you find you need a Japanese user interface, simply install the Japanese Windows SDK (Software Development Kit) from your Microsoft Developer Network CD-ROM. Then pray no one asks for Arabic.

Fortunately, there is a better way to design software for the global market. Globalization is an approach to designing software that can support the processing of data in all languages simultaneously. Each of the various Windows platforms supports software globalization to some extent; however, many of these features are restricted to specific local versions.

One for All, or All for One

Language properties get extraordinarily complex once you extend beyond the Latin script. To sort them all out requires a team of experts. The best design approach to globalizing software is to maintain strict language independence throughout your code. No portion of your software should contain code that is specific to any one language. Also, your code should rely entirely on the language services offered by the operating system or another qualified language API.

If you deviate from the language-independent model, things can quickly get out of control. The task of managing the multitude of language properties on your own can be overwhelming. Think back to your days of applications development for DOS. How many printers did you have to borrow to write all those printer drivers? Since the advent of the Windows GDI (Graphical Device Interface), you'd be crazy to use anything but the available GDI functions if you expect your application to work with any printer.

Each Windows platform offers a variety of language support functions. Unfortunately, none of the platforms are adequate for supporting true software globalization. The services they provide are generally limited to those needed for processing only in the specific local language. This means that Arabic Windows provides you with the means for processing Arabic but not Hebrew, even though the concepts and algorithms for Arabic and Hebrew are

WINDOWS LANGUAGE SUPPORT

WINDOWS VERSION	3.1 U.S./EUROPE	3.1 CHINESE/JAPANESE/KOREAN	3.1 ARABIC/HEBREW	WIN32S U.S./EUROPE	NT U.S./EUROPE	NT CHINESE/JAPANESE/KOREAN	CHICAGO [1] U.S./EUROPE
Unicode APIs	No support	No support	No support	No support	Adequate support	Adequate support	No support
Unicode conversions	No support	No support	No support	Adequate support	Adequate support	Adequate support	Adequate support
Unicode BIDi algorithm	No support	No support	Some support [2]	No support	No support	No support	No support
Keyboard switching	No support	Some support [3]	Some support [3]	No support	Some support	Some support	Some support
Input method editor	No support	Adequate support	No support	No support	No support	Adequate support	No support
Contextual analysis	No support	No support	Some support [4]	No support	No support	No support	No support
Combinational analysis	No support	No support	Some support [4]	No support	No support	No support	No support
8-bit characters	Adequate support	Adequate support	Adequate support [5]	Adequate support	Adequate support	Adequate support	Adequate support
16-bit characters	No support	Adequate support	No support	No support	Adequate support	Adequate support	Adequate support
Multibyte characters	No support	Adequate support [6]	No support	No support	No support	Adequate support [6]	No support
Font mapping	No support	No support	No support	No support	Some support	Some support	No support
Language independence	No support	No support	No support	No support	Some support	Some support	No support

❑ = No support
■ = Some support
■ = Adequate support

[1] Based on available information regarding the prerelease version of Chicago. Subject to change.
[2] Implemented with 8-bit characters.
[3] Manual keyboard switching only between the local keyboard and a Latin keyboard.
[4] Support is only for the local language.
[5] Characters from 128 to 255 are right to left.
[6] Characters from 128 to 255 indicate the first byte of a double-byte character. Local character set only.

nearly identical. Far East versions of Windows provide yet another paradigm for text processing in Chinese, Japanese, and Korean, each with idiosyncrasies of its own. Consequently, localizing your product to each Windows platform can become time-consuming and expensive yet yield only a minimal solution.

Microsoft has recognized these limitations and plans to address these issues in upcoming releases of Chicago and Cairo. This shift toward language independence is already evidenced in Windows NT.

Unicode to the Rescue

When it comes to how you store and process the characters you must use for a given language, there's little to debate. Unicode is the worldwide character-encoding standard destined to replace ASCII and the multitude of other single- and multibyte character sets currently in existence. It was constructed by a consortium whose membership list reads like a who's who of computer companies around the world. Unicode is a fixed-width, 16-bit character set, which means it can represent more than 65,000 characters. The standard encompasses scripts and general-purpose symbols for writing text in nearly every language in modern use, as well as many ancient languages.

Characters are organized by scripts so that every character with a unique semantic is assigned a unique character value. This means that a *B* in English is the same as a *B* in French, because both English and French are written with the same script: Latin. However, they are not the same as a *B* in Russian, which shares the same glyph (i.e., character shape) as the Latin *B* but belongs to the Cyrillic script. Since you must be able to keep track of such differences in characters from dozens, if not hundreds, of languages at once, Unicode will serve as a solid foundation for software globalization.

Although there is a minor penalty for storing uniform 2-byte (16-bit) values for each character, Unicode has significant advantages. It eliminates the confusion of overlapping, single-byte (8-bit) code pages in which a character's identity is dependent on the active code page. Also, the uniform 16-bit width of each character makes it easy to determine character boundaries in contrast to multibyte character encodings that, by definition, contain characters of either 1 or 2 bytes in size.

More important, you can maintain the identity of more than 256 characters at once and process characters by their intrinsic meaning, independent of the code points that represent the character in a font. Last, but not necessarily least, Microsoft has recognized Unicode's role as the new character-encoding standard by fusing it into the fundamental architecture of Windows NT. Windows 3.1, Win32s, and (regrettably) Chicago are all sans the Unicode support provided in NT, though this is not entirely a problem, as discussed later. Note that Chicago has some sprouts of Unicode growth as evidenced by the fact that the new, long filenames are actually stored in Unicode on disk.

What Goes Out Must First Get In

How often have you paused to consider the connection between pressing a letter key on your keyboard and seeing that letter appear in your document? A typical user will modify the keyboard driver from the Control Panel when Windows is installed, if it is not already set by default, and never give it a second thought.

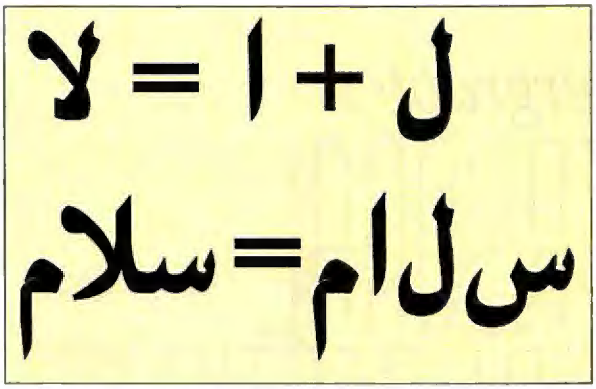
Assuming you have a Latin-based keyboard, how can you type characters for Punjabi or Khmer? You need a mechanism for switching the keyboard on the fly as you switch languages. This type of mechanism exists in Windows in three varieties.

The SDK for Windows 3.1 (and Win32s, which relies on the services of Windows 3.1 in this case) does not offer a function call to switch between keyboards. You need to make changes manually, independent of the application, through the Internationalization section in the Control Panel.

Although making manual changes isn't necessary for switching among languages such as English, German, French, and Spanish, it is a must for typing Greek or Russian. This procedure is cumbersome when you constantly need to switch between

layouts in an application or when you use only a single layout in one application and need to return to the system keyboard layout for your other applications.

Windows NT and Chicago offer the flexibility of changing the active keyboard layout through the API function calls `LoadKeyboardLayout()` and `ActivateKeyboardLayout()`. Any changes made by an application, however, will be made to the entire system, thereby affecting your other applications.



Example of the Arabic Lam-Alef character (top). Below is the Lam-Alef used in the Arabic word for *peace*.

Additionally, you may have difficulty remembering that the Dvorak keyboard is loaded under the alias "00010409" (in string, not integer, format). This is because keyboards are indexed by their language identifier, discussed later. Also, the gamut of keyboards currently supported by any Windows platform is quite limited for true multilingual computing.

The third type of keyboard switching is available only in Arabic and Hebrew versions of Windows. Aware applications can switch between one local keyboard and one Latin keyboard by choosing a button on a window title bar. This exemplifies how keyboard switching becomes a priority once you begin to type text in differing scripts (such as Hebrew and English). The implementation must be extended in globalized software, however, to allow for a wider variety of keyboards that can support any script.

The standard method for entering text in Far East versions of Windows is through the IME (Input Method Editor) standard, which allows you to type the thousands of CJK (Chinese, Japanese, and Korean) characters from Latin character combinations. This, of course, saves you the hassle of learning to touch-type on a 10,000-key keyboard. The principles involved in using an IME to type any of the CJK languages can also be useful for typing in any other language. In essence, text of any type can be piped through an input method to produce text of any other type.

Detour Ahead

Once characters exist in your document, you need to learn how to process them in a language-independent fashion. If you can envision the crux of multilingual text processing as a journey that begins in Los Angeles and ends in New York City, be prepared to make a pit stop somewhere near Budapest. Everything you already know about text processing is old baggage and will get you lost in a hurry. Throw it all away. You'll have to pack some clean underwear for this trip.

Examine this segment of code, which should look familiar:

```
char szBuffer[] = “Hello
 World!”;
ExtTextOut
 (hDC,x,y,0,NULL,szBuffer,12,NULL);
```

There are a thousand and one reasons why this code will now pose a problem in the multilingual world. For starters, because you are using Unicode, you must allocate 2 bytes per character instead of 1 byte. This can be rectified as follows:

```
wchar_t wzBuffer[] = L“Hello
 World!”;
```

where `wchar_t` is the data type for a wide character, and the operator preceding the `“Hello World!”` string specifies a string of typewide characters. Since the size of `wchar_t` is actually compiler-dependent (in Win32, it is defined to be 16 bits) and refers to any generic 16-bit character, try the additional modification:

```
typedef wchar_t WCHAR;
WCHAR wzBuffer[] = L“Hello
 World!”;
```

This emphasizes the fact that the data type you're storing is Unicode because `WCHAR` is the preferred Unicode character type in Win32, and it provides some protection against compiler variations should you encounter problems porting your code to another platform. Also, since Windows 3.1 does not support the `wchar_t` data type, you should use:

```
typedef unsigned short WCHAR;
```

This happens to be the same way `wchar_t` is defined in the Win32 SDK.

That leaves about 999 problems to deal with, most of which involve assumptions about the content of the text that do not account for variances in processing and rendering that don't exist in the world of Latin text. For example, it would be incorrect to assume that the Unicode values you store are the same as the values you use for rendering. One process that affects this is contextual analysis, which is the act of assigning the cursive shapes of characters depending on their relative position to surrounding characters. This is most evident in a language such as Arabic where it is a requirement that each character connect appropriately to its adjoining characters, similar to cursive handwriting.

As a result, each character is capable of rendering in one of four forms. There is a side benefit from all this extra work, though. By accounting for this type of behavior for Arabic, you have a nifty way of implementing beautiful calligraphic handwriting in English, provided you follow a language-independent model.

Furthermore, combinational analysis is used to combine clusters of characters that need to be rendered as a single unit, or to generate separate characters for those that may be rendered only by their components. For example, Arabic requires that the character sequence *Lam* followed by *Alef* combine to form the Lam-Alef ligature. This single glyph is now used to represent both characters, which means that your original string has one less character to render.

The biggest obstacle is the assumption that all text is displayed from left to right. Multilingual text is frequently bidirectional, which means it may be displayed as a mix of left-to-right and right-to-left text. You'll have to decide from the start of your development whether or not bidirectional text support is a priority. Because it is probably the single most complex issue to implement, it may not be worth the potentially overwhelming effort for some developers. Consider carefully, because *not* supporting bidirectional text eliminates potential customers who use languages of the Arabic and Hebrew scripts as well as those who prefer to process Chinese in the customary horizontal right-to-left direction. Microsoft provides a complement of bidirectional functions to help arrange text of mixed directions in the appropriate visual order but only in Arabic and Hebrew Windows SDKs.

Windows NT is the only platform that provides some built-in support for transforming text through its Unicode and language APIs. As mentioned earlier, you can access NT language-support API functions through a language identifier. This provides a mechanism, called NLS (National Language Support), for specifying the appropriate rules that should be applied to text of a given language or locale. For example, the function `CompareStringW()` can be used to compare one string to another by specifying the language of the strings. This is necessary because the expected sorting order of identical pairs of strings varies from one language to another. Better yet, Microsoft offers a complete set of NLS resources across local versions of Windows NT.

Unfortunately, Win32s, which is used to run 32-bit NT applications on Windows 3.1, leaves out these Unicode and language APIs. But before you convince yourself to make the jump to NT in hopes that all will be solved, be aware that the technology for implementing the variety of character transformations for a multitude of complex languages does not yet exist and will not likely be included before the turn of the century. Until then, applications will have to continue to rely on the specific language services provided by each local version of Windows for enhanced local-language support.

Seeing Is Believing

All this is meaningless if you can't actually see the text on the screen and the printed page. Once the process of transforming Unicode character values into renderable characters is complete, you need to locate the appropriate glyphs in the appropriate fonts and find a way to place those characters at the appropriate location on the device. This is not as easy as it used to be. Tens of thousands of characters are needed to support all the languages of the world, but only 224 characters are available in a standard single-byte font.

One apparent solution is to simply create a Unicode font: a double-byte font that contains a glyph for each Unicode character. While this solution may seem ideal at first, it is probably the most unlikely prospect to provide a good working solution. The sheer quantity of characters makes these fonts incredibly large (on the order of 4 MB or more) and expensive to develop.

The size is compounded by the fact that many characters are rendered by more than a single glyph, depending on numerous factors. As discussed earlier, four shapes for each character must be present to render Arabic text. Also, in the absence of some extraordinarily complex rendering algorithms, it is necessary to maintain dual or even multiple representations of non-spacing diacritics at various locations in the character frame to correctly position the diacritic on base characters. In some instances, this can be accomplished only by rendering precomposed glyphs not defined by Unicode. The most compelling obstacle to Unicode fonts is that Windows 3.1 and Win32s do not provide any means of processing or rendering double-byte fonts.

continued

The most promising solution for rendering fonts lies in font mapping, which provides a mechanism for converting Unicode characters into independent glyph codes in a font. Here, you can use all the existing fonts and font technology built into the operating system by grouping subsets of characters within standard single-byte fonts. This is effective because text from any language (with the exception of the CJK languages) can almost always be represented effectively by 224 characters, including numbers and punctuation. Therefore, the font-mapping layer must understand the relationship between the Unicode and the available glyphs within a given font.

While this introduces an extra layer of complexity, it also provides extra flexibility that could allow you to take advantage of a more complex font, such as an English handwriting font capable of providing contextual handwriting, as in Arabic. Besides, a Unicode font would surely require a similar mapping process to choose the appropriate glyphs from the font.

In the cases of languages with very large character sets, you can use either multiple single-byte fonts (adding somewhat to the complexity of the font-mapping layer) or a double-byte font. Such a double-byte font does not have to contain all Unicode characters, just the subset of characters you want to use with that font. Although Windows NT and Chicago are the only Windows platforms that provide the built-in functionality for handling double-byte fonts, it is possible for software developers to add this functionality to the other Windows systems, though the technology is not inexpensive to develop or license.

To #define or Not to #define

A final note about compiling your code is that the Win32 SDK for Windows NT offers the `#define UNICODE` function. But don't expect to include this definition at the top of your source module and automatically enjoy mixed Sinhalese and Klingon editing. You'll probably have more luck using `#define NOBUGS` to eliminate the possibility of logic errors creeping into your source. For most purposes, this flag merely decides the manner in which your application exchanges information with the system and does not effectively alter the range of services provided.

Windows NT is, at heart, a Unicode-based operating system. That means it keeps track of character information in Unicode rather than in the system ANSI code page as in Windows 3.1 and Chicago. This character information must be converted to the single-byte ANSI code page for applications that expect characters in this form. Additionally, in 32-bit executables, resource data is inherently stored as strings of Unicode characters; the ASCII text you used to write the source module is converted at compile time. You can use `#define UNICODE` to help retrieve resource information in its native Unicode format, which is useful if you are actually storing multilingual strings in your resource file. It can also reduce the overhead involved in translating strings between the application and the operating system.

But beware. One of the most appealing aspects of developing applications on

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Windows NT is that you can enjoy the benefits of a 32-bit application running on Windows 3.1 with Win32s. But the `#define UNICODE` option is incompatible with Win32s, because Windows 3.1 does not contain the same underlying Unicode support built into Windows NT. So if your target platform is Windows 3.1, your best bet is still to develop on NT, leaving out `#define UNICODE`. Even if your target environment is Windows NT, the `#define UNICODE` option is not necessary for multilingual computing.

Class Dismissed

What good is all this going to do if Windows does not yet provide the necessary services for software globalization? The answer is that you must first understand the principles of globalization before you can expect to support a model of language independence.

Should you feel compelled to begin implementing some of these concepts right now, you'll want to obtain the entire Unicode 1.1 standard. It consists of *The Unicode Standard Worldwide Character Encoding Version 1.0*, Volumes 1 and 2, and *Unicode Technical Report #4*. The books are published by Addison-Wesley, and you can purchase them at your local bookstore or order them from the Unicode Consortium by calling (408) 777-5870 or sending E-mail to unicode-inc@unicode.org via the Internet. The books describe a wide variety of languages and provide algorithms for many of the issues that have been discussed here. A consolidated single-volume edition for Unicode 1.1 should be available in early 1995.

Once you become familiar with the underlying concepts, you can begin to incorporate them into your software immediately by organizing your software so that all the processes related to languages are completely encapsulated in DLLs that supply the necessary language-independent functions. By doing so, you can eventually replace your own functions with services from the system, once they satisfy all your needs.This should give you a good head start by the time the functionality becomes available. ■

Dean Abramson is the Unicode and language-technology architect at Gamma Productions, Inc. (Los Angeles, CA). Gamma recently released the beta version of its ILI (International Language Interface), which provides complete language support for Win32s, Windows NT, and Chicago. You can reach the author via the Internet at editors@bix.com.

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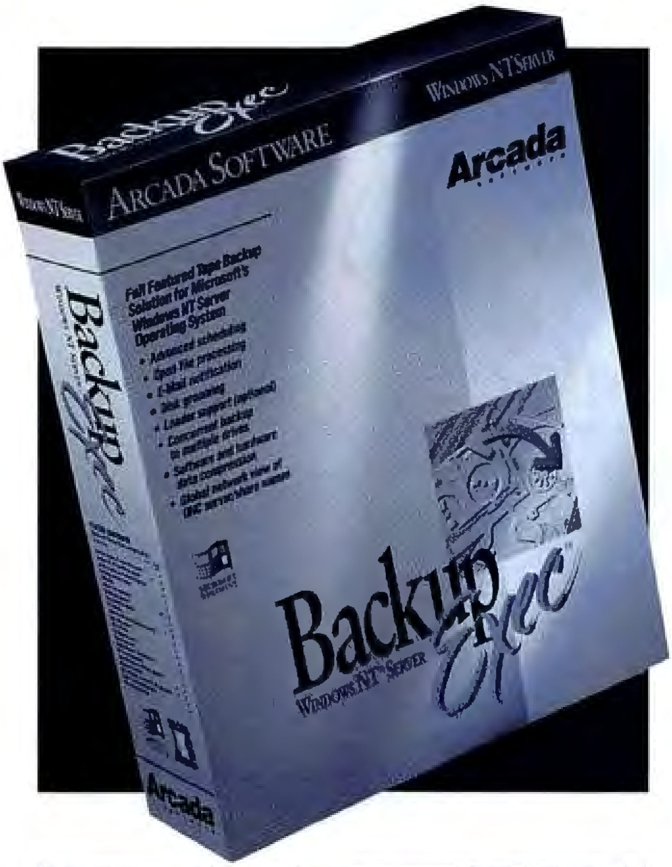

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Automating TCP/IP in NT

PETER WAYNER

ILLUSTRATION: GORDON STUDER © 1994

Laptop computers make it simple to carry almost all your desktop environment with you. Everything except your network connectivity, that is. If you carry a laptop to a meeting or another office and then plug it in there, you may or may not get what you wanted because the file servers and other connections might not be available on that subnet. More important, mail and other messages might not be able to find you because your computer is now in a different branch of the network. This problem is growing larger as more and more people turn to standards like the IP (Internet Protocol), which can handle large networks but requires continual upkeep to adapt to new configurations.

Microsoft recently announced plans for creating a new set of protocols that would add much of the flexibility of small office LANs to the IP so that companies can grow and evolve their networks quickly and easily. Microsoft will offer two open standards to the Internet community. One, DHCP (Dynamic Host Configuration Protocol), lets computers set up their network addresses on their own without stepping on toes. The other, WINS (Windows-Internet Naming Service), allows computers to publish their names to the world. The combination of these two protocols will allow ordinary machines to automatically establish themselves as clients on an Internet-capable network with much the same ease that they do in systems like AppleTalk.

This approach is necessary because Microsoft decided to adopt the IP when it became apparent that this standard would dominate the worldwide Infobahn. The standard is robust and flexible in part because it was designed by DoD (Department of Defense) researchers seeking to find a way to create a fault-tolerant network to link U.S. armed forces in the midst of battle. For this reason, the network can route packets between nodes even when the links are dropping in and out of service.

This high-speed flexibility is only possible when machines keep the same network addresses and stay in the same location. If you pick up your laptop and walk to another building with a different local network environment, the network administrator must reconfigure the network so that your packets can follow you. This may take only a few keystrokes, but even these finger taps can be prohibitive if hundreds of users are always renotifying the network administrator when they get up and move.

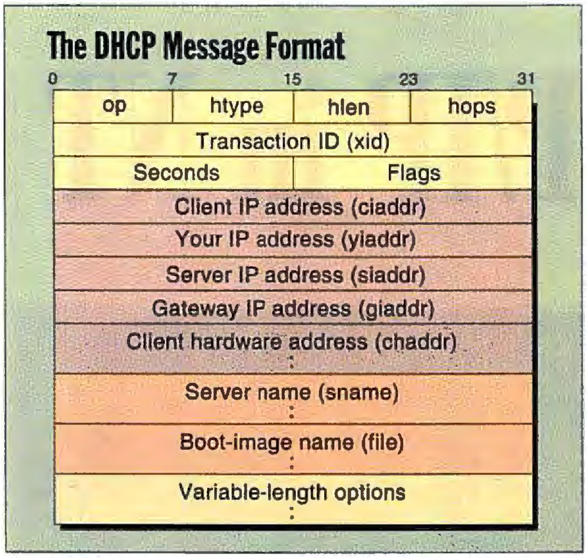
Microsoft gives Windows NT greater capability to assign network addresses

Many low-end LANs have this flexibility as a side-effect of their simple design that links all computers with one shared pair of wires. This means that a packet sent from one machine to another will reach all machines in the network. If you move your machine to a different connection, then it will still receive all the messages and pick out the ones intended for it. But this approach quickly breaks down as more users crowd the cable. Once a router is installed to break up the network, techniques like the DHCP and WINS become necessary.

DHCP

The first new layer in the system is the DHCP, which runs on a router or centralized machine. This DHCP server maintains a collection of addresses and assigns them to users. When a new machine signs on, DHCP gives it an available address if it has one.

A DHCP server maintains order on the network by enforcing a time limit on the addresses. When a computer requests an IP address, it doesn't get to own that address; it only receives a "lease" with a set expiration date. When the lease is half over, the computer is responsible for renegotiating its lease with the DHCP server. In almost all cases, the lease will be renewed. The protocol is designed so that a laptop's lease on an IP address will simply expire



The DHCP initialization data structure is designed with the same format as the popular BOOTP format. This lets it interoperate with old BOOTP systems.

if that laptop isn't around to ask for it again. Then it can be reassigned later.

The lengths of the leases is automatically determined by the DHCP server using parameters established by the network administrator. If a network supports plenty of laptop computers that are disconnected and reconnected frequently, then the administrator will choose a short lease that only lasts several hours. This ensures that unused IP addresses will be freed up as soon as possible. But if a network includes many stable desktop machines that rarely migrate, then the administrator will probably allow leases that last several months.

The administrator will also choose a lease length by examining the number of users and the number of available IP addresses. If the network is crowded, then the administrator needs to choose a shorter expiration time to keep the few extra addresses available. Less saturated subnets that might have 30 to 40 machines and 254 available IP addresses can extend much longer leases. Ambitious administrators might want to study queuing theory, which will give them a basic estimate of the right length of time for the leases.

Failure Mode

Microsoft is also recommending that the minimum length of a lease be set to be twice the maximum amount of time that a DHCP server might be down. So if the network staff always takes the full weekend off, then you should choose a minimum lease length of four days. In the worst possible case, a server will crash at the beginning of the weekend just before a machine starts to ask for a renewal. If you've set the leases to be twice the maximum expected downtime, then the machine will still have two days to go before the lease expires.

If a DHCP server is still down after 87.5 percent of the length of a lease, a client goes into a "panic" mode and searches everywhere for a new IP address. If there is another DHCP server available, then it will offer a new IP address and the computer will switch over. This can be disastrous if it happens while your machine is expecting data at the old address. An FTP connection, for instance, would be broken. But it won't make a difference if you're not using the network at that moment.

Microsoft suggests leaving two DHCP servers on a network so that one can solve problems if the other is down. The DHCP software was designed to live with any of the ambiguities caused by having two or more servers trying to supervise a network. For instance, the client gets to choose addresses if several servers respond to a request for an IP address.

There are limitations to the software. At this time, there is no way for two DHCP servers to coordinate their use of a shared address space. That means if there are 200 available IP addresses for a network governed by two DHCP servers, then the administrator must split them up between the two. If one machine fails, then the other will only be able to dispense leases for the IP addresses that it holds. The lack of coordinating mechanisms prevents it from completely assuming the duties of the other. Microsoft says it is developing a future version of DHCP that will allow communication between the DHCP servers.

This DHCP server maintains a collection of addresses and assigns them to users.

Deep Structure

The structure of the DHCP request is built to be "nearly identical" to the BOOTP format used by companies like Sun Microsystems to allow machines to start up from a remote disk. Keeping the same basic format makes it easier for software authors to upgrade their software. BOOTP routers will correctly route DHCP addresses with little modification. Several of the reserved bits were converted into flags and also several fields were used for different purposes.

The flags were created out of 16 unused bytes in the BOOTP message format. One bit specifies whether a new computer is able to receive messages before the address is formally allocated. Some of the additional fields allow a machine to request a particular IP address if it is available. Another contains the address of any gateway that is relaying the packet into another subnet.

The main difference is built into the intelligence of the servers. The BOOTP server needs to be programmed with the network address codes of all machines asking for IP addresses. The DHCP server adapts itself to requests.

Other Solutions

The DHCP approach seems simple, but it is still an improvement over previous attempts. For instance, the MacTCP extension to the Macintosh system can dynamically set its own IP address when the Macintosh starts up. But many network administrators have found that MacTCP's approach often yields problems in networks with several different types of machines.

The MacTCP software randomly chooses an IP address from a small predetermined set and then broadcasts a message asking if there is anyone out there with this address. This approach works fine if the network is only used by other MacTCP users who leave their machines turned on to this random setting. Many users quickly discovered problems when their Macintoshes shared the network with workstations or other machines that thought they had a fixed address carved in stone. A freshly turned on Macintosh would often steal the address of one of these systems when it was off. When both were on, they would start using the same address and get their data mixed. This problem

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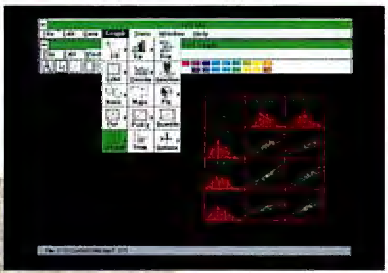

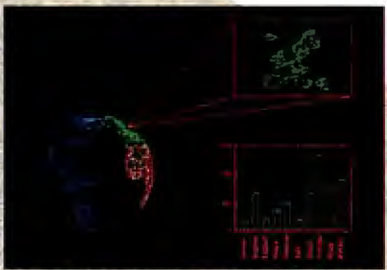

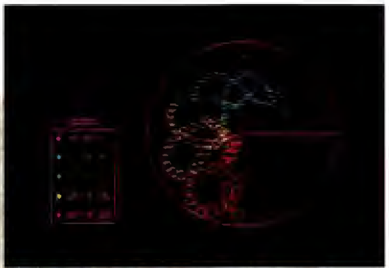

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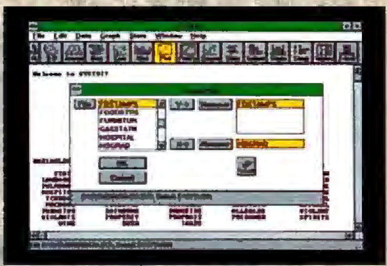

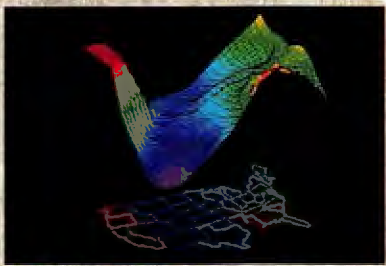

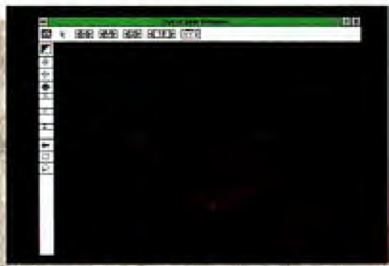

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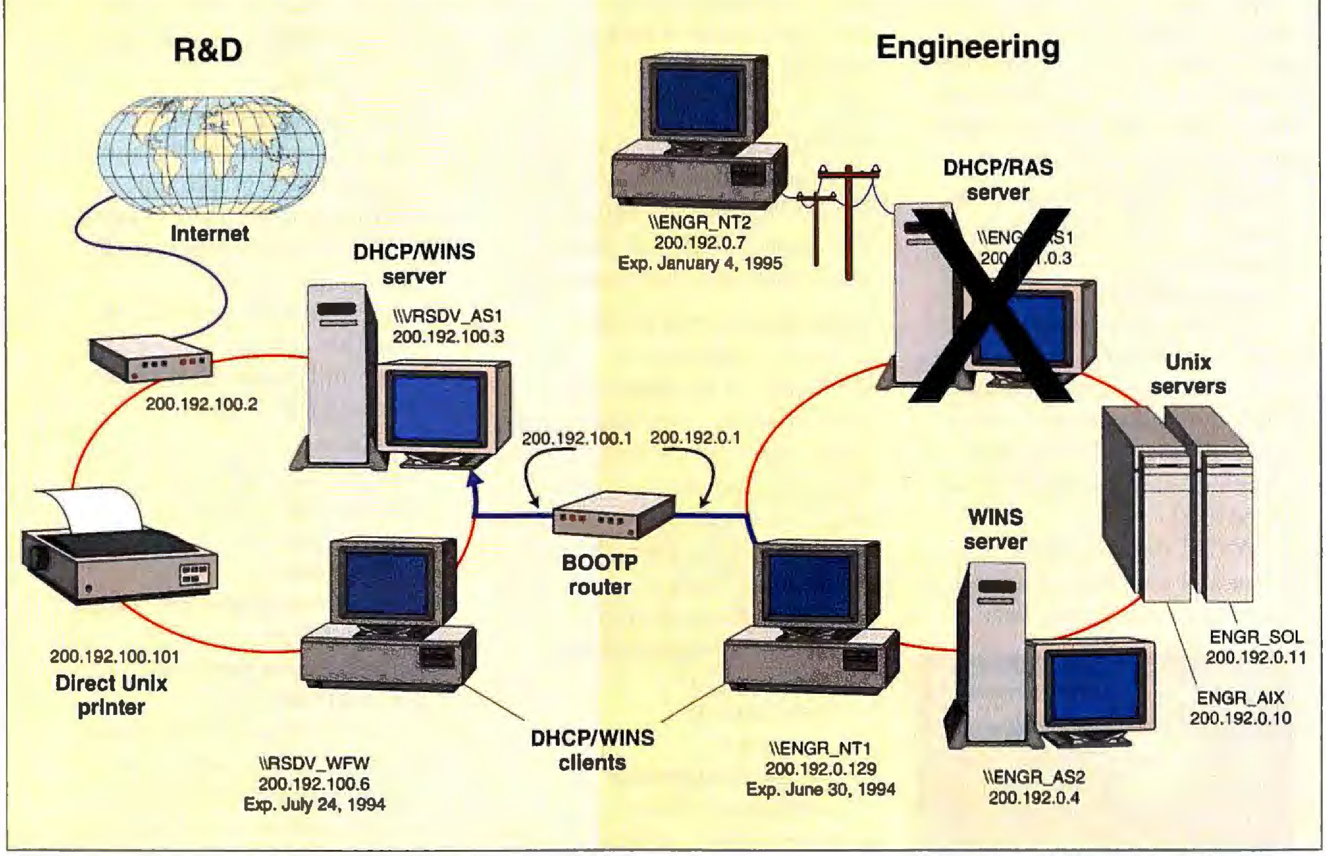
When a DHCP Server Goes Off-Line



In this hypothetical example, a DHCP server in the engineering department is off-line. You power up the desktop labeled \\ENGR_NT1, and the BOOTP relay router relays a DHCPREQUEST message to the DHCP server (\\RSDV_AS) at address 200.192.100-3 in the R&D department. Because the scope of the R&D subnet is different, the \\RSDV_AS server gives it a new IP address at 200.192.0.129.

occurred frequently in places where users turned off their machines at night.

This weakness arises because the MacTCP is not relying on a central server. This may be an advantage if a company does not want to invest the extra money and resources, but it also causes its share of problems. Imagine you wanted to fix one particular address to one machine. If you wanted to do it with the decentralized MacTCP, you would need to go from machine to machine to remove this address from its list of available choices. A centralized DHCP server is the only stop necessary in a server-based system.

WINS of Change

The next layer of Microsoft's addition to its network environment, WINS, allows computers to look up other computers by name instead of Internet address. If a machine moves, then it can still carry the same name with it if the WINS system tracks the move and changes the listing information. Naturally, this system must work closely with the DHCP server so that machines do not get lost as they roam from subnet to subnet.

After a client receives an IP address from the DHCP server, it sends a copy of this address and its chosen name to the WINS server asking for a listing. If all goes well, the WINS server responds affirmatively and sends along a time limit for the listing. The WINS listing must also be renewed like the DHCP lease.

The process may fail if there is another machine that has already reserved the name and IP address binding. At this point, the WINS server challenges the first computer to reserve that name to prove that it is the rightful user of the name. If that first user responds, then the server makes a simple choice to go with the first. There is no authentication or password system built into the current version of the system. Microsoft hopes to add a layer to do this in the future.

A fair amount of fault tolerance and flexibility is also built into the WINS protocol. If there are multiple WINS servers on a network, then they will coordinate their listings of names and swap new names. This broadcasts a name to the local WINS servers so someone can look up a distant name without sending packets throughout the Internet. It also provides some fault tolerance so that names to IP conversion will still be available even if one machine goes down.

The network administrator can set the amount of time between these swaps according to the load on the network. If the two WINS servers are on different continents joined by a low-speed, expensive link, then the coordination can be done once a day. If the servers are joined by an unsaturated local network, then they can constantly keep each other informed about new users.

Bringing You the World

Unfortunately, WINS is still a local solution to providing a name space. If someone

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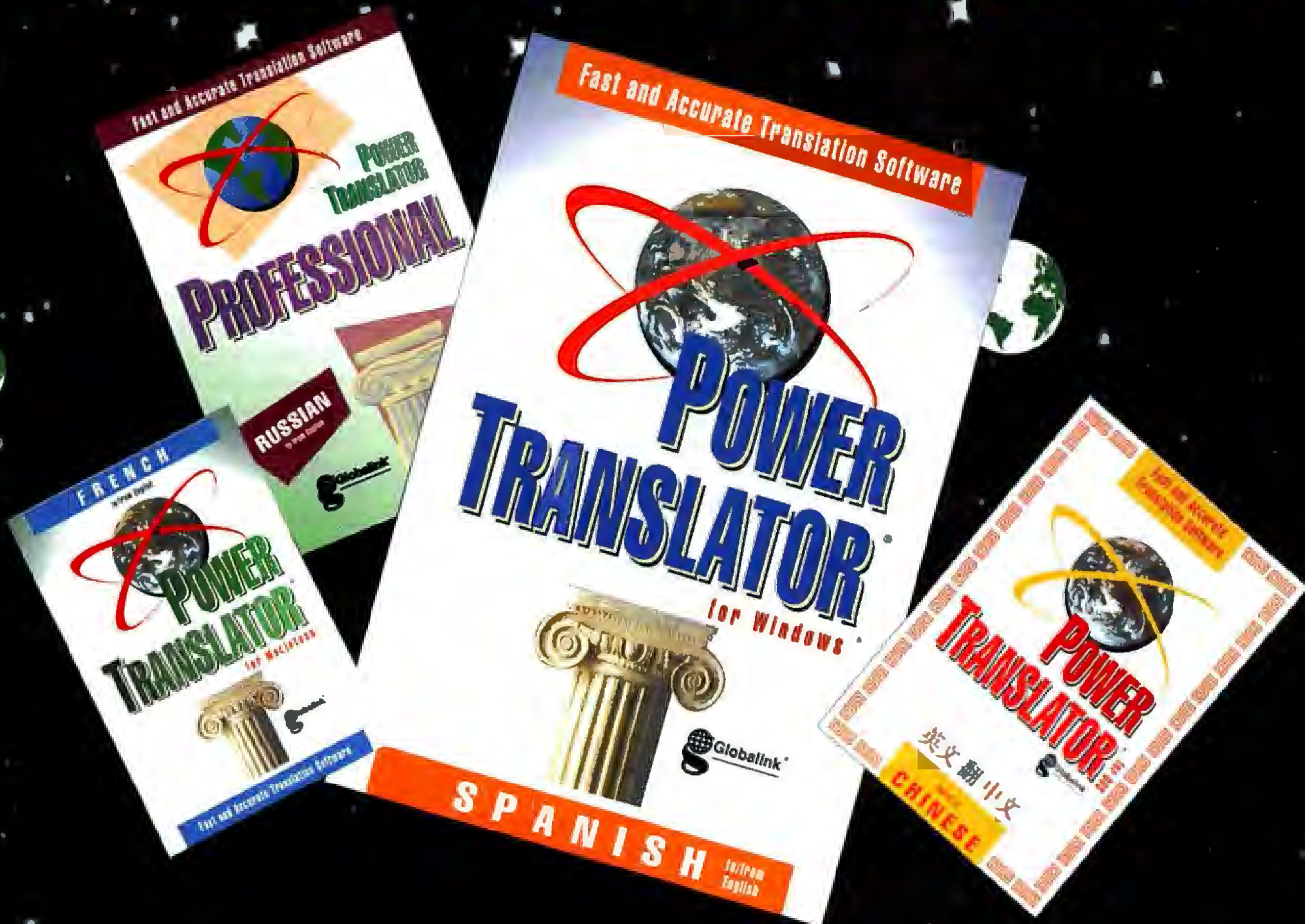

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SECURITY

One of the subtle problems in any network environment is security. Any new automation system has the potential to open up doors for mischief. DHCP's automatic registration process makes it easy for you to hook up a laptop and tell the network that it's you. But it also makes it simple for someone else to do the same thing.

Network administrators will need to be aware of the potential for spoofing and users who might masquerade as others. Microsoft points out that this problem existed before. This is certainly correct, but the inflexibility of the old IP routers hobbled some of the efforts of spoofers. An administrator had to type in the MAC-code from the network interface card on the machine into the IP address database before the spoof would be complete. The automatic registration process makes it easier for someone to completely assume the network identity of another.

DHCP has enough of the old "inflexible" IP configuration procedures built in to circumvent this problem if it occurs. It is possible, for instance, to direct the DHCP server to always give a certain IP address to a certain computer, although this defeats the purpose of the dynamic DHCP system.

Many network administrators will probably choose to ignore the problem of malicious users and choose the flexibility of a fully functional DHCP. The trade-off will certainly be worth it for many. DHCP doesn't introduce the problem of masquerading users, it just makes it slightly easier. The most secure environments solve the problem by using cryptographically secure protocols for establishing identity. It is clear that the world is reaching a point where an infrastructure is needed for authentication that would allow people to identify themselves properly on the network.

from outside your company tries to call up and get the IP address of your computer, they won't be able to do it. This is important to do if someone tries to finger, ftp, or use a talk program with your local machine.

For instance, right now someone can type `talk pcw@access.digex.com` and the network routing software would decode this to get the net address of the machine `access.digex.com` before trying to initiate a talk command. This is because `access.digex.com` is published in the Internet's name tables. It's like getting the phone number of the person you're trying to reach, not the phone number of the receptionist.

But if I started running WINS and I registered my local name "epinonymous" with the WINS server, my IP address would not be available to anyone from the rest of the world. They would still need to send me mail through the gateway.

This is largely the fault of the Internet for using static tables with fixed addresses. If you want to publish a name and IP address to the world, then you need to ask DHCP to always give you a fixed address. Microsoft anticipated this problem and added this feature even though widespread use of it would largely destroy the dynamic nature of DHCP.

Microsoft is actively pursuing getting the wider Internet to accept dynamic naming tables. In the future, it hopes that others will adopt a dynamic standard that will work with DHCP. The company is approaching the IETF (Internet Engineering Task Force) at this time, and it hopes to move toward a dynamically bound DNS (Domain Name Service) standard in the future.

Unfortunately, WINS is still a local solution to providing a name space.

As this proposal advances, you will probably see an expansion of the capabilities of WINS. At this time, it accepts NetBIOS names and addresses. The architecture is not limited to this complicated structure, and the IETF plans to expand the name space to include Internet names as well as any other naming conventions that emerge in the future.

For Big Networks

The DHCP/WINS combination is an excellent way to solve the irritating problem of introducing users to a network. The current systems that handle wide-array systems like TCP/IP require too much work by an administrator. The smaller network protocols like NetBEUI, IPX, or AppleTalk will not easily scale to large networks. Microsoft built this system to handle 250,000 people moving their laptops around from office to office without dealing with the local network administrator.

Smaller network users will probably not feel the need to adopt such a protocol. The low-end systems already offer all this flexibility as a side-effect. This may change with time, though, because the worldwide expansion of the Internet is rapidly making purely local networks an anachronism. Everyone will want to plug into this network and get their own IP addresses, even when there are only a few machines on the local network.

Microsoft's push to make the IP part of the foundation for Windows NT ensures that the Internet connectivity may be an attractive side-effect. Sure, in a small office you've got only a few users and the network administration chores are so small that you don't need the flexibility of DHCP. But, if it provides an easy way to create a gateway to the Internet, then the operating system may be more desirable.

The adoption of this system may give Microsoft a better competitive position against workstation manufacturers like Sun and Hewlett-Packard. The operating systems on these machines were built around TCP/IP long ago and the applications running on the system embraced the standard from the beginning. If Microsoft wants to push NT into the traditional domain of workstations, then it needs to talk the local language. It's made the commitment to this and now DHCP and WINS will give it a more flexible environment. ■

Peter Wayner is a BYTE consulting editor based in Baltimore, Maryland. You can reach him on the Internet at pcw@access.digex.com or on BIX as "pwayner."

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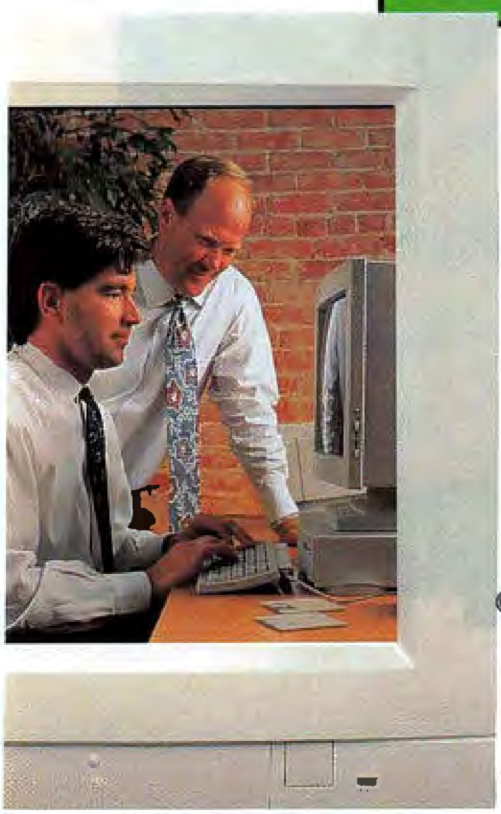

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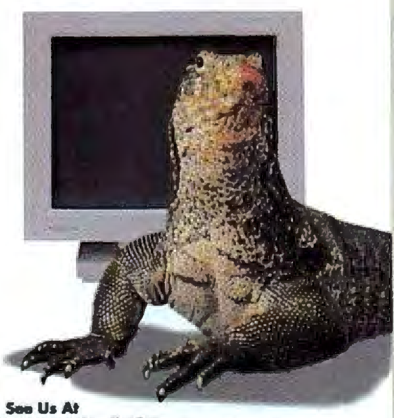

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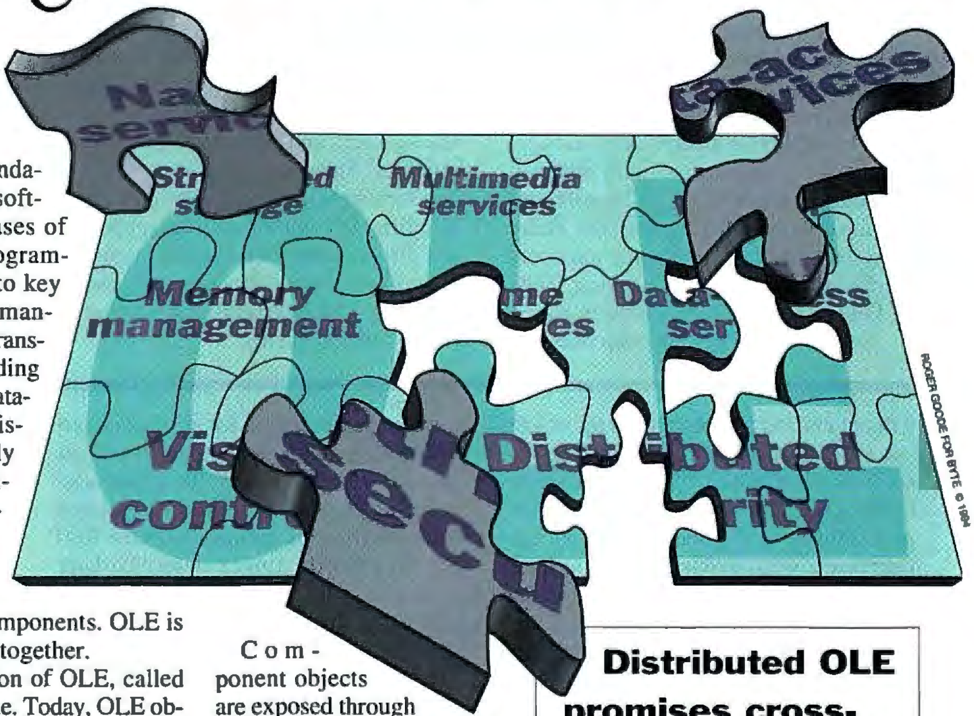

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For Microsoft, OLE is the foundation not only of component software but also of future releases of Windows itself. OLE serves as a programming model for and provides access to key Windows services, such as memory management, structured storage, and data transfer. In the future, new services—including visual controls, multimedia services, data-access services, name services, and distributed security—will be available only through OLE. As object-based capabilities become more prevalent, the distinction between applications and the system will start to disappear. Ultimately, the operating system itself will become a collection of replaceable components. OLE is the "glue" that will bind these objects together.

By mid-1995, a more capable version of OLE, called Distributed OLE, will appear on the scene. Today, OLE objects may run in the same process as in-process servers and OLE Controls or in another process, such as a separate executable file like Microsoft Excel. Under Distributed OLE, objects will be able to run on another machine via a newly defined flavor of RPC (remote procedure call). For in-process servers, this will mean greater efficiency, tighter control, and fewer concurrency problems. For executable files, Distributed OLE will bring improvements in process security while permitting objects to use existing code. Over a network, the whole programming model will change, and things such as shared specialized object servers will become possible. Such servers will have the ability to store graphic images that require literally hundreds of megabytes of memory to render, objects that require particular hardware (e.g., digital signal processors, or DSPs), or databases that require specialized connectivity. (See the text box "Cairo Takes OLE to New Levels.")

OLE Technology

Underlying OLE is COM (Component Object Model), the language that OLE speaks. It doesn't impose any restrictions on applications or say anything about how they're designed (see "Componentware," May BYTE). Rather, COM facilitates interoperability between OLE components, including (in the future) those running on remote machines. OLE itself embodies the object services—such as visual editing, structured storage, and object conversion—that the system provides to facilitate COM interactions.

Distributed OLE promises cross-platform remote capabilities for linking component software

Component objects are exposed through interfaces, each of which is a group of closely related member functions. A component object can have any number of interfaces, each providing a well-defined service. All interface names begin with an *I*. `IDropSource` and `IDropTarget`, for instance, handle a drag-and-drop function in OLE documents, `IDispatch` controls OLE automation, and `IOleControl` and `IOleControlSite` are responsible for the recently defined OLE controls. OLE handles communications between the interfaces.

The essential component object interface is `IUnknown`; all objects must support it and its three base member functions: `QueryInterface`, which is used to obtain pointers to interfaces, and `AddRef` and `Release`, which are used for reference counting over an object's lifetime. All other COM interfaces are derived from `IUnknown`. They are not inherited, which has myriad religious object-oriented connotations, because interfaces are independent of implementation. Their purpose is to enable interface pointers that shield the component object. These pointers are 128-bit integers that are virtually guaranteed to be globally unique, even in networks with millions of objects.

The separation of interface and implementation lets you replace or modify the code for a particular implementation

Cairo Takes OLE to New Levels

The next version of Windows NT, code-named Cairo and targeted for release sometime in 1995, will be built around the concepts of objects and component software. It will have a native OFS (Object File System) and distributed system support.

In addition to incorporating the Chicago user interface, the Cairo shell will include integrated OLE Controls contained within OLE Forms. The entire system will be built from component objects (e.g., Desktop, Explorer, Tray, Folder, User, Scraps, Property pages, and Toolbar). New system services will appear as system component objects. Cairo will also support custom objects that enhance the operating system.

Cairo will extend OLE structured storage to the computer's native file system, implementing a complete OFS with support for link tracking, space management, and content and property indexing. Standardized stream names and formats will let you view data inside files. Distributed systems support in Cairo includes link tracking across networks, network directory services, distributed files systems, and support for distributed events.

without making any changes in the objects and systems that call into it. You can also add new interfaces without breaking existing applications, which is what component software is all about. Clients see only interfaces; what exists behind the interfaces is opaque, even though the internal representations may be handled as if they were true objects. Put another way, what you think of as a Worksheet object in Microsoft Excel does not, in fact, exist. Rather, it's a useful abstraction. Excel supports a set of interfaces to something that it calls a Worksheet. How Excel manages that Worksheet is something only those inside Microsoft will ever know.

Monikers and Binding

So, the minimum COM object is very lightweight. This is fortunate, because COM objects are used for virtually everything in OLE. A perfect example of this is the OLE naming object called a moniker, which implements the `IMoniker` interface. Monikers are used for the names of link objects that the system recognizes. They are more efficient at representing data than, for instance, filenames, although, for convenience, monikers can use the `GetDisplayName` member function of `IMoniker` to generate a text-display name readable by humans. Human-readable names are stored locally to prevent problems with name collisions over a network.

The basic purpose of a moniker is to bind an object to a discrete piece of data. What's returned is an interface pointer to the linked object. When it's asked to render itself, the object can go through that interface pointer to ask for an updated presentation. A moniker, and thus its pointer, can be stored persistently; the object is activated and bound only when it's required. When activated, a moniker uses the ROT (Running Object Table), described later, to locate existing instances of the object. Indirectly, through the Service Control Manager, monikers may also use registry information to instantiate objects if they are not present in the system.

Distributed OLE offers three main types of monikers: file monikers, item monikers, and composite monikers. A file moniker can identify any object that is stored as an individual file and act as a wrapper for the path name that the native file system assigns to the file. For example, C:\DATA\BUDGET.XLS might be the file moniker for an Excel workbook object stored as a file on disk. Calling the `BindToObject` member function for this moniker would launch Excel (if it weren't already running), load this workbook, and return a pointer to it. Binding can have a significant impact on your system.

Item monikers identify an object contained within another object. The exact format varies by application and the corresponding nature of the application's data, but an Excel example might be Sheet1!A1:D20. A composite moniker is composed of two or more monikers, concatenated. For example, a composite moniker could be constructed from the above file and item monikers. You can see the human-readable version of a composite moniker such as this when you create a linked item (e.g., Copy...Paste Link); the moniker is embedded into the linked item. A composite moniker is bound in right-to-left order, which avoids unnecessarily activating objects if a pointer to an intermediate-level object already exists. In contrast, activation—the act of running an object to perform an operation—generally occurs in left-to-right order.

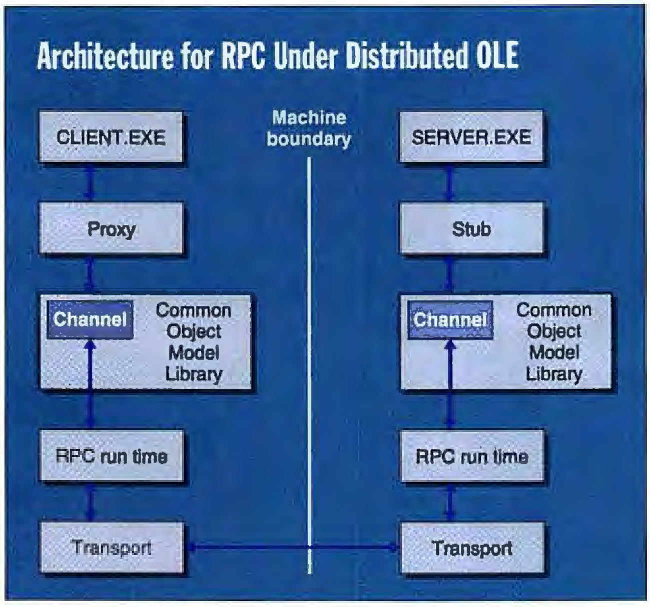
To bind a moniker, the link source must be running. To handle this efficiently, OLE maintains yet another COM object, the ROT that implements the `IRunningObjectTable` interface. If an object doesn't register itself in the ROT when it starts running, extra copies of the object might be loaded if other objects try to bind to it. This would lead to consistency problems and, ultimately, to the loss of data. The ROT is local to a desktop and maintains a list of all objects running on that machine. In a Distributed OLE environment, which lets you bind objects on remote machines, the ROT becomes more of an abstraction.

Common Object Model

Microsoft and DEC have defined a specification, called the Common Object Model, for making the two company's object systems interoperate (to avoid confusion with Component Object Model, whose acronym is also COM, I will spell out references to Common Object Model). In defining the specification, Microsoft contributes a subset of its OLE technology, and DEC supplies its ObjectBroker product for implementing UDT (uniform data transfer) by using minor extensions to the OSF-sponsored (Open Software Foundation) DCE (Distributed Computing Environment) RPC system. UDT uses the `IDataObject` interface, which encapsulates the various methods for exchanging data between applications. Current methods include using the Clipboard, drag and drop, and OLE Automation. This particular RPC implementation is called ORPC (Component Object RPC).

Prior to the creation of the Microsoft/DEC specification, Microsoft developed an equivalent RPC version for doing networked RPC (but not networked OLE RPC) under Windows NT. This implementation was called Microsoft RPC, and this name still appears in the Win32 SDK (Software Development Kit) and in Microsoft presentations at developer conferences.

Obviously, to take advantage of support for distributed OLE, a remote machine must support OLE. That support is already available in PCs running the 16- or



This diagram gives an overview of the system architecture of the RPC portion of Distributed OLE. Note that CLIENT.EXE talks only to the proxy; it is unaware that the server functions are being handled remotely by another machine. All components other than the client and server executables are based on OSF's DCE RPC.

