FEBRUARY 1998 Vol. 9 No. 2 $5.50

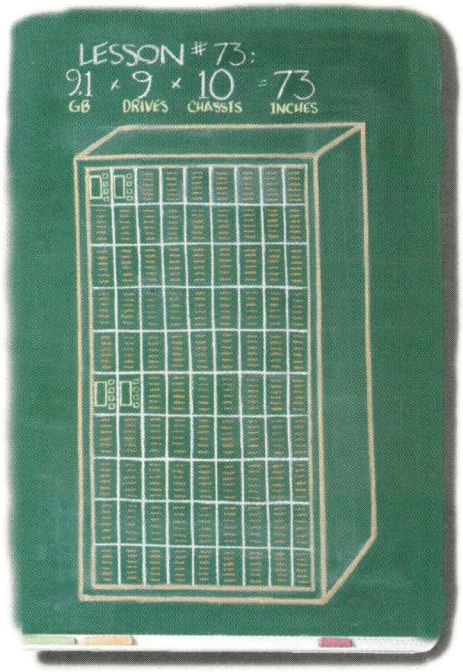
SUNEXPERT

The Server/Workstation Magazine

urvey: Disk Drives

Celebrating 100 Issues

Artecon's New RAID Math



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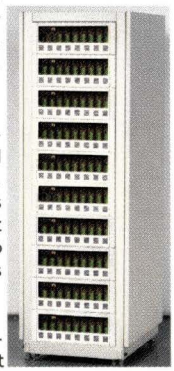

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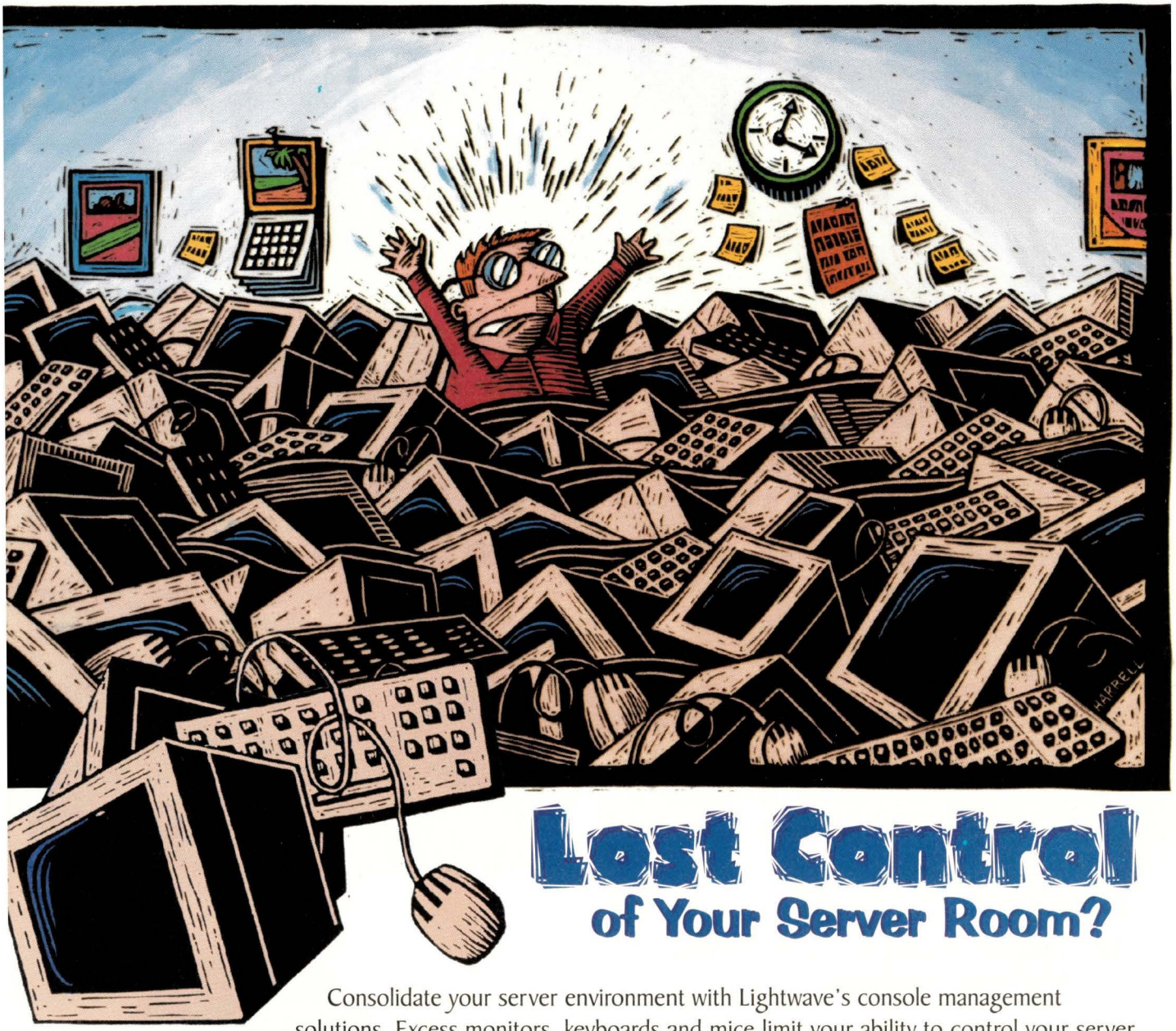

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SUNEXPERT
The Server/Workstation Magazine

February 1998
Volume 9
Number 2

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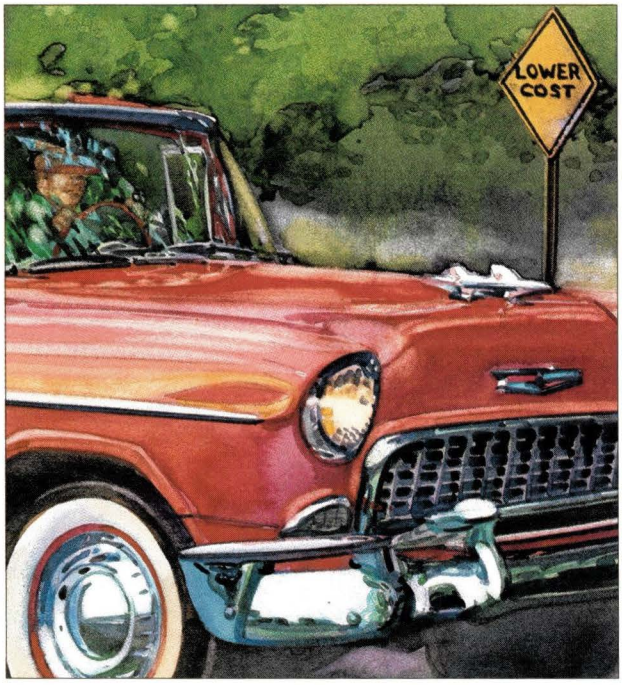

COVER ILLUSTRATION: KEN CALL

News

Columns

SUNEXPERT Magazine (ISSN 1053–9239) is published monthly by Computer Publishing Group, 320 Washington St., Brookline, MA 02146. Telephone (617) 739-7001. Periodicals Postage Rates paid at Boston, MA, and at additional mailing offices. Posted under Canadian IPM #0235873. This publication is free to qualified subscribers as determined by the publisher. Subscription rates are $60 per year in the United States, and $95 (surface mail) and $150 (air mail) outside the United States. Subscription requests can be sent to Circulation Department, *SUNEXPERT* Magazine, 320 Washington St., Brookline, MA 02146 or electronically mailed to circ@cpg.com.

POSTMASTER, please send all address changes to *SUNEXPERT* Magazine, Circulation Department, 320 Washington St., Brookline, MA 02146. Please allow 6-8 weeks for change of address. Include your old address as well as new–enclosing, if possible, an address label from a recent issue.

Material for publication should be sent to the attention of Doug Pryor at the above address or electronically mailed to dpryor@cpg.com. Letters sent to the publication become the property of the publication and are assumed to be intended for publication and may be used so. *SUNEXPERT* Magazine is not sponsored or endorsed in any way by Sun Microsystems Inc. All information herein is believed to be accurate to the best of our ability.

Source: Seagate Technology Inc.

Survey

57 Disk Drives

compiled by Maureen McKeon

Facts and features of more than 20 4-GB or higher, 3.5-inch drives from seven original manufacturers.

SUPPLEMENT begins Page 60

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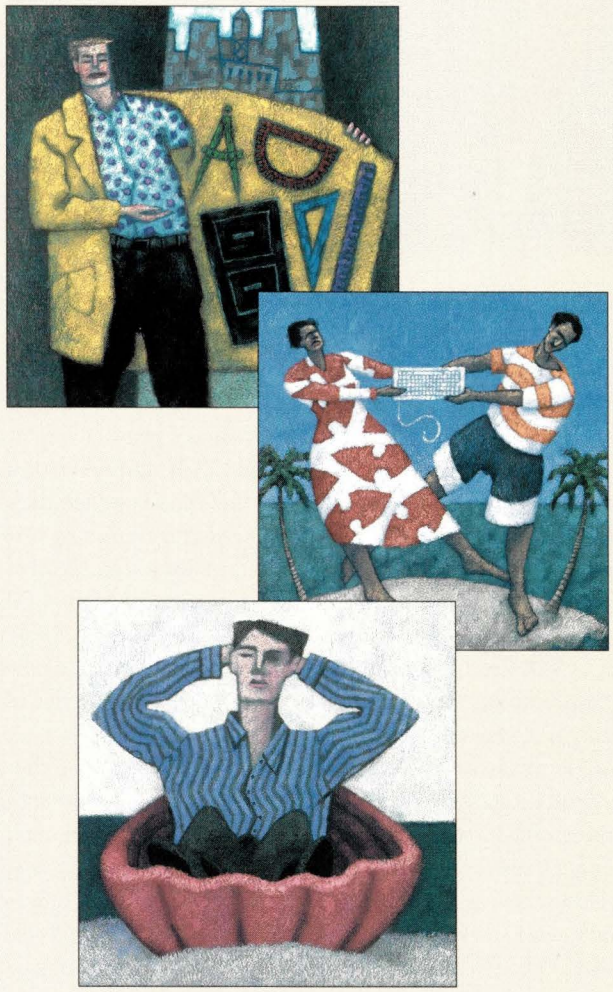
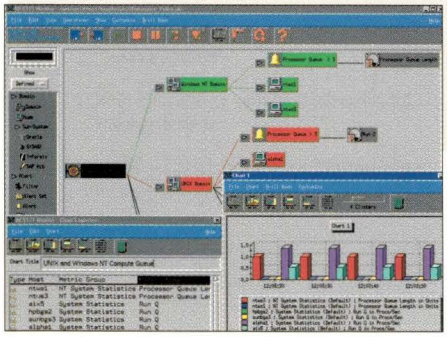
Columns



Columns illustrated by STEPHEN SCHILDBACH



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EDITORIAL

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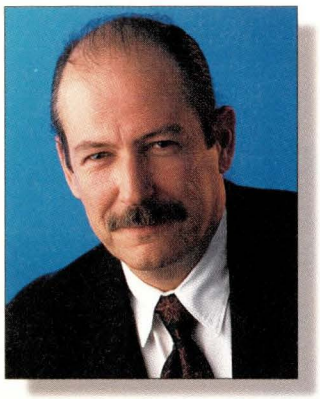

100 and Counting

This issue marks a milestone for *SunExpert*: It's number 100, believe it or not. All of us owe a debt of gratitude to our readers–some of you have been with us from the start. And several of our columnists have appeared in all 100 issues.

If you're an Ask Mr. Protocol fan, you certainly won't want to miss this month's installment, in which he answers the most intriguing and heretofore baffling question of all: "How did Mr. Protocol get that way, anyway?" It has something to do with being a part of the UNIX and networking world for many, many years and seeing the birth, childhood and adolescence of the Net we have come to know. You can read all about it beginning on Page 16.

For UNIX Basics readers, this issue contains a retrospective beginning on Page 28. It covers the nine years of this column. Many of the editors and some of the readers of *SunExpert* have learned much of what they know about UNIX from Peter Collinson. This month, you'll learn why we have such appreciation for his know-how and ability to share that skill and understanding in a way that once in a while makes even UNIX a joy to work with.

Also in this issue, we revisit a topic that seems always on the minds of computer professionals–the hard disk market. When *SunExpert* was new, there was this thing called a workstation that by definition displayed one megapixel and had enough disk space to store the UNIX operating system–paging and swapping along the way. Disks are different today. To find out how, read Alexandra Barrett's cover story, "Vintage Disks in High Gear," Page 48. Remember when they were called Winchester drives because of their performance specs: 30 MB of capacity and a 30-msec access time, like the .30-caliber rifle? In this article, you'll find out what disk manufacturers have done to improve them so dramatically since then. Alex asks a telling question, "Will they be able to keep promising better price/performance and lower dollars per megabyte, or are we in for a surprise?" Time will tell.

Doug Pryor

SUNEXPERT
The Server/Workstation Magazine

February 1998 Vol. 9 No. 2

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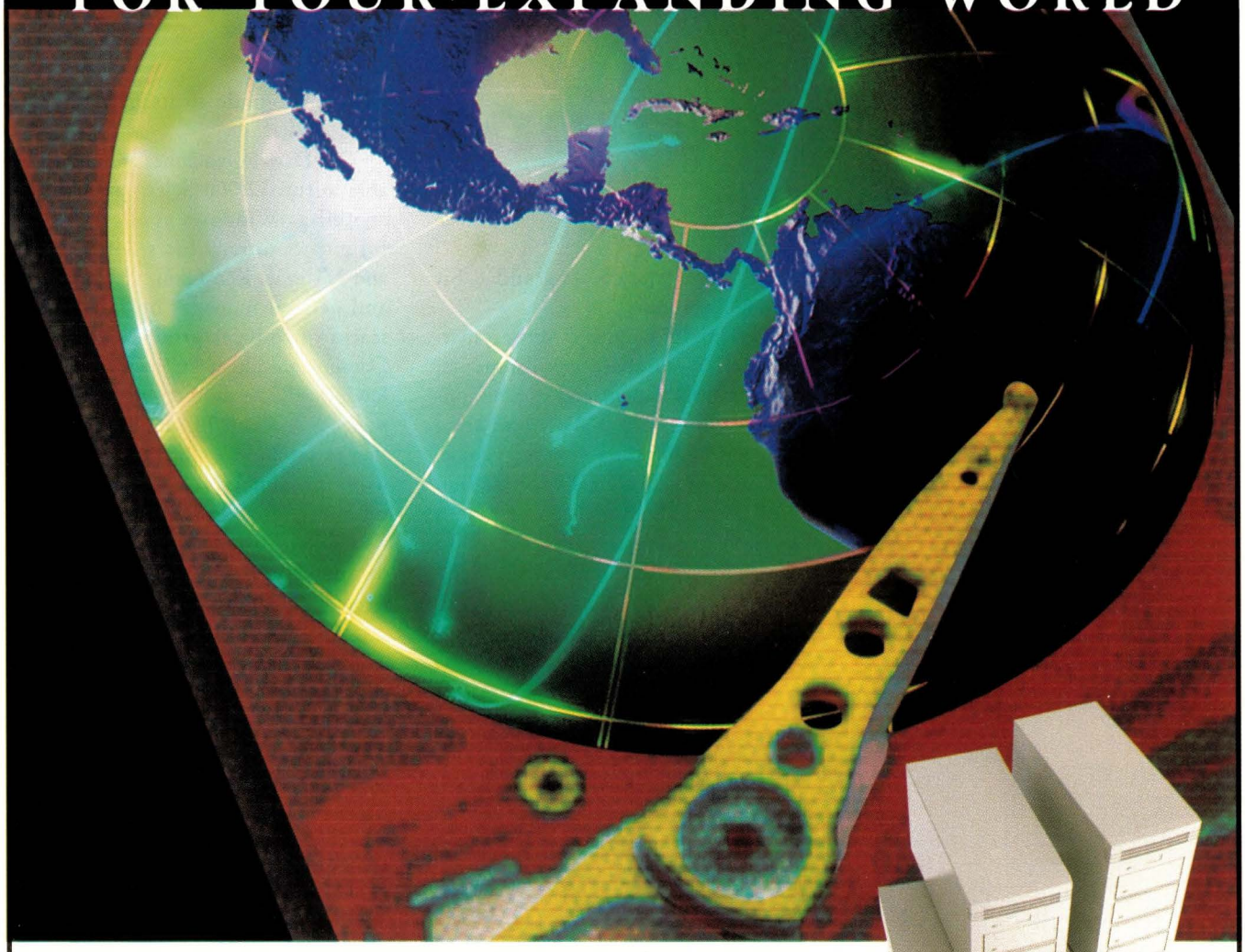

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SunExpert NEWS

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Sun Workstations at PC Prices

Sun Microsystems Inc.'s January workstation rollout offers new options for users at both the high and low ends of the market. All the new machines offer a 64-bit, 66-MHz PCI bus and a packet-switched crossbar architecture. The new additions expand Sun's PCI workstation product family, which debuted in August with the announcement of the Ultra 30 workstation.

Sun's new Ultra workstations all offer a 64-bit, 66-MHz PCI bus.

The low-end products, the Ultra 5 and Ultra 10, both code-named Darwin, are reported to cost $2,995-$4,495 and $5,595-$10,295, respectively (the lowest priced models ship without monitors). The Ultras initially ship with Solaris 2.5.1.

The Ultra 5 offers a 270-MHz UltraSPARC IIi [integrated] processor, support for 64 MB to 512 MB of ECC RAM and a 4-GB disk. Three PCI I/O slots come standard as well as 10/100BaseT networking and 8-bit integrated graphics.

The Ultra 5 is aimed at vertical markets such as database environments, software development and digital content creation. "These machines are a very good value proposition for people. Given the choice, a UNIX workstation is still a much better machine than a PC or NT workstation," says Bob Sakakeeny, analyst at The Aberdeen Group, Boston, MA. He adds, "UNIX still leads in graphics capabilities, and many more technical applications are available for UNIX platforms."

The Ultra 10, which Sun refers to as the Ultra 5's big brother, differs by offering a 300-MHz UltraSPARC IIi processor, 64 MB to 1,024 MB of RAM, a 4-GB or 8-GB disk and four PCI I/O slots instead of three. This model offers 10/100BaseT networking, but also offers Sun's Creator graphics with an upgrade to its new Elite3D m3 graphics.

The Darwin machines are said to be able to run 12,000 Solaris applications as well as Windows applications via Insignia Solutions Inc.'s Softwindows and NTrigue. Ken Okin, vice president and general manager of Sun's workstation products group, says, "The Darwins are like a PC in that they are low priced, use industry-standard components and run PC applications, but they're far superior because they offer users proven UNIX reliability and uptime." These low-end machines are also able to handle large data sets and data models as well as faster real-world modeling and offer scalability to a complete line of products from Sun.

On the higher end, Sun announced its Ultra 60, a multiprocessing workstation for under $20,000. The Ultra 60 offers one or two 300-MHz UltraSPARC II processors, 2-GB RAM, 2 MB of cache and up to 18 GB of internal hard drive capacity. Two 64-bit PCI buses come standard providing four PCI I/O slots. Two UPA graphics slots support up to two 24-inch monitors and a choice of either Creator 3D or Elite3D graphics (see below).

Like the low-end Ultras, the Ultra 60 supports 10/100BaseT networking and runs Windows applications. This high-end workstation is targeted at markets such as animation, film and video digital content creation, financial analysis and MCAD.

Both the low- and high-end machines allow users to integrate PC networks with Solaris networks via third-party networking software and allow for transparent file sharing between PC and Solaris environments,

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Sun Service Options

Sun has added several new lower cost choices for customers who may not be working in mission-critical environments and, therefore, can afford to wait a day or two for service.

The first offering, called SunClient Maintenance, costs $276 per year in the United States and entitles customers to next-business-day on-site repair and on-site maintenance for each desktop purchased from Sun resellers. One step below that is SunClient Central Maintenance, which costs $216 per year and ensures a repair by the second business day as well as on-site maintenance. With this plan, however, a technician will not be sent to a site to repair just one machine; there must be multiple units in need of repair. A third offering, SunClient Software Technical Support, gives users telephone support for all Sun applications during regular business hours. Pricing is based on a tiered structure and must be quoted by Sun.–*mm*

Sun says. PC applications can print to all Solaris and Windows NT networked print services, and PC and Solaris applications share the same screen. Aberdeen Group's Sakakeeny says that with the introduction of these new machines, "Sun is protecting their own turf. They're not necessarily going after new PC customers, but instead offering these machines to their current customers and offering them an alternative to going to Microsoft [Corp.], Dell [Computer Corp.] or IBM [Corp.] for low-end machines."

With the announcement, Sun also unveiled a new line of higher performance graphics products called the Elite3D graphics family. The Elite3D option reportedly gives users high-performance geometry acceleration, increasing performance up to five times that of Sun's Creator 3D graphics. Optimized OpenGL libraries are standard with the new graphics products. The Elite3D m3 and m6 support 24-bit double-buffered plus z-buffer graphics, accelerated imaging, sub-pixel addressing, antialiased lines and dots, and a resolution of up to 1,280 by 1,024 at 76 Hz. In addition, the Elite3D m6 comes with two on-board serial ports for virtual reality applications and single pass stereo.

The Elite3D m3, the low end of Sun's 3D graphics family, offers 2.9 million triangles per second, CDRS (Parametric Technology's modeling and rendering software for computer-aided industrial design) performance at 73 and PLBsurf of 458. While the m6 version reports performance of 5.9 million triangles per second, CDRS performance of 130 and PLBsurf of 600.

Sun will also be extending Sun service options to an area called SunClient Support (see "Sun Service Options"), which focuses specifically on service and support for network computers and non-critical usage workstations.–*mm*

Java JumpStart

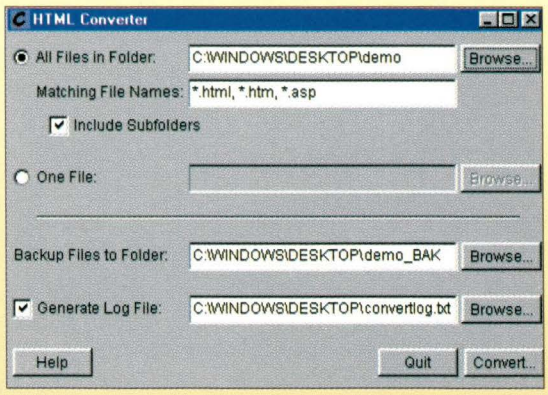
At Internet World in New York in December, Sun Microsystems Inc.'s JavaSoft division made a host of announcements aimed at encouraging corporate software developers to use Java in a wider array of business applications. Dubbed Java JumpStart for the Enterprise, the suite of products and specifications are supposed to provide an "end-to-end solution for deploying and managing Java in the enterprise," according to JavaSoft President Alan Baratz.

Included in the JumpStart package is the Java Runtime Environment (JRE), platform APIs, JavaPC–a package for turning aging PCs into Java machines–and Java Web Server 1.1, an HTTP and proxy server that is sold separately for $300. Java Web Server uses Java Servlets–server-side programs–in place of CGI scripts. Pricing had not been set for the Java JumpStart bundle at press time.

JavaSoft also introduced the Java Activator. Using this product, Web designers implant special Activator code into their pages. This code then checks visiting Web browsers for the presence of Sun's Java Virtual Machine (JVM). If a JVM is absent, Java Activator will "upgrade" Microsoft Corp. Internet Explorer and older Netscape Communications Corp. browsers to run the latest version of Sun's JVM.

Sun also announced a beta release of the latest Java Developer's Kit (JDK 1.2), with new Foundation Classes that feature the Swing set, a collection of sliders, buttons and other utilities for building cross-platform GUIs; security enhancements, including policy-based access control and certificate interfaces; and the Java 2D API, a set of classes that extends Sun's Abstract Windowing Toolkit (AWT) and allows shapes, text and images to be rotated and scaled. Also included in the new JDK are just-in-time compilers for all major platforms, and native Solaris thread support.

At the same time, Sun released the initial draft of its Enterprise JavaBeans, a specification that, Sun hopes, will broaden Java's reach to mission-critical, server-side application development. The Enterprise JavaBeans specification–supported by vendors such as Novell Inc., Netscape, Informix Software



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Circle No. 5

Inc., Symantec Corp. and Sybase Inc.–outlines an API to extend the JavaBeans model to allow developers to build components for complex business processes. For instance, a developer of an inventory management system could create one JavaBeans component to search an inventory database and another to send an alert when the stock falls below a critical level. The current specification has been released for public comment (see `http://java.sun.com/products/ejb/docs.html`), and Sun will post the final version on its Web site some time early this year.

"Sun is sending out the message that Java is more than a generator for client-side 'eye candy' ... that Java is ready for your corporate needs, and here's the specs to prove it," says Ron Rappaport, analyst with Zona Research Inc., Redwood City, CA. "The adoption of Enterprise JavaBeans is going to be a reflection of the industry's willingness to embrace Java as a mission-critical language."

Sun still needs to convince customers that Java is fit for mission-critical applications, and it needs to encourage independent software vendors and corporate developers to build enterprise Java applications. If successful, Sun could spark the growth of a vast new market. A recent report from Zona predicts that the potential market for server-side, enterprise Java applications will be much greater than that for client-side Java.

One proponent of enterprise Java, Oracle Corp., is hoping to tap that potential market. Oracle chose Internet World to unveil its Network Computing Architecture (NCA). Oracle's NCA blueprint calls for all applications and data to be stored on servers, with the NC, or "appliance client" as Oracle CEO Larry Ellison has dubbed it, acting as a graphical interface. In addition, the company announced that all of its client/server applications will now be available in Java, and Ellison boasts that he expects a "100% migration" of Oracle's customers from the client/server versions of Oracle's applications to the new Java versions.

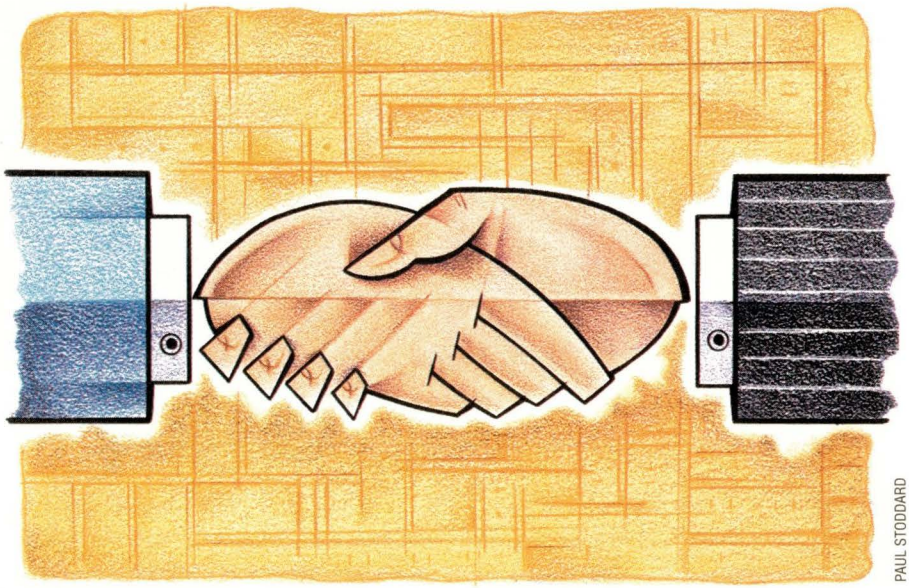
In other Java news, Sun's JavaSoft division was recently awarded the status of Publicly Available Specifications (PAS) submitter by the International Standards Organization, despite a negative vote from the U.S. delegation. PAS status gives Sun the right to submit its JVM, core class libraries and other key Java technologies for approval as international standards–and, thus, control the development of the Java language. This is the first time that a for-profit company has been given PAS submitter status.–*sh*

Sun Supports Merced

Sun Microsystems Inc. and Intel Corp. have agreed to work together to bring the Solaris operating system to Intel's IA-64 chip when it is released. IA-64, code-named Merced, is still in development and is not scheduled to hit the market until 1999. The two companies also plan to create an optimized 64-bit version of Solaris for the chip. "Sun will deliver a very optimized version of Solaris on Merced to take full advantage of all its capabilities," says Janpieter Scheerder, president of Sun's software division SunSoft.

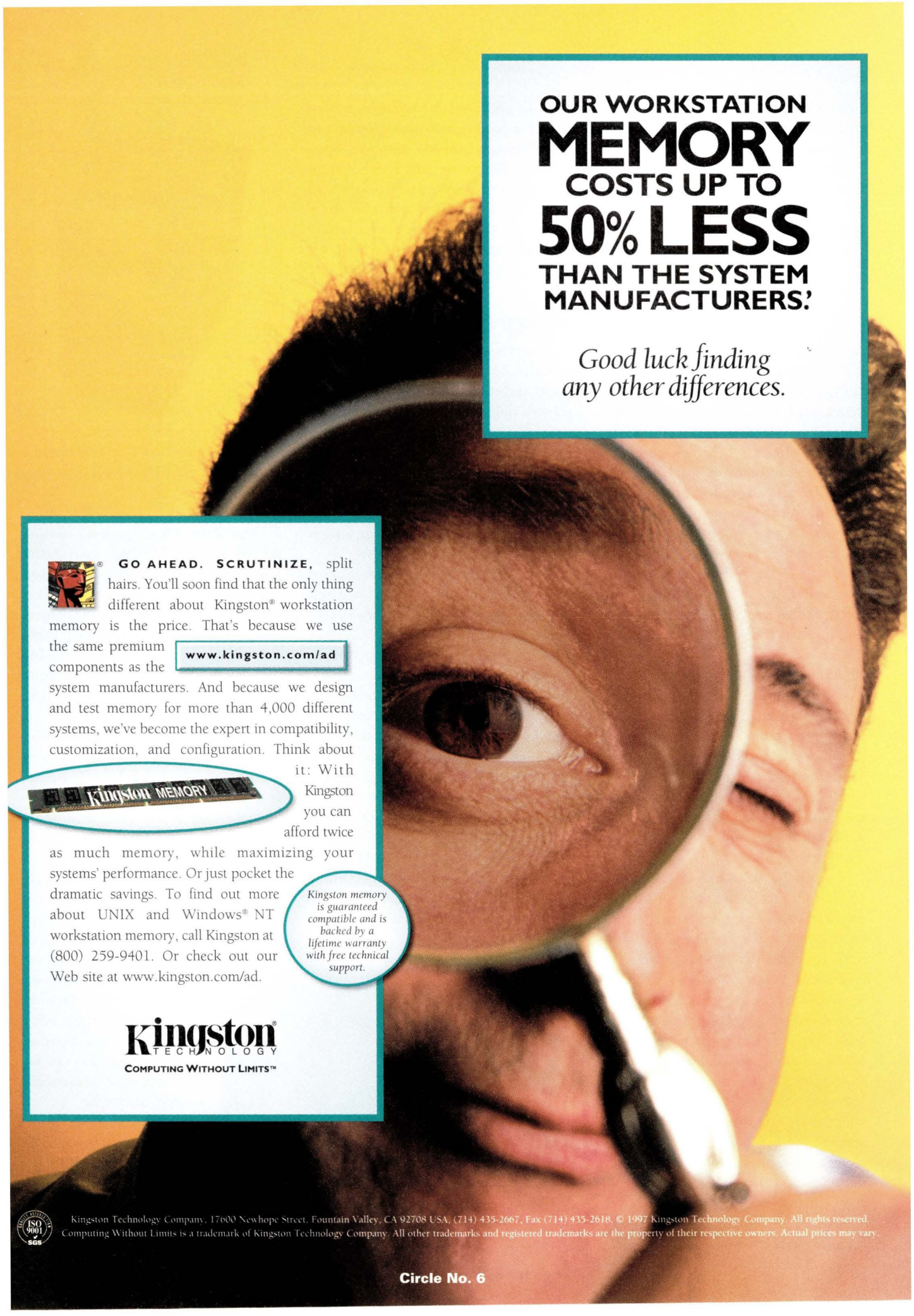
The plan to port Solaris to Merced was made possible because the two companies have entered into a royalty-free patent cross-licensing agreement that covers microprocessors, systems and software technology. The specific details of the agreement were not released. "I think the important concept is that it enables us to work together on this Merced-Solaris port," says John Miner, vice president and general manager of Intel's enterprise server group. "That is the important essence of the cross license. Other than that there really is no other significance."

Merced, codeveloped by Intel and Hewlett-Packard Co., is expected to have significant impact on the microprocessor market when it is released. The reason for all the hype comes from Intel's claims that Merced will offer impressive performance, particularly in running parallel programs. The target for this next-generation chip will be the high-end workstation and server market, which is a significant portion of Sun's SPARC business. "I think the world is consolidated to two processors, SPARC and Intel, and we [Sun] play on both platforms," says Scheerder. "What the world wanted to hear is that Intel and Sun Microsystems [will] work together to put together the Intel processor set and Sun software set. That's what they wanted to hear because that will give them the comfort level to commit to this."



PAUL STODDARD

Sun and Intel have already worked together with Solaris on Intel's x86 chip, but so far the union hasn't yielded much success. Some analysts feel the reason simply has to do with the market. Big system makers like IBM Corp. and HP already have their own UNIX and have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no need for Solaris on x86. While second-tier manufacturers typically turn to Microsoft Corp. Windows NT.

Some companies have embraced the Solaris on x86. For example, NCR Corp. offers UNIX systems with Sun's Intel x86 version of Solaris and plans to offer the Merced release when it becomes available. "I think it is mainly the market," says Linley Gwennap, editor-in-chief and publisher of *Microprocessor Report*, Sunnyvale, CA. "There is nothing particularly bad about Solaris on x86 versus NT on x86 in terms of performance. In the big systems, Solaris definitely scales better, but it is a market reality that most people are going to want go with the Microsoft product where they can."

This market scenario may foreshadow a similar situation when Merced is released. "All the people that are [building] big x86 servers have announced they will be building big Merced servers," says Gwennap. "The same operating systems that are available on x86 today are going to be available on Merced. So there is nothing that really changes the picture that much."

Sun joins HP and Digital Equipment Corp. in offering its UNIX operating systems on Merced. "We're very pleased that Sun has supported the IA-64 architecture," says David Scott, director of HP-UX software marketing at HP. "Sun becomes the third, superscalar RISC vendor to freely declare that the way forward is through IA-64. [This] signals the death knell of SPARC."

Ultimately, the market will decide if HP's Scott is correct or merely wishing this news truly represents the "death knell of SPARC." More likely, the agreement is a reflection of Sun's attempts to fend off Microsoft's Windows NT. Sun's Scheerder says that Sun's goal with this announcement is to penetrate the enterprise. Intel, for its part, is willing to let customer demand decide which operating system will win out. "[Solaris on Merced] means that customers can select their favorite operating system and get the full benefit of Intel-based servers," says Intel's Miner. "It expands the options available to OEMs, ISVs and IT managers."

Support for Solaris on Merced will come from Sun's SunService organization. In addition, the companies plan to create porting and tuning centers to help ISVs and OEMs tune and optimize applications and their system environments on both Solaris and Intel. "Sun and Intel will also share certain patents and licenses on a variety of products to make this a little bit easier," Scheerder says.–*ptc*

Proxy Cache in a Box

Internet service providers, telephone companies and large corporations rarely debate whether or not a proxy server could save them money. If it's true that around 40% of Web-page requests are redundant, then it's easy to see how caching local copies of frequently requested Web pages could slash telecommunications charges as well as increase the speed at which pages get delivered.

Apparently, both Sun Microsystems Inc., Mountain View, CA, and Network Appliance Inc., Santa Clara, CA, believe that the wisdom of proxy servers has dawned on network service providers. In December, at Internet World in New York, both companies announced a proxy caching hardware/software bundle. Sun's implementation, the Netra Proxy Cache, is based on an UltraSPARC server running Solaris and is loaded with Sun's own Netra Proxy Cache 1.0 software. Network Appliance's cache solution, called NetCache, adheres to the company's single-purpose appliance philosophy, running on a combination of proprietary hardware and operating system software.

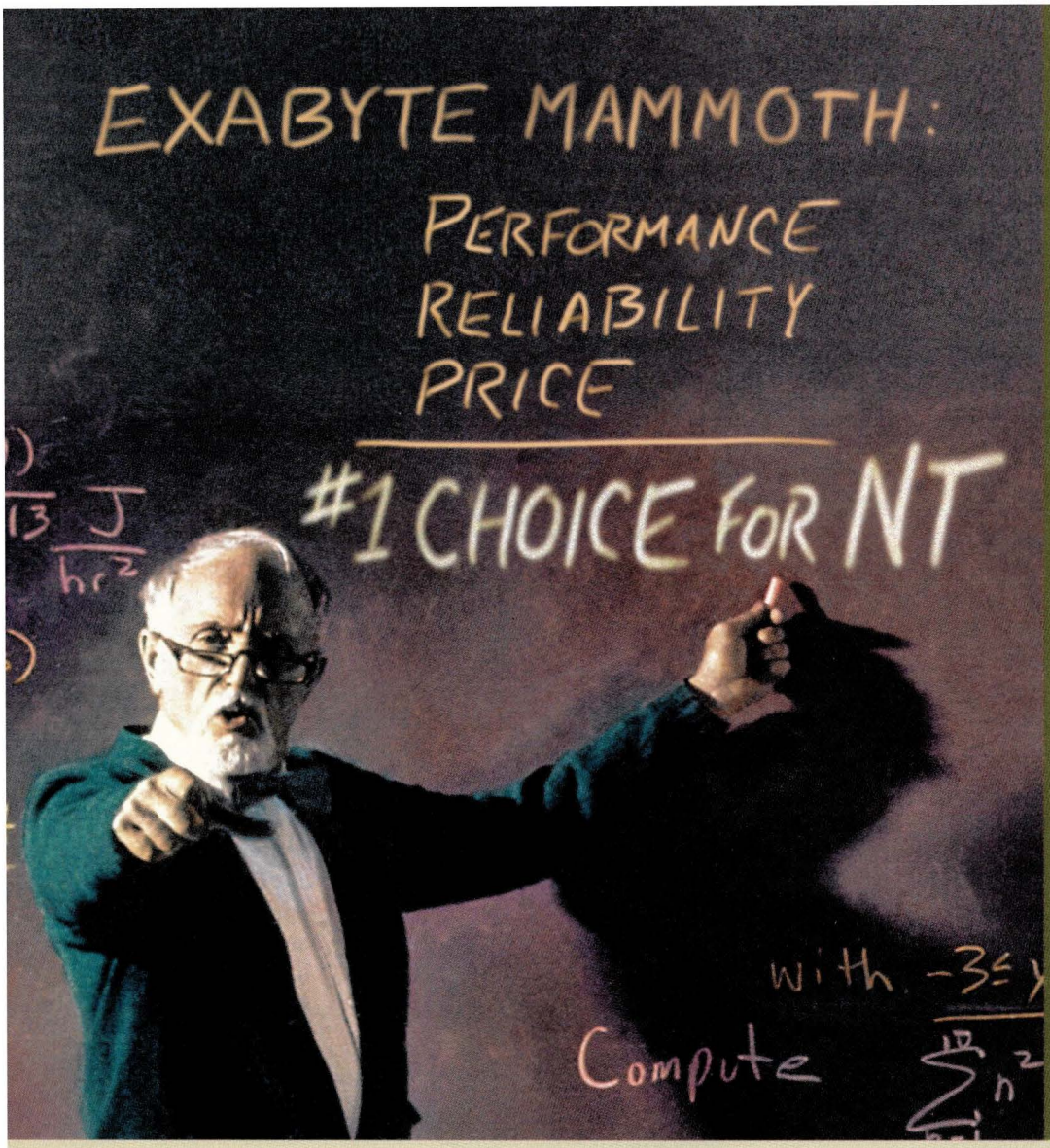
Sun's Netra Proxy Cache is based on an UltraSPARC server running Solaris.

The actual cache software running on the Sun and NetApp proxy caches hails from essentially the same source. According to Sun's Shiva Mandalam, senior product manager for the network products group, the Netra Proxy Cache 1.0 software derives from the public domain Harvest cache, with some significant enhancements tacked onto it–such as load balancing between servers. NetApp's NetCache software has its roots in the same soil: In March, NetApp acquired San Jose, CA-based Internet Middleware Corp., the company founded by University of Southern California Professor Peter Danzig to commercialize the Harvest cache.

To date, proxy caches have typically come as software-only. Examples include proxy servers from both Netscape Communications Corp. and Microsoft Corp., and the public-domain Squid. So in a sense, both the Sun and NetApp offerings represent a departure from the way proxy caches have traditionally been marketed.

Sun's offering comes in two flavors. The lower-end model, the Netra Proxy Cache Server, features a single 250-MHz UltraSPARC processor with 128 MB

The NetCache C630 supports up to 512 MB of memory and a maximum of 26 drives.



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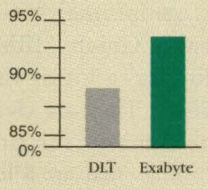
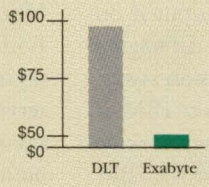
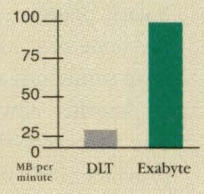


Annual Reliability Rate



Cost per Megabyte



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of RAM, a 8.4-GB disk capacity, 100BaseT Ethernet connectivity, CD-ROM and floppy, as well as Solaris 2.5.1 operating system software. Meanwhile, the Netra Proxy Cache Array 30 features two 100BaseT Ethernet connections, which allow users to take advantage of the caching software's failover and load-balancing functionality. The two models are priced at $13,995 and $18,995, respectively.

NetApp's NetCache also comes in two configurations: the C230 and the C630. The C230 supports up to 256 MB of memory and 14 4.3-GB Wide SCSI or 9.0-GB Ultra SCSI drives. The C630 supports up to 512 MB of memory and a maximum of 26 drives. Connectivity options for both models include all varieties of Ethernet, FDDI and ATM. Pricing for the two models starts at $16,550 and $65,720, respectively.–*ab*

Looking Out for the Little (Business) Guy

Is Internet business becoming a serious subject for the people at IBM Corp.? Big Blue recently unveiled several Web-serving and Internet-related products and services. The most significant aspect of these announcements is the indication that IBM is focusing its attention on helping companies that are not yet members of the Fortune 1,000. "This is a very good step for IBM," says Eric Paulak, senior analyst at Gartner Group Inc., Stamford, CT. "It gets them out of the 'build them big and powerful, custom Web-hosting business,' which is pretty much all they have been doing."

Instead of constructing custom Web servers only for large companies, IBM hopes to offer a standard approach that will meet the needs of a broader audience. "We can build the large Web-hosting sites on a custom basis," says Larry Thompson, brand manager at IBM. "The challenge in the marketplace is to bring that level of reliability and performance to those customers that are not spending millions of dollars a year on Web hosting."

Specifically, IBM has unveiled several enhancements to its Content Hosting Service, which offers companies a means to outsource Web site operations. The enhancements offer more choices for customers, including different database, platform and firewall configurations, as well as making Microsoft Corp.'s Internet Information Server (IIS) an option.

PAUL STODDARD

Furthermore, IBM has altered its pricing model for bandwidth connectivity from one that charges per number of bits transferred to a fixed-amount pricing structure or a specific speed, such as T1. In addition, IBM now offers customers a choice of three server platforms, IBM RS/6000 and Sun Microsystems Inc. servers running the corresponding UNIX operating systems as well as Intel Corp. Pentium Pro II servers using Windows NT. Typically, users can pick a platform based on the type of system they operate within their company. "If they write scripts on a Solaris platform they want to put it on the same one, as opposed to debugging it on something else," Thompson says.

Another new offering from IBM is one directed at the Internet service provider (ISP) market. Called the IBM Intelligent Subscriber Management System (ISMS), the product is available only on IBM's AIX platform, but ports to Solaris and other operating systems are planned for later this year. ISMS offers ISPs a user-profiling system that collects demographic information on their customers and tracks online access patterns. IBM says this information can help an ISP offer its customers more individualized information as well as generate revenue by providing information for targeted advertising.

Other related IBM announcements include Asset Services, an Internet delivery service that allows companies to track and manage their desktop computers and software, and the beta release of a new technology for embedding hot links into digital video, dubbed Hot Video. With HotVideo, users can click on video elements and connect to another Web page. Also, IBM has partnered with United Parcel Service (UPS) to distribute a CD-ROM called UPS/IBM HomePage Creator to 6,000 small business customers. The CD-ROM is designed to offer businesses the services required to create an e-commerce Web site. Furthermore, UPS Online Office shipping software can be installed from the CD, and users can gain access to UPS' Internet-based package tracking service, which can be built directly into Web sites designed with the IBM HomePage Creator.

While analysts agree that these latest product offerings are certainly a positive step for IBM and its customers, on a technological side, nothing really new is being offered. "Is this something significant from a architecturally and technical perspective? Not really," says Matthew Kovar, senior analyst with Boston-based Yankee Group. "IBM is trying to 'productize' a lot of their services and abilities. They are clearly trying to define some of the price points and offer things that are a little more standard."–*ptc*

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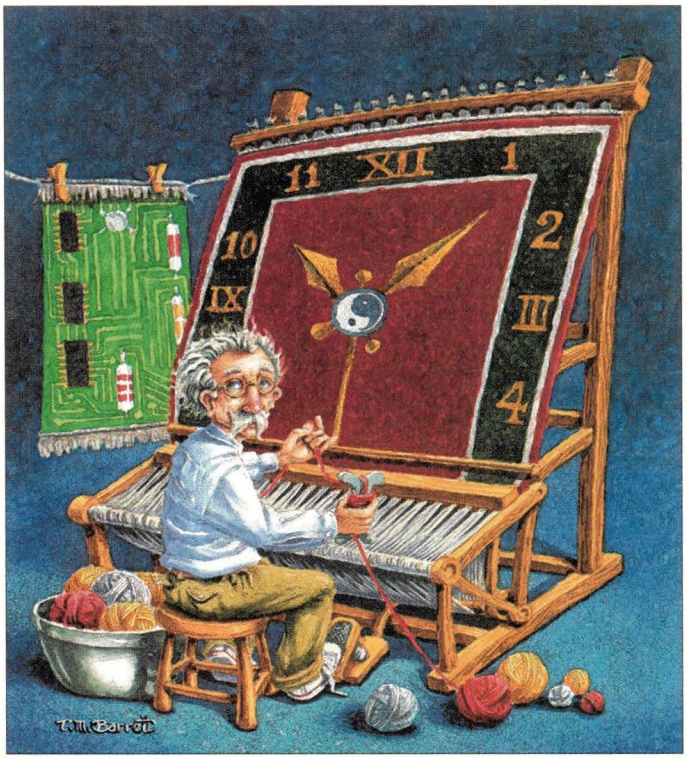
Ask Mr. Protocol

by Michael O'Brien



TOM BARRETT

"Never look back. Someone might be gainin' on you."
– Satchel Paige

"256 hosts is essentially infinite." – Original ARPANET planners

"Sometimes the Host Ready relay gets stuck. You have to thump it."
– Steven Tepper

Mr. Protocol Looks Back

Q: *How did Mr. Protocol get that way, anyway? And is it catching?*

A: To answer your second question first: Yes, occasionally, especially when it looks as if it might be profitable.

Your first question is much harder. Let's consider something easier instead, such as *Mary Poppins*. In the Disney movie of this remarkable tale, echoes of *Fantasia* are brought to bear as we listen and watch the bird woman on the steps of St. Paul's Cathedral ("Feed the birds, tuppence a bag."). The birds at the real St. Paul's are pigeons, not half so graceful as the abstract dove-like flocks in the movie, but St. Paul's is its own best advertisement and is beautifully rendered in the movie. In fact, this movie sequence is made memorable not by the flocks of birds, or the old woman on the steps below. It is St. Paul's that lends magnificence to the music.

Because England is not the United States, it is possible to climb to the top of the dome of St. Paul's, mostly because people have been doing it for hundreds of years. It is a mainstay of British society that anything that people have been doing for hundreds of years is something to be cherished and continued, including encouraging anything that's been going on for hundreds of years, so the whole thing sort of carries itself along, if you see what I mean.

The dome of St. Paul's is actually two domes, one inside the other. The inner dome carries the paintings that people see as they stand beneath, looking up from the floor of the church. This dome is shaped like a flattened beehive, so that people can actually see the paintings. If the paintings lay on the inside surface of the hemispherical dome we see from the street, most of them would be invisible, because they would be vertical.

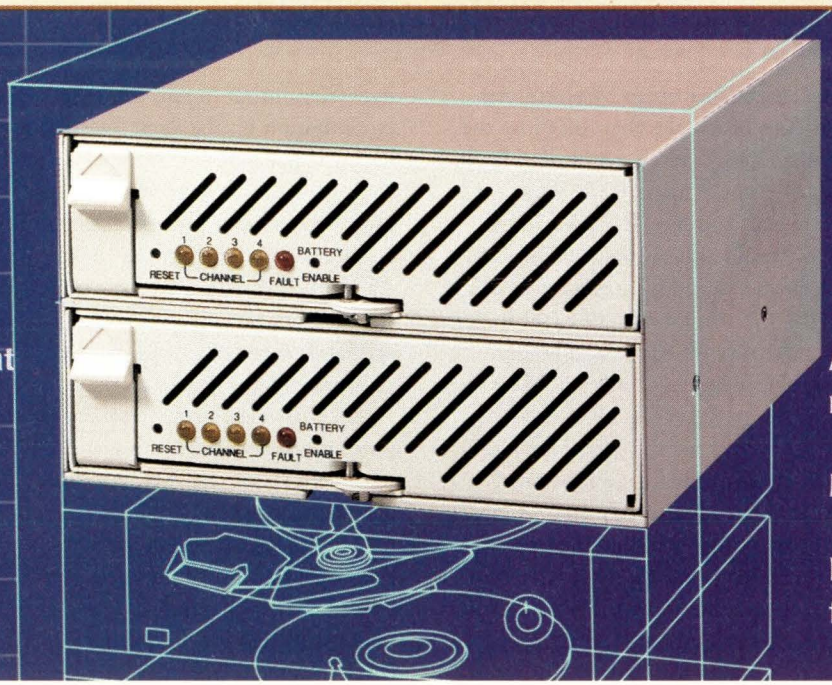
The way to the cathedral spire lies between the two domes, inner and outer. At the last, one comes out to a dizzying prospect no more than 50 feet across: The "lantern," or square spire, sits within a round gallery, leaving no more than 18 inches of clearance between the corners of the spire and the railing around the gallery. No one minds. Beyond lies the London cityscape. It is this view that we must consider.

Greater London burned to the ground in the great fire of 1666. There are few buildings in the center of London that date from before this time, and no large ones. What we are left with is a skyline that consists of a mishmash of buildings constructed between 1667 and the present.

London consists of about two dozen parishes, each with its own parish church. All of these churches burned in the fire, along with the original St. Paul's. England's greatest architect, Christopher Wren, not only designed St. Paul's, but also many if not most of the parish churches that can be seen from the lantern of St. Paul's.

Knowing this, the thoughtful observer will see not a mishmash, but a palimpsest. One or two of these churches now lie in ruins due to the blitz of World War II,

VARBusiness Editor's Choice



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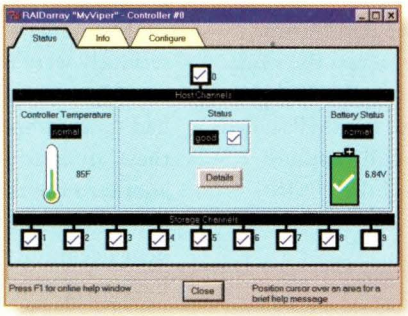

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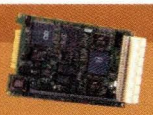


ORD-5330

ORD-5640

Circle No. 9

but the rest stand. The London of Christopher Wren still lies before the observer, in the dozens of steeples that rise above the common buildings below. Shakespeare, Wren, naval clerk Pepys and Marlowe, the tavern brawler, could name many if not most of the churches you see before you, and the Houses of Parliament and Westminster Abbey would also be familiar. Their London is still there to be seen and visited by anyone who will take the time, and who has the will and knowledge to see it.

The old does not often make way for the new. The new grows up in and around the old, shaped and influenced by it.

The Internet grew out of the ARPANET. Most folks would say the ARPANET made way for the Internet. The ARPANET was made up of Interface Message Processors (IMPs), Host/IMP interfaces, leased lines, Terminal Interface Processors (TIPs) and other large, heavy pieces of jargon-laden hardware that are now sought after by museums. No one dials in to TIPs any more to make terminal connections on the road. Space doesn't have to be made for a six-foot rack with a computer in it, just to connect four other computers (maximum!) to the Net. Yes, the ARPANET is gone all right, and good riddance, they say. Hmmm.

Sherman, set the Wayback Machine for 1977 in Santa Monica, CA. IMP #1 was still in service at the University of California at Los Angeles (UCLA) in nearby Westwood, with a big, glossy photo of Robbie the Robot plastered on it. Hollywood being nearby, Robbie had paid the IMP a visit and left a publicity still behind. The IMP was a favorite trophy to display, not least because of the huge steel ring bolted to the top: The first IMPs were designed to be craned into submarines if necessary.

IMP #7 was buried in the basement of The Rand Corp. (not yet The RAND Corp.) in Santa Monica, across the street from the beach. The machine room that contained it had previously held the JOHNNIAC computer. Now, the IMP shared space with a large Digital Equipment Corp. minicomputer running the first commercially licensed copy of the UNIX operating system.

An IBM World

The ARPANET was developed in a computing world that, although dominated by IBM Corp., was far more pluralistic than today's. Every mainframe machine room contained an IBM 360 or 370, with few holdouts running Univac or Honeywell hardware. Rand was no exception. Host #1 on IMP #7 was an IBM 370 mainframe running MVT. At Bell Labs, scientists interested in what we'd call scientific supercomputing today were figuring out how to change the microcode in a 370. They did this successfully and reported in the academic paper describing the process that one of the more interesting results is that IBM did nothing to hinder them–IBM at that time being something of a natural force to be researched rather than a company to be negotiated with.

IBM was the center of the computing universe. Its operating systems were oriented to serving batch computing jobs and running large numbers of terminals doing transaction processing through terminal concentrators. Then, as now, its mainframe business was oriented more toward moving large amounts of data from hither to yon than supporting large amounts of computation on the data. This led to a highly optimized and highly specialized I/O system that so dominated its system architectures that support of what we now think of as general-purpose computing was baroque in the extreme. Word processing was so far from the IBM mainframe model that Prof. An Wang created a gigantic corporation to fill the gap with special-purpose engines...which crashed years later when the special-purpose engines were swept away by cheaper general-purpose engines that filled the same ecological niche.

So, with IBM firmly established in the center of the computer room, it came as no surprise that many machines on the ARPANET were IBM mainframes. UCLA supported a nearly unique Model 360/90 that was a supercomputer for its time.

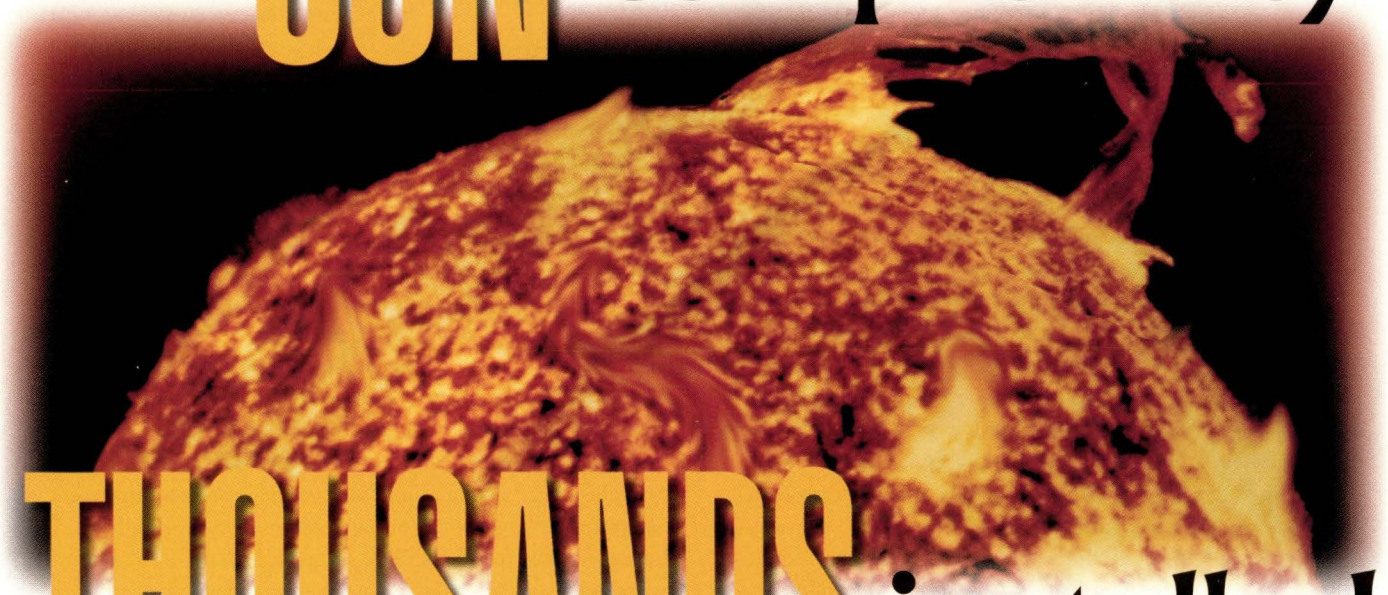
The ARPANET supported batch computing. Early RFCs describe a number of interesting attempts at creating general-purpose batch queuing systems that were really quite ingenious, failing only because no one developed any general-purpose batch jobs to go with them. Batch jobs were intrinsically non-portable, and the "software tools" culture was years in the future. So, while IBM mainframes resided on the ARPANET, most of the traffic was originated by other hosts–hosts with a more interactive usage style.

From its earliest days, the ARPANET shone in its interactive applications. Telnet acted as a generalized dial-up service. `Finger` told you where people were and what they were doing. You could even find out the temperature in the machine room: There was a special socket number reserved for a time and temperature service. The only serious background processing that took place was mail.

The result was that most people who used the ARPANET seriously were not IBM users. The ARPANET users favored a wide variety of other systems. Carnegie Mellon University had its C.mmp and CM* multiprocessor systems. One of these, interestingly, had no mail system–its users favored another system for email–and sent out precisely one electronic mail message in its entire lifetime, announcing its imminent decommissioning. The University of California at Santa Barbara sported a Culler-Fried graphics system, which had two full-size keyboards, one above the other. It had been designed for mathematical modeling, and its two keyboards, plus shift, alt and several meta keys, supported a mathematical character set of immense size. Locals called it the "Culler-Fried Chicken" system.