32-bit version of Windows and on the Macintosh (680x0 and Power Mac), and Microsoft is licensing its OLE source code to Unix vendors. When OLE support becomes available on Unix systems, the Microsoft/DEC Common Object Model will provide a means of fostering enterprise-wide cooperation—across networks and across platforms—between OLE applications and objects. Existing local-based OLE applications should get this capability without additional programming, because all objects appear local.

The system-level code that implements the Common Object Model functions is called the Common Object Model Library. It handles the creation of Common Object Model applications and the specialized objects required for distributed object support. The Common Object Model Library also encapsulates the channels over which the network RPC takes place. The system-level code that handles the actual transmission is the RPC run-time library, which runs in both the client and server processes (see the figure "Architecture for RPC Under Distributed OLE").

Each machine has an SCM (Service Control Manager). The SCM is an RPC server that acts as the central point for object activation. It ensures that a server is started in response to a client request. To do this, it must maintain the ROT and a local cache of system-registry class information for use by the Common Object Model Library.

The SCM controls the type of an object server: in-process, cross-process (local), and distributed cross-process. If the requested server is an in-process DLL, the SCM passes the request to the Common Object Model Library for loading. When a local (on the same machine) cross-process request arises, the SCM passes the request to the server if it's already running or creates the server process if it isn't. For a remote cross-process request, the SCM forwards the request to the SCM on the server (see the figure "SCM and Distributed OLE").

Marshaling

Before you can make an RPC, you need one more fundamental piece of OLE technology: marshaling, a method for packaging the function calls and parameters, passing them across the process boundary, and unpackaging them at the other end. Marshaling takes care of details like how each of the possible parameter types is passed. Marshaling also converts data into a binary stream format and packages it for RPC transmission, using Network Data Representation to make differences such as byte ordering and character sets compatible.

Two types of marshaling for interface pointers exist: standard and custom. A server object has to support one or the other but may not support both. Standard marshaling support is provided for all the standard COM interfaces; the support proxies and stubs are loaded from OLEPRX32.DLL, and the server does not implement the `IMarshal` interface. Custom marshaling handles a particular set of circumstances. Monikers, for example, require marshaling by value, so a copy of the server object is created in the client process and changes made to it are not reflected in the server. Custom marshaling is also required when memory is shared—when the name of the memory segment is passed to the client. Compound files are marshaled in this way. Custom marshaling requires implementing custom proxies and stubs for the server object (see the figure "Distributed OLE Architecture").

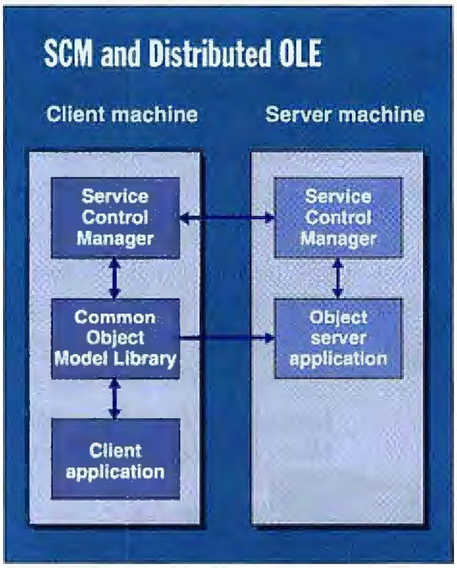
Proxy and Stub

Crossing a process boundary or machine boundary for distributed-object RPCs involves a process called interface remoting. To permit you to cross boundaries transparently, proxy and stub objects translate local procedure calls into remote procedure calls.

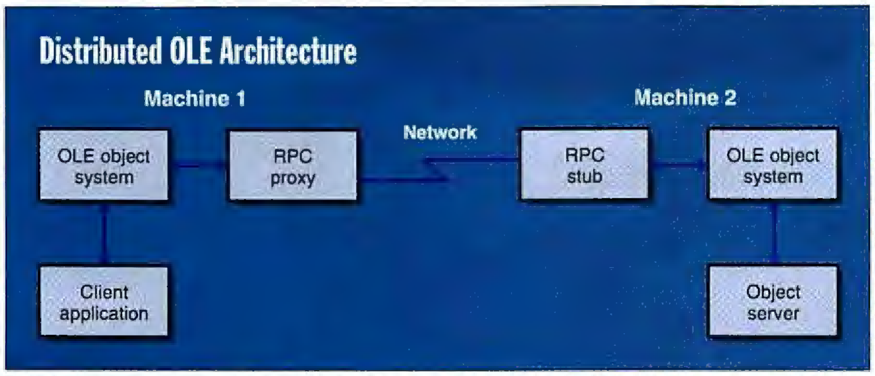
The proxy runs in the client process, between the client and the server object. It supports identical interfaces, called interface proxies—one proxy per interface—as the server object, though their implementation differs. As its name suggests, a proxy's function is to marshal (package) the interface parameters for its server interfaces and pass that package via an RPC (using the RPC run-time libraries) across the network to the server object. There, the package is unmarshaled.

These steps are transparent to the client. The stub, the counterpart of the proxy on the server, unmarshals the server interface calls. It runs in the server process and is similar to the proxy in that it provides an encapsulation of the server's interfaces (as with a proxy, each interface is allocated one stub).

continued



The SCM plays an important role in the Distributed Object RPC architecture. Note that each machine has an SCM, which manages that machine's ROT (Running Object Table) and a local cache of system-registry class information for use by the Common Object Model Library.



This diagram shows where OLE integrates with Distributed Object RPC. OLE is isolated from network operations.

MIDL

Because C data types may be different sizes on different systems, a special-purpose C-like language and compiler are required to generate the data types and declare statements used in an RPC. The DCE calls this the IDL (Interface Definition Language), and Microsoft's particular implementation is called, not surprisingly, MIDL.

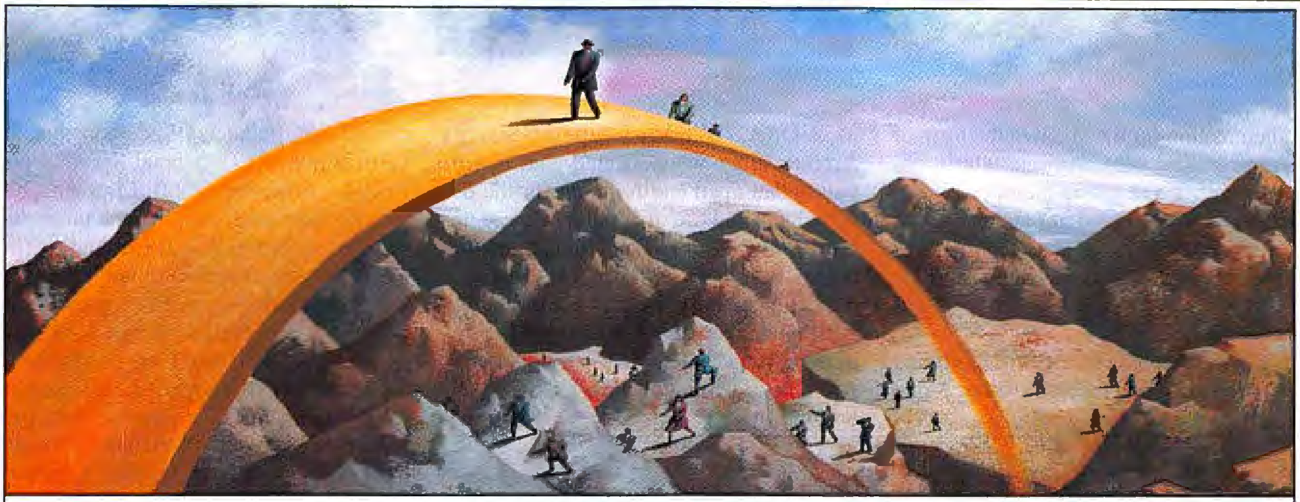
Microsoft-specific changes to standard IDL support custom Common Object Model interfaces to handle object references, string bindings, reference counting, path resolution, new object creation, and object activation. The MIDL compiler creates code for talking to the RPC run-time library for each interface definition: proxy/stub code, header files, and an interface identifier file. The proxy/stub DLLs, which must be installed in the system registry, are built from these files.

Distributed Security

The security of objects and the data they encapsulate is a matter of concern in any object system. In distributed systems, security is more important than it is for local systems, where it is often taken for granted. OLE offers relatively limited security; when multiple clients are accessing one server, a separate instance is run for each client. So, each client/server connection, and thus the data being transmitted, is isolated from that of other client/server connections.

Distributed OLE will provide improved security through the connection ORPC offers to DCE. These services are accessed by applications through the Common Object Model Library, which checks flags in the system registry to control where a server can be run. Object servers may run where the client is running, where the data is stored, or elsewhere on the network.

In distributed object systems built on DCE (e.g., ORPC), authenticated RPC and DCE Security Services provide security. Under authenticated RPC, DCE automatically contacts the Security Server to obtain



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authentication for the client in the form of a Privilege Attribute Certificate, which contains identity and group membership information. The protocol for authentication is based on the industry standard Kerberos 5 authentication system developed at MIT.

Open Tools

To alleviate concerns about OLE being too proprietary, Microsoft has made it part of WOSA (Windows Open Services Architecture), whose stated goal is providing "an open environment for the development and use of Windows-based applications." WOSA components include common application services (Open Database Connectivity, MAPI, the Telephony API, and Licensing Service API); communication services (Systems Network Architecture, Windows Sockets, and Microsoft RPC); and WOSA extensions for vertical markets (Financial Services and Real-Time Market Data). Microsoft has also licensed OLE source code to several vendors, including Locus Computing (Inglewood, CA), MainSoft (Sunnyvale, CA), and Insignia Solutions (Mountain View, CA). These companies will provide OLE capabilities on diverse Unix platforms.

Ultimately, however, the success of OLE—distributed or not—depends on more than Microsoft's willingness to maintain an open-door policy. One important factor is the quality of the tools available for creating new applications. (Distributed OLE promises to eliminate the need for changing *existing* OLE applications.) After all, applications are only as good as the tools used to create the objects. Right now, your choices in tools for creating server applications boil down to just one product: Microsoft Visual C++ 2.0.

Despite its advertised openness and language independence, for most developers OLE will be approachable only if it's encapsulated in a framework like Microsoft Foundation Classes. Implementing this encapsulation is such an enormous and expanding undertaking—volumes 1 and 2 of the *OLE2 Programmer's Reference* total more than 1200 pages and don't even include OLE Controls—that eventually all C++ tool vendors will probably license the code from Microsoft. As extensions are added to OLE, though, it's a safe bet that Microsoft tools will be the first to provide access to those services.

In the component software world that is just emerging, high-level integration languages play an important role, too. To create and use OLE objects, a programming language must create structures of pointers and explicitly or implicitly call functions through those pointers. Microsoft's Visual Basic, for instance, can do this. It manages the pointers internally and provides high-level mapping between language objects and OLE objects.

However, just as using a framework today is no substitute for understanding the Windows API, no encapsulation will completely eliminate the need to understand the OLE equivalent: the assorted OLE interfaces. Developers investing in OLE development today will be well positioned for the "OLE Everywhere" of tomorrow's distributed OLE environment. ■

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Windows Becomes LAN Friendly

BARRY NANCE

ILLUSTRATION: GORDON STUDER © 1994

Windows 3.x has made LAN administrators' lives miserable over the past few years. The 3.x versions of Windows aren't easily integrated into corporate LAN management infrastructures and don't provide system access interfaces to PC inventory and configuration information. Third-party LAN management products from vendors like Saber Software can't provide complete, open solutions to LAN management problems with Windows 3.x. With Windows95, Microsoft set out to provide an environment that would easily mesh with current and future LAN management technologies.

LAN management functions include taking inventory, monitoring traffic, detecting viruses, distributing software, monitoring applications, metering software licenses, mapping the network, notifying administrators when errors occur (i.e., alerts), and creating trouble tickets for help-desk resolution. Remote access to the LAN management functions is a plus, as is the ability to globally modify workstation configuration files from a central site. Windows95 offers features, some built into Windows and some available as APIs for third-party LAN management software vendors, in almost all these LAN management categories.

Opening the Cache Register

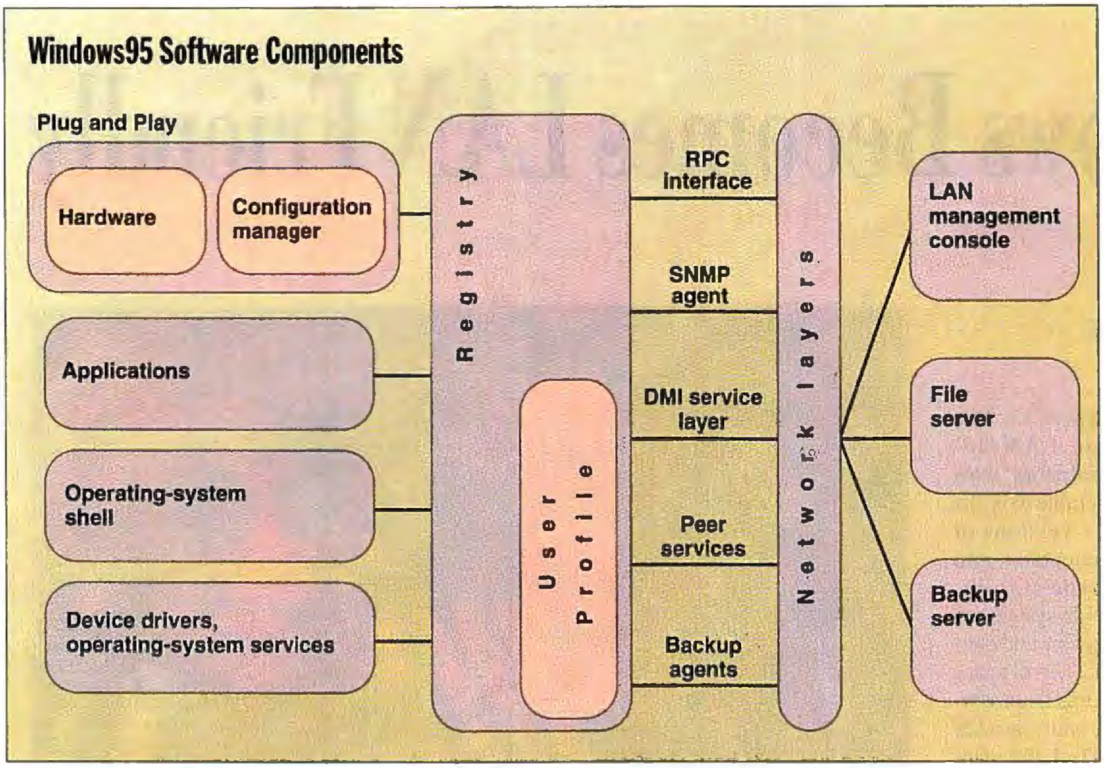
Windows95 uses its Registry to store LAN management details. The operating system also provides programming interfaces that can present LAN-oriented Registry information in formats that LAN management products expect. The Registry is a hierarchically organized system file containing configuration information, driver settings, operating-system parameters, user option choices, and other data. The Registry takes the place of the Windows 3.x–style INI files, although Windows95 still keeps INI files around for backward compatibility with 3.x applications.

The heart of Windows95's new resource management features, the Registry supplies information about network hardware (both Plug and Play and legacy devices), authorization levels (i.e., permissions), user profiles, network protocols, installed software packages, recent backups, and shared resources (including drive letter mappings, printer queue preferences, and whether the workstation can act as a peer to share its resources with other PCs).

Windows95 aims to right the networking wrongs of Windows 3.x with a new suite of management features

The information the Registry stores is exactly the kind of information LAN administrators need to manage LAN-attached, Windows-based PCs. To help administrators get at the information, Windows95 lets administrators remotely view and modify a PC's Registry through the LAN cable or through a dial-up telephone connection. For management through the LAN cable, Windows95 offers an RPC (remote procedure call) interface that LAN management products can use to access the Registry. An administrator can even set (or reset) a Windows95 PC's configuration, including screen colors, from a central console.

If you have hundreds or thousands of PCs and you upgrade them to Windows95, you'll be able to set what Microsoft calls System Policies. With the System Policies editor or a third-party administrative tool, you set up configurations, restrictions, and other global corporate standards that you want to apply to all PCs. When a Windows95 PC logs on to the LAN, Windows95 looks on the network for the policies you've set up. Windows95 retrieves the administrator's policies from the network, applies those policies, and continues with the log-on process. An administrator can, for example, selectively remove system capabilities such as peer resource sharing from a



The Plug and Play configuration manager reflects hardware component settings in the central Windows95 Registry. Applications, the operating-system shell, drivers, and operating-system services also store information in the Registry. Through RPC, SNMP, and DMI agents, Windows95 makes the information in the Registry available to LAN management products. Administrators can restrict peer disk and printer sharing, and they'll be able to use third-party backup utilities that can make backup copies of workstation files as well as server files.

group of PCs. People using those PCs then won't be able to make their hard disks publicly available.

Through user profiles stored in the Registry, Windows95 makes it possible for different people to share a pool of desktop computers and see a consistent Windows configuration no matter which machine the person might use. With its user-level pass-through security features, Windows95 restricts the ability to make configuration changes to the LAN administrator and people specially designated by the administrator.

Windows95 software components (e.g., Plug and Play configuration manager, applications, operating-system shell, device drivers, and operating-system services) store system configuration information in the hierarchical structure of the Registry. A separate user-profiles structure within the Registry holds information about each person who uses the PC. Windows95 interfaces (e.g., RPC, SNMP, DMI, peer services, and backup services) allow over-the-wire access to the information in the Registry. The RPC interface enables remote access, the peer services interface controls resource sharing within the PC, and the backup services interface lets administrators perform remote backups of Windows95 PCs.

Plug and Play

To make installing and configuring new PC hardware components simple and almost foolproof, Plug and Play tracks system resources (e.g., DMA channels, IRQs [interrupt requests], base I/O addresses, and UMB [Upper Memory Block] use) as well as device-driver configuration settings. The Plug and Play configuration manager stores the information in the Registry.

For the new Plug and Play hardware you buy, the obvious benefit is quick, easy configuration. For LAN administrators, the Plug and Play information becomes a valuable source of inventory detail, detail that's available over the wire to LAN management software products.

SNMP, DMI, and CMIP

Different LAN management products accept over-the-wire resource information in different formats, using different protocols. Using the information stored in the Registry, interfaces built into Windows95 provide resource management information required by those different third-party LAN management products.

For management products expecting data through SNMP, Windows95 includes an SNMP agent. SNMP is a popular Internet protocol for sending network management information from one computer to another. The Windows95 SNMP agent is patterned after the Windows NT SNMP agent and consists of a 32-bit Windows software module. Network management products such as Hewlett-Packard's OpenView and Novell's NMS (Network Management System) can accept data via SNMP. Windows95 can send the SNMP messages over the IPX transport layer or the TCP/IP transport layer.

Windows95 invokes a *MIB handler*, which converts the information in the Registry into MIB (Management Information Block) format, and the SNMP agent transmits the MIB data to the requesting remote management console. Because each LAN component can have a completely different MIB format, Windows95 needs a different MIB handler for each component. The MIB handler extracts data from the Registry, puts the data for that component into the appropriate format, and hands the data to the SNMP agent for transmission across the LAN cable. Microsoft claims that writing MIB handlers will be an easy programming task. At this writing, the MIB handler specification has not been completed.

DMI is an emerging standard for how LAN management products describe and control the components in a desktop computer. DMI doesn't address how the information crosses the LAN cable, but rather how the management products interface to and describe the PC components.

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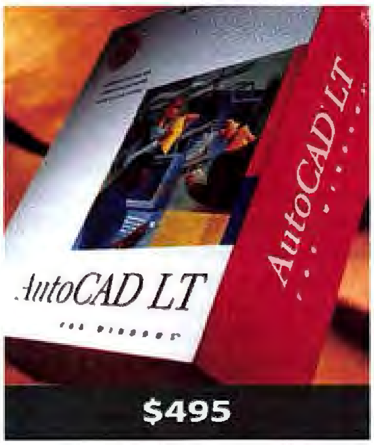

Autodesk.

The Registry editor lets you view and modify Windows95's central repository of resource management data.

Microsoft will supply a DMI SL (Service Layer) interface to the Registry. That interface will reformat information in the Registry into DMI's MIF (Management Information Format).

The DMI specification defines the contents of the MIF files produced by the component-level modules; describes the MI (management interface) through which software can issue commands to query, reset, or control components; provides an SL that implements the MI and directs the activities of the various DMI modules; and identifies the CI (component interface) that a LAN product vendor can use to provide querying and controlling access to its product. Not only can the CI respond to commands, but it can also generate event notifications (called *alerts* in some LAN management products). Microsoft supplies the SL; third-party vendors will have to supply the other pieces of DMI.

Microsoft is hedging on whether DMI support will appear in the initial release of Windows95. However, the company says you'll be able to get Windows95 DMI support by downloading Windows95 patches and updates from a variety of electronic sources (e.g., CompuServe) soon after the release of Windows95. The group of companies promoting DMI, called the DMTF (Desktop Management Task Force), have already created DMI software components for DOS, Windows 3.x, and OS/2 workstations.

An alternative management protocol that's part of the OSI standard, CMIP, won't appear in Windows95 at all. Microsoft says that a CMIP agent would consume a considerable amount of system resources (primarily memory and CPU), CMIP isn't in wide use yet, and customers aren't asking for CMIP in Windows95.

Peer, Backup, and Other Services

LAN administrators complain that the peer-to-peer network operating system Windows for Workgroups has a cavalier attitude toward letting people share drives and printers. With Windows95, Microsoft lets administrators clamp down on indiscriminate sharing of drives and directories. A person using a Windows95 workstation might, for instance, want to make his or her entire local hard disk available to others on a read/write basis and thus avoid having to use a central file server to share files. Windows95 would prohibit the operation if the LAN administrator had previously set up peer sharing restrictions.

Even after the fact, an administrator can (from a central console) close files and delete existing peer connections that he or she finds inappropriate. Windows95 gives administrators virtually the same control over peer resource sharing that those administrators have over departmental file servers. An enhanced version of the Windows for Workgroups NetWatcher module gives administrators remote control and management of peer resource sharing.

Windows95 includes backup agents for Cheyenne's ARCserve and Arcada's Backup Exec. A backup agent is a specially designed peer sharing function that makes a workstation's files available, just for backup purposes, across the LAN. The backup agents give administrators the ability to make copies of a workstation's files via a central backup scheme. Cheyenne and Arcada, for their part, have announced they'll modify their products to interface with the backup agents in Windows95.

Backup agents are bidirectional in the sense that remote software distribution and installation can occur through the backup agent interface. With yet-to-be-developed third-party software distribution utilities, administrators will be able to install or upgrade software on a workstation through the backup agent interface just by instructing the backup agent to pull files from a central file server. Windows95 also has provisions for configuring the installed software, including new program groups, icons, and application-specific entries in the Registry.

Windows95, at least in its initial release, won't offer the LSAPI (Licensing Services API) developed by Brightwork, DEC, Gradient Technologies, Microsoft, and Novell. However, future versions of Windows will likely contain LSAPI components, according to Microsoft. The LSAPI will let LSAPI-enabled applications software products monitor and control the number of concurrently-in-use instances of those applications. Through the LSAPI, an application can register itself with a license server. When run on a workstation, the application asks the license server if the license agreement recorded in the license server permits another instance of the application to run.

People often perceive a response-time or performance problem at their workstations. Windows95 includes a Performance Monitor module that administrators can use to see the types and categories of resource use occurring at a workstation in real time. An enhanced version of Windows for Workgroups' WinMeter utility, Performance Monitor can show a graph of, say, file I/O and CPU usage at a workstation. The administrator can run Performance Monitor at a central console, indicate which workstation to monitor and which statistics to graph, and then analyze that workstation's workload in real time.

The Costs of Resource Management

The resource management features of Windows95 are several orders of magnitude

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richer than those provided by earlier versions of Windows. If Microsoft is late and misses its announced release date of December 1994 for Windows95, a big part of the reason could well be the extra programming effort these new features require. Rob Price, program manager in the Personal Operating System Division of Microsoft, says, "Microsoft wants Windows95 to be just another asset on your network that's simple to manage and well integrated." LAN administrators know that's a tall order, one that isn't achieved overnight.

The new features, in the form of code modules on your hard disk, will naturally consume disk space. An upgrade to Windows95 will likely entail a hard disk housecleaning or purchase of bigger drives to accommodate the additional 35 MB that Windows95 requires.

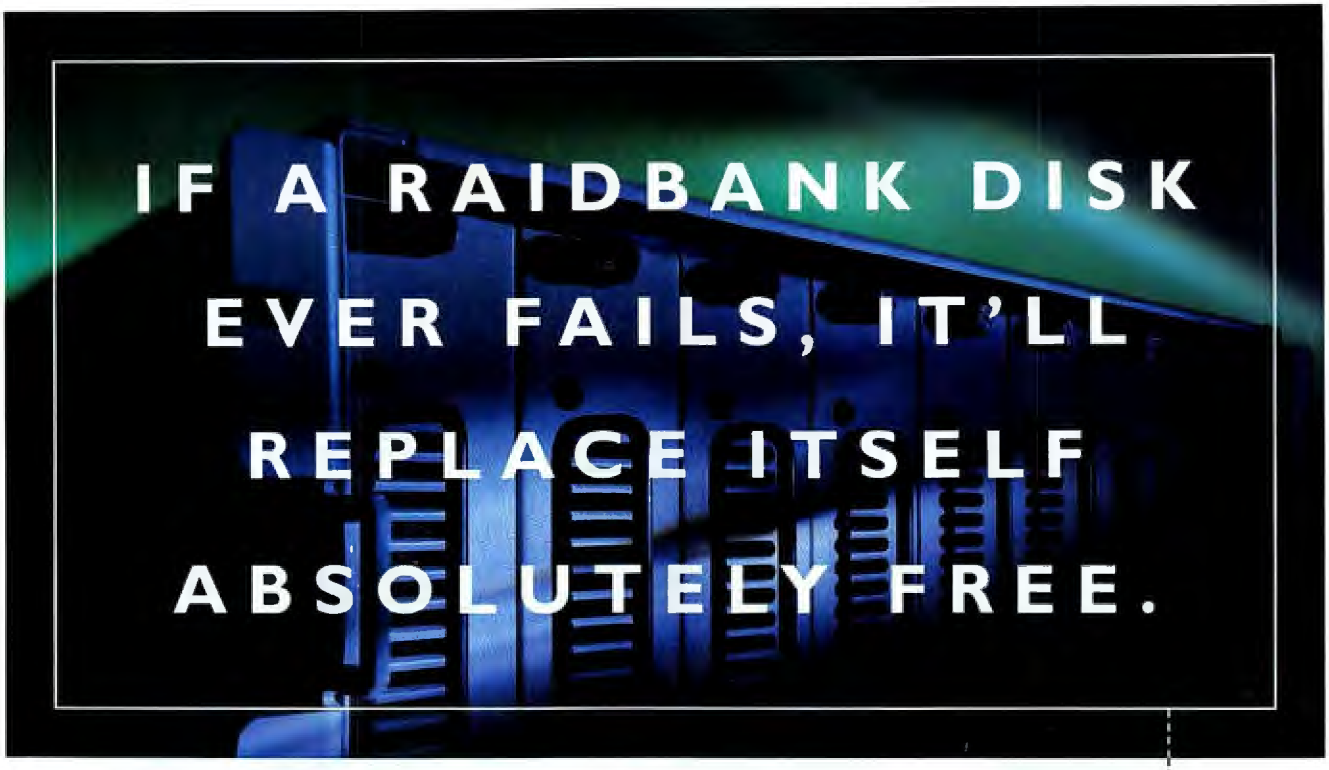
As you load and run Windows95, you'll notice that these features—especially the new agent modules—use additional RAM, perhaps as much as 300 KB. You may need to buy additional memory for those workstations. And you may notice that workstations don't seem quite as peppy when running Windows95; the new features will need to use some CPU time to get their work done.

Perhaps the biggest cost of these new resource management features is the risk that not all third-party LAN management product vendors will embrace the new interfaces right away, or not all vendors will do so with bug-free software. The development of resource management drivers and utilities for Windows95 closely parallels the Windows 3.x video driver development situation of a few years ago—you may recall that vendors took years to produce high-quality Windows 3.x video drivers.

You may, for instance, find yourself waiting for a new version of your preferred backup software that supports the Windows95 backup agent technology, or you may find that the hardware component vendors you deal with don't write Windows95 MIB handlers so that you can take advantage of the SNMP agent interface. Windows95 offers a lot of potential in the area of LAN management, but some time may pass before you can realize that potential in your organization.

The resource management interfaces and resource data organization that Microsoft has designed into Windows95 represent a strong reaction to the complaints from LAN administrators about Windows 3.x. If third-party vendors rise to the occasion—and early signs indicate that they will—Windows95 PCs will easily manage assets on a LAN. To take advantage of Windows95's new management features, a PC will likely need more RAM and more CPU power. However, the benefits of the rich set of Windows95's management facilities may well make the extra cost worthwhile. ■

Barry Nance is a BYTE contributing editor who has been a programmer for 20 years. He is the author of Using OS/2 2.1 *(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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Managing Color in Chicago

With Chicago's ICM, the color of an imported image will more closely match what you see on a monitor or printout

TOM R. HALFHILL

As color printers and scanners grow in popularity, users face the challenge of maintaining color fidelity throughout the tricky process of importing an image, modifying it on the screen, and rendering it on a printer. All too often, the result is a disappointment: off-balance color, harsh or weak contrast, too dark or too light. The main problem is the wide variation of color accuracy among input devices, color monitors, and output devices. In the world of desktop color, what you see is rarely what you get. Users need a color management system that knows the characteristics of all devices in the process and can automatically compensate for their vagaries.

Some desktop publishing programs, such as QuarkXPress, Photoshop, PhotoStyler, and CorelDraw, offer their own color management systems, usually licensed from other companies. But these systems are not always compatible with each other, and people who use several programs must deal with several different mechanisms.

Apple addressed this problem on the Macintosh in 1993 by introducing ColorSync, an open-architecture color management extension for System 7. ColorSync defined a file format for profiles that record the attributes of input devices, monitors, and output devices. Vendors can ship calibrated profiles with their devices, and programs can apply those profiles to maintain consistent quality during color-space conversions and other transformations.

With the release of Chicago, Microsoft is not only building a similar framework into its own system software, it's also cooperating with Apple and other vendors to support a standard profile format that works across multiple platforms. The result is the first industry-standard color management system for desktop publishing.

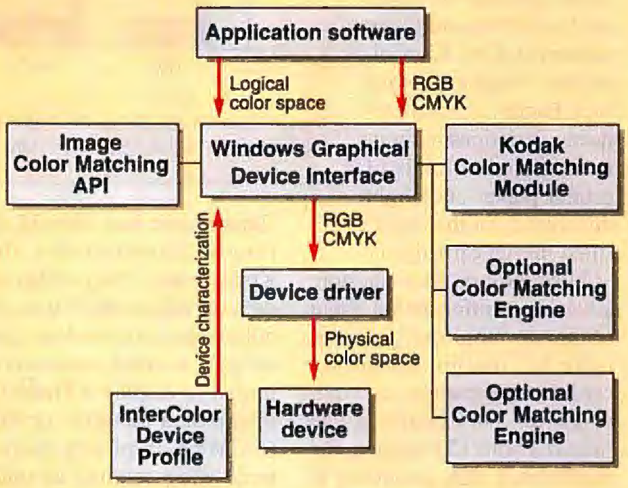
Chicago's color management architecture is called the Image Color Matching Framework (usually abbreviated ICM), a library of about 16 new API routines that are callable from any Chicago application. Another component is the Kodak Color Matching Module, a color management engine licensed from Eastman Kodak (Rochester, NY). It's the same engine already included with Adobe Photoshop and Aldus PhotoStyler and scheduled for inclusion with the next release of Aldus PageMaker. In Chicago, both ICM and the Kodak color engine are contained in a DLL called ICM32.DLL that will occupy about 224 KB in the WINDOWS\SYSTEM directory.

"It's basically a way of keeping the drivers and the applications from having to build in their own color management features," says Myron Kassaraba, director of licensing and market development for Kodak. Developers still have to modify their applications to take advantage of ICM, he notes, but the availability of color management in the operating system will save them a lot of trouble.

Chicago's color profiles will conform to the InterColor Profile Format, which was recently defined by the InterColor Consortium. Members include Adobe, Agfa, Apple, Kodak, Microsoft, Silicon Graphics, Sun, and Taligent. The standardized profiles will be compatible with Apple's ColorSync 2.0 and with a future version of SunSoft's Solaris.

ICM also supports the new Plug and Play specifications for video monitors recently adopted by VESA (Video Electronics Standards Association). These specifications define a back channel that allows monitors to pass information back to the computer along the video cable, thus providing an avenue for auto-calibration. For the most critical applications, however, users still need to calibrate their screens with a spectrophotometer or colorimeter to compensate for such factors as the color shift of the CRT over time. *continued*

Chicago's Image Color Matching Framework



Chicago's device-independent color architecture, or Image Color Matching Framework, consists of 16 new API calls, a color management engine (the Kodak Color Matching Module, which can be replaced by other engines), and device profiles that adhere to the InterColor Profile Format. Applications call on ICM to map colors between the physical color spaces of input and output devices, thus maintaining more consistent color throughout the process of scanning, viewing, and printing.

For instance, X-Rite (Grandville, MI) is introducing a color-calibration solution called RiteColor Pro that works with both ICM in Chicago and ColorSync on the Mac. The $2995 package includes a reflective color test chart for scanners, two colorimeters (one for measuring the screen and another for measuring hard-copy output), and a program that analyzes the meter readings to create the InterColor-compliant custom profiles. RiteColor Pro compensates for such factors as manufacturing variations in monitors, different kinds of printer paper, and slight differences in the color of refilled ink-jet cartridges.

Market research firm Dataquest predicts strong growth in sales of color printers, increasing from about 13 percent of the market in 1992 to nearly 34 percent in 1996.

InterColor profiles can store a wealth of information about scanners, monitors, printers, color fax machines, film recorders, imagesetters, and other devices. For example, if you import Photo CD images, the profile may vary according to the type of film that was scanned onto the CD: Kodak Ektachrome has slightly different characteristics than Kodachrome. The profiles also contain information that aids color-space conversions, such as YCC to RGB (which is required to display a Photo CD image on a monitor) or RGB to CMYK (typically encountered when sending an image to a printer).

Image file formats such as TIFF and GIF may be redefined to include similar data. "Right now, when you load an RGB image such as a TIFF file, you have no idea what references were used when it was created," says Kassaraba. "It might have been created on a system with a completely different gamma and everything else."

Color page scanners are steadily growing in popularity, although research firm Dataquest predicts a strong surge in monochrome scanners due to rapidly dropping prices.

This problem is readily apparent when moving some kinds of image files between Macs and PCs. Macintosh images often look too dark on PCs, and PC images often look washed out on Macs. The usual solution is to manually alter the gamma curve with an image editor such as Photoshop, but that adjustment could happen automatically if image files were tagged with gamma values according to a standard format. A program could read those values while importing the file and call `SetDisplayGammaRamp`, a gamma-correction function in Chicago's ICM API that is absent from Windows 3.1 (the Macintosh Toolbox has a similar QuickDraw function, called `SetDeviceAttribute`).

Since most existing devices don't have color profiles yet, Chicago will come with a database of popular monitors and graphics cards. You can access this database from the Desktop Property Sheet and pick from a scrolling list.

If you don't have a program that's been upgraded to support ICM, try the new Paintbrush accessory. By the time Chicago is released, there is a good chance Paintbrush will be ICM-aware, according to Microsoft's Chicago core program manager George Moore. And since Paintbrush is an OLE server, Moore notes, you could embed it in applications that do not support ICM and still reap some benefits of hassle-free color management.

ICM's open architecture also lets users install different color management engines that override the Kodak engine included with Chicago. For example, Pantone (Carlstadt, NJ) has a new version of its POCE (Pantone Open Color Environment) that is compatible with both ICM and ColorSync 2.0.

POCE is the only engine that addresses Pantone colors, which are widely used in the publishing industry. Richard Herbert, vice president of Pantone's Electronic Color Systems, says POCE is licensed for free to developers, who can bundle it with their Chicago and Macintosh programs.

A standardized approach to color management will strengthen Microsoft's bid to challenge the supremacy of the Macintosh in professional desktop publishing. But it will also make life easier for users, whether they prefer Chicago, the Macintosh, or any other platform that adopts the InterColor format. ■

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

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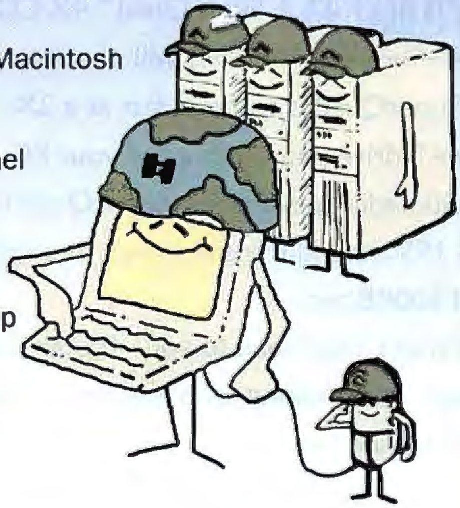

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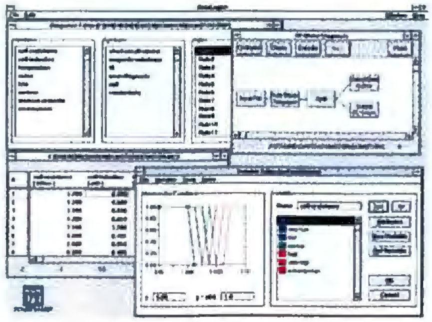

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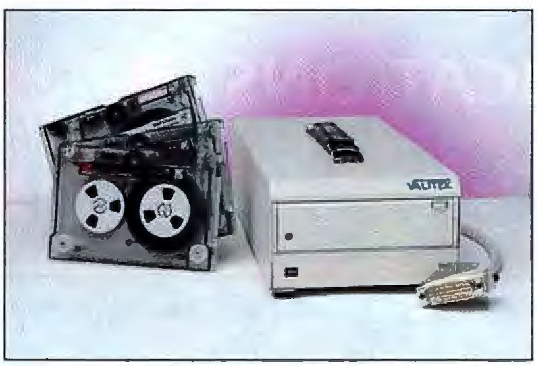

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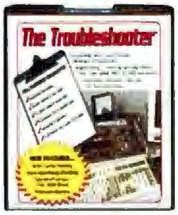

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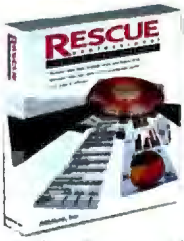

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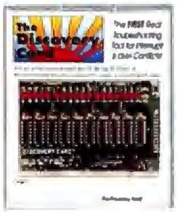

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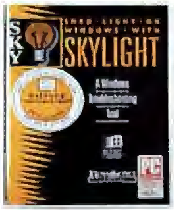

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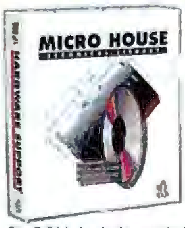

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Answer BYTE's Expert Opinion Poll on Windows and Windows NT

As a technology leader, you and your company are no doubt already evaluating Windows 95 and Windows NT 3.5 for a variety of applications. BYTE wants to know your opinions and plans regarding Microsoft's newest operating systems. So what are you waiting for? Please take five minutes to answer the questions below, and let us know what you think!

Windows 95/Windows NT Survey

1. Do you agree with the statement that Windows NT 3.1 is a

	True	Somewhat true	Very true
Enterprise server platform	❑	❑	❑
Desktop OS	❑	❑	❑
Both of the above	❑	❑	❑

2. Do you agree with the statement that Windows NT 3.5 (Daytona)is a

	True	Somewhat true	Very true
Enterprise server platform	❑	❑	❑
Desktop OS	❑	❑	❑
Both of the above	❑	❑	❑

3. If you have not purchased Windows NT 3.1 yet, will you purchase Windows 95 in place of Windows NT?
❑ Very likely ❑ Somewhat likely ❑ Not likely

4. If you have purchased Windows NT 3.1, will you upgrade to Windows NT 3.5 (Daytona)?
❑ Very likely ❑ Somewhat likely ❑ Not likely

5. I believe Window NT 3.5 (Daytona) will be better than Windows NT 3.1, because
❑ It has better RAM management
❑ It has better graphics capability

6. I believe Windows 95 will be better than Windows 3.1, because
❑ It has superior multitasking
❑ Its 32-bit architecture is more robust & reliable
❑ It has a new, easier to use user interface

7. Are you are planning to evaluate Windows 95
❑ for yourself ❑ for workgroup/dept ❑ for organization

8. How quickly after the product is available will you deploy
❑ 0-3 months ❑ 4-6 months ❑ 7-10 months

9. What would hold you back from deploying Windows 95?
❑ Cost of deployment
❑ Compatibility with existing applications
❑ Stability of release
❑ Other____________________

10. Would you purchase a new system to run Windows 95?
❑ Very likely ❑ Somewhat likely ❑ Not likely

11. Would you upgrade your system to run Windows 95?
❑ Very likely ❑ Somewhat likely ❑ Not likely
If yes, which components would you add?
❑ CD-ROM drive ❑ Hard drive
❑ Video accelerator ❑ Memory
❑ Sound board

12. How much, if anything, have you seen, heard or read about Daytona (Windows NT 3.5)?
❑ Great deal ❑ Nothing at all
❑ Fair amount ❑ Don't know
❑ Only a little

13. What is the most important source of information for you concerning Operating Systems?
❑ Computer publications like BYTE
❑ Company literature
❑ Trade shows
❑ Information received from friends and coworkers

14. From what you have heard of Windows 95 so far, would you purchase it?
❑ Very likely ❑ Somewhat likely ❑ Not likely

15. From what you have heard of Windows NT 3.5 (Daytona) so far, would you purchase it?
❑ Very likely ❑ Somewhat likely ❑ Not likely
Why not?____________________

16. How much would you pay for Windows 95?
❑ \$50-\$60 ❑ \$80-\$90
❑ \$60-\$70 ❑ \$90-\$100
❑ \$70-\$80 ❑ >\$100

17. About how many people are employed throughout your entire company, including all divisions and locations?
❑ Less than 50 ❑ 1,000 to 4,999
❑ 50 to 99 ❑ 5,000 to 9,999
❑ 100 to 499 ❑ 10,000 to 19,999
❑ 500 to 999 ❑ 20,000 or more

18. What is your company's primary business?
❑ Manufacturing ❑ Wholesale/Retail Trade
❑ Independent consulting ❑ Communications/Utilities
❑ School or university ❑ Medical/Dental/Legal
❑ Engineering/R&D ❑ Aeropace/Defense
❑ Government/Military ❑ Mining/Construction
❑ Finance/Insurance/Real Estate ❑ Other business

19. Additional comments: ____________________

FAX this completed form (without a cover sheet please!) to (603) 924-2530.

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SmartPad Developer Edition includes SmartScripts, a fully VBA Compatible macro language, that allows you to add decision-making power to your single-click applications — easy-to-use "procedural snippets" for incorporating if-then-else logic, looping, subroutines, and more. Plus you can compile SmartScripts for tamper-free, higher performance.

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- Add BalloonHelp and ButtonClues to any application for ease of use.
- Automate repetitive and complex tasks with Macros, DDE, Scripts, etc.
- Automate data sharing across Windows, DOS and host-based applications.
- Create customized shell to replace Program Manager.
- Standardize the look, feel and function across applications from different vendors.

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Face-to-Face Collaboration

Despite the need for more standards and affordable bandwidth, current desktop videoconferencing products work well for group collaboration

ERIC GARLAND AND DAVE ROWELL

Videoconferencing is not a new industry, but until recently, it has been confined to large room-based systems and cartable (roll-about) small-group systems costing $20,000 and up. Faster desktop PCs, increased network and communications bandwidth, and more-capable digital video components—all at lower prices—have brought videoconferencing on desktop systems into the realm of possibility and even affordability (see "Video Conquers the Desktop," September BYTE 1993).

A broad range of videoconferencing products is now available for a variety of hardware platforms and communications channels. We look at five of them in this review. Two are Unix software packages that work over networks on video-equipped Silicon Graphics, Inc., and Sun Microsystems' workstations: InPerson Desktop Conferencing from SGI and ShowMe from Sun. Two are Windows-based hardware/software kits that give a PC videoconferencing abilities over ISDN: Vistium Personal Video 1300 from AT&T Global Information Solutions and PictureTel Live PCS 100 from PictureTel. And one, InVision Desktop Video/Document Conferencing Software V.3.0, from InVision Systems, is a software product that turns a Windows PC equipped with relatively inexpensive video and audio hardware into a network videoconferencing station. It works with a variety of network operating systems and media types.

New Uses

Putting videoconferencing capabilities into desktop systems has spawned new applications like document conferencing, or whiteboarding, where people work together on an electronic document using software tools (see "Desktop Data Conferencing," May BYTE). Many videoconferencing programs allow application sharing, where participants collaborate on projects using the same virtual spreadsheet or word processor.

These new videoconferencing applications don't require the same video quality as do long-distance meetings, where appearances and the ability to detect nuances of expression are critical. As a result, they've created a market for even lower-priced videoconferencing systems. Although companies like Compression Labs and PictureTel have had desktop products for several years, their systems are still expensive because they rely on a hardware codec to digitize, compress, and decompress the transmitted video data.

Intel started the current trend toward more-affordable systems when it introduced its ProShare Video System 200 in January. By relying on a software codec (based on its Indeo codec) that doesn't depend so much on DSPs (digital signal processors), Intel can offer its hardware/software package for $2500. The Intel product provides the same software features as the more expensive PC upgrade kits, works over the same 128-Kbps ISDN connections, but produces somewhat diminished video quality. Creative Labs recently took that trend further by offering a $1500 upgrade kit that works over regular phone lines (see the text box "Low-End Conferencing").

Old Barriers

In spite of lower prices and mature applications, there are reasons to wait regarding desktop videoconferencing. Lack of standards is one. H.320 is an ITU-T (International Telecommunications Union-Telecommunications Standards Section) group of standards (see the text box "Videoconferencing Standards") that includes the H.261 video codec standard among several others (H.320 has come to represent its parent Px64 videoconferencing standard). This standard has encouraged the proliferation of videoconferencing products in the last couple years, but it isn't well suited to software processing by a CPU, nor does it support document conferencing. Companies like Intel have used their own codecs to ship affordable products. Although Intel has promised H.320 support by year's end, the ProShare Video System 200 has been popular enough that it threatens to make the Intel codec a de facto standard.

For remote connections, ISDN is the connection of choice. Unfortunately, switched digital phone services such as ISDN aren't yet universal or fully standardized. Also, no inexpensive and simple way exists to videoconference over ISDN with more than two parties involved. To do so, you must go through a service provider with MCU (Multipoint Control Unit) capability.

In fact, AT&T plans to have a complete multipoint conferencing service available by the first quarter of 1995, using its existing digital infrastructure. As part of its WorldWorx Network Services, AT&T will offer multipoint collaboration by linking two to 22 people in a videoconferencing session. The service will also include data transfer and application sharing. Although WorldWorx will be based on H.320 standards, AT&T has agreed to support Intel ProShare by transcoding. This strategy would allow ProShare systems to link with H.320 systems in a multipoint videoconference, but transcoding would entail some measure of delay. The

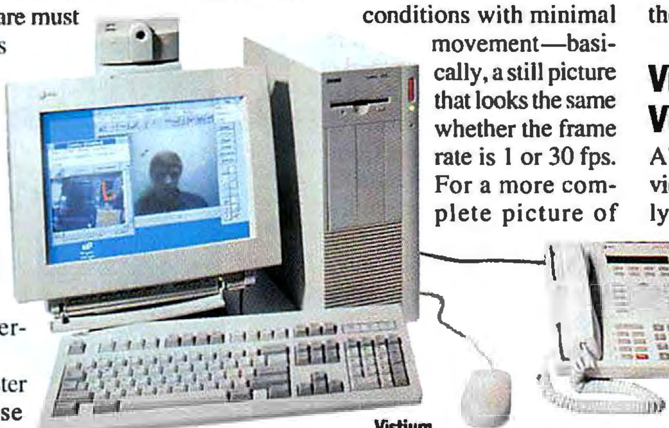
AT&T announcement makes Intel's future support of H.320 a bit less critical.

Regarding LANs, there are no standards for videoconferencing at all. LANs have plenty of bandwidth compared with ISDN, but the unpredictable and bursty nature of data transmission over shared-media networks like Ethernet and Token Ring isn't naturally suited for transmitting audio and video data, which require dependable isochronous bandwidth. LAN-based videoconferencing software must jump through a few hoops to provide smooth audio and video without unacceptable delays. H.320 does not yet fit well with LAN requirements, and although some programs provide it, LAN products use proprietary codecs that prevent interoperability.

Switching hubs and faster LAN standards will ease data flow and reduce the traffic burden that video data places on a network. Also, ITU-T LAN videoconferencing standards are under development, as well as an IEEE standard for isochronous Ethernet. For long distance networking, ISDN is still your best bet.

ATM (Asynchronous Transfer Mode) may solve the problems involving bandwidth and standardization. At speeds ranging from 155 Mbps to over 2 Gbps, ATM can provide the necessary speed to handle videoconferences and still have plenty of bandwidth left over for other operations. ATM will also span from LAN to WAN, including communications service pro-viders, raising hopes of videoconference standards that work at all levels.

One advantage that LAN-based videoconferencing packages have over ISDN-based products is multipoint conferencing. If your LAN can support the traffic, LAN programs like those from SGI and Sun let you conference with multiple parties.



Vistium

Frame Test

All the products we evaluated provide real-time color videoconferencing. Evaluating video quality involves several factors, including resolution, image clarity, and frame rate. The first two factors are subjective; frame rate can be measured.

Testing actual frame rate at the receiving end of a videoconference is tricky. Movement in the image, for example, makes video compression less effective and increases the amount of data sent per frame. Where bandwidth is limited, the software usually drops frames or, as in the case of AT&T's Personal Video 1300 software, lessens image quality. Therefore, frame rate and image quality typically vary with the degree of movement.

All the systems we tested boast frame rates of at least 15 frames per second (full motion is usually defined as 30 fps). These frame-rate estimates are based on best-case conditions with minimal movement—basically, a still picture that looks the same whether the frame rate is 1 or 30 fps. For a more complete picture of frame rate, you need motion.

We developed the VCBench test to provide a measure of frame rate, given a great deal of motion. Using a Creative TV Coder from Creative Labs, the VCBench test creates a test image at the sending end of a conference connection. The image is a white rectangle on a black background. The white rectangle fills one quadrant of the video image and moves sequentially from quadrant to quadrant at a set interval that can be adjusted with the test program. At the receiving end, four optical sensors monitor the video image, recording when the rectangle appears in each quadrant. (Thumper II, BYTE Lab's battery testing system, read the optical sensors.)

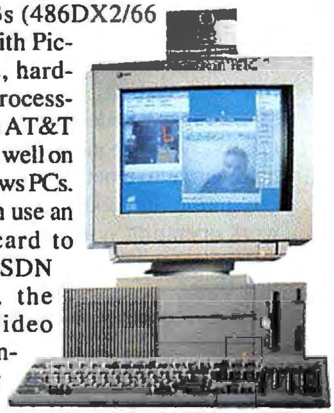
To test frame rate, we slowly increase the speed of the moving box so that it switches quadrants at a speed that matches the frame rate. The VCBench test detects dropped frames, which makes it easy to match box movement to frame rate. The test then displays actual frame rate. With all systems, we tested with the maximum supported video resolution (160 by 120 pixels for InVision, 352 by 288 pixels for AT&T and PictureTel, 320 by 240 pixels for SGI, and 640 by 480 pixels for Sun. We tested the three LAN-based systems on an isolated 10Base-T segment to remove traffic as an uncontrollable variable. For the two ISDN products, we used Teleos ISDN units to make the connection. Both local and remote video windows were active in the receiving systems.

While a white rectangle moving over a black background hardly resembles a talking head, the image stresses the tested system. More important, the results matched our own subjective estimates of frame rate with high motion in real images. Also, the relative ranking of the five systems matched our own impressions. Frame rates for typical video sequences will fall somewhere between the vendors' estimates and the VCBench test results.

Vistium Personal Video 1300

AT&T has been involved in bringing videoconferencing to the desktop from early on, providing chip sets as well as its own add-in boards. The Vistium Personal Video 1300 is one of the two H.320-compatible ISDN systems we tested. It's the one we like best because of its functional software, fluid video, and use of a speakerphone as its ISDN interface.

The $4995 kit is designed for PCs running Windows and includes two joined expansion cards, Windows software, a camera, and a speakerphone. The two cards handle voice, video, and data transmission with AT&T's AVP codec chip set and several DSPs. The two boards are joined and require adjacent ISA slots. The host system's graphics card works through the Personal Video 1300 cards via a pass-through connector. The host systems that AT&T provided for testing were two System 3333s (486DX2/66 CPUs). As with PictureTel Live, hardware video processing means the AT&T system works well on slower Windows PCs.



Vistium

Rather than use an expansion card to provide an ISDN connection, the Personal Video 1300 can connect directly to an AT&T 8510T ISDN speakerphone. We really like this setup because it uses the already familiar phone interface. You can make telephone calls without having to deal with a software interface or having your computer on. The phone has all the buttons you would find on a standard PBX phone and a few more.

This is a handy way to implement

Crossing Platforms

If you can't wait for network videoconferencing standards and need to support multiple platforms now, Communique 3.0 from InSoft (Mechanicsburg, PA) will interest you. It's a multiplatform videoconferencing program that originated on Unix platforms and moved to Windows-based PCs this summer. The program can talk between an impressive list of hardware that includes Sun and compatibles, HP Apollo 9000, Digital Alpha AXP, IBM RS/6000, and 486-/Pentium-based computers. Communique support for both LANs and switched services includes TCP/IP, Ethernet, FDDI, ATM, Frame Relay, T1, ISDN, Switched 56, and others.

The program includes all the frills of a high-end videoconferencing package, including whiteboarding, file transfer, and meeting minutes. The program does application sharing that works across platforms. This means you could be sitting at an Alpha AXP and control an application running on a Sun machine, or vice versa. Like InVision, Communique supports PCs with many different video and audio boards. It isn't for the faint of heart, though. It requires 16 MB of RAM (32 MB recommended) and 50 to 60 MB of swap space on a hard drive.

Pricing per seat starts under $2000, depending on platform. A Communique ConferenceKit for Windows 3.1 is $1995 and includes software, a video board, a camera, and a microphone.

ISDN, and we hope this is the way they all will be some day. Our only complaint is that a regular incoming phone call causes the videoconferencing software to give you a "Call ringing on invalid type" error message that shouldn't come up. You can still answer the call as you normally would, so it isn't a major inconvenience.

A big problem with the audio portion of conferencing is echoing, which occurs when the microphone gain on the other end is too high and sends your voice back to you. This is not a problem with headsets and can be solved easily with some systems by moving the mike and speaker farther apart or adjusting the volume.

InVision

The best approach with speakerphones, however, is echo cancellation, where the audio system subtracts some manifestation of your outgoing audio signal from the incoming signal after an appropriate delay, thus removing the echo. Both the AT&T and PictureTel systems have hardware echo cancellation for their speakerphones. When you start it up, the AT&T system also produces a series of initialization tones that allow the speakerphone to adjust its mike gain to the acoustic surroundings.