If the ARPANET had a dominant species, it was the DEC PDP-10 running TENEX. TENEX was written at Bolt, Beranek and Newman (BBN), which, funnily enough, was the same company that built and deployed the ARPANET under contract to Advanced Research Projects Agency (ARPA). BBN wanted to build a general-purpose time-sharing system with a unified architecture, unlike the ratbag of special cases that made up the IBM architecture. Time-sharing was the most powerful way of using the ARPANET, because local workstations and local-area networks were still experimental toys at Xerox Palo Alto Research Center (Xerox Corp. had not yet fumbled the future). In order to provide the page-oriented virtual memory they desired, the BBN

full SUN compatibility



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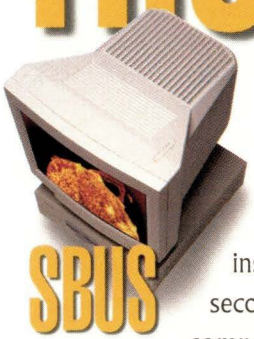

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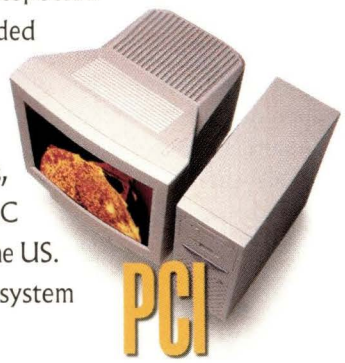

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researchers built their own paging hardware and bolted it onto the side of their PDP-10.

TENEX was wildly successful. People who believe that Macintosh users are fanatics have never met a TENEX fan. In fact there are a large number of former TENEX users who would really prefer to still be using TENEX, and who believe that it was, is and always will be far superior in design and implementation to UNIX. They aren't deranged, either, even though they sound like it. Of course, show them "@" as an interactive prompt and they go all soggy on you.

The PDP-10 had one real peculiarity, though. It was a 36-bit, word-addressed machine. Now, 36 has factors of 3, 3, 2 and 2. This gives you the possibility of defining a byte as four bits, six bits, nine bits, 12 bits, 18 bits or even seven bits or eight bits, if you don't mind a few odd bits left over. Lisp being the favored programming language of the day, a rich supply of tag bits was fairly universally felt to be a Good Thing, so byte lengths varied considerably in practice. SAIL, the Stanford Artificial Intelligence Laboratory, used to regularly hack on the microcode in its PDP-10's KI-10 processor, leading to the (eventually infamous) message of the day, which appeared with astonishing regularity, "The XYZ instruction has now been implemented. Please update your programs." Many of these instructions found their way back into DEC to become the basis of the KL-10 processor, the most powerful in the PDP-10 line.

So popular were the PDP-10 architecture and the TENEX operating system that Xerox PARC researchers, looking for a good central machine to hang their local net and workstations off of, tried to buy one. Xerox being itself at this time a commercial manufacturer of computers, having bought the Scientific Data Systems line of Sigma processors, refused to buy a competitor's top-of-the-line engine. (Years later, Apple showed no such signs of incipient senility when it bought a Cray to do circuit design. Apple's senility lies in other areas, such as marketing. ["What do you mean, people want to buy them? What on earth for? Tell them to make an appointment."]) Xerox researchers responded by beginning an initiative in microprogramming, designing and building a general-purpose microprogrammable mainframe engine that could be coded to emulate a variety of mainframes. The only emulation ever written was for the PDP-10. Once the emulation was working, TENEX was booted on the PARC-MAXC mainframe, and that was the quiet end of Xerox's research into mainframe emulation.

From the Sublime to the Ridiculous

To be sure, there were other systems out there. In large measure, that was the whole point of the ARPANET: to make unique resources available to researchers at other institutions. There were some doozies. The National Center for Atmospheric Research mounted the Datacomputer, which consisted of a central processor and a ridiculous amount of disk storage, all fronting for an Ampex Terabit Memory System. This set of about 10 special-purpose tape drives, recording onto two-inch videotape, represented by far the largest storage capacity available anywhere. Of course, a terabit is only on the order of 100 gigabytes, plus check bits, so anyone with a Platinum card can go down to Fry's and build their own terabit memory system today. It'll hold most of the games on sale at Fry's, too. At the time, though, the space made available by the Datacomputer was so immense that people seriously considered doing their daily backups to it over the ARPANET. Given the fact that the ARPANET was glued together with 56-Kb/s leased lines, when someone in Washington, D.C., fell into the daily habit of dumping several hundred megabytes of weather data to the Datacomputer in the middle of the night, the ARPANET became more useful during the day than during the night. This is the only period during the entire history of the Internet when this has been so.

Several different institutions wrote code to put UNIX on the ARPANET, and most of the efforts were underwhelming.

When the Datacomputer was eventually decommissioned, the public at large was given two entire weeks to get all their data off it over the Net and do something else with it. Those who had not become dependent on the Datacomputer breathed a self-congratulatory sigh of relief.

Another one-of-a-kinder was the ARPANET Terminal System, ANTS. This was developed at the University of Illinois at Urbana (aka "Shampoo-Banana"), and consisted of a large PDP-11 system running special-purpose software. It was a terminal concentrator for the ARPANET, and it never worked right. Its most successful feature was that someone had carefully created a trail of large ant cutouts along the top facing of the machine.

ANTS shared machine time with a few researchers who were playing with a system they'd gotten for $150 from Bell Labs, called UNIX. The idea was to see if this system might make a good candidate for being put on the ARPANET. It seemed a logical match, because it supported interactive use better than most other systems, had a number of useful tools in its own right, was cheaper than dirt compared with mainframe prices and came with full source code.

The answer turned out to be, "Well, sort of, if you try hard." Several different institutions wrote code to put UNIX on the ARPANET, and most of the efforts were underwhelming. One natural extension was to put host names out in the file system name space. On several of these early attempts, every host on the ARPANET was represented by a hostname in the `/dev` directory. This didn't work out too well. OK, you've done an `open()`, so now what? The semantics of the UNIX file system turned out to be a poor match to the requirements of networking semantics.

Someone finally wrote an ARPANET interface daemon that worked right. Because it had been foreseen that ARPANET hosts would be flaky, and indeed almost all ARPANET hosts were flaky, the ARPANET was designed to be connected via a group of special-purpose computers called Interface Message Processors (IMPs). These IMPs, in turn, were connected via 56-Kb/s leased lines. IMPs did not go down, or if they did, were designed to be rebooted remotely over the Net. Physical

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Circle No. 11

human intervention, outside of the monthly periodic maintenance that just about all computers of the era suffered, was almost never required. Because the weird byte sizes of the PDP-10 systems had shown people that different hardware architectures stored their bits differently, the connection between a host and its IMP was a bit-serial connection. Given the speeds the ARPANET ran at, this was not a performance problem. Hosts also had control over a one-bit relay, called the Host Ready relay, which they would turn on or off depending on the host's readiness to accept connection requests over the Net. It was part of the protocol of bringing a host up on the Net after a reboot that this line be "waggled" up and down three times, according to a specified timing interval, to alert the IMP to the reboot. And, for the sake of reliability, it was part of the hardware specification that this Host Ready relay be a mechanical reed relay, not a piece of logic.

Big mistake.

At Rand, the Host Ready relay had a tendency to become stuck. This necessitated taking the PDP-11 down, shutting it off, pulling the interface card out of the Unibus cage and thwacking the relay just so with the middle finger released off the thumb. If your fingernail hurt, you'd done it right. Plug the card back in, reboot the system, and when the Network Control Protocol (NCP) daemon started, look at the IMP to see if the Host Ready light on the front panel blinked on and off three times.

Meanwhile, upstairs, in the showcase computer center with the big IBM machine, the IBM's ARPANET interface was an entire box, a cube two-and-a-half-feet on a side, covered in blinking lights. The sad thing was, IBM's NCP was one of the best NCPs ever written. Stable, correct and with outstanding hardware to match (that cube, one of Advanced Computer Communication's earliest products, was a sterling piece of engineering), the IBM machine was one of the most capable ARPANET hosts around, but it was so hard to get at the ARPANET software that few people ever found a use for it, except as a remote printer. Everyone stayed on the flaky PDP-11 UNIX system, because Rand had converted a whole bunch of ARPA's finest dollars into software that is still being used today, under ARPA's Office of the Future initiative. This was the period when the Rand editor and the MH mail system were first written.

Along with a working NCP daemon, UNIX received a working Telnet, FTP and mail suite. Other useful packages came along too, which Mr. Protocol has mentioned before, such as SUPDUP, a Massachusetts Institute of Technology invention that was Termcap and Terminfo done right. Some stayed the course, some disappeared. But eventually, everything was forced to change.

The scientific workstation had been invented, and it cried out for a network. Several competing local-area networks existed at this time, and which one you ran depended on which workstations you were using. If you went the Xerox route, you strung 3-Mb/s Ethernet coaxial cable and learned how to deal with PUPnet software. If you ran Symbolics Lisp machines, you strung 10-Mb/s Ethernet in big fat coaxial cable and ran Chaosnet protocols.

And none of these workstations could talk to the ARPANET, because the ARPANET was based on a mainframe view of the world, where each IMP could only be hooked to four hosts (or, in rare cases, eight), at a cost of about $150,000 per year for each host. And the NCP protocols didn't allow for any such thing as routing. You connected the host directly to the IMP and the IMP did all the routing.

It was the LSI-11 routers that superseded the IMPs as Internet routers that made it possible to connect local networks to the big wide world.

All sorts of cockamamie schemes having to do with virtual host addresses were dreamed up to allow these new campus-wide LANs to be connected to the ARPANET, but wiser heads prevailed. This was not time for a kludge. This was a time for transition to a whole new set of protocols.

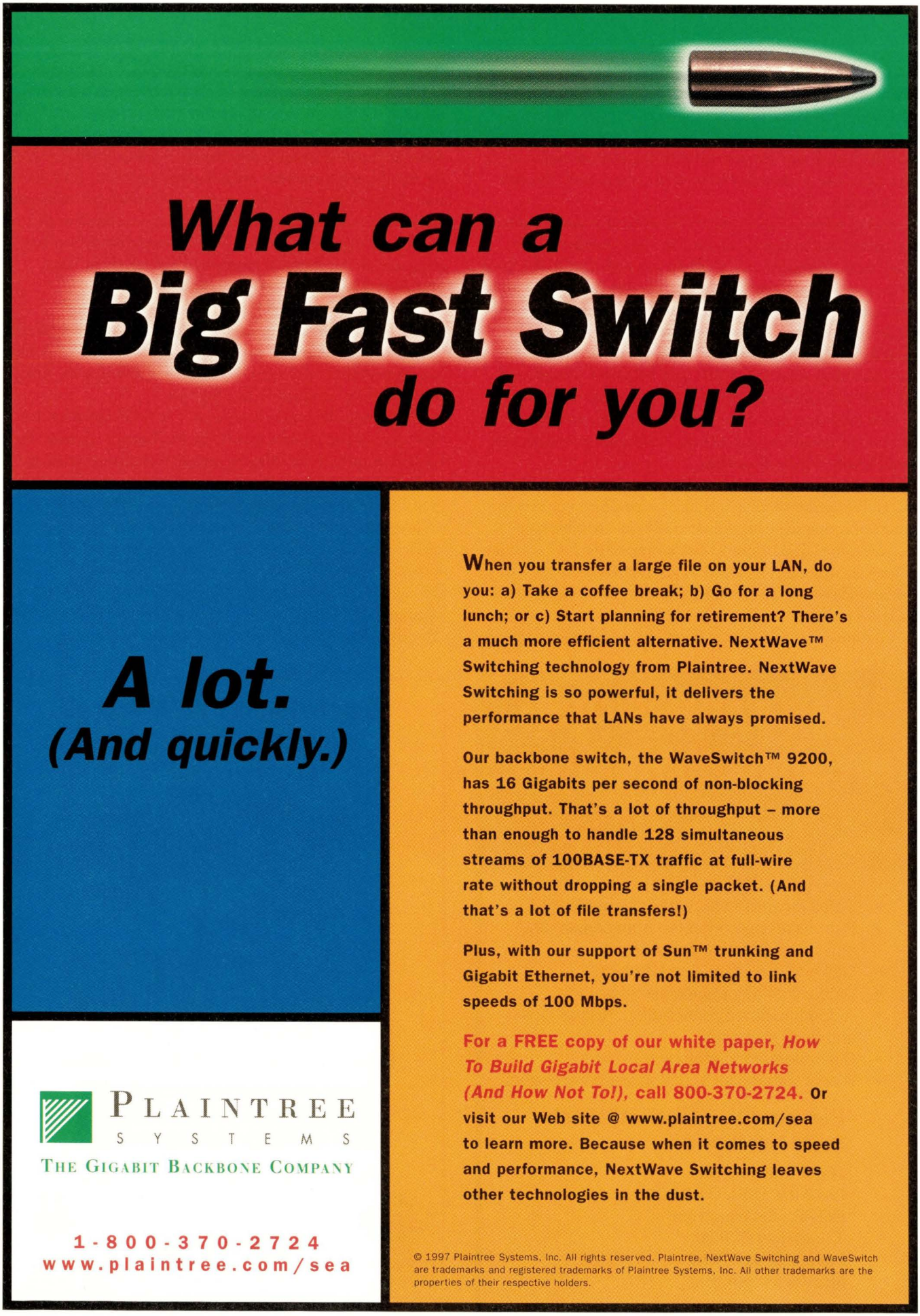
Not everyone was willing to see things this way. For one thing, many legacy machines lacked the dollar support necessary to develop an implementation of the new network protocols for them. For another, a transition to a new protocol suite required the establishment of a "flag day" on which the IMPs would be commanded, at midnight, to quit routing NCP traffic, and to route only the new protocols. They sounded funny. For one thing, there were two of them, somehow related. One was called IP and the other was called TCP. And IP wasn't even reliable. Gaaah. What a terrible idea this was. Political pressure forced the "flag day" to be put off several times, for more than a year.

A Victim of Its Own Success

OK, so here's this brave new Internet. There's only one Net, and it's Net #10. What happened to Nets 1 through 9? Good question. Mr. Protocol is glad you asked. They were assigned to campus nets that had done work in developing TCP/IP, and needed IP network addresses before TCP/IP was deployed on the ARPANET at large.

Now, the ARPANET had more troubles than just this. It was a victim of its own success. Real-world, practical routing theory was in its infancy at this point. All the IMPs ran the same routing protocol, and there were only about two other IMP-based nets in the world that could be used to test new routing algorithms for the IMPs. The original protocol broke down badly under conditions of load, causing routing thrashing on the ARPANET's cross-country backbone links. This made the Net almost unusable during the day, far worse than the Internet congestion seen today. In fact, this happened several times, for months at a time, first because the routing protocols needed improvement, and later because the links were honestly saturated, and the phone company lacked the high-speed long-haul links necessary to replace them. Lead times of nine months meant nine months of an ARPANET that was practically useless for interactive applications during the day.

What's interesting about the Internet is not the first Net, which was the ARPANET. What's interesting is the second Net, which was MILNET. This consisted of the military bases,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Circle No. 12

as opposed to the not-for-profit research and academic centers. Many of these had been doing classified networking over the ARPANET for years, using link-level encryption. Now the plan was to partition the ARPANET into two nets, the original ARPANET and the new MILNET, and allow traffic to flow from one to the other only via electronic mail, through "mail bridges." Nice try.

Strong political factors, of the "Your head is mine" variety, forced the mail bridges to become the first Internet routers. They were overloaded and didn't do too well. Eventually, more were commissioned, and finally the Internet was opened up to the campus networks. Network numbers other than 10 were finally seen, but only when new routers were installed, connected via leased lines. IMPs still couldn't be convinced that networks other than ARPANET and MILNET existed, and they still only connected mainframes, not entire networks.

The result was that dinky little LSI-11 microcomputers became the world's second routers. And desktop workstations could finally Telnet off campus.

The Internet as we know it today is not purely a product of the TCP/IP protocol suite–that made it possible to express the notion of connectivity between networks in a sensible fashion. But it was the LSI-11 routers that superseded the IMPs as Internet routers that made it possible to connect local networks to the big wide world. The Internet began to grow into the entity we know today.

Commercial activity was verboten at first, of course, because the U.S. government was still footing the bills. It wasn't until CSNET, the Computer Science Research Network, was established as the first commercial Internet service provider, that people could just pay money to go on the Net. They still had to show some sort of research orientation to satisfy CSNET's charter, but this was sometimes rather loosely construed, as in the case of Omnibus Computer Graphics, a now-defunct computer special effects house that used CSNET not to connect to the Internet at large, but to act as a WAN connecting its own far-flung operations. If virtual private nets had existed in 1984, Omnibus would have done that instead.

The major players still hung back, because although CSNET was profitable, it was not wildly so. It took a while for Sprint, MCI and the rest to become large-scale Internet service providers in their own right. UUNET was probably the first one to go fully commercial in a big way.

And, gradually, as new services such as WAIS and then the Web came along, the character of the Net began to change. No longer was there traffic bringing unique resources to far-flung researchers. Now it was a matter of uniform resources being available everywhere, and the information itself being unique.

It is a principle of ecology that the smaller the number of species making up an ecology, the less resilient and healthy the ecology is. The ARPANET was extremely resilient, all the way through to the early days of the Internet, because although a large amount of legacy hardware was left behind forever on IP "flag day," there was still a lot left. People were running

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TENEX, UNIX, TOPS-10, MULTICS, MVS, MVT, VM, DEC hardware, IBM hardware, Univac hardware, Honeywell hardware, homebrew hardware, whatever could be coerced into running an NCP or a TCP/IP stack. Even versions of UNIX varied among large research centers. Rand never even bothered to run UNIX Version 7. It stayed with its own highly hacked UNIX Version 6 because most of the features of Version 7 had either been duplicated by parallel evolution, or had been retrofitted on a case-by-case basis. This doesn't even mention the system calls introduced by Rand (it had named pipes in 1976). Mr. Protocol spent a happy couple of years ripping extraneous code out of the Rand kernel until it quit crashing. Others, at other institutions, can tell similar stories. Rand had one of the first VAXen on the Internet, even before native VAX network code was available, by writing a daemon that took network requests and shipped them via a 9,600-baud terminal line to a PDP-11 running a stand-alone NCP. Almost all of Rand's net traffic moved over that line...people still weren't using the IBM mainframe.

UNIX – The Standard Internet OS

As the Internet grew, however, things changed. TENEX fell by the wayside, a victim of DEC's decision to go with the VAX at the expense of PDP-10 development. The Jupiter project, which was to develop a killer PDP-10, was disbanded and team members reassigned to the VAX.

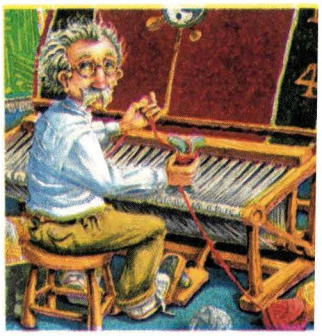
VAX architecture was more mainstream than the PDP-10, being an extension of the PDP-11 to a 32-bit architecture with safe, sound, stable, mainstream 8-bit bytes. VMS, the VAX operating system, was confidently seen by DEC as a UNIX-killer. VAX hardware and VMS had been codesigned, so how could UNIX compete with VMS on a VAX?

UNIX spread like a virus. ARPA didn't help, or it did help, depending on your view. Refusing to pour any more millions into competing operating systems providing similar infrastructure, ARPA held a quiet meeting among its current crop of principal investigators and asked them to decide on a common operating system software base, which ARPA would support as a network operating system to be used across ARPA projects. UNIX was that choice, and the University of California at Berkeley was chosen as the institution to act as the architects and implementors of UNIX as the standard Internet operating system.

As a result, UNIX wiped the floor with just about everything else, at least on the Internet. Microcomputers and PCs might run CP/M or DOS or Windows, but these were laughable as network systems. Most researchers thought they were laughable as any kind of system. Nonresearchers didn't care, and got rich. Caveat emptor.

As a result, while the Internet continued to grow and apparently became robustly healthy and self-supporting, there was basically a single operating system on the Net: UNIX. Versions began to coalesce as it became commercially supported and source became scarcer. What cost a university $150 for UNIX Version 5 in 1975 came to cost a commercial company $70,000 for source code, if they could get it at all. In a little-noted contretemps, Sun Microsystems Inc., which when it was founded promised to fold developments back into the Berkeley release, reached the point within only about three years where it refused to sell source code to BBN at any price. Only the intervention of ARPA, which promised that without source, Suns were useless as ARPA research platforms, caused Sun to release source code.

Researchers today are profoundly depressed by the advent of greaseball operating systems emanating from Redmond, WA, and sullying the network scene. People with a greater historical perspective know better. Windows 95, Windows 98 and Windows NT are not going to take over the Internet, no matter how badly Mr. Gates needs the entire output of Turkmenistan to carpet his front hall. The advent of new operating systems into the networking world is an unmitigated Good Thing, because it keeps the Net honest. The Netscape Navigator/Microsoft Explorer wars merely go to point out the disadvantages to all of ignoring standards in favor of proprietary software. Aside from the corporate sites of the two combatants, any Web designer worth her salt knows that a site designed to work with both browsers is far, far preferable to a "sabotage site" that breaks one or the other. In fact, it encourages a third party to do just what the original Mozillans did: build a better browser.



New operating systems, no matter where they come from, or how bad they are, are not going to kill the Internet. "Rough consensus and working code" has been the Net's watchword from the beginning, and it still works. The only appreciable strain that the Internet Engineering Task Force is showing, is scaling up its operations to deal with all the new initiatives in multimedia, bandwidth management and satellite service.

In fact, Mr. Protocol, at the conclusion of this, his hundredth column for *SunExpert*, feels confident that diversity, not uniformity, is going to mark the future of the Internet, as embedded systems and wireless connectivity combine to form a much richer, more multilayered network environment than we enjoy today.

Now, if only he could Telnet to the drip system that waters his front yard. ⊸

Mike O'Brien *has been noodling around the UNIX world for far too long a time. He knows he started out with UNIX Research Version 5 (not System V, he hastens to point out), but forgets the year. He thinks it was around 1975 or so.*

He founded and ran the first nationwide UNIX Users Group Software Distribution Center. He worked at Rand during the glory days of the Rand editor and the MH mail system, helped build CSNET (first at Rand and later at BBN Labs Inc.) and is now working at an aerospace research corporation.

Mr. Protocol *refuses to divulge his qualifications and may, in fact, have none whatsoever. His email address is* amp@cpg.com.

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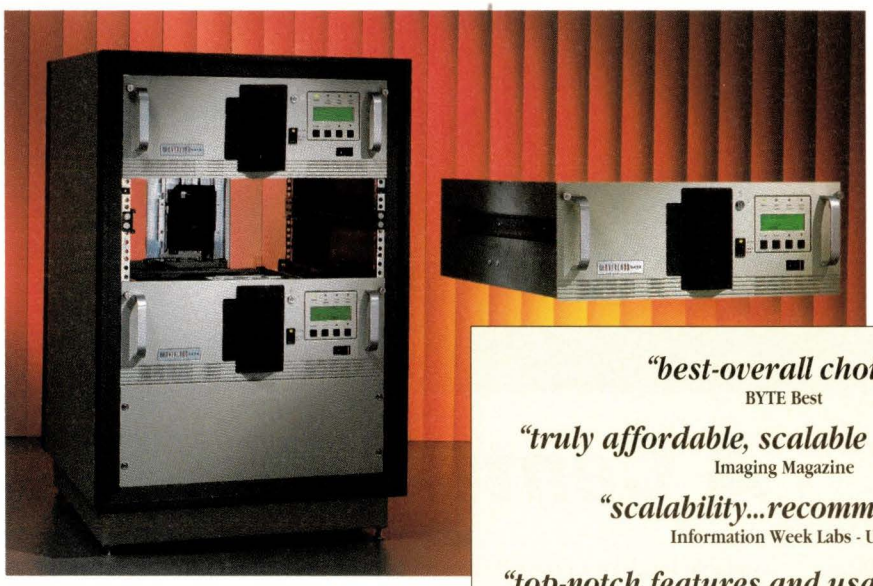

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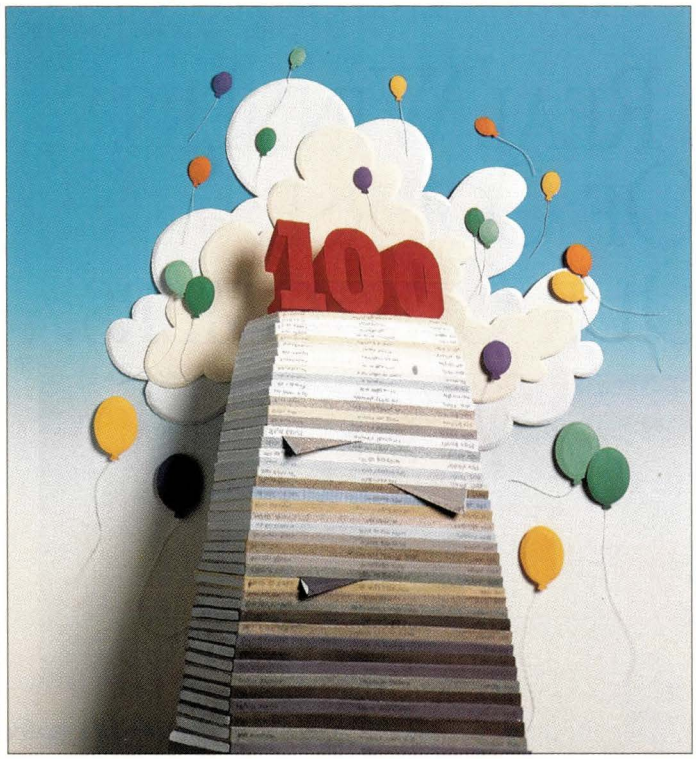

DENISE ORTAKALES

A Century

Tempus fugit. This is my 100th article for *SunExpert*. Because this column has appeared in every issue, you can deduce that this is the 100th edition of the magazine too. I thought the milestone provided an opportunity for some introspection on the years that have zoomed past since I started to write that first article in 1989.

Back in 1989, I had just left my safe and secure employment as a lecturer in Computer Science at the University of Kent, Canterbury, UK. A lecturer translates into an associate professor in U.S. terms. I'd been there for 15 years, having considerable fun. I had become a UNIX guru; ran the first UNIX VAX11/780 in the United Kingdom, providing UNIX service to all the users at the university; and was deeply involved in the kernel work needed to glue that machine (and others once the code was done) onto our campuswide local-area network. The network was based on Cambridge Ring technology, at a time before there were commercially available local-area networks.

I'd also fallen into the role of the first commercial network provider in the United Kingdom by enabling the UUCP network to reach our shores. I then found that I needed to fund the communications costs and started to sell the service to academic and commercial institutions. We called this network UKnet. I remained involved with UKnet and the company that it became until it was sold to PSInet some three years ago.

Anyway, in May 1989, I was suddenly a freelance computer consultant. I couldn't conceive of not having a UNIX machine to work with. Actually, at that time, having a UNIX machine at home was not as easy or cheap as it is today. There were no BSD clones, and Linux was some way down the line. You could look to the commercial market and buy Xenix, but that was like stepping back in time to UNIX Version 7. To be current with things that were happening, you needed a Sun. SunOS was the "reference" operating system; it was ubiquitous in universities worldwide. Most, if not all, freely available software was created by users of SunOS for the SunOS platform.

The cheapest machine running SunOS that you could buy was a Sun 386i. This cost a five-figure sum in British pounds, actually pretty nearly the same sum in U.S. dollars, around 10,000. (The price differential is not caused by taxes and tariffs, which is a popular U.S. myth about European pricing; it's what the market is used to, companies charging what the market will bear.) Anyway, I dipped into our family savings to buy the machine. The Sun 386i seemed fast at the time. One factor was that I was the only one using it. I was used to shared computers at the university.

There were many problems with the Sun 386i; for example, its internal clock was massively inaccurate. The main problem was overheating. In the summer, my non-air-conditioned office

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became hot, and the machine turned itself into a toaster. I remarked in an article at the time ("Environment Variables," July 1990, Page 29):

"It's early May, and we have been having a heat wave in the United Kingdom. My Sun 386i has been suffering a little from heat exhaustion and began to weep, wail and gnash its teeth mightily about servos not working properly. Allowing the machine to cool down meant that all was well, so I decided that I should take the opportunity to remove the filth that builds up inside the machine, clogging various grilles and fans. A clean grille improves the internal airflow and cools the disk down just below marshmallow-browning temperature. A user-serviceable air filter would be a good add-on for these machines. However, while working out which four screws were needed to remove the front grille, I removed the plastic skin on the back of the machine–to discover a lot of embossed signatures." The names of all the people involved in the project had been placed permanently in the metal casing. A nice touch.

I was more than pleased when later Sun decided to get out of Intel-based machines and made me an offer of a cheap upgrade to a SPARCstation I. It had loads more MIPS and a more "standard" operating system.

From the start, I'd been on the world network, and working for UKnet meant that it was convenient for the company to allow me to continue to log into its machines using a leased line at slow speeds. At that time, I used a UUCP connection to ship email and could have had news if I'd wanted it. Anyway, I was well set up in terms of computing power and communications when Mark Seiden mailed me about this new magazine that he was working on, and would I like to write for it? Sure, why not?