We also like the Personal Video 1300 software. It's a group of six applications managed by an overlord program called Video Manager. There's a window for the videoconferencing function and a separate whiteboard window. The package also includes file transfer, application-sharing, directory, and phone-dialing programs. The whiteboard program follows the paradigm of a draw program, so everything you draw is an object that you can manipulate. Video Manager makes it easy to manage the different pieces of the package. For instance, if you load the whiteboard program, you can shrink the videoconferencing program into an icon in the Video Manager to get it out of the way.

The Personal Video 1300 hardware uses chroma keying to superimpose a video over an image generated by the graphics card. The graphics card generates a box filled with a key color where the video should display and sends that image to the video board via a pass-through connector. The video board then uses the chroma key to overlay the video image and sends the resulting mixed image to the monitor.

Chroma keying has several benefits. Because the graphics card controls the video area, it's easier to put video in a well-behaved window that can be overlapped by other windows. Another benefit is that the video data doesn't have to be stored in the graphics card's frame buffer, an action that requires work by the CPU—nor is the CPU involved in decompressing the incoming video. With chroma keying, the video card does that work. By not loading down the CPU, Personal Video 1300 can run gracefully on slower systems.

One hitch with overlaying the video with chroma keying is that screen capture implemented through the graphics card will show just a colored box where the video window is. However, the AT&T system provides a way to capture video images directly from the video board.

Video boards with multiple input and output jacks give you flexibility. The Personal Video 1300 software lets you toggle between its two video inputs so that you can, for instance, switch to a document camera or a prerecorded video sequence.

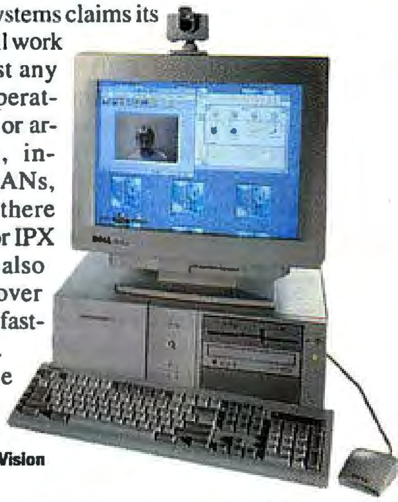
Personal Video 1300 got an impressive VCBench test rating of 7.9 fps, but its snappy response with motion came at the expense of image quality. When there was a lot of movement, the picture got blocky. Still, it had the most fluid video next to Sun's ShowMe, and that's impressive for a system communicating over a 128-Kbps ISDN line.

Since we tested the Personal Video 1300, AT&T upgraded the quality of the camera, which should sharpen images. The company also introduced Vistium Personal Video 1200, which uses a software H.320 codec. Priced at $2500, it's intended to compete with Intel's ProShare videoconferencing system.

InVision Desktop Video/ Document Conferencing Software V.3.0

Invision software's strong point is its $595 price and its support of both LAN and long-distance communications. This Windows-based videoconferencing package's weak point is video quality. A software-only product, it handles several codecs and communications protocols and will support more in the future, including H.320. InVision Systems claims its package will work with almost any network operating system or architecture, including WANs, as long as there is TCP/IP or IPX support. It also will work over V.32bis or faster modems.

Because InVision is a software-



InVision

Low-End Conferencing

As we completed this review, Creative Labs introduced a videoconferencing kit for use over standard phone lines. If you're on a tight budget and want to do whiteboarding and application sharing, with a little low-quality video thrown into the mix, or if you need to videoconference where ISDN isn't available, Creative Labs' $1500 Share Vision 3000 system could be the answer.

It's a two-board solution that includes a Video Blaster RT300 frame grabber card, an NTSC camera, a 28.8-Kbps modem, and a Share Vision card, which handles the serial I/O and audio. The Share Vision software includes modules for videoconferencing, whiteboard capabilities, application sharing, file transfer, and a phone book.

You can adjust the video resolution to any of three resolutions: 96 by 80 pixels, 128 by 96 pixels, or 160 by 120 pixels. Creative Labs claims frame rates ranging between 5 and 15 frames per second, though the highest figure must apply to the smallest resolution due to the limited 28.8-Kbps bandwidth. A zoom button on the video windows is a useful feature that allows you to make your face fill more of the video window.

A benefit to this system is that the components can serve other functions. You can, for example, use the 28.8-Kbps modem as a regular modem. The Video Blaster RT, a high-power video frame grabber with built-in hardware-assisted compression, includes Video for Windows drivers, so it can be used as a video digitizing board.

PictureTel

only product, it relies on a third-party video capture board for digitizing a camera's video input and a Novell or TCP/IP network driver for communications. The program currently works only with Video for Windows compression cards but will support H.261 and MPEG codecs in an upcoming version. InVision Systems has found that decompressing the incoming video stream in software and displaying it on the monitor directly through the graphics card provides the best video response on a LAN. With this approach, a faster host system with local-bus graphics makes a big difference in video response.

We tested InVision software with two 66-MHz 486 Dell Dimension 66Vs equipped with Intel Smart Video Recorder cards and Number Nine 64-bit VL-Bus graphics cards over 10Base-T Ethernet running NetWare. The Intel boards use Intel's Indeo software codec. The host system must also have Wave-compatible sound support. Like many current desktop videoconferencing products, it communicates only with itself.

You can vary video frame rate from 1 to 20 fps to fit the capabilities of your communications pipe. On a LAN, that sets the program's bandwidth requirement between 56 and 512 Kbps. With a modem, you must drop image size down to 100 by 100 pixels to get any kind of motion in the video. You can't count on the built-in compression abilities of V.32bis and faster modems, because the data is already compressed. In addition, audio with a modem connection must be "out of band," which means it must be a regular call over a separate phone line so you can talk while viewing the video image.

LAN Audio is unidirectional (because of the Wave sound cards), so InVision software provides settings for the threshold volume that puts a card in record mode, and a stop delay so that the card will wait out a set period of silence without stopping recording.

InVision comes bundled with Vision Graphics, a revamped version of Future Labs' Talk Show, which is a typical whiteboard program with features like a slide-tray interface for presentations. The package provides no application-sharing abilities but can do JPEG compression for data transfers. One feature that InVision software offers that most others don't is multipoint document conferencing (for up to 12 people). InVision Systems promises multipoint videoconferencing in the next version.

Despite testing on an isolated 10-Mbps Ethernet segment, InVision software gave the worst video performance of any system. Running on a 486DX2/66, the program's result on the VCBench test was a slow 2.9 fps. There were no problems with audio response and flow, but it tripped up on video periodically. We measured occasional delays between frames as long as 990 milliseconds.

The benchmark only confirmed our subjective impressions of the test system's video abilities. This program relies on Indeo software compression to digitize, compress, and uncompress the video while its own software spits the video out over the Ethernet. The computer simply couldn't keep up. The program should run better on a Pentium system. As systems become faster and codecs more efficient, this type of product will provide more-satisfactory videoconferencing.

PictureTel Live PCS 100

PictureTel has been in the videoconferencing business for a long time and is well known for its larger systems. PictureTel Live brings some of that technology to the desktop. Like AT&T's Personal Video 1300 system, it's a competent two-board, ISDN add-in kit ($5995) that provides H.320 compatibility with hardware codec processing. It also has the best camera of all the systems we tested. If your company already has higher-end PictureTel equipment, PictureTel Live will work with it.

Unlike Personal Video 1300, PictureTel Live has SVGA (up to 1024- by 768-pixel resolution) on its video board. The video board and audio-communications board connect and must sit in neighboring ISA slots. (An EISA version is also available.) The audio board connects directly to an ISDN line, unlike that of the Personal Video 1300, which goes through an ISDN phone. A phone-like unit acts as the audio interface, providing a handset and speakerphone capability but no dialing pad.

The PictureTel Live system has an excellent camera with lots of features: lever adjustments for brightness, focus, and zoom,

PictureTel

Videoconferencing Standards

H.320

The dominant videoconferencing standard developed by the ITU-T (International Telecommunications Union-Telecommunications Standards Section). It is a standard for describing videoconferencing terminals, but the term *H.320* has come to represent a whole suite of specifications for enabling a compliant videoconferencing session. It was originally adopted for room-based videoconferencing and for digital lines such as ISDN.

H.261

The compression component of H.320. It specifies a range of intraframe and interframe compression algorithms that can work with Px64 digital channels (64 Kbps to 2.048 Mbps).

CIF

Common Intermediate Format. The optional high-resolution display format at 352- pixel (horizontal) by 288-pixel (vertical) resolution.

QCIF

Quarter CIF. The minimum display format of 176-pixel (horizontal) by 144-pixel (vertical) resolution.

H.231 and H.243

These standards cover MCUs (Multipoint Control Units). H.231 defines how three or more H.320-compatible videoconferencing systems link together in a single conference. H.243 defines the MCU protocol standard.

H.233 and H.KEY

H.233 specifies the data-encryption methodologies supported under H.320. H.KEY standardizes the electronic management of encryption keys.

T.120

A standard-in-development, T.120 will cover document-sharing protocols. Once T.120 is adopted, compliant whiteboard applications will be able to talk to one another. Today, you must have the same whiteboard software on both ends of a conference.

and a black, metal camera stand that lets you flip the camera straight down for shooting documents. You can also set the camera on your monitor.

The PictureTel Live software is a modified version of Person-to-Person, IBM's Windows-based videoconferencing software. You wouldn't recognize it as such because PictureTel added its own software interface, which we found relatively easy to use. The software has a full set of features, including whiteboarding, application sharing, file transfer, meeting minutes, and a phone directory. When you pick up the audio unit's handset, a keypad comes up in a little box on the screen so you can dial. If the number isn't stored in the directory, you must dial using the mouse or keypad. We much prefer the AT&T approach where you dial on the attached phone.

One annoyance is the lack of a video-hold feature. If you want momentary privacy, you have to slide shut the camera's lens cap (the mute button on the audio unit cuts only sound).

The audio box has a handset and speakerphone, with a button to toggle the speaker on and off. A jack in the unit lets you plug in an optional headset. PictureTel Live's audio unit stands out for the deafening volume it can produce on its speakerphone. This can be a real benefit for room conferencing.

InPerson

Like AT&T's Personal Video 1300 system, the Personal Live system uses chroma keying to place the video image onto the screen. Unlike the AT&T product, PictureTel's system doesn't give you a way to capture a still video image, one of the most useful side functions of having a videoconferencing system on your desk.

The PictureTel Live achieved a respectable 4.9 fps on the VCBench test. The number is lower than that of the AT&T system because the PictureTel system maintains a higher image resolution during high motion (i.e., a clearer but jumpier video sequence). Both systems transmit reasonably good images when there is little motion, but we prefer AT&T's approach when there is motion (e.g., gesticulation)—it looks more real to us.

Because both systems are H.320-compatible, we called one from the other. Unlike almost everything else in this review, it worked on the first try. Of course, none of the document or applications features worked because H.320 doesn't yet deal with these functions.

InPerson Desktop Conferencing

SGI's InPerson is one of the two LAN-based Unix products we tested. The $495 program works on SGI's video-equipped workstations. We tested it over a 10Base-T Ethernet using two SGI Indy workstations equipped with 20-inch displays. Like Sun's ShowMe, InPerson supports multipoint videoconferencing and makes use of the built-in video capabilities of the host workstation.

The Indy comes equipped with a camera and a microphone and has strong graphics-handling capabilities for its price (see "Digital-Media Power," January BYTE). The nice feature of the Indy Cam digital cameras is that you can focus them. The Indy also has a clip-on mike, which looked unobtrusive and performed well.

InPerson communicates using TCP/IP over Ethernet with a proprietary compression standard, which limits communications to other SGI workstations. SGI is working on an ISDN version using H.320-compatible hardware compression that will talk with the outside world. The program already supports H.320 audio codecs.

The whiteboard function for document sharing integrates well with the rest of the program. You click a button to bring it up, and it appears as a part of the window that holds the live video. InPerson doesn't give you application sharing, although you can get the same function through a third-party shared X server. Support for file transfers is also clever: You drag a file icon from elsewhere in the user interface and drop it onto InPerson's Shared Shelf graphic to distribute the file to all connected parties.

Appropriate to a LAN-based videoconferencing package,

InPerson

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PC World Best Buy
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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

PC Computing BEST
May 1994 Pentium-66

Windows Sources Experts' Pick
June 1994 Pentium-66
August 1994 Pentium-90

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Processors	Package 1	Package 2	Package 3	Package 4
486SX-33	$1445 Lease $61/mo.	$1745 Lease $64/mo.	$2245 Lease $82/mo.	$2745 Lease $100/mo.
486DX-33	$1545 Lease $57/mo.	$1845 Lease $68/mo.	$2345 Lease $86/mo.	$2845 Lease $104/mo.
486DX2-50	$1545 Lease $57/mo.	$1845 Lease $68/mo.	$2345 Lease $86/mo.	$2845 Lease $104/mo.
486DX2-66	$1595 Lease $58/mo.	$1895 Lease $69/mo.	$2395 Lease $88/mo.	$2895 Lease $106/mo.
Pentium-60	$1945 Lease $71/mo.	$2245 Lease $82/mo.	$2745 Lease $100/mo.	$3245 Lease $108/mo.
Pentium-66	$2095 Lease $77/mo.	$2395 Lease $88/mo.	$2895 Lease $106/mo.	$3395 Lease $113/mo.
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- Choice of Lotus Windows application

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- Six-bay desktop case with two cooling fans
- MS-DOS 6.2, Windows for Workgroups 3.11, Microsoft Mouse
- Choice of Lotus Windows application

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DESKTOP VIDEOCONFERENCING—COMPARING FEATURES

The AT&T Personal Video 1300 and PictureTel Live prices are high because they include the necessary hardware to turn a Windows PC into an ISDN videoconferencing node. Also, both kits have hardware codecs for better video quality. InVision's Windows software provides videoconferencing over networks, near and far, but requires that the host PC have video hardware. SGI's InPerson and Sun's ShowMe are Unix programs that provide LAN videoconferencing for video-equipped versions of each company's workstations.

COMPANY	AT&T GLOBAL INFORMATION SOLUTIONS	INVISION SYSTEMS CORP.	PICTURETEL CORP.	SILICON GRAPHICS INC.	SUN MICROSYSTEMS COMPUTER CO.
Product	Vistium Personal Video 1300	InVision Desktop Video/ Document Conferencing Software V.3.0	PictureTel Live PCS 100	InPerson Desktop Conferencing	ShowMe
Nature of product	Add-in kit, hardware and software	Software	Add-in kit, hardware and software	Software	Software
Price (software, teleconferencing hardware, and host system)	$4995	$595 (includes VisionGraphics Document Conferencing Software)	$5995	$495	$1280
Host systems/operating system	AT&T System 3333 (486DX2/66)/Windows	Dell Dimension 466V (486DX2/66)/ Windows	AST Premier (486DX2/50) and NEC Image (486DX/33)/Windows	SGI Indy/Irix	Sun SparcStation 5M and 20M/Solaris
Tested communications channel	ISDN	10-Mbps Ethernet LAN	ISDN	10-Mbps Ethernet LAN	10-Mbps Ethernet LAN
H.320 support	●	N/A	●	N/A	N/A
Whiteboarding	●	●	●	●	●
Whiteboard object style (paint/draw)	Draw	Paint	Paint	Draw	Paint
Application sharing	●	○	●	○	●
Background file transfer	●	○ (Can use standard network file transfer, however)	●	●	●
Maximum video resolution	352x288 (CIF)	160x120 (QCIF)	352x288 (CIF)	320x240	640x480
Video window size adjustment	●	●	●	●	●
Video quality adjustment	●	Only if video input board supports it	●	○	●
Color controls	●	●	●	●	●
Best-case frame rate (claimed fps)	15	20	15	20	30
Frame rate adjustment range (claimed fps)	○ (automatic)	1–20	○	1–20	1–30
VCBench high-motion benchmark result (fps)	7.9	2.9	4.9	5.3	30
Audio sampling rate adjustment	○	○	●	●	●
Audio echo cancellation	●	○	●	● (in software)	○
Bandwidth use indicators	N/A (fixed)	○	N/A (fixed)	●	○
Can lock video window in foreground	●	●	●	○	○
Video on-hold/privacy feature	●	●	○	●	●

● = yes, ○ = no; N/A = not applicable

InPerson provides a bandwidth meter so that you can gauge the effect of videoconferencing on LAN traffic. Displaying a full-size 320- by 240-pixel image at 20 fps requires about 2500 Kbps of bandwidth.

The InPerson package uses software video and audio codecs, relying on the processing power of the host system's RISC CPU and graphics subsystem. On the Indy, video is definitely adequate, coming up with a reading of 5.3 fps in the VC-Bench test. Although this is in the same ballpark as the two ISDN systems we tested, you get a much clearer image with InPerson. This is due mostly to the greater bandwidth available on a LAN, although the quality of codec algorithms and processing speed available from DSPs or the CPU also have a big affect on frame rate and image quality.

ShowMe

ShowMe

ShowMe provides full LAN videoconferencing abilities to Sun Microsystems' M series of workstations under Sun's Solaris operating system. The $1280 software package provides a full set of conferencing functions, including application sharing and whiteboarding. We tested the package on an isolated 10Base-T Ethernet segment using SparcStation models 5M and 20M (see "SparcStation Overhaul," September BYTE). The M models of Sun's workstations come equipped for videoconferencing; all you need is ShowMe.

The SunVideo card in a SparcStation M model does hardware video encoding but not decoding. The result is excellent video performance. Sun's microphone fell short in our estimation, however. Although designed to sit on your monitor, Sun provides no means of attachment. Because the weight of its cord frequently pulled it off the monitor, we fashioned our own Velcro attachment.

Compared with InPerson, the ShowMe interface is functional but without grace. It works, but it's not very much fun. ShowMe, however, has functions that InPerson lacks, such

ShowMe

The C-Phone Solution: Out of Band

STANFORD DIEHL

Target Technologies (Wilmington, NC) has come up with a relatively inexpensive way of putting videoconferencing on existing LANs without bogging down the network. The system, called C-Phone, uses a PBX model to deliver desktop videoconferencing to both LAN stations and remote locations. With C-Phone installed on an Ethernet network, you can make live video phone calls from your desktop to any other C-Phone installation on the LAN.

A C-Phone gateway connects the video phone to the outside world. The Windows software supports a telephone-style interface that any business office can easily grasp. You simply start up a C-Phone session, check your image to make sure you've wiped the doughnut crumbs off your chin, and select the person you want to call up from a list. The party on the other end receives a ring, decides to accept the call, and—after wiping his or her own chin—picks up the line.

C-Phone is a hardware and software solution selling for $1995 per PC. An integrated camera/microphone/speaker unit sits on top of the PC's monitor. C-Phone requires a 386-based PC or better, running Microsoft Windows over Novel Netware, Artisoft Lantastic, a NetBIOS-compatible network, or Windows for Workgroups. The video system supports 64 lines (32 simultaneous two-way calls) on each workgroup. Bridging hardware for calling across multiple LANs and WANs is not yet available.

C-Phone operates out-of-band, consuming bandwidth not occupied by Ethernet traffic, so the video network does not degrade LAN performance. Your LAN cabling must be a shielded type to keep external high-frequency signals from interfering with the C-Phone traffic. If not, you must upgrade your network cabling or install dedicated cabling for the video network.

The optional C-Gate gateway connects the video phone system to the outside world via ISDN (BRI, or Basic Rate Interface), Switched 56, or T1 lines. Again, the PBX metaphor applies. Callers on the in-house video phone system share a set of outgoing lines. A number of different compression engines sit on a server, offering callers H.261 compression (for connection with other H.320-compatible conferencing systems, including room-based systems), Indeo compression, or other proprietary codecs. The caller dials out, selects a compression engine, and receives the first available "trunk."

The software supports 720- by 484-pixel picture resolution at 30 frames per second over the LAN, or CIF (Common Intermediate Format) resolution (352 by 288 pixels) at 15 fps over BRI. You can view multiple people taking part in the conference on a divided screen (a "Hollywood Squares" scenario), or broadcast one caller to many recipients. The software also supports standard telephone features such as caller ID, call waiting, call forwarding, call hold, and stored messages that can be played back, forwarded, replied to, or archived. C-Phone does not come bundled with any whiteboard or application-sharing software, although a whiteboard program running on a standard phone line could operate in conjunction with C-Phone. And the software developer's kit will allow developers to support C-Phone in other software packages. ■

Stanford Diehl is director of the BYTE Lab. You can reach him on the Internet at sdiehl@bix.com.

as application sharing. Its snapshot capability lets you send uncompressed still video images at 640- by 480-pixel resolution. This allows good detail in something like a close-up shot of a new product design. ShowMe also provides video that's virtually unaffected by motion in the image.

ShowMe's main window houses buttons for starting the video, audio, and whiteboard programs as well as the address book you use to call other people. The whiteboard software uses the paint model for annotating documents. To start a conference, you open the address book, select the people who are participating, and then return to the ShowMe window and click on the call-conference button. You can have more than two parties in a conference.

ShowMe then calls the other people's systems. If you are one of the selected participants and are logged in and running ShowMe, you see a box pop up with the choice of either accepting or rejecting the conference request. Upon acceptance, appropriate connections are made. You then open the video and audio tools to see small windows pop up showing each of the other members of the conference. ShowMe's "picture in a picture" feature lets you nest the view of yourself into the corner of the view of one of the other participants, shrinking it down to do so. This saves screen real estate when you're conferencing with a group of people.

You can set frame rate as high as 30 fps and image size as high as 640 by 480 pixels—way beyond what the other tested packages can do. You wouldn't want to use these settings routinely because of the LAN traffic it would generate. You can also set audio for half- or full-duplex. With half-duplex, audio goes in only one direction at a time, triggered by who is speaking. Using half-duplex reduces bandwidth requirements. Many systems work only at half-duplex.

ShowMe provides a bandwidth meter so you can see the impact of your settings on LAN traffic. We measured LAN traffic independently and found that a typical 15-fps session with 320- by 480-pixel resolution created from 10 percent to 20 percent LAN utilization on an isolated 10-Mbps segment. You can't have too many sessions going on with any of these LAN-based systems unless you go to switching or a faster Ethernet.

The most outstanding thing about Sun's videoconferencing system is its amazing ability to maintain frame rate in spite of motion in the video. When running the software at 30 fps, the video coming across the LAN connection was virtually identical to the video being generated.

What the Future Holds

The desktop videoconferencing market changes fast, with new products being announced almost every week. The current crop of products we tested all work well for video-assisted collaboration, despite the need for more standards and more-affordable bandwidth. The ISDN systems can also serve for long-distance meetings.

The technology is improving at a rapid pace, creating less expensive systems that can work better with less bandwidth. Within a year, you should see single-board videoconferencing products priced under $700 that work on standard phone lines. We can also hope for the quick arrival of standards for less expensive systems, LAN systems, and document conferencing.

As ATM services become widely implemented, there will be new standards constructed and new systems for multipoint videoconferencing. These high-end business systems will support 30-fps high-resolution video at a moderate cost. The market is still young and dynamic. ■

Eric Garland designed and wrote the BYTE Lab's videoconferencing frame-rate benchmark. You can reach him on the Internet at ejg@christa.unh.edu or on BIX c/o "editors."

Dave Rowell is a BYTE technical editor. You can reach him on the Internet or BIX at drowell@bix.com.

About the Companies

AT&T Global Information Solutions
(Vistium Personal Video 1300)
1700 S. Patterson Blvd.
Dayton, OH 45479
(513) 445-5000
(800) 225-5627
Circle 1083 on Inquiry Card.

InVision Systems Corp.
(InVision Desktop Video/Document Conferencing Software V.3.0)
8500 Leesburg Pike, Suite 300
Vienna, VA 22182
(703) 506-0094
fax: (703) 506-0098
Circle 1084 on Inquiry Card.

PictureTel Corp.
(PictureTel Live PCS 100)
222 Rosewood Dr.
Danvers, MA 01923
(508) 762-5000
(800) 716-6000
fax: (508) 762-5245
Circle 1085 on Inquiry Card.

Silicon Graphics, Inc.
(InPerson Desktop Conferencing)
2011 N. Shoreline Blvd.
Mountain View, CA 94043
(415) 390-1445
(800) 800-7441, Dept. D150
fax: (415) 390-6218
Circle 1086 on Inquiry Card.

Sun Microsystems Computer Co.
(ShowMe)
2550 Garcia Ave.
Mountain View, CA 94043
(415) 960-1300
(800) 821-4643
fax: (415) 969-9131
Circle 1087 on Inquiry Card.

Windows Illustration

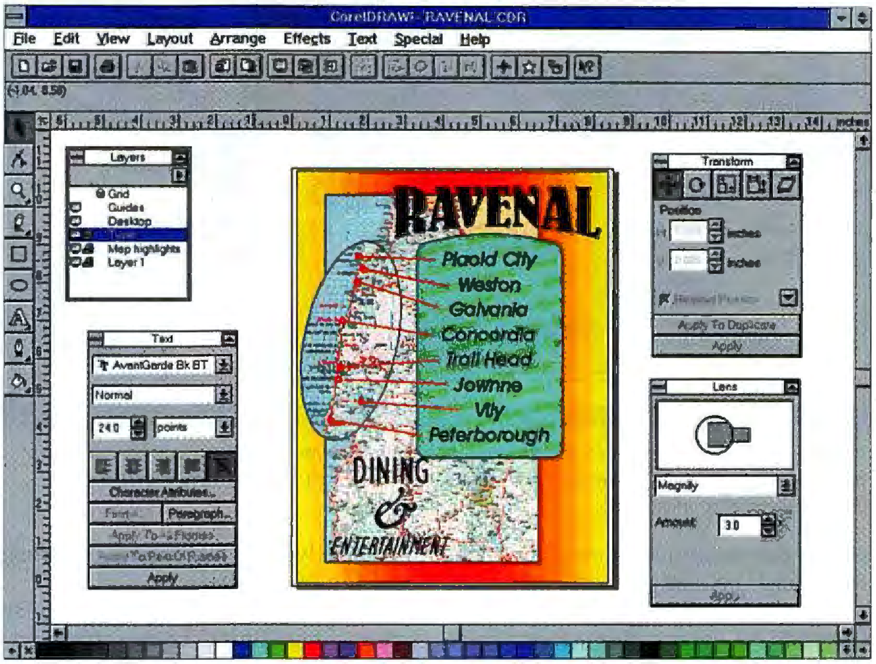
If Windows illustration is what you do and you want it all, you'd better buy both Aldus FreeHand and CorelDraw

G. ARMOUR VAN HORN

Trying to compare a straightforward graphics design and illustration program with a product that encompasses a whole suite of graphics and publishing applications is like comparing apples to fruit salad. But if you're a graphic designer working in Windows, you'll want to know about both of these new releases: Aldus FreeHand 4.0 and CorelDraw 5.0.

Aldus FreeHand is a widely used graphics program especially popular for the creation of newspaper and magazine ads and for infographics. It is incredibly successful on the Mac and becoming quite successful under Windows. CorelDraw began as a "business graphics" solution but has evolved into a set of graphics and desktop publishing applications plus utilities, clip art, and sound samples—literally a graphics and publishing environment unto itself. Corel has sold over a million copies of the CorelDraw suite, making it the most popular Windows graphics program.

If you were hoping that this comparison would tell you which of these competing products to buy, the truth of the matter is this: After using both FreeHand and CorelDraw since versions 2.0, I can't imagine being without either one.



I used Corel's new Lens tool to create the magnified map detail in the sample seaside entertainment advertisement. In this screen, the roll-up palettes are dropped down, but when they're rolled and stacked in one corner, you get lots of screen space while still having easily accessible controls.

Kitchen Sinkware Supreme

CorelDraw is updated each year at the end of May. Long-time Corel users are accustomed to this annual mix of joy and suffering: Important new features are often accompanied by bugs, the inevitable result of a rigid release schedule. In working with CorelDraw 5.0, I've found it to be the most stable x.0 release yet. This year's overall improvements to the suite include a general revision of interfaces to make the applications more tightly integrated with each other, improved memory allocation, enhanced file management, and faster performance.

Corel wisely decided not to include in this release Ventura Publisher 5.0, the desktop publishing package it recently acquired from Ventura; the company will wait to include it in a maintenance release. Bundled with utilities for SGML (Standard Generalized Markup Language) tagging and ODBC (Open Database Connectivity), Corel Ventura will also be available as a stand-alone product.

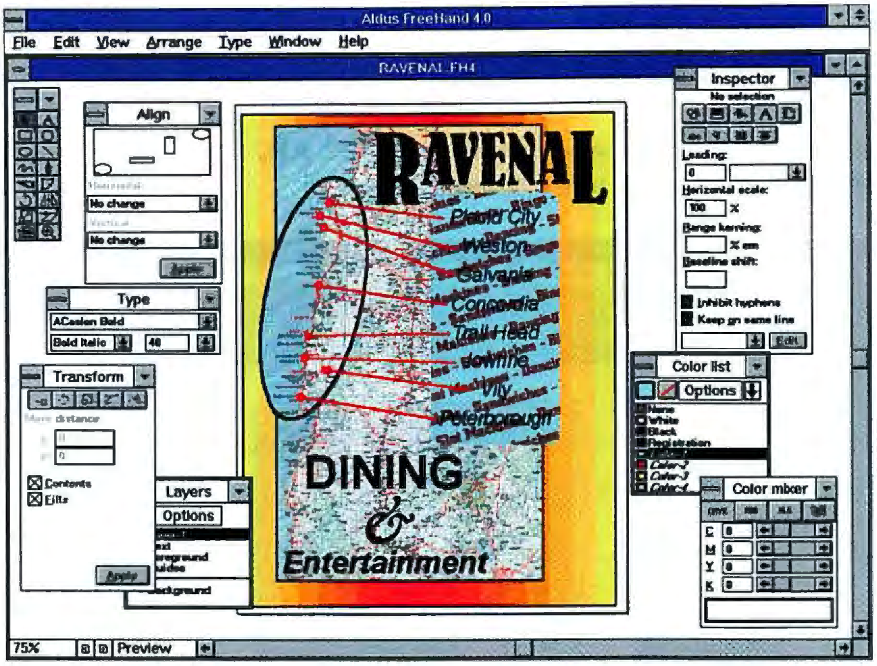
In CorelDraw itself, one significant new feature, PowerClip, provides functions that users have been adamantly requesting for years. It lets you edit a clipped image without taking your structure apart. If you want an illustration to fill a shape but not go outside the shape, you PowerClip it to the shape. The portion of the object that falls within the shape is visible; the part that falls outside might as well not exist.

The new Lens feature may not be useful to everyone, but it allows you to convert any Corel object into a lens. The lens can magnify, gray out, invert the tones of, or set a color cast to whatever is underneath it. An obvious use for it would be to provide detail magnification in a technical illustration.

Corel has also licensed a PostScript interpreter, which reads EPS files and converts the commands in the files into Corel objects. It often crashed during testing, but when it did run to completion, I was able to get excellent results from Illustrator and FreeHand EPS files. The conversion worked much better when no text was involved or when I instructed the filter to treat text as curves rather than as fonts.

Version 5.0 is miles ahead of previous versions in the range of formats it can import and export. And although CorelDraw has always offered Adobe Illustrator format—the lingua franca of illustration programs—as both an import and export option, in version 5.0 the export option actually works well.

Photo-Paint was completely reworked for this release. It still lacks the power and control of heavyweight tools like Adobe Photoshop or Aldus PhotoStyler, but it does have scanning, retouching, and color-balancing capability, plus the ability to edit in 32-bit CMYK format. The prepress tools aren't bad, and Photo-Paint finally shares the Corel interface. Also newly available are three main types of masking, new filters, canvases, and 50 new brush types. As long as files are maintained in the Corel Paint format, elements pasted into Photo-Paint are maintained as separate



This FreeHand screen shows the new color mixer, which lets you have four different color models available concurrently. You can now work in a 56½-inch-square "live" area, which lets you design multiple pages in a variety of orientations.

objects and can be moved, rotated, scaled, or distorted. You can also now load partial, resized, or cropped images, and PowerClip and Lens are available in Photo-Paint as well as in CorelDraw.

On the type front, Corel has boosted the font selection from 755 to 825 fonts in TrueType and PostScript Type 1. It's easy to install too many fonts and slow even a fast system dramatically. To manage fonts and make it easier to install and remove them, Corel has bundled an introductory version of Ares Font Minder into the suite.

Clip art? The industry's most generous collection has grown to 22,000 selections, and they are organized more logically than ever before. There are also 1000 animation actors, props, and sound files, plus 100 high-resolution color photo images.

The Test

To put these programs through their paces, I created a sample advertisement using each product's tools. I was equipped with an AMD 40-MHz 486 computer with 32 MB of RAM, a Diamond SpeedStar 8-bit accelerated video card, a 300-MB SCSI hard drive, MS-DOS 6.0, Windows 3.1, and a Dataproducts LZR 1560 printer on a server.

The biggest problem I had was that, several times as the review progressed, CorelDraw was unable to open and save my sample test illustration. Basic file stability should be assured before the release of any product. I've also had trouble importing complex Corel 4 files.

In creating the magazine ad (see the screen), I found that Corel was able to perform each function, although the file was huge and ran slowly. As soon as the 3-MB TIFF was placed in an empty document, its file size ballooned to over 7 MB.

I used the PowerClip's map highlight feature to fix the position of the clipped component of the map, and then I used a separate lens to magnify it. I colored the text background behind the city names and rotated and PowerClipped the object into a deformed rectangle. I warped the text using Corel's Envelope feature. Envelope editing lets you surround Draw elements with a deformable rectangle and then apply distortion proportionately to all points within that shape. (Although this feature is not unique to Corel, neither FreeHand nor Illustrator provides it.) Then, to contain the yellow-red-yellow blend, I created a compound shape on the same layer as the map.

Since Corel's leading specifications apply only to full text blocks rather than to individual characters, I had to create the "Dining & Entertainment" element in two pieces. Leading suitable for "Dining &" was far too great for the "Entertainment" line, so I had to break out "Entertainment" as a separate element, move it into position, and then group the two elements.

Screen redraws to place the red highlight lines from the city names to the map locations took more than 3 minutes each. The final file size was 7.1 MB, and printing a composite image required 2 hours, 17 minutes. You might as well throw out the TIFF unless you will need it again for another file.

Although I still can't recommend CorelDraw as the single solution for the professional artist, the fonts, clip art, and wide file conversion options make this version a must-buy for the Windows artist. Updates will be forthcoming, offering improved stability and performance enhancements.

The Future of FreeHand

Since Adobe's merger with Aldus, Aldus FreeHand is temporarily being offered by Adobe Systems. However, the Federal Trade Commission questioned whether Adobe's control of Illustrator, Photoshop, and FreeHand would give it an unfair monopoly in the graphics software market. Plus, when Altsys developed FreeHand for Aldus, their agreement included a noncompetitive clause prohibiting Aldus from

The CorelDraw Bundle

CorelDraw	Drawing, illustration with 50 templates
Corel Ventura	Desktop publishing application with 75 stylesheet templates
Corel Photo-Paint	Painting and image editing
CorelChart	Spreadsheet
CorelMove	Animation and morphing application
CorelShow	Slide show and multimedia presentation
Corel Query	Search and query tool for databases, spreadsheets, and text
Corel Mosaic	Drag-and-drop graphics browser and visual file manager
CorelTrace	Bit map to vector conversion utility
CorelCapture	Screen capture utility
CorelKern	Visual kerning utility
Corel DB Editor	Utility for creating and editing Paradox databases
TagWrite	Document conversion utility, SGML or RTF files
Ares Font Minder	Font management application
22,000 clip-art images	
1000 animation actors	
825 fonts	
100 photo images	

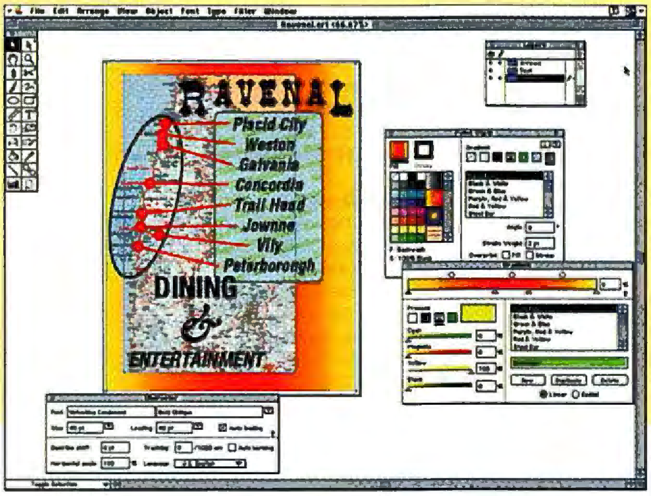
Adobe Illustrator 5.5 for Macintosh

Adobe Illustrator has long had a reputation for having the best line and shape tools, but it lacked the numerical position, size, and alignment controls that turned artists toward FreeHand. With version 5.0, and now 5.5, Adobe has added more controls.

With 5.5, Adobe has refined a few elements and released a true PowerPC-native application alongside the 68000 code. Illustrator has a fluidity that comes, no doubt, from being continually refined rather than overhauled. Although Illustrator is still unable to import TIFF images (the EPS version of my map was 8 MB compared to the 3-MB TIFF), the Illustrator file itself was only 40 KB. The process of creating my test using Illustrator entailed a few more steps than when using either Corel or FreeHand, but it felt quick due to relatively rare screen redraws.

To create the ad, I began a new document and placed the EPS-file map. I then combined two rectangles into a single object to contain the blend, copied and enlarged the map, and then masked it with an ellipse. Illustrator's masks cannot be stroked or filled, so I created a matching ellipse to carry the outline. I also used a mask to create the type-filled rectangles. I filled one with blue for the background, and I stroked the other with black and brought it to the front. These extra steps are not required in FreeHand or Corel; in those programs, a PowerClipped or Pasted Inside image is placed in front of the fill and behind the stroked outline, which requires only a single shape. The problem is that masked elements can be selected even if they're not visible. I've selected them accidentally far more often than intentionally.

The last step in creating a first draft, inserting the black type, was simple. The composite proof printed in 14 minutes, on a much faster printer than was available to the PC.



Adobe Illustrator 5.5's Mac interface, showing its visual and numerical control capability for creating color blends. The character palette displays Illustrator's intricate text-control features.

marketing a similar product until their contract expired. Aldus has agreed, amicably, to give Altsys control of FreeHand beginning in 1995, although Altsys may have another company market it.

In any case, Aldus FreeHand has always been a rock-solid product. True, there are no fractal fills, very limited clip art, and—compared to CorelDraw—only a handful of fonts. But FreeHand has always allowed the production artist a great deal of control, reliable printing, and a fast working environment. FreeHand 4.0 supports OLE 1.0 smoothly and can handle TrueType fonts, but its foundation is PostScript.

Unlike CorelDraw or even Adobe Illustrator 5.5 (see the text box "Adobe Illustrator 5.5 for Macintosh"), FreeHand 4.0 looks entirely different from any previous version or package other than Virtuoso, the Unix illustration program Altsys released in November 1992. I believe "Virty" was the first illustration program to use what Corel calls *roll-ups*. FreeHand 4.0 gives you floating roll-up palettes with a vengeance, and artists with screen resolutions lower than 1024 by 768 pixels have expressed concern (read "rage") over the lost screen real estate. While a quick look at the FreeHand screen shows just how cluttered the interface becomes with several palettes open, many features are available quickly.

Altsys implemented drag-and-drop color in FreeHand 4.0. The color mixer enables four color models: The CMYK mixer is shown at the lower right of the screen; RGB, HLS (hue, luminance, saturation), and the system palette are also available by clicking on the four buttons that appear at the top of the palette. You can drag colors to the color list, to the color wells in the Inspector, or directly to objects.

The Inspector is where almost every text control lives, although certain basic text controls—font, style, and size—are in a separate palette. Eleven palettes now replace 70 dialog boxes, and everything can be kept right where you are working at all times. The disadvantage is that a few functions that used to be attached to keystrokes are no longer available. The new

New in FreeHand 4.0

- Entirely redesigned interface for faster access to commands
- OLE client and server support
- More import and export formats
- 56½- by 56½-inch worksheet space
- Nine path-editing graphics commands
- Support for Aldus FreeHand EPS files and FreeHand 4.0 Mac files
- Professional page design with simplified object linking and unlinking
- Additional controls for kerning, drop caps, hyphenation, spacing, and tabs
- New calligraphic, pressure-sensitive drawing tool
- 120 Type 1 PostScript fonts
- Automatic text wrap, around or within irregular shapes
- Four-color models that provide drag-and-drop color application
- Color separation of RGB TIFF files

layout has other annoying problems, too, but many FreeHand users have come to appreciate the new approach.

In the screen, the background behind the list of cities should be the same pale green on pale blue that is portrayed accurately on the Corel screen. Many colors simply refuse to display properly; fortunately, they are accurate when printed. Throughout most of the job, I disabled the high-resolution display of TIFF files, which left the screen image coarse and blotchy but sped the screen redraws immensely. High-resolution screen redraws were dramatically faster than Corel's, particularly in the case of zoomed-in screens.

In my mock advertisement, I placed objects using the same method as in the other packages and then created and joined two rectangles to make the frame that holds the gradual fill. FreeHand does not support three-color fills, so this frame had to be duplicated twice. To display the border, I left one copy without a fill. I then selected the other two copies and cut down the middle of the page. With each side of the frame closed again, these inherited the yellow-to-red fill. I reversed the direction of the fill on the element to the right to simulate the yellow-red-yellow fill that the other programs were able to create directly.

After creating and rotating the oval for the zoomed highlight, I selected the map and duplicated it, enlarging the copy to its final size, cut it, and pasted it inside the oval. When I moved the oval, its contents would move with it automatically.

The heading "Ravenal" was set, but among these programs only Corel has an envelope feature, so I settled for decreasing the size of all letters except the first and last. I drew the panel for the city names, using the rectangle tool and the Shape Inspector to set round corners. I then colored and pasted the background text inside this panel; the colors are notably inaccurate.

About the Products

Adobe Illustrator 5.5 for Macintosh........$595
Adobe Systems, Inc.
1585 Charleston Rd.
Mountain View, CA 94039
(415) 961-4400
fax: (415) 961-3769
Circle 1077 on Inquiry Card.

Aldus FreeHand 4.0 for Windows.............$595
Aldus Corp.
411 First Ave. S
Seattle, WA 98104
(800) 628-2320
(206) 622-5500
Circle 1078 on Inquiry Card.

CorelDraw 5.0
CD-ROM only.............US$695/$945 Canadian
disk and CD-ROM.....US$895/$1195 Canadian
Corel Corp.
The Corel Building
1600 Carling Ave.
Ottawa, Ontario,
Canada K1Z 8R7
(800) 772-6735
(613) 728-8200
fax: (613) 761-9176
Circle 1079 on Inquiry Card.

I created the city names and the "Dining & Entertainment" text in what I think of as a straightforward manner, with the font, style, size, and leading all set on a character-selection level. Finally, after defining the arrowheads, I placed the key lines with the Line tool. Unlike in the other two programs, FreeHand's Line tool creates 2-point paths without your having to apply the arrowheads or deselect an element before creating the next.

The final file size was 31 KB, plus the TIFF, which is linked—a dramatic advantage where several files or versions will be created using a single scanned image. Composite printing took 43 minutes; outputting the PostScript code is quite fast, and linking the bit map, rather than including it, is not a problem.

Which One to Buy?

Designing a simpler layout might have left the scales more balanced, given Corel's more accurate color portrayal and more readable palettes. As I said earlier, I believe I need both programs. Corel's clip art and font collection are worth a great deal, and the ability to apply text effects like the moderate envelope operation in this job, as well as the ability to create more radical extrusions and distortions, is valuable regardless of which illustration program you create your final job in. The range of file conversions can be critical, particularly since Corel is the only program that is able to convert any Corel file.

In the final analysis, the operating speed, reliability, and accuracy of FreeHand are too valuable to tempt me to switch for production work, and the current lack of file stability makes it impossible to rely on Corel's product, especially if you're up against a deadline. ■

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Network Problem Solver

Fluke's LANMeter 675 can replace a shelf full of network-testing tools

BEN SMITH

Fluke crams a useful mix of LAN-testing functions into the LANMeter's rugged 4½-pound, 11½- by 6½- by 2⅛-inch package. Batteries last up to 3 hours if you don't use the screen backlighting. Five keys located below the LCD display take on the functions displayed on the screen above (inset).

Something has caused a workstation to go down. Is it an application, the server, or the network? If it's the network, it may take a whole shelf-load of tools—load analyzers, protocol analyzers, cable testers, and traffic generators—to track down the problem. Or you can use the Fluke LANMeter, a veritable shop of networking tools that you can hold in one hand.

Fluke's LANMeter products provide you with just the network traffic information you need. To use it, you don't have to understand the low-level engineering of network communications or learn how to use a protocol analyzer. If your problems seem to be coming from a router, bridge, hub, or NIC (network interface card), you can plug the LANMeter directly into the suspect device to test it. If the problem is not with the electronics, the LANMeter analyzes cables, too. Because it analyzes and tests protocols, networking hardware, and cables, this single tool can help you quickly isolate network problems.

With its backlit LCD graphics display and front-panel alphanumeric keyboard, the battery-powered LANMeter is a pleasure to use. A row of "soft keys" located below the LCD display take on the menu functions displayed along the bottom of the screen above, which makes it easy to navigate through the many LANMeter functions. More important, the 4½-pound LANMeter is easy to carry around and connect to a network anywhere you go.

There are three LANMeter models to choose from. Fluke introduced the 670 Token Ring LANMeter ($6495) last year; the 672 Ethernet ($6495) and 675 Ethernet/Token Ring ($9495) models appeared this year. Models with screen backlighting cost $300 more. All prices include a case, an AC adapter, a wire-map/cable-ID remote adapter, and a utility disk.

I tested a 675 LANMeter for this review; I'll refer to it as simply the LANMeter hereafter. The three models differ externally only in the functions that they provide through the display and some of the connectors—depending on whether the particular unit supports Ethernet, Token Ring, or both.

Well-Mannered Statistics

Network-traffic analysis is the single most important tool in tracking down poor network performance. It's rarely necessary to see the contents of each packet for each protocol (the method a protocol analyzer uses), but it is important to find out which protocols are merely flowing and which are flooding.

Not only can the LANMeter display the distribution of network loads during normal operation, but it can also show you the source of error packets and, for Token Ring networks, perform soft error-domain analysis. Even when you are using the LANMeter for functions other than statistics, its multicolor LEDs display overall network load and errors.

On Ethernet networks, the LANMeter's display of overall network statistics shows bandwidth utilization, collisions, errors, and broadcasts. The display shows the current and maximum percentage of each statistic in an active bar meter, next to a numeric display of the average and total for your sampling period. You can view the bar meter either as a logarithmic count or as a percentage of full load.

Another view shows error statistics, including, for Ethernet, *jabber* (illegally long frames), FCS (frame check sequence) errors, short frames, late collisions, remote collisions, local collisions, and *ghosts* (noise that might be mistaken for a frame). The display of these values consists of a pie chart with a count list. You can pursue many of the statistics to greater depth by pressing the zoom key on the front panel.

Two other network-monitoring views—protocol mix and collision analysis—provide you with similar displays, combining bar meters or pie charts with percentages or logarithmic counts. If you experience traffic-load problems, three more statistics are of particular value to your problem analysis: the top senders, the top receivers, and the top sources for broadcasts (a common source of trouble in IPX networks).

When you use the LANMeter on a Token Ring network, the general network-statistics display gives you appropriate information for that area, including beacons, claim tokens, ring purges, broadcasts, and stations seen. The error-statistics display includes line errors, burst errors, receiver-congestion errors, frame-copied errors, lost token errors, and other soft errors. You can display fault-domain information for any error type, which shows both the error-reporting station and its nearest active upstream neighbor. Another display shows statistics on token-rotation time.

You can configure your LANMeter to log any of these statistics for time periods ranging from 24 minutes (at 1-second intervals) up to 5 days (at 5-minute intervals) and then download the table of statistics directly to a PC or over a modem. This is a valuable capability because it allows you to further analyze the data.

The only impediment to this process is the short 1- to 3-hour battery life of the LANMeter. Battery life depends on how much you use the display backlighting. You can, of course, leave the battery charger plugged in while you use the LANMeter.

continued

If the battery is fully charged, the charger continues to trickle power to the unit.

NICs, Hubs, and MAUs

The basic electronic devices of a LAN are the NICs in each workstation, the hubs and concentrators from which twisted-pair Ethernet LANs fan out, and MAUs (multistation access units), which are the Token Ring equivalents of hubs. Needless to say, these potential sources of trouble need to be identifiable and tested. For those purposes, the LANMeter provides a user-definable station list and a suite of tests.

The station-list database is another of the LANMeter's great conveniences. By default, each MAC (media access control) or Ethernet address is automatically associated with a default-station address that, if possible, is derived from the device on the network. Then, using the LANMeter's alphanumeric keyboard, you can add your own symbolic name.

The LANMeter is capable of maintaining 32 separate lists of 512 stations each. You can import or export the list to or from a PC, download NetWare and IP host tables, and even sort the lists. LANMeter uses the symbolic names in any reports that identify a station, including network-monitoring reports of top network users.

For each test, the LANMeter displays a diagram of how to connect it to the device or network for that particular test. Each test has a help screen describing the test. For example, the expert-T, NIC, and hub auto-tests display the following message: "In the Expert-T test LANMeter checks the network Hub and the connecting NIC looking for any problems that could keep the NIC from successfully connecting to the network. If cabling problems are suspected, appropriate cable tests will also be run." This explanation goes on for a few dozen screens.

The NIC test suite can discover the address of the device and test its link pulse, transmission sensing and generation, response speed, and phantom voltage, as well as check for duplicate addresses and lobe cabling (if appropriate). The final test is to let the LANMeter generate test network traffic. You can start by having it send PING (packet internet groper) packets to the devices and determine if they are alive and connected. Then you can have the LANMeter generate traffic loads while you monitor how the network handles it.

The Wire

If your network problems aren't in the applications or devices, they could just be in

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4191P $32.95
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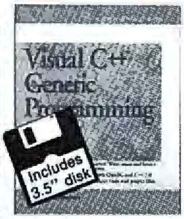

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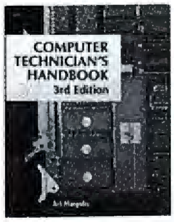

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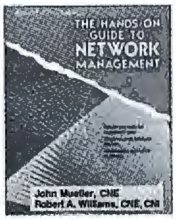

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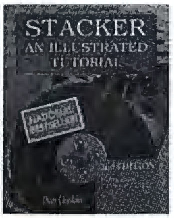

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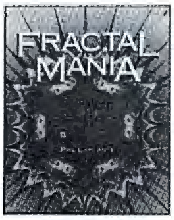

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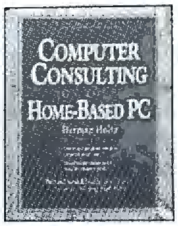

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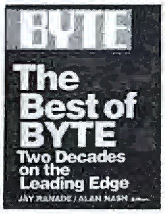

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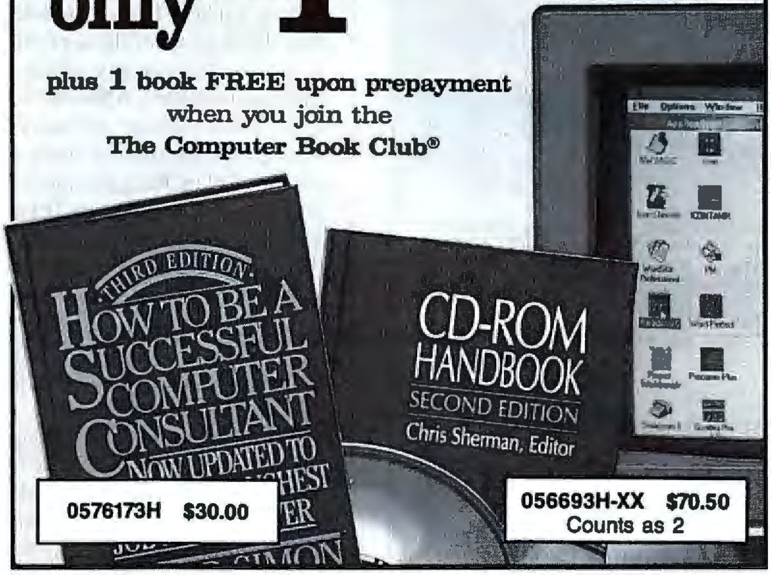

0576173H $30.00

056693H-XX $70.50
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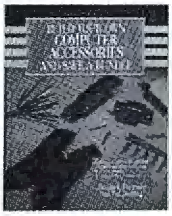

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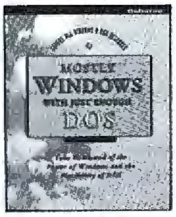

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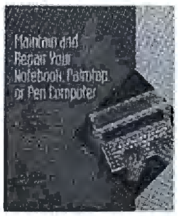

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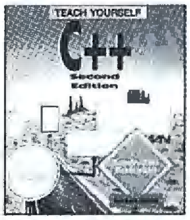

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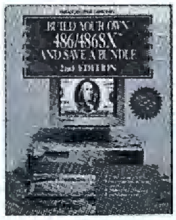

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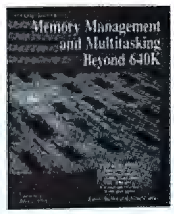

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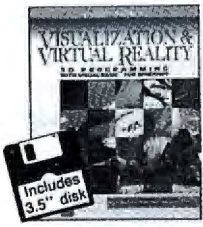

4225H-XX $49.95
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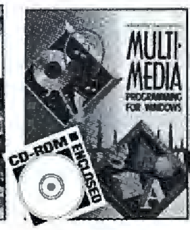

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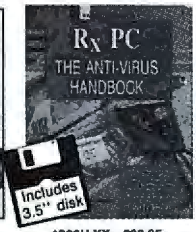

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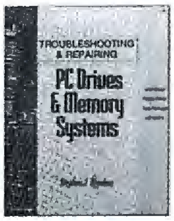

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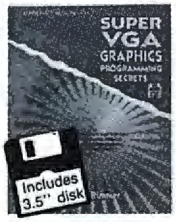

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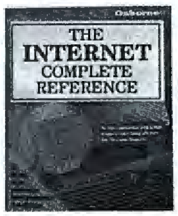

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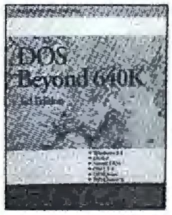

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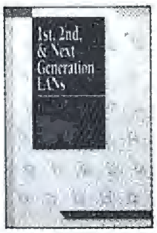

0425868H-XX $45.00
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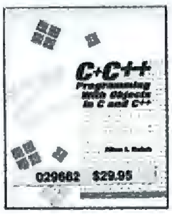

029662P $29.95
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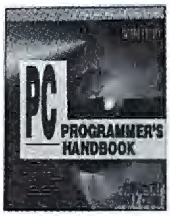

0549486P $39.95
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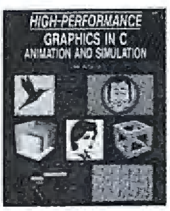

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the wiring. There could be crossed pairs in the wiring closet, broken wires, bad terminators, or just one wire plugged into the wrong socket. The LANMeter can help you discover all of these problems.

Before you run any of the cable tests, you must tell the LANMeter what kind of cable you are testing: 10Base-T category 3, 4, or 5; RG-58 (thin or foam thin); RG-8 (thick); Token Ring shielded twisted-pair (type 1, 2, 6, 8, or 9); or Token Ring unshielded twisted-pair (category 3, 4, or 5). Then you can test for cable length, distance to the largest fault, impedance, and DC continuity. For twisted-pair cabling, the LANMeter checks the transmit and receive pairs and detects split pairs occurring at the connector.

By attaching identifier dongles (which are optional) to the ends of twisted-pair cables, you can give each cable a separate identifier with which the LANMeter can generate a logical wiring map from the closet. This is a far cry from wire testing with two technicians, a Multimeter, and walkie-talkies. Thanks to the LANMeter, a technician working alone can be far more productive in figuring out a wiring closet.