The Articles

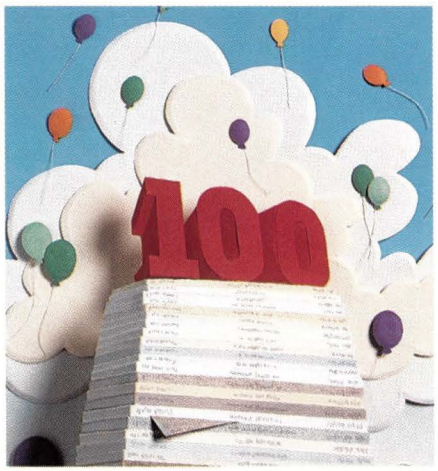
I had not actually considered that people might be prepared to pay me for writing. Up to that point, my literary output had consisted of my Ph.D thesis, some academic papers, zillions of UNIX man pages and a bunch of pieces for the newsletters of two UNIX user groups: The European group, then called the EUUG, and the U.S. one, USENIX. The notion of writing commercially had not occurred to me.

Some short time later, Mark Seiden mailed to ask me what I might like to write about? I plumped for UNIX Basics, because it was an open-ended topic and I could easily think of at least four possible subjects that would work as articles.

Writing a monthly column is somewhat strange. You are now reading an article that has around 3,500 words and covers a lot of space in the magazine. However, a chapter in a book is considerably longer. The length–which has crept up over the years–and my desire to have a complete "story" in each article, limits the topics that can be covered. Some topics are too small to be made into a complete article, so you have to find some strand that can be used to group things together; other topics are too large. For instance, I wrote about the `make` command back in 1992, as a two-part article ("Make: Parts I and II," February and March 1992, Pages 34 and 26, respectively). I am not happy with making two consecutive issues contain one topic. It can be quite hard to make each article of the pair into something that is also self-contained. Also, if the reader is not interested in that topic, or knows about it already, then he knows in advance that next month's article won't be of interest either.

I think that when writing, you have to have some idea of who your reader is. Broadly, I've tried to aim my articles at some mythical "interested" UNIX user. There are UNIX users who are interested in practical help, so a proportion of the articles are basically "here's some tips and tricks." There

Broadly, I've tried to aim my articles at some mythical 'interested' UNIX user.



are UNIX users who are interested in expanding their knowledge of how to get their work done, so some of the articles are introductory material on UNIX tools and utilities. There are UNIX users who are interested in finding out how things work, so a proportion are about the underlying mechanisms with some free bits of computer science thrown in for good measure. Of course, articles don't always split cleanly along these lines. There are usually elements of all three in every article.

A tiny proportion of the articles are what I call "self-indulgent," encapsulating some topic that's interesting me at the moment but perhaps does not quite fall under the "UNIX Basics" banner. I guess that you are now reading one of those. Most of the ideas for articles spring from something I am doing, so they are often topical for me when I write them. The time delay that publishing imposes sometimes means that my currency in that topic is long gone by the time I get email from someone querying something in the article.

I also find that there are some readers who consume the articles to discover whether I know what I am talking about (no one is infallible) or to find out whether they know all there is to know about some topic or other.

I have one other mental ground rule. I try to write about the programs and utilities that you will find on your Sun machine when the system was installed from the CD. I must confess that I don't always stick to this rule, but I am sure it's a reasonable guideline. There is a great deal of high-quality free software available on the Net, but I suspect many people are unable to install and use it. I don't necessarily mean that they cannot pull the file with FTP, run the `Configure` script and type `make`. But they are prohibited from doing so, perhaps by company policy, perhaps by unimaginative management,

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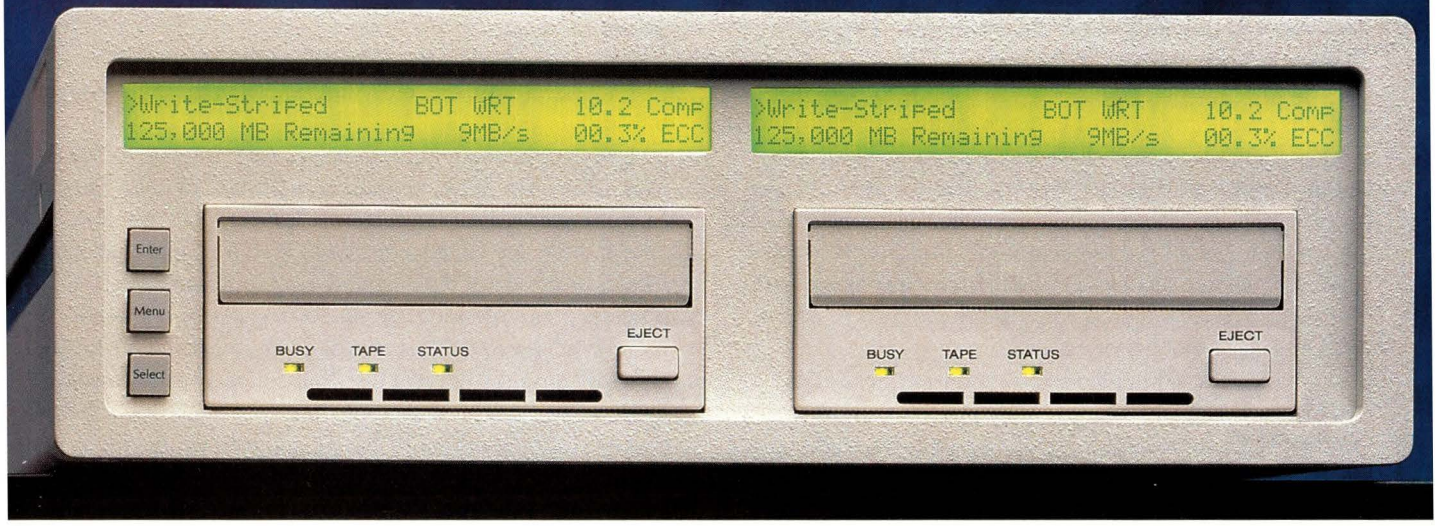

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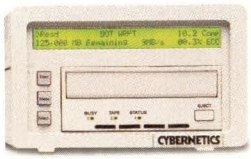

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perhaps by lack of resources, perhaps by lack of privilege on the machine, perhaps by lack of confidence in their ability to install or test the result. After all, free software is always *caveat emptor*–let the buyer beware. Once installed it will require maintenance, and that maintenance costs time. Of course, it's gotten harder with Solaris, when there is no C compiler on the machine, and installing one is either a matter of money or some hard work.

The strange thing about being a writer who started as a techie is that I have no idea why people like the stuff I write. I know that at least some people do, because unlike many authors, email provides me with frequent feedback, people can ask questions, send in comments, complain and criticize. Most of the email I get seems to imply that people like the articles. I get very few bits of purely hate mail, except when I tickle someone's religious convictions about some editor, shell or system that I have criticized.

However, I have no idea how to improve the articles. *SunExpert* has a good policy of providing its authors with a proof of their article after copyediting, so I've learned quite a bit about improving my writing technique from seeing what these excellent people have changed in my text. Of course, they have a special problem with me: I write with English spelling, and they need to alter it into something that's palatable for U.S. readers. I also occasionally use an English idiom or make an English cultural reference. Usually, these are inadvertent. I try to check things that I am writing if I am suspicious that they won't port into U.S. culture. Often English idioms work, although I recall that I "came out" as a Brit after I had used the Victorian game of Snakes and Ladders to illustrate symbolic links. It seems that in some parts of the United States, this game has become known as "Chutes and Ladders," a practical game about building. Someone spotted this and emailed, "Ah ha, you're a Brit!"

The Systems

Well, what's happened to computing in these past eight years? As more and more machines have been sold, hardware prices have dropped dramatically, with disks and memory becoming cheap(ish). To replace my SPARCstation II today with some equivalent desktop machine would cost about half of what I paid eight years ago. It goes without saying that the system would run much faster. It seems to me, though, that much of the speed increases in CPUs have not been passed onto users, but eaten up in kernel code by the overhead in supporting objects in the language that the program was written in, or by the interpreted programs that are now in vogue.

Certainly, Sun has lost its preeminent position as the main UNIX software reference platform. To be fair, the developers at Sun have worked hard to make the Solaris system environment as "open" as possible. A C source program written for any UNIX system is likely to compile out of the box on your Solaris system. There are masses of backwards compatibility libraries and kernel hooks in a Solaris system to ensure that code will compile and run.

I resisted the move to Solaris for a considerable time. Waiting was the right thing to do, in hindsight. It took Sun about two years to get Solaris to the point where it performs as well as SunOS does. The move to Solaris was fairly painless, I suppose. I must confess that I have never become used to the "new" arguments to the `ps` command, although I did try for some time. But my reflexes are too strong. I always type

```
ps ax
```

I now always use the "old" SunOS version that Sun thoughtfully still provides.

I was prompted to move to Solaris (see "Moving to Solaris," May 1996, Page 20) by the adoption of the Common Desktop Environment (CDE) running on a "proper" X11 Window system. I like the CDE virtual desktop, but I cannot say that I make much use of the drag-and-drop interface that CDE provides. I am still using my windowing system to present me with a large number of virtual text terminals into which I type my commands or edit text. You could say that I use an interpreted graphical program to deal with mail. Brent Welch's `exmh` program is written in Tcl/Tk and does all the things I need in a mail program, with the bonus that I can access mail via the command line-based `mh` suite should I want to, and I do, when I am far from home dealing with mail by using telnet over the Internet.

The Internet

I suppose we all concede that the big world change in the past eight years has been the growth of the Internet. From my perspective, wide-area networking has changed from store-and-forward UUCP connections to machines talking with IP, allowing me access out to the world, and for the world to have access to my machines. Sun has always been well placed to generate systems that allow you to create servers accessible from IP. There have been a great swath of articles in this column that examine how the Internet works and how to use it.

The Internet has changed my life considerably. I've always telecommuted these articles from Canterbury in the bottom right-hand corner of England to the *SunExpert* offices in the top right-hand corner of the United States. I'm still originating articles in `troff`, largely because I am used to it, but also because actual page layout is not an issue to article writers. Using `troff` means I can make font selections and set up subheads and paragraphs. Also, and this is a big plus, I end up with a text file with which I can use the standard UNIX tools, notably `grep`. However, the folks in the *SunExpert* editorial office use different systems, so I convert my `troff` input into Microsoft Word format using some Word macros (don't get too excited; the macros are very limited and only understand the subset of `troff` that I use), and use Word to generate the Rich Text Format file that is dispatched by email to the editorial team.

The Web has been a big factor in my life in recent times, and again this has been reflected in my articles. I now telecommute 6,000 miles from Canterbury to Berkeley, CA, to Webmaster the USENIX Web site. It's viable not only to use telnet over that distance, but also to use it within an encrypted `ssh` data stream.

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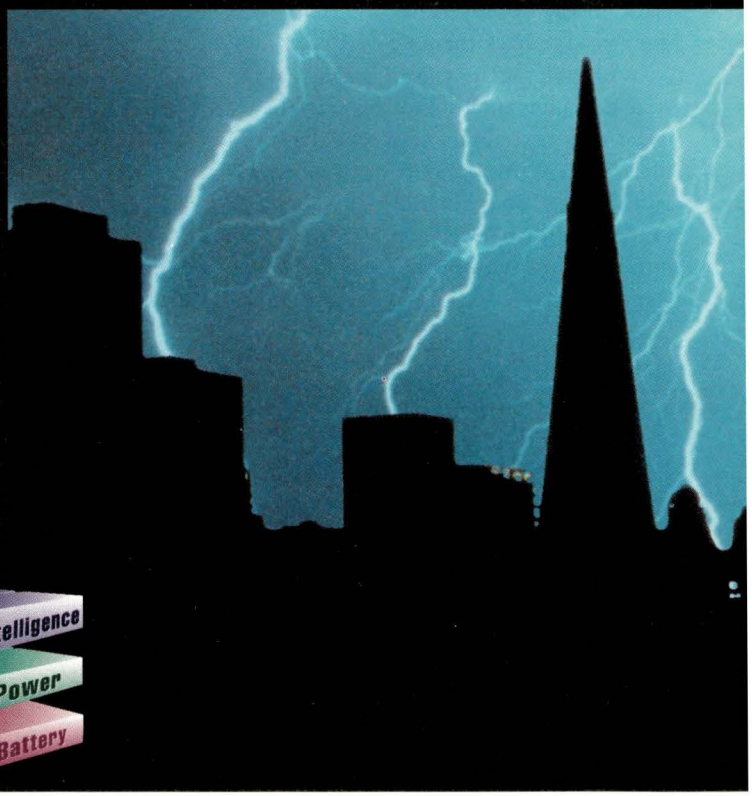

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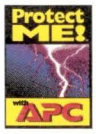

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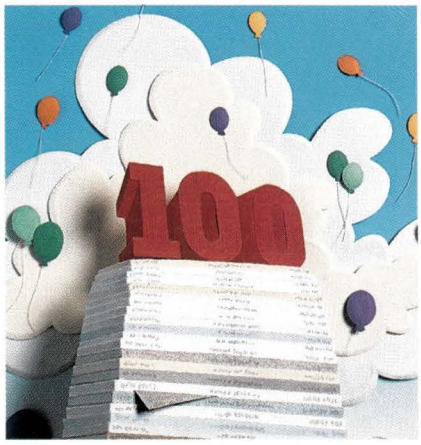
Circle No. 19

The Growth of Microsoft

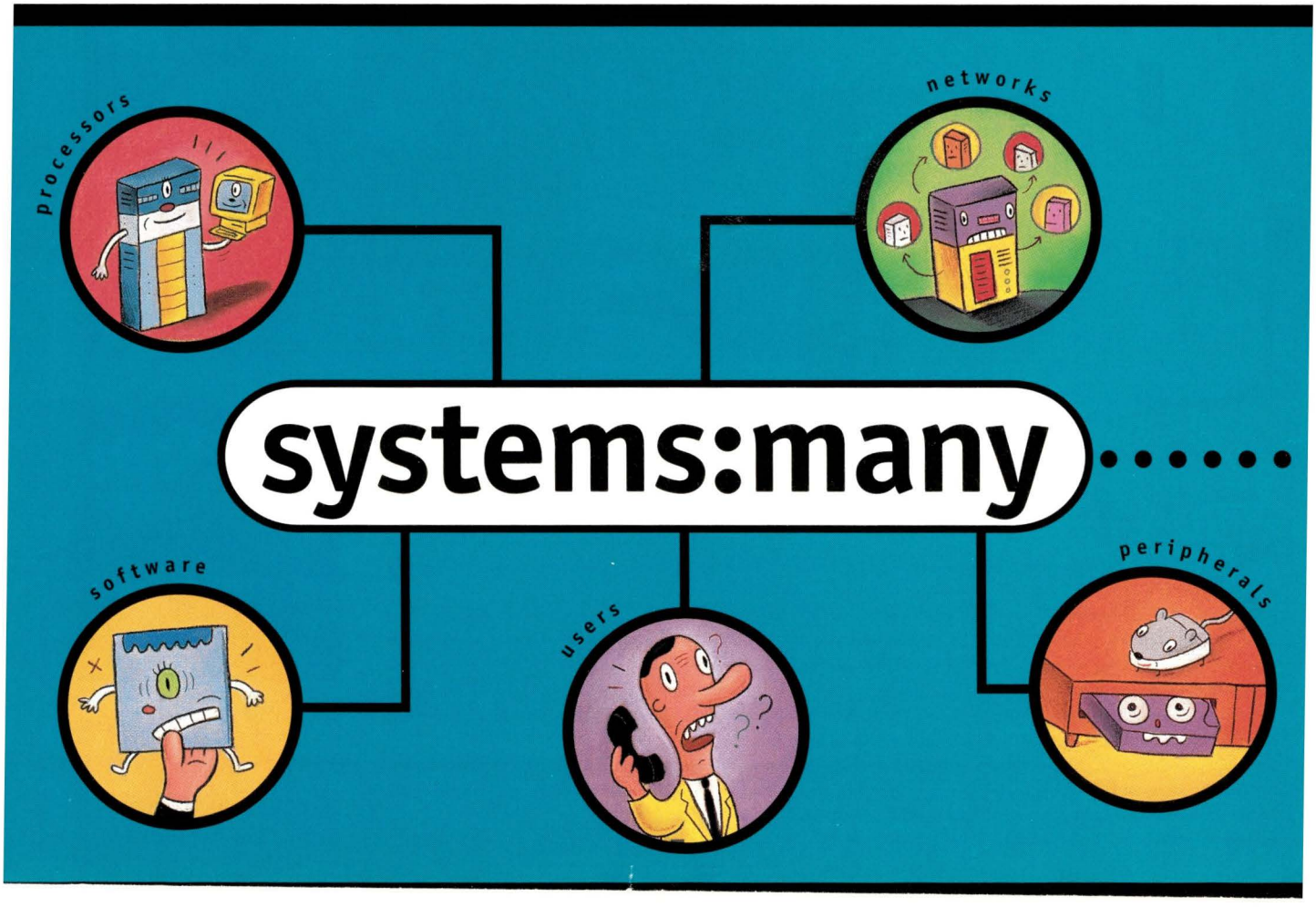
Of course, another huge change in the world of computing has been the aggressive rise of Mr. Gates' organization. I suppose we can thank him for contributing toward making computers into relatively cheap items. The number of machines I possess has grown from a single Sun to include a PC running BSD/OS and several machines each running one of Microsoft's systems; I run Windows NT 4.0, Windows 95 and Windows 3.1. All of these machines are on my LAN, and all can access files using some form of networked file system. I've used NFS for the Windows 3.1 system for some time, and always heap huge quantities of praise on Samba, which provides remote file access for the remaining Windows releases. Andrew Tridgell and the rest of the team have generated a UNIX product that makes the Microsoft systems usable. I keep no file of value on any of the Microsoft systems, so I don't need to back them up.

What I desperately need is a virtual file system implementation for my Sun that uses the Samba library to access files on the various Windows systems from my Sun. There's something that does this for Linux, but it isn't particularly portable into the Sun environment (on a cursory glance anyway).



I run Microsoft systems because they support desktop applications that I cannot obtain for UNIX systems. I have a need to be able to deal with Microsoft Word format documents. (Whatever that may be. Microsoft is great at changing formats with every release, so that documents quickly become incompatible.) I have a need to edit graphical images and, basically, there are simply no UNIX tools with the appropriate power at a reasonable cost. To be fair, I haven't looked for such a product, because I assume that if it exists, then it will be more expensive than the equivalent Windows product and will not offer the same functionality. This assumption could be completely wrong, I suppose, but the market has conditioned me to think this way.

I am not alone. As was pointed out to me in some recent email, and rather triumphantly I thought, Microsoft has won the desktop battle. The reasons that UNIX has "lost" are complex. I think that it was basically a failure to deliver point-and-click technology fast enough, a failure to deliver cheap applications at the right time, a failure of UNIX companies to cooperate to battle a growing monopoly, a failure of application developer companies to price software reasonably for the UNIX market, and a failure to provide a single technology base that could be picked up



by application developers and used to create a large application market. A failure.

Microsoft has generated a machine culture where every user is on their own; where every single machine is set up differently, making support a nightmare; where there is no adequate support for software; where work is lost; where systems crash; where programs that work fine today will fail tomorrow because of some apparently unrelated change to the system; where programs are created to be just adequate; and where simple tasks are simple, but complex tasks are accomplished by people doing simple tasks again and again because there is little or no automation easily available to users.

And the people purchasing systems have bought it, because it all looks so easy. They were sold the idea that you could get some cheap software that would apparently do some simple job, but they were not told that it would cost them significant sums in human time to get around the problems that the software would induce.

So, the UNIX world's failure is not only a failure to deliver applications, but a failure to communicate to the person buying the system that reliability, predictability, automation, good quality support and robust hardware are worth more than just a little. It's also possible to argue that the companies involved didn't provide any of these qualities, but I am not so sure.

The world is now locked into Mr. Gates' products, and his monopoly is demonstrably a bad thing. It's bad that his company doesn't need to react to user pressure to improve things, to make reliable products that don't crash, to enable systems to be predictable and to make the system work for the user rather than the user working for the system.

Finally

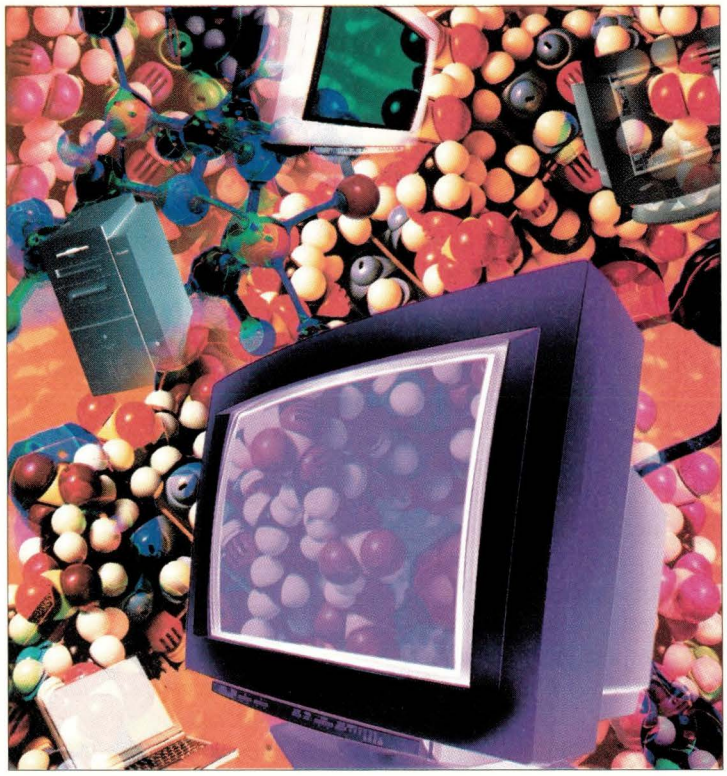
Well my ramblings seem to have reached the appointed size, and I should stop. I hope that you will join with me in wishing all those involved with this magazine, contributors and staff, a Happy Hundredth Birthday. I'd also like to take the opportunity to thank everyone who has emailed me a comment, good or bad, or sent in some questions, dumb or hard. Getting a response from readers matters, and questions help me develop article topics.

For your information, you can find `exmh` on `http://sunscript.sun.com/exmh/`, and Samba is at `http://samba.canberra.edu.au/pub/samba`. The USENIX Web site is `http://www.usenix.org`. Finally, the latest version of `ssh` is available for testing, see `http://www.cs.hut.fi/ssh`.

***Peter Collinson** runs his own UNIX consultancy, dedicated to earning enough money to allow him to pursue his own interests: doing whatever, whenever, wherever... He writes, teaches, consults and programs using Solaris running on a SPARCstation 2. Email:* `pc@cpg.com`.

I/Opener

by Richard Morin, **Technical Editor**



ERIC YANG

Genetic Diversity

Although public awareness of ecological issues is a Good Thing, some scientists are concerned about the simplistic way in which ecological issues are often perceived. A friend of mine says that by emphasizing cute, large-eyed animals, we are "making the world safe for creatures that remind us of human infants."

Sarcasm aside, my friend has a point. The real issue in loss of species is the chance that life on Earth (quite possibly the only life around!) may need particular sets of genes to deal with changing environmental pressures. Because we cannot know what challenges will arise, we should keep Earth's "gene pool" as diverse as possible.

Similar arguments can be made for economies. The world's economy is incredibly diverse, including activities that are amazingly specialized and occasionally rather mysterious, at least to me. If there is a buyer for these products and/or services, however, these activities will persist. And, if there is ever a critical need for nylon lunar wainshafts, some vendor is likely to have them in stock.

The computer industry, in particular, benefits from this kind of diversity. I use a Macintosh to compose and submit my I/Opener columns because I like the Mac's polished user interface. My screens also contain a batch of UNIX sessions, however, because UNIX excels at some tasks that the Mac does not do well, if at all. If I had to choose between Mac OS and UNIX…well, let's just say I hope I never need to do so.

Apple Computer Inc.'s current "Think Different" ad campaign, grammatical nits aside, speaks to this need. Different users have different computing needs, sometimes simultaneously. If we rely on Microsoft Corp. to predict and fulfill all our computing needs, we are likely to be disappointed. By encouraging a diverse set of suppliers, we can enjoy a variety of facilities, while protecting ourselves from monopolistic abuses.

These days, Intel Corp. and Microsoft hold positions of great dominance. Although I hope that their competitors will continue to survive, there are some indications that this may not happen. Consequently, I am worried about our industry's "diversity."

Hardware Diversity

In the hardware arena, the situation is alarmingly simple. Chip fabrication plants are already hideously expensive. With each round, moreover, the stakes get higher. Consequently, the economics of mass production totally dominate the processor manufacturing market. An architecture that cannot retain a substantial number of customers will be unable to support the engineering and production costs needed to compete in future rounds.

Today's offerings are down to a small handful of architectures, almost entirely dominated by Intel's Pentium. The situation looks even bleaker for the upcoming 64-bit processor wars. Intel has acquired the technological (and perhaps, customer) bases of both Digital Equipment Corp. and Hewlett-Packard Co. Mean-

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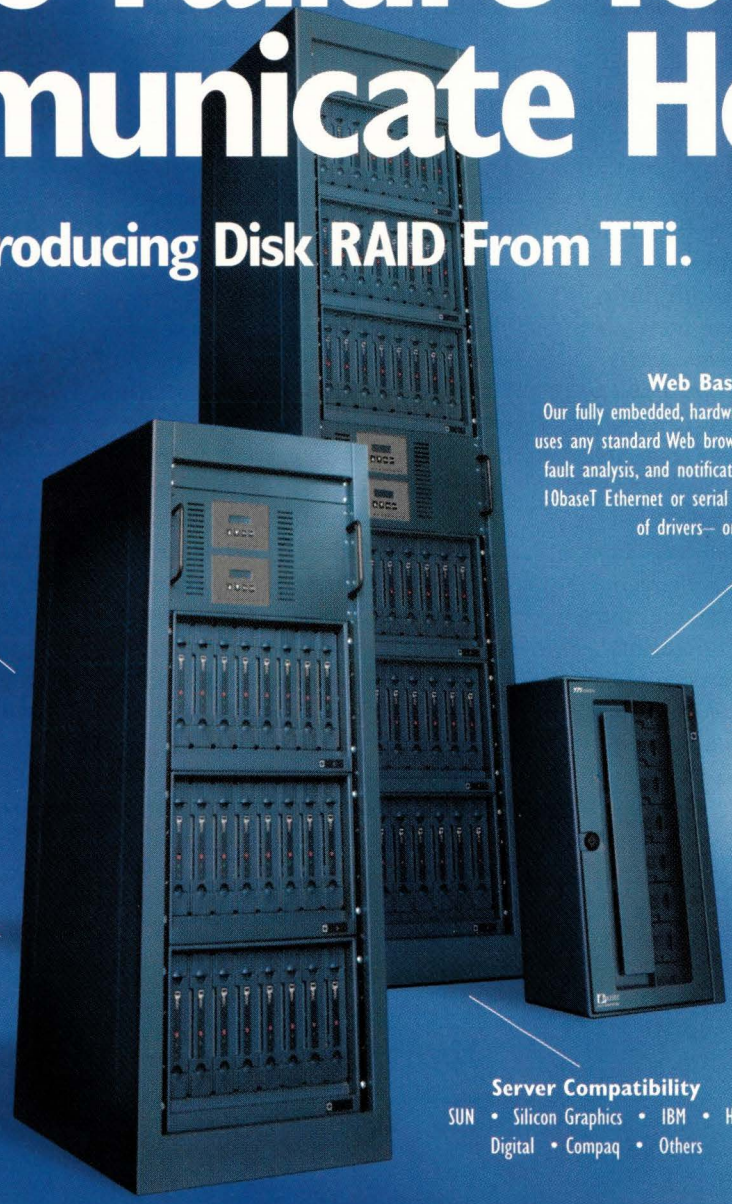

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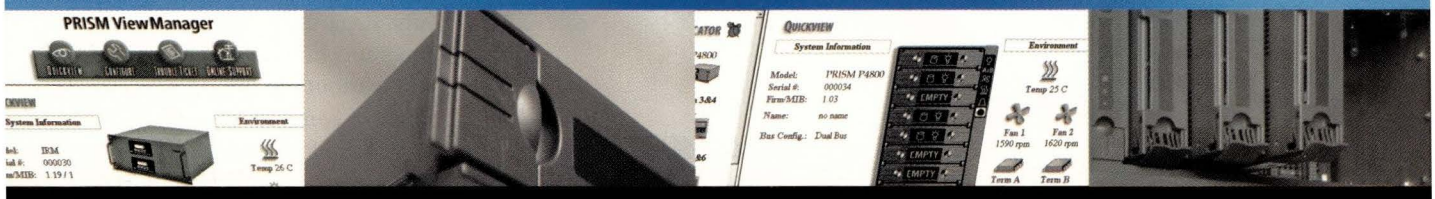

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Circle No. 21

while, Apple has killed off most of its clone vendors, dramatically reducing the market for the PowerPC.

Can the Alpha, MIPS, PowerPC and SPARC processors (have I forgotten anyone?) survive in the upcoming 64-bit processor wars? Maybe, but I am worried. It appears I'm not alone in this. Here is the lead-in from a full-page "spin control" ad from DEC:

What does tomorrow hold for Alpha technology, and the customers it serves, in light of Digital's recent agreement with Intel? Simply, a powerful commitment to the Alpha platform, now and in the future.

– *San Jose Mercury News* (Page 5C, December 10, 1997)

Even with obvious technological superiority (a very dangerous assumption, given Intel's engineering might and the DEC/ HP patents), the other chip vendors will be hard-pressed to compete. Can Sun Microsystems Inc. keep SPARC alive (read, competitive), fueled only by workstation and server sales? Similar questions apply to the other vendors.