Solving TCP/IP and NetWare Problems

The LANMeter lets you analyze TCP/IP or NetWare activity separately from all other activity on mixed-protocol LANs. The LANMeter logs information on ICMP (Internet Control and Message Protocol) packets that tell of unreached destinations, redirection, source quenching, exceeded delivery time, parameter problems, and echo requests and replies (i.e., PINGs). For any of these statistics, you can zoom in to see who the top senders and receivers are and to whom they are talking.

While there are plenty of TCP/IP network problems that you can identify with the LANMeter, there are also special NetWare IPX/SPX problems for which the LANMeter is unusually well suited. For instance, the LANMeter can identify all visible NetWare servers. Then if you know which workstations are running on NetWare, you can send a NetWare PING to see if a server or workstation is available from the LANMeter's location.

The NetWare-specific statistics collection separates total IPX activity into file activity (i.e., delays, file, and print) and packet activity (i.e., delays, routed packets, and burst packets). Then you can also do a routing analysis that displays local-to-local, local-to-remote, and remote-to-local activity in a pie chart. As with most LANMeter statistics, you can drill down with all NetWare tests and see more detailed statistics on the top local-traffic nodes. Using the NetWare menus, you can also see the top senders and receivers of NetWare activity only.

Fishing Expeditions

Within my first hour of using the LANMeter, I successfully identified a network printer that was unnecessarily loading the BYTE network with broadcast error messages, and I narrowed an intermittent problem to in-the-wall wiring between BYTE's editorial offices and the BYTE Lab. It's that easy to use.

The LANMeter is also strong in performing routine analysis. You can set it up in a wiring closet and let it collect data on the subject of your interest for a day or so and then send the data to a computer for further analysis. You can also send all the data and screens to an internal print spooler that will relay the information to a printer when you've returned from your data-collection expedition.

There is little that I can criticize the LANMeter for. The price is high and the battery life is short, but when you consider the functionality and ease of learning that characterize this attractive instrument, its convenience far outweighs its cost. The LANMeter is certainly less expensive, more portable, and easier to set up than the array of instruments it replaces.

Indeed, there is much to praise the LANMeter for. Its manual is exceptionally well written, giving instruction in not only how to operate the LANMeter but also how to use it to find different kinds of problems and what might be causing them; it even offers some solutions. But the greatest praise goes to the LANMeter's designers, who knew what the major tools for network diagnostics are and how to organize them all into one solid, compact unit. ■

Ben Smith is a consultant, a former BYTE Lab testing editor, and the author of Unix Step-by-Step *(Hayden Books, 1990). You can reach him on the Internet at ben@ronin.com or on BIX as "bensmith."*

About the Product

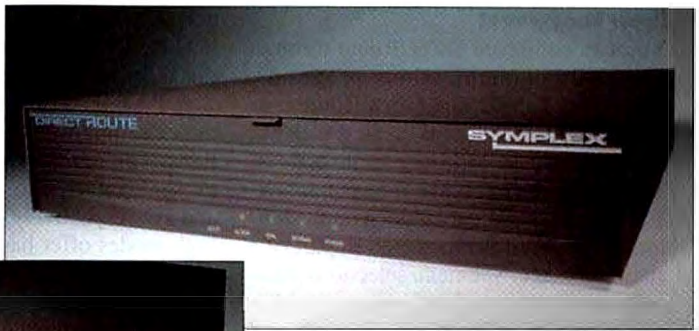
Fluke 675 LANMeter $9795
(for Token Ring and Ethernet, with backlighting)

Fluke Corp.
P.O. Box 9090
Everett, WA 98206
(800) 443-5853
(206) 347-5500
fax: (206) 356-5116
Circle 1060 on Inquiry Card.

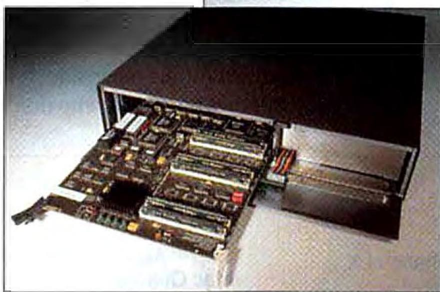
Switching ISDN

DirectRoute's ISDN switching technology, inverse multiplexing, and data compression can cut the cost of remote LAN connections

JEFFREY FRITZ



The front of the DR-2's 19-inch-deep, black metal chassis shows only activity LEDs.



The DR-2's front panel is a pull-down door that provides access to the hot-swappable processor cards. If you have two cards installed, you can remove or exchange one while the other continues to function.

On the back panel, a BRI/Ethernet I/O module provides four RJ-45 jacks for ISDN and an Ethernet AUI connector. A serial port in the main chassis can handle out-of-band management.

Symplex Communications pioneered synchronous data compression for WANs with its Datamizer products. It has now entered the internetworking arena with a family of devices called DirectRoute. Like current Datamizer products, DirectRoute uses data compression and inverse multiplexing with switched digital connections to provide bandwidth on demand for more efficient and economical long-distance network links. But while Datamizers use these capabilities to supplement an existing leased-line connection, DirectRoute products can rely solely on switched services, particularly ISDN, to provide on-demand remote connections.

Although it's tempting to label DirectRoute a bridge or router, it's really a hybrid design. Like a bridge, it operates on the MAC (media access control) layer (layer 2). But it functions like a router when it comes to packet destinations. Routing-like tables, maintained in the form of destination telephone numbers, identify remote devices and their port addresses.

In creating DirectRoute, Symplex has applied matrix-switching technology to WANs. In a sense, this is an electronic version of the crossbar switches that were used in the telephone network for years or are used in hub switches today. Hub switches send packets directly to simultaneous, multiple destinations without sending them through an intermediary network. This topology makes for more efficient WAN interconnectivity than is provided by typical setups using expensive dedicated lines. After all, it doesn't make sense to travel from Nashville to Los Angeles through Atlanta when you can get a direct flight. DirectRoute provides connection-oriented switching technology for ISDN.

Using multiple-channel aggregation and compression, DirectRoute can accomplish WAN bandwidths of up to 4 Mbps. Currently, it does this using a proprietary protocol. However, Symplex plans to use multilink (PPP over ISDN) so that DirectRoute can interoperate with other vendors' ISDN WAN products.

For sites with digital services other than ISDN, all Direct Route products can be provisioned for frame-relay, T1, Switched-56, or other digital services. Generally, access to non-ISDN services is accomplished through a V.35 serial interface option.

DirectRoute Configuration and Description

The DirectRoute product family has three members. The top-of-the-line DR-5 is intended for central sites with high-volume backbones. It can connect up to 160 sites simultaneously, with 1 Mbps of bandwidth per site (more with compression). It uses a five-slot modular chassis. BRI (Basic Rate Interface)/LAN cards provide four BRI ISDN and one network connection per card. Mixing in PRI (Primary Rate Interface)/Serial cards (which provide two PRI ISDN and two V.35 serial connections per card), the DR-5 can also support frame-relay and leased-line connections. With one BRI/LAN card, the DR-5 has a $7999 base price. Additional BRI/LAN and PRI/Serial cards cost $6000 for Ethernet versions and $6500 for Token Ring versions.

The DR-2 model I reviewed is a scaled-down product capable of connecting up to 64 sites simultaneously and providing 1 Mbps of bandwidth per site. It has a two-slot modular chassis and supports the same cards as the DR-5. The DR-2 has a $6999 base price, which includes one BRI/LAN processor card.

The DR-1, available later this year, is the bottom of the line at $2999. Unlike the DR-2 and DR-5, the DR-1 is slotless. It can connect up to eight remote sites and provides only 512 Kbps of throughput per site. (Not that 512 Kbps is all that bad; most telecommuters do very well with 128 Kbps.) The DR-1 supports four BRI lines plus two serial (V.35) connections for frame relay or leased lines.

Processing power for all units comes from AMD 29030 RISC processors, one per card, each with 1 MB of flash RAM for program memory and 1 MB of SRAM for buffering. Both flash RAM and SRAM expand to 4 MB.

I tested a pair of DR-2s, each configured with a single Ethernet BRI/LAN processor card. The sleek, 19-inch, black metal chassis is suitable for stacking or rack mounting. A front-panel door provides access to the hot-swappable processor cards. On the back panel, a BRI/LAN I/O module provides four RJ-45 jacks (labeled A, B, C, and D) for the ISDN lines, and a port E (for Ethernet, no doubt) with an AUI (attachment unit interface) connector. If you plan to use 10Base-T or thinnet (10Base-2) cabling, you'll need transceivers. There is also an RS-232 monitor port and a second AUI port, labeled LAN Command Port, which is not currently used.

Upper Management

You can configure DirectRoute through standard communications programs, SNMP, or Telnet. The DirectRoute system software interface is menu driven but has a nasty tendency to hide menu options. The reinitialize (reboot) command, for example, is mysteriously hidden on the bottom of the Card Setup screen as part of a status message. Submenu selections show only one item at a time, making it difficult to remember locations of options and features. Several menu items haven't been implemented, although they appear as selections. Clearly, the interface needs work.

A Card Statistics screen provides an array of throughput statistics, including packets per second to and from the LAN and bits per second to and from the WAN. Unfortunately, there is no way to tell if packets are out of sequence, lost, dropped, or corrupted. To help in diagnosing a bad link, the Symplex software should provide this information for each channel.

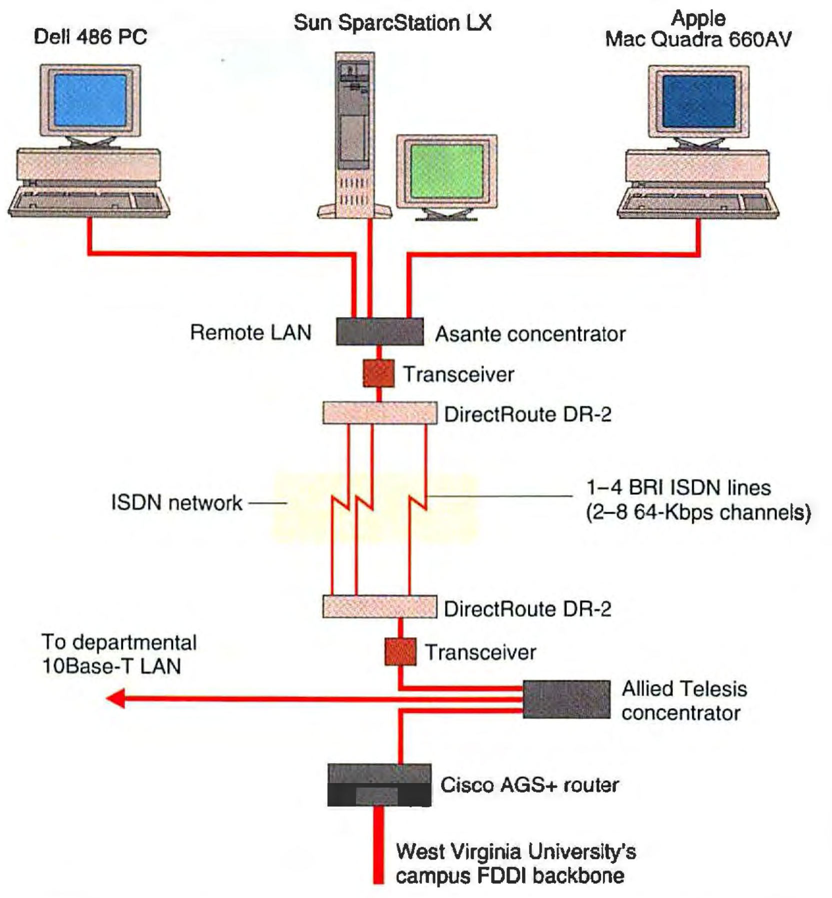
A PAT (Priority Action Table) determines calling patterns. There are two options, Throughput On Demand and Data Present (referred to as Action Table 1A and 1B, respectively). Despite the names, both modes offer bandwidth on demand. The difference is that Throughput On Demand does not place calls, even when there are packets destined for the other side. It is intended for Internet providers who don't want to issue calls to remote users whenever, say, an E-mail message arrives but would rather wait for the user to call in and then send the E-mail.

For this scheme to operate properly, one side (typically the remote side) has to be set up in Data Present mode. Bringing both sides up in Throughput On Demand mode means that neither side will call and, thus, connections will never be made. Strangely, the default configuration is Throughput on Demand. You must explicitly change that setting to allow connection.

Symplex promises future PAT enhancements, including time-of-day action tables that allow different connectivity based on hour or day parameters. The hooks are in place for these advanced PAT options, but they do not operate yet.

The DirectRoute product line supports SNMP through generic MIBs (management information bases) or through a Symplex-developed MIB. The Symplex MIB provides additional management benefits, one of the most important being call-detail reporting. The Call Data Collection and Processing modules in the MIB provide information on call duration, call status, and bandwidth utilization. This provides managers with a good tool to determine if digital lines are sufficient to meet user demand. In addition, the modules allow network managers to charge back usage for WAN connections.

DirectRoute Test Configuration



DirectRoute DR-2s connected the test remote LAN to a production 10Base-T Ethernet LAN using ISDN services. Four ISDN lines provided eight 64-Kbps ISDN channels between the two LANs. On the remote LAN, a Dell 486 PC, Sun SparcStation LX, and Apple Mac Quadra 660AV allowed testing with Novell IPX, TCP/IP, and AppleTalk protocols, respectively.

Security and Manuals

DirectRoute provides several security options. Authentication is used whenever a connection is made to ensure that legitimate calls have been placed. Access to the management interface has authority levels and password protection.

The documentation can be summed up in one word—skimpy. The product comes with a 19-page installation guide and a single-sheet quick installation guide. Both guides have screen shots, but the text is sparse, often leaving out important details. There is no operating manual and no reference documentation, both of which are critical to proper operation of something as complex as DirectRoute. This is an unforgivable oversight. Although Symplex plans to include improved documentation in the future, the product should not have shipped without adequate documentation.

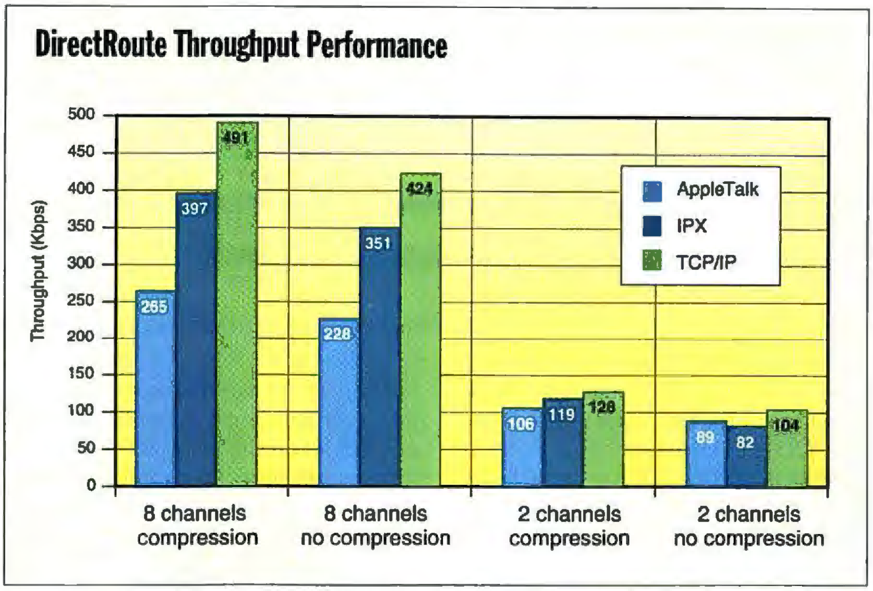
Performance

To test the DR-2, I set up a small 10Base-T Ethernet network to simulate a remote LAN. The host site was a production 10Base-T Ethernet LAN. This Ethernet connected through a Cisco AGS+ router to an FDDI (Fiber Distributed Data Interface) backbone and from there to the Internet. Each DR-2 connected to the phone network with four ISDN lines. (See the figure "DirectRoute Test Configuration.")

I tested DR-2 throughput for AppleTalk, Novell IPX, and TCP/IP protocols by transferring a 1.9-MB binary file between LANs using eight- and two-channel configurations, with and without compression (see the figure "DirectRoute Throughput Performance"). Binary files compress less effectively than text files, so performance with text-only or mixed files should generally be better.

TCP/IP with compression over eight channels was the best performer, with a throughput of 491 Kbps. With 512-Kbps bandwidth, that represents an impressive 95.83 percent link efficiency. As expected, eight channels with compression yielded the best throughput for all the tested protocols. But even the lowest rate, two channels with no compression, was slightly more efficient than measurements made in similar modes with Combinet CB-400 and Digiboard Dual IMAC ISDN bridges. The results weren't shockingly higher, but the difference was measurable.

To test compression, I transferred a 1.9-MB binary file and a 1.1-MB text file with and without compression (see the table "Compression Results"). The text file did quite well, while the binary file's compression ratio was somewhat less impressive. Compressing the binary file provided a 1.35-to-1 increase in throughput with eight channels and a 1.44-to-1 increase with two channels. On the text file, the DR-2 achieved only a 1.67-to-1 throughput increase when compressing with eight channels. Text-file compression worked much better on two channels, with an increase of 3.13 to 1. Although this is far from the 20-to-1 compression promised in the product literature, compression was good enough that the file actually moved across the two-channel link at almost the same speed as with eight channels and no compression. Like gas mileage figures, compression estimates are only an approximation of what you can expect.



In transferring a 1.9-MB binary file, throughput differed for each of the three tested LAN protocols. In each case, using eight 64-bit ISDN channels with inverse multiplexing provided higher throughput than using just two lines, and DirectRoute's data compression enhanced compression somewhat. Performance using compression with text or mixed files will be better.

Filtering

DirectRoute can filter transmissions based on device address or network protocol or on a custom basis. Custom filtering works inside the packet, and it filters based on bit patterns. Up to 1000 individual filters can be maintained, which should be more than adequate for most networks.

You can create filters at any time, but they don't become active unless you explicitly turn them on. That makes it simple to prepare filters, but it also makes it easy to forget to turn them on. Once filters are on, the only way to turn them off is by erasing them from the active filter list. This is an awkward process; it would be better to use check boxes for turning filters on and off.

To set up protocol filters, you must enter the Ethernet type code for the protocol. The documentation does not provide any type codes. I had to ask Symplex to fax a list of codes before I could set up protocol filtering.

Unfortunately, you have to reboot DirectRoute for new filters to take effect, and, obviously, network access is interrupted during the reboot. While the DR-2 reboots quickly (a warm boot typically takes 20 seconds), it is still a nuisance.

> **About the Product**
>
> **DirectRoute DR-2**............................$6999
> (as reviewed with one BRI ISDN/Ethernet module)
> Symplex Communications Corp.
> 5 Research Dr.
> Ann Arbor, MI 48103
> (313) 995-1555
> fax: (313) 995-1564
> **Circle 1076 on Inquiry Card.**

Telco Liaison

Symplex provides support directly from its headquarters in Ann Arbor, Michigan, and through its distributors and resellers. Standard telephone support is available, as is an optional 24-by-7 (24 hours a day, seven days a week) support program. Third-party on-site service is provided by G.E. Information Services.

Generally, I was pleased with the quality of the technical support. The technicians were knowledgeable and were willing to admit when they didn't know the answer to a problem. If it was a new problem, they made note of it and were never defensive. When I had to travel to the remote site, they offered to call me back (good thing, since Symplex support doesn't have a toll-free number). They always called me right on time.

The toughest part of an ISDN installation should be the easiest: ordering the ISDN service. The telephone carriers have done a terrible job of implementing ISDN ordering. You need to understand telcospeak to order even the simplest service. Symplex, sympathizing with the user's plight, has responded by forming a TLT (Telco Liaison Team).

Prior to installation at the desired locations, the TLT determines if ISDN service is available in the local exchanges, and if not, when it will be and what alternative services are available. The TLT then generates a work order on behalf of the user. Symplex claims that it will work with any independent carrier and with the seven RBOCs (Regional Bell Operating Companies).

This is a good start, but the support isn't open ended. Once the ISDN service is operating, Symplex says, "All line network

COMPRESSION RESULTS

Enabling the DR-2's built-in compression provided a greater increase in throughput with a 1.1-MB text file than with a 1.9-MB binary file. With compression, the text file moved across the two-channel link at almost the same speed as with eight channels and no compression.

Number of ISDN B channels	8	2
Link bandwidth (Kbps)	512	128
Binary-file throughput (Kbps, compressed/uncompressed)	469/346	119/82
Effective compression ratio (binary)*	1.35	1.44
Text-file throughput (Kbps, compressed/uncompressed)	584/350	283/90
Effective compression ratio (text)*	1.67	3.13

*The effective compression-ratio figures are lower than actual compression because of LAN protocol overhead.

management is the responsibility of the RBOC providing the carrier service." Since RBOCs rarely take responsibility for anything in the ISDN world, it would be better to offer continuing support to users after the ISDN service is installed, even for a fee.

Bugs and Gotchas

The DR-2 has some bugs, particularly in the management interface. For example, Telnet management sessions to the device were unstable. They often failed with cryptic messages like "Session task creation failure! (15)." Once this occurred, I could no longer Telnet into DirectRoute. And if a Telnet session aborts, DirectRoute can't time-out the user. As a result, the maximum user limit is quickly reached, and users attempting to log on are greeted with a message saying: "Sorry—Maximum number of logins exceeded!"

Twice during throughput testing, the DR-2s died. ISDN and LAN connections were maintained, but the remote workstations reported the loss of network services. It appeared that the bridging protocol had crashed, because traffic was recorded at the WAN and LAN ports, but nothing was passing between them. The problem stumped the company's technical-support people. The only cure offered was to reboot the dead DR-2.

The DirectRoute product line is new. Features are still being implemented, the documentation is sparse, and the bugs are painfully obvious. Nevertheless, DirectRoute is a good choice for network administrators looking for improved LAN access. Its ability to provide exceptional bandwidth on multiple ISDN channels with decent compression makes it viable for large networks. For diverse networks, it adds value by acting as a matrix switch for multiple sites. These features make DirectRoute a flexible and powerful tool for remote LAN access. ■

Jeffrey Fritz (Morgantown, WV) is a telecommunications engineer who is responsible for the design and management of data communications for West Virginia University, including its ISDN Applications Lab. He is the author of Sensible ISDN Data Applications *(West Virginia University Press, 1992). You can contact him on the Internet at jfritz @wvnvm.wvnet.deu or on BIX c/o "editors."*

Dynamic-Viewing Spreadsheets

Take a custom slice of your data with dynamic data viewing

BOBBY JOE REFF

The electronic spreadsheet revolutionized the computer world with a row-and-column format that enabled quick analysis of data by a variety of formulas. Today's spreadsheets, however, need more dimensions as applications track more complex sets of data. While the consolidation features of multiple 3-D worksheet programs such as Lotus 1-2-3 and Microsoft Excel offer increased capability, it is not always easy to view certain slices or customize views of the data. The task of creating reports using the massive amount of data accumulated by multinational corporations becomes incredibly unwieldy. Today's powerful spreadsheets can handle the data, but grasping the significance of that data may require the power of dynamic-viewing spreadsheets.

NSTL reviews three products that provide flexible viewing of data by simply rearranging a preset category or group. Although the three products are similar in providing dynamic-viewing capability, they contain subtle differences based on their primary purpose.

Lotus Improv, originally covered in this review, was discontinued by Lotus Development. The reviewers found that it was the program of choice when performing data modeling or when dynamic viewing is of primary importance. IThink is a modeling program, but it does not offer a dynamic-viewing spreadsheet. Lotus 1-2-3 release 5 for Windows now has some dynamic-viewing capabilities but only when combined with Lotus Approach.

Program Concepts

Dynamic-viewing capability is useful in both data modeling and data analysis applications. Modeling spreadsheets, such as Lotus Improv, specialize in creating a model to determine how different variables (e.g., sales forecasts or inventory levels) will affect outcomes (e.g., profits). Data analysis makes sense of existing data by managing different views while retaining data relationships (e.g., looking at sales over time to explore trends and predictors).

Microsoft focuses on analysis rather than modeling as the key to Excel. Summarizing and analyzing large data sets require the comprehensive versatility of an advanced spreadsheet, and Excel offers this in its outlining, filtering, analysis tools (including functions), and, in version 5.0, tabbed notebooks.

Data analysis, however, is incomplete if you cannot interpret the meaning of complex data. This is where dynamic viewing becomes important. You can access preexisting data from your spreadsheet to create PivotTables and maintain links to the data, regardless of how the view changes. Full-featured viewing lets you summarize data, collapse or expand categories, track data, analyze trends, and rearrange data to determine different outcomes without manually re-creating the model.

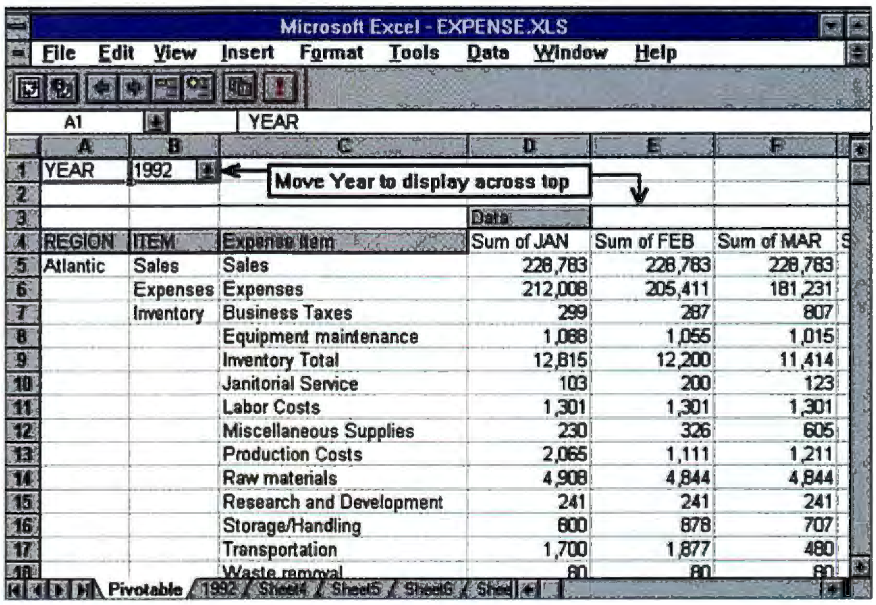
TM/1 Perspectives from Sinpor takes a different approach. TM/1 attains true multidimensionality by adding database-type access to the capabilities of the spreadsheet you're already using. TM/1 stores the data in previously established dimensions; then you browse through the data tables residing in the spreadsheet.

This approach eliminates the need to rekey data or rearrange it for different views. It also offers an efficient storage system for data, while maintaining a spreadsheet's ability to analyze, manipulate, modify, and enhance data. The vendor calls this approach OLAP (On-Line Analytical Processing), since the consolidations are also dynamically calculated. This approach also lends itself well to multiuser systems. The Sparse Matrix technology adds to the inherent ability of storing the data once to incorporate large amounts of data by not allocating space to cells that do not contain data.

Like Microsoft Excel, Quattro Pro for Windows adds a dynamic-viewing module to its spreadsheet. Unlike Excel's module, Quattro Pro's module is a separate program. However, it maintains hot links to and from the spreadsheet. The program offers a full range of viewing capabilities that aid you in spotting trends, making decisions, tracking data, summarizing data, and creating reports.

Building Models

You typically create models by either entering data manually (i.e., building from scratch) or importing data (usually from external databases). Creating models in any of the programs requires planning; poorly constructed structures only produce



Microsoft Excel combines dynamic viewing with a powerful, feature-rich electronic spreadsheet. You transfer data to a PivotTable to view the model in different perspectives. You create the model with PivotTable Wizard.

Highlights

	STRENGTHS	LIMITATIONS
Microsoft Excel	Most feature-rich spreadsheet; has excellent analysis tools Microsoft Query can be invoked from within PivotTables VBA for Microsoft Office can access PivotTables	Cannot dynamically view data from multiple sheets without consolidating Initially, models difficult to set up
Quattro Pro Workgroup Edition	Models easy to create Excellent analysis tools Database Desktop queries and imports data from databases	Two separate modules Hot links do not work with multiple sheets Transferring data loses formatting
TM/1 Perspectives	Sparse Matrix technology handles large amounts of data well Can make use of Excel's or 1-2-3's programming language Spreadsheet Connector queries act as a server for TM/1 data	Difficult to learn Initially, models difficult to set up No drag-and-drop capability

poor models that show nothing, regardless of how you try to manipulate the view.

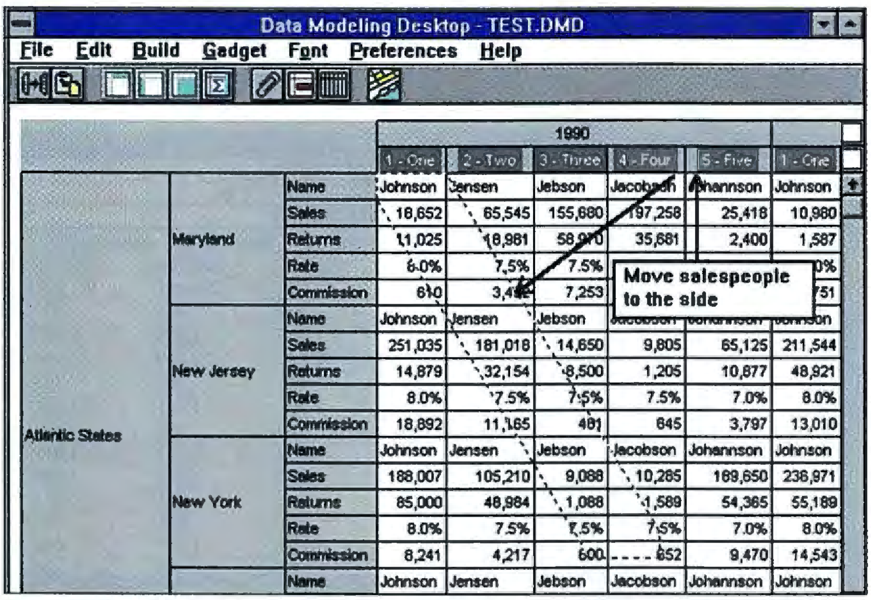
Both Microsoft Excel and Quattro Pro for Windows require you to first input data into a spreadsheet and then create the dynamic-viewing model afterward. When building models, usability testers preferred Quattro Pro's modeling module over Microsoft Excel's PivotTables.

Excel incorporates the PivotTables (dynamic-viewing model) in a tabbed notebook, while Quattro Pro transfers the data to the Data Modeling Desktop. In Quattro Pro, you see a source window, with the category names in the top row and the data displayed beneath it. You drag the fields to the modeling window, and the program places the data, giving you a step-by-step creation procedure that aids in constructing a model.

Excel provides a PivotTable Wizard that forces you to set the framework of the model and then attempt to create it. Problems occur if the model is not perfect or if it contains an incorrect construction. A preview feature, similar to the one found in Text Wizard and Chart Wizard, would be very helpful when creating PivotTables.

TM/1 Perspectives' database approach to storing data can be confusing when you are first attempting to build models. With TM/1, you must create dimensions first and then create the tables using the dimensions. Next, you input the data into the table, and it is stored within the dimensions. The program limits text data to one dimension only and then requires that dimension to be placed last in the table.

Microsoft Excel uses Microsoft Query to build models from external data and accepts the data directly into PivotTable Wizard. TM/1 uses the underlying spreadsheet to import data and then updates the dimensions. Sinpor also offers the optional Spreadsheet Connector ($4995 and up), which connects multiple stations using TM/1 Perspectives in a client/server architecture. Quattro Pro queries data using the Database Desktop module.



Quattro Pro's dynamic-viewing module is a separate program. The Data Modeling Desktop provides good usability features, but the procedure for transferring the model back to the main spreadsheet for any type of output is cumbersome.

Data Analysis

Each of the reviewed programs has a different way of analyzing data. Excel offers extensive analytical capabilities through the Excel spreadsheet. You can achieve better results using the analytical features found elsewhere and then using PivotTables to dynamically view the different aspects. The program does offer useful consolidation features, such as automatic summing of data, running totals, and automatic conversion of an entry to a percentage (e.g., percentage of total sales). The subtotaling feature also permits automatic averaging, minimums, maximums, and variations. You cannot enter formulas into the PivotTables. You can view the detail in a new sheet that lets you work with the total flexibility the spreadsheet has to offer.

In Quattro Pro, you cannot modify data without creating the model with hot links to the spreadsheet. Creating the model using multiple tabbed sheets disables the hot links. The program does let you assign various mathematical qualifiers to data, such as summing, averaging, counting, increase, and automatic conversion to percentage. The limit dialog box replaces the page field concept used by the other programs but also adds the capability to easily consolidate user-specified subsets of the category.

All the programs collapse and expand groups, which aids in clarifying large amounts of data. The beauty of the expansion rests in the "at your fingertip" details of what the summary shows.

Reporting

Excel offers many options, and its charting is quite powerful. If you use custom formatting to create borders and shading, you will lose the formatting when the view changes. However, you can use auto-formatting to reapply formatting each time a new view is generated. And by building a special PivotChart, you can also maintain charts built from your PivotTables.

TM/1 Perspectives makes use of the formatting capabilities of 1-2-3 for Windows or Excel's formatting capabilities. The formats for the table are attached to the cells, however, not to the data.

With Quattro Pro, you have to transfer your data from the Data Modeling Desktop back into the main spreadsheet program and then format it for the report. The program does not even keep the numeric format of the modeling module; it transfers everything back as general numbers. Formatting in Quattro Pro is easy, but if the view changes, you'll have to transfer the data again.

Thanks to 1-2-3's excellent spreadsheet enhancements, such as frames, borders, and colors, TM/1 outscores the other products for the sheer number of its high-quality reporting options. Excel also scores high in this regard, offering many different types of enhancements.

A Model Spreadsheet

Microsoft Excel represents the most advanced of all spreadsheets. Although not primarily a dynamic-viewing spreadsheet, the addition of this capability rounds out a powerful tool that can be used in a multitude of solutions. It scored high, considering that we tested none of its other powerful features.

TM/1 Perspectives provides analytical processing to normal spreadsheets. It lacks the drag-and-drop viewing found in the

About the Products

Microsoft Excel 5.0 .... $495
Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
(800) 426-9400
(206) 882-8080
Circle 1080 on Inquiry Card.

Quattro Pro for Windows 5.0 .... $495
Standard Edition $49.95
Novell, Inc.
WordPerfect Applications Group
1555 Technology Way
Orem, UT 84058
(800) 321-5906
Circle 1081 on Inquiry Card.

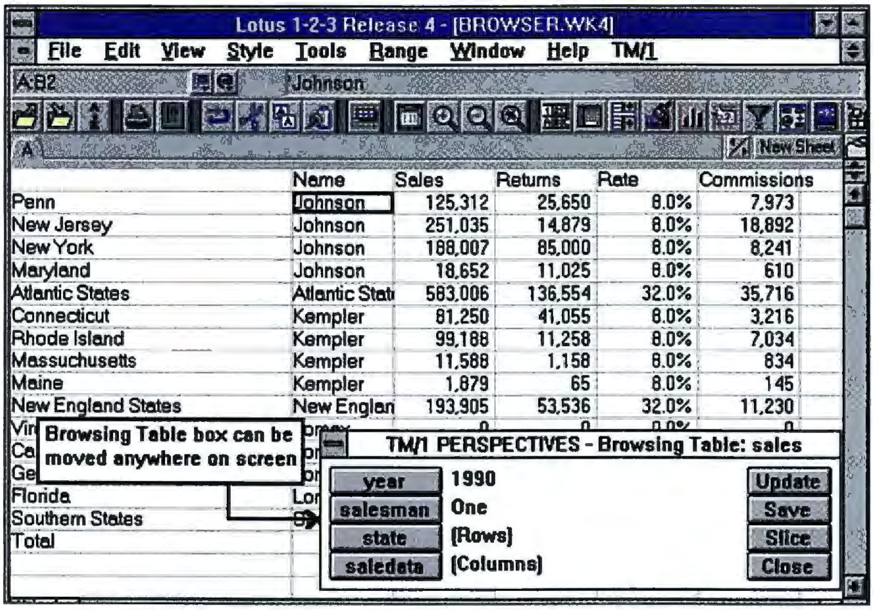
TM/1 Perspectives 1.0 .... $795
Sinpor Corp.
31 Mountain Blvd., Building N
Warren, NJ 07059
(908) 755-9880
Circle 1082 on Inquiry Card.

DYNAMIC-VIEWING SPREADSHEETS

Excel and Quattro Pro offer the rich functionality of a full-featured spreadsheet, while TM/1 Perspectives adds dynamic viewing to Excel or Lotus 1-2-3.

	MICROSOFT EXCEL	QUATTRO PRO WORKGROUP EDITION	TM/1 PERSPECTIVES
Parameters			
Number of dimensions or categories	①	①	8
Number of nested categories	①	①	②
Maximum worksheets in a model	②	256	②
Keystroke recorder	●	○	●
Programming or macro language	●	○	●
Dynamic viewing			
Drag-and-drop viewing	●	●	○
Collapse/expand groups	●	●	●
Sort by categories or dimensions	●	○	●
Formula manipulation			
Global formulas	●	●	●
Prioritize formulas (for use in overlap)	○	○	●
Natural-language formulas	○	○	●
Cell-level override capability of formulas	○	○	●
Automatic summary tables	●	●	③
Group formulas	●	○	●
Data entry			
Automatically add subtotals	●	○	●
Automatically add grand totals	●	●	●
Automatically format cells in view	●	○	○
Custom formats	●	④	●
Transpose rows and columns during copy	④	④	●
Workgroup/network capability			
Mail-enabled	●	⑤	⑥
Routing	●	○	⑦
Version management	●	⑤	●
Author stamp	●	○	⑦
File locking	●	●	●
Auditing/security			
Dependency highlighting or diagrams	●	○	⑥
Annotations feature	●	○	⑧
Find and replace	●	○	●
Password-protect from viewing and modification	●	○	●
Lock data from inadvertent entry	●	○	●
Show circular references	●	○	●
Reporting and charting			
Print preview	●	⑤	●
Specify page breaks	●	⑤	●
Save named report styles	●	⑤	●
3-D charts	●	⑤	⑥
Bar charts (grouped and stacked)	●	⑤	⑥
Pie charts	●	⑤	⑥
Line charts	●	⑤	⑥
Group objects	●	⑤	⑥
Relayer objects	●	⑤	⑥

① Limited only by memory
② Unlimited
③ If defined when creating the dimension
④ Through spreadsheet functionality only
⑤ Must copy data model back to Quattro Pro and then use Quattro Pro's print options
⑥ Through the spreadsheet functionality of Excel or Lotus 1-2-3
⑦ When using Microsoft Excel only
⑧ Can draw a text box in Lotus 1-2-3; annotate in Excel
● = yes; ○ = no



TM/1 Perspectives was one of the first products to make use of dynamic-viewing technology. It uses database-type storage procedures to handle large amounts of data. The TM/1 module accesses just the data needed from within Microsoft Excel or Lotus 1-2-3 (shown here).

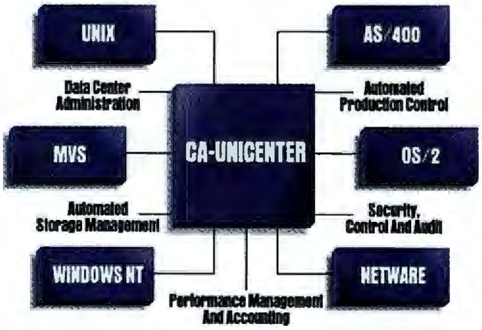
other programs and concentrates mainly on processing numerical data that needs to be manipulated in a variety of ways and settings. TM/1 accomplishes this with excellent integration within either Excel or Lotus 1-2-3. Its biggest weaknesses are its documentation and help system, which do not adequately prepare you for the program's complexity.

Quattro Pro adds the Data Modeling Desktop to its already-powerful spreadsheet. The module has more dedicated modeling functionality than Excel, but it does not offer the flexibility found in the other products. Having to transfer data back to the spreadsheet to format, print, or chart makes it a less attractive option. Its performance is poor; the program takes quite a bit of time to perform certain view changes that other programs accomplish in relatively short order. ■

This report contains the partial results of a recent issue of Software Digest, *a monthly publication of NSTL, Inc. To purchase a complete copy of the report, contact NSTL at 625 Ridge Pike, Conshocken, PA 19428, (610) 941-9600, fax (610) 941-9950; or on the Internet at editors@nstl.com. For a subscription, call (800) 257-9402.* BYTE Magazine *and NSTL are both operating units of McGraw-Hill, Inc.*

Presenting The 7
Of Systems Mana

1 Replace Disparate Point Products With A Single, Integrated, Comprehensive Solution.



2 Choose A Client/Server Application That's Interoperable, Scalable and Portable.

3 Demand An Open Solution That Supports All Key Industry Standards And Protocols.

COMPUTER ASSOCIATES®
Software superior by design.

92 PRINTERS GO

The newest laser, color, ink-jet, and dot-matrix printers compete for top honors in our applications-based rankings

JIM KANE AND JOHN MCDONOUGH

Innovations continue to redefine the printer market. As a sign of just how fast the printer world changes, 47 of the 92 laser, color, ink-jet, and dot-matrix printers we evaluate in this report are new or have been updated since our last printer report, only six months ago (see "Head to Head: 71 Printers," May BYTE).

Notable among the new models this time are 10- to 12-ppm (pages per minute) laser printers that can be quickly configured with Ethernet interfaces for small workgroups. For a handful of vendors, including Hewlett-Packard and Texas Instruments, these fast laser printers have replaced 8-ppm models. They now represent mainstream laser offerings. These laser printers save small workgroups money, because the printers don't require a dedicated print server. You wire them into a network as easily as you can install a workstation to the network. If you need high-volume laser printers to serve a large network, the rankings on page 269 show the latest choices for 16- to 20-ppm printers.

Also significant is how color is energizing the ink-jet market. A new generation of ink-jet printers that cost under $1000 produce respectable monochrome and color output in their standard configurations (see page 277 to see how they stack up). To address the evolving color market, this report ranks color printers in two classes: High-Quality Color, for applications that require four-color output, and Draft Quality, where the primary need is for black-and-white output with color highlights.

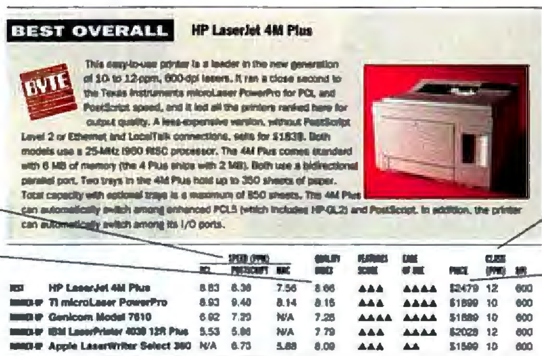
We tested 46 laser printers for General Business, Workgroup, and CAD and DTP applications. We also ranked 25 color printers using ink-jet, thermal-wax-transfer, and dye-sublimation technologies. Eight monochrome-only ink-jet printers selling for under $1000 arrived for our draft-quality considerations. Finally, we tested 13 high-volume dot-matrix printers for our Listings and Forms category.

How to use this guide

We used our standard suite of PC- and Macintosh-based printer tests to choose printers with the best speed and output quality for six key business applications. We summarize test details about the winners and runners-up in each of the categories, using charts like the one shown here.

Combined engine and processor speed when running our test files, measured in pages per minute. Higher numbers indicate faster performance.

A composite rating for text and graphics output quality; based on a 10-point scale, with higher numbers indicating better print quality.



		SPEED (PPM) PCL	POSTSCRIPT	MAC	QUALITY INDEX	FEATURES SCORE	EASE OF USE	PRICE	CLASS (PPM)	DPI
BEST	HP LaserJet 4M Plus	8.83	8.36	7.56	8.66	▲▲▲	▲▲▲▲	$2479	12	600
RUNNER-UP	TI microLaser PowerPro	8.93	9.40	8.14	8.15	▲▲▲	▲▲▲▲	$1899	10	600
RUNNER-UP	Genicom Model 7610	6.92	7.29	N/A	7.26	▲▲▲▲	▲▲▲▲	$1689	10	600
RUNNER-UP	IBM LaserPrinter 4039 12R Plus	5.53	5.86	N/A	7.79	▲▲▲	▲▲▲▲	$2029	12	600
RUNNER-UP	Apple LaserWriter Select 360	N/A	6.73	5.88	8.09	▲▲▲	▲▲	$1599	10	600

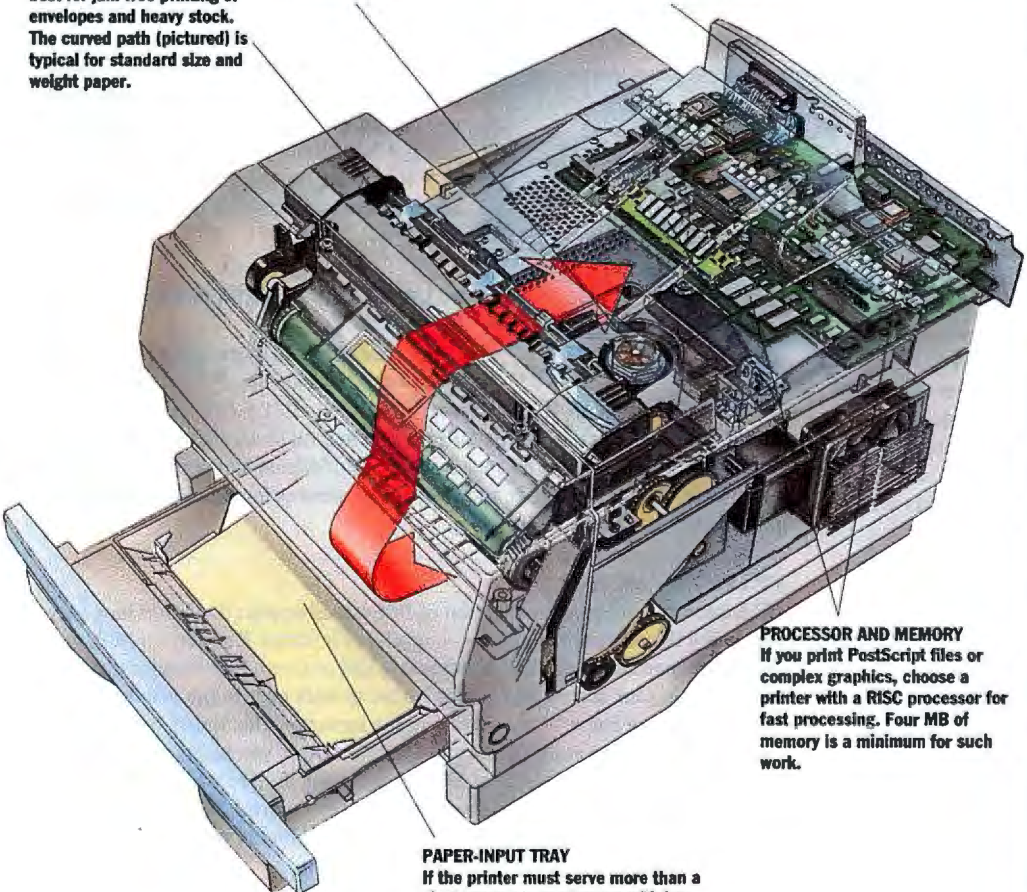
Vendor's rating for engine or print-head speed; does not include printer processing time.

Retail price in the as-tested configuration, which may include optional memory (see the Roll Call on page 280).

PHOTOGRAPHY: STEVE BELKOWITZ © 1994

TO BATTLE

Key Components



PAPER PATH
Straight-through paths are best for jam-free printing of envelopes and heavy stock. The curved path (pictured) is typical for standard size and weight paper.

ENGINE
Twelve-ppm, 600-dpi engines have emerged as the speed and print-quality standard for general-purpose laser printers. Nevertheless, slower, 300-dpi engines continue to offer substantial cost savings for those who can accept less in quality and performance.

INTERFACES
Many laser and high-end color printers offer Ethernet and Token Ring interfaces for shared environments. If your workgroup is small, consider a 10- to 12-ppm laser printer. Many new models in this class have such interfaces standard or as relatively low-cost options (some models offer bidirectional communication that lets an administrator set up the printer from his or her workstation). For large networks, 16-ppm or faster laser printers offer greater paper capacities and higher duty cycles.

PROCESSOR AND MEMORY
If you print PostScript files or complex graphics, choose a printer with a RISC processor for fast processing. Four MB of memory is a minimum for such work.

PAPER-INPUT TRAY
If the printer must serve more than a single user or a workgroup with low-volume printing needs, choose a unit with a 500- or 1000-sheet capacity. Also check how easily and inexpensively you can add additional paper trays if print volume grows in the future.

ILLUSTRATION: BRUCE SANDERS © 1994

BEST

GENERAL BUSINESS
HP LaserJet 4M Plus
This fast, 600-dpi laser led the category in output quality and offered a range of features (including bidirectional communication) unmatched by its competitors.
PAGE 264

WORKGROUPS
Xerox 4520ps
No other printer in our sample matched this 20-ppm laser in printing PCL files. For large-volume printing environments, the 4520ps can hold up to 2250 sheets of standard-size paper.
PAGE 269

CAD AND DTP
Xerox 4520ps
In addition to PCL and PostScript speed, this luxury printer offers high-quality 800- by 400-dpi output and the ability to print 11- by 17-inch formats.
PAGE 271

HIGH-QUALITY COLOR
Tektronix Phaser 220i
This easy-to-use thermal-wax-transfer printer produced superb four-color output and solid PostScript speed scores.
PAGE 273

DRAFT QUALITY
DECcolorwriter 520ic and Texas Instruments microMarc color
These almost-identical ink-jet printers cost less than $500 and offer clear monochrome output and excellent color for highlights.
PAGE 277

LISTINGS AND FORMS
Mannesmann Tally T6082
The dot-matrix printer of choice for those who spare no expense for high-volume jobs where speed overshadows print quality.
PAGE 279

THE BEST PRINTERS FOR GENERAL BUSINESS

If your print jobs typically consist of text and some graphics for correspondence, reports, and other business documents, the laser printers we rank here will serve you well. The predominant resolution for these lasers is 600 dots per inch; only the under-$1000 "personal" lasers we ranked in this category still print 300-dpi output.

While 6- and 8-ppm print engines once were the standard for laser printers, all the products we ranked for Best Overall are rated at 10 or 12 ppm. These faster engines, when teamed with high-clock-speed processors, translate into significantly faster performance. For example, the Texas Instruments microLaser PowerPro used a 10-ppm engine and a proprietary 25-MHz processor to achieve the fastest PCL (Printer Control Language) score in our tests. This score of 8.93 ppm is 26 percent faster than that of the Xerox 4011, which at 6.59 ppm was the speediest 8-ppm printer in this report. Similarly, HP's LaserJet printers have benefited from beefed-up engines and processors: The current 12-ppm LaserJet 4M Plus completed our PCL tests 36 percent faster than the 8-ppm 4M model it replaced.

Many of these printers are becoming easier than ever to share among workgroups. Thirteen of the laser printers we tested in this category offer an option (with costs ranging from $300 to $600) for Ethernet capabilities. Small offices can now get a network printer for significantly less than the cost of 16- to 20-ppm printers designed for larger networks. Nevertheless, large-network printers offer more in terms of speed, paper-handling capabilities, and monthly duty cycles.

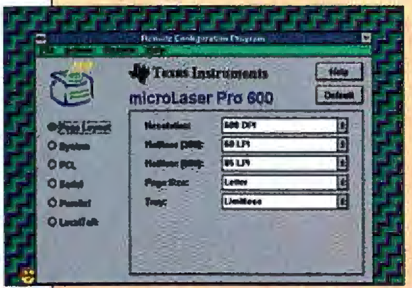
Although the HP LaserJet 4M Plus won Best Overall honors, some of the runners-up are worthy of consideration, depending on your applications. For example, the speed-leading microLaser PowerPro isn't as fully featured as the LaserJet 4M Plus, but it costs almost $600 less. The NEC Silentwriter Superscript 610, a host-based printer without its own memory or processor, is the lowest-priced laser in our sample at $500. Although this 300-dpi printer missed our cutoff for Low Cost runners-up, it provides fast PCL speed and high quality (its performance is directly related to the computer you connect to it, so you'll see relatively faster or slower performance if you're not using a 66-MHz 486, as we did in our testing). The Apple LaserWriter Select 360 appears as a runner-up in Best Overall as well as in the Macintosh category, thanks to solid PostScript and Mac performance (6.7 and 5.88 ppm, respectively).

INTERACTIVE PRINTERS

Some of the printers we tested take advantage of parallel interfaces that can exchange data between the computer and the printer. Using this bidirectional communication, you can configure these printers from your PC screen using remote-configuration utilities that reflect the capabilities of the printer's control panel. Among other things, you can reset resolutions and default printer languages through these on-screen utilities so you don't have to walk over to the printer to look through the control-panel menu. Here are a few examples of some remote-operator panels we liked best.

TEXAS INSTRUMENTS MICROLASER POWERPRO AND MICROLASER 600

TI's RPC (Remote Control Panel) for Windows and DOS (we used the Windows version) is a snap to use. You just double-click on the RCP icon, and you can set resolutions, set page orientation, change paper-tray designations, or anything that you can do with a printer's control panel. If you get lost, there is an on-line help file. RCP is a must for the microLaser 600 because it does not have a physical control panel.



TI's Windows-based control panel.

LEXMARK IBM LASERPRINTER 4039 12R PLUS AND 16L PLUS

In the case of the Lexmark printers, the Windows-based MarkVision Printer Utility supports local and remote 4039 printers (via NPAP) in PCL 5 emulation and PostScript Level 2 emulation. Large buttons and helpful illustrations make it easy to change printer settings on your system. A MarkVision icon flashes to let you know when there's a problem; you then open a window for a graphic view of the printer that explains what's wrong.

HP LASERJET 4M PLUS

HP Explorer—which is a collection of DOS-based applications that look very much like Windows applications—consists of a Status Monitor, an RCP, and an on-line manual. The Status Monitor is a TSR program that broadcasts error messages to your screen so you don't have to walk over to the printer to discover something like a "Paper Jam" status message. The Status Window performs similar duties under Windows. The RCP allows you to set passwords to lock the printer's control panel and brings most printer control-panel settings to your desktop. The on-line manual uses colorful illustrations to describe the printer's functions. The RCP and Status Monitor do not work on networked printers.

We also reviewed other members of HP's venerable LaserJet family. The 4-ppm LaserJet 4L is a runner-up in the Low Cost category, with the third-fastest PCL score in those rankings.

The 12-ppm Lexmark IBM LaserPrinter 4039 12R Plus placed in both the Best Overall and High Quality classes. This laser printer received the second-highest usability scores of the ranked printers, thanks in part to its intuitive MarkVision Printer Utility (see the text box "Interactive Printers").

The Genicom Model 7610 walked away with our performance tests in our previous printer report, thanks in part to being one of the few 10-ppm printers shipping at that time. The Genicom still produced excellent performance, although its PCL and PostScript speeds are no longer category-leading. Two of the 300-dpi laser printers that we examined—the Citizen ProLaser 6000 and the Canon LBP-430—produced clear text and accurate line rendering that surpassed many of the 600-dpi laser printers that visited our labs. These printers are ranked in our Low Cost category. They cost $1000 less than some laser printers that produced less-satisfactory output.

The Lexmark IBM 4037 5E, DEClaser 5100, and LaserJet 4M Plus and 4 Plus all have an indicator on the front of the paper tray that tells you at a glance how much paper remains.

We didn't publish a separate High Quality category for General Business because the rankings would have mirrored the Best Overall results.

KEY	
Excellent ▲▲▲▲	Good ▲▲▲
Fair ▲▲	Poor ▲

BYTE BEST — GENERAL BUSINESS

Need speed, quality, and networking ease?

BEST OVERALL — HP LaserJet 4M Plus

This easy-to-use printer is a leader in the new generation of 10- to 12-ppm, 600-dpi lasers. It ran a close second to the Texas Instruments microLaser PowerPro for PCL and PostScript speed, and it led all the printers ranked here for output quality. A less-expensive version, without PostScript Level 2 or Ethernet and LocalTalk connections, sells for $1839. Both models use a 25-MHz i960 RISC processor. The 4M Plus comes standard with 6 MB of memory (the 4 Plus ships with 2 MB). Both use a bidirectional parallel port. Two trays in the 4M Plus hold up to 350 sheets of paper. Total capacity with optional trays is a maximum of 850 sheets. The 4M Plus can automatically switch among enhanced PCL5 (which includes HPGL2) and PostScript. In addition, the printer can automatically switch among its I/O ports.

		SPEED (PPM) PCL	POSTSCRIPT	MAC	QUALITY INDEX	FEATURES SCORE	EASE OF USE	PRICE	CLASS (PPM)	DPI
BEST	HP LaserJet 4M Plus	8.63	8.38	7.56	8.66	▲▲▲	▲▲▲▲	$2479	12	600
RUNNER-UP	TI microLaser PowerPro	8.93	9.40	8.14	8.15	▲▲▲	▲▲▲▲	$1899	10	600
RUNNER-UP	Genicom Model 7610	6.92	7.20	N/A	7.26	▲▲▲▲	▲▲▲▲	$1889	10	600
RUNNER-UP	IBM LaserPrinter 4039 12R Plus	5.53	5.86	N/A	7.79	▲▲▲	▲▲▲▲	$2028	12	600
RUNNER-UP	Apple LaserWriter Select 360	N/A	6.70	5.88	8.09	▲▲▲	▲▲	$1599	10	600

For budgets under $1000...

LOW COST — Citizen ProLaser 6000

If you don't need PostScript and you're on a tight budget, consider this 6-ppm laser that costs $849. Its PCL speed doesn't approach the Best Overall leaders, but no other under-$1000 printer we ranked ran faster than the ProLaser 6000. The output quality of its 300-dpi engine was also unsurpassed in this group.

		SPEED (PPM) PCL	POSTSCRIPT	MAC	QUALITY INDEX	FEATURES SCORE	EASE OF USE	PRICE	CLASS (PPM)	DPI
BEST	Citizen ProLaser 6000	5.05	N/A	N/A	7.92	▲▲▲	▲▲▲▲	$849	6	300
RUNNER-UP	HP LaserJet 4L	3.13	N/A	N/A	6.49	▲▲▲	▲▲▲	$849	4	300
RUNNER-UP	Okidata OL 410e	3.16	N/A	N/A	7.00	▲▲▲	▲▲▲▲	$899	4	300
RUNNER-UP	Digital DEClaser 1800	4.67	N/A	N/A	6.11	▲▲▲	▲▲▲	$779	6	300
RUNNER-UP	Canon LBP-430	2.91	N/A	N/A	7.62	▲▲	▲▲▲	$799	4	300

Want a printer as easy to use as your Mac?

MAC — HP LaserJet 4M Plus

As in Best Overall, the TI microLaser PowerPro leads the field in flat-out Macintosh speed, but we chose the LaserJet 4M Plus for its print quality, ease of use, and competitive speed score. The 4M Plus comes with 35 Intellifont, 10 TrueType, and 35 PostScript typefaces. The printer saves downloaded fonts in memory when it switches among printer languages.

		SPEED (PPM) PCL	POSTSCRIPT	MAC	QUALITY INDEX	FEATURES SCORE	EASE OF USE	PRICE	CLASS (PPM)	DPI
BEST	HP LaserJet 4M Plus	8.63	8.38	7.56	8.66	▲▲▲	▲▲▲▲	$2479	12	600
RUNNER-UP	TI microLaser PowerPro	8.93	9.40	8.14	8.15	▲▲▲	▲▲▲	$1899	10	600
RUNNER-UP	Apple LaserWriter Select 360	N/A	6.70	5.88	8.09	▲▲▲	▲▲	$1599	10	600
RUNNER-UP	GCC SelectPress 600	4.20	3.90	3.97	7.95	▲▲▲▲	▲▲▲▲	$4499	8	600
RUNNER-UP	Digital DEClaser 5100	6.03	5.21	4.15	8.18	▲▲▲	▲▲▲	$1599	8	1200

N/A= not applicable.

WHICH *printers* SEE THINGS

Insist on printers that use genuine Adobe™ PostScript™ software. It's your assurance that whatever you create will print out exactly the way you expect it to, now and in the future. In a world where technology changes by the minute, Adobe PostScript software is the one constant technology that over 50 major printer manufacturers swear by. That's why Adobe PostScript software is available in hundreds of devices, assuring the highest quality possible

SET YOUR SIGHTS ON GENUINE ADOBE POSTSCRIPT DEVICES:

How We Tested

PERFORMANCE

Our nine speed tests measure each printer's ability to print documents with dense or sparse text, graphics, and fonts in a range of styles and sizes. The dense-text test requires printing a 2-KB file of ASCII text with little white space. Performance in this test correlates to raw speed, because there are no fonts or graphics for the printer to interpret. A second test document consists of ASCII text blocks broken up by areas of white space. Designed to simulate the printing of invoices and forms, this test is geared primarily to evaluating how fast dot-matrix printers can advance paper.

The graphics tests use bit-mapped images to simulate documents with custom fonts or screen shots. These tests help us determine how efficiently each printer communicates with a computer. One test measures the printer's ability to draw complex lines and filled areas. A second test concentrates on producing curves and gray scales.

We use the font test to measure the speed of the printer's processor. The test requires printers to create serif and sans serif fonts in regular and bold faces in 30 point sizes.

We generated a performance index for each printer by combining individual test scores with weightings that emphasized the tests that were most significant for an application category. For example, the results of the graphics tests counted for more of a color printer's overall speed score than did the results of the paper-handling test.

PRINT QUALITY

Our monochrome print-quality tests are PostScript-based tests that measure a printer's ability to produce a photographic image; print attractive, legible text in a wide range of sizes; and draw lines. For example, the line-squeeze test forces a printer to draw two lines successively closer together until the gap between them vanishes—indicating that the printer can no longer make the black-to-white-to-black transition. The monochrome suite also gauges more esoteric features, such as how accurately the printer positions paper and how well the printer displays reversed (i.e., white-on-black) text and graphics.

The color-quality tests, also written in PostScript, in part stress a color printer's ability to print a wide range of hues and to blend hues (see the text box "Color Quality").

Although we wrote the monochrome and color tests in PostScript, we were able to test printers that don't support PostScript by using a custom Windows-based interpreter application that talks to the printer driver without any overhead that may be associated with commercial PostScript interpreters.

OTHER FACTORS

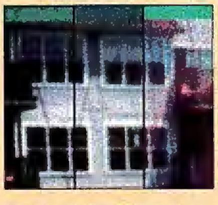
For each printer, we evaluated how easy it was to set up and configure the machine, load paper, and replace consumables. For individual application categories, we used the presence or absence of important features to determine whether a printer was eligible. For example, the CAD and DTP category considered only laser printers that can accommodate 11- by 17-inch paper.

CONFIGURATIONS

We disabled print servers, spoolers, and buffers during testing. We ran PC-based tests using Compaq Deskpro 66M (66-MHz) computers with DOS 6.0 and Windows 3.1. For Macintosh testing, we used Quadra 640AV computers with System 7.1.

This issue also includes printers from previous Lab Reports that are still on the market. We retested any non-PostScript versions of these printers so we could compare quality using our new interpreter.

COLOR QUALITY



(Left to right) High-end thermal, thermal, and ink-jet.

This month, we introduce expanded color-quality evaluations with a new color print-quality test that challenges printers to produce a complex document with a variety of graphics elements, images, and fonts. After having each color printer produce this page, we presented the results for grading by our quality jury, which consisted of 30 people with a mix of expertise in graphics and printer testing. This subjective testing provides a real-world evaluation of the quality these color printers can produce. The samples shown here generally represent the quality differences we saw among each printer technology.

The test document included many different elements that were printed over a graduated color background. They include a 24-bit TIFF image of a photograph with primary colors and some shadow detail; a vector graphic using curved objects, lines, and strong cyan, magenta, and yellow colors; a pie chart with text included inside the wedges; and varied serif fonts.

(Left to right) High-end thermal, thermal, and ink-jet.

We evaluated color printers by considering trueness of color, line handling, shading technique, and object placement. The results, when compared side to side, ranged from mishandled colors and line approximations on the downside to, on the upside, well-formed documents with photographic-quality images, precise line placement, and superior font handling.

Contributors

Alan Joch, Senior Editor/BYTE, *coordinates the combined testing between the BYTE Lab and NSTL.*

Jim Kane, Project Manager/NSTL, *led the testing for this report. He has evaluated printers, systems, and peripherals for three years at NSTL.*

Siva Kumar, Technical Analyst/NSTL, *specializes in hardware and network-operating-system evaluations.*

John McDonough, Technical Writer/NSTL, *has covered the computer industry for seven years.*

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 ajoch@bix.com or at (603) 924-9281.

BYTE BEST

WORKGROUPS

We evaluated 10 laser printers with engine speeds faster than 12 ppm. They are able to connect directly to a network as a print server. This saves NetWare network users the cost of a dedicated print server. In our last report, only three of the eight Workgroup laser printers had this networking capability. The Workgroup printers in this month's report come standard with coaxial or twisted-pair Ethernet connections.

None of the printers ranked here have engine speeds that rated less than 17 ppm, and all cost much more than the General Business laser printers that provide Ethernet options (see page 264).

At $3749, the Hewlett-Packard LaserJet 4SI is the lowest-priced laser in this category. In our past three printer reports, the 4SI reigned as the leading Workgroup printer in output quality and led or closely followed the leaders in print speed. It continues to rank highly in both instances, although newer printers such as the Xerox 4520ps and DEC PrintServer 17/600 surpass it in speed or quality.

Among the items that helped the LaserJet 4SI achieve an "excellent" Features score is its ability to handle multiple print jobs. If the printer is producing a job while a second print job arrives, the 4SI can begin processing the new job in the background to help keep the print queue flowing.

At $4054, the Genicom Model 7170 carries the second-lowest price in this group, while the faster and higher-resolution Dataproducts LZR 2080 tops out at $7580 (even with its higher resolution, the LZR 2080 finished fourth in this group for output quality).

DEC's PrintServer 17/600 posted the slowest PCL and PostScript performance in this group, but its quality score of 9.55 makes it the highest-rated laser in the entire sample for output. The printer provides a base paper-tray capacity of 1000 sheets, compared to the 751-sheet base input tray that the Xerox 4520ps has. When it comes to maximum capacity, however, you can't expand the DEC printer, while the Xerox machine climbs to 2250 sheets when all its paper options are installed.

Most of the Workgroup printers examined here offer at least three paper trays. Multiple paper trays are helpful if you need to print on standard U.S. letter and legal sizes as well as the European-standard A4. The Xerox 4520ps, LZR 2080, and Genicom Model 7170 are the most generous, with up to four input trays. The last time we tested, only the Genicom printer supported four trays.

Because the prices of these laser printers are so close, we didn't find enough differentiation to name Low Cost winners in a separate category.

For the new standard in speed...

BEST OVERALL Xerox 4520ps

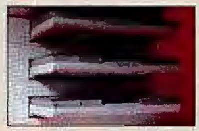
NOVEMBER 1994 BYTE BEST WORKGROUP PRINTER

This fast, high-quality printer reigns as the leading choice for workgroup printing. It was the fastest printer we tested for PCL speed. The 20-ppm Xerox 4520ps has a resolution of 800- by 400-dpi and supports up to 2250 sheets of paper. The 4520ps includes software that provides NetWare users with two-way communications among the printer, servers, and workstations. The utility displays printer information, such as availability, paper sizes, and image-resolution settings.

		SPEED (PPM) PCL	POSTSCRIPT	MAC	QUALITY INDEX	FEATURES SCORE	EASE OF USE	PRICE	CLASS (PPM)	DPI	MAXIMUM INPUT (SHEETS)
BEST	Xerox 4520ps	10.48	9.48	9.25	8.89	▲▲▲▲	▲▲▲	$6483	20	800 × 400	2250
RUNNER-UP	HP LaserJet 4SI	9.23	9.75	N/A	7.87	▲▲▲▲	▲▲▲▲	$3749	17	600	2000
RUNNER-UP	Genicom Model 7170	9.33	8.10	5.40	6.98	▲▲▲	▲▲▲▲	$4054	17	300	2000
RUNNER-UP	Dataproducts LZR 2080	6.81	6.59	1.23	8.29	▲▲▲	▲▲▲▲	$7580	20	800 × 400	850
RUNNER-UP	DEC PrintServer 17/600	6.09	5.74	N/A	9.55	▲▲▲	▲▲▲	$4695	17	600	2000

For the best in output and performance...

HIGH QUALITY Xerox 4520ps



If output quality is your only concern, DEC's PrintServer 17/600 surpasses every other laser we tested for this report, including 1200-dpi models. However, we didn't rank it first in this category because of its slow print speed. We give first-place honors to the Xerox 4520ps because of its unequaled print speed and 800- by 400-dpi resolution that produces a quality score that approximates the PrintServer 17/600's.

		SPEED (PPM) PCL	POSTSCRIPT	MAC	QUALITY INDEX	FEATURES SCORE	EASE OF USE	PRICE	CLASS (PPM)	DPI	MAXIMUM INPUT (SHEETS)
BEST	Xerox 4520ps	10.48	9.48	9.25	8.89	▲▲▲▲	▲▲▲	$6483	20	800 × 400	2250
RUNNER-UP	HP LaserJet 4SI	9.23	9.75	N/A	7.87	▲▲▲▲	▲▲▲▲	$3749	17	600	2000
RUNNER-UP	Dataproducts LZR 2080	6.81	6.59	1.23	8.29	▲▲▲	▲▲▲▲	$7580	20	800 × 400	850
RUNNER-UP	DEC PrintServer 17/600	6.09	5.74	N/A	9.55	▲▲▲	▲▲▲	$4695	17	600	2000
RUNNER-UP	Genicom Model 7170	9.33	8.10	5.40	6.98	▲▲▲	▲▲▲▲	$4380	17	300	2000

N/A = not applicable.

KEY

Excellent ▲▲▲▲ Good ▲▲▲

Fair ▲▲ Poor ▲

The Typhoon 30 laser printer from Dataproducts is an irresistible force to meet your network/high volume printing needs. The Typhoon 30 offers you a powerful set of features at a surprisingly affordable price.

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Consider one of the models ranked here if you require high-resolution printers that can handle 11- by 17-inch paper for large schematic drawings or page layouts. These printers are considered the luxury models of the laser-printer market. All the laser printers that we ranked here support resolutions of from 800 to 1800 dpi and come with at least 4 MB of base memory (the LaserMaster Unity 1800XL-O carries 24 MB of memory standard and can support up to twice that amount).

These printers can operate in many environments. In almost all cases, they have built-in ports or low-cost options for Ethernet and LocalTalk, in addition to standard serial and parallel connections. All these laser printers include emulation sensing, which enables them to switch on the fly into an appropriate mode depending on the data received.

Performance and quality vary considerably, because the engines in this category cover a wide range of resolutions. The NewGen Imager Plus 12 and LaserMaster Unity are rated at 8 ppm, with resolutions of 1200 and 1800 dpi, respectively. The trade-off for high resolution is slow speed: The LaserMaster Unity was almost five times slower than the 800- by 400-dpi Xerox 4520ps in our PostScript speed tests and about 2.5 times slower in PCL speed.

High price is another characteristic common to these specialty laser printers. The lowest cost among the ranked models is $6483, and the high-resolution LaserMaster Unity has is the highest-cost printer in this report at $8995. Because prices for the laser printers clustered in the $6500 to $9000 range, we limited our Low Cost rankings to ink-jet printers that offered excellent print quality and the ability to handle 11- by 17-inch formats. All of them cost well under the price points of large-format laser printers (the two ranked printers sell for below $1000) and provide a good alternative to laser printers for inexpensive proofs of layouts and drawings.

Do you need high quality for large formats?

BEST OVERALL **Xerox 4520ps**

The Xerox 4520ps was faster than any other printer in this category in our PostScript tests. Although its 800- by 400-dpi print engine competes in a class dominated by higher-resolution printers, the Xerox's quality score of 8.89 was the highest of the printers ranked here. The 4520ps comes with HP PCL 5 and Adobe PostScript Level 2.

			SPEED (PPM)			QUALITY	FEATURES	EASE		
			PCL	POSTSCRIPT	MAC	INDEX	SCORE	OF USE	PRICE	DPI
BEST	Xerox 4520ps	●	10.48	9.48	9.25	8.89	▲▲▲	▲▲▲	$6483	800 × 400
RUNNER-UP	Xante Accel-a-Writer 8200	●	8.15	8.24	9.31	8.35	▲▲▲▲	▲▲▲	$6995	1200
RUNNER-UP	NewGen Imager Plus 12	●	3.56	3.83	N/A	7.09	▲▲▲▲	▲▲▲	$6695	1200
RUNNER-UP	LaserMaster Unity 1800XL-O	●	4.03	2.00	2.72	8.04	▲▲▲	▲▲▲▲	$8995	1800

The best large-format printer for proofs.

LOW COST **Epson Stylus 1000**

This is the leader among ink-jet printers that can handle tabloid-size paper. The Stylus 1000 can't match the speed of lasers ranked in Best Overall, but for drafts and proofs, this inexpensive printer posted solid performance and quality that surpassed some laser printers we tested.

			SPEED (PPM)			QUALITY	FEATURES	EASE		
			HIGH QUALITY	POSTSCRIPT	MAC	INDEX	SCORE	OF USE	PRICE	DPI
BEST	Epson Stylus 1000	■	2.23	N/A	N/A	7.50	▲▲	▲▲▲	$599	720 × 360
RUNNER-UP	CalComp TechJet Personal	■	2.50	N/A	N/A	6.36	▲▲▲	▲▲▲	$699	360

For flat-out Mac speed...

MAC **Xante Accel-a-Writer 8200**

Unexcelled for Mac speed, the Xante came in a close second to the Xerox 4520ps for output quality. This printer was also the easiest model to use in this group, thanks to a simple and intuitive control panel that speeds setup. This printer also lets you switch resolutions from the host computer.

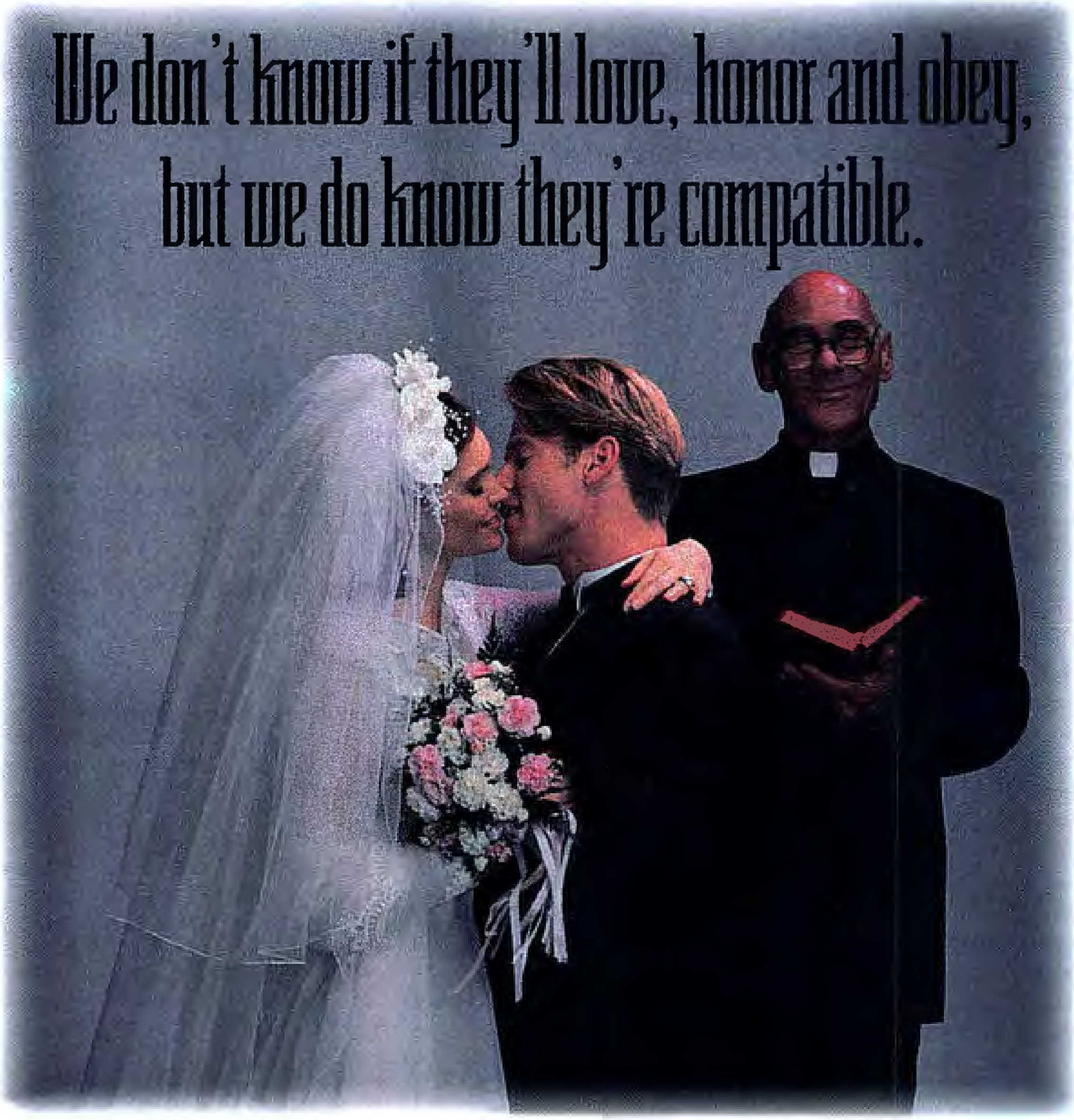
			SPEED (PPM)			QUALITY	FEATURES	EASE		
			PCL	POSTSCRIPT	MAC	INDEX	SCORE	OF USE	PRICE	DPI
BEST	Xante Accel-a-Writer 8200	●	8.15	8.24	9.31	8.35	▲▲▲▲	▲▲▲	$6995	1200
RUNNER-UP	Xerox 4520ps	●	10.48	9.48	9.25	8.89	▲▲▲	▲▲▲	$6483	800 × 400
RUNNER-UP	LaserMaster Unity 1800XL-O	●	4.03	2	2.72	8.04	▲▲▲	▲▲▲▲	$8995	1800
RUNNER-UP	NewGen Imager Plus 12	●	3.56	3.83	N/A	7.09	▲▲▲▲	▲▲▲	$6695	1200
RUNNER-UP	Dataproducts LZR 2080	●	6.81	6.59	1.23	8.29	▲▲▲	▲▲▲▲	$7580	800 × 400

N/A = not applicable.

KEY

Excellent ▲▲▲▲ Good ▲▲▲
Fair ▲▲ Poor ▲

Printer Technology:
Laser ● Ink-jet ■



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HIGH-QUALITY COLOR

Accurate color output is a requirement for graphic arts and business presentations. With that in mind, we limited our evaluations in this category to dye-sublimation, ink-jet, and thermal-wax-transfer printers designed primarily for producing high-quality four-color images. We set a price limit of $8000, because models above that amount are generally meant for more narrow market niches (e.g., color proofing and photographic-quality output).

Of the 14 color printers tested in this category, nine were thermal printers, two utilized dye-sublimation technology, and three were high-end ink-jet printers. The Tektronix Phaser 220e finished third in the Best Overall and second in the High Quality categories. It costs $2395 less than the Phaser 220i (the leader in those two groups), and its color-quality scores matched those of the 220i. The highest color quality of the ranked printers came from the DECcolorwriter 1000.

The unranked Fargo Primera and PrimeraPro offer inexpensive dye-sublimation printing, although their speed is slow.

KEY	
Excellent ▲▲▲▲	Good ▲▲▲
Fair ▲▲	Poor ▲
Printer Technology:	
Thermal ★	Ink-jet ■

Need the best color quality and PostScript speed?

BEST OVERALL — Tektronix Phaser 220i

This was the best thermal-wax-transfer printer we tested. Its high-quality and relatively fast output (0.23 ppm for color PostScript) combined with its high ease-of-use score to push it over the top. The printer comes standard with SCSI and Apple LocalTalk interfaces.

			SPEED (PPM)			QUALITY INDEX					
			COLOR POSTSCRIPT	NATIVE COLOR	MONO POSTSCRIPT	MONO	COLOR	FEATURES SCORE	EASE OF USE	PRICE	DPI
BEST	Tektronix Phaser 220i	★	0.23	N/A	0.85	7.86	8.33	▲▲▲	▲▲▲	$6390	600 x 300
RUNNER-UP	HP DeskJet 1200 C/PS	■	0.58	0.97	3.39	7.01	6.67	▲▲▲	▲▲▲	$2749	600
RUNNER-UP	Tektronix Phaser 220e	★	0.21	0.84	0.83	8.11	8.33	▲▲▲	▲▲▲	$3995	600 x 300
RUNNER-UP	DECcolorwriter 1000	★	0.21	1.01	0.83	7.89	8.67	▲▲▲	▲	$3999	600 x 300
RUNNER-UP	Lexmark IBM PS 4079	■	0.31	N/A	1.80	6.66	6.67	▲▲▲	▲▲▲	$3199	360

When price and quality matter...

LOW COST — HP DeskJet 1200 C/PS

Compared to its competition, this $2749 ink-jet printer is a bargain. It's the least expensive color printer ranked for this application. In return, it posts the fastest color PostScript score and solid quality ratings. The HP DeskJet 1200 C/PS had the highest color-quality rating of all ink-jet printers tested. The ability to produce high-quality color output has improved to the point where ink-jets compare favorably with thermal printers. While this printer costs four times as much as some of the ink-jet printers ranked in Draft Quality (see page 277), it is worth the extra money if you need its output quality.

			SPEED (PPM)			QUALITY INDEX					
			COLOR POSTSCRIPT	NATIVE COLOR	MONO POSTSCRIPT	MONO	COLOR	FEATURES SCORE	EASE OF USE	PRICE	DPI
BEST	HP DeskJet 1200 C/PS	■	0.58	0.97	3.39	7.01	6.67	▲▲▲	▲▲▲	$2749	600
RUNNER-UP	Tektronix Phaser 220e	★	0.21	0.84	0.82	8.11	8.33	▲▲▲	▲▲▲	$3995	600 x 300
RUNNER-UP	DECcolorwriter 1000	★	0.21	1.01	0.83	7.89	8.67	▲▲▲	▲	$3999	600 x 300
RUNNER-UP	Lexmark IBM PS 4079	■	0.31	N/A	1.80	6.66	6.67	▲▲▲	▲▲▲	$3199	360
RUNNER-UP	General Para. Spectra*Star GTx	★	0.22	N/A	0.85	7.62	7.33	▲▲▲	▲▲▲	$4995	300 x 600

Need a quality leader?

HIGH QUALITY — Tektronix Phaser 220i

The DECcolorwriter 1000 offers slightly better color output than the Phaser 220i, but we give Tektronix the nod because its color PostScript speed score was faster, and the printer was among the easiest-to-use color models we tested.

			SPEED (PPM)			QUALITY INDEX					
			COLOR POSTSCRIPT	NATIVE COLOR	MONO POSTSCRIPT	MONO	COLOR	FEATURES SCORE	EASE OF USE	PRICE	DPI
BEST	Tektronix Phaser 220i	★	0.23	N/A	0.85	7.86	8.33	▲▲▲	▲▲▲	$6390	600 x 300
RUNNER-UP	Tektronix Phaser 220e	★	0.21	0.84	0.83	8.11	8.33	▲▲▲	▲▲▲	$3995	600 x 300
RUNNER-UP	HP DeskJet 1200 C/PS	■	0.58	0.97	3.39	7.01	6.67	▲▲▲	▲▲▲	$2749	600
RUNNER-UP	DECcolorwriter 1000	★	0.21	1.01	0.83	7.89	8.67	▲▲▲	▲	$3999	600 x 300
RUNNER-UP	Lexmark IBM PS 4079	■	0.31	N/A	1.80	6.66	6.67	▲▲▲	▲▲▲	$3199	360

N/A = not applicable.

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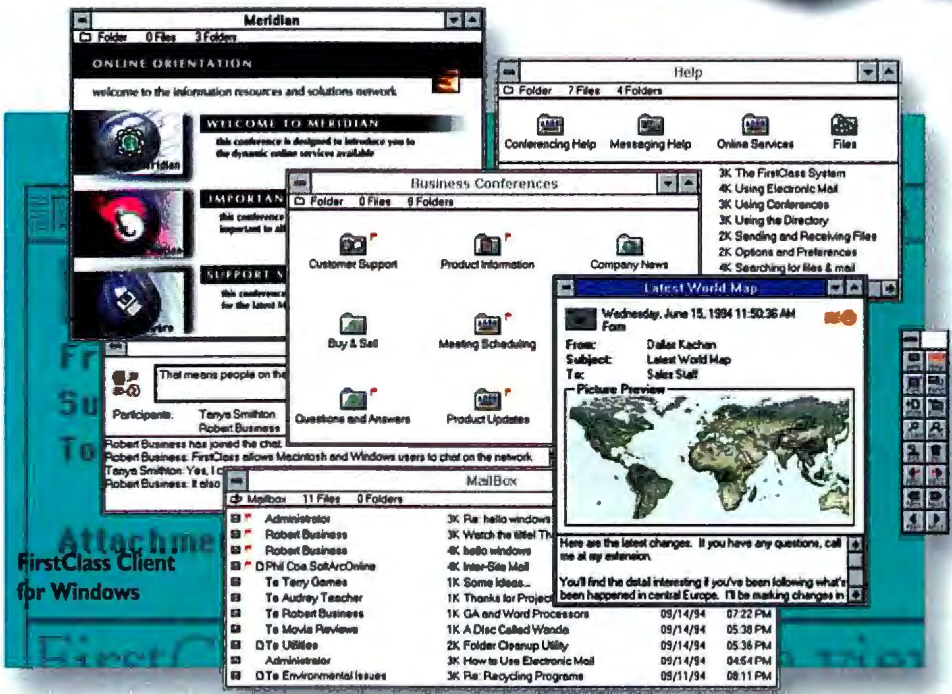

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1993 BYTE AWARD OF MERIT

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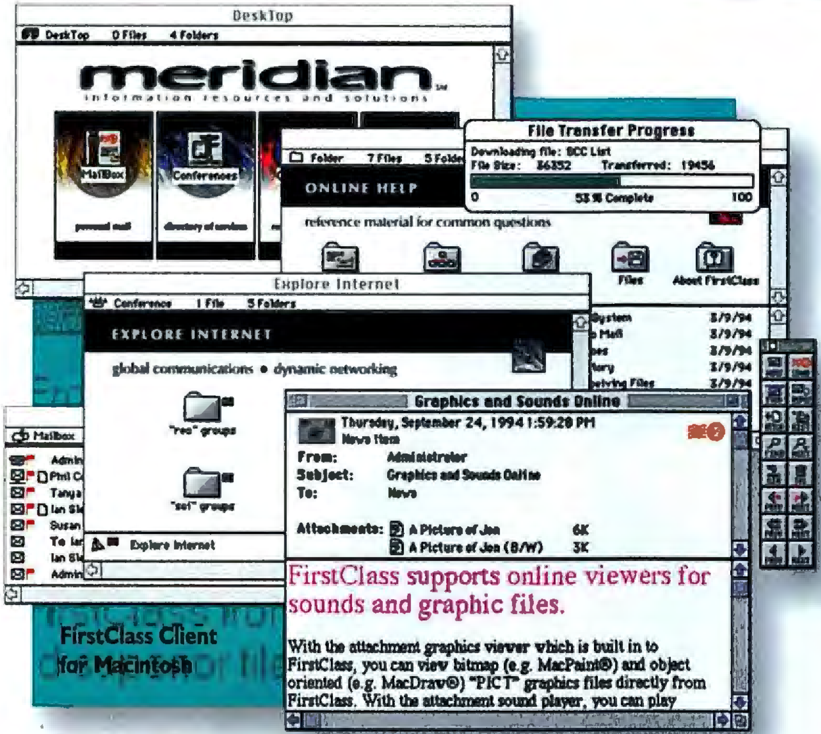
MacUser, November, 1993



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FirstClass Gateways To Other Mail Systems & Technologies

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.

	FirstClass	Lotus Notes	cc:Mail	QuickMail	MS Mail
Conferencing?	Y	Y	Pseudo	-	-
Cross-Platform Chatting?	Y	-	-	-	-
Fully Customizable Interface?	Y	Y	-	-	-
Bulletin Board Functions?	Y	-	-	-	-
Modems Per Server?	Up to 48	8	1	1	1
Restrict Any Feature?	Y	Y	-	-	-
Internet News Gateway?	Optional	Optional	-	-	-
Command Line Access?	Y	-	Y	Y	Y
10 Users	$690	Min. $4950	Min. $640	$599	$695
Remote Access	Free	Free	$170/user	Free	Free

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BYTE, September, 1993

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BYTE BEST

DRAFT QUALITY

A new generation of ink-jet printers now offers monochrome output just under a laser printer's quality with prices well below $1000. As a bonus, many of these ink-jet printers provide color output that may not match the quality of higher-price models but still goes a long way to enhance correspondence and highlight important elements in a report or spreadsheet.

Because color has become such an important element in the low-cost ink-jet-printer market, our rankings for this category include only those models that offer monochrome and color at prices under $1000. However, if you never need color, some monochrome-only ink-jet printers are available at low prices. For details, see "Ink-Jet" in the Roll Call on page 280.

The color-quality index of Epson's Stylus Color ranks near the leaders in this category; however, its speed scores for both monochrome and color output kept it out of our rankings. The Stylus Color and the DeskJet 560C both fared well in our ease-of-use ratings, thanks to a combined monochrome and three-color ink-jet cartridge.

KEY	
Excellent ▲▲▲▲	Good ▲▲▲
Fair ▲▲	Poor ▲

Need low-cost monochrome and spot color?

BEST OVERALL

DECcolorwriter 520ic and Texas Instruments microMarc color

These similar 300-dpi color ink-jet printers tied for monochrome speed; both are excellent choices for clear output at prices less than those commanded by laser printers. The DECcolorwriter 520ic registered a slight edge over the TI printer for monochrome quality, which we gave more value to versus color quality for this group. Quality scores made the difference for our runner-up printers. The difference between HP's DeskJet 540 and DeskJet 560C, both 3-ppm printers, was also in the quality index. The DeskJet 560C outperformed the DeskJet 540 in monochrome speed tests (2.44 to 2.38 ppm) and had better features and usability scores, but the DeskJet 540 had superior color speed scores (0.75 to 0.62 ppm) and higher monochrome-quality ratings.

		SPEED (PPM)					QUALITY INDEX					
		NATIVE MODE	POSTSCRIPT	MAC	NATIVE COLOR	COLOR POSTSCRIPT	MONO	COLOR	FEATURES SCORE	EASE OF USE	PRICE	DPI
BEST	DECcolorwriter 520ic	3.79	N/A	N/A	1.06	N/A	6.54	3.00	▲▲▲	▲▲▲	$449	300
RUNNER-UP	TI microMarc color	3.79	N/A	N/A	1.12	N/A	6.15	6.00	▲▲▲	▲▲▲	$439	300
RUNNER-UP	HP DeskJet 540	2.38	N/A	N/A	0.75	N/A	7.14	5.67	▲▲▲	▲▲▲	$414	600 × 300
RUNNER-UP	HP DeskJet 560C	2.44	N/A	N/A	0.62	N/A	6.61	5.67	▲▲▲	▲▲▲	$719	600
RUNNER-UP	HP DeskJet 320	1.93	N/A	N/A	0.54	N/A	7.15	5.67	▲▲	▲▲▲	$379	600 × 300

Want the best ink-jet for Mac applications?

MAC

HP DeskWriter 560C

Among the color ink-jet printers for the Mac, the 3-ppm DeskWriter 560C (the Mac cousin of the DeskJet 560C) outperformed its two competitors in our color speed tests. It also excelled in our ease-of-use ratings.

		SPEED (PPM)					QUALITY INDEX					
		NATIVE MODE	POSTSCRIPT	MAC	NATIVE COLOR	COLOR POSTSCRIPT	MONO	COLOR	FEATURES SCORE	EASE OF USE	PRICE	DPI
BEST	HP Deskwriter 560C	N/A	N/A	2.37	0.48	N/A	5.40	3.33	▲▲	▲▲▲	$719	600 × 300
RUNNER-UP	HP DeskWriter 320	N/A	N/A	2.25	0.45	N/A	4.99	5.67	▲▲	▲▲▲	$379	600 × 300
RUNNER-UP	Apple Color StyleWriter Pro	N/A	N/A	1.73	0.34	N/A	NA	NA	▲▲	▲▲▲	$629	360

When quality counts...

HIGH QUALITY

DECcolorwriter 520ic and Texas Instruments microMarc color

When considering monochrome and color output quality and speed, these similar printers led the field. Canon's BJC-600 was the all-out color-quality winner in this group. However, its slow speed scores kept it from winning top honors.

		SPEED (PPM)					QUALITY INDEX					
		NATIVE MODE	POSTSCRIPT	MAC	NATIVE COLOR	COLOR POSTSCRIPT	MONO	COLOR	FEATURES SCORE	EASE OF USE	PRICE	DPI
BEST	DECcolorwriter 520ic	3.79	N/A	N/A	1.06	N/A	6.54	3.00	▲▲▲	▲▲▲	$449	300
RUNNER-UP	TI microMarc color	3.79	N/A	N/A	1.12	N/A	6.15	6.00	▲▲▲	▲▲▲	$439	300
RUNNER-UP	HP DeskJet 540	2.38	N/A	N/A	0.75	N/A	7.14	5.67	▲▲▲	▲▲▲	$414	600 × 300
RUNNER-UP	HP DeskJet 560C	2.44	N/A	N/A	0.62	N/A	6.61	5.67	▲▲▲	▲▲▲	$719	600
RUNNER-UP	Canon BJC-600	1.02	N/A	N/A	0.32	N/A	6.86	6.33	▲▲▲▲	▲▲▲	$719	360

N/A = not applicable.

LISTINGS AND FORMS

Despite premature reports of its demise, dot-matrix technology continues to fill an important niche for those who need workhorse printers for multipart forms, large runs of labels, and oversize paper. We evaluated 13 high-end dot-matrix printers (none supported the Mac) that serve these needs as no laser or ink-jet printer can. Several of these printers, all priced above $1000, run faster than typical low-end lasers. However, there are two trade-offs for this speed: noise and inferior print quality.

These printers emphasize raw output over fancy formatting. None offers PostScript, PCL, HPGL (Hewlett-Packard Graphics Language), or scalable fonts. None of the printers we tested support color. Most of these printers offer at least two paper-feed paths.

Runners-up deserving attention are the Mannesmann Tally MT 360-2T, which finished a distant second to the company's far-more-expensive T6082 in performance tests. Nevertheless, the $2795 MT 360-2T outpaced all other runners-up by a minimum of 1.3 ppm in high-quality mode.

Prices range from $499 for the Epson FX-1170 to $8799 for the T6082. If you have a limited budget, consider the FX-1170, the DFX-5000+, or the CIE America CI-5000. The latter two cost about $2000.

KEY	
Excellent ▲▲▲▲	Good ▲▲▲
Fair ▲▲	Poor ▲

Does speed matter more than quality?

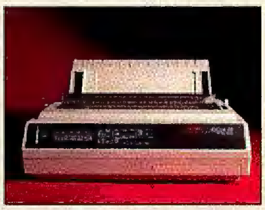
BEST OVERALL Mannesmann Tally T6082

This expensive dot-matrix printer received a speed score almost double that of its nearest competitor. For high-volume applications that depend on economies of scale, this washing-machine-size printer is a clear choice. However, if your volumes don't justify an $8799 printer, consider Mannesmann Tally's other offering: the MT 360-2T, which ranked second fastest and sells for about $6000 less. The Okidata Microline 395 and DEC's LA600 MultiPrinter finished ahead of the other printers in quality testing, although quality takes a back seat to speed in our weightings.

		SPEED (PPM) NATIVE[1]	QUALITY INDEX	FEATURES SCORE	EASE OF USE	PRICE	DPI	OPERATING NOISE (DB)	NUMBER OF PINS
BEST	Mannesmann Tally T6082	10.44	4.05	▲▲▲	▲▲▲	$8799	240	50	—[2]
RUNNER-UP	Mannesmann Tally MT 360-2T	5.45	3.98	▲▲▲▲	▲▲▲▲	$2795	360	55	24
RUNNER-UP	Digital LA600 MultiPrinter	4.11	5.09	▲▲▲▲	▲▲▲	$2999	360	53	24
RUNNER-UP	Okidata Microline 395	3.87	5.60	▲▲▲	▲▲▲	$1499	360	58	24
RUNNER-UP	CIE C.Itoh CI-5000	3.44	4.99	▲▲▲	▲▲▲	$1995	330 × 216	55	18

Need high-volume printing at a low cost?

LOW COST Okidata Microline 395



The $1499 Microline 395, which won this category in last May's report, is still the reigning champ for under-$2000 printers. It combines economy with highly readable output. Its print speed is much slower than that of the Best Overall runners-up, but the Microline outruns the other printers in the Low Cost subcategory. As a bonus, the standard-configuration Microline 395 can print bar codes. The Epson DFX-5000+ and DFX-8000 did poorly in our usability testing, because we had difficulty installing the printer ribbons.

		SPEED (PPM) NATIVE[1]	QUALITY INDEX	FEATURES SCORE	EASE OF USE	PRICE	DPI	OPERATING NOISE (DB)	NUMBER OF PINS
BEST	Okidata Microline 395	3.87	5.60	▲▲▲	▲▲▲	$1499	360	58	24
RUNNER-UP	CIE C.Itoh CI-5000	3.44	4.99	▲▲▲	▲▲▲	$1995	330 × 216	55	18
RUNNER-UP	Epson DFX 5000+	2.62	4.72	▲▲▲▲	▲▲▲	$1899	240	55	9
RUNNER-UP	Epson FX 1170	1.75	4.40	▲▲▲	▲▲▲▲	$499	240 × 216	55	9
RUNNER-UP	AMT Accel - 294d	1.23	3.90	▲▲▲▲	▲▲▲▲	$1190	240	55	9[3]

The speed leader...

HIGH SPEED Mannesmann Tally T6082

This 900-line-per-minute printer is the flat-out speed leader. However, its 240-dpi print quality is merely acceptable.

		SPEED (PPM) NATIVE[1]	QUALITY INDEX	FEATURES SCORE	EASE OF USE	PRICE	DPI	OPERATING NOISE (DB)	NUMBER OF PINS
BEST	Mannesmann Tally T6082	10.81	4.05	▲▲▲	▲▲▲	$8799	240	50	—[2]
RUNNER-UP	CIE C.Itoh CI-5000	8.26	4.99	▲▲▲	▲▲▲	$1995	330 × 216	55	18
RUNNER-UP	Digital LA600 MultiPrinter	6.87	5.09	▲▲▲▲	▲▲▲	$2999	360	53	24
RUNNER-UP	Mannesmann Tally MT 360-2T	5.70	3.98	▲▲▲▲	▲▲▲▲	$2795	360	55	24
RUNNER-UP	Okidata Microline 395	6.63	5.60	▲▲▲	▲▲▲	$1499	360	58	24

[1] High-quality mode. [2] 66 hammers. [3] Dual heads. [4] Draft mode.

ROLL CALL OF PRINTERS TESTED

VENDOR	MODEL	PRICE AS TESTED	SPEED (PAGES PER MINUTE) HIGH-QUALITY	DRAFT	POSTSCRIPT	MAC	QUALITY INDEX MONOCHROME	CLASS	RESOLUTION (DPI)
DOT MATRIX									
Advanced Matrix Technology	AMT Accel - 294d	$1190	1.23	3.91	N/A	N/A	3.90	540 cps	240
Advanced Matrix Technology	AMT Accel - 535dsi	$2495	2.04	5.38	N/A	N/A	4.01	480 cps	480
CIE America, Inc.	CI-5000 High Speed Printer	$1995	3.44	8.26	N/A	N/A	4.99	450 cps	330 × 216
Dataproducts Corp.	8524	$2395	1.78	4.14	N/A	N/A	5.26	520 cps	360
Digital Equipment Corp.	LA600 MultiPrinter	$2999	4.11	6.87	N/A	N/A	5.09	600 cps	360
Epson America, Inc.	DFX-8000	$3199	3.50	6.04	N/A	N/A	3.68	160 cps	240 × 216
Epson America, Inc.	FX-1170	$499	1.75	4.45	N/A	N/A	4.40	57 cps	240 × 216
Epson America, Inc.	DFX-5000+	$1899	2.62	2.83	N/A	N/A	4.72	504 cps	240
Genicom Corp.	Model 3840EP	$2995	3.72	7.84	N/A	N/A	2.60	600 cps	400 × 144
IBM	IBM 4230/32 Printer	$3995	2.04	3.57	N/A	N/A	4.40	600 cps	144 × 144
Mannesmann Tally Corp.	MT 360-2T	$2795	5.45	5.70	N/A	N/A	3.88	720 cps	360
Mannesmann Tally Corp.	T6082	$8799	10.44	10.81	N/A	N/A	4.05	1980 cps	240
Okidata	Microline 395	$1499	3.87	6.63	N/A	N/A	5.60	162 cps¹	360
INK-JET									
Advanced Matrix Technology	AMT Intelli-Plot InkJet	$1995	1.68	2.14	N/A	N/A	6.71	300 cps	360
C-Tech Electronics, Inc.	C.Itoh ProWriter CJ-300	$449	2.21	2.22	N/A	N/A	6.52	300 cps	360
CalComp	TechJET Personal	$699	2.50	2.68	N/A	N/A	6.36	248 cps	360
Canon Computer Systems, Inc.	BJ-200e	$399	2.69	N/A	N/A	N/A	8.36	248 cps	360
Canon Computer Systems, Inc.	BJ-100	$359	1.86	2	N/A	N/A	7.17	140 cps	300
Epson America, Inc.	Stylus 1000	$599	2.23	2.30	N/A	N/A	7.50	250 cps	720 × 360
Epson America, Inc.	Stylus 800+	$359	1.03	2.76	N/A	N/A	7.84	250 cps	360
Lexmark International, Inc.	IBM ExecJet II 4076	$349	2.37	N/A	N/A	N/A	4.81	300 cps	300
LASER									
Alps America	LSX 1000	$1599	6.37	N/A	6.25	N/A	6.90	10 ppm	600
Alps America	LSX 1600e	$3295	7.19	N/A	N/A	N/A	6.85	16 ppm	300
Apple Computer, Inc.	LaserWriter Select 360	$1599	N/A	N/A	6.70	5.88	8.09	10 ppm	600
Apple Computer, Inc.	Personal LaserWriter 320	$1124	N/A	N/A	N/A	2.82	6.74	4 ppm	300
C-Tech Electronics, Inc.	C.Itoh ProWriter CI-8Xtra+	$2099	5.69	6	4.13	N/A	8.34	8 ppm	600 × 300
Canon Computer Systems, Inc.	LBP-430	$799	2.91	N/A	N/A	N/A	7.62	4 ppm	300
Canon Computer Systems, Inc.	LBP-860	$1989	5.89	4.50	N/A	N/A	8.09	8 ppm	600
Citizen America Corp.	Citizen ProLaser 6000	$849	5.05	5.36	N/A	N/A	7.92	6 ppm	300
Dataproducts Corp.	LZR 2080	$7580	6.81	N/A	6.59	1.23	8.29	20 ppm	800 × 400
Digital Equipment Corp.	DEClaser 1800	$779	4.67	5.55	N/A	N/A	6.11	6 ppm	300
Digital Equipment Corp.	DEClaser 5100	$1599	6.03	6.58	5.21	4.15	8.18	6 ppm	1200
Digital Equipment Corp.	PrintServer 17/600	$4695	6.09	N/A	5.74	N/A	9.55	17 ppm	600
Epson America, Inc.	ActionLaser 1500	$1048	4.65	N/A	N/A	N/A	8.15	6 ppm	300
Epson America, Inc.	ActionLaser 1600	$1199	5.08	5.40	N/A	N/A	8.09	6 ppm	600
GCC Technologies	SelectPress 600	$4499	4.20	N/A	3.90	3.97	7.85	6 ppm	600
Genicom Corp.	Model 7170	$4054	9.33	N/A	8.10	5.40	6.98	17 ppm	300
Genicom Corp.	Model 7610	$1889	6.92	7.43	7.20	N/A	7.26	10 ppm	600
Hewlett Packard Co.	LaserJet 4M Plus	$2479	8.63	8.82	8.38	7.56	8.66	12 ppm	600
Hewlett Packard Co.	LaserJet 4 Plus	$1839	8.53	8.98	N/A	N/A	8.62	12 ppm	600
Hewlett Packard Co.	LaserJet 4L	$849	3.13	N/A	N/A	N/A	6.49	4 ppm	300
Hewlett Packard Co.	LaserJet 4ML	$1279	3.13	N/A	3.13	3.03	8.49	4 ppm	300
Hewlett Packard Co.	LaserJet 4MP	$1729	3.09	N/A	3.14	3.02	7.66	4 ppm	600
Hewlett Packard Co.	LaserJet 4P	$1229	3.09	N/A	3.14	N/A	8.49	4 ppm	600
Hewlett Packard Co.	LaserJet 4 Si	$3749	9.23	11.05	9.75	N/A	7.67	17 ppm	600
Hewlett Packard Co.	LaserJet 4 SiMX	$5299	9.23	11.06	9.75	9.86	7.87	17 ppm	600
Kyocera Electronics, Inc.	Ecosys FS-1500 A	$3300	7.02	4.84	4.84	4.87	7.23	10 ppm	300
Kyocera Electronics, Inc.	Ecosys FS-3500 A	$5380	4.74	N/A	10.74	N/A	7.19	18 ppm	300
LaserMaster Corp.	Unity 1600XL-O	$8995	4.03	7.07	2.00	2.72	8.04	6 ppm	1800
Lexmark International, Inc.	IBM 4037 5E	$1078	4.03	N/A	N/A	N/A	7.27	5 ppm	300
Lexmark International, Inc.	IBM LaserPrinter 4039 12R Plus	$2028	5.53	9.07	5.86	N/A	7.79	12 ppm	600
Lexmark International, Inc.	IBM LaserPrinter 4039 16L Plus	$3399	5.38	10.95	6.13	N/A	7.66	16 ppm	600
NEC Technologies	Silentwriter 640	$750	N/A	N/A	N/A	4.05	6.43	6 ppm	300
NEC Technologies	Silentwriter Superscript 610	$500	4.12	N/A	N/A	N/A	6.76	6 ppm	300
NewGen Systems Corp	Imager Plus 12	$6695	3.56	N/A	3.83	N/A	7.09	8 ppm	1200
Okidata	OL 410e	$899	3.16	3.44	N/A	N/A	7.00	4 ppm	300
Okidata	OL410e/PS	$1249	2.98	3.42	3.12	3.06	8.40	4 ppm	300
Sharp Electronics Corp.	JX 9460 PS	$1428	5.23	N/A	5.27	N/A	8.13	6 ppm	800
Sharp Electronics Corp.	Sharp JX-9400	$828	5.26	6.64	N/A	N/A	7.76	6 ppm	300
Sharp Electronics Corp.	Sharp JX-9660PS	$1728	6.37	6.64	6.27	3.36	8.01	8 ppm	600
Texas Instruments	microLaser 600	$1099	3.56	3.53	3.65	3.50	8.42	5 ppm	600
Texas Instruments	microLaser PowerPro	$1899	8.93	9.66	9.40	6.14	8.15	10 ppm	600
Xante	Accel-a-Writer 8200	$6995	6.15	8.28	8.24	9.31	8.35	16 ppm	1200
Xerox Corp.	Xerox 4011	$1599	6.59	3.31	3.31	N/A	7.12	8 ppm	300
Xerox Corp.	Xerox 4505ps	$1814	1.77	4.12	1.85	1.75	8.43	5 ppm	600
Xerox Corp.	Xerox 4510ps	$2523	4.00	7.70	3.14	3.09	8.13	10 ppm	600
Xerox Corp.	Xerox 4520ps	$6483	10.48	12.14	9.48	9.25	8.89	20 ppm	800 × 400

VENDOR	MODEL	TECHNOLOGY	PRICE AS TESTED	MONOCHROME SPEED (PPM) HIGH-QUALITY	DRAFT	POSTSCRIPT	MAC	COLOR SPEED (PPM) POSTSCRIPT	NATIVE-MODE
COLOR									
Apple Computer, Inc.	Color StyleWriter Pro	■	$629	N/A	N/A	N/A	1.73	N/A	0.34
Canon Computer Systems, Inc.	BJC-600	■	$719	1.02	1.84	N/A	N/A	N/A	0.32
Canon Computer Systems, Inc.	BJC-4000	■	$599	0.94	N/A	N/A	N/A	N/A	0.27
Dataproducts Corp.	Jolt PSe	■	$5595	N/A	N/A	1.40	1.40	0.30	N/A
Digital Equipment Corp.	DECcolorwriter 1000	★	$3999	1.63	N/A	0.83	1.58	0.21	1.01
Digital Equipment Corp.	DECcolorwriter 520ic	■	$449	3.79	4.37	N/A	N/A	N/A	1.06
Epson America, Inc.	Epson Stylus Color Ink Jet Printer	■	$699	0.98	2.13	N/A	N/A	N/A	0.26
Fargo Electronics, Inc.	Primera Color Printer	★	$995	0.95	N/A	N/A	0.88	N/A	0.46
Fargo Electronics, Inc.	Primera w/ Photo Realistic Upgrade Kit	◆	$1245	0.16	N/A	N/A	0.20	N/A	0.11
Fargo Electronics, Inc.	PrimeraPro Color Printer	★	$1895	0.24	N/A	N/A	N/A	N/A	0.28
Fargo Electronics, Inc.	PrimeraPro Color Printer	◆	$1895	0.04	N/A	N/A	N/A	N/A	0.07
General Parametrics Corp.	Spectra*Star GT	★	$4495	N/A	N/A	1.74	1.63	0.43	N/A
General Parametrics Corp.	Spectra*Star GTx	★	$4995	N/A	N/A	0.85	0.81	0.22	N/A
Genicom Corp.	Genicom 7025	★	$995	N/A	N/A	N/A	0.49	N/A	0.33
Hewlett-Packard Co.	DeskJet 540	■	$414	2.38	2.61	N/A	N/A	N/A	0.75
Hewlett-Packard Co.	DeskWriter 320	■	$379	N/A	N/A	N/A	2.25	N/A	0.45
Hewlett-Packard Co.	DeskJet 1200 C/PS	■	$2749	4.12	5.55	3.39	N/A	0.58	0.97
Hewlett-Packard Co.	DeskJet 320	■	$379	1.93	2.20	N/A	N/A	N/A	0.54
Hewlett-Packard Co.	DeskJet 560C	■	$719	2.44	N/A	N/A	N/A	N/A	0.62
Hewlett-Packard Co.	DeskWriter 560C	■	$719	N/A	N/A	N/A	2.37	N/A	0.48
Lexmark International, Inc.	IBM Color JetPrinter PS 4079	■	$3199	N/A	N/A	1.80	1.19	0.31	N/A
Tektronix	Phaser 200e	★	$2995	N/A	N/A	1.10	1.05	0.27	N/A
Tektronix	Phaser 220e	★	$3995	1.69	N/A	0.83	1.47	0.21	0.84
Tektronix	Phaser 220i	★	$6390	N/A	N/A	0.85	0.82	0.23	N/A
Texas Instruments	microMarc color	■	$439	3.79	4.36	N/A	N/A	N/A	1.12

= BYTE Best. Printer technology: Dye-sub ◆ Ink-jet ■ Thermal ★ N/A = not applicable. ¹ At 12 cpi.