If Intel's new architecture completely dominates the computer industry, we will lose a great deal. Competing chip vendors will be history. Architectural tricks that might have been tried by these vendors will be moot if they don't fit into Intel's plans. Systems integrators that don't want to do things "Intel's way" will be marginalized.

Software Diversity

Diversity in software is also constrained by engineering difficulties, but the difficulty of creating and maintaining assorted "ports" often dwarfs the initial development and design costs. Ports must deal with byte-ordering issues, system call and library interfaces, and even the vagaries of compilers and linker. Porting a package to a few dozen platforms is a real challenge for any company; smaller companies and free software authors can be totally overwhelmed by the difficulties involved.

If a package is not available on a given platform, both the package and the platform suffer (from a competitive perspective). The UNIX community is quite familiar with this problem. By comparison with PC-related offerings, the application packages for most UNIX platforms tend to be both limited in number and rather expensive.

The difficulty of porting software has also had an impact on the nature of UNIX "freeware." Making a virtue out of necessity, UNIX freeware authors distribute their offerings primarily as source code. PC and Mac freeware, in contrast, is generally available only in binary form.

The efforts of Grace Hopper, the U.S. military and the American National Standards Institute (ANSI) have given COBOL a great deal of consistency in syntax and application programming interfaces (APIs). Still, it is not a trivial matter to port a COBOL application from, say, an IBM mainframe to a UNIX workstation. Issues of file naming, access styles and even data representation formats arise to trap the unwary programmer.

C and FORTRAN have similar problems. Most computer languages, in fact, contain operating system and CPU architecture dependencies that can make code difficult to port. Even RATFOR, Brian W. Kernighan and P.J. Plauger's noble effort at an "improved" FORTRAN, suffered from these problems.

Fortunately, we are seeing the emergence of some truly portable programming environments. Some, like Java, are "strongly hyped" commercial offerings. Others, like Perl and Tcl, come out of the free software community. Regardless, it is easy to create programs in these languages that will run without modification on a wide range of computers.

Much of this portability comes from the "virtual environments" that these languages provide. A Perl programmer, for example, sees essentially the same set of library functions whether he's working on a Mac, UNIX or Windows platform. This allows the programmer to write for Perl, rather than for a particular platform.

A Java programmer, modulo the efforts of Bill Gates, sees an even higher level of compatibility. Because of Java's

design, it is possible for a Java application to be totally isolated from architectural issues that might plague a Perl program. Java's strong emphasis on portability, moreover, tends to cover up most of the random incompatibilities that different operating systems can present.

Whither Software?

C has been described as an "algebraic assembly language." Much of its virtue lies in the fact that it compiles into very efficient code. The other side of the coin, however, is that C code is not as portable as we might wish. Java attacks the portability issues in a very direct manner, giving up efficiency as necessary. Given the increasing speed of processors, and the continuing difficulty of porting software, this seems like a rational trade-off.

If I were starting a substantial development project, I would look very hard at doing it in Java, even if no immediate network or portability issues were involved. The cost of being wrong–and thus needing to rework the C code for portability–is just too high to accept.

Consequently, although I don't expect C to go away any time soon, I think we will see a great deal of new software being created in more portable languages. At the same time, the C community will continue to work on its own portability issues. Libraries will become more standardized, language features may be modified and so on. In short, C is quite likely to "borrow" some of Java's tricks.

At the same time, I expect to see Perl gaining increasing acceptance. Administrators will find more and more tools becoming available in Perl. Freeware authors will opt to use Perl as a simple way to avoid portability problems. Commercial vendors who fear the need to give out source code will be comforted by the upcoming compiler.

The Comprehensive Perl Archive Network (CPAN) already contains hundreds of modules (object libraries) that have been contributed by public-spirited Perl programmers. I expect to see more of these over time, as well as a raft of finished application programs. If these programs do not run as fast as their C counterparts, their increased portability is a more than compensation.

In short, there will continue to be two paths in software development: the closed path of developing to the "Wintel" (Windows on Intel) platform and the open path of developing for portability across many platforms. The closed path will continue to get most of the traffic, but the open path will have more interesting scenery. ➸

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by S. Lee Henry

KEN CALL

A Tale of Two Pretties

Once upon a time, long long ago (i.e., more than a week), a beautiful princess decided that she was ready to meet and marry a handsome prince. There were a couple of problems, though. For one, she had never seen a handsome prince. Many years before she was born, the kingdom had been a prosperous, "classy" place to live. But shortly before the king and queen brought forth their very lovely daughter, there had been a famine. Almost all of their subjects had packed up their goods and moved to another land. The only residents rugged enough to withstand the drought were ogres and gnomes. For another, she had no idea where to look for a handsome prince. The fleeing subjects had left no tracks that had survived the years, and the neighboring kingdoms were inhabited by malodorous creatures whose dimensions reminded her more of her pet wombat than herself.

With no idea where to look for what she wouldn't recognize if she found it, the princess was truly in the dark. "If only I could nail down just one of these factors!" she cried, "I might be able to solve the problem. If I knew where to look for a handsome prince, I might go there and try to encounter one, hoping he would introduce himself as such. Ah," she sighed, "if only I knew what a handsome prince looked like, I could travel the globe searching for one. This is too hard!"

Once upon another time in an office in El Segundo, a not-so-beautiful computer geek sat in front of a system she had been asked to upgrade. There were a couple of problems, though. For one, the system had no monitor (and no video circuitry to support one!). For another, the only terminal at her disposal was a Texas Instruments Inc. Silent 700 of unknown vintage that might or might not work. It powered up and echoed anything she typed, but showed no sign of communicating with the system. She longed for a `login` prompt.

With no idea where to look for a solution, the computer geek was truly in the dark. "If only I could nail down just one of these factors," she exclaimed, "I might be able to solve the problem. If I knew whether this terminal worked, I might give it a try," she sighed. "Or if I knew if this Sun server would talk to a terminal rather than its nonexistent monitor… This is too hard!"

Fortunately for both the princess and the geek, columns, like fairy tales, have happy endings. Before we get to the happy-ever-after's, however, let's take a look at what the geek did to make progress on her problem.

For both the princess and the geek, the basic problem was not knowing how or where to start. When attacking a complex problem, it is useful to find some way to break it down into a number of smaller problems and establish some "knowns," thereby reducing what is unknown to a smaller and smaller mass.

When the technophobe from down the hall says his computer isn't working, for example, you might first ask him if it's plugged in. If it isn't, you've probably solved the problem. If it is, you've at least

THINKING ABOUT

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reduced the scope of the problem to be solved. Starting with the simplest facts, we can begin mentally checking off what we know and what we don't know. For our heroines, the first step was not so easy to determine.

When the geek plugged the terminal into the serial port of the system and turned it on, there weren't any clues to help her figure out why there wasn't any visible sign of life. The terminal could be bad. The port could be bad. The cable could be bad. The system might not be configured to support a terminal. The devices at the ends of the cable could be configured so differently that nothing was being successfully transmitted.

One way to reduce the number of unknowns is to apply part of the problem to another setting. The geek could borrow a terminal and cable known to work and then she could take her Silent 700 and try it out on a different system in place of a working terminal.

The geek decided that she would use her laptop as a dumb terminal and try to get it to "talk" to the Sun server. Because she had done this once before, she knew the cables she had were the right ones for the job and, even if she didn't know which of the mysterious COM ports to use, there were only four of them, thus limiting the number of tries she would have to make. The cable she used converted her laptop's 15-pin port into a DB25. She ran this through a null modem adapter to switch the send and receive data lines, and plugged this into the A/B serial port on the Sun. Nothing happened.

"I need some feedback from this system," she thought to herself, and then came up with an idea. She took a 3.5-inch floppy from her drawer and inserted it into the floppy drive on the Sun. Then, she typed the `L1-A` command that she had promised to use only in emergencies. She paused for a moment and then typed `eject`. In that instant, the floppy shot out of the drive. "Yes!" she congratulated herself, as the other residents of the office bull-pen sneered and then resumed their loudspeaker phone conversations. "I know where I am." She knew that if the system weren't in `PROM` mode (she imagined she could see the `OK` prompt), that the `eject` would not have worked.

With this small success, she then decided that she could trust herself to type "in the dark." "I don't know how it's set up now, but I know how to set it to what I want," she said. Without feedback, her fingers moved slowly over her keyboard.

```
setenv ttya-mode 9600,8,n,1,-
```

"This command will update the contents of the `EEPROM`," she reminded herself. "Let's see, 9,600 baud, 8-bit characters, no parity and one stop bit. Yes, that should work." She glanced at the screen on her laptop. There was nothing showing in her HyperTerminal window. "Durn!" she muttered, "shows me for thinking myself so clever!"

```
setenv ttya io
```

She typed and then glanced at the laptop screen. Swiveling in her office chair, she moved her hands over the laptop keyboard and typed `help`. The screen responded with a list of items for which help was available. `printenv`, she quickly added. A list appeared on the screen (see Figure 1).

From this point on, reinstalling the system and configuring it so that it could be easily used "in the field," even without a Sun monitor, was the pleasant activity that installing a Sun system was meant to be. The not-so-beautiful computer geek finished the job and attached a note to the box before sending it out, explaining that a dumb terminal could be used with the system if set up with the parameters listed.

As for the beautiful princess, the problem proved to be too much for her to handle. Eventually, she decided to marry one of the ogres. Fortunately for her, the ogre was a talented raconteur and a UNIX wizard. He beguiled her with stories of sysadmins in distress and they lived happily ever after. ⊸

Figure 1. printenv Response

```
ok printenv
Parameter Name                Value           Default Value

tpe-link-test?                true            true
output-device                 screen          screen
input-device                  ttya            keyboard
keyboard-click?               false           false
keymap
ttyb-rts-dtr-off              false           false
ttyb-ignore-cd                false           true
ttya-rts-dtr-off              false           false
ttya-ignore-cd                false           true
ttyb-mode                     9600,8,n,1,-    9600,8,n,1,-
ttya-mode                     9600,8,n,1,-    9600,8,n,1,-
fcode-debug?                  false           false
local-mac-address?            false           false
screen-#columns               80              80
screen-#rows                  34              34
selftest-#megs                2               1
scsi-initiator-id             7               7
silent-mode?                  false           false
auto-boot?                    true            true
watchdog-reboot?              false           false
More [<space>,<cr>,q] ?
```

S. Lee Henry *is a security services engineer at Infonet in El Segundo, CA. No beautiful princess, she is nevertheless intent on living happily ever after and is doing so with her new husband and stepdaughter in the foothills to the North of LA. You can send her email by addressing it to* `slee@cpg.com`.

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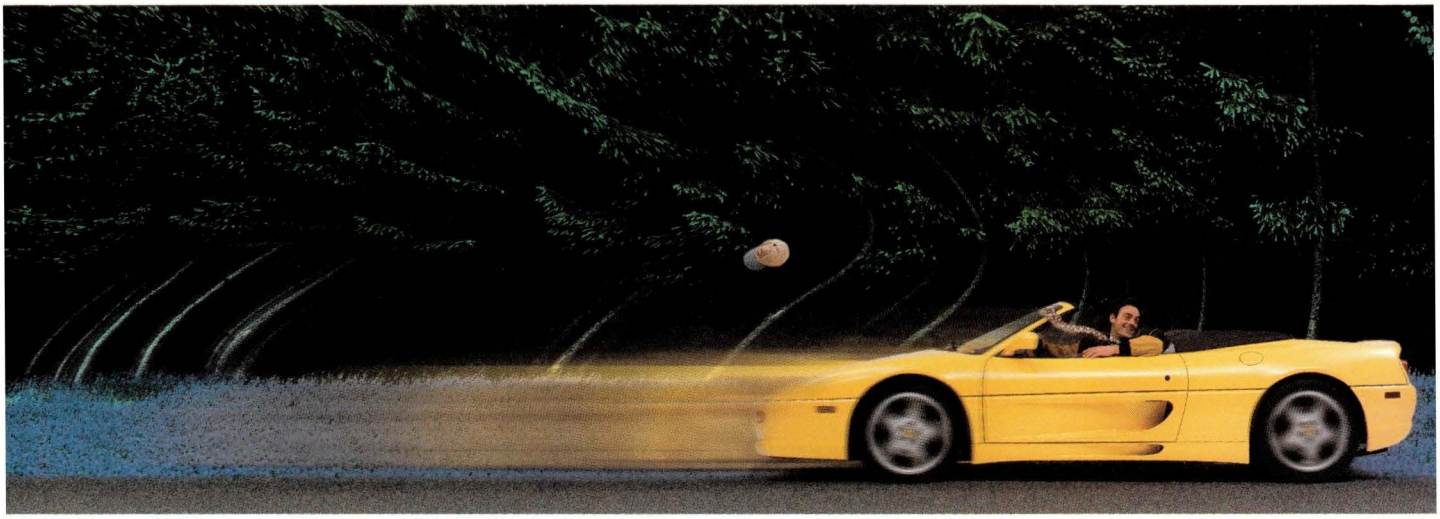

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by Æleen Frisch

WILL TERRY

Managing Disks

Setting up the file system is one of the first tasks you face with any computer system, and Windows NT is no different. UNIX users will be pleasantly surprised by the flexibility and relative sophistication of the Windows NT file system capabilities. Our consideration of them will consist of two parts: This month, we'll look at the way Windows NT handles disks and disk partitions, and next month, we'll examine the NT file system in detail.

Disk partitioning under Windows NT reflects its DOS heritage. Physical disks can be divided into a maximum of four partitions. Disk partitions are designated as either *primary partitions* or *extended partitions* (as under DOS and Windows). Under Windows NT, the important difference between them is that extended partitions can be further subdivided into *logical drives*. Note: Only one extended partition may be placed on a given physical disk.

Windows NT provides the Disk Administrator facility for displaying disk layout information and manipulating disk partitions and file systems. You can start the Disk Administrator by selecting the **Programs=>Administrative Tools (Common)** menu item or entering the `windisk` command.

The Disk Administrator's main window is displayed in Figure 1, which also illustrates a sample disk configuration. This example setup is designed to illustrate all of the Windows NT disk partition features rather than to represent a typical configuration that you might encounter on a real system.

This system has four hard disks plus a CD-ROM drive (and a floppy drive that is ignored by the Disk Administrator). The display shows a high-level picture of disk usage, focusing on its deployment within the system. Each primary partition and logical drive appears as a separate area within the corresponding disk showing its drive letter, volume name, file system type (if a file system has been built on it) and size. The colored band at the top of each area indicates the type of entity it is.

For example, Disk 0 has three file systems. Two of them, C: and D:, reside in primary partitions, indicated by their dark blue color coding. The third partition on this disk is an extended partition containing a single logical drive, designated by the drive letter E:.

Disk 1 is divided into the maximum of four partitions: three primary partitions and one extended partition; the extended partition is further subdivided into two subsections, the logical drives K: and L:. Of all the items on this disk, only drive L: is a normal file system. The other file systems illustrate the advanced features offered by Windows NT. We'll consider them in order of increasing complexity:

- **Drive K:** is part of a *volume set*–a series of two or more disk partitions and/or logical drives that are treated as a single file system and appear to users as a single drive. A volume set can contain up to 32 partitions. (Drive J: is another volume set on this system, with components on Disk 2 and Disk 3). Existing file sys-

tems can be enlarged by converting them to a volume set.

• **Drive H:** is one-half of a *mirror set*. Disk mirroring is one of the options Windows NT provides for fault tolerance. In a mirror set, all data within the file system is maintained in duplicate, on two identically sized disk partitions on separate physical disks. If one of the component disks should fail, everything within the file system would still be intact via the duplicate copy.

• **Drive G:** is part of a *stripe set*. Disk striping is used to increase I/O performance by dividing the data across the component physical devices and carrying out the resulting I/O operations in parallel. It is most effective for large I/O operations performed by a single process.

• **Drive I:** is part of a *stripe set with parity*, another file system type designed for fault tolerance. As in plain disk striping, I/O operations are divided among the components of the stripe set, and successive chunks of data are stored to each disk in turn. In addition, parity data is stored for every block of the actual data. The parity data rotates among the components in the stripe set. This scheme again ensures that all of the file system data will be preserved even in the event of a physical disk failure (because it can be reconstructed from the remaining raw data and parity information).

The other components of these file systems are found on Disks 2 and 3. Disk 2 currently contains three primary partitions, a 400-MB extended partition for which no logical drives have yet been defined and a region of free space consisting of 710 MB. Although both of these areas are labeled as *Free Space*,

Figure 1. Disk Administrator

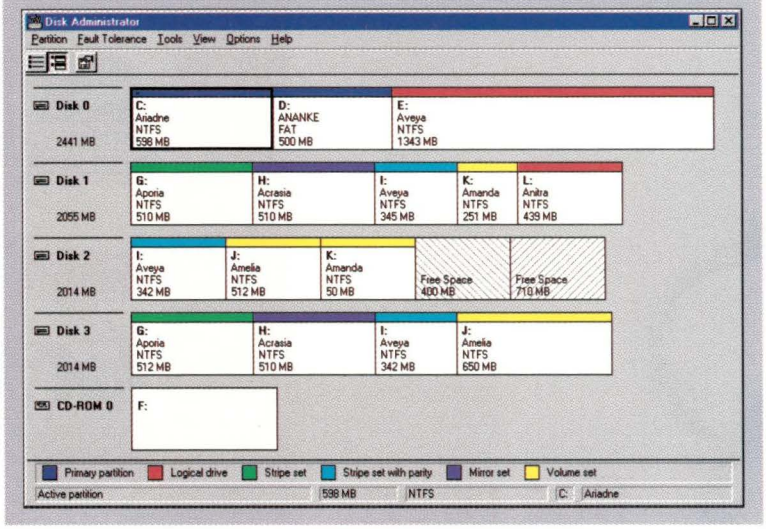
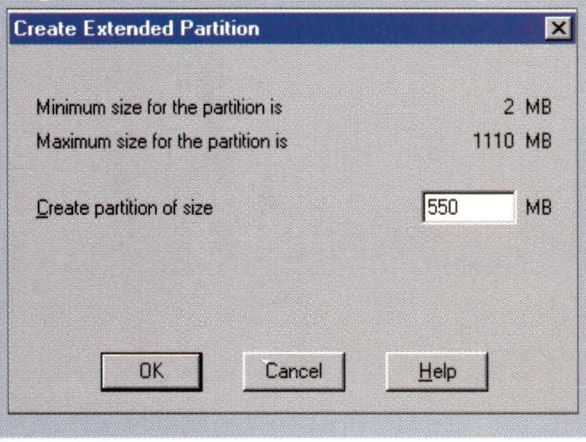


Table 1. Disk Administrator Commands at a Glance

Menu Item	Purpose and Use
Partition=>Create...	Create a new primary partition in the selected free space area or a new logical drive in the selected extended partition.
Partition=>Create Extended...	Create a new extended partition in the selected free space area.
Partition=>Create Volume Set...	Create a new volume set from the selected area(s) of free space.
Partition=>Extend Volume Set...	Extend the selected volume set using the selected area(s) of free space.
Partition=>Create Stripe Set...	Create a stripe set from the selected areas of free space (two or more, on separate disks).
Fault Tolerance=>Create Stripe Set with Parity...	Create a stripe set with parity from the selected areas of free space (three or more, on separate disks).
Fault Tolerance=>Establish Mirror	Establish a mirror for the selected partition using the selected area of free space.
Partition=>Delete	Delete the selected entity.
Fault Tolerance=>Break Mirror...	Break a mirror set, creating two independent partitions (initially holding identical data).
Fault Tolerance=>Regenerate	Attempt to recover the data in the selected stripe set, using the selected area of free space. The actual regeneration process occurs during the next system reboot.
Partition=>Commit Changes Now...	Write configuration changes to disk, making them permanent (this action is often necessary before you can format a new partition).
Tools=>Format...	Create a file system in the selected partition or entity.
Tools=>Assign Drive Letter...	Assign a specific drive letter to a selected partition.
Partition=>Mark Active	Mark the selected partition as active (designated as the boot partition if on the system disk).
Partition=>Configuration	Save or restore a disk configuration.
Tools=>Properties	Display information about the selected entity.

Figure 2. Partition Size Dialog Box



note that there is a difference in the way the latter two regions are shaded. The extended partition has stripes running from the upper left to the lower right, while the stripes in the area of free space run in the opposite direction (upper right to lower left). In this configuration, this area of free space is actually inaccessible and wasted, because the disk already has its maximum of four partitions.

Creating a new partition or other entity follows the same general process:

- Select one or more areas of free space (and possibly an existing file system in some cases).
- Choose the appropriate item from the Disk Administrator's **Partition** or **Fault Tolerance** menu.
- Specify the size of the file system in the resulting dialog box. A sample dialog box (for a new extended partition) is illustrated in Figure 2.
- Format the resulting entity via the **Tools=>Format...** menu item.

The most important menu items provided by the Disk Administrator are summarized in Table 1. See those descriptions for more information on creating specific partition and file system types.

As we've seen, partition boundaries are not always explicitly displayed in the Disk Administrator. Use the **showdisk** utility in the Resource Kit to obtain detailed information about raw disk partitions.

Beyond the Basics with PartitionMagic

The Disk Administrator does a good job of handling basic disk partitioning tasks. However, it is capable of performing only routine disk administration. PartitionMagic from PowerQuest Corp. (`http://www.powerquest.com`) is a far more powerful disk partitioning utility. These are among its most important capabilities:

- Altering the size of a partition containing an existing file system – A partition can be made larger or smaller, provided that the current disk configuration supports the desired size. Successfully decreasing a partition's size requires a nontrivial amount of free space within the file system so that existing files can be relocated. Increasing a partition's size is possible only when there is unallocated free space directly beyond the existing partition on the disk; otherwise, you can always increase the available space in the file system by creating a volume set.
- Relocating an existing partition to a different location on the same physical disk.
- Copying an existing partition–including all its data–either to the same disk or to a different disk.
- Changing the partition type of a partition.
- Hiding a partition–marking it as inaccessible without otherwise altering it.

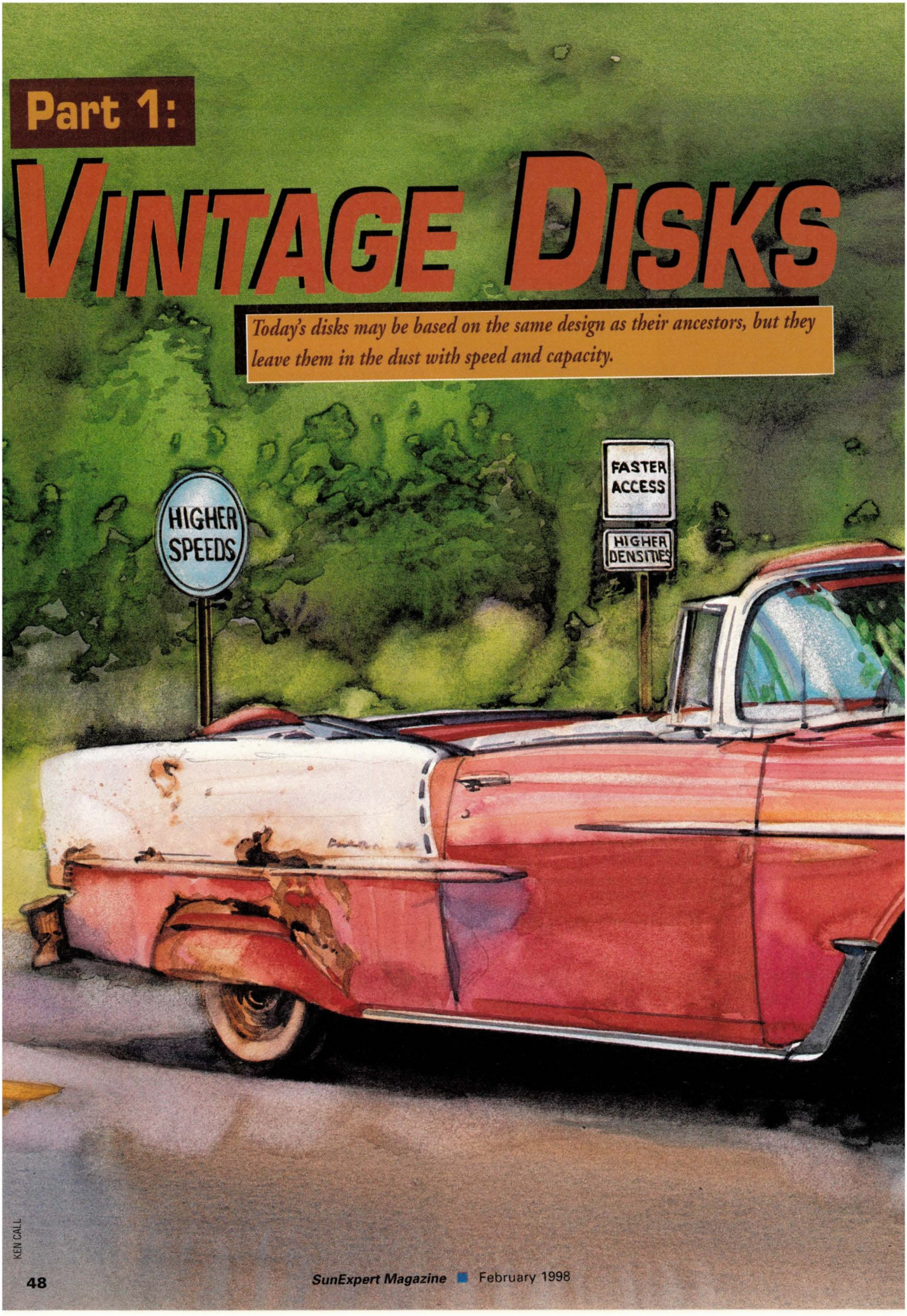
Under Windows 95, PartitionMagic provides a GUI interface for performing its operations. However, this will not run under Windows NT because it works by directly accessing a disk's partition tables. The easiest way to use it on a Windows NT system is to boot from a DOS diskette and run the text-based version (**PQMagicT.Exe**) directly from the product CD. Alternatively, you can boot from a Windows 95 partition and run the graphical version. ⊷

Æleen Frisch *is systems administrator for a very heterogeneous network of UNIX and NT systems. She is also the author of the books* Essential System Administration *and* Essential Windows NT System Administration *(both from O'Reilly & Associates Inc.). In her (almost nonexistent) spare time, she enjoys painting and lounging around with her cats, Daphne, Susan, Talia and Lyta. Email:* `aefrisch@lorentzian.com`.

Part 1:

VINTAGE DISKS

Today's disks may be based on the same design as their ancestors, but they leave them in the dust with speed and capacity.



KEN CALL

IN HIGH GEAR

by Alexandra Barrett, Staff Editor

Magnetic hard disk drives (HDDs) have the pleasing property of getting cheaper and better over time. Consumers take it on faith that, every year, they are guaranteed to get more capacity and better performance for a smaller price tag. Try saying that about anything else in this world. So the next time you are feeling bad about having spent $8 to sit through a turkey of a flick, console yourself with memories of megabyte (not gigabyte) capacities, head crashes and the sound of spinning disks.

The remarkable thing about magnetic HDDs is that today's models employ the same basic technology as that developed by IBM Corp. in the 1960s. Sometimes referred to as Winchester drives, the early models featured a flying head that recorded onto a spinning magnetic disk, just as

today's drives do. The name Winchester reportedly derives from the early models' performance specifications: 30 MB of capacity and a 30-msec access time, like the .30-caliber rifle of the same name.

These days, of course, 30 MB wouldn't hold your average office productivity suite, and an access time of 30 msec would send us into fits of frustrated rage. The storage industry has taught us to expect more from our hard drives–specifically, more capacity and much better performance.

But if it's true that today's disks are genetically similar to their '60s ancestors, what have the disk manufacturers done to improve on them so dramatically? And more to the point, will they be able to keep promising better price/performance and lower dollars per megabyte, or are we in for a surprise? In this article, we'll look at the main areas that engineers focus on to eke better numbers out of their disks, to give you an idea of what to look for when buying a disk subsystem for your UNIX machine.

Magnetic HDDs: You Haven't Seen the Last of Them

"When I joined the company 17 years ago," reminisces M.S. Bhat, business line manager for the server disk drive business at IBM Storage Systems Division, San Jose, CA, "we were going to be overtaken by optical in five years." Nearly two decades later, optical technology is commonplace in the removable storage arena, but it has yet to make substantial inroads into the online storage market. Shipments of magnetic-based storage don't show any signs of slowing down either. According to numbers compiled by International Data Corp. (IDC), Framingham, MA, in 1997, the total capacity shipped in the UNIX multiuser storage disk subsystem market stood at 22.5 petabytes. In 2001, the number is expected to reach 281.3 petabytes, for a compound annual growth rate of 88.1%.

From a market standpoint, magnetic HDDs are clearly not on the endangered species list. From a technology standpoint, however, engineers may have a harder time keeping the rate of performance and capacity increases up, the way they have in the past. Thus far, areal densities–the measure of how tightly bits are packed on a track–have increased at an average annual rate of 60%. Bob Katzive, vice president at DiskTrend, Mountain View, CA, a consulting firm that concentrates on the storage industry, says he expects to see areal densities increase at those rates "for a couple of years, at least." But, he adds, "the law of diminishing returns has begun to set in. An end is in sight."

When exactly that end will occur is anyone's guess. What experts do think is that beginning at areal densities of 40 GB/in^2, information stored on the disk becomes very unstable. However, with areal densities at only 3 GB/in^2 today, Katzive says he believes we have between seven and 10 years at current growth rates before something radical has to change in how disks are designed. Other industry watchers give the magnetic disk drive a much longer life expectancy: "Between 20 and 30 years," predicts Pat McGarrah, director of strategic and technical marketing for Milpitas, CA-based disk drive manufacturer Quantum Corp.

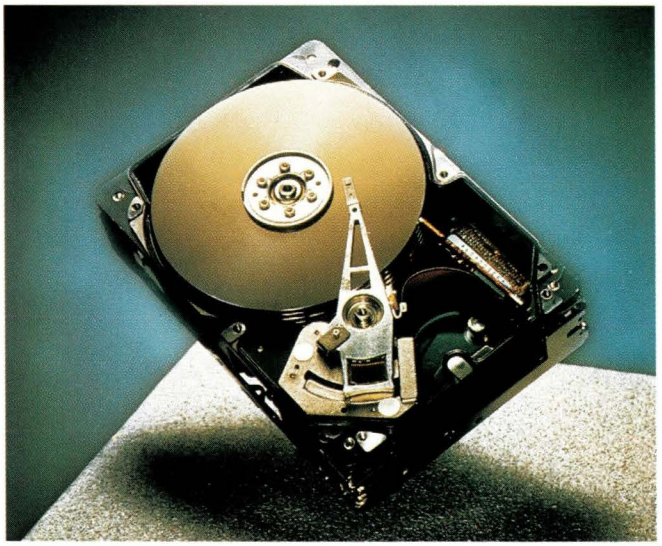
Before considering the future of disk drives, however, it's important to take stock of where we are now. In the 3.5-inch server-class disk drive market, a good example of state-of-the-art comes from Seagate Technology Inc., Scotts Valley, CA. Its high-performance Cheetah family of disk drives–the industry's first drive to spin at 10,000 rpm–comes with up to 18 GB of storage capacity. Average seek times go as low as 5.2 msec, with heads flying at about 2 microinches above the surface.

Improved Head Design

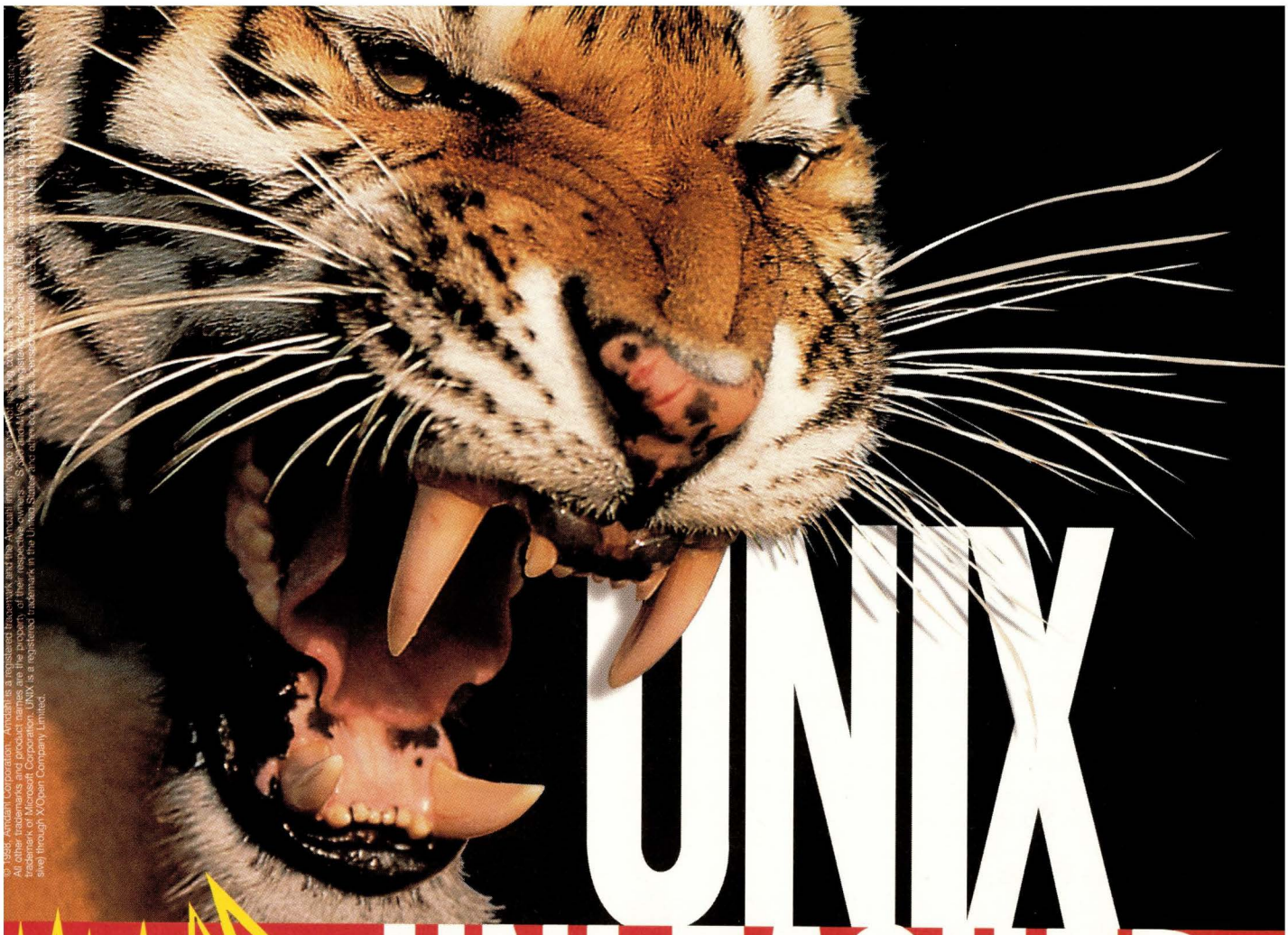
In order to get better areal densities and, hence, capacities, disk drive manufacturers concentrate heavily on improving the design of the head. Increases in areal density are directly related to improvements in head technology. For today's generation of magneto-resistive (MR) heads–the de facto technology in all heads now in manufacture–the aim is to be more sensitive to magnetic fields on the disk's surface. An obvious way to render heads more sensitive to magnetic fields is to fly the heads closer to the media–these days, at about 40 nanometers above the surface. But when you fly a head too close to the media, you also run an increased risk that the head will contact the media and cause a disk crash, which nobody wants.

The trick, then, is to fly the head a little higher, but improve on the sensitivity of the head to fields on the disk. To that effect, IBM in November announced its next-generation head, the Giant Magneto-Resistive (GMR) head, with which the company has equipped its 16.8-GB Deskstar 16GP, a desktop-class drive. This drive features a 3-GB/in^2 areal density, which will reportedly jump to 10 GB/in^2 by the year 2000. IBM will not, however, use GMR heads in its server-class drives, the Ultrastar family, until 1999, Bhat says. GMR heads are not yet refined enough to detect data at the rotational speeds expected of server-class drives.

IBM is not alone in driving improvements to MR head technology. For example, in addition to developing its own version of GMR heads, Fujitsu Computer Products of America, San Jose, CA, is bringing to market a head based on a so-called



In addition to developing a version of Giant Magneto-Resistive heads, Fujitsu plans eventually to include stiction-free slider technology in all its disk drives.



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stiction-free slider. Currently featured in Fujitsu's 18-GB Enterprise drives, the stiction-free slider enables the head to fly closer to the media, allowing for increased areal densities.

"Stiction," the molecular force that draws smooth surfaces to one another, "is the death of disk drives," says Fujitsu's Paul Hansen, vice president of enterprise storage products. To give you an idea of what stiction is, imagine laying two pieces of cellophane wrap one on top of the other, suggests Quantum's McGarrah–they stick together. Heads and disks are not exempt from stiction, a problem that engineers currently resolve either by flying heads high above the disk's surface, or by reducing the media's smoothness and adding nanometer-size grooves to it. With the latter approach, however, heads become subject to a whole new set of problems: thermal asperities. Resulting from the friction of the head moving over the grooves, thermal asperities can blind the head to the data contained on the media, in effect rendering the head useless.

Fujitsu's solution, the above-mentioned stiction-free slider, rests on the idea that stiction is weaker if you have less surface area. Therefore, the stiction-free slider head is composed not of one large surface, but of four small ones, laid out at the four corners of a rectangle. With the decreased surface area, Fujitsu is able to fly the heads lower, all the while using smoother media and avoiding thermal asperities.

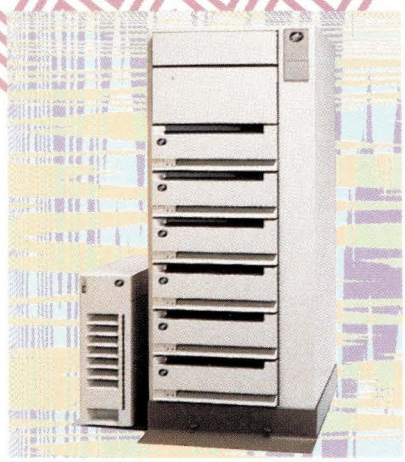
Spin Those Disks

Besides capacity, what users demand from a disk drive is performance. This is especially true of server-class drives, which are typically entrusted with storing and retrieving data for high throughput applications such as file serving and transaction processing. For a hard disk drive, performance is intimately related to the speed at which you can spin the disk: The faster the disk rotates, the faster the head can get to the desired track and the faster the data can get pumped back to the CPU.

While most drives shipped with UNIX systems today spin at 7,200 rpm, the next generation of 10,000-rpm drives is beginning to get some airplay. Of four major disk drive manufacturers to ship into the UNIX market in 1997–Seagate, IBM, Fujitsu and Quantum–all have announced 10,000-rpm drives, and Seagate is shipping them.

Upping the rotational ante to 10,000 rpm, however, uncovers yet another set of problems. "Power diffuses as either light, acoustic or temperature," explains Quantum's McGarrah. In the case of disk drives, temperature is a problem, and the $60,000 question is how to keep it down.

"It's all a question of how you manage your power consumption," says Fujitsu's Hansen. Different vendors have opted for different solutions in their quest to cool down their disk drives. The solution adopted by Seagate and IBM was reduce the size of the disks in 10,000-rpm drives from 3.5 inches to 3 inches, while maintaining an external 3.5-inch form factor. To make up for the areal density lost by employing smaller disks, IBM and Seagate stacked more disks into the drive. And while the move to 3-inch disks is a likely direction for the industry to go, Hansen warns of increased costs resulting from the use of nonstandard disks, as well as the additional heads required when you add more disks to a drive.



IBM's Serial Storage Architecture, as used in its 7131 storage system (left), is one of many interface options.

Interfaces: A Bevy of Options

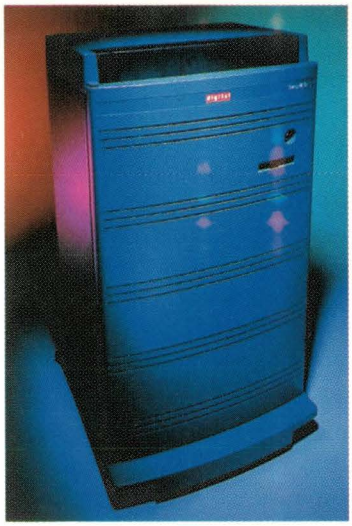
"If I were Joe Systems Administrator looking to buy a new disk drive today, one of the first things I'd look at is the kind of interface it has," says Ken Osterberg, product planning manager for Seagate. These days, people in the market for a server-class disk drive can choose from a bewildering number of interfaces, each with its own advantages and disadvantages. Today's Sun Microsystems Inc. systems can readily interface with disks based on Small Computer Systems Interface (SCSI) or Ultra SCSI technology and, increasingly, with Ultra2 SCSI. Given the right host adapter, a Fibre Channel interface is also an option, as is IBM's Serial Storage Architecture (SSA), thanks to a new SBus-to-SSA Interface Controller card, linking Sun systems to IBM's Seascape Storage Enterprise Architecture.

As to which interface to choose, that largely depends on what your storage needs are, and on what your particular host system will support. "The main advantage of SCSI is that it's cheap," says Bill Pinkerton, vice president of worldwide marketing for open systems storage at IBM. As the default storage interface technology for the past decade, SCSI is both ubiquitous and easy to implement. And for organizations whose storage needs are relatively small and stagnant–and who don't require barn-burning performance–it is entirely sufficient.

Choosing an earlier version of SCSI, however, isn't the way to go if you plan to buy a high-speed drive, says Seagate's Osterberg. "Some of the new Cheetah 18-GB 10,000-rpm drives are actually too fast for an Ultra SCSI bus. In order to get your money's worth, you really need to go with Ultra2 SCSI." Going from Ultra SCSI to Ultra2 SCSI, the amount of available bandwidth essentially doubles from 40 to 80 MB/s. Thanks to the Low Voltage Differential (LVD) feature in Ultra2 SCSI, cables also lengthen to a theoretical 25 meters from 7.5 meters, using a bus extension. Also, the number of devices Ultra2 SCSI will let you attach more than doubles, from seven to 15.

Fibre Channel on Its Way

Despite the impressive new features that Ultra2 SCSI promises, the real news in the storage world isn't the further refinement of a more than 10-year-old technology, but the long-awaited emergence of Fibre Channel. Bolstered by a wealth of new Fibre Channel products such as host adapter



DEC's StorageWorks RAID Array 7000 is one alternative to Sun's Fibre Channel offerings.

cards, hubs and switches, 1998 promises to be the year when we begin to see substantial shipments of Fibre Channel-based disk subsystems into the high-end market. Forecasts of Fibre Channel-based disk drives reflect this. According to IDC, Fibre Channel disk drive shipments stood at 100,000 in 1997, and they are expected to jump to 1,000,000 in 1998, and to 6.9 million by the year 2000.

In the context of storage, Fibre Channel will wield a lot of potential benefits, experts say. The most obvious advantage is bandwidth: Vendors talk of a theoretical 200-MB/s data transfer rate in full-duplex mode (sending and receiving on two ports, simultaneously). Cable lengths far surpass any distances offered by SCSI: up to 10 kilometers compared with 25 meters with differential SCSI. And as for the number of devices that you can put on any one Fibre Channel loop, the spec calls for a maximum of 126.

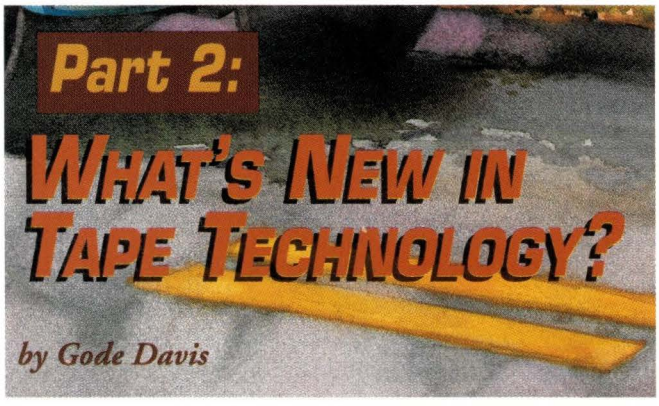
One-to-one comparisons of data specs don't do Fibre Channel justice, though. "The real reason Fibre Channel will succeed," says Walt Hinton, vice president of product planning at Storage Technology Corp.'s network systems group, Louisville, CO, "is because it changes from a point-to-point [SCSI] to switched topology [Fibre Channel]." Hinton likens the migration from SCSI to Fibre Channel in the open systems world to a similar phenomenon in the mainframe world, when in the 1980s, IBM introduced Enterprise Switching Connection (ESCON) in addition to block multiplexing.

Given a switched topology, organizations are free to create so-called networks of storage, sometimes referred to as storage-area networks, where loops of up to 126 devices are connected to other loops via switches, and where any node on one loop can talk to any node on another. Fibre Channel "fabrics," as they are called, are easily expandable and have many of the properties of a network. In comparison, "SCSI isn't terribly convenient when it comes to growing your system," says Robin Harris, senior product manager at Sun in Menlo Park, CA.

When it comes to the availability of Fibre Channel products, Sun users are actually fairly fortunate. "Sun customers have been using Fibre Channel for years and really like it," says Harris. "Unlike people working with other platforms, for us Fibre Channel isn't some scary new thing that's going to mess up our systems." Sun itself has been shipping a Fibre Channel-based storage product since 1994, when it first introduced the SPARCstorage Array.

The SPARCstorage Array was well received in terms of units shipped, but was not a pure Fibre Channel solution. From the host to the controller–the upper channel–the SPARCstorage Array featured a quarter-speed (25-MB/s) Fibre Channel connection. But in the lower channel that goes between the controller and the disks, the SPARCstorage Array used a SCSI interface. In October, however, Sun announced the Sun Enterprise Network Array A5000. The A5000 features Fibre Channel all the way to the disks, with dual-ported 100-MB/s channels. Thanks to the dual-porting, the A5000 can provide automatic failover between drives and load balancing between loops. Also, says Harris, "the host adapter card used with the A5000 features dual Fibre Channel ports, which means, in the event that you want to take advantage of dual porting, you don't waste an extra slot."

Fibre Channel alternatives to Sun's offerings are in the works from most major storage vendors as well, for example, StorageWorks RAID Array 7000 from Digital Equipment Corp., Maynard, MA, and the 9137 from StorageTek. One of the more notable Fibre Channel announcements came in December from EMC Corp., Hopkinton, MA, manufacturer of storage solutions. EMC announced it is shipping the Symmetrix enterprise storage system, featuring connectivity to both Sun Solaris and Hewlett-Packard Co. HP-UX platforms, as well as optional Fast/Wide Differential SCSI, Ultra SCSI or mainframe ESCON support. Doug Fierro, EMC's manager of product marketing, says these features should appeal to organizations that don't run exclusively on Sun systems and have not yet completed their migration to a Fibre Channel infrastructure. "Sun has a very proprietary approach to connecting storage to their servers," Fierro says, which isn't in keeping with the nature of this transitioning marketplace.



In 1987, the tape storage industry went agog over an 8mm product. On January 14 of that year, Exabyte Corp., headquartered in Boulder, CO, introduced its Model 8200 drive. It was the first popular data-storage tape device to use helical scan, and with a formatted capacity of 2.32 GB (uncompressed), it blew away the competition. The ripple effect was that a single vendor's name virtually monopolized the 8mm tape arena for almost a decade.

Almost. By the time Exabyte's 20-GB Model 8900 drive made its way to market in mid-1996, its oft-touted Mammoth was deemed woolly. "The Mammoth was radically behind schedule, and the window created by not having the product in there caused an 18-month downward spiral in Exabyte's fortunes," says Jim Hamilton, analyst with Freeman Associates Inc., Santa Barbara, CA.

Milpitas, CA-based Quantum Corp.'s half-inch Digital Linear Tape (DLT) products moved in quickly to fill the vacuum. And while DLT stand-alone tape drives effectively squelched Exabyte's momentum (ironically, Exabyte sells an automated tape drive library featuring DLT), Sony Electronics Inc.'s Advanced Intelligent Tape (AIT) devices–also distributed by Seagate Technology Inc.–left Exabyte scrambling to pick up the pieces. Meanwhile, the market grew fuzzier with the presence of "better mousetrap" 4mm wide Digital Data Storage (DDS) tape drives and revamped quarter-inch cartridge (QIC) products–each scavenging for respect as legitimate 10-GB+ capacity contenders. And what if backup wasn't a user's primary concern? Although IBM Corp.'s Magstar MP (Multi-Purpose) is somewhat capacity-challenged at a mere 5 GB, it can be used for near-line storage–where data is not as accessible as it would be if on hard disk or CD-ROM, but is accessible nevertheless. Talk about choices.

Data, data, so much data! Backup windows shrink as fast as storage capacities multiply and install bases divide. And if the industry weren't jumbled enough, a lineup of new technologies seems prepared to jump into a chaotic marketplace already crowded with a roster of diverse formats and form factors. What to buy? There's a criteria blizzard to consider–if you're just thinking about capacity and price, think again. And because considerable overlap exists within this mad plethora, options are seldom clear-cut, and trade-offs are legion.

The Dazzle of DLT

Quantum's products are overkill for the low-end market, but for midrange to enterprise configurations, DLT dazzles. Who would have thought it back in 1992 when the DLT-2000, blessed with a then amazing 10-GB capacity, first allowed Digital Equipment Corp. (not Quantum–it didn't own the technology until 1994) to expand into the tape storage industry? More aggressive in marketing the DLT than DEC ever was, Quantum's digital tapes keep getting more capacious with succeeding generations; more capacity, it seems, than any "snake" should swallow. All DLT drives write serpentine tracks parallel to the edge of the tape. But because the three-way rotating head assembly on Quantum's latest linear serpent writes blocks of data in a "herringbone" or symmetrical phase recording pattern, the DLT7000 produces a higher track density and a higher data capacity (35 GB native) on a given length of tape than a DLT4000 ever could.

Good transfer rates (5 MB/s) and a level of robustness (especially crucial for library configurations) have as much to do with the current DLT7000 market juggernaut as does capacity, yet DLT's major drawback is still the C word. An avalanche of recent sales volume has cut the street price of a DLT7000 tape drive from $8,000 to $6,400, but an Exabyte Mammoth ($3,900) or Sony AIT-2 tape drive ($4,995) cost considerably less. The latter–helical scan technologies in which data tracks are written at an angle with respect to the edge of the tape–are also faster than a DLT. The Sony AIT is especially fast, showing average file-access times of as little as 27 seconds, compared with 55 seconds for Mammoth drives, 60 seconds for the DLT7000 and 68 seconds for the DLT4000.

At the heart of Sony's super-fast AIT is a 16-KB flash EEPROM memory chip. The chip, marketed as Memory In Cartridge (MIC) by Sony, is able to hold the tape's data structure, history and other user-definable information. While both the Exabyte and Sony drives transfer data at 3 MB/s, the compression algorithm used by Sony AIT drives is more efficient than that of Exabyte's Mammoth or any DLT. Even if a DLT7000 can store 70 GB of uncompressed data–compared with the Sony AIT's 65-GB uncompressed capacity–its ratio, like that of Exabyte's helical scan technology, is only 2:1. Sony also uses the most compact form factor, which doesn't really matter all that much–except that a

An Exabyte Mammoth, at $3,900, costs considerably less than a DLT drive.

DLT tape is also 9 inches long, which may matter to someone, somewhere, someday. Claiming "six-figure" (200,000 hours) mean-time-between-failure (MTBF) rates, a rather nebulous statistic, each of these front-running drives can be considered reliable. But because of an internal, self-contained fan that keeps dust off the head, Sony AIT drives are less likely than a Mammoth to stop in the middle of a backup because too much time between head cleanings has expired. That said, Sony AIT tapes might also be regarded as an "island technology."

"It isn't compatible with the only other 8mm products on the market that have an installed base," says Richard Severa, vice president of marketing at Tandberg Data Inc., Simi Valley, CA, manufacturer or quarter-inch tape drives. "Obviously, this undermines Exabyte, but it also provides no opportunity for all the 8mm Exabyte cartridge owners to make an easy transition to Sony's AIT."

DDS drives (also called DAT, for digital audio tape) are 4mm wide and use a helical scan recording style originally perfected for audio use. Since their introduction in 1989, the DDS market has steadily grown and is no longer perceived as being strictly low end. Hewlett-Packard Co., Sony and Tecmar Technologies Inc. offer the latest DDS-3 drives, which can store 12 GB of data on a 125mm tape and capture a recording density of 122K bits per inch (bpi). DDS-3 drives can also write to all earlier DDS formats–a compatible feature that lends itself to data-interchange capabilities for those inclined towards mix-and-match server-drive configurations.

QIC tape drives might seem oldfangled to UNIX users–espe-

cially if you're visualizing a 60-MB QIC drive corroding in some musty UNIX server. But in March 1997, Tandberg Data introduced Multichannel Linear Recording (MLR1), pushing the QIC format within the 5.25-inch form factor to 13-GB native, giving it a burst transfer rate of 1.5-MB/s using 1,200-foot tapes. In fact, when Tandberg announced the availability of 1,500-foot tapes in June 1997, the MLR1 capacity blossomed to 16 MB. Tandberg also offers low-end single-channel linear-recording (SLR) products–giving users a viable road map of interchangeability from entry-level to midrange and soon-to-be-enterprise. Tandberg's 25-GB native capacity MLR2 tape drive is due out this summer, and on the heels of that announcement, expect MLR3 to mushroom storage potential to 50 GB sometime in 1999. So what else is new?

Deep Thoughts

Tape libraries can store terabytes of data instead of gigabytes, but there's a trade-off. While the average stand-alone tape device is actually working on average only about 20% of each day, that figure balloons to 80% on average for tape drives laboring in library configurations–a made-to-order recipe for premature tape failure.

And ah, the triumvirate! In November, Hewlett-Packard, IBM and Seagate agreed to develop a "standardized" tape technology designed to simplify the network storage industry. Is it a ploy to break into the game after missing the DLT bandwagon? In any case, the triumvirate's new technology is likely to be modeled after IBM's Magstar MP. Currently low capacity, the Magstar design has scalability potential while incorporating both backup and near-line storage. But is Seagate's current distribution of Sony AIT products a stopgap measure? Time will tell.

And don't be surprised to see a reconstituted Trevan-NS product moving into the server space; expect something new and midrange from Storage Technology Corp, not to be confused with TeraStor Corp., San Jose, CA. Projected for a mid-1998 release, TeraStor's new product will use near-field recording technology and be a high-capacity, random access, hard disk removable media that it is claimed will provide cost-per-megabyte ratios formerly reserved for tape. Says Mike Hardy, TeraStor's senior product marketing manager, "Its restore times are absolutely minimal, and we believe it will compete with QICs and DDS and 8mm and will also impact some DLT." If that doesn't raise your hackles, maybe this will: Among the library vendors rushing to automate TeraStor's proposed new offering is Exabyte, should the marvel somehow come to pass.

Gode Davis is a Rhode Island-based freelance writer who specializes in computer-industry topics.