FEATURES CONTINUE ON NEXT PAGE

EMULATIONS									MEMORY	
AUTO-SENSING	POSTSCRIPT	HP PCL 5[1]	HP PCL 4	HPGL	EPSON LQ/FX	IBM PROPRINTER	IBM GRAPHICS	DIABLO 630	BASE	AS TESTED
					✔				8 KB	8 KB
				$610	✔	✔		✔	60 KB	60 KB
					✔	✔			8 KB	8 KB
						✔	✔		48 KB	48 KB
✔						✔			48 KB	48 KB
					✔	✔	✔		3 KB	3 KB
						✔	✔	✔	24 KB	24 KB
					✔				20 KB	20 KB
					✔	✔	✔		64 KB	64 KB
					✔	✔	✔		128 KB	128 KB
					✔	✔			128 KB	128 KB
✔			✔	✔	✔				0 KB	4 KB
									64 KB	64 KB
✔				✔		✔			1 MB	1 MB
									16 KB	16 KB
				✔	✔	✔			40 KB	40 KB
					✔	x24E 1			256 KB (host-based)	256 KB
✔						✔			50.4 KB	50.4 KB
									128 KB	128 KB
					✔				32 KB	32 KB
							✔		21 KB	21 KB
✔	Level I	✔		✔	✔	✔	✔	✔	2 MB	4 MB
✔		✔		✔					2 MB	4 MB
✔	Level II	✔							7 MB	4 MB
	Level II								2 MB	4 MB
✔	Level II	✔							4 MB	4 MB
		✔	✔	✔					1 MB	5 MB
✔	Level II	✔	✔						2 MB	6 MB
		✔			✔	✔			1 MB	1 MB
✔	✔		✔						8 MB	32 MB
✔		✔			✔	✔			1 MB	1 MB
✔	Level II	✔							6 MB	6 MB
✔	✔	✔	✔			✔			16 MB	16 MB
✔	Optional	✔		$299	✔				1 MB	3 MB
✔	Level II ($329)	✔		✔	✔				2 MB	2 MB
✔	✔	✔		✔					8 MB	8 MB
	Level I ($595)	✔	✔	✔		✔			1 MB	9 MB
✔	Level I	✔	✔	✔	✔	✔		✔	2 MB	10 MB
✔	Level II	Enhanced		✔					6 MB	6 MB
✔	Level II ($399)	Enhanced		✔	✔	✔	✔	✔	2 MB	2 MB
✔		Enhanced		✔					1 MB	4 MB
✔	Level II	Enhanced		✔					4 MB	4 MB
✔	Level II	Enhanced		✔					6 MB	6 MB
✔	Level II	Enhanced		✔					6 MB	6 MB
✔	Level II	Enhanced	✔	✔	$199	$199			10 MB	10 MB
✔	Level II	Enhanced	✔	✔	$199	$199			10 MB	10 MB
	Level I ($399)	✔		✔	✔	✔		✔	1 MB	4 MB
	Level I ($399)	✔		✔	✔	✔		✔	2 MB	10 MB
✔	Level II		✔						24 MB	24 MB
			✔			✔	✔		512 KB	4.5 MB
✔	Level II	✔		✔					2 MB	5 MB
✔	Level II			✔					4 MB	4 MB
	Level II								3 MB	3 MB
	Level I ($99)		✔						(Host-based)	(Host-based)
✔	Level I	$199	✔	✔					40 MB	40 MB
		✔		✔					2 MB	4 MB
✔	Level II	✔		✔					2 MB	5 MB
✔	Level I	✔			✔	✔	✔		2 MB	4 MB
			✔		✔	✔	✔	✔	512 KB	2 MB
Optional	Level I	✔			✔	✔	✔		2 MB	6 MB
✔	Level II	✔							2 MB	2 MB
✔	Level II	✔							6 MB	6 MB
✔	Level II	✔		✔					12 MB	40 MB
	Level I ($595)	✔	✔	✔	✔	✔		✔	3 MB	3 MB
✔	Level II ($299)	Enhanced		✔					2 MB	6 MB
✔	Level II ($399)	Enhanced		✔					2 MB	6 MB
✔	Level II ($799)	Enhanced		✔					4 MB	24 MB

QUALITY INDEX		RESOLUTION	EMULATIONS						MEMORY		FCC
MONOCHROME	COLOR	(DPI)	AUTO-SENSING	HP PCL 5C	POSTSCRIPT	HP PCL 5	HPGL	IBM PROPRINTER	BASE	AS TESTED	CLASS
N/A	N/A	360	✔						(Host-based)	(Host-based)	A
6.86	6.33	360			Level II			✔	60 KB	60 KB	A
5.95	4.00	720 × 360	✔					✔	64 KB	64 KB	B
6.85	5.33	300	✔		Level I		✔		6 MB	6 MB	B
7.89	8.67	600 × 300	✔		Level II	✔	✔		8 MB	8 MB	B
6.54	3.00	300						$145	128 KB	128 KB	B
5.36	6.67	720							64 KB	64 KB	B
7.72	5.00	203			Level II ($299.95)				32 KB	32 KB	B
5.74	5.33	203			Level II ($299.95)				32 KB	32 KB	B
7.68	4.00	300 × 600			Level I (Level II $400)				32 KB	32 KB	B
7.69	6.33	300 × 600			Level I (Level II $400)				32 KB	32 KB	B
6.26	6.67	300			Level II		✔		6 MB	6 MB	A
7.62	7.33	300 × 600			Level II		✔		10 MB	10 MB	A
6.46	4.00	203							(Host-based)	(Host-based)	B
7.14	5.67	600 × 300	✔	✔	Level II	✔	✔	✔	512 KB	512 KB	B
4.99	5.67	600 × 300	✔					✔	80 KB	80 KB	B
7.01	6.67	600			✔				4 MB	4 MB	B
7.15	5.67	600 × 300						✔	48 KB	48 KB	B
6.61	5.67	600						✔	64 KB	N/A	B
5.40	3.33	600 × 300						✔	48 KB	48 KB	B
6.66	6.67	360			Level II ($249)				4 MB	4 MB	B
6.60	6.00	300	✔		Level II		✔		4 MB	6 MB	B
8.11	8.33	600 × 300			Level II	✔	✔		8 MB	8 MB	B
7.86	8.33	300 × 600	✔		Level II	✔	✔		10 MB	14 MB	B
8.15	6.00	300			Level II ($249)				128 KB	128 KB	B

✔ = yes. [1] Enhanced PCL 5 includes HPGL2.

ROLL CALL OF PRINTERS TESTED

DOT MATRIX

VENDOR	MODEL	FCC CLASS	PROCESSOR/CLOCK SPEED (MHZ)	INTERFACES: AUTO-SWITCHING	CENTRONICS	RS-232C	RS-422A	LOCALTALK	ETHERNET
Advanced Matrix Technology	AMT Accel - 294d	B	N/A		✔	✔	✔		
Advanced Matrix Technology	AMT Accel - 535dsi	B	N/A		✔	✔	✔		
CIE America, Inc.	CI-5000 High Speed Printer	A	N/A		✔	✔			
Dataproducts Corp.	8524	B	N/A		✔	✔	$154		
Digital Equipment Corp.	LA600 MultiPrinter	B	N/A	✔	✔	✔			$999
Epson America, Inc.	DFX-8000	B	N/A		✔	Optional			
Epson America, Inc.	FX-1170	B	N/A		✔	$88			
Epson America, Inc.	DFX-5000+	B	N/A	✔	✔	✔			$499
Genicom Corp.	Model 3840EP	B	N/A		✔	✔	$131		Optional
IBM	IBM 4230/32 Printer	A	N/A		✔	✔	✔		$549
Mannesmann Tally Corp.	MT 360-2T	B	N/A	✔	✔	✔			
Mannesmann Tally Corp.	**T6082**	**B**	**N/A**	✔	✔	✔			
Okidata	Microline 395	B	N/A		✔	✔			

INK-JET

VENDOR	MODEL	FCC CLASS	PROCESSOR/CLOCK SPEED (MHZ)	INTERFACES: AUTO-SWITCHING	CENTRONICS	RS-232C	RS-422A	LOCALTALK	ETHERNET
Advanced Matrix Technology	AMT Intelli-Plot InkJet	B	N/A	✔	✔	✔			
C-Tech Electronics, Inc.	C.Itoh ProWriter CJ-300	B	N/A		✔	$29.95			
CalComp	TechJET Personal	B	N/A		✔				
Canon Computer Systems, Inc.	BJ-200e	B	N/A		✔				
Canon Computer Systems, Inc.	BJ-100	B	12		✔				
Epson America, Inc.	Stylus 1000	B	N/A	✔	✔				
Epson America, Inc.	Stylus 800+	B	N/A		✔				
Lexmark International, Inc.	IBM ExecJet II 4076	B	68000/10 MHz		✔	$119	$119		$699

LASER

VENDOR	MODEL	FCC CLASS	PROCESSOR/CLOCK SPEED (MHZ)	INTERFACES: AUTO-SWITCHING	CENTRONICS	RS-232C	RS-422A	LOCALTALK	ETHERNET
Alps America	LSX 1000	A	MC68EC030/20 MHz	✔	✔	✔			
Alps America	LSX 1600e	A	AMD29200/16 MHz	✔	✔	✔			
Apple Computer, Inc.	LaserWriter Select 360	B	AMD29200/16 MHz	✔	✔	✔		✔	
Apple Computer, Inc.	Personal LaserWriter 320	B	AMD 29205/16 MHz	N/A				✔	
C-Tech Electronics, Inc.	C.Itoh ProWriter CI-8Xtra+	B	LPC 8200/16 MHz	✔	✔	Optional			
Canon Computer Systems, Inc.	LBP-430	B	NS32CG16V/16 MHz		✔				
Canon Computer Systems, Inc.	LBP-860	A	i960/16 MHz	✔	✔	✔		Optional	
Citizen America Corp.	Citizen ProLaser 6000	B	CLC6000/12.9 MHz	✔	✔	✔			
Dataproducts Corp.	LZR 2080	A	LPC 8200/8 MHz	✔	✔	✔		✔	$695
Digital Equipment Corp.	DEClaser 1800	B	AMD29200/16 MHz	✔	✔	✔			
Digital Equipment Corp.	DEClaser 5100	B	i960/20 MHz;	✔	✔	✔	✔	✔	$399
Digital Equipment Corp.	PrintServer 17/600	A	On-Chip System/150 MHz						✔
Epson America, Inc.	ActionLaser 1500	B	68000/16.67 MHz	✔	✔	✔	Optional	$399	
Epson America, Inc.	ActionLaser 1600	B	Sparcite MB86930/17.6 MHz	✔	✔	✔	✔	$399	$499
GCC Technologies	SelectPress 600	B	AMD 29030/25 MHz	✔	✔	✔	✔	✔	✔
Genicom Corp.	Model 7170	B	NS32GS/25 MHz	✔	✔	✔	✔	$595	$545
Genicom Corp.	Model 7610	B	68030/20 MHz	✔	✔	✔			$545
Hewlett Packard Co.	**LaserJet 4M Plus**	**B**	**i960/25 MHz**	✔	✔	✔		✔	✔
Hewlett Packard Co.	LaserJet 4 Plus	B	i960/25 MHz	✔	✔	✔			$429 (includes LocalT…
Hewlett Packard Co.	LaserJet 4L	B	i960KA/ 18.5 MHz	✔	✔				$399
Hewlett Packard Co.	LaserJet 4ML	B	i960KA/18.5 MHz	✔	✔			✔	$399
Hewlett Packard Co.	LaserJet 4MP	B	i960KA/20 MHz	✔	✔			✔	$399
Hewlett Packard Co.	LaserJet 4P	B	i960KA/20 MHz	✔	✔				$399
Hewlett Packard Co.	LaserJet 4 Si	A, B	i960CF/25 MHz	✔	✔				$369
Hewlett Packard Co.	LaserJet 4 SiMX	A, B	i960CF /25 MHz	✔	✔			✔	✔
Kyocera Electronics, Inc.	Ecosys FS-1500 A	B	68000/16 MHz	✔	✔	✔		$199	$299
Kyocera Electronics, Inc.	Ecosys FS-3500 A	B	AMD29000/16 MHz	✔	✔	✔		$199	$299
LaserMaster Corp.	Unity 1600XL-O	A	Proprietary 66 MHz	✔	✔	✔		✔	✔
Lexmark International, Inc.	IBM 4037 5E	B	68000/10 MHz		✔	$119[a]	$119[a]		
Lexmark International, Inc.	IBM LaserPrinter 4039 12R Plus	B	AMD29200/16 MHz	✔	✔	✔		$299	10Base-T $439-$499
Lexmark International, Inc.	IBM LaserPrinter 4039 16L Plus	B	AMD29000/20 MHz	✔	✔	✔		$299	10Base-T $439-$499
NEC Technologies	Silentwriter 640	B	NEC Custom ASIC					✔	
NEC Technologies	Silentwriter Superscript 610	B	87C51/8 MHz		✔				
NewGen Systems Corp	Imager Plus 12	A	XL-8220/25 MHz	✔	✔	✔	✔	✔	$499
Okidata	OL 410e	B	Mips 3000/16 MHz	✔	✔	✔			
Okidata	OL410e/PS	B	Mips 3000/16 MHz	✔	✔	✔		✔	✔
Sharp Electronics Corp.	JX 9460 PS	B	AMD29005/16 MHz	✔	✔	$45		$96	
Sharp Electronics Corp.	Sharp JX-9400	B	68000/10 MHz		✔	$45			
Sharp Electronics Corp.	Sharp JX-9660PS	B	AMD29005/16 MHz	✔	✔	✔		✔	
Texas Instruments	microLaser 600	B	Proprietary/16 MHz	✔	✔	$49	$49	✔	
Texas Instruments	microLaser PowerPro	B	Proprietary/25 MHz	✔	✔	$49	$49	✔	$599
Xante	Accel-a-Writer 8200	A	AW8200/33 MHz	✔	✔	✔		✔	$395
Xerox Corp.	Xerox 4011	B	68302/16 MHz		✔	$99			
Xerox Corp.	Xerox 4505ps	B	AMD29200/16 MHz	✔	✔	✔	✔	$185	$499
Xerox Corp.	Xerox 4510ps	B	AMD29200/20 MHz	✔	✔	✔	✔	$185	$499
Xerox Corp.	**Xerox 4520ps**	**B**	**AMD29030/25 MHz**	✔	✔	✔	✔	**$185**	**$499**

COLOR

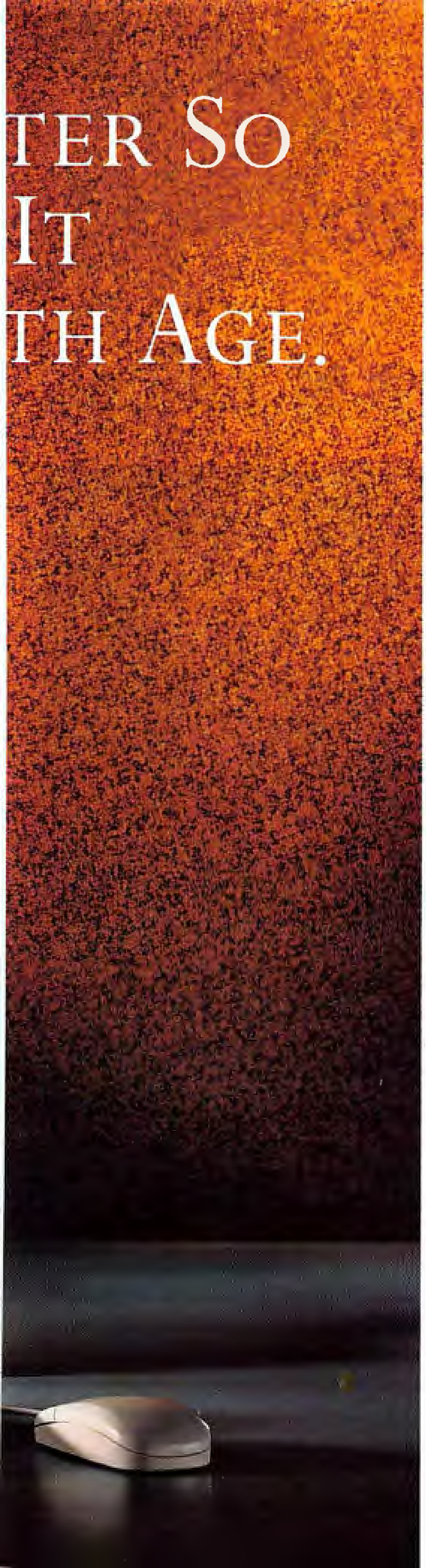
VENDOR	MODEL	PROCESSOR/CLOCK SPEED (MHZ)	INTERFACES: AUTO-SWITCHING	CENTRONICS	RS-232C	RS-422A	LOCALTALK	ETHERNET	TOKEN RING
Apple Computer, Inc.	Color StyleWriter Pro	N/A				RS-422			
Canon Computer Systems, Inc.	BJC-600	Motorola SC415850FC/16 MHz		✔					
Canon Computer Systems, Inc.	BJC-4000	Toshiba TMP96C141F/16 MHz		✔					
Dataproducts Corp.	Jolt PSe	8220/24 MHz		✔	✔		✔	VPT $770	
Digital Equipment Corp.	DECcolorwriter 1000	AMD29000/16 MHz	4	4				$379	
Digital Equipment Corp.	**DECcolorwriter 520ic**	**i80C186XL/20 MHz**		✔	**Optional**				
Epson America, Inc.	Epson Stylus Color Ink Jet Printer	N/A	✔	✔		✔	Optional		
Fargo Electronics, Inc.	Primera Color Printer	N/A		✔					
Fargo Electronics, Inc.	Primera w/ Photo Realistic Upgrade Kit	N/A		✔					
Fargo Electronics, Inc.	PrimeraPro Color Printer	N/A		✔		✔	✔	$500	
Fargo Electronics, Inc.	PrimeraPro Color Printer	N/A		✔		✔	✔	$500	
General Parametrics Corp.	Spectra*Star GT	i960ca/33 MHz	✔	✔	✔		✔		
General Parametrics Corp.	Spectra*Star GTx	Intel RISC/33 MHz	✔	✔	✔		✔	$695	
Genicom Corp.	Genicom 7025	N/A;		✔					
Hewlett-Packard Co.	DeskJet 540	68000/16 MHz		✔					
Hewlett-Packard Co.	DeskWriter 320	Zilog 84C01/8 MHz				✔	✔		
Hewlett-Packard Co.	DeskJet 1200 C/PS	Zilog 84C01/8 MHz	✔	✔			✔	$449	$699
Hewlett-Packard Co.	DeskJet 320	Zilog 84C01/8 MHz		✔			✔		
Hewlett-Packard Co.	DeskJet 560C	Zilog 84C01/8 MHz	N/A	✔					
Hewlett-Packard Co.	DeskWriter 560C	Z80/8-11 MHz		N/A		✔	✔		
Lexmark International, Inc.	IBM Color JetPrinter PS 4079	AMD29200/16.7 MHz	✔	✔	✔		✔	$549	$699
Tektronix	Phaser 200e	AMD 29000/16 MHz	✔	✔	✔		✔		
Tektronix	Phaser 220e	AMD29000/24 MHz	✔	✔	RS-232		✔		
Tektronix	**Phaser 220i**	**Proprietary/24 MHz**	✔	✔	✔	✔	✔	**$695**	
Texas Instruments	**microMarc color**	**i80C186XL/20 MHz**		✔					

= BYTE Best. ✔ = yes. N/A = not applicable. [a] Price includes RS-422.

		INPUT (SHEETS)		PAPER SIZES							INQUIRY
TOKEN RING	SCSI	BASE	MAXIMUM	LETTER	LEGAL	A4	11 X 17	ENVELOPE	TOLL-FREE PHONE	PHONE	NUMBER
		150	300	✔	✔	✔	✔	✔	(800) 992-2264	(805) 388-5799	1105
		150	300	✔	✔	✔	✔	✔	(800) 992-2264	(805) 388-5799	1106
		N/A	N/A	✔	✔				(800) 877-1421	(714) 757-4494	1107
		80	80	✔	✔	✔			(800) 980-0374	(818) 887-8000	1108
		180	360	✔		✔		✔	(800) 777-4343	(508) 493-5111	1109
		N/A	N/A						(800) 289-3776	(310) 782-0770	1110
		N/A	150	✔	✔	✔	✔	$Optional (102)	(800) 289-3776	(310) 782-0770	1111
		N/A	N/A	✔	✔	✔			(800) 289-3776	(310) 782-0770	1112
Optional		N/A	N/A	✔	✔	✔	✔	✔	(800) 436-4266	(703) 949-2441	1113
$699		660	660	✔	✔	✔			(800) 736-6268	(203) 849-6844	1114
		N/A	N/A	✔	✔	✔		✔	(800) 843-1347	(206) 251-5524	1115
		N/A	N/A	✔					(800) 843-1347	(206) 251-5524	1116
		N/A	N/A						(800) 654-3282	(609) 235-2600	1117
		100	200	✔	✔	✔	✔	✔	(800) 992-2264	(805) 388-5799	1118
		100	100	✔	✔	✔		✔	(800) 347-4017	(714) 573-4604	1119
		100	100	✔	✔	✔	✔	✔	(800) 932-1212	(714) 821-2000	1120
		100	100	✔	✔	✔		✔	(800) 848-4123	(714) 438-3000	1121
		100	100	✔	✔	✔		✔	(800) 848-4123	(714) 438-3000	1122
		100	100	✔	✔	✔	✔		(800) 289-3776	(310) 782-0770	1123
		100	100	✔	✔	✔			(800) 289-3776	(310) 782-0770	1124
$549		150	150	✔	✔	✔		✔	(800) 358-5835	(606) 232-2000	1125
		250	500	✔	✔	✔		✔	(800) 825-2577	(408) 432-6000	1126
		750	785	✔	✔	✔		✔	(800) 825-2577	(408) 432-6000	1127
		300	800	✔	✔	✔		✔	(800) 446-3000 x445	(408) 996-1010	1128
		100	100	✔	✔	✔		✔	(800) 446-3000 x445	(408) 996-1010	1129
		250	550	✔	✔	✔		✔	(800) 347-4017	(714) 573-4604	1130
		100	100	✔	✔	✔		✔	(800) 848-4123	(714) 438-3000	1346
		250	850	✔	✔	Option		Optional ($299)	(800) 848-4123	(714) 438-3000	1347
		150	400	✔	✔	✔		✔	(800) 477-4683 x77	(310) 453-0614	1348
	✔	250	850	✔	✔	✔	✔	Optional ($395)	(800) 980-0374	(818) 887-8000	1349
		150	400	✔	Optional ($69)	Optional ($69)		✔	(800) 777-4343	(508) 493-5111	1350
	120	350	850	✔	✔			Optional ($289)	(800) 777-4343	(508) 493-5111	1351
		1000	2000	✔	Optional ($115)	Optional ($115)		Optional ($445)	(800) 777-4343	(508) 493-5111	1352
		150	400	✔	✔	✔		✔	(800) 289-3776	(310) 782-0770	1353
		150	400	✔	✔	✔			(800) 289-3776	(310) 782-0770	1354
		250	650	✔	✔	✔	✔	✔	(800) 422-7777	(617) 275-5800	1355
$875		500	2000	✔	✔	✔		✔	(800) 436-4266	(703) 949-2441	1356
$875		250	500	✔	✔	✔		✔	(800) 436-4266	(703) 949-2441	1357
$619		250	850	✔	✔	✔		✔	(800) 752-0900	(415) 857-1501	1358
$619		250	850	✔	✔	✔		✔	(800) 752-0900	(415) 857-1501	1359
$619		100	100	✔	✔	✔		✔	(800) 752-0900	(415) 857-1501	1360
$619		100	100	✔	✔	✔		✔	(800) 752-0900	(415) 857-1501	1361
$619		100	250	✔	✔	✔		✔	(800) 752-0900	(415) 857-1501	1362
$619		100	250	✔	✔	✔		✔	(800) 752-0900	(415) 857-1501	1363
$619		1000	2000	✔	Optional ($129)	Optional ($129)		Optional ($480)	(800) 752-0900	(415) 857-1501	1364
$619		1000	2000	✔	Optional ($129)	Optional ($129)		Optional ($480)	(800) 752-0900	(415) 857-1501	1365
$499		250	1250	✔	✔	✔		Optional ($199)	(800) 367-7437	(908) 560-3400	1366
$499		250	1250	✔	✔	✔		Optional ($199)	(800) 367-7437	(908) 560-3400	1367
		250	650	✔	✔	✔	✔	✔	(800) 950-6868	(612) 944-9330	1368
		150	400	✔	✔	✔		✔	(800) 358-5835	(606) 232-2000	1369
$649-$699		200	800	✔	Optional ($349)	✔		Optional ($349)	(800) 358-5835	(606) 232-2000	1370
$649-$699		500	1100	✔	Optioanl ($349)	✔		Optional ($349)	(800) 358-5835	(606) 232-2000	1371
		200	200	✔	✔	✔		✔	(800) 632-4636	(508) 264-8000	1372
		50	200	✔	✔	✔		✔	(800) 632-4636	(508) 264-8000	1373
	✔	250	650	✔	✔	✔	✔		(800) 756-0556	(714) 641-8600	1374
		100	450	Optional	Optional ($89)			Optional ($89)	(800) 654-3282	(609)235-2600	1375
		100	450	✔	Optional ($85)			Optional ($149)	(800) 654-3282	(609)235-2600	1376
		250	250	✔	Optional ($70)			Optional ($157)	(800) 237-4277	(201) 529-8200	1377
		250	250	✔	Optional ($70)			Optional ($157)	(800) 237-4277	(201) 529-8200	1378
		250	500	✔	Optional ($70)	N/A		Optional ($157)	(800) 237-4277	(201) 529-8200	1379
	$149	250	500	✔	Optional ($89)	Optional ($99)		Optional ($109)	(800) 848-3927	(512) 794-5970	1380
	$149	250	500	✔	Optional ($89)	Optional ($99)		Optional ($109)	(800) 848-3927	(512) 794-5970	1381
		250	650	✔	✔	✔	✔	✔	(800) 926-8839	(205) 476-8189	1382
		250	550	✔	✔	✔		✔	(800) 275-93769 x4500	(716) 423-5090	1383
$699		300	800	✔	Optional ($85)	✔		Optional ($85)	(800) 275-93769 x4500	(716) 423-5090	1384
$699		300	800	✔	Optional ($85)	✔		Optional ($85)	(800) 275-93769 x4500	(716) 423-5090	1385
$699		751	2250	✔	Optional ($85)	Optional ($85)	✔	Optional ($595)	(800) 275-93769 x4500	(716) 423-5090	1386

	INPUT (SHEETS)			PAPER SIZES							INQUIRY
SCSI	BASE	MAXIMUM	SPECIAL PAPER?	TRANSPARENCIES	LEGAL	A4	11 X 17	ENVELOPE	TOLL-FREE PHONE	PHONE	NUMBER
	100	100	Rec./Not Req.	✔	✔	✔		✔	(800) 446-3000 x445	(408) 996-1010	1387
	100	100		✔	✔	✔		✔	(800) 848-4123	(714) 438-3000	1388
	100	100	Rec./Not Req.	✔	✔	✔		✔	(800) 848-4123	(714) 438-3000	1389
	200	200		✔	✔	✔			(800) 980-0374	(818) 887-8000	1390
	100	200		[4]		[4]			(800) 777-4343	(508) 493-5111	1391
	150	300		✔	✔	✔			(800) 777-4343	(508) 493-5111	1392
	100	100	Rec./Not Req.	✔	✔	✔		✔	(800) 289-3776	(310) 782-0770	1393
	50	50	Rec./Not Req.	✔	✔	✔			(800) 327-4622	(612) 941-9470	1394
	50	50	Rec./Not Req.	✔	✔	✔			(800) 327-4622	(612) 941-9470	1395
	50	50	Rec./Not Req.	✔	✔	✔			(800) 327-4622	(612) 941-9470	1396
	50	50	Rec./Not Req.	✔	✔	✔			(800) 327-4622	(612) 941-9470	1397
	100	200	Rec./Not Req.	✔		✔			(800) 223-0999	(510) 524-3950	1398
	100	200	Rec./Not Req.	✔		✔			(800) 223-0999	(510) 524-3950	1399
	50	50	Rec./Not Req.	✔		✔			(800) 436-4266	(703) 949-2441	1400
	100	100		✔	✔	✔		✔	(800) 752-0900	(415) 857-1501	1401
	1	60		✔	✔	✔			(800) 752-0900	(415) 857-1501	1402
	180	180		✔	✔	✔		✔	(800) 752-0900	(415) 857-1501	1403
	1	60		✔	✔	✔			(800) 752-0900	(415) 857-1501	1404
	100	100		✔	✔	✔		✔	(800) 752-0900	(415) 857-1501	1405
	100	100		✔	✔	✔		✔	(800) 752-0900	(415) 857-1501	1406
	100	100		✔	✔	✔	✔	✔	(800) 358-5835	(606) 232-2000	1407
	100	200	✔			✔			(800) 853-6100	(503) 682-7377	1408
	100	200	✔	✔		✔			(800) 853-6100	(503) 682-7377	1409
✔	100	200		✔		✔			(800) 853-6100	(503) 682-7377	1410
	120	120		✔	✔	✔		✔	(800) 848-3927	(512) 794-5970	1411

[4] Depends on ribbon type.



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VLIW Questions

Will VLIW mean "very long investment window" for Hewlett-Packard and Intel?

PETER WAYNER

Over the last 10 years, the notion of RISC made its way from the labs of computer architects to the word processors of the marketplace. Along the way, it brought great performance gains to the companies that invested in it (Hewlett-Packard, IBM, Mips, Motorola, Sun, and, to some extent, everyone else) and cemented itself as the guiding philosophy for microprocessor design. And now, just as RISC has won the mind-share war over CISC, along come Intel and HP to roil the waters.

The hot news in Silicon Valley is HP and Intel's announced plan to jointly design a new chip that will run both Intel x86 software and HP Precision Architecture code. Just as important, the companies describe the technology they plan to use as "post-RISC." Based on the fact that HP had already announced its interest in VLIW (very large instruction word) and that it has many engineers on-board from VLIW vendor Multiflow, informed opinion is that post-RISC equates to VLIW.

VLIW is a logical extension of RISC. Like a superscalar RISC processor, a VLIW machine executes several simple operations at a time. The difference is where you put the smarts to deal with the dependency issues that arise when you perform several operations in parallel. With VLIW, the smarts come from the compiler, which is responsible for packing many simple instructions into one long instruction word. VLIW compilers are responsible for determining which instructions depend on others. For instance, the compiler can put R1+R2->R3 and R4+R5->R6 together into the same instruction word, because they do not use the same registers. It cannot bundle R1+R2->R3 and R3+R4->R5 together because the second instruction needs to wait for the results of the first to be posted to R3.

What is VLIW?

VLIW (very large instruction word) describes an instruction-set philosophy in which the compiler packs a number of simple, noninterdependent operations into the same instruction word. When fetched from cache or memory into the processor, these words are easily broken up and the operations dispatched to independent execution units. VLIW can perhaps best be described as a software- or compiler-based superscalar technology.

The Parallel Question

VLIW is a new way to attack an old problem. Scalar RISC and CISC chips that employ pipelining have to deal with many of the same problems of inter-instruction dependency. Like VLIW compilers, compilers for pipelined processors try to rearrange code and spread out interdependent instructions so they do not follow each other down the pipeline. If this isn't done, the CPU must wait until the first instruction is finished before executing the second, and this delay largely destroys the value of the pipeline. The overriding difference between the approaches lies in which piece of the puzzle—the compiler or the chip—takes primary responsibility for instruction scheduling. Conventional technology says the chip does the final, real-time scheduling; VLIW says to leave that job to the compiler.

This debate was common in the mid-1980s when computer architects had to decide the next natural path to take to speed up basic RISC machines. At that time, heavily pipelined machines that handled dependencies in hardware were easier to build. VLIW machines required constructing multiple logic units to handle the extra instructions packed into a wider word. That meant committing a substantial piece of silicon real estate—especially if a logic unit had to handle something like integer multiplication.

Deep pipelines for RISC machines, on the other hand, can be built by finding a way to split up the stages of the computation into smaller stages. The basic tasks of fetching the information, decoding the instruction, performing the computation, and returning the value are natural choices for pipeline stages. These simple four-stage pipelined machines can, in theory, execute four times as many instructions as a nonpipelined processor can, as long as the interdependence between instructions does not delay the execution. The pipelined approach won out in the end because it was doable in the transistor budgets of the day. As evidence of this success, today you find some RISC processors whose pipelines have five or six stages.

As budgets increased, designers started putting multiple execution units on-chip—the superscalar approach—but left the work of handling most dependencies to hardware. They did this because one of the most important advantages to the hardware approach is that any code created for one generation of an architecture can still be used in the next generation, which might have a different, better pipeline or a different number and mix of functional units. Although such code might benefit from recompiling, the precise FIFO (first-in/first-out) ordering enforced a simple discipline that was easy to maintain across generations. This is a major issue in an age when people are still running software on the latest, greatest machines that was written for their original Macintosh or PC.

The Price We Pay

The cost of hardware scheduling and its inherent intergenerational flexibility is complexity. The decode/issue logic must be very intelligent to filter out problems created by running older code on a newer processor or by running scalar code on a superscalar processor. The number of transistors required to implement this level of intelligence is substantial—witness the complex instruction tracking mechanisms used in the PowerPC 620, the AMD K5, and the Mips T5, for example—and the time it takes to execute this work also adds significant overhead to the pipeline. Simpler decode and issue stages would permit clock rates to soar, as these stages normally have the longest latency in current superscalar and superpipelined processors.

This is the promise of VLIW: By removing complexity from the hardware, you create simple processors that let you increase performance far more simply than you can with current processors. On the one hand, simple hardware lets you increase clock speeds more aggressively than is possible with today's complex RISC chips. On the other, you can easily add more functional units to wring out all the parallelism that exists in your code.

If VLIW machines are to work well, they require smart compilers that are responsible for identifying which operations can run in parallel. This decision is made at compile time and frozen in place when the operations are packed into instruction words. In essence, the compiler makes many of the interference decisions that are currently made on the run by the decoding stage of a pipelined, superscalar processor.

VLIW TECHNOLOGY

PRO	CON
• The compiler handles instruction interdependencies.	• Very intelligent and complex compilers are required.
• Faster clock speeds are possible.	• The compilers work best when they are tuned to a specific microarchitecture.
• Added execution units don't increase the complexity of the processor.	• There is less flexibility in handling dynamic run-time events; there is no native software base.
• Similarities to CISC may provide better x86 performance.	

Compiler Imperatives

Is compiler technology ready for VLIW? There certainly has been no lack of research on the topic. For example, in the mid-1980s, IBM sponsored a research project to develop a test VLIW machine. The research-grade compiler used with it was able to find as many as 10 operations to run concurrently—and this was in nonscientific code. The compiler achieved this level of parallelism by unrolling loops and then percolating the operations up the path of instruction as far as they could go before they encountered interference.

More vexing are questions of adaptability. Although simplified decoding electronics leads to significant gains in speed, simplified decoders do not have the ability to adapt as well to dynamic run-time situations, such as those you encounter when a branch instruction executes. Even more important, because a VLIW compiler must know the details of the microarchitecture of a target chip, any code that it produces will run well only on the target chip. In a pure VLIW world, moving from one generation of a processor family to another one means that you have to recompile all your code.

It is possible to design an instruction set in which the number of instructions per word varies from chip implementation to chip implementation and that does not require recompilation. What is unknown is how much complexity this introduces in the processor implementations. Will maintaining binary compatibility across VLIW generations mean trading the devil we know—hardware scheduling—for one we don't know?

One thing is certain: History shows that users place a great deal of emphasis on binary compatibility. The initial success of sales of the Power Macs, Apple's RISC-based Macintosh systems, is in part due to the fact that these computers run existing CISC binaries. In fact, users accepted some loss in performance in exchange for binary compatibility and the promise of faster native applications down the road. Any planned VLIW implementation will have to take binary compatibility into serious consideration, despite the risks.

Why VLIW?

Given the unknowns, there is reason to wonder why HP and Intel chose to stake their CPU futures on VLIW. The key may be that the chips that come out of this agreement must be able to run Intel x86 CISC instructions and run them just as fast as, or even faster than, products from competing x86 vendors, such as AMD and Cyrix. One compelling viewpoint is that CISC instructions are essentially several RISC instructions bundled into one—that is, low-rent VLIW. The PUSH instruction, for instance, both accesses memory and decrements a pointer. VLIW provides a natural way to split up the CISC instructions into the basic RISC-like operations that would then be executed by the different logical units of the VLIW machine.

How to get there from here is unclear. If the chip devotes substantial resources to breaking up these CISC instructions, then it may be effectively introducing a large decoding operation that would nullify many of the reasons for using VLIW. The HP/Intel alliance might consider doing a one-time cross-compile for the x86 code that would do most of the translation ahead of time, but this would create substantial headaches for the base of installed software and users. Equally important, there is no indication as to how, in the brave new world of VLIW, the companies plan to make one generation of processors binary-compatible with the next. Finally, no one outside of HP and Intel knows how they plan to support three instruction sets (x86, PA-RISC, and native VLIW) on one chip.

The first fruits of the HP/Intel alliance won't be available until 1997 or 1998. Until then, questions will remain concerning the viability of VLIW as a mainstream commercial processor technology. The burden of proof is on HP and Intel. They say it can be done, but don't be surprised if Intel keeps a pure x86 project going on the side—just in case. ■

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Whither NextStep?

Next's proselytizing for object-oriented development may set the stage for Taligent and Windows NT

BRUCE F. WEBSTER

Version 1.0 of NextStep was released on September 18, 1989. At its first public showing 11 months earlier, Steve Jobs showed a slide to illustrate his theory that advances in operating-system technology tend to come every five years—thus, CP/M (1979), Macintosh (1984), and NextStep (1989). According to Jobs, as the new technology arises, the old one starts a slow glide downward, diminishing in influence and innovation, held back by its installed base and the need to maintain compatibility.

It's now 1994. NextStep has been arguably the most influential operating system of the last five years: widely envied, often imitated, seldom matched. It offered a true object-oriented environment with system foundation classes, a uniform imaging model, and a graphical interface builder in a time of MS-DOS 3.x, Windows 1.0, and Mac System 5.4. It has been cited as having the best user and development environments around. It has won awards and received glowing reviews. It currently runs on three platforms, with more to come, and the OpenStep effort may establish its concepts and technology as a standard.

What NextStep lacks is a significant number of users. After five years of sales, the total number of active NextStep seats—systems at which you can sit down today and use NextStep—is less than the number of new Mac systems sold each month or the number of new Windows systems sold each week. Lack of users means lack of income for Next; as important, it means scant revenue for NextStep VARs and third-party developers, which is prompting them to cut back on or abandon Next. For Next to succeed, it must convince potential customers to adopt NextStep—and that's the challenge it faces.

The State of NextStep

At the core of NextStep is a version of the Mach microkernel, which handles memory management, process management, and interprocess communications. It is buried within a Unix-derived operating system that is compatible with the BSD 4.3 release. On top of this sits NextStep itself, comprising Display PostScript, which provides a common imaging model for screen rendering, faxing, and printing; the Window Server, which manages the display, as well as user events and interactions; the Application Kit, an object class library for building NextStep applications, including user-interface objects; and Workspace Manager, the NextStep user interface.

The current NextStep, release 3.2, is available for Intel-based systems, Hewlett-Packard HP-PA workstations, and the original Next hardware. At this writing, release 3.3 was due out in November 1994 and should include a native SPARC-based version that can run on Sun workstations. Release 4.0 is due in 1995; it will adhere to the OpenStep API specification and have other enhancements. Beyond 4.0 is Mecca; its name is an intentional double pun, which plays off both Microsoft's Cairo and Next's market focus on mission-critical custom applications, or MCCAs.

Besides the user version of NextStep itself ($795), Next also sells the NextStep development tools ($2995); its PDO (Portable Distributed Objects) toolkit ($4995 to $9995) for developing NextStep-compatible server applications on plain-vanilla Unix systems; and a wide assortment of training and consulting services for object-oriented development. Next has also set up what it calls the Object Channel to distribute and sell software components developed by Next and third-party firms.

continued

Where Have All the Users Gone?

If NextStep is so wonderful, why isn't it used more widely? First, for a long time, NextStep was available only on Next hardware. Next hardware was, frankly, great stuff, but corporate America wasn't ready for a custom Unix workstation made by a small company. Next finally dumped the hardware and pushed NextStep out onto Intel-based systems, but that version has been available only since mid-1993.

Second, NextStep has high secondary costs. Besides its own stiff price tag, it has significant CPU, video, memory, and hard disk requirements: I recommend a 486DX with local-bus and/or accelerated video, 16 MB of RAM, and 300 MB of hard disk space for starters. For development, plan on double the RAM and hard disk capacity.

Third, because NextStep is targeted at mission-critical custom applications, corporations and government agencies that adopt it typically deploy a small number of seats for evaluation and development purposes. Once they complete the custom application, they typically deploy additional seats for end users, but most firms using NextStep have not reached that phase yet.

Fourth, NextStep tends to take over a desktop. You can run DOS and Windows applications via SoftPC (from Insignia Solutions), but users haven't been entirely happy with its performance and other constraints.

Finally, Next is not Microsoft, and NextStep isn't Windows. Nobody ever got fired for selecting Microsoft, but championing NextStep can entail a lot of risk.

The OpenStep Initiative

To broaden the focus and appeal of NextStep, Next has joined with SunSoft (a Sun Microsystems division) to create OpenStep, an object-based application environment standard derived from NextStep. OpenStep implementations sit on top of various operating systems, providing a standard API and set of facilities for custom and third-party applications. Any program written to the OpenStep API is supposed to be source-code compatible with any OpenStep implementation.

The OpenStep standard includes three major components: the Foundation Kit, which provides fundamental object classes; the Application Kit, which provides application and user-interface object classes; and Display PostScript, which provides a uniform, device-independent imaging system. The specification has been published, and any vendor is free to implement it for a given operating system. In practice, however, it is much easier to license the technology from Next.

Two OpenStep versions have been announced. First, SunSoft is doing a Solaris version and plans to bundle it with Solaris 2.3; the combination should ship in early 1995. All Sun workstations shipped after that release will have OpenStep on them; likewise, all Solaris upgrades to version 2.3 will get OpenStep.

Second, NextStep 4.0 itself will be OpenStep-compliant. Developers can then use the same source code for OpenStep and NextStep 4.0 (except for minor differences in direct calls to the operating system), because most NextStep applications have few direct Mach dependencies. For those that do, Next and SunSoft have published porting guidelines showing what matches exist between Mach and Solaris calls.

However, the API and architectural changes in OpenStep—including a new set of foundation classes and methods for creating and freeing objects—will require that current NextStep 3.x developers do significant rewriting of their applications to recompile them under 4.0. Next may offer scripts and other automated tools to help with the rewriting, but it will still be no easy task.

Taligent and Cairo/OLE

Having spent the last several years promoting and demonstrating the benefits of an object-oriented environment, Steve Jobs must be watching with some chagrin as Microsoft and the Taligent consortium—Apple, HP, and IBM—follow in the path blazed by Next.

Taligent is attempting to learn from Next's lessons. The TalAE (Taligent Application Environment) is designed to sit on top of any operating system meeting certain standards (e.g., 32-bit and preemptive multitasking). Versions of TalAE for OS/2, AIX, HP-UX, and PowerOpen have been announced, and Taligent has shown TalAE running on top of Windows NT. TalAE is thoroughly object-oriented and attempts to provide as many services as possible to applications, easing the development task.

Taligent is targeting the mission-critical market in corporations, where it could be a real threat to NextStep/OpenStep. The key issue deals more with business than technical superiority. Standing behind NextStep is Next, with support from SunSoft for OpenStep. Standing behind Taligent are Apple, HP, and IBM. For corporations making large commitments, the last three names carry much more weight than the first two.

Microsoft, for its part, is seeking to retrofit the Windows environment with object technology, or at least what it calls object technology. Few outside of Microsoft with significant training in object-oriented development would call OLE 2.0 object-oriented, since it lacks both key aspects of object-oriented technology (e.g., inheritance) and key benefits of object-oriented development (e.g., reusable code and faster development).

As for Cairo, beyond making some comments about an object-based file system, Microsoft remains vague about what truly object-oriented features the next major version of Windows NT will provide. The delivery date also remains in question. It has moved from mid-1995 to early 1996.

The very fact that Microsoft says it will do an object-oriented environment has frozen the decision making of many prospective NextStep/OpenStep (and, for that matter, Taligent) customers. Such is the influence of Microsoft.

What's Next for NextStep?

Regardless of its technical merits, and regardless of the fact that it will be in its fourth major release before version 1.0 of TalAE or Cairo ever ships, NextStep faces a continuing uphill battle for acceptance. The OpenStep effort will ease, but not eliminate, these challenges. Next's best chances probably lie in emulating Taligent: moving OpenStep into as many operating systems as possible and lining up major partners for distribution and backing.

On top of all its other troubles, NextStep is five years old. If Jobs' theory of operating-system cycles is correct, NextStep should be starting on the downward slope, with some new technology rising to replace it. That advance may be Taligent, it may be Cairo, or it may simply be Chicago, dominating through installed base and application support. Or it may be NextStep itself, reborn through OpenStep. Even if NextStep does decline, its legacy and influence will be felt for years to come, but that may be small comfort to those who have poured their lives into it. ■

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Power Mac Code Optimizations

Understanding this RISC system's run-time architecture will let you write faster native applications

TOM THOMPSON

Apple's move to RISC computing is embodied by its new line of PowerPC-based Macintosh computers, the Power Macintoshes. These computers have been fine-tuned to obtain the best performance out of the PowerPC RISC processor, while also being able to run the existing Mac software base, written as CISC code for the 680x0 processor (from now on, I'll use the term 68K to denote this processor). The Power Mac has a robust 68LC040 emulator that not only executes such 68K applications but also handles with aplomb most Control Panels and Extension software that heavily patch the operating system.

This ability to use the existing base of 68K software was crucial to the Power Mac's survival in two ways. First, not many folks would buy a faster computer if it meant scrapping the huge investments made in 68K applications software. More important, the Power Mac OS requires the emulator to execute portions of its own operating system. Approximately 85 percent of the ROM code responsible for implementing the Mac API—collectively known as the Mac Toolbox—is still 68K code, drawn from the ROMs of 68040-based Quadra systems. To improve system performance, portions of the operating system (e.g., QuickDraw, the Font Manager, the Memory Manager, the numeric libraries, and parts of the Resource Manager) were written in "native" (i.e., PowerPC) code. Making these key sections of the Mac OS native boosted system performance where it was needed. A special Mixed Mode Manager transparently mediates the processor context switch between the emulated 68K processor environment and the PowerPC processor environment. The result is a RISC computer that not only hosts 68K applications and Extensions but is stable, is reasonably fast, and was shipped in early 1994.

The emulator musters decent performance in most situations, on average about that of a 25-MHz 68040. By "going native," or recompiling the application so that it exists as PowerPC code, better performance is possible because the application spends less time in the emulator. However, the emulator can't be kept out of the picture completely, because of the 68K Toolbox code. As the thread of execution hops from emulator to PowerPC and back, the overhead of the Mixed Mode Manager's context switches degrades performance. However, although this overhead can't be eliminated, it can be reduced by a careful understanding of what's occurring at any given moment in the Mac OS. What I'll cover here are the performance pitfalls you might encounter because of the Mac OS's unique nature.

Improving Math

With regard to floating-point performance, the PowerPC processor excels because it has a built-in FPU that supports both single- and double-precision IEEE 754 floating-point computations. If your Mac application makes heavy use of floating-point math, you'll want to take advantage of this PowerPC feature. It involves a few changes to your application code, which I'll explain in a moment. The reason for the change lies in the original Toolbox support for this type of calculation. Floating-point calculations and trigonometric functions were supported via an API known as SANE (Standard Apple Numeric Environment). SANE either communicates to a math coprocessor if the Mac has one or calls the appropriate math library if it doesn't. Programmers simply declared floating-point variables to be `extended` and made calls to SANE without worrying about the hardware.

Apple implemented SANE as native code on Power Macs to support those 68K applications that use it. However, the SANE interface uses the same 68K trap mechanism as the other Toolbox calls, so the Mixed Mode Manager exacts a performance hit. On a Power Mac 8100/80, SANE cranks out the performance of a 25-MHz 68040. This is adequate performance for emulated 68K programs, but native applications obtain far better performance by directly using the PowerPC processor's floating-point instructions. You do this by calling the floating-point functions found in the header file `fp.h`. These functions follow the FPCE (Floating-Point C Extension) specification, which defines support for IEEE 754/854 floating-point calculations. As a developing standard, the use of these function calls should ensure cross-platform compatibility at a future date. With these functions, your program calls the PowerPC math instructions in-line, rather than taking a trip to the Mixed Mode Manager, perhaps into the emulator, and back. It's important to note that PowerPC's single-precision floating-point values are 32 bits in size (for type *float*), and double-precision values are 64 bits (for type *double*). These are smaller than the 80- and 96-bit values used by SANE's `extended` variable

Polling the Event Manager—A Sample Listing

```
while (FSRead(input, &amount, &buffer) == noErr)
  {
  Decompress_Data(&buffer, &pointerToMem, expandedBytes);
  pointerToMem =+ expandedBytes;
  WaitNextEvent(everyEvent, &gmyEvent, SHORT_NAP, NO_CURSOR);
  } /* end while */
```

type. If necessary, you might have to modify your program code to compensate for this loss in precision.

Data Alignment

The PowerPC processor handles memory accesses differently than the 68K processor. The 68K processor readily accesses data of any size (byte, word, and longword) at even memory addresses. However, accessing anything larger than a byte at an odd address on a 68K processor produces the much-beloved address-error bomb box. The 68K compilers typically add padding bytes at certain points in a program's data structures to ensure that the data remains aligned on even addresses (i.e., word-aligned).

The PowerPC processor favors memory accesses that correspond to the data's size: It accesses bytes at every address, words (16 bits) at every even address, and longwords (32 bits) at every address divisible by four. The PowerPC handles memory accesses at any address (thus, no bus errors), but doing so requires extra bus cycles. These extra bus cycles result in a performance hit each time unaligned data accesses are made. Similar to 68K compilers, PowerPC compilers pad a program's data structures to achieve an alignment that minimizes the bus cycles required to access the data.

However, data that's optimally aligned for the PowerPC might result in data that's not word-aligned for the 68K processor. This creates a serious problem when you're working with data that gets handed to an emulated Toolbox call. If you're creating data structures that you expect a 68K-based Mac to use, whether the data is read from a file or passed through a network, it had better be word-aligned or you'll crash these systems. Unless you're writing a special high-performance Power Mac application, the numbers require that you take care of your 68K Mac users.

Now that you're aware of the dangers and promise of data alignment, what do you do about it? First, most compilers provide a `#pragma` statement so that you can indicate what type of data alignment the compiler should use. If you snoop around in the Mac Toolbox header files, you'll see that those data structures used by the Toolbox are bracketed with the statements `#pragma options align=mac68k` and `#pragma options align=reset`. The first directive enforces 68K word alignment for the data structure, and the second lets the compiler resume the use of the preferred PowerPC data alignment for your program. The Mac header files quietly perform this sleight of hand for any of the Toolbox calls you use.

The general rule that emerges is this: If you're declaring data destined for the Toolbox or for a program on a 68K Mac, then word-align the data by using the `#pragma` directives. If the data is used exclusively by your application, then let the compiler arrange the optimal data alignment for the PowerPC processor.

Timed Event Manager Call—A Sample Listing

```
/* Modify for desired time interval */
#define NEXT_EVENT_CHECK_INTERVAL  10;

startTime = LMGetTicks();          /* Get starting ticks value */
while (FSRead(input, &amount, &buffer) == noErr)
  {
  Decompress_Data(&buffer, &pointerToMem, expandedBytes);
  pointerToMem =+ expandedBytes;
  nextTime = LMGetTicks();         /* Get ticks again */
  if ((nextTime - startTime) > NEXT_EVENT_CHECK_INTERVAL)
    {
    WaitNextEvent(everyEvent, &gmyEvent, SHORT_NAP, NO_CURSOR);
    startTime = nextTime;          /* Set up start of new interval */
    } /* end if */
  } /* end while */
```

Reduce Mode Switches

As mentioned earlier, the Mixed Mode Manager helps 68K code and PowerPC code to coexist and execute on a Power Mac. The penalty for this versatility is a performance hit, as the Mixed Mode Manager massages the stack to set up and tear down the context-switch frames between two disparate processor environments. Again, these switches are unavoidable because most of the Toolbox code is emulated, and applications make heavy use of these calls. However, it is possible to reduce the frequency of Toolbox calls at certain points in the application to minimize the effect of the Mixed Mode Manager.

For example, suppose the file I/O function in your program is reading and decompressing data. You want your program to be a good, cooperative, multitasking neighbor, so in this function, you have a Toolbox call that reads a buffer of data, calls a function that processes the data, and then calls the `WaitNextEvent()` Toolbox routine so that processor time is given to other applications (see the listing "Polling the Event Manager"). When the program is compiled as a native program, an unexpected result occurs. As native code, the decompression function runs much faster, so `WaitNextEvent()` is called more frequently. Unfortunately, the `WaitNextEvent()` routine (as well as any other Event Manager routine) is emulated Toolbox code. Therefore, as the I/O loop runs faster, the Mixed Mode Manager intervenes more often. The result is that the performance gain achieved by the native code can be whittled away by the overhead of two processor context switches each time `WaitNextEvent()` gets called and returns.

The solution is to not call `WaitNextEvent()` or other Toolbox routines indiscriminately within a processing loop. Instead, call the accessor function `LMGetTicks()`, which returns elapsed system time as ticks, where *ticks* represents an interval of one-sixtieth of a second. Use the ticks value and a little code to compute a time interval that determines when to call `WaitNextEvent()` (see the listing "Timed Event Manager Call"). In summary, don't poll the Event Manager routines when doing lengthy processing. Instead, make the Toolbox call only after a specific amount of time has passed. This way, the processing loop remains in native code and performs more work during the fixed time interval, yet `WaitNextEvent()` gets called just often enough so that other programs can run smoothly. This arrangement keeps the Mixed Mode Manager overhead at a fixed level, even when the code runs on Power Macs with faster (100 MHz or more) and more-powerful processors (such as the PowerPC 604).