Companies Mentioned in this Article

Digital Equipment Corp.
146 Main St.
Maynard, MA 01754
http://www.dec.com
Circle 150

EMC Corp.
171 South St.
Hopkinton, MA 01748
http://www.emc.com
Circle 151

Exabyte Corp.
1685 38th St.
Boulder, CO 80301
Circle 152

Fujitsu Computer Products of America Inc.
2904 Orchard Pkwy.
San Jose, CA 95134
http://www.fujitsu.com
Circle 153

Hewlett-Packard Co.
3000 Hanover St.
Palo Alto, CA 94304
http://www.hp.com
Circle 154

IBM Corp.
Contact local sales office

Quantum Corp.
500 McCarthy Blvd.
Milpitas, CA 95035
http://www.quantum.com
Circle 155

Seagate Technology Inc.
920 Disc Drive
Scotts Valley, CA 95066
http://www.seagate.com
Circle 156

Sony Electronics Inc.
3300 Zanker Road
San Jose, CA 95134
http://www.sony.com
Circle 157

StorageTechnology Corp.
2270 South 88th St.
Louisville, CO 80028
http://www.stortek.com
Circle 158

Tandberg Data Inc.
2685-A Park Center Drive
Simi Valley, CA 93065
http://www.tandberg.com
Circle 159

Tecmar Technologies Inc.
1900 Pike Road, Bldg. E
Longmont, CO 80501
http://www.tecmar.com
Circle 160

TeraStor Corp.
95 W. Plumeria Drive
San Jose, CA 95134
http://www.terastor.com
Circle 161

SAMPLING OF

4-GB+, 3.5-INCH HARD DISK DRIVES

KEY

— = Information not available
IN = Internal drive
EX = External drive
SE = Single ended
SCA = Serial channel architecture
IDE = Integrated drive electronics
EIDE = Enhanced integrated drive electronics
SSA = Serial storage architecture
ATA = Advanced transfer adapter
LVD = Low voltage differential

compiled by MAUREEN MCKEON

Company	Model	Internal/external drive	Capacity (formatted)	Interface(s)	Multimedia-ready	Average seek time read/write (msec)	Average latency (msec)	Burst transfer rate (MB/s)	Average sustained transfer rate (MB/s)	MTBF (hours)	RPM	Warranty	List price ($)
Fujitsu	MPB3043AT	IN	4.32 GB	Ultra ATA, ATA-3	Yes	10/11	5.56	16.7	5	500K	5,400	3 years	389
	MPB3052AT	IN	5.24 GB	Ultra ATA, ATA-3	Yes	10/11	5.56	16.7	5	500K	5,400	3 years	409
	MPB3064AT	IN	6.48 GB	Ultra ATA, ATA-3	Yes	10/11	5.56	16.7	5	500K	5,400	3 years	429
Hitachi	DK329H-91	IN	9.1 GB	Fast SCSI, Ultra SCSI, Ultra2 SCSI, Fibre	Yes	7.5/8.5	4.17	20-100*	15.4	1M	7,200	5 years	995
	DK319H-18	IN	18 GB	Fast SCSI, Ultra SCSI, Ultra2 SCSI, Fibre	Yes	7.5/8.5	4.17	20-100*	4	1M	7,200	5 years	1,895
IBM	Deskstar 14GXP	IN/EX	14.4 GB	Ultra ATA-4	Yes	9.5/—	4.17	175.6	13	—	7,200	3 years	849
	Ultrastar 9ZX	IN/EX	9.1 GB	Fast/Wide SCSI, Ultra2 SCSI, SSA, Fibre	Yes	6.3/—	6.3	40	13.8	—	10,020	5 years	1,245
	Ultrastar 18XP	IN/EX	9.1 GB	Fast/Wide SCSI, Ultra2 SCSI, SSA, Fibre	Yes	7.5/—	4.17	40	12.6	—	7,200	5 years	1,745
Maxtor	DiamondMax 84320D5	IN	4.3 GB	EIDE	Yes	<10/—	5.77	33	15.1	500K	5,200	3 years	230
	DiamondMax 85250D6	IN	5.2 GB	EIDE	Yes	<10/—	5.77	33	15.1	500K	5,200	3 years	280
	DiamondMax 86480D8	IN	6.4 GB	EIDE	Yes	<10/—	5.77	33	15.1	500K	5,200	3 years	330
	DiamondMax 87000D8	IN	7.0 GB	EIDE	Yes	<10/—	5.77	33	15.1	500K	5,200	3 years	360
	DiamondMax 88400D8	IN	8.4 GB	EIDE	Yes	<10/—	5.77	33	15.1	500K	5,200	3 years	410

*Rate dependent on interface

Disk Drives

Company	Model	Internal/external drive	Capacity (formatted)	Interface(s)	Multimedia-ready	Average seek time read/write (msec)	Average latency (msec)	Burst transfer rate (MB/s)	Average sustained transfer rate (MB/s)	MTBF (hours)	RPM	Warranty	List price ($)
Quantum	Fireball SE	IN	8.4 GB	Ultra ATA, Ultra SCSI-3	Yes	9.5/—	5.56	33	6	—	5,400	5 years	659
	Viking II	IN	9.1 GB	Ultra2 SCSI, Wide Ultra2 SCSI, Ultra SCSI, Wide Ultra SCSI	Yes	7.5/—	4.17	80	12	—	7,200	5 years	895
	Atlas III	IN	18.2 GB	Ultra SE SCSI-3, Wide Ultra SE SCSI-3, LVD Ultra2 SCSI, Fibre	Yes	7.5/—	4.17	80-200*	12	—	7,200	5 years	1,395
Seagate	Barracuda 9LP	IN	9.1 GB	Ultra SCSI, Wide Ultra SCSI, Ultra2 SCSI, Wide Ultra2 SCSI, LVD Ultra2 SCSI, Fibre	Yes	7.1/—	4.16	200	16	1M	7,200	5 years	995
	Barracuda 18	IN	18.2 GB	Ultra SCSI, Wide Ultra SCSI, Ultra2 SCSI, Wide Ultra2 SCSI, LVD Ultra2 SCSI, Fibre	Yes	7.6/—	4.16	200	16	1M	7,200	5 years	1,695
	Cheetah 9LP	IN	9.1 GB	Ultra2 SCSI, Wide Ultra2 SCSI, LVD Ultra2 SCSI, Fibre	Yes	5.2/—	2.99	200	21	1M	10,025	5 years	1,080
	Cheetah 18	IN	18.2 GB	Ultra2 SCSI, Wide Ultra2 SCSI, LVD Ultra2 SCSI, Fibre	Yes	5.7/—	2.99	200	21	1M	10,025	5 years	1,755
	Elite 47	IN	18.2 GB	Wide Ultra SCSI	Yes	13/—	5.6	40	14	800K	5,400	5 years	2,995

*Rate dependent on interface

Companies Mentioned in this Survey

Fujitsu Computer Products of America Inc.
2904 Orchard Pkwy.
San Jose, CA 95134
Circle 200

Hitachi America Ltd.
Computer Division
2000 Sierra Point Pkwy.
Mail Stop 600
Brisbane, CA 94005
Circle 201

IBM Corp.
Storage Systems Division
5600 Cottle Road
San Jose, CA 95193
Circle 202

Maxtor Corp.
510 Cottonwood Drive
Milpitas, CA 95035
Circle 203

Quantum Corp.
500 McCarthy Blvd.
Milpitas, CA 95035
Circle 204

Seagate Technology Inc.
920 Disc Drive
Scotts Valley, CA 95066
Circle 205

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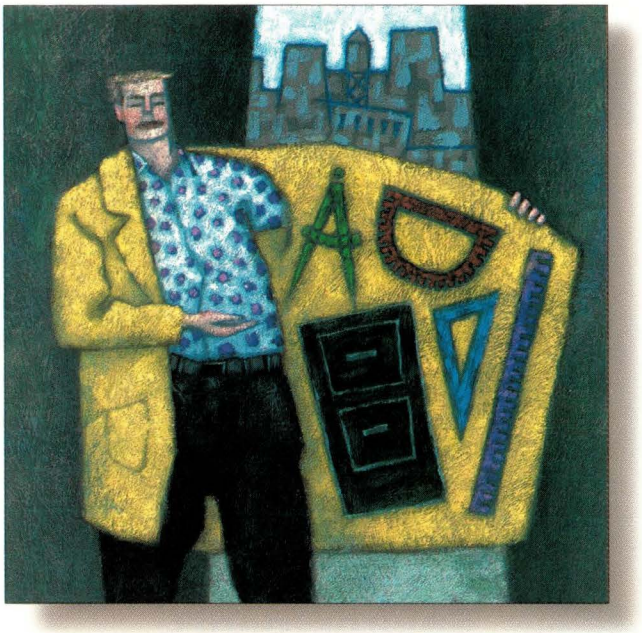
Sun microsystems

Q&AIX

by Jim Fox



As Easy as CDE

Jim Fox *works as a systems programmer for the University of Washington. He writes and maintains distributed applications that run on a variety of UNIX systems–and some non-UNIX ones. He is also the deputy manager for the Interoperability Project for SHARE's Open Systems Group. Email:* `fox@cac.washington.edu`.

wizard's apprentice

super user

wizard

Q: The answer to the question published in October is Common Desktop Environment. Please consider this wonderful, easy-to-use tool as well.

Hal Jennings
IBM Corp.

A: This comment refers to the question featured in the October 1997 Q&AIX article ("Virtual Windows," Page 75). A reader was curious about a window manager he had seen that resembled Microsoft Corp. Windows–it was able to switch between several virtual screens. I suggested it was the `fvwm` window manager, which can be configured to look like almost anything. Several readers disagreed and suggested it was the Common Desktop Environment (CDE). Well, it could have been.

CDE is indeed a complete, easy-to-use graphical user interface (GUI) for UNIX. You might say, it is the UNIX answer to Windows (either NT or 95). It certainly has that Windows look and feel–with some handy extensions thrown in.

CDE was developed over the past few years as part of the Common Open Software Environment (COSE) by IBM Corp., Sun Microsystems Inc., Hewlett-Packard Co., Novell Inc. and some others. COSE is their effort to create open, standard UNIX interfaces across many diverse platforms. CDE is the result of that effort.

CDE provides an integrated set of services; some previously existing as discrete and independent components, some new. These services include a window manager, session manager, display manager, file manager, program launcher, help system and a collection of useful desktop tools.

Window Manager

CDE's window manager component provides a virtual desktop, which can be much larger than your physical screen. Each view of this desktop is known as a workspace. You can easily switch your view from one workspace to another and move windows between them. It allows you to specify how a particular window should appear in more than one workspace–similar to the "stick" function of `fvwm`, although you can't slide windows between workspaces as easily as you can with `fvwm`'s pager. This virtual desktop is something I really miss when I work with Windows NT. Maybe someday Microsoft will bring its system up to the CDE standard.

Daily Times

Special Edition

TODAY'S NEWS...

IBM®AIX® 3.2.x Users Need to Upgrade to 4.x

By Bill Stevens

After December 31, 1997, IBM will no longer support older AIX versions 3.2.x. According to Stephan Moen, Vice-President of Information Technology, Aspen is ready to upgrade all AIX 3.2.x users to the latest version of AIX 4.x. "This is just one of the many system integration services that Aspen offers," commented Moen.

As the system integrator to the AIX user community, Aspen Consulting is a full service firm handling all aspects of the RS/6000 and AIX. Aspen consultants are experts working with IBM RS/6000™SP™, Storage Systems, HACMP, Tivoli®,

SEE UPGRADE, PAGE 5

Martian Pathfinder Mission A Success

IBM® RS/6000™ Capabilities Make It All Possible

By Linda Smith
DAILY TIMES NEWS SERVICE

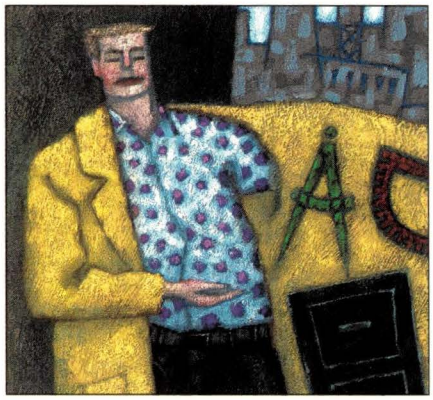
This month's proper soft landing on develop- captured th and testing. It would no rol, AIX the comput municate the IBM RS ace-dust technology ess beam on board th hnology Pathfinder. metime

The new ,000 IBM budget, usir 00's are in off the shelf in over businesses h 00 com- Developed t l and tech- in less than customers the vehicle v AIX, the to carry cam UNIX the Sojourne operating meteorologic environ- communicate computer back to earth ler. The withstand tak mission landing on un me up to deploy its scie 0 IBM direct the expe commer- the mission to stomers using AIX, the closest in comp IX based operating system. The computer

The flight c is based on a vers IBM's RS/6000 technology and the first commercially based processor to travel into deep space. Since software development was critical to the success of the mission, using known and successful technology was key to saving money and time to allow

SEE PATHFINDER, BACK PAGE

The CDE windows themselves resemble those of Motif, Windows and fvwm: They have buttons at the top to initiate various window functions, and they have resize handles on all sides and corners to facilitate window resizing. Users have a choice of common focus styles: point to focus or click to focus. You also get to choose whether or not you want the focus window to automatically pop to the front. You are, it seems, stuck with those truly boring icons at the top of the windows (fvwm lets you substitute little pictures for these icons). Maybe someday CDE will bring its system up to the fvwm standard.



Front Panel

Central to the CDE desktop is the front panel. It has many of the capabilities of Motif's dashboard, Windows' taskbar and other systems' program launchers. The front panel allows you to start applications, adjust the desktop settings, move between workspaces, check on printers, lock your screen and whatever else you can think of. It's configurable. A sample front panel is shown in Figure 1.

Most of the icons trigger pop-up menus, like the one shown in Figure 2. Click the rectangles in the middle of the front panel to switch among your various workspace views.

File Manager

I've finally gotten used to the Windows Explorer file manager that comes with Windows NT. It turns out to be convenient for many common file handling tasks. Having a similar interface for UNIX is a welcome addition. A sample file manager window is shown in Figure 3.

CDE's file manager is similar to Windows. It allows varying view styles: list or icons, details or not. You can move or copy files using the drag-and-drop interface. CDE even automatically associates a program with each file, based on the file's extension–just like Windows.

Help

The help system is not the cool, Web-based help we now see on Windows systems, but it is at least integrated into the desktop. I suspect you'll soon find yourself reaching for the Web browser for help, instead of the dedicated help system. Web tools are just too convenient not to be used for this sort of thing. CDE needs improvement here.

Where to Learn More About CDE

A good overview of CDE for AIX, including instructions on how to get and install it, can be found at the Web site: http://www.rs6000.ibm.com/software/OS/CDE/. Since AIX Version 4.2, CDE has been shipped as a standard product, so you won't have to go surfing for it.

An excellent tutorial on CDE can be found at http://dept.physics.upenn.edu/~anthonyc/. It was written specifically for one of the physics computer labs at the University of Pennsylvania, but is nonetheless a good and comprehensive guide. There is also an Internet newsgroup dedicated to CDE: alt.windows.cde.

CDE is really a total solution that gives UNIX the look and feel of Windows. Regardless of where we stand on the UNIX vs. NT debate, we will definitely see more and more integrated applications. And we will also encounter many potential UNIX users who are familiar with, and prefer, the Windows interface. CDE is a great step toward providing this class of user with a comfortable UNIX environment.

If your shop is not entirely peopled with troglodytes, you might find even old UNIX hackers can appreciate this new look. Remind them that CDE has invaded the pristine world of Linux. Red Hat Software Inc., one of the most popular suppliers of Linux software, has released a version of CDE. The handwriting is on the wall. ⊸

Figure 1: The front panel is central to the CDE desktop.

Figure 2: Clicking on a front-panel icon will trigger a pop-up menu.

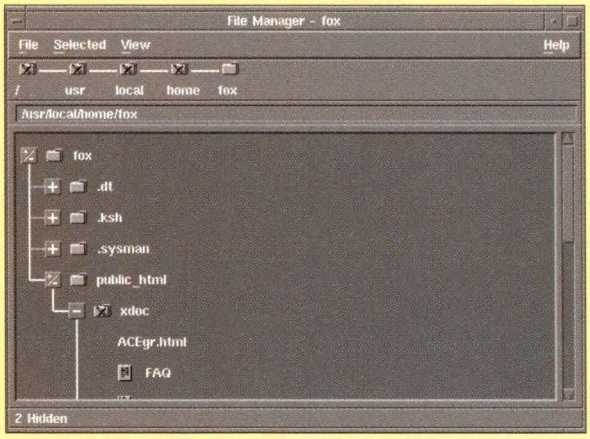


Figure 3: CDE's file manager is similar to Windows in that it allows varying view styles.

by John S. Quarterman

Haiti, Déjà Vu

John S. Quarterman *is president of Matrix Information & Directory Services Inc. (MIDS), which publishes* Matrix Maps Quarterly, Matrix News *(monthly) and the* MIDS Internet Weather Report *(daily). John has written or co-authored seven books, but the best known one is still* The Matrix. *For more information, see* `http://www.mids.org`. *He can be reached by email at* `jsq@mids.org`, *by voice at (512) 451-7602 or by fax at (512) 452-0127.*

In March 1997, the Internet Assigned Numbers Authority (IANA) gave the HT domain for Haiti briefly to one registrar (REHRED, `http://www.ht.refer.org/rehred/domaine/`) and then a week later to another registrar (Focus Data, `http://www.haitiworld.com`). The latter change of registration was made without any warning and without any of the due process spelled out in IANA's own published guidelines, RFC 1591 of March 1994 "Domain Name System Structure and Delegation" by Jon Postel (see `http://ftp.internic.net/rfc/rfc1591.txt`).

I examined this problem and several related issues in a two-part article in the July and August 1997 issues of *SunExpert* ("Haiti and Internet Governance, Parts 1 and 2," Pages 78 and 69, respectively) and in the May issue of *Matrix News*.

Recent Developments Regarding HT

Let's summarize what has happened since then.

• *How many subdomains have been registered under the HT top-level domain?* Zero.

• *Has any agreement been reached among the various parties in Haiti regarding who should be the registrar of the HT domain?* Not as of this writing.

• *Has the Haitian government changed or clarified its position?* No, it has not. Meanwhile, the prime minister has resigned (for unrelated reasons), making it difficult even to find out who would be in charge of such a position, and removing whatever impetus there was from the government toward a resolution.

• *Has IANA changed its position?* No, it has not. However, IANA was one of the few participants to provide a position statement in response to a request for updates on the situation. Figure 1 shows IANA's reply.

• *Has IANA published its previously unpublished rule?* No, it has not. The new rule, as you may recall is:

"Follow the expressed wishes of the government of the country with regard to the domain name manager for the country code corresponding to that country."

• *Has the Internet DNS Names Review Board (IDNB) that is mentioned in RFC 1591 been established?* No, it has not, despite requests from several well-known parties that it be established. The main reason appears to be that IANA has not agreed to its establishment.

Figure 1. IANA's Reply

```
Date: Wed, 1 Oct 97 11:06:09 PDT
From: iana@ISI.EDU
Posted-Date: Wed, 1 Oct 97 11:06:09 PDT
Message-Id: <9710011806.AA02769@ode.isi.edu>
Received: by ode.isi.edu (4.1/4.0.3-6)
          id <AA02769> Wed, 1 Oct 97 11:06:09 PDT
To: jsq@mids.org
Subject: Re: Haiti domain situation
Cc: iana@ISI.EDU

John,

The IANA has asked the parties is (sic) Haiti to work together to
come up with a commonly agreed on plan for the management of
the .HT top level domain. As yet, we have not received any
such plan or proposal for such a plan.

Thanks.

IANA
```

Note: The message from IANA quoted above also included a copy of my request message, which I omit here for brevity.

• *What about the two contending parties who want to be the HT registrar?* The name of the original registrar of HT, REHRED, is a French acronym for Haitian Telematic Network for Research and Development. REHRED promised a brief update but never supplied one directly. Communications from other parties and direct investigation of the HT domain through the Internet have yielded basically only what I've described above: stasis.

However, Daniel Pimienta reports that his organization, FUNREDES, has donated a Sun SPARCserver II (which FUNREDES received in donation from Sun Microsystems Inc.) to REHRED, and REHRED plans to use that machine to set up its own node and domain, under a different top-level domain than HT.

I received no direct response from the current holder of the HT domain, Focus Data, neither under that name nor as HINTELFOCUS or haitiworld.com.

However, it did indirectly provide me with a belly laugh. One morning, I read a message that Focus Data had sent to all the parties in Haiti *except* REHRED (someone forwarded it to me). The message called a meeting to discuss the domain situation, which is innocuous, and probably even appropriate, except for excluding one of the interested Haitian parties, namely REHRED.

What was so funny about it was that it took time out in the middle to misspell my name, "Quaterman," refer to me by a racist epithet, "petit blanc," and as a "foreign agent provocateur," among other things. This was in a letter that claimed to speak for the partners of Focus Data. I had taken Focus Data for an organization with a real position to stand on, and it was amusing to discover that the best it could do was to fling names at a journalist.

The other main thrust of the Focus Data message was to reiterate a position that the HT domain is solely Haitian property and is of no concern to anyone but Haitian nationals. This is an interesting position, considering that the Internet does not stop at the borders of Haiti, and if it did there would be no need for the HT domain. It's also interesting considering that the president of haitiworld.com, Archie Marshall, is allegedly a Jamaican national.

I asked Marshall if the above-mentioned article was an official position of Focus Data and if he had any objections to my publishing it. He returned no answer.

Present Status

What we appear to have here is a general debacle. The various parties in Haiti did not adequately consult one another before the original registration of the HT domain. IANA ignored its own guidelines and reregistered the domain, following a rule IANA had promulgated and had used before but had never published. There has been no change since then in the nominal registrar of the HT domain, no consensus has been reached among the Haitian parties and IANA has refused to change its position.

Meanwhile, no one is in fact registering any subdomains under HT, so the actual situation is that there is no acting registrar for HT, regardless of who is officially the registrar.

Regarding the basic process problem, IANA has still neither published its unpublished rule nor approved the formation of an IDNB. So there is still no appeal from any decision of IANA, nor do we even have a published set of rules by which IANA makes decisions for national TLDs.

National TLDs: Whose Property?

One source of this problem is the question of who owns a national TLD, anyway.

One school of thought, of which IANA is a leader, holds that the national government owns the national TLD. I've received several messages from proponents of this argument since the publication of my previous articles about the HT domain. The messages use wording like, "I think that a national domain is the property of the national government." Well, let's take this point of view out of the realm of pure opinion and think it through instead.

This is an interesting point of view for an organization that is no longer funded by the U.S. government (see below) but is the registrar for the US domain. It's also an interesting

point of view for an organization based in a country whose constitution begins "We the People" and whose Tenth Amendment in its Bill of Rights expressly states that all powers not explicitly vested in the national government are reserved to the states or to the people. If there is any text in the U.S. Constitution stating that communications networks or their naming systems are automatically the property of the national government, I haven't been able to find it. The U.S. government doesn't own the U.S. telephone system, nor even the U.S. Postal Service anymore. So why should it own the Internet Domain Name System top-level domain US?

So, for at least one prominent country on the Internet, it is simply not true that national property is automatically the property of the national government. That's the crux of the matter. There's no debate about a national TLD being the property of the nation named. The difficulty arises regarding who represents the nation. Does a nation's government automatically own all property of that nation? Or is such ownership not automatic?

In many countries, the usual solution to ownership of many communications media was national government ownership, often in the form of an office of post, telephone and telegraph. Even in many of those countries, however, there usually was no office of books, magazines and newsletters. And many of those countries have recently, or are now, privatizing their telecommunications.

In most countries around the world, the Internet TLD is not owned by the government and never was. In many cases, the national TLD was registered by a research or educational organization, which took upon itself the task of managing the national domain. This is the same pattern that REHRED was following in Haiti.

Giving national governments dictatorial powers to decide who runs the national TLD is an innovation, as witnessed by the fact that RFC 1591 says nothing about it, and as confirmed by my personal experience and private communications with several parties who have been involved with DNS registrations for many years. IANA has not denied that it is an innovation. The only defense IANA offers is of the "I think that..." form.

Finally, many of us have recently devoted noticeable amounts of time and resources to preventing the U.S. government from trying to censor the Internet, resulting in the defeat of the so-called Communications Decency Act of 1996 (see `http://www.mids.org/mn/707/cda.html` for my commentary on the CDA defeat, which ran in the July issue of *Matrix News*). The U.S. Supreme Court said in its decision on the matter that "the Internet is 'a unique and wholly new medium of worldwide human communication.'" Let's think twice before handing it over to that antique form of human organization, the nation-state.

If there is any text in the U.S. Constitution stating that communications networks or their naming systems are automatically the property of the national government, I haven't been able to find it.

Any Positive Developments?

Few positive developments appear to have arisen from this HT domain morass. But there are some.

IANA appears to have been much more careful in other national and international situations recently. For example, there was a challenge to some registration practices of the registrar of the PE domain for Peru. Rather than suddenly changing the registrar, as happened with HT, IANA discussed the problem with the affected parties and has arrived at a resolution.

Regarding the recent attempts to form a Network Information Center (NIC) for Latin America and the Caribbean (ALyC) (more on this at `http://www.mids.org/mn/711/foronic.html`), IANA has taken a consistent and proper stance that it will not delegate IP address blocks for ALyC to any organization that cannot demonstrate consensus across that region.

Regarding the US domain, for which IANA is the registrar, IANA has recently updated its rules for registration of state and local subdomains to say that only governments of the named geographical regions may register such domains. While this rule is unfortunately similar to IANA's unpublished rule for national TLDs, it is at least published.

All these positive developments are related to IANA and process, not to the HT domain. It is good that IANA is paying more attention to process, because that was the general issue in the HT problem. It is unfortunate that there has been no progress with the specific HT problem, and that IANA continues to do nothing to resolve a problem that it helped create.

It is also interesting that IANA is acting in three different roles in the positive developments listed above: as assigner of national TLDs in the PE case; as ultimate assigner of IP addresses in the ALyC NIC case; and as registrar of a particular national TLD in the US case. Part of the problem here is that IANA has too many roles to play.

Networkers in Europe and Asia Pacific have already helped by coming forward with funding for IANA after the U.S. Advanced Research Projects Agency (ARPA) for obscure reasons terminated its funding for IANA in April 1997.

Networkers in ALyC could help with this part of the problem by getting their act together and getting consensus on who should run an ALyC NIC, so that IANA could do its job and delegate address blocks to that NIC. This would also help prevent debacles like the one with HT by giving candidates for national TLDs a more local referee.

There aren't many national TLDs left to assign, but there are plenty more potential TLD management problems. Perhaps regional NICs such as RIPE (`http://www.ripe.net/`) in Europe and APNIC (`http://www.apnic.net/`) in Asia Pacific, plus the eventual African and ALyC NICs, should consider going further than just funding IANA and assigning IP address space, and proceed to devolve more IANA functions to the regional level. ⊸

by Jim DeRoest

Passwords – Keep 'em off the Wire

Jim DeRoest *has been involved (for better or worse) with IBM UNIX offerings from the IX/370 days, through PC/IX, AIX RT, AIX PS/2, AIX/370, PAIX, AIX/ESA and AIX V3. He is employed as an assistant director supporting academic and research computing at the University of Washington, and is the author of* AIX for RS/6000–System and Administration Guide *(McGraw-Hill). He plays a mean set of drums for the country gospel band Return. Email:* `deroest@cac.washington.edu`.

Those of us who manage large multi-user systems and servers spend a great deal of time securing our environment from network- and software-based attacks–far more time than our employers, our families or we would like. We do a good job of keeping our own houses in order, but what about those of our clients? Many of our clients connect from computers over which we have no administrative control or authority. It's anybody's guess as to whether such systems have been properly secured or whether the owners allow access to all their friends, relatives and neighbors. This situation usually results in someone with far too much time on their hands installing password sniffers on unsecured or shared computers. User names and passwords are collected over a period of time and then shared with other unscrupulous users through bulletin boards and newsgroups around the world. Can you say, "Arrrrgggghhh"? I can and do more often than I would like to admit.

What can we do to eliminate clear text passwords from the network or at least reduce our exposure to attacks? Fortunately, a number of solutions exist that inhibit or reduce the exposure of clear text passwords on the network. Unfortunately, implementing these solutions also means dictating access mechanisms to our client community. This usually isn't too big of a problem in that most people like to keep their passwords to themselves. A bigger hurdle is the user support issues involved with these solutions for large user communities. It's a fact of life that you can't get anything for free (except maybe somebody's password), so here's what you do.

Secure Shell Security

One of the easiest solutions to hardening the security of a network communication channel is Secure Shell (`ssh`), developed by Tatu Yloemen at the Helsinki University of Technology, Finland (`http://www.cs.hut.fi/ssh/`). Functionally, `ssh` is a drop-in replacement for UNIX remote shell, `rsh`, and derivative r-commands such as `rlogin`. You're probably thinking, "I already use `rsh` with `.rhost` or `host.equiv` files on my servers to eliminate transmitting passwords over the network for trusted users. Why should I consider using `ssh`?" `ssh` goes beyond the security features of `rsh` by including strong client/server authentication to inhibit DNS spoofing and session encryption to thwart the efforts of pesky network eaves-

droppers. ssh also supports secure X11 connection forwarding and arbitrary TCP port redirection. The latter enables ssh to coexist with firewalls.

At session start-up, ssh authenticates both sides of the connection via an RSA (Rivest, Adleman, Shamir) public-key exchange. The server first passes its host and server keys to the client. The client uses these keys to generate a 256-bit session key. Note that the keys used to generate the session key are not stored on disk and that session keys expire and regenerate every hour. The client passes the session key back to the server and negotiates a cipher type to be used for session encryption. ssh supports pluggable cipher algorithms to satisfy various patent and legal requirements. Ciphers include IDEA, DES, triple-DES and blowfish. Once the encryption method has been negotiated and activated, the client authenticates itself to the server.

Client-side authentication methods can include RSA public key. RSA users generate a key pair by invoking the ssh-keygen command. The public key is then stored in a file called $HOME/ssh/authorized_keys on each system they use regularly. The user's private key should be stored in a secure location on their workstation. Some implementations provide a mechanism for encrypting the private key and using an ssh-agent to hold the decrypted key during operation. One's private key should not be stored in directories on networked file systems that might be vulnerable to eavesdropping attacks.

On the host side, the ssh server, sshd, can either be run as a system-wide service on port 22 or invoked as a user process on nonprivileged ports by individuals. In the latter case, sshd can be used only to set up connections for the process owner.

ssh is available for most mainstream UNIX systems, Windows, OS/2, Amiga and Macintosh. A version for VMS is in the works. Converting from rsh to ssh can be transparent to your user community because the ssh client will fall back to rsh behavior if ssh is not supported on a target system. ssh can also be combined and layered with other security systems such as Kerberos. If you intend to use RSA public keys for client authentication for large numbers of users, you're going to need a mechanism for collecting and storing public keys. This key collection mechanism must also be secured against network-based attacks. Large-scale public key management is a problem for most public key systems.

S/KEY Technology

Researchers at Bell Communications Research Inc. attacked the network-passwords-in-the-clear problem with a technology based on single-use passwords (http://www.bellcore.com). Their solution, called S/KEY, provides tools for generating a sequence of onetime passwords for each user. Each password may be used only once, thus the list must be refreshed periodically. The S/KEY system effectively protects against network eavesdropping attacks, but it does require that system server binaries used for authentication be replaced with S/KEY versions. Affected authentication applications include rshd, rlogind, login and ftpd.

To generate a sequence of passwords, a secret pass phrase is used as a seed for a one-way function based on MD4 or MD5 hashing. This one-way function is

applied multiple times to generate the sequence of onetime passwords. After each password is generated, the number of hash function repetitions is decreased by one. Passwords are represented as strings of six words or 16 digits. Each password in the list is associated with a sequence number. The sequence number is used by the server to validate a password by applying the one-way function to generate and compare the next password in the sequence.

When authenticating, the server will challenge the user to supply the previous password in the sequence by number. A successful comparison results in the server updating a local copy of the password with the one received in the challenge. This effectively advances the password sequence for the next session.

It's always easier to see how this stuff works with an example:

1. The user connects to the system and provides an account name to the server.

2. The system, after looking up the account name, challenges the user by presenting a host-specific seed and a password sequence number. The seed provides a means for using a single password list with multiple services.

3. The user enters the seed, sequence number and pass phrase into the S/KEY tool on the client computer, which displays the requested password, and the password is then sent to the server.

4. The server then applies the one-way function to the password and compares the result with the one it has previously stored. If the comparison is successful, it updates its stored password entry with the password and sequence number it requested and permits the user to log in.

As you might guess, there is a little bit of work involved in initializing the password name space for large numbers of users. There is also some exposure to users who elect to generate a hard-copy list of passwords rather than use a client. These lists inevitably end up taped to the display or keyboard. S/KEY servers and authentication binaries are available for most mainstream UNIX systems. A Windows NT server is under development. Clients are available for UNIX, Windows, DOS and Macintoshes.

The Kerberos Model

Kerberos, which has been around for more than a decade, is a technology for eliminating clear text passwords on the wire. It was originally developed at Massachusetts Institute of Technology, Cambridge, and is based on a trusted third-party ticket exchange model (`http://web.mit.edu/Kerberos/www/index.html`). The original design was described in a series of papers presented at the 1988 USENIX Winter Conference. The technology was adopted as the security model for the Open Software Foundation's (OSF) Distributed Computing Environment (DCE) and, more recently, as the new authentication mechanism for Windows NT 5.0. The latter is responsible for renewed interest in Kerberos by many systems administrators.