This is only a partial list of what you can do to avoid unexpected performance hits when you retool your application as native code. Keep in mind that Apple will implement more of the Toolbox as native code, which will improve system performance and make your job easier. ■

Tom Thompson is a BYTE senior technical editor at large. 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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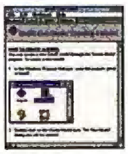

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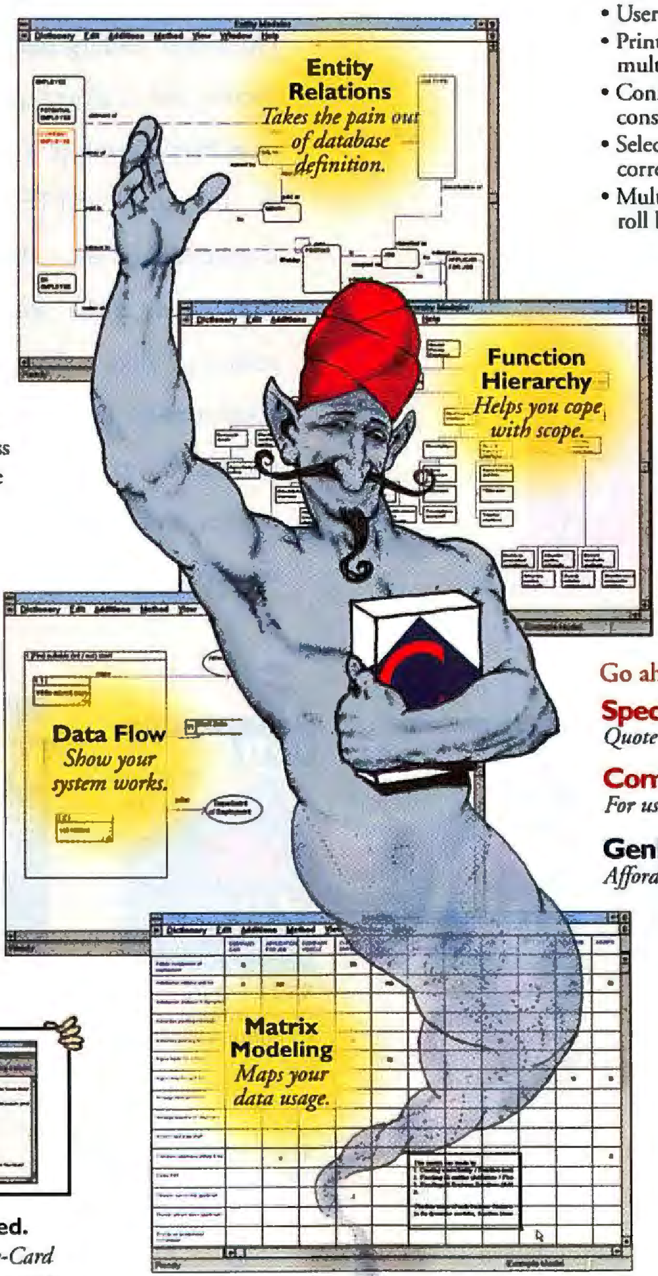

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Running the Frame-Relay Race

Know the ups and downs that await you when implementing this low-cost LAN-to-WAN connection

MICHAEL MCPARLAND AND ETHAN WILANSKY

In the fast-evolving WAN connectivity market, frame-relay technology is a winner for most network managers seeking an effective way to link remote LANs. A circuit-switching technology derived from the ISDN standard, frame relay uses digital rather than analog lines. Additionally, it avoids the error-correction overhead of the older X.25 standard. The result is fast and affordable data transmission.

Frame relay is a connectionless, best-try protocol. This makes it ideal for LAN traffic, which transmits data in bursts at low bit error rates.

When expensive WAN circuits are used, frame relay optimizes the cost-to-bandwidth ratio by working on the principle of *bandwidth on demand*, which uses the circuit efficiently and reduces delays by automatically increasing bandwidth during bursts of activity. Also, unlike other fast-packet schemes, frame relay employs variable-size frames to maximize bandwidth. And since it requires a single WAN card for multiple connections, frame relay decreases CPE (customer premises equipment) costs. (For details on frame-relay hardware and protocols, see "Faster Packet Networks," November 1991 BYTE.)

THE FRAME-RELAY ADVANTAGE

RELIABILITY

As an all-digital technology, frame relay avoids the transmission problems of older analog circuits and the user intervention required for modem connections.

PERFORMANCE

Packets don't have to carry the addressing, flow-control, and error-correction data required for switching over hybrid networks. As a result, frame relay is up to 20 times faster than the older, analog-to-digital X.25 standard.

SINGLE-LINE ACCESS

You don't have to maintain separate point-to-point circuits, each with its own LAN and WAN hardware.

Why Frame Relay?

Frame relay has three main advantages: reliability, performance, and single-line access. As a digital technology, it is inherently more reliable and provides a higher level of user transparency than traditional asynchronous modem links.

Circuit-switching frame relay is also more efficient than packet-switching technologies such as X.25, because it doesn't require error correction. This streamlining is accomplished by removing OSI (Open Systems Interconnection) layer 3 error-correction algorithms used by X.25. Instead, error correction is handled by the DTE (data terminal equipment) at either end of the link. The DTEs work at the data-link layer (layer 2) to provide flow control, addressing, and error correction. All nodes along the frame-relay network can drop bad packets, but only the end points or DTEs can request retransmission. Error correction is effectively kept off the network, freeing it for fast-packet transmission.

Another advantage of frame relay over other WAN access methods is its ability to handle multiple data sessions over a single access line. For instance, our employer, U.S. Generating, an independent power producer based in Bethesda, Maryland, uses a 512-Kbps access line with two incoming 256-Kbps connections and five incoming 56-Kbps connections.

Single-line access means less hardware. Before the frame-relay implementation, USGen had multiple point-to-point circuits, each requiring separate WAN and LAN hardware and dedicated circuits. Frame relay allowed us to reduce hardware and circuit requirements to one T1 pipe with seven sites on the WAN.

Frame relay's success is also due in part to its scalability. Once T1 access to the carrier is established, you can implement the service at lower bandwidths (e.g., 112 Kbps) and increase it to 1.544 Mbps (T1 speed) by progressing through bandwidth "jumps" as your organization's needs change.

Mastering Implementation Issues

Once you've made the decision to install frame-relay circuitry, it's important to choose networking hardware and communication protocols that can handle future demands. As network traffic increases with multiple protocols, multiple PVCs (permanent virtual circuits, or fixed logical channels between DTEs on the network), and more people accessing the WAN, it is best to set up routing for intelligent packet filtering, dynamic traffic control, and fault tolerance. Together, these can minimize avoidable congestion. At USGen, we use the TCP/IP protocol suite for SNMP management and the IPX/SPX protocol suite for connectivity to Novell NetWare.

Choosing a vendor from among the dozens that offer frame-relay service can be difficult. It is particularly hard to compare WAN carriers' service suites. Each provider has its own pricing plan and network implementation. You should look for a vendor with reliable service, an acceptable network, and competitive pricing. An acceptable network has quality switching equipment and is engineered to meet a growing demand for frame-relay service.

continued

Visiting the frame-relay network control center is a good way to assess a provider's equipment and service.

"Sizing" the Network

Making decisions about circuit bandwidth is called *sizing the network*, and it is far from a science. At USGen, we tested our point-to-point 56-Kbps circuits to determine how much bandwidth was appropriate for frame relay. We knew that our current bandwidth was unacceptably slow for file transmission, E-mail, and SQL client/server requests. To verify this, we executed SQL calls, file transfers, and program executables over the 56-Kbps circuits, recording the number of characters transmitted and received at our Microcom bridge.

Using these transmission rates as a basis, we hoped that engineers at frame-relay providers could tell us what bandwidth would reduce the latency (the interval between channel requests and availability) by two to three times. The best they could provide were educated guesses, since there is no direct correspondence between bandwidth and latency. Our best guess was 256-Kbps access to development offices and 56-Kbps access to power plant sites.

Glossary of Frame-Relay Terms

Bandwidth on demand
The ability to jump to higher bandwidths automatically as network traffic increases.

Committed information rate (CIR)
The minimum bandwidth guaranteed by an access vendor.

Channel service unit (CSU)
A modem-like device that terminates the digital channel at each customer site and handles certain line-monitoring functions.

Data terminal equipment (DTE)
The terminals or computers at either end of a frame-relay link.

Discard eligible
A packet bit that notifies the network that the frame was transmitted above the CIR, making it eligible for discarding during congested periods.

Permanent virtual circuit (PVC)
Fixed logical channels between DTEs connected to the network.

Point of presence (POP)
The place where the frame-relay access provider's lines connect to the local phone company's lines.

Choosing Vendors

Bridge/router equipment varies only subtly from vendor to vendor. One possibly meaningful distinction is the level of service and technical support the vendor provides during and after implementation.

CSUs (channel service units), which are the high-speed modem-like devices required to interface DTEs to the network, have become commodity products. There are two buying ranges: $300 to around $595, and $595 to $750. Lower-priced CSUs have less reliable power supplies, so cutting corners here can be dangerous.

Once you've made these hardware decisions, you must pick an access vendor to provide the connection from your company location to the frame-relay provider's POP (point of presence). Access costs vary depending on the distance to the POP. Our site in Syracuse, New York, is close to the POP, and the total 56-Kbps circuit cost is $300 per month. At our remotely located site in Indiantown, Florida, the POP is relatively distant, raising the monthly cost to $550.

Traditionally, access to a carrier's POP was available only through the local phone company. But the situation has started to change in recent years as competitors have entered the market.

A good POP access arrangement will have a redundant link to access circuits. With this feature, if one leg of the circuit fails, the provider immediately cuts to the redundant link without interrupting service. This feature is not standard with BOC (Bell Operating Company) access lines but can be purchased at extra cost.

Carrier Choices

Frame-relay carriers provide customers with access to the public network, commonly referred to as a *network cloud*. Pricing seems to be the distinguishing factor among the carriers.

Of the three major carriers—AT&T, MCI, and Sprint—we chose Sprint because of its creative Zero K CIR pricing plan, which is used by 99 percent of Sprint's frame-relay customers. The CIR (committed information rate) is the network bandwidth guaranteed by the carrier. With any carrier's CIR offering, any frames above the CIR will be flagged as *discard eligible*, which means they may be dropped from transmission during periods of network congestion. With a Zero K CIR, all packets are discard eligible.

However, if the carrier's network is not designed to handle more capacity than current activity dictates, congestion will occur and frames will be discarded. Sprint's network is designed to maintain 30 percent extra capacity. This allows all subscribers to simultaneously burst to port speed without losing frames. Practically speaking, then, it is a waste of money to pay for CIR if the network has extra capacity to handle peak demand.

Sage Advice

If you are upgrading your current WAN implementation to frame relay, check with your hardware vendor to determine upgrade costs. Upgrading our prior point-to-point bridge/router equipment allowed USGen to convert to frame relay without losing our prior investment in CPE. The additional costs were minor: To migrate to frame relay, we spent $1600 for an upgraded WAN card in the bridge/router and $199 for a simple software upgrade.

Make sure all CPE is approved for the carrier's network. If problems occur in bringing up the service, be prepared for the usual finger-pointing when more than one vendor is involved.

When pricing frame-relay service, make sure you understand how access hardware relates to port speed. If port speed increases above 56 Kbps, T1 access is required, at roughly three times the cost of a 56-Kbps line.

Don't be surprised if you encounter reliability problems with the local access loop. We experienced repeated circuit loss with local access loops at our Bethesda and Jacksonville sites. We resolved the problem by demanding that the access vendor test and troubleshoot its portion of the service. In Bethesda, we asked that our local loop be rerouted onto another high-speed digital trunk because the initial routing had been causing intermittent circuit loss.

Finally, expect a built-in delay before new frame-relay links are activated. We find that it takes approximately 45 days' notice before a carrier activates a new link.

Frame relay is an excellent choice if you are seeking a reliable, flexible, and cost-effective solution for interconnecting remote networks. If you research carefully and consider thoroughly your current and future data access needs, you can easily find an effective way to build an enterprise-wide network. ■

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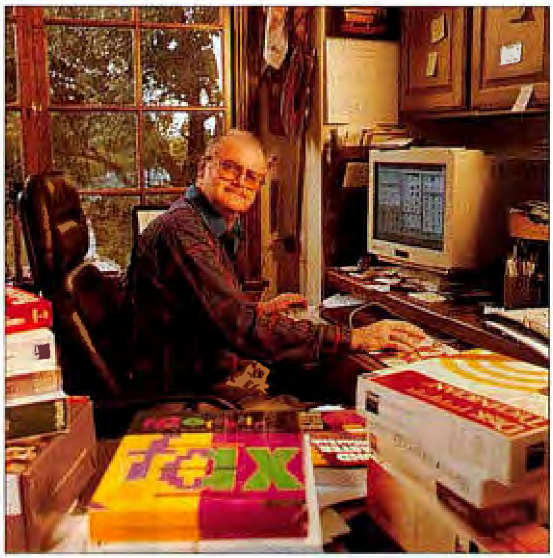
JERRY POURNELLE

A Look to the Future



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After visits to some computer giants, Jerry discusses several major trends he sees in the industry. He also looks at new fax devices, CD-ROMs, and modems.

I've just finished a week talking to Microsoft and IBM, and I'd like to tell you about the future. Alas, that doesn't mean I can tell you what's going to happen, any more than Denver can tell you when they'll be able to open their new airport. It seems their new automated baggage system doesn't work, and it appears to be software. At $30 million a month, that's a lot of software costs. We very much live in interesting times.

Now that was an old Chinese curse, but it's what I'd call a mixed cursing: there are advantages to living in interesting times. Karl Marx said that a sufficient quantitative change becomes a qualitative change; thus, Lenin thought you could create the new Soviet man. That didn't work, but as hardware and software capabilities grow without any limit in sight, we get something very like the Marxian transformation of quantity into quality. Example: three years ago, there simply could not have been a program like Myst. No one would have thought to try it. In another year, it will be the standard.

We're also seeing distributed computing with a vengeance. The special effects on the science fiction show *Babylon 5* are created with a network of 40 Amigas, and they're simply unparalleled in TV. In another few years, that quality will be the standard, and *Jurassic Park*–quality simulations will be common.

I see several major trends in the industry. The first is easy: more and more power in smaller machines. Until recently, the PowerPC was merely a way to make your Mac applications run slower, but that's changing even as I write this. A splendid example is Adobe Photoshop. It comes with both 680x0 and PowerPC native code, figures out which it's running on, and chooses the proper code set. That means it comes fat, but there are remedies for that, too. Apple has clearly put a lot of thought into making it inviting to write applications for Power Macs.

There will be more of that. I expect within five years—and I won't be astonished if it's less than half that—to see a PowerPC system capable of running Apple System x, Unix, OS/2, DOS, Windows, and NextStep applications all on the same machine, and allow some communication between those applications. The first of those machines will be expensive, but that won't last.

This means that the operating-system wars will be quite important for Microsoft, IBM, and some other companies, but not so much for users. There will also be some consolidations in the user interface. Quarterdeck Office Systems' SideBar for Windows is a good candidate: it is easy to learn, has enough functions to get the job done, and is small enough to be easily ported to other graphical interfaces (see my October column).

The second major trend is object-oriented software. I have seen demonstrations of Microsoft OLE 2, and it's wonderful. You can take program "objects" from a variety of sources and link them together so they operate as a new program, or even a new kind of program.

For example, one program object may know how to go out on a modem and gather stock-market information. Another one can take that information and stuff it into a database. A third can take selected database information and put it into a spreadsheet. A fourth examines the spreadsheet data for trends and passes that information to a fifth object, which makes predictions and records them in the original database. All this is watched by a neural-network object, which is looking for the best predictions.

Given the required program objects—and many of them are already available—you could build the program I described in a matter of days. The objects might have been written in C++, Modula-2, Visual Basic, Pascal, or COBOL; as long as they follow the published OLE 2 specifications, it won't matter, because you'll never see their source code. The only code you'd write would be the control links, and that can be done in Visual Basic or whatever language you want to use, including some programming tools that don't look like "languages" at all. You see the objects as a series of shapes with inputs and outputs and then connect them with drag-and-drop operations.

The OLE 2 demonstration I saw on the Microsoft campus wasn't quite that elaborate, but it was close, and I was much impressed.

Microsoft has become so enthusiastic about object-oriented programming that newcomers can be excused for thinking Microsoft must have invented it. That distresses IBM, because one of the reasons they give for saying OS/2 is superior to both Windows and Chicago is that IBM understands object-oriented programming and built OS/2 around the object concept.

Of course, IBM didn't invent objects either. I'm not sure who did; but the concept of code blocks reusable without new compilation has long been advocated by Niklaus Wirth, was partially implemented in Pascal, and is very much at the heart of both Modula-2 and Wirth's latest system, Oberon. For that matter, the ability to use a few lines to link up chunks of code to build complex new programs was what made Wirth's Lilith such a wonderful programming environment.

I've seen demonstrations of OLE 2. I've seen less of OpenDoc, IBM's answer to OLE 2. Everyone familiar with OpenDoc, though, says it will be completely compatible with OLE 2, but it will have more features and a better developers' interface to make it easier to program. That's important, and we'll get back to it.

The third major trend grows out of the first two: feature wars. We already see them in games. For example, OutPost describes features in the manual that they simply didn't manage to implement, presumably because of great pressure to ship it. MicroProse Software's XCOM: UFO Defense has several horrible bugs that must have been encountered in testing. I suppose they had no suspicion that XCOM, which they acquired from the British company Mythos Games, would become a best-seller (and very likely the Chaos Manor game of the year) and thus warrant the necessary investments in bug hunting.

The good news is that object-oriented programming lets you add features without adding bugs by incorporating thoroughly tested objects, either ones you previously wrote or from an outside source. I don't suppose I will live to see programs without bugs, but at least the trend is in the right direction.

Donkey's years ago when I began these columns, the most important people in the industry were programmers who could teach the machines how to do things. I predicted that wouldn't last: that there would come a time when it would be far more important to think up interesting things for the computer to do. That has happened.

Centuries ago, the mere ability to read and write made you an important person. You might have nothing original to say, but you could always get a job as a temple scribe or palace clerk. Over the years, literacy became fairly common (alas, no longer can you say universal). Consequently, *what* you write is what counts. I said back then there would be a time when the ability to "write programs" would be nearly as common as the ability to read and write human languages, so that *what* you could teach the machine would be what counts. Object-oriented programming takes us much closer to that time.

OLE will generate as big a change in the way software is produced as did the change to interactivity from batch processing. The process has already started. Cruise through the Internet, and you'll find hundreds of public domain and shareware objects, some questionable, some extremely useful. Often they're available with source code, and they get modified, tested, and put back up for distribution. That will continue.

Finally, everyone seems agreed that the next big computer market will be in home systems. Many companies—Microsoft prominent among them—are reorganizing into home and business system divisions. That may not be wise. I agree that the straight business market is somewhat saturated, so that replacement sales outnumber new system sales; but I'm not at all sure that's true of the home-business market.

As federal regulations make it more and more expensive to hire people, the trend toward part-time work, consulting, and independent contracting will accelerate. We'll thus see a consequent expansion of people who work as contractors from home offices. They're going to need computers, not only to do their consulting work but also to keep books that satisfy the IRS that they really are independent consultants; and they'll probably need expert systems with frequent rule updates to keep them square with the EEOC, OSHA, EPA, HUD, and whatever other outfits the Congress sees fit to send to "protect" them. Presumably, the Congress doesn't need protection, since it exempts itself from all those laws, so it may not need as much computing power as the average citizen will.

And we certainly do live in interesting times.

Today we had an adventure. Chip Hilts, industry pioneer and an old friend, had an appointment to show me his new Fax<HQ software. I had forgotten he was coming.

I was late getting in on the fax revolution. For years, I simply didn't bother. People would come show me new fax boards. They seemed like ways to slow down my system. When I decided I needed a fax system, I got a standard low-cost thermal-paper system and put it in an unused area under the stairs. It has its own telephone line, and it works just fine. If we want to send something, we put in the paper, dial the number, push a button, and walk away. That means I have to print a paper copy, and I have to put up with those curly thermal papers that fade. I always knew I would one day have to put in something better.

I've long been an admirer of the Intel Satisfaxtion board, which has an on-board coprocessor, but where would I put it? I don't want anyone else using my main system, so I can't put it there. I concluded that what I needed was a way to install the Intel board in a machine accessible by the network, and I'd begun fooling around with programs that would work under Windows for Workgroups. Meanwhile, Alex had just installed NetWare on a Gateway 2000 486DX2/50 and hooked that into the Ethernet daisy-chain that runs my W4WG network. I'd been told that it's easy to get NetWare and W4WG running together, and we were about to do that when the earthquake hit.

In addition to throwing most of my books, bookcases, computers, and software into a pile and dumping the fish tank on top, the earthquake made a real mess in the cable room. That's the small room in which I keep all my tools and spare cables. It has its own air-conditioning unit, and it's also the home of the Cheetah 386, the machine that runs the Pioneer New Media Technologies DRM-604X CD-ROM drive and the optical drive for the W4WG network, and the Gateway 2000 486DX2 NetWare server.

The Cheetah sits under a desk and came through just fine. It came back up all by itself when the power was restored. The Gateway got dumped on the floor and was covered with paint cans, tools, cables, the entire disk recycling bin, and heaven knows what else. The machine itself didn't look damaged when we dug it out, but it no longer had a monitor. I kept promising myself I'd get the NetWare network started up again, but I kept putting it off. After a while, the poor Gateway got buried as more stuff got "temporarily" stored in the cable room. That was the situation when Chip Hilts and John Hammill arrived.

Fax<HQ lets you set up any machine, such as an older 386, and turn it into a "fax server" usable by anyone on a NetWare network. Alas, my NetWare server was in the cable room under piles of junk, and none of my systems were set up to use NetWare anyway.

Thus, the adventure of hacking my way into that cable room to rescue the Gateway, set it up, find it a monitor, and then turn it on.

It booted up, trundled, and John, who is Headquarters Software's technical director, announced that NetWare had come up just fine. Now all we needed was a system with an Ethernet board and a Satisfaxtion board to be the fax server. I looked around and spied the little AST Bravo, another machine put on hold because of the general mess from the earthquake. It already had an Intel EtherExpress network board, so all we had to do was install Satisfaxtion.

That went well, so while John set up the network, I attacked the cable room. I'd actually got about 3 cubic feet of cables untangled and coiled when he announced that NetWare was running with W4WG, and it was time to install Fax<HQ.

The rest is anticlimax. Fax<HQ installed itself on the Gateway that acts as the NetWare server and on the AST Bravo that became our fax server. We then went over to Pentafluge (the Pentium system) and made it a NetWare client and told it about Fax<HQ. As it happens, I needed to send a fax to NASA headquarters anyway, so I called up Word for Windows, composed the fax, used Word's Print Setup to tell it to print to the fax server—it sees that as a possible "printer" device—and sent it on its way. While I was at it, I sent copies to a couple of people and sent a text fax to my own system downstairs.

It worked like a charm.

Fax<HQ will certainly take care of the fax needs of most small- to medium-size network establishments. It will answer the phone, store incoming faxes on disk, and make them available to the appropriate users. It stores and logs outgoing faxes and sends them by priority or at specified times. It will send to lists. It maintains phone books. If you have a lot of users, it's fairly inexpensive per user. The neat part is that the server does all the work—your personal workstation isn't time-sharing with anyone, including yourself. Fax<HQ is available now.

Meanwhile, Microsoft and Ricoh have a different approach. They will soon introduce Microsoft WinWriter: a laser printer that has its own CPU, hard drive, network card, and fax capability, including a scanner. It will work with W4WG (and presumably NetWare). It prints, accepts paper or electronic input directly or through the network, and seems to promise most if not all the things Fax<HQ does. Of course, it costs more. but it won't need a dedicated PC and Satisfaxtion board.

I suspect that within a couple of years, you'll have a wide choice of laser printers that will also work as a networkable fax server.

We also have single-user fax systems, which come with various fax modems. Probably the best known (and my favorite) of these is Delrina Technology's WinFax, which is available stand-alone or bundled with modems like those from Supra and Macronix. It's pretty good on DOS as well as Windows. There's also QuickLink, which comes with U.S. Robotics and some other modems; its Windows capability is all right, but I'm not fond of its DOS performance.

Still, any of these are good enough. Add a good low-cost scanner, such as Logitech's ScanMan, and they can be used with both electronic and paper inputs. With a bit of ingenuity and a program like Norton PC Remote or Artisoft's Network Eye, any of those can be set up on their own dedicated machine and controlled remotely. You'll be happier with a real network and something like Fax<HQ or the Microsoft/Ricoh system, but for single users, a good data/fax modem and its accompanying software will do the job for a while.

For years, the telephone and the small computer have looked at each other without communicating, but now the needs of electronic commuters are changing all that. Another sign that we live in interesting times.

Although I was late getting into the fax revolution, I've been using modems since the mid-1970s. Modem capabilities grew slowly for years, but now they change by leaps and bounds. The latest ones we have at Chaos Manor are a pair of U.S. Robotics Courier Dual Standard V.34 Data/Fax modems. U.S. Robotics advertises that these modems will automatically communicate at the fastest possible rate and says "just plug it in and forget it."

I did that. On one machine, I replaced an earlier U.S. Robotics modem with the new one, and on another I replaced an AST modem. Then I called what I call "the modems from hell," a number of nodes I have real problems getting connected to, such as one Tymnet node in Washington, D.C. The new U.S. Robotics modems connected up just fine, although because of the need for frequent retries, the actual throughput to the 9600-bps node in Washington was closer to 1500 bps. I can actually send and receive data faster to an alternate 2400-bps number there. Still, it worked, and nothing I've ever tried before has done so.

My opinion on modems hasn't changed much since last year. If you want trouble-free communications, get the latest and greatest U.S. Robotics external modem, plug it in, and forget it. I say external because there are times when you really do need the little flashing lights, and sometimes the only way to get out of a goofy on-line situation is to physically turn off the modem.

When I travel, I generally put the latest and greatest Supra external modem and its power unit into my checked luggage. Supras aren't as absolutely reliable in making an error-correcting connection as the U.S. Robotics modems, but they are much smaller. My typical experience is that I may have to try three or four times to get a Supra to lock on properly on a particularly noisy line, while a U.S. Robotics modem never requires more than two tries. Of course, with normal connections, you can't tell the difference between them.

I'm still evaluating ultralight modems such as the Macronix PCMCIA-card modem. I haven't been able to make it work with every portable that has a PCMCIA slot, but that seems to be a driver problem, which is getting taken care of. When the Macronix modem does work, it's quite good at normal lines, but you can have problems locking in when there's a lot of line noise.

I'm in the process of testing some new portables and modems, so I'll have more on this another time.

On the subject of portables, Phillip continues to send us E-mail from aboard the USS *Tripoli* in the Persian Gulf. He's got one of Zenith's classy new color portables (it's a lot nicer than any portable I have just now), and he sure loves it. A full report on that when he gets back. Certainly, anyone with a relative in the Navy will look forward to a time when E-mail can regularly connect to ships at sea.

The CD-ROM explosion continues. There are commercial products everywhere, and many are splendid. I'll get back to those.

Another vital use for CD-ROMs is in academic and scientific publication. Many extremely important but highly technical journals have small circulations and consequently are very expensive to produce in traditional print media. The CD-ROM not only allows them to be produced at reasonable costs but also to include a great deal more supporting data. A single CD-ROM can contain years' worth of information.

continued

Example: Lightbinders now publishes a number of professional journals, including the *Journal of Biological Chemistry*, on CD-ROM. The costs to professional societies are kept down, more information goes out in a form that makes it easy to retrieve and search, and the whole world benefits.

On the home front, Microsoft has hundreds of highly motivated people producing CD-ROMs. Microsoft believes that for many people their first computer experience will be with a CD-ROM on a home computer. They want that experience to be positive, and they're willing to spend a lot to make it so.

They spent millions getting their Encarta multimedia encyclopedia right, and it shows. The Dangerous Creatures CD-ROM, produced with the help of the World Wildlife Federation, lets you see through a cheetah's eyes, watch rattlesnakes wrestle, and visit lionfish. The Ancient Lands CD-ROM brings ancient history to life. Dinosaurs is self-explanatory. Kids of all ages will love these. I expect what will happen is that parents will buy them for their home. When the kids get tired of them, they'll give them to schools. For that matter, kids may swap them.

I've previously reviewed some of the Microsoft music CD-ROMs. They also have a sports series. I'm not a baseball fanatic, but one of my boys is.

While we're on Microsoft's home division, I should mention some of their non-CD-ROM products. I'm not an arcade-game player, but Larry Niven is addicted to Centipede. It comes in the Microsoft Arcade (for Windows) package that includes Missile Command and a couple of others, and has turned out to be a surprise best-seller. There's a whole bunch of other stuff, and if you haven't seen the Microsoft Home Software Catalog, it's worth while getting one.

Microsoft has the resources to do things right, and they use the new object-oriented programming methods to add features while keeping down the bugs. They seem determined to set new standards for home-use software. I'm all for that.

I couldn't review every CD-ROM worth looking at if I used the whole column, but it's worth listing some more just to show how far things have gone. I have in front of me, in no particular order, the Microsoft Developer Network CD-ROMs; developers would be well advised to sign up for those as they come out. I have Knowledge Media's Language\OS Resource Library, a CD-ROM with about 100 computer languages and operating systems, including Oberon, ICON, Forth, Ada, Amoeba, and a whack of a lot more. Compilers, interpreters, libraries, you name it; if you play with code, you'll want this.

I've got the Xiphias Timetables of History Series, which includes Arts & Entertainment; Science & Innovation; and Business, Politics, & Media. They're the ones who did the The Way Things Work series I mentioned a couple of months ago. Worth looking into.

I've got more dinosaur CD-ROMs than you can shake a fossil at. Microsoft's is the most interesting, but I suppose the most complete is Smithsonian Institution Dinosaur Museum published by Software Marketing in conjunction with the Smithsonian Institution. It has maps and detailed information on collections. It also comes with 3-D viewing glasses for those who like that sort of thing.

Incidentally, I'm reliably informed that the movie *Jurassic Park* really did incorporate the latest and best theories of how dinosaurs looked and acted. They think they got sizes and shapes and motions right. They had to guess about the colors.

Here's Smartek's WordSmart for Windows CD-ROM; it's part of a series for building vocabulary from first grade to college level. This one has about 5000 words. Like most of these self-help systems, you'll get no more out of it than you put in, and few of them are particularly self-motivating. If you want to increase your vocabulary, this is less painful than most methods.

Then there's geography. Software Toolworks has a new edition of their World Atlas. DeLorme publishes their detailed U.S. map CD-ROM, called Street Atlas USA, with maps of just about every city and town in the country.

And finally there's a new edition of Microsoft Bookshelf, the one that started it all by putting *Roget's Thesaurus*, *Bartlett's Quotations*, *Columbia Desk Encyclopedia*, *American Heritage Dictionary*, and a partridge in a pear tree on one CD-ROM;

it's still the single most useful one I have.

That's all in this stack, but I can see five other stacks just as interesting that are on the other side of the room. If you don't have a CD-ROM drive, you're missing a lot. Double-speed drives are now available for under $150.

BYTE reader Troy Brooks reports that when he installed his new Creative Labs' Sound Blaster sound and CD-ROM system, he got snaps, crackles, and pops instead of cool sound. Since he'd bought the company's high-quality Yamaha speakers, this wasn't thrilling. It was a while before he discovered that his problem was his video card: one of the first of the Hercules Graphite 2-MB VLB cards. The BIOS was out of date. That got updated and the problems went away. Brooks is quite pleased with the technical support he got from both Creative Labs and Hercules Computer Technology.

My favorite backup system is DAT (digital audiotape) controlled by Palindrome's Network Archivist software; it's the system I recommend for people who just can't afford to lose their data or work. It's expensive, but you can get 2 GB on a $15 tape bought in a record store, so all the expense is in the tape drive. Ours is external, which means we can carry it over to the Mac and use it there, too.

The Colorado Memory Systems Jumbo 250 tape drive is a good choice for those who are waiting for prices to drop before buying a DAT drive. The most popular size is 250 MB. The tape drive itself is about the size of a cigar box. There are also internal versions, but the external one is handy for transferring data to another machine. The unit connects to your existing floppy drive controller (another version, the Colorado Trakker, connects to the printer port with a parallel cable). You can also buy a version that comes with its own high-speed controller card.

Alex has installed Jumbo backup units on a number of systems for clients and reports that about 85 percent of the time there's nothing to it: follow instructions, run the software, and Bob's your uncle. If that doesn't work, you need to understand things like IRQ (interrupt request) and port addresses, so one of Pournelle's laws applies here. If you don't know what you're doing, be sure you buy from someone who does.

Colorado Backup for DOS comes with the Jumbo 250. There's also enough software to allow you to back up and retrieve under Windows. If you want to do something more complex, however, such as automatic scheduled backups, you'll need to buy Colorado Backup for Windows 2.0, the company's more advanced Windows backup program.

If you don't have a backup system or you're still backing up to floppy disks, you're taking needless chances. The Colorado Jumbo 250 and Colorado Trakker tape drives don't cost much, and you can rely on them. Recommended.

Murphy's Law says that whatever toolkit you carry will lack the one tool you need. I don't guarantee that won't happen even if you carry the Kludgewerks Kludge-Kit, but for something that fits in your breast pocket, this is pretty good. Among its tools are screwdrivers, pliers with side cutters, a chip puller, and a little gripper gizmo that will retrieve the screw you dropped down between two slots. There's also some glue, adhesive-backed Velcro, and even a couple of inches of heat-shrink tubing. The case is leather and smells like a new car.

This thing was designed by someone who got tired of having to go back for tools and wanted something that could be carried around. It's neat.

Many academic institutions have one and only one person who knows how to put mathematical papers into the Tex (pronounced "tech"; the *x* is a Greek chi) format demanded by most scientific journals. Tex is a great PDL (page-description language), but no one ever claimed it was easy to learn.

Comes now Scientific Word from TCI Software Research, which accepts input about the way you'd expect and outputs in Tex; and nearly anyone can learn how to use it. It works. You'll still have to write your mathematics or physics paper, but at least you won't have to wait for someone else to format it. Not everyone will need this, but if you need it, you need it bad.

It took a while to get it tuned up, but I'm having a love affair with Pentafluge, the Pentium built up from a PC Power & Cooling tower case, a Micronics Computers M5Pi motherboard, a DEC 3107 1.05-GB digital hard drive, and a Maxoptix T3-1300 1.3-GB optical drive. It has long been connected into the W4WG network; now it's part of the NetWare setup as well. I'll have a lot more on the joys of NetWare another time.

Pentafluge uses a Distributed Processing Technology SmartCache III SCSI controller to run the hard and optical drives, but we had originally let the motherboard controller run the floppy drives. Last week, Alex tried to add a video features board to the system so we could play with the little VideoLabs Flexcam camera. We got an odd result: the video board worked fine, but the floppy drives stopped working. However, if we removed the Intel EtherExpress board, the floppy drives would work again.

We looked for address and IRQ conflicts, but we never figured out what was wrong. Instead, we solved the problem by allowing the SmartCache III to run the floppy drives as well (like most advanced motherboards these days, the M5Pi has software-configurable IDE and floppy drive controllers; we just turned both off).

While we were at it, we installed another 8 MB of SmartCache error-correcting memory (for a total of 12 MB, probably wretched excess, but it makes saving in XCOM: UFO Defense *fast*). Not only did that solve the problem, but it speeded up the floppy drives something wonderful.

We generally think of high-end machines as intended for business, but games actually make the greatest demands on small computers. I'm quite fond of Origin's Wing Commander and its sequels, but when I'm flying a space mission against the Kilrathi and find myself in an asteroid field with half a dozen enemies, keeping track of all those rapidly moving objects in three dimensions takes a lot of computing power. There aren't many sequences that can noticeably slow SuperCow, the Gateway 2000 486DX2/66, but a few in Origin's Privateer game can do it. I haven't found anything that makes Pentafluge look slow, except Video for Windows—which should be fixed Real Soon Now.

I'm sure Intel will sell a lot of Pentiums to businesses, but I bet they sell even more to game fanatics.

The book of the month is by James Dunnigan and Raymond Macedonia, *Getting It Right: American Military Reforms After Vietnam* (Morrow, 1993). It's a good account of how the Army went from Vietnam to Desert Storm, readable but with plenty of detail. It's not as complete on what the Air Force did. I like to think that Possony and Pournelle's *Strategy of Technology*, which was a text in the Air Force Academy and War College during some of the critical years, had some influence on Air Force weapons and doctrine. That's a quibble, though; Dunnigan has done an excellent job, as usual.

Several computer books this month. First, a whole series on CD-ROMs published by Mecklermedia. *Government CD-ROMs*, edited by John Maxymuk, is subtitled *A Practical Guide to Searching Electronic Document Databases*, and that's a good description: it looks at a dozen agencies, describes the kinds of data to be found, and goes into your rights under the Freedom of Information Act. They also have books on games and entertainment on CD-ROM and a series on the Internet. Meckler has a deserved reputation for high-quality technical books.

The PowerPC Macintosh Book by Stephan Somogyi (Addison-Wesley, 1994) is an understandable discussion of what RISC machines are and how they're different from what we're used to. The book assumes the reader is intelligent but fairly new to computers. Old hands may skip past some of the introductory-level discussions, but I guarantee there's something here for everyone. Recommended.

The game of the month remains for now

MicroProse Software's XCOM: UFO Defense, and once again, fair warning: this thing is addictive.

Now that we've got NetWare running with W4WG, I'll be doing a lot of experimenting with the joys of full networks—including Macs and OS/2. IBM is bringing out a new version of OS/2 Network, which I ought to get to this month. Now I'm off to moderate a session at the annual meeting of the American Psychological Association. Roberta will be one of the speakers at my session. ■

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. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on the Internet or BIX at jerryp@bix.com.

For More Information

The **Colorado Jumbo 250** ($199) and **Colorado Trakker 250** ($399) tape drives don't cost much, and you can rely on them. If you want to do more complex backups, you'll need to buy **Colorado Backup for Windows 2.0** ($49.95), the company's more advanced Windows backup program. Contact **Colorado Memory Systems, Inc.**, Loveland, CO, (800) 845-7905 or (303) 669-8000; fax (303) 667-0997. **Circle 1146 on Inquiry Card.**

If you want trouble-free communications, get the **Courier Dual Standard V.34 Data/Fax** ($795). Contact **U.S. Robotics, Inc.**, Skokie, IL, (800) 342-5877 or (708) 982-5010; fax (708) 982-5235. **Circle 1147.**

Fax<HQ will take care of the fax needs of most small- to medium-size network establishments (standard package with one copy of Fax<HQ Gateway Fax Server software and 25 copies of the Fax<HQ client module, for a total of 27 users, $1295; Expansion Kits to add 25 users, $695). Contact **Headquarters Software, Inc.**, Pleasant Hill, CA, (510) 284-2877; fax (510) 284-3238. **Circle 1148.**

Putting professional journals, such as the **Journal of Biological Chemistry** ($790; CD-ROM, $65, available only to subscribers or members of the society), on CD-ROM keeps the costs to professional societies down and gets more information out in a form that is easy to retrieve and search. Contact **The American Society for Biochemistry and Molecular Biology**, Bethesda, MD, (301) 530-7154; fax (301) 571-1824. **Circle 1149.**

For something that fits in your pocket, the **Kludge-Kit** ($39.95) is a good toolkit. Contact **Kludgewerks, Inc.**, St. Louis Park, MN, (800) 477-6751 or (612) 925-1534. **Circle 1150.**

If you play with code, you'll want Knowledge Media's **Language\OS Resource Library** CD-ROM ($34.95). Contact **Knowledge Media, Inc.**, Paradise, CA, (800) 782-3766 or (916) 872-3826; fax (916) 872-3826. **Circle 1151.**

Microsoft spent millions getting their **Microsoft Encarta** ($99.95) multimedia encyclopedia right, and it shows. The **Dangerous Creatures** CD-ROM ($59.95) lets you see through a cheetah's eyes and watch rattlesnakes wrestle. The **Ancient Lands** CD-ROM ($59.95) brings ancient history to life. I think Microsoft's **Dinosaurs** CD-ROM ($59.95) is the most interesting one on dinosaurs. Larry Niven is addicted to the Centipede game, which comes in the **Microsoft Arcade for Windows** ($34.95) package that includes Missile Command and a couple of others. If you haven't seen the **Microsoft Home Software Catalog**, it's worthwhile getting one. Developers would be well-advised to sign up for the **Microsoft Developer Network CD-ROMs** (single-user license, $40; Level 1 annual subscription, $195; Level 2, $495) as they come out. There's also a new edition of **Microsoft Bookshelf** ($69.95)); it's still the single most useful one I have. Contact **Microsoft Corp.**, Redmond, WA, (800) 426-9400 or (206) 882-8080; fax (206) 883-8101. **Circle 1152.**

My favorite backup system is DAT controlled by **Network Archivist** ($1695) software. Contact **Palindrome Corp.**, Naperville, IL, (800) 288-4912 or (708) 505-3300; fax (708) 505-7917. **Circle 1153.**

Not everyone will need **Scientific Word** (corporate/government, $495; educational, $395), but if you need it, you need it bad. Contact **TCI Software Research**, Las Cruces, NM, (800) 874-2383 or (505) 522-4600; fax (505) 522-0116. **Circle 1154.**

The most complete dinosaur CD-ROM is **Smithsonian Institution Dinosaur Museum** ($59.95). Contact **Software Marketing Corp.**, Phoenix, AZ, (800) 545-6626 or (602) 893-3377; (602) 893-2042. **Circle 1155.**

The **Software Toolworks World Atlas 5** ($59.95) is the new edition. Contact **Software Toolworks, Inc.**, Novato, CA, (800) 234-3088 or (415) 883-3000; fax (415) 883-3303. **Circle 1156.**

Street Atlas USA ($169) contains maps of just about every city and town in the country. Contact **DeLorme Mapping Co.**, Freeport, ME, (800) 227-1656 or (207) 865-1234; fax (207) 865-9291. **Circle 1157.**

The **Timetables of History Series** ($39.95 each) is worth looking into. Contact **Xiphias Corp.**, Los Angeles, CA, (800) 421-9194 or (310) 841-2790; fax (310) 841-2559. **Circle 1158.**

If you want to increase your vocabulary, the **WordSmart for Windows** CD-ROM ($64.95) is less painful than most methods. Contact **Smartek Educational Technology, Inc.**, La Jolla, CA, (800) 858-9673 or (619) 456-5064; fax (619) 456-3928. **Circle 1159.**

SINGLE-PASS GRAPHICS AND IMAGING SCANNER

The JX-330 flatbed color scanner from Sharp Electronics provides clear color registration and fast scanning by using Sharp's patented process of strobing three colored fluorescent bulbs in a single-pass scan. The JX-330 provides true 600-dpi scanning in 16.7 million colors, 256 shades of gray, or black and white; a full-color letter-size page scans in about 45 seconds. The Mac- and PC-compatible unit's built-in support for TWAIN lets you scan directly from any TWAIN-compliant software. Optional units for scanning transparencies, 35mm slides, and 4- by 5-inch chromes are CCD-based with resolutions of up to 2400 dpi through interpolation. An optional 50-page automatic document feeder is also available. The base unit's retail price is $1499; transparency options start at $1000; the ADF is $495.

Contact: Sharp Electronics, Mahwah, NJ, (800) 237-4277 or (201) 529-9593.

Circle 1315 on Inquiry Card.

ROAM OVER TO THE NETWORK

The DaynaComm Roamer cordless PCMCIA network adapter ($699) is based on Xircom's Netwave spread-spectrum, frequency-hopping radio technology. The adapter uses the 2.4-GHz bandwidth and has a roaming range of 150 feet. From Dayna Communications (Salt Lake City, UT), the Roamer has a data transmission rate of 1 Mbps; it connects directly through a PowerBook 500 PCMCIA expansion module and consists of a Type II PCMCIA card and a small integrated antenna.

Phone: (801) 269-7349.

Circle 1318 on Inquiry Card.

HIGH-CAPACITY TAPE DRIVE

The plug-and-play Backpack 3010 tape drive ($599) ships with Windows and DOS backup software. The drive attaches via your computer's parallel printer port; with its 400-foot tape, it has a native data capacity of 340 MB, which is extendable up to 680 MB with compression. Transfer speed of the Micro Solutions (DeKalb, IL) drive is rated at up to 9 MB per minute.

Phone: (800) 890-7227 or (815) 756-3411.

Circle 1319 on Inquiry Card.

IR FAX MODEM ▼

A wireless PCMCIA fax modem, the Airplex Model 2705 ($499) uses diffuse, omnidirectional infrared technology to eliminate the cord connection between your PCMCIA fax modem and indoor phone jack.

From K and M Electronics (West Springfield, MA), the Model 2705 lets you move as far as 1000 feet away from the jack and remain connected to the phone line. The unit supports up to 14.4-Kbps operation and provides access to public networks, E-mail servers, printer servers running modem-server software, fax machines, and other computers with modems.

Phone: (413) 781-1350.

Circle 1320 on Inquiry Card.

RECORD ON CD

Available for the Mac, Windows, DOS, and Unix, the PlayWrite 4000 ($5995) is a turnkey multiformat 4X CD-R (CD Recordable) system. From Microboards of America (Carver, MN), the system comprises a Microboards 4X CD-R drive, Dataware Technologies' CD-Record software, blank media, a SCSI cable, and customer support from National Computer Systems.

Phone: (612) 448-9800.

Circle 1321 on Inquiry Card.

THINKPAD FLEXIBILITY

A 515-MB hard drive for selected models of the IBM ThinkPad 360, 750, and 755, the QED/TP750-540 ($1295) gives multiple users of the same ThinkPad secure and separate storage. From Sigma Data (New London, NH), the easily installed drive lets you dedicate an entire drive to a specific application or operating system.

Phone: (800) 446-4525 or (603) 526-6909.

Circle 1322 on Inquiry Card.

GET THE LATEST WEATHER ON YOUR PC

A third-generation weather satellite demodulator with software that can run under Windows or DOS, the OFS WeatherFax PCMCIA Convertible (from $495) uses Carrier Peak Sampling technology for noticeably sharper satellite images. From OFS WeatherFax (Raleigh, NC), the PCMCIA Type II card acquires weather satellite pictures directly from all polar-orbiting and geostationary satellites and HF Marine fax when attached to the audio output of an SSB or VHF receiver. Enhancement tools allow you to obtain cloud and sea surface temperatures. You can view images as they are transmitted and save them as TIFF, GIF, or BMP files.

Phone: (919) 847-4545.

Circle 1323 on Inquiry Card.

READ THE HANDWRITING ON THE MONITOR

PenDirect for Windows ($298) is a desktop conferencing system that lets individuals in different locations simultaneously communicate with one another by using direct, on-screen input. From FTG Data Systems (Stanton, CA), PenDirect uses the company's light pen and Future Labs' TalkShow Duo desktop point-to-point conferencing software. Participants can interactively review any document, schematic, spreadsheet, CAD design, or bit-mapped picture in real time. Each user's comments are color-coded.

Phone: (800) 962-3900 or (714) 995-3900.

Circle 1324 on Inquiry Card.

MPEG 1 PLAYBACK

A real-time video and audio MPEG 1 playback card for the PC, VicPlayer ($349) decodes an MPEG 1 bit stream from a standard CD-ROM or hard drive. It provides simultaneous 24-bit motion-video playback and 16-bit stereo audio at up to 48 kHz. From Vic Hi-Tech (El Segundo, CA), the card is compatible with NTSC, VGA, and S-Video at 30 frames per second and PAL at 24 fps; it can send the video to a TV, VCR, or VGA monitor.

Phone: (310) 643-5193.

Circle 1325 on Inquiry Card.

SCAN, FAX, OR PRINT

Scan-by-Fax ($149.95) lets you convert any fax machine into a multipage scanner or printer. From Infinity Computer Products (Norristown, PA), the multisheet-feed device scans images at the maximum resolution of your fax machine without requiring outside phone lines or batteries. It connects between your PC and fax machine and can scan unattended. OCR software bundled with the unit includes applications for E-mail.
Phone: (610) 539-9494.
Circle 1326 on Inquiry Card.

COLOR X TERMINAL

Human Designed Systems' (King of Prussia, PA) ViewStation LX14C X Window System terminal ($1099) ships with 4 MB of RAM and a 14-inch color monitor. Based on RISC architecture, the terminal lets X client applications run inside the terminal, improving their performance. Bundled software includes OSF/Motif and Open Look window managers, DEC VT320 and IBM 3270 emulation, and a PostScript display application. Options include PCMCIA slots for local storage via flash PROM or hard drives.
Phone: (800) 437-1551 or (610) 277-8300.
Circle 1327 on Inquiry Card.

SPARC-BASED WORKSTATION

Sparcstation 5–compatible, the SWS5/85 ($3495) is based on MicroSparc II technology and offers an upgrade path to the SparcStation 20. From Integrix (Newbury Park, CA), the modular unit ships with an 85-MHz processor and 24 KB of cache. It has 16 MB of internal RAM, three 32-bit SBus expansion slots, and a 64-bit AFX graphics bus. Options include a 644-MB double-speed internal Photo CD–ready CD-ROM.
Phone: (800) 300-8288 or (805) 375-1055.
Circle 1328 on Inquiry Card.

CROSS-PLATFORM REMOTE LINK SERVER

The PPP-based TribeLink server ($1995) lets remote Mac, PC, and Unix users conduct eight simultaneous dial-in sessions to AppleTalk and TCP/IP networks over standard phone lines at speeds of up to 57.6 Kbps. From Tribe Computer Works (Alameda, CA), the server provides a set of security features, SNMP management, dial-out and LAN-to-LAN routing, and use of existing modems.
Phone: (800) 778-7423 or (510) 814-3900.
Circle 1329 on Inquiry Card.

POWER HAMMERS

The most recent of FWB's (San Francisco, CA) SledgeHammer disk arrays, the 8.2-GB SledgeHammer 8200FMF Wide ($9399) and SledgeHammer 8200FMF II ($9999) and the 17.4-GB SledgeHammer 17400FMF Wide ($14,299) combine fast SCSI-2 or fast and wide SCSI-2 storage with the company's Raid ToolKit. MatrixRaid technology lets you configure a single array to perform simultaneous fault-tolerant mirroring and high-speed data striping on different partitions. The arrays are compatible with Macs, Power Macs, and SCSI Manager 4.3.
Phone: (415) 474-8055.
Circle 1330 on Inquiry Card.

INTERACTIVE CONFERENCING TAKES ON A VOICE

A document-conferencing system, the HP OmniShare lets two people in different locations share graphics, text, and handwritten information while they are speaking on the telephone. Data and voice are transmitted simultaneously across the same standard phone line. You can load your documents into the notebook-size tablet directly from your PC or via any standard fax machine or modem. With an electronic pen, you can then annotate the bit-mapped image of the document that appears on the tablet's screen, writing and viewing each other's comments in real time. You can flip through pages and rotate or zoom in on graphics; later, you can print the annotated documents on your printer or fax machine. The $2595 unit stores up to 500 pages.

Contact: Hewlett-Packard, Santa Clara, CA, (800) 322-4772.
Circle 1316 on Inquiry Card.

HOT-START YOUR UPS

The Station/28 UPS ($142) automatically activates during power interruptions such as blackouts, sags, surges, line noise, and brownouts. The Upsonic (Aliso Viejo, CA) unit has a power rating of 280 VA and provides up to 15 minutes of battery power. A hot-start button lets you manually reactivate your computer for a few minutes of full functionality in the event of a complete power failure.
Phone: (800) 877-6642 or (714) 448-9500.
Circle 1331 on Inquiry Card.

PORTABLE MAPPING SYSTEM

Infrared Technologies' (Columbia, MD) GPS video-based mapping system (from $7995) displays GPS satellite data from different mapping sources. The system consists of a 50-MHz 486DX2 or 75-MHz 486DX4 laptop with an internal CD-ROM, a GPS receiver, and aviation and terrain-mapping software that lets you display your physical location in real time. A video option lets you encode the GPS data onto a videotape and then play back and review the information; at the same time, the exact position is plotted and displayed on the electronic map on the laptop's screen.
Phone: (301) 470-4055.
Circle 1332 on Inquiry Card.

REDUNDANT SCSI EXPANSION

The stackable ST-8008 Redundant scsiTerminal Server ($2995), which connects to a Unix workstation or server via the SCSI bus, provides eight fully redundant serial ports for connecting modems, printers, terminals, or other RS-232 devices to your computer. You can connect the ST-8008, from Central Data (Champaign, IL), to two Unix hosts; if one host fails, the second one can take control of all eight ports. A power-fail switchover mode is available in case one of the ST-8008's internal scsiTerminal Servers loses power.
Phone: (800) 482-0315 or (217) 359-8010.
Circle 1333 on Inquiry Card.

What's New Hardware

ETHERNET FOR THE MAC

A one-piece Ethernet wireless station, the Manta ($699) uses a standard Ethernet driver and connects via the built-in AAUI connection. From Digital Ocean (Lenexa, KS), the Manta is powered by a nickel-metal-hydride battery for up to 4 hours of use. It incorporates AT&T's WaveLAN 915-MHz direct-sequence spread-spectrum radio, which reduces interference and boosts the Manta's ability to communicate through walls and floors. The station is compatible with PowerBook 500 laptops and Mac desktops and servers equipped with an Ethernet port and using standard EtherTalk drivers.
Phone: (913) 888-3380.
Circle 1342 on Inquiry Card.

SYNTHESIZED SOUND

An FM/wave-table synthesizer PC sound board, the AudioMaster 32 ($199) provides 16-bit stereo recording and playback at a sampling rate of up to 48 kHz. From OmniLabs (San Francisco, CA), the board has two synthesizers that can operate together for a total of 44 simultaneous voices. An on-board stereo 4-W power amplifier and a line-level audio-out are included.
Phone: (800) 706-3342 or (415) 512-2638.
Circle 1334 on Inquiry Card.

TWO TYPES OF INTERFACES

The Ultra-485 ($179), from Sealevel Systems (Liberty, SC), is a single-channel serial I/O adapter with 16-bit addressing for DOS, OS/2, Windows, and Windows NT communications. It provides automatic control of the RS-485 driver-enable signal, has selectable IRQs and address settings, and lets you connect up to 32 devices to the port.
Phone: (803) 843-4343.
Circle 1335 on Inquiry Card.

Sun Microsystems' (Mountain View, CA) PCMCIA Interface/SBus card ($295) adapts a SparcStation's SBus expansion slot, so it has the ability to accept up to two PCMCIA Type II cards or one Type III card. The Interface/SBus card is compatible with SparcStations running Solaris 2.3 or higher. Interface logic is provided by way of an SBus-to-PCMCIA ASIC chip that you can license through Sun's SPARC Technology Business.
Phone: (800) 821-4643 or (415) 960-1300.
Circle 1336 on Inquiry Card.

POWER SAVER

The PowerSaver ($46.95), from Defenders Network (Mobile, AL), can put your monitor and printer to sleep after either 10 or 20 minutes of keyboard inaction. The processor, internal fax modem, and floppy and hard drives are not affected and continue operating normally in the background. The hardware-only product warns you via a red light if you inadvertently switch it off.
Phone: (800) 513-1984 or (205) 661-1244.
Circle 1337 on Inquiry Card.

MODEMS IN THE FAST CLASS

The internal 2842F ($279) and external 2842FX ($319) V.fast-class modems provide 28.8-Kbps data and 14.4-Kbps fax transmission with V.42 error correction. Their V.42bis data compression yields throughputs up to 115.2 Kbps. From Best Data Products (Chatsworth, CA), the modems can send and receive faxes with any V.17, Group 3, or Group 2 fax machines and are upgradable to the V.34 standard.
Phone: (800) 632-2378 or (818) 773-9600.
Circle 1338 on Inquiry Card.

SHARE A MODEM

A modem- and port-sharing device, the Model 330 ($495) lets up to four computers or terminals share a master modem, multiplexer, front-end processor port, or DDS circuit. From Telebyte Technology (Greenlawn, NY), the device can pass data to or from the master either asynchronously or synchronously and can be cascaded to provide as many as 16 ports. You can configure the Model 330 to broadcast signals received from the main channel onto all subchannels or only the contending subchannel.
Phone: (800) 835-3298 or (516) 423-3232.
Circle 1339 on Inquiry Card.

SLIDE TEXT INTO WINDOWS

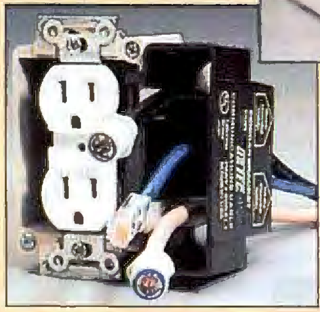
The DataPen ($399) lets you scan printed or typed text directly into your Windows applications. From I.R.I.S. America (Boca Raton, FL), the DataPen consists of a pen-size OCR scanner and I.R.I.S.'s Pen Character Recognition technology. You can enter up to 100 cps simply by sliding the DataPen over the text you want to enter.
Phone: (407) 395-7831.
Circle 1340 on Inquiry Card.

PROTECT AGAINST VIRUSES

An Ethernet adapter with boot-sector virus protection, the NE2000 plus-3V ($119) uses McAfee Associates' ROMShield ROM chip to automatically scan the host PC for boot-sector viruses during start-up. The adapter disinfects floppy disks while they are in the drive, preventing them from directly accessing your system's BIOS. From Microdyne (Alexandria, VA), the adapter offers AUI, BNC, and 10Base-T connections.
Phone: (703) 739-0500.
Circle 1341 on Inquiry Card.

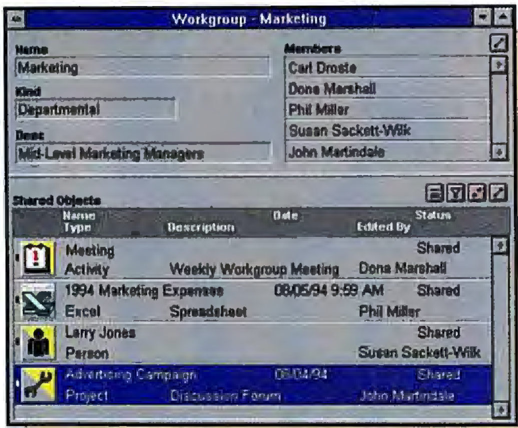
HIGHER BANDWIDTH FOR YOUR HOME

Developed to accommodate the growing digital communications needs of the home, the TecSystem wiring backbone is a CEBus-compliant home LAN system that can distribute high-bandwidth digital signals. The TecSystem consists of a patented TecPlate wall plate, a central server, and special networked cabling. You can use the TecSystem to communicate on global computing networks and to access programmable news and information, video on demand, multiple TV channels, and other multimedia services while having plug-and-play flexibility with other electronic devices anywhere in your house. The entry-level four-TecPlate network starts at $500; an eight-TecPlate network starts at $1500. The system can handle as many as 32 TecPlates.



Contact: U.S. Tec, Canandaigua, NY, (800) 836-2312 or (716) 396-9860.
Circle 1317 on Inquiry Card.

What's New Software



Cross the Network with Your Workgroup

CrossTies for Workgroups 1.0 lets participants in workgroups share and manage information over their existing network without custom programming. You can create, access, and manage all types of information—called objects—and turn any object into a discussion forum. You can use your preferred off-the-shelf software to create your files and then link the files using CrossTies' InfoTies technology. In addition to supporting Novell MHS, Microsoft Mail, Lotus cc:Mail, and CompuServe E-mail, CrossTies for Workgroups offers its own complete E-mail system. The suggested retail price for one user is $199.

Contact: CrossTies Software, Carrollton, TX, (800) 955-8437 or (214) 732-9080.

Circle 1271 on Inquiry Card.

SMART FORMS FOR THE NEWTON

Data-collection software for Apple's Newton PDA (personal digital assistant), OmniForm ($1500; additional Newton runtime applications, $150 each) lets you create intelligent forms in Windows or on a Mac for downloading to the Newton. After you load the form on the PDA by modem or serial cable, you complete the fields as they appear on the Newton's screen; you record answers by writing or tapping on the screen. After you complete the form, you send the data back to the host PC for incorporation into your spreadsheet or database. OmniForm is from Wright Strategies (Solana Beach, CA).

Phone: (800) 666-1228 or (619) 794-2494.

Circle 1276 on Inquiry Card.

REAL-TIME DOS CONTROL FROM WINDOWS

Based on VxDs (virtual device drivers), the RobinHood Developer's Toolkit ($495) lets you remotely control, in real time, any DOS application from within any DDE-aware Windows application. From WinGate Technologies (Morristown, NJ), RobinHood has DDE-compliant remote controls that can launch, terminate, and send keystrokes to any DOS program. It can also write data to, read data from, and manipulate the cursor position on any DOS screen.

Phone: (800) 946-4283 or (201) 539-2727.

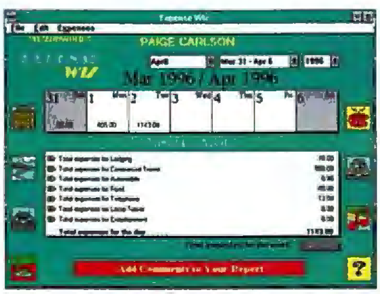
Circle 1279 on Inquiry Card.

NOTEBOOK WIZARDRY ▼

The CompuWorks Notebook Companion ($59.99), from The WizardWorks Group (Minneapolis, MN), is a collection of software programs specifically designed for notebook computers. Included in the package are a three-component information security system, Battery Watch-Pro for Windows, ScheduleWork for Windows, and Expense Wiz for Windows.

Phone: (612) 559-5140.

Circle 1275 on Inquiry Card.



SHARE A SCSI DEVICE

Macintosh networking software, SCSI-Share ($89) from Stalker Software (Larkspur, CA) allows you to share SCSI devices, such as scanners, printers, and CD-ROM or magnetic-tape drives, over any AppleTalk-compatible LAN. SCSI-Share arbitrates concurrent requests to the same device and indicates the network activity of other users on the network. The software runs in the background and includes password protection.

Phone: (800) 262-4722 or (415) 927-1026.

Circle 1280 on Inquiry Card.

PRECISE YET FLEXIBLE SKETCHING

OLE 2.0–compatible SmartSketch ($79.95), from FutureWave Software (San Diego, CA), seamlessly blends the precision of drawing with the flexibility of paint. With the program, you can create a shape by making back-and-forth swipes with the mouse, just as you would in a paint program; the shape becomes a discrete object that you can move and reshape. You can also delete an entire shape or erase any portion of it. The program's intelligent shape recognition automatically straightens and smooths lines or converts them into precise ovals, circles, rectangles, or squares.

Phone: (800) 619-6193 or (619) 637-6190.

Circle 1277 on Inquiry Card.

LAN ANALYZER

For token-ring and Ethernet LANs, LANSleuth+ ($690) simultaneously decodes SNA, TCP/IP, AppleTalk, and Novell's protocols. From Systems and Synchronous (Naperville, IL), LANSleuth+ permits simultaneous viewing of multiple traces or packets within a trace. The software has a full Windows interface, full use of colors to identify packet types and errors, a Ping utility, a packet-generation utility, and intelligent filters. It also displays real-time statistics while capturing data and lets LAN administrators view network traffic for problem isolation.

Phone: (708) 505-3900.

Circle 1281 on Inquiry Card.

LEGAL HELP FOR BUSINESS DOCUMENTS ▲

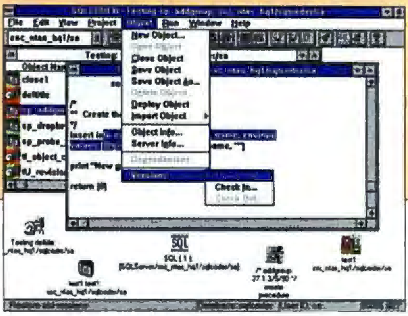
LegalPoint 1.0 for Windows ($99.95) provides more than 70 frequently used business contracts and documents with guidelines and suggestions on when to use a particular form, what that form means, and the best way in which to complete it. From Teneron (Overland Park, KS), LegalPoint's intuitive, step-by-step guidance system helps you fill in the items in a document and presents business examples, options, and explanations of legal clauses.

Phone: (800) 529-5669 or (913) 451-3663.

Circle 1278 on Inquiry Card.

Develop Objects for Multiple Databases

A Windows-based development tool, SQL Coder lets RDBMS applications developers create, manage, and organize database-server objects. The tool supports simultaneous connections to heterogeneous RDBMS servers for deployment and other interactive SQL operations, letting you manage server objects within single or multiple repositories. The editing environment provides syntax pasting, version control, and off-line syntax checking and supports an intuitive project metaphor. A single-user license costs $795; a five-user license costs $2995.



Contact: SQL Software, South San Francisco, CA, (800) 462-1199 or (415) 794-2800.

Circle 1272 on Inquiry Card.

WATERMARK YOUR PAGES

A background printing utility, Working Watermarker for Windows ($49.95) lets you print a watermark graphic of any size onto a page behind any document printed from any application, including applications that do not support graphics. You can use the Working Software (Santa Cruz, CA) utility's ready-to-use watermarks or create your own; you can also combine multiple text and graphical objects into a watermark, rotate text and objects to any angle, and set a watermark to whatever degree of darkness you wish.

Phone: (800) 229-9675 or (408) 423-5696.

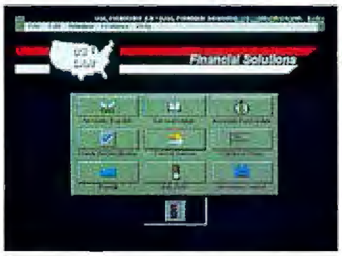
Circle 1282 on Inquiry Card.

FULL-ENCUMBRANCE ACCOUNTING ▼

The USL Financials FundMaster SQL client/server suite (from $3500) is a full-encumbrance fund-accounting program for government agencies and non-profit organizations. From US LAN Systems (Vienna, VA), FundMaster SQL is scalable and is based on an open architecture. The client interface is in Microsoft Access under Windows, which lets you import data from the accounting system directly into your Windows applications; the server software runs on SQL Server and operates in multiple environments.

Phone: (800) 800-0768 or (703) 790-2754.

Circle 1283 on Inquiry Card.



A CLEAR CASE FOR SHARING

A software-configuration management system for Unix, ClearCase MultiSite (from $1875) supports parallel development and software reuse by geographically distributed project teams in networked and non-networked environments. The software automatically replicates project databases and provides transparent access to all software elements. After it's finished replicating VOBs (versioned object bases), the Atria Software (Natick, MA) system synchronizes them based on the update pattern selected by the software team in each location. Update options include a built-in store-and-forward system, standard Unix file transfer facilities, and magnetic-tape-based transfer.

Phone: (508) 650-5100.

Circle 1284 on Inquiry Card.

WORKGROUP FILE CABINET

A file- and information-sharing application, Network Central for Windows ($179.95) is designed to be installed by individuals and then expanded throughout a workgroup, one user at a time, without disrupting work in progress. From First Floor (Mountain View, CA), Network Central is network independent; if a user is connected to more than one network, the software works with multiple Windows-compatible network operating systems.

Phone: (800) 639-6387 or (415) 968-1101.

Circle 1285 on Inquiry Card.

REMOTE LINKS IN WINDOWS

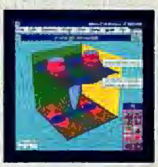
With remote control for Windows and DOS, LapLink for Windows ($199.95) lets you continue to access your E-mail and desktop and network databases while you travel. The software lets you connect to more than one computer for remote control and file transfer and simultaneously perform multiple tasks among those computers. From Traveling Software (Bothell, WA), LapLink for Windows supports V.Fast, cellular, and PCMCIA modems, as well as National Semiconductor's AirShare radio modules. A Chat feature lets you communicate with a remote user as you share tasks on connected computers.

Phone: (206) 483-8088.

Circle 1286 on Inquiry Card.

Software Update

Origin 3.5, Microcal Software (Northampton, MA), has three new add-on modules: The Real Time Module, The Peak Fitting Module, and The File Utilities Module. $495.



Phone: (800) 969-7720 or (413) 586-2013.

Circle 1300 on Inquiry Card.

VB/Link 2.0 for Lotus Notes, Brainstorm Technologies (Cambridge, MA), supports rich text, file attachments and other embedded objects, and Lotus Notes views and lets you create and track response documents. $795.

Phone: (617) 492-3399.

Circle 1301 on Inquiry Card.

ColorQuartet 3, ScanView (Foster City, CA), provides native PowerMac support, selective color correction, CMYK on the fly, and unsharp masking on the fly. $1650; RGB-only version, $1100.

Phone: (415) 378-6360.

Circle 1302 on Inquiry Card.

db-UIM/X 2.6, Bluestone (Mount Laurel, NJ), adds support for Oracle7 and Dynamic SQL capabilities for Oracle and Sybase on Sun, Hewlett-Packard, and IBM platforms. $6500.

Phone: (609) 727-4600.

Circle 1303 on Inquiry Card.

LanCD 3.0, Logicraft (Nashua, NH), adds native Windows support. $695 for 10-user version.

Phone: (603) 880-0300.

Circle 1309 on Inquiry Card.

Drive Rocket 1.14, Ontrack Computer Systems (Eden Prairie, MN), adds an enhanced FastDisk driver. $39.95.

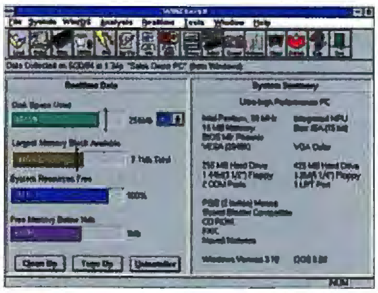
Phone: (612) 937-1107.

Circle 1343 on Inquiry Card.

What's New Software

SCHEDULING FOR SERVICE

The Windows-based W-6 Service Scheduler (from $1495) features both automatic and manual scheduling with decision support to help a person scheduling service calls find the most qualified, closest available service person for each customer. An open system, the IET Intelligent Electronics (Burlington, MA) software supports ODBC-enabled SQL databases, so scheduling-related data (e.g., work orders, customer records, and spare parts inventories) can automatically be imported and exported.
Phone: (617) 229-5855.
Circle 1287 on Inquiry Card.



CHECK YOUR WINDOWS ▲

WinCheckIt diagnostic software ($79.95) provides utility and troubleshooting tools and also lets you view configuration and performance readings from your system. From TouchStone Software (Huntington Beach, CA), WinCheckIt includes an uninstaller, a cleanup facility, a memory optimizer, a system file editor, special DOS utilities that rescue critical system files and CMOS settings, and testing and analysis features.
Phone: (800) 531-0450 or (714) 969-7746.
Circle 1288 on Inquiry Card.

DIAL IN TO NETWARE

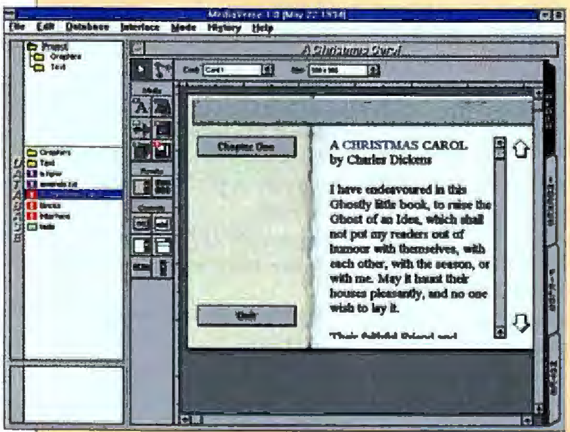
WanderLink (from $295) lets remote PC users dial in over standard phone lines to a NetWare network. From Funk Software (Cambridge, MA), WanderLink includes data-compression and security features such as NodeID, data encryption, and domain filtering. After connecting with the software, a remote user becomes a node on the network and can operate as if directly connected to the network. Installed and administered from Windows, WanderLink runs as an NLM on a NetWare file server.
Phone: (617) 497-6339.
Circle 1289 on Inquiry Card.

AUTOMATED SURVEY SYSTEM

An integrated-module approach to defining, executing, and managing surveys, Survey Pro for Windows ($695) is based on the concept of user-defined, reusable questionnaire tiles. From Apian Software (Menlo Park, CA), Survey Pro for Windows provides a WYSIWYG questionnaire design interface. It has format and layout options such as multiple columns, facing pages, and landscape page orientation. The software also features multiple questionnaire feeds from a common database and statistical analysis capabilities.
Phone: (800) 237-4565 or (415) 694-2900.
Circle 1290 on Inquiry Card.

BECOME A NETWORK GURU

A Windows-based drawing package designed for network administrators, NetGuru Manager ($495) lets you quickly design, illustrate, and document LANs. The American Hytech (Pittsburgh, PA) software can validate a network design based on standards or de facto standards with an internal rule-checking knowledge base that you can invoke anytime. This process ensures that all components of a network are accounted for before a network is built or enlarged.
Phone: (412) 826-3333.
Circle 1291 on Inquiry Card.



MULTIMEDIA AUTHORING TOOL

A multimedia authoring system, MediaVerse ($799) seamlessly integrates a multimedia database builder, an interface builder, and support for Windows, NT, and Macs. Stand-alone components are available for distributed processing development.

The Multimedia Database Builder supports OLE 2.0 and provides built-in media editors for text, audio, video, graphics, and the creation and editing of 3-D objects and virtual worlds. The Interface Builder defines relationships between media items so that you can separate media creation and development from interface development.

Contact: Looking Glass Software, Inglewood, CA, (310) 348-8240.
Circle 1273 on Inquiry Card.

Software Update

IMSL Exponent Graphics 2.1, Visual Numerics (Houston, TX), features language independence and supports PCs running Windows NT. Floating Unix license, $3550; Windows NT license, $895.

Phone: (713) 784-3131.
Circle 1304 on Inquiry Card.

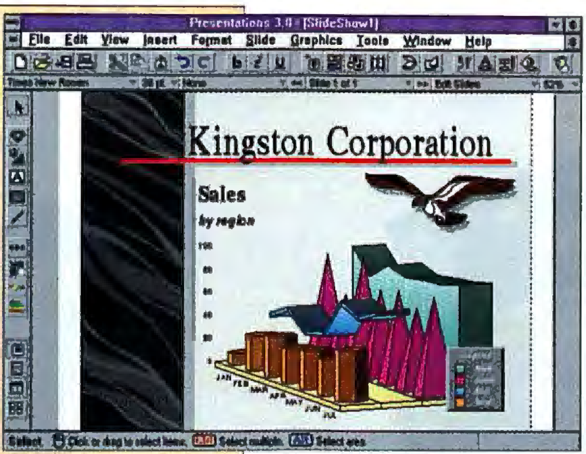
NetTune 2.0, HawkNet (Carlsbad, CA), adds server management features, including a memory-mapping capability, custom graphing capabilities, and a server statistics feature. $695 per server.
Phone: (800) 429-5638 or (619) 929-9966.
Circle 1305 on Inquiry Card.

KanjiWord 3.0, Pacific Software Publishing (Bellevue, WA), adds OLE 2.0 word processing capabilities, linking, Mincho and Gothic TrueType Japanese fonts, and a Word Registration feature. $279.
Phone: (206) 562-1224.
Circle 1306 on Inquiry Card.

Eudora by Qualcomm 2.1, Qualcomm (San Diego, CA), includes color coding, mailbox convenience features, message drag and drop, Kerberos support, and server mail-drop management. From $65.
Phone: (619) 587-1121.
Circle 1307 on Inquiry Card.

Fractal Design Painter 3.0, Fractal Design (Aptos, CA), adds more than 50 features, including a refined user interface, multiple floating selections, multimedia and animation tools, and enhanced creative and compositing tools. $499.
Phone: (408) 688-5300.
Circle 1308 on Inquiry Card.

CREATE INNOVATIVE PRESENTATIONS



Presentations 3.0 for Windows ($495) has enhanced its ease of use with features such as Show Expert, which provides suggested outlines to help you define and organize your presentation. Coaches and Startup Dialogs help you define the look and feel of your presentation, while Direct Editing and In-Place Editing let you edit text and attributes, as well as edit and create charts, without leaving the slide view. The mail-enabled software is an OLE 2.0 client and server and supports the ODMA and NetWare Navigator. Other enhancements include such features as Quick3-D, Perspective, QuickWarp, and Bitmap Filters.

Contact: WordPerfect/Novell Applications Group, Orem, UT, (800) 451-5151 or (801) 225-5000.

Circle 1274 on Inquiry Card.

HIGH-SPEED FORMS SCANNING

Part of the family of Advanced Imaging Extensions for the KIPP Advanced Developers Toolkit, Forms Recognition ($1995) distinguishes generic forms at high speed with no degradation of scanner performance. From Kofax Image Products (Irvine, CA), Forms Recognition provides best-match percentages and information on registration displacement to improve the accuracy of optical-character and mark-sense recognition.

Phone: (714) 727-1733.

Circle 1296 on Inquiry Card.

MULTIMEDIA TRAINING

A CBT (computer-based training) multimedia course development system that's on CD-ROM, CBT Express for Windows ($2995) has a prebuilt courseware blueprint for rapid CBT development. From AimTech (Nashua, NH), CBT Express is designed especially for first-time developers of interactive training. Features include student tracking to a built-in database, a set of 375 background color graphics, and the ability to automate CBT development without scripting, flowcharting, or programming.

Phone: (603) 883-0220.

Circle 1293 on Inquiry Card.

FORMS CREATION

Visual Forms for Windows ($249) enables you to create complex forms in PCL format for integrating into an application. The Bytech Business Systems (Pomona, NY) software generates files that have no overhead or control codes, resulting in small files that are completely portable and in true PCL code. You can integrate forms into any application, such as FoxPro, Clipper, and Clarion, that can send a macro to the printer. The program includes .DLL for Windows developers.

Phone: (914) 354-8666.

Circle 1294 on Inquiry Card.

3-D DESIGN FOR THE POWER MAC

DesignReality for the Power Macintosh ($1995) does real-time 3-D surface modeling on your desktop. The 3-D polyhedral and NURBS modeler provides construction, assembly, display, and viewing tools and curve- and surface-modeling capabilities for rapid prototyping. Redraws occur in real time, letting you view a 3-D project from every angle. The software is from Ashlar (Sunnyvale, CA).

Phone: (800) 877-2745 or (408) 746-1800.

Circle 1295 on Inquiry Card.

WINDOWS NT SERVER

A 32-bit multithreaded NFS server, NFSware (from $295) lets you export multiple file systems from a Windows NT system. Remote users of Unix, Windows for Workgroups, and other TCP/IP-based systems can access the files from their local systems. From Process Software (Framingham, MA), the native NT application provides full support for NT security.

Phone: (800) 722-7770 or (508) 879-6994.

Circle 1292 on Inquiry Card.

STREAMLINE YOUR EXECUTABLES

ApplicationMaster (from $650) searches out and removes nonrequisite classes and methods from your object-oriented executable files. According to Mission Software (Raleigh, NC), this increases the performance of executables by up to 60 percent and reduces load time, required RAM, and required disk space by the same amount.

Phone: (919) 779-1033.

Circle 1297 on Inquiry Card.

Software Update

HotDocs 2.0 for Windows, Capsoft Development (American Fork, UT), adds library and Insert File features and has an enhanced programming capability. $99; optional database module, $49.

Phone: (800) 500-3627 or (801) 763-3900.

Circle 1310 on Inquiry Card.

MathTensor 2.2, MathSolutions (Chapel Hill, NC), adds differential forms functions, functions to help you deal with dimensional reduction, and methods to speed up the computation of Riemann tensors and related objects. DOS/Windows or Mac version, $550; Unix version, $800.

Phone: (919) 967-9853.

Circle 1311 on Inquiry Card.

Vermont Test 2.0 (formerly Dr. Taylor's Test), Vermont Creative Software (Richford, VT), includes full mouse support, a scripting language, single-step playback enhancements, more record and playback options, and support for additional video modes. $395.

Phone: (800) 848-1248 or (802) 848-7731.

Circle 1312 on Inquiry Card.

TestDrive Super Store CD-ROM 2.0, TestDrive (Santa Clara, CA), adds an animated, multimedia guided tour and free trial software products. Single copy, $9.95; one-year subscription, $19.95.

Phone: (800) 788-8055 or (408) 496-0555.

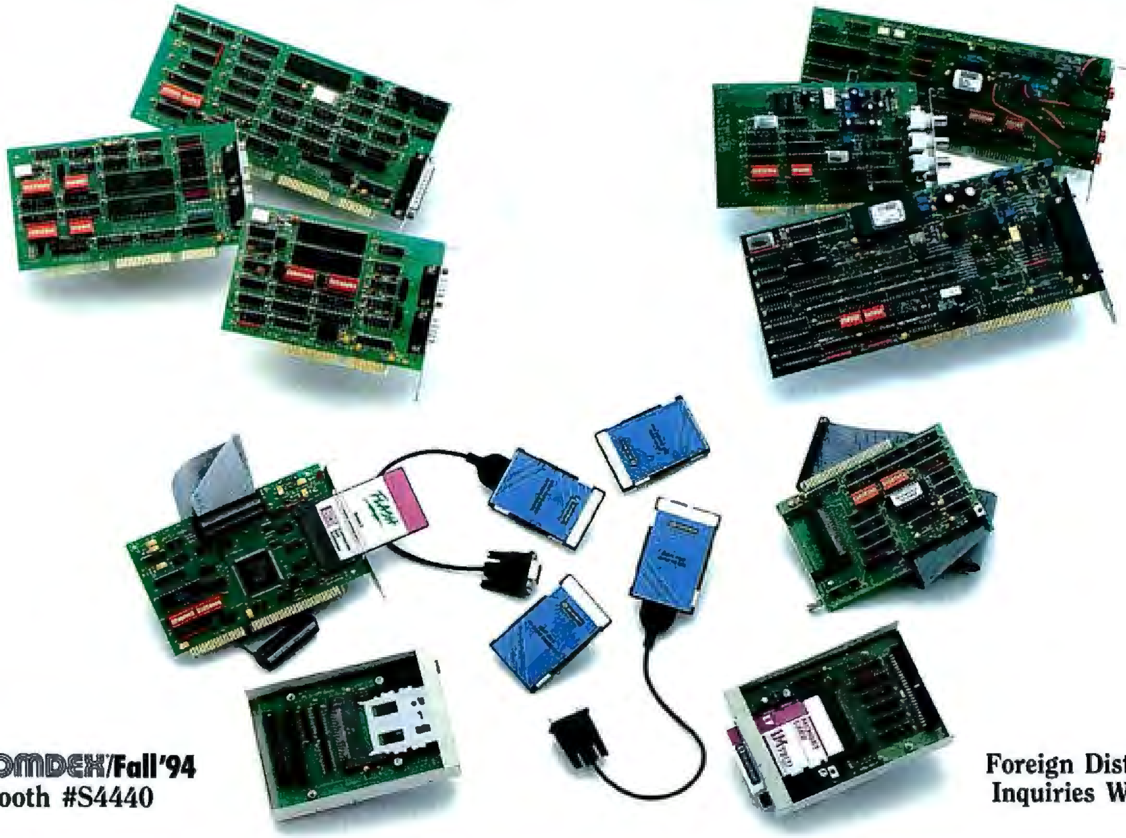
Circle 1313 on Inquiry Card.

FastTrax 5.0, FastTrax International (Berkeley, CA), has simplified menus; adds directory sorting, surface testing, and a Contiguous Placements feature; supports Windows, the OS/2 FAT file system, and DOS 6.x DoubleSpace drives; and adds DOS and DoubleSpace disk maps. $70.

Phone: (510) 525-3510.

Circle 1314 on Inquiry Card.

The Solution To Your Application Requirements



COMDEX/Fall'94
Booth #S4440

Foreign Distributor Inquiries Welcome

Quatech, Inc. manufactures a variety of communication, data acquisition, PCMCIA, and control products for the IBM PC/XT, PC/AT, PS/2, notebook, and compatible systems. We are committed to providing our customers with quality products, exceptional service and support, and competitive prices.

COMMUNICATION adapters meet asynchronous, synchronous, serial, and parallel communication requirements with protocols such as RS-232, RS-422, RS-485, Current Loop and IEEE-488. Intelligent and coprocessor adapters are also available.

DATA ACQUISITION products add analog to digital, digital to analog conversions and digital I/O capabilities in 8 to 16-bit resolution. Other boards provide the capabilities for digital multimeters, digital frequency synthesizers, arbitrary waveform synthesizers, and IEEE-488 GPIB interfaces.

PCMCIA Internal Interface Adapters support Type I, II and III memory and I/O cards. The Solid State Memory Card Drive supports Type I PCMCIA FLASH and SRAM memory cards. Quatech's digital I/O, EPP parallel port, serial RS-232, RS-422, and RS-485 PCMCIA I/O cards give you maximum flexibility for your application. **New PCMCIA I/O cards** include two channel asynchronous RS-232; one channel RS-232 and one channel RS-485 serial port; 8 channel, 12-bit D/A; 16 channel analog input card with 12-bit resolution; 16 channel analog input card with 16-bit resolution; and a synchronous comunication card. Call **1-800-553-1170** today for more information and a free catalog.

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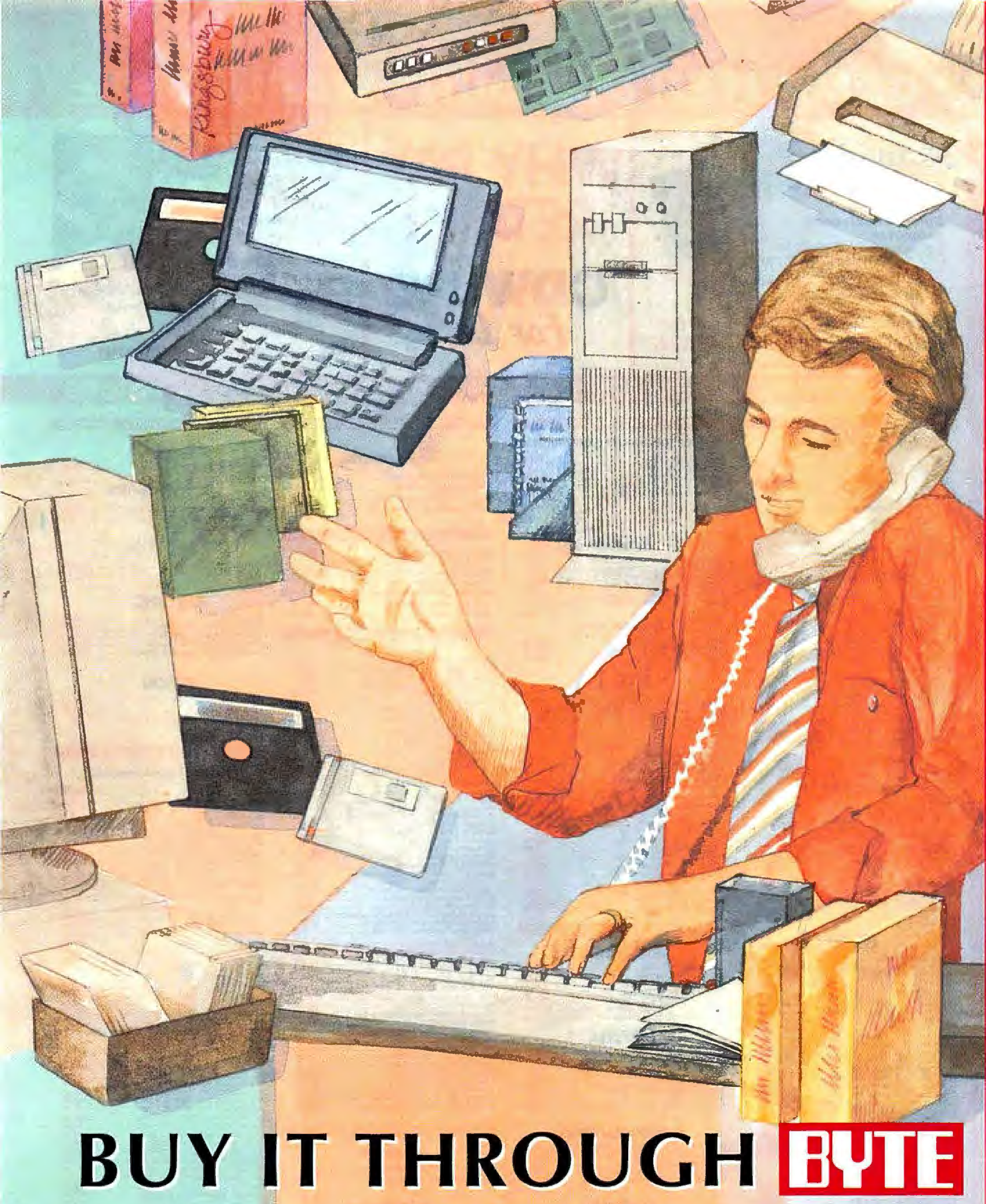

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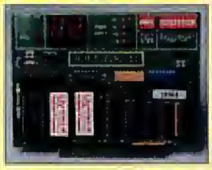

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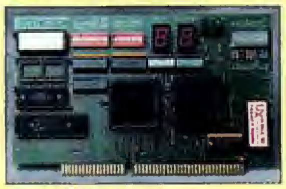

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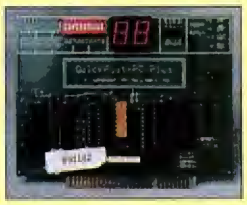

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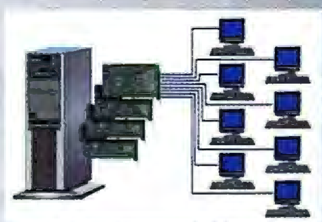

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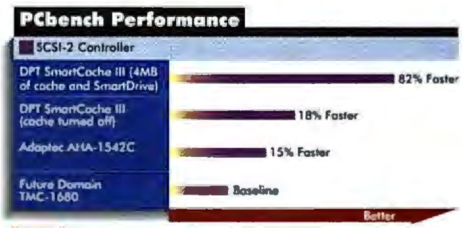

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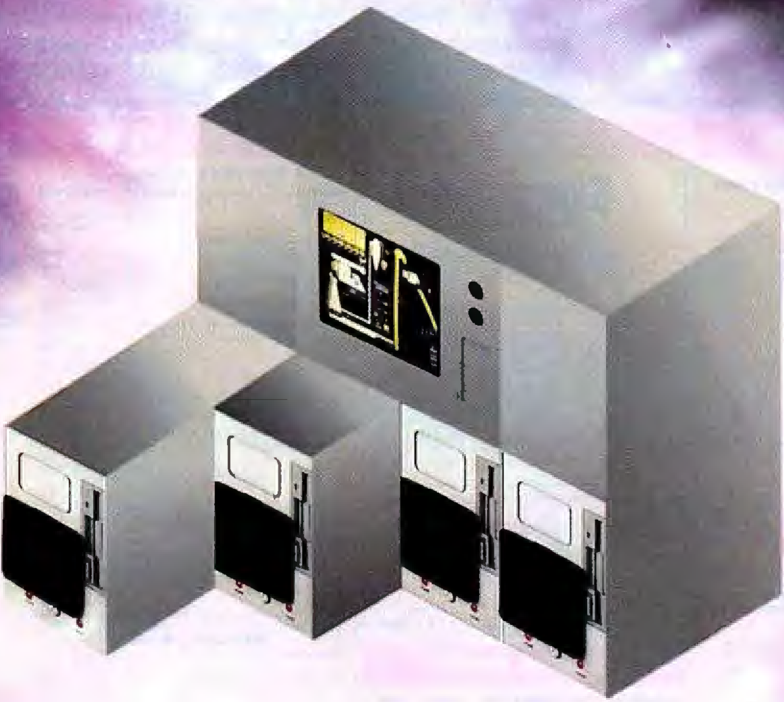

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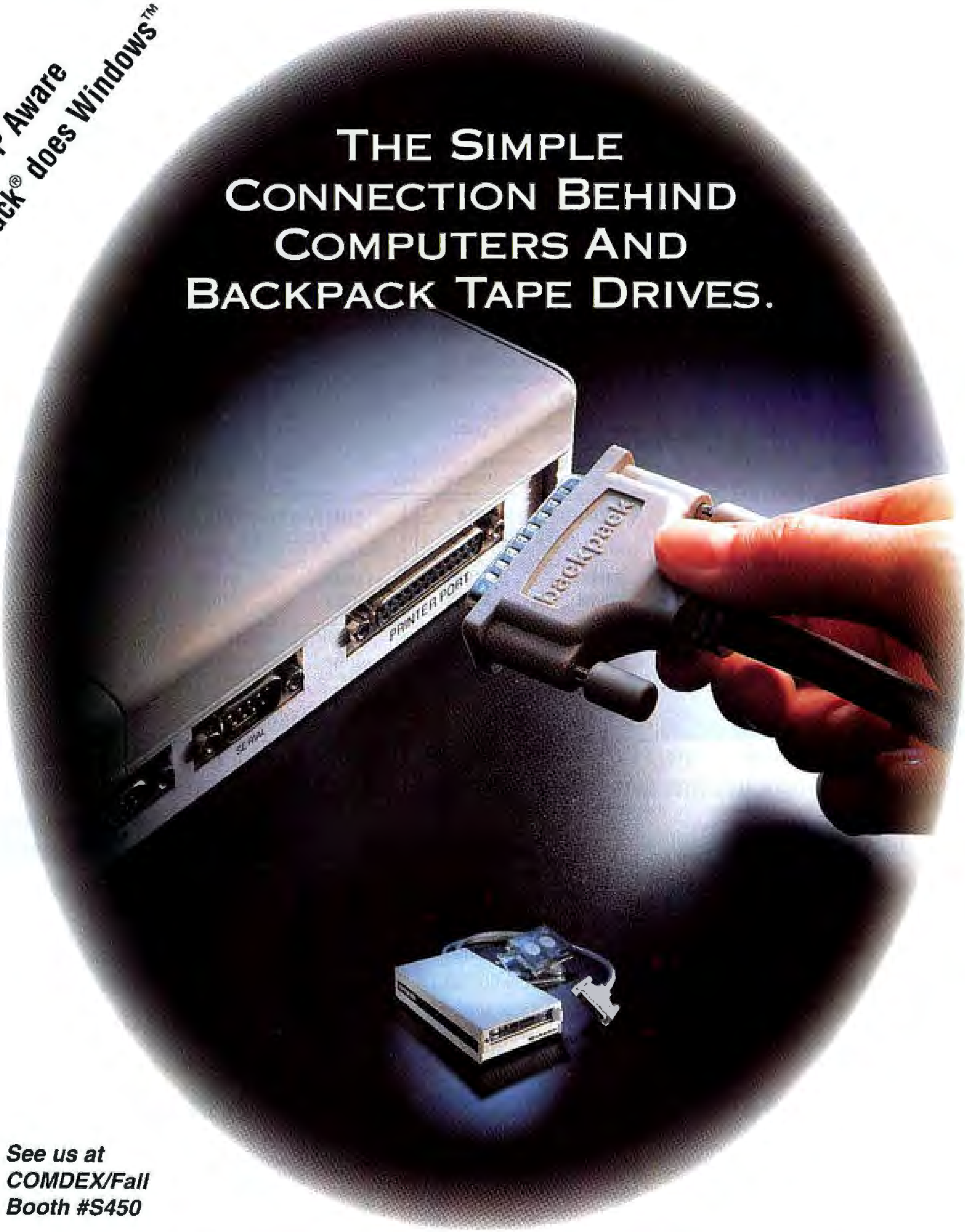

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T4400SX, SXC T6400, T6600	4Meg	PC-PA2004U	199.00
T4400SX, SXC T6400, T6600	8Meg	PC-PA2005U	369.00
T4400SX, SXC T6400, T6600	16Meg	PC-PA2010U	699.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	4Meg	PC-PA2012U	199.00
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AST Bravo & Explorer	4Meg/16Meg	501255-001, -002	189/789
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AST Power Exec 3/25C, 425EL	4Meg		199.00
AST Power Exec 3/25C, 425EL	16Meg		819.00
AST Power Exec 425SL	4Meg	501166-001	199.00
AST Power Exec 425SL	16Meg	501166-003	819.00
AST Power Exec 4/33SL	4Meg/16Meg	501318-001,002	194/769
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Bondwell B310, Plus	1Meg	23050-09100	109.00
Bondwell B310V, SX	1Meg		109.00
Bondwell B310V, SX	4Meg		229.00
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Canon Notejet 486	4Meg/ 8 Meg		199/389
Chicony, Ultra, Hyundai 386	4Meg		199.00
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Gateway 2000 486 Handbook	4Meg/16Meg		199/799
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NCR Safari 3180	4Meg/ 8 Meg		229/440
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NEC Prospeed 386SX-20	1Meg	PC43-21	79.00
NEC Prospeed 386SX-20	4Meg	PC43-22	195.00
NEC Ultralite Versa	4 Meg/8Meg/16Meg/20Meg	DP4104	183/359/799/988
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Packard Bell Statesman	2Meg/8Meg		119/419
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Panasonic CF-V21P, CF-580	4Meg/16Meg		219/819
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Epson Action Laser II	–	–	89	–	208	–	–	327	–			
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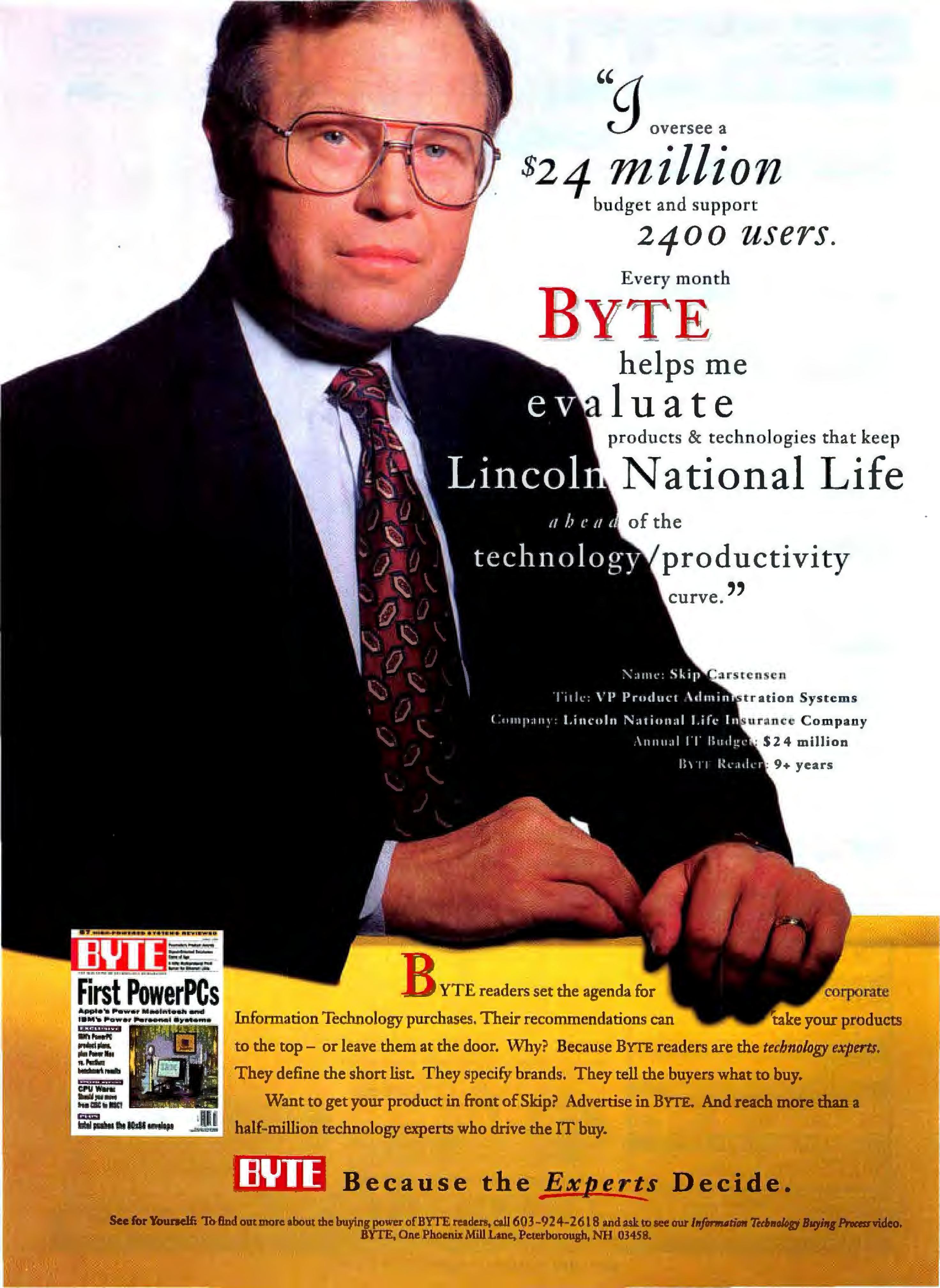
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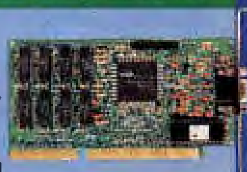

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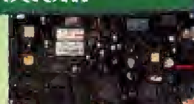

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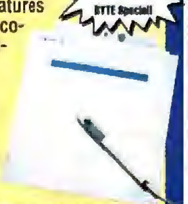

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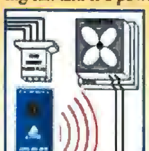

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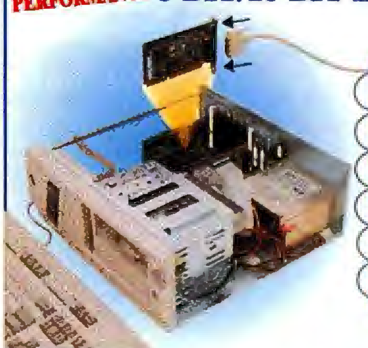

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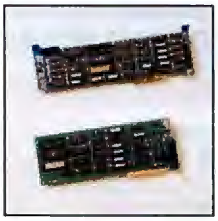

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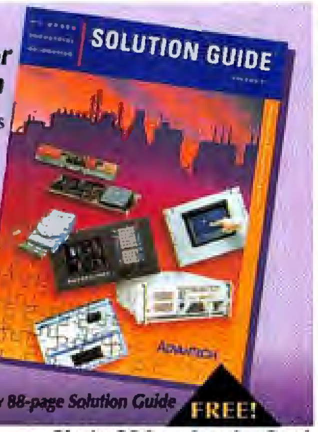

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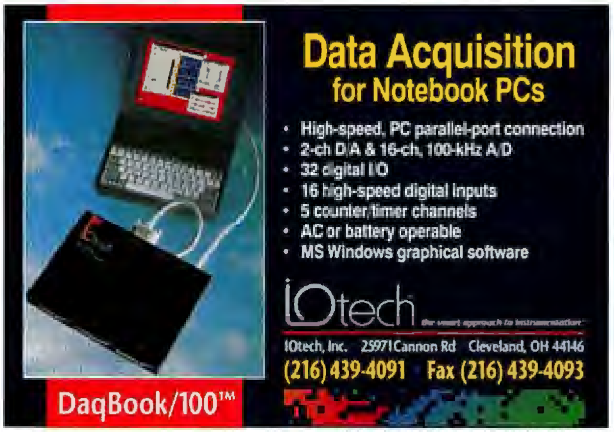

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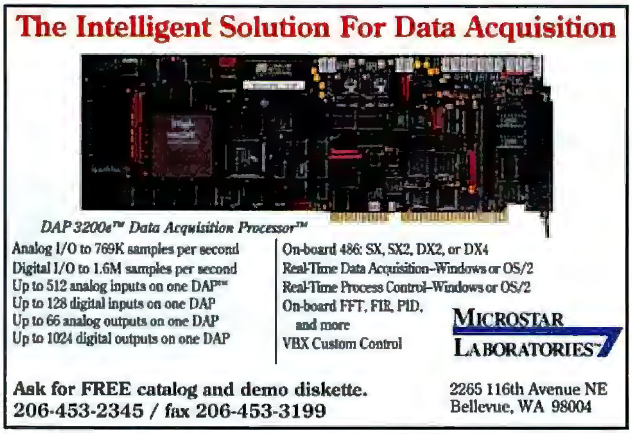

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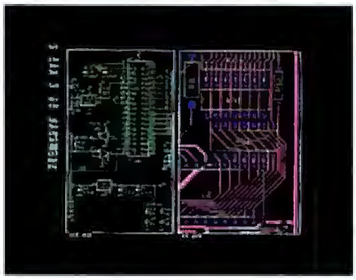

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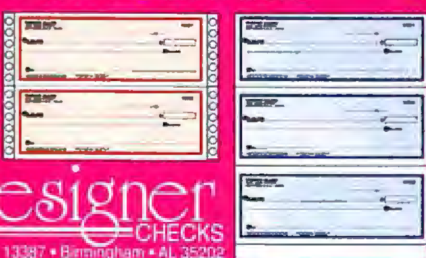

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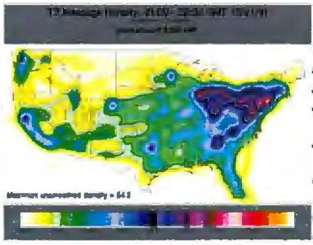

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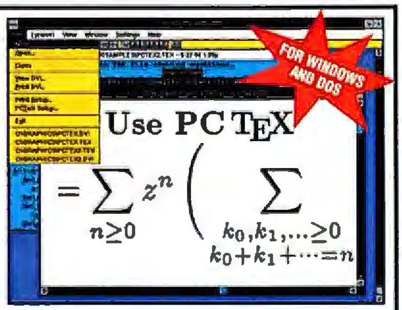

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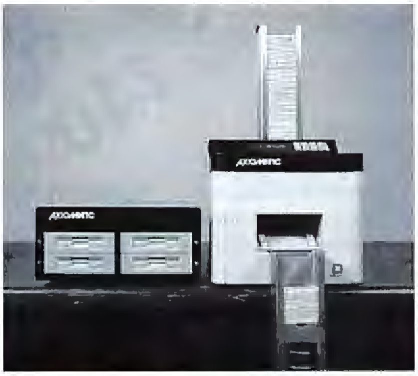

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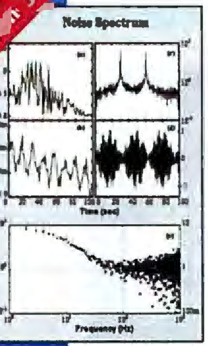

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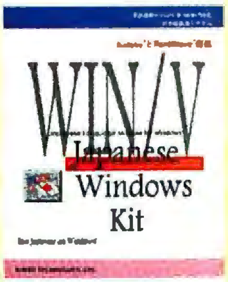

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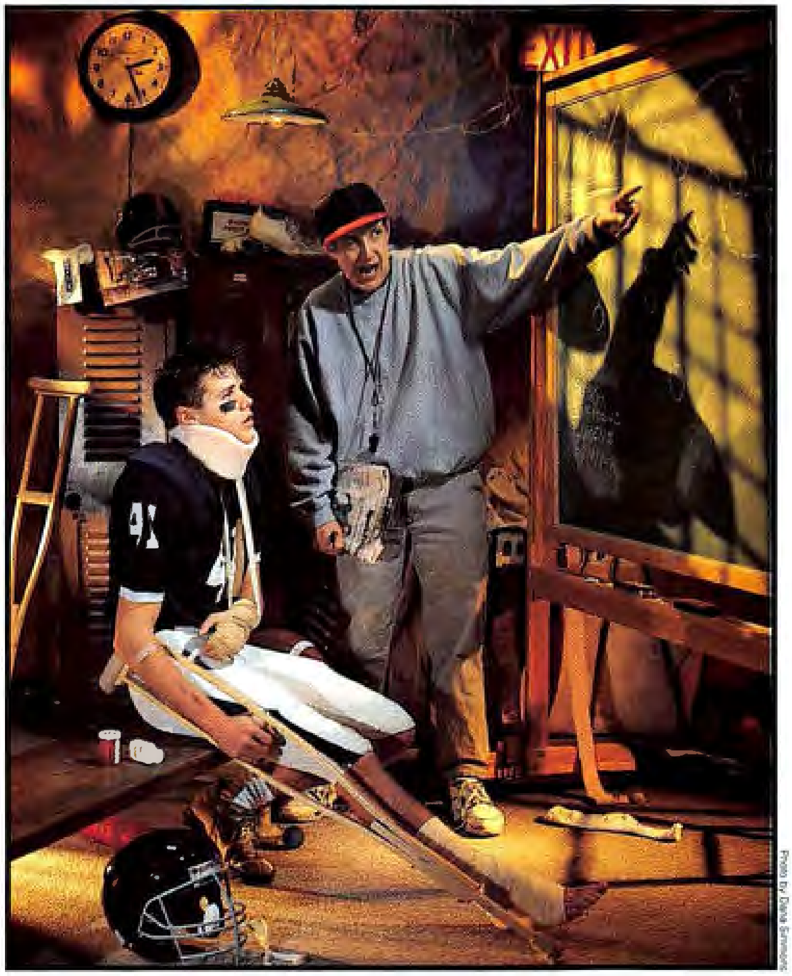

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Teacher Training Is Key

The acquisition of computers is not enough. To ensure their proper use, teacher training is critical.


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The latest onslaught of high-speed multimedia computers into schools might lead us to believe that the use of computers in the classroom will soon be limited only by the imagination of the user. That sounds good—to parents, school administrators, and eager teachers—but it simply is not accurate. Spiffy new hardware is only one small part of an equation that includes computer-literate teachers and user-friendly software. Then, and only then, will computer use in schools move beyond the mundane tasks of word processing, E-mail, and typing drills.

Teacher training is critical. If teachers can't use the technology, they won't. Too many school systems are following the corporate model of the 1980s, buying technology without the training, resulting in a great deal of frustration and an arsenal of underused equipment. A small town recently appropriated $28,000 to bring a "state-of-the-art" computer lab into its elementary school. Twelve Mac LC 575 computers with CD-ROM drives, "friendly software," and two laser printers cost $27,084. That left $916 for training. Every dollar spent on technology should be matched dollar-for-dollar on training, yet few schools have made such a commitment.

There are exceptions, of course. The school where I teach participates in the Hands-On Universe project through the University of California at Berkeley, working with a network of professional scientists, teachers, and curriculum developers to bring real science into the classroom. This project integrates astronomical images, contemporary astrophysics research, and newly emerged technologies to teach the subjects of astronomy, physics, and math, and to develop relevant curriculum materials.

Students can request and retrieve astronomical images from telescopes at the Leuschner Observatory in California using little more than their classroom computers, a modem, and a user-friendly version of a professional image-processing and communications software program developed by the Hands-On Universe project. Once these images are downloaded, students can search for exploding stars in distant galaxies, examine the eclipsed sun, and manipulate images of planets.

As this example illustrates, the PC can be a very powerful learning tool. But for the uninitiated and perhaps technophobic teacher, mastering this complex tool requires lots of encouragement and ongoing training.

There are many ways to promote computer literacy in the classroom. Many schools have computer experts on the faculty who could be partially released from teaching duties to run workshops for their colleagues. At my school, one faculty member runs regular evening and Saturday classes for Mac users as part of his contract. Another teacher works with colleagues on Internet access. A physics teacher has assumed as part of his contractual responsibility the management of computers and software in the physics labs and the training of teachers.

Schools should set up computer help centers staffed with experts, similar to the computer center at Kinko's. The centers should be available to students and faculty for problem solving and additional training. Corporate training centers should share their expertise and facilities with schools during summers and weekends to offer in-service training. A small investment by a local corporation can help ensure a more highly qualified work force in the future. Magazines designed for the computer user should begin to devote more space to computers in education.

Today, teachers from kindergarten through high school and college are likely to find themselves face-to-face with students who know more than they do about computers. This can be disconcerting, even threatening, for those teachers who believe they must be the highest authority in the classroom. But a significant portion of my computer knowledge has come from students.

As younger people enter the teaching profession, the lack of computer-skilled teachers will gradually become less of an issue. To this end, all high schools and colleges should have a computer-literacy graduation requirement. Conversely, schools should now require computer literacy of all serious job applicants.

If our very significant investments in technology are to pay off, they must be coupled with equally significant investments in training teachers. Those administrators who control the purse strings must establish a broader long-range vision. The machine can't work alone. ■

S. Hughes Pack is the Theodore R. Carpenter fellow at the Northfield Mt. Hermon School in Northfield, Massachusetts. He teaches physics and astronomy. He can be reached on the Internet at hpack@k12.ucs.umass.edu or on BIX c/o "editors."

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Dell's featured computer artist is Glenn Mitsui of Studio MD, Seattle.