What Kerberos does is use a system of encrypted credentials called "tickets" and a trusted third party whose job is to validate the two principals involved in a network transaction. The trusted third party, known as the Key Distribution Center (KDC), is the cornerstone of the architecture. The KDC manages a database of all known principals in the network and their secret keys–principals are the users, services and hosts that make up the computing environment. The scope of the entries in this database is called the Kerberos "realm" or a "cell," in the DCE Kerberos world. Facilities exist in the protocol that allow principals in one realm to be authenticated to other realms. Kerberos assumes that everything inside and outside the network is untrustworthy except the KDC itself. It's a good idea to practice this same ideology by locking your KDC system in a closet and entrusting the key to as few people as possible.

Again, it's probably useful to see how the KDC works with an example:

1. To use a network service, a client must first identify itself to the KDC. The client sends a message to the KDC, which contains the client's login name and the requested service name. For initial sessions, the service is usually the Kerberos ticket granting service.

2. The KDC looks up both service names from its database of principals and retrieves the associated encryption keys. These keys are usually one-way encrypted passwords.

3. The KDC builds a ticket for the requested service that includes a newly generated session key and encrypts it with the service's secret key. This sealed ticket and the session key are then packaged into a message, encrypted with the client's secret key and sent back to the client.

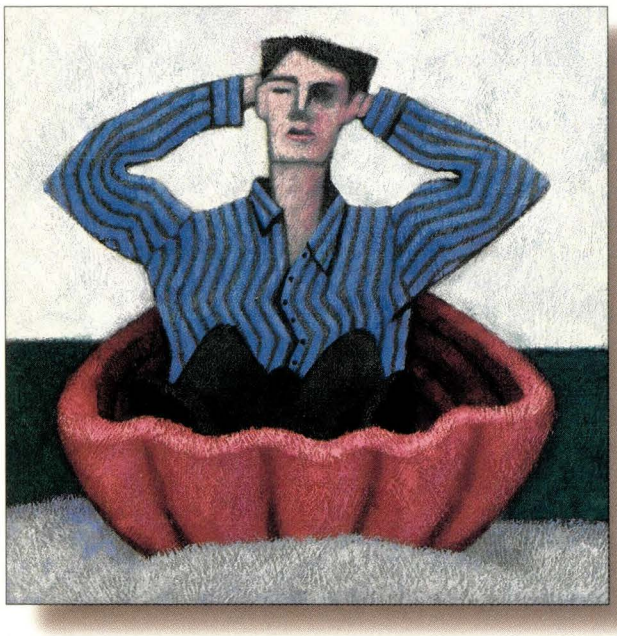
4. The client receives the message and uses its key (usually a password) to decrypt the message. After saving a copy of the sealed ticket and session key, the client creates an authenticator message. This message includes the client name, IP address and time stamp. The authenticator is sealed with the session key and sent to the service along with the sealed service ticket.

5. The service provider then decrypts the sealed ticket with its secret key to obtain the session key. The session key is then used to decrypt the authenticator, identifying the client.

This may seem like a lot of hand waving just to inhibit clear text passwords and improve authentication. On the other hand, it is extremely easy to eavesdrop. Note that this description is a simplified version of what actually takes place between the three parties in a Kerberos transaction–there are many additional steps. Remember also that all this negotiation is taking place under the covers and is not visible to your end users. End users enter their password only once on the client for a particular session. Tickets obtained are time stamped and remain valid for a specified period of time.

In most implementations, the secret key used by the client when communicating with the KDC is based on a login password. Kerberos provides login and password maintenance replacement code to facilitate this. It is important to remember that Kerberos will not restrict access to someone who has already compromised a valid user login ID and password. Additional measures such as smart card systems can be employed to provide random seeds for the secret key algorithms, thereby reducing exposure to compromised passwords.

There are many other technologies that can be employed to reduce exposure to network eavesdropping, for example, Secure Sockets Layer (SSL) for Web applications. The nice thing about `ssh`, S/KEY and Kerberos is that they are all software-based solutions that allow for flexibility in how they are implemented to meet your site's requirements. Kerberos will likely become much more important to many of us when Windows NT 5.0 becomes a reality. Interoperable, secure Kerberos authentication in Windows should reduce overall exposure to these types of attacks in mixed UNIX and Windows environments. I emphasize the word "interoperable." I know, as they say in the Windows world, "Resistance is futile. You will be assimilated." ➸



"We will encourage you to develop the three great virtues of a programmer: laziness, impatience and hubris."
– Larry Wall

"Work is the curse of the drinking classes."
– Oscar Wilde

Work and How to Avoid It

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Jeffrey S. Haemer (jsh@usenix.org) *works at QMS Inc. in Boulder, CO, building laser printer firmware. Before he worked for QMS, he operated his own consulting firm, and did a lot of other things, like everyone else in the software industry.*

Note: The software from this and past Work columns is available at http://alumni.caltech.edu/~copeland/work.html.

If you hate doing unnecessary work, then this month's column is right for you–we'll give you some tips on sloth. On the other hand, if you like doing unnecessary work, then you should read this month's column because you'll ignore our advice and, therefore, reading it would be unnecessary work. Bertrand Russell would be proud of us.

The quotation from Larry Wall that introduces this column is taken from *Programming Perl*, his book about a language designed to save us all a lot of work. Some programmers miss this point. Given an assignment by his boss to write a Perl script to format and print a bunch of files, one of our coworkers produced the following:

```
#!/usr/bin/perl

# Allow files to be written over
system("unset noclobber");

# Set up some environment variables
$ENV{"PRINTER"} = "Viper";

# Create the files
system("groff file1 > /tmp/file1.ps");
system("groff file2 > /tmp/file2.ps");
system("groff file3 > /tmp/file3.ps");
system("groff file4 > /tmp/file4.ps");
system("groff file5 > /tmp/file5.ps");
system("groff file6 > /tmp/file6.ps");
system("groff file7 > /tmp/file7.ps");

# Print the files
system("lpr /tmp/file1.ps");
system("lpr /tmp/file2.ps");
system("lpr /tmp/file3.ps");
system("lpr /tmp/file4.ps");
system("lpr /tmp/file5.ps");
system("lpr /tmp/file6.ps");
system("lpr /tmp/file7.ps");

# Cleanup
system("/bin/rm /tmp/file1.ps");
system("/bin/rm /tmp/file2.ps");
system("/bin/rm /tmp/file3.ps");
system("/bin/rm /tmp/file4.ps");
system("/bin/rm /tmp/file5.ps");
system("/bin/rm /tmp/file6.ps");
system("/bin/rm /tmp/file7.ps");
```

What's wrong with this picture? First, while Perl eschews many sacred computer science cattle–nowhere, for example, can you find a Bachus-Naur Form grammar for Perl–loops and subroutines are both venerable control

structures that even Perl provides. All those nearly identical system calls could have been replaced with the following:

```
sub one_file {
    $file = shift;
    system("groff $file > /tmp/$file.ps");
    system("lpr /tmp/$file.ps");
    system("/bin/rm /tmp/$file.ps"); }

foreach $file (file1 file2 file3 file4
        file5 file6 file7) {
    one_file($file);
}
```

Indeed, though Perl lacks grammatical simplicity, many of us use it because it has power and elegance of expression. For example, many Perl programmers might at least pare the code down to this:

```
sub one_file {
    $file = shift;
    system "groff $file > /tmp/$file.ps";
    system "lpr /tmp/$file.ps";
    system "/bin/rm /tmp/$file.ps"; }

foreach (1..7) {
    one_file "file$_";
}
```

And how about making the program more flexible by replacing the hard-wired list of files with a list supplied on the command line:

```
while (@ARGV) {
    one_file shift;
}
```

We Roll up Our Sleeves to Do Even Less Work

Not enough, not enough. Each of those `system()` calls forks a subshell. We could cut it down from 21 subshells (7x3) to seven by making each subshell perform more than one action. For example,

```
sub one_file {
    $file = shift;
    system "
      groff $file > /tmp/$file.ps &&
      lpr /tmp/$file.ps
    ";
    die "one_file($file) failed" if $? != 0;
    unlink "/tmp/$file.ps" or
        die "can't unlink /tmp/$file.ps";
}

while (@ARGV) {
    one_file shift;
}
```

Here, each call to `one_file()` creates a single subshell, which performs both the `groff` and `lpr` for the source file to be printed. We've also done a couple of pieces of noteworthy sanity checking: First, the double ampersand, `&&`. The sequence

```
$ command_1 && command_2
```

translates as "do `command_1`; if that succeeds, then do `command_2`." This idiom can be a surprisingly useful safeguard. We recently helped a coworker restore his home directory from tape after he had done the following in his home directory:

```
$ cd bogus_directory_name; rm -rf *
bogus_directory_name not found
```

We recommended typing this instead:

```
$ cd bogus_directory_name && rm -rf *
```

which only does the `rm -rf` if the `cd` command succeeds. Thus in our rewritten script, we only try to print the file when our invocation of `groff` succeeds.

We've also taken the reasonable precaution of checking the exit status of the `system()` call, which is held in the predefined Perl variable, `$?`. Moreover, instead of calling the shell-level `rm` command, we use the Perl function, `unlink()`.

As long as we're trying to be careful, we ought to turn

```
#!/usr/bin/perl
```

into

```
#!/usr/bin/perl -w
```

But when we do so, we get a sharp reprimand:

```
Can't exec "unset": No such file or directory at 1 line 4
```

Here, what we're seeing is that `unset` is not an external executable command, but a shell built-in.

```
$ type unset
unset is a shell built-in
```

Just as a `cd` in one shell doesn't affect the current working directory of another unrelated shell, `set` and `unset` change the values of shell variables for a particular shell and, potentially, its children. Perl is warning you that

```
system("unset noclobber");
```

is useless, because it only affects the value of `noclobber` for the subshell invoked by that specific call to `system()`; it has no effect on the subshells invoked by the other `system()` calls.

Each `system()` call executes a miniature shell script. The original program is nothing more than a shell script broken into 23 little, one-line shell scripts, sequentially invoked by the Perl interpreter. Even experienced programmers will occasionally forget that rules in a `Makefile` have this same property.

The production

```
clean_tmp:
    cd /tmp
    rm *
```

will change directories to `/tmp` in one subshell and then, in a separate subshell, remove all the files in your *current* directory. The correct way to write this production is:

```
clean_tmp:
    cd /tmp; rm *
```

Lazier and Lazier

So this brings us to the crux of the matter: Why fork all of these subshells? Here's the more-or-less-equivalent shell script:

```
#!/bin/sh

# Allow files to be written over
unset noclobber;

# Set up some environment variables
PRINTER=Viper;

# Create the files
groff file1 > /tmp/file1.ps
groff file2 > /tmp/file2.ps
groff file3 > /tmp/file3.ps
groff file4 > /tmp/file4.ps
groff file5 > /tmp/file5.ps
groff file6 > /tmp/file6.ps
groff file7 > /tmp/file7.ps

# Print the files
lpr /tmp/file1.ps
lpr /tmp/file2.ps
lpr /tmp/file3.ps
lpr /tmp/file4.ps
lpr /tmp/file5.ps
lpr /tmp/file6.ps
lpr /tmp/file7.ps

# Cleanup
/bin/rm /tmp/file1.ps
/bin/rm /tmp/file2.ps
/bin/rm /tmp/file3.ps
/bin/rm /tmp/file4.ps
/bin/rm /tmp/file5.ps
/bin/rm /tmp/file6.ps
/bin/rm /tmp/file7.ps
```

If nothing else, there's a third less typing to do–639 characters instead of 900. But it isn't just "nothing else." If we do timing tests, this version runs about 12% faster. Of course, just as we did with the first script, we can make the program more general and shorter by adding loops and subroutines:

```
#!/bin/sh
unset noclobber
PRINTER=Viper
one_file() {
    groff $1 > /tmp/$1.ps
    /usr/bin/lpr /tmp/$1.ps
    /bin/rm /tmp/$1.ps
}

for i in file*
do
    one_file $i;
done
```

Oh, but that's still far too much work. Because `lpr` and `rm` will both take more than one file name, we can drop their invocations to a single call apiece, like this:

```
#!/bin/sh
set noclobber
for i in file*
do
    groff $i > $i.ps
done
/usr/bin/lpr -PViper /tmp/file*.ps
/bin/rm /tmp/file*.ps
```

We eliminate the extra variable assignment by using the `-P` argument to `lpr`. We're down to one invocation of the shell, one of `lpr`, one of `rm` and a handful of `groff`s.

Still, the restriction on file names means we might have to rename our input files to suit the script before invoking it. Moreover, in all these versions we've been assuming that the files are in the current directory, and that the only files named `file*.ps` in `/tmp` are the ones we have put there. We fix these problems by again pulling the file names from the command line, and by constructing our own temporary directory for output, removing it when we're done. In the end, we arrive at this 12-line script:

```
1)  #!/bin/sh
2)  PRINTDIR=/tmp/$$.dir
3)  mkdir $PRINTDIR || exit 1
4)
5)  for i in $*
6)  do
7)    OUTFILE=$PRINTDIR/${i##*/}.ps
8)    groff $i > $OUTFILE || rm -f $OUTFILE
9)  done
10) cd $PRINTDIR
11) lpr -P${PRINTER:-Viper} *
12) rm -r $PRINTDIR
```

Here's what it all means:

Line 1 makes UNIX pass the script to the correct shell, even if it isn't the user's login shell.

Lines 2 and 3 create a directory for our temporary files, using the process ID `$$` to generate a unique name.

Lines 5 through 9 are a loop that formats all the input files named on the command line. Line 7 strips any directory information from the input file name, in case it was specified with an absolute path, so that if the file name is `$HOME/project/printfiles/foo`, `$OUTFILE` becomes `$PRINTDIR/foo.ps`.

In older shells, this sort of manipulation was done with the stand-alone executable `/usr/bin/basename`, but POSIX-conforming shells allow users to extract substrings of shell variables with a built-in facility called *parameter expansion*. In this case, the expression `${i##*/}` means "Give me the value of `$i` stripped of the longest possible prefix that matches the glob (shell) expression `*/`" – in other words, the file name, but with any directory name stripped off.

Line 8 formats an input file, taking care to remove any unsuccessful attempts.

Lines 10 and 11 print all successful formatting efforts. In line 11, we see another example of parameter expansion. The expression `${PRINTER:-Viper}` means "use the value of `$PRINTER`, if it's set in the environment (after all, you might, someday, want to print to another printer). If it isn't set, use the value `Viper` as the default." You can find more information about other kinds of parameter expansion in the shell manual page.

Line 12 removes all temporary files by removing the temporary directory. You may wonder whether you can remove a directory while you're still in it. You can, and because we have finished, we do. In a more robust version, we might use a signal handler to remove the temporary directory if the script terminates prematurely, but that seems like overkill here. Finally, because the call to `set noclobber` seemed questionable to us in the first place, we've eliminated the call altogether.

OK, where are we? We've gone from a 34-line Perl script to a 12-line shell script that's both more robust and more general. At the same time, we've made it run faster by reducing an invocation of the Perl compiler/interpreter plus 22 separate invocations of the shell, to a single invocation of the shell.

Unfortunately, all of this presupposes that we can go to our boss and say, "Please don't micromanage me by forcing me to use Perl for a job better done with a simple shell script." If you can't do that, we suggest an easier, alternative approach. First, write a simple shell script, as above, and place it in the directory `/usr/local/real_code`. Second, for your boss, write the following, easy-to-maintain Perl script:

```
#!/usr/bin/perl -w
$real = "/usr/local/real_code";
$0 =~ s(.*/)();              # basename
system "$real/$0 @ARGV";     # call real version
```

And Now We Rest

That's all for this month. Next time, we'll eschew sloth and take as the text for our sermon a sentence from the introduction to *The Art of Computer Programming* by Donald Knuth: "The process of preparing programs for a digital computer is especially attractive, not only because it can be economically and scientifically rewarding, but also because it can be an aesthetic experience much like composing poetry or music."

Until then, happy trails.

NEW PRODUCTS

The product descriptions are compiled from data supplied by the vendors. To contact them for more detailed information, circle the appropriate reader service number on the card located elsewhere in this issue.

Super-Small DLT Device

ADIC has announced a small, seven-tape DLT device called FastStor. It has been designed to be an effective alternative to external DLT drives and to bring the reliability of centralized backup to distributed environments. ADIC says FastStor is an ideal implementation in situations such as remote offices and multiple-server sites.

By attaching a FastStor unit directly to each high-volume server, it is said to provide backup that is typically three times faster than bringing data over the network to a central site. Backup software solutions from companies, including Legato Systems Inc. and Veritas Software Corp., are supported, and when FastStor is combined with such backup server failover, multiple FastStor units can offer more redundancy and higher levels of protection than large, centralized data repositories, ADIC says.

FastStor can sit easily on a standard server, or two devices can be mounted side by side in seven vertical inches of rack space. This means that in a typical

19-inch rack, one FastStor device with seven drives uses the same vertical rack space as a device holding a single drive.

FastStor supports various network topologies and operating systems, including UNIX, Windows NT and PC LANs. FastStor units include a single-DLT drive and seven-DLT tape cartridge and are available with either DLT4000 or DLT-7000 drives, offering a total capacity of up to 490 GB, with an average 2:1 compression. A unit configured with DLT4000 drives costs around $5,995.

Advanced Digital Information Corp.
10201 Willows Road
Redmond, WA 98073
http://www.adic.com
Circle 101

Makeover for UNIX Apps

JSB has unveiled MultiView 2000 Version 3.0, a terminal emulator suite that includes a new Web-enabling technology and GUI enhancements, which are said to improve integration between legacy UNIX applications and Windows PCs.

MultiView 2000 is designed to give UNIX applications a contemporary look and feel, the company says. Windows users can apply 3D visual attributes, including color and font enhancements, to character-based text and charts, creating a Windows-like interface. Corporations running legacy applications on UNIX can Web-enable their programs using MultiView 2000, without having to reprogram the entire application, the company says.

The MultiView 2000 Active Rules agent reportedly enables users to embed and launch a Web browser from within a legacy application by creating hot links. Hot link fields can also be established between link users, Web sites, FTP sites and PC files, so that users can navigate between the UNIX and PC

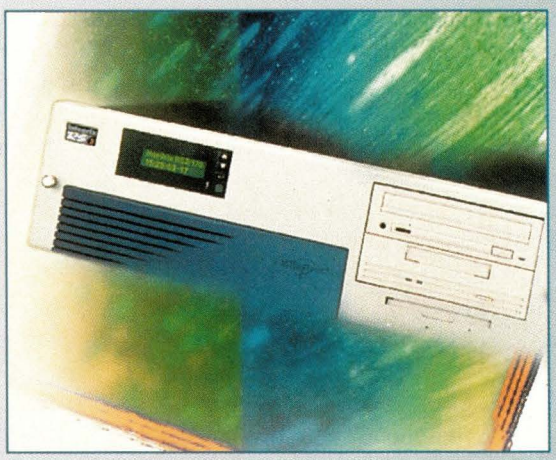
UltraSPARC Server in Rack-Mount Chassis

Integrix has introduced the RS2, an UltraSPARC II-powered server in a rack-mount chassis. The company says the server is ideal for use as an email, Web, Java, application, file or database server, while offering scalable system performance with room for two 200- or 300-MHz CPUs.

The system's motherboard and box temperature are monitored by DM100, a built-in diagnostic module, which comes with a Java GUI for remote monitoring, configuration and centralized systems administration, Integrix says.

The RS2 comes with scalable, removable hard disks and an UltraSPARC V9 CPU for 64-bit processing with modular CPU capability, a clear upgrade path and multiple CPU scalability. In addition, the server comes with a Creator Graphics 24-bit accelerated graphics interface.

The RS2 supports up to 2 GB of memory and includes four 64-bit SBus slots. The RS2/200 with a single 200-MHz UltraSPARC II module, 256-MB RAM, user-removable hard disks, Solaris 2.x and DM100 diagnostic monitor with Java GUI is priced at $13,500. The RS2/300 with the same configuration and a single 300-MHz CPU lists for $16,500.



Integrix Inc.
2001 Corporate Center Drive
Newbury Park, CA 91320
http://www.integrix.com
Circle 100

environments, the company says.

Application and URL links can be set up as hot spots that will launch a Web browser. Input fields and other areas in a UNIX application can be defined as live hot spots through the use of visual effects. An interactive control dial lets users adjust the brightness of colors. In addition to drag-and-drop FTP in a Windows 95-style interface, files can be transferred using the "Kermit" protocol for serial line connections.

MultiView 2000 Version 3.0 costs $199 for a single license.

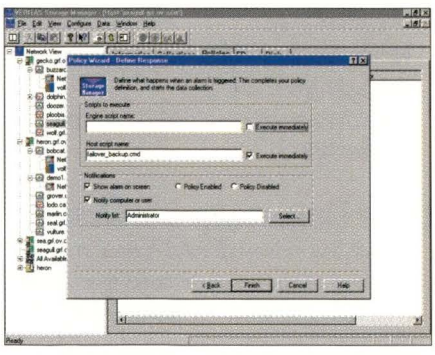
JSB Corp.
108 Whispering Pines Drive
Ste. 115
Scotts Valley, CA 95066
http://www.jsbus.com
Circle 102

'Intelligent' Software Management Suite

Veritas has announced a series of three products that when put together form the Intelligent Storage Management product set.

Storage Manager is said to provide a central management interface from which diverse distributed storage objects can be monitored and managed. This component acts as an interface for up to thousands of distributed network storage objects, including databases, file systems, data volumes, tape drives, robotic devices, network-connected storage, backup jobs and highly available clustered servers, and allows for the monitoring and management of an array of storage components in UNIX and NT environments, Veritas says.

The second product, Storage Advisor, provides proactive, systemwide storage configuration analysis and recommends storage layout changes to optimize system performance.



Finally, Storage Planner is a storage resource analysis tool that is designed to forecast future storage needs. It reportedly analyzes data gathered by Storage Manager to see how quickly storage objects are reaching capacity and recommends when additional storage is needed. A "what if" scenario planning tool enables administrators to anticipate and plan for problems such as insufficient free space.

Pricing starts at $5,000 per server, depending on configuration.

Veritas Software Corp.
1600 Plymouth St.
Mountain View, CA 94043
http://www.veritas.com
Circle 103

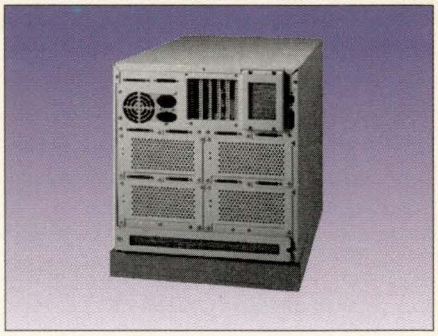
Expandable DLT Library

ATL Products is now offering the P1000 Series of DLT libraries. Based on the company's Prism Library Architecture, the P1000 reportedly features many industry firsts: an embedded PCI expansion bus to support Fibre Channel host adapters; support for Ethernet network adapters and PCI single-board computers; hot-swappable DLT drives; and a touch-screen GUI with the look and feel of a Web browser.

The P1000 Series is designed for "scalability in a box," the company says, with support for up to four DLT4000 or DLT7000 drives, and 30 DLT cartridges. DLT systems typically come in two-drive configurations.

Administration of the P1000 takes place from the system's touch-screen GUI. From it, administrators can set passwords, monitor tape drives and robotics, cartridge location, inventory, as well as import/export cartridges and load and unload tape drives. The P1000 also includes the WebAdmin feature, which allows for library administration over the Web via the industry standard Java Management API (JMAPI). Functions of WebAdmin include set-up, monitoring, event logging and event notification. WebAdmin also includes an SNMP agent for integration with major network management frameworks from Sun, IBM, Hewlett-Packard and Cabletron.

In addition, the P1000 features hot-pluggable hardware components such as PCI adapter cards and hot-swappable



DLT drives. The company's IntelliGrip precision cartridge-handling system has a mean-swap-between-failure rate of 2 million, minimizing unwanted surface contact and maximizing data availability, ATL says.

The P1000 Series is compatible with most UNIX operating systems, including Solaris, HP-UX, AIX, IRIX, Digital UNIX, as well as NetWare, OpenVMS and Windows NT. The P1000 Series can also emulate ATL's popular 520 series libraries, which support more than 40 data management software packages. It is currently shipping with an entry-level price of $25,000.

ATL Products Inc.
2801 Kelvin Ave.
Irvine, CA 92614
http://www.atlp.com
Circle 104

Time-Series Data Analysis

A new data analysis tool from Inventure reportedly integrates real-time and historic time-series data for viewing by traders, analysts and salespeople. Called Ranger, the product is a middleware engine that integrates with various data sources and servers on multiple platforms and in different geographic locations, the company says. Early access users have used the tool to integrate data from databases and real-time feeds such as Sybase, FAME, LIM, ASCII, TIB and Triarch, as well as proprietary data sources, the company says. Ranger then displays the integrated data in a single, hierarchical view.

Ranger consists of client and server components. The Ranger server is implemented as a Netscape Communications Corp. FastTrack plug-in, enabling it to multiprocess and multithread information and, thus, handle multiple requests simultaneously. The Ranger server reportedly

connects data to applications through a configurable metadata layer, making it easy to change data sources at the application level. And because the server uses the HTTP protocol, it's easy to integrate applications written in C/C++, Visual Basic and Java, the company says.

Ranger also performs data visualization, providing users with a GUI front end to visualization and analysis tools. Inventure's ObjectMatrix technology allows users to perform an analysis and then recalculate the study based on a different data sources or market conditions, the company says.

Ranger includes a scripting language that is compatible with Netscape's JavaScript. Running under Windows NT, Ranger supports Microsoft Corp.'s ActiveX Automation paradigm. Platform availability includes Solaris and Windows NT. Pricing was not available; contact company directly.

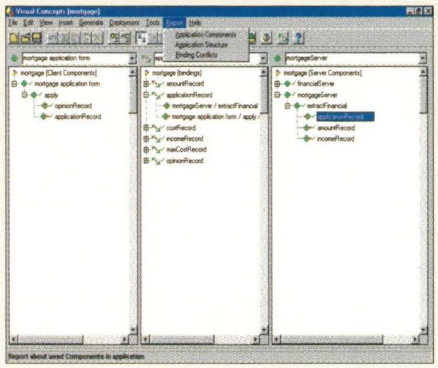
Inventure America Inc.
30 Broad St.
New York, NY 10004
http://www.inven.com
Circle 105

Platform-Independent Component Assembly

SuperNova has announced a development environment for the assembly of component-based enterprise applications. Called SuperNova/Visual Concepts, the tool is said to be both platform- and language-independent, allowing developers to incorporate components developed in more than 20 different platforms–with more than 25 different commercial databases–written in any development language that supports either ActiveX, OLE/COM or CORBA/IIOP, such as Visual Basic, Java, C, C++, Delphi, PowerBuilder and SuperNova/Application Developer.

Developers are encouraged to use SuperNova/Visual Concepts to migrate legacy systems, integrate packaged applications and unite disparate computing environments. Thus, developers can combine components from a variety of platforms, mix-and-match messaging protocols and wrap legacy applications, the company says.

SuperNova/Visual Concepts consists of a graphical component repository and



application modeling environment, a deployment manager and a component execution broker, which interprets application definitions, executes component functionality and so on.

SuperNova/Visual Concepts runs on Windows 95/NT and most popular flavors of UNIX. Pricing ranges from $7,000 to $350,000, depending on configuration.

SuperNova Inc.
2025 Lincoln Hwy.
Edison, NJ 08817
http://www.supernova.com
Circle 106

Ultra 2 SCSI Controllers

Ultra 2 SCSI Raid controllers, the Z-9200 Ultra 2 SCSI RAID 3 and the Z-9250 Ultra 2 SCSI RAID 3 and 5, are now available from Digi-Data. The company says the Z-9200 features transfer speeds of up to 80 MB/s and can handle the high-performance throughput demands of video, prepress and other imaging applications. The Z-9250, meanwhile, is designed to support high-volume office, network, file server and online transaction processing applications, Digi-Data says.

The new controllers each feature six Wide Ultra 2 SCSI disk channels: four for data disks, one for parity disks and one for spare disks. In addition, the Z-9250 contains hardware enhancements to support RAID 5.

Software for the controllers is downloadable from Digi-Data's Web site and supports SCSI command tag queuing and automatic status notifications. In addition, the Z-9250 includes the capability to configure each logical unit on the disk array as either a RAID 3 or RAID 5 application, the company says.

With 256 MB of cache memory, the SCSI controllers can reportedly support several host I/O tasks simultaneously. Also, each controller can support 15 tiers of disks on each of its channels, for a total of 90 disks including spares.

The Z-9200 and Z-9250 are priced at $4,995 and $5,295, respectively.

Digi-Data Corp.
8580 Dorsey Run Road
Jessup, MD 20794
http://www.digidata.com
Circle 107

PC X Server Upgrade

Exceed, the PC X server from Hummingbird Communications, is now fully compliant with the X11R6.3 specification, aka Broadway. Broadway is an X Window standard developed by The Open Group and includes so-called Low Bandwidth X (LBX) for optimized serial X, as well as application group, security, print and firewall proxy support.

This latest version of Exceed, Version 6.0, also includes Jconfig, a Java-based application management system, and Wizard-based X client startup with NIS integration, among other features. Using Exceed as a browser plug-in or helper application, users can now run their X applications anywhere, including over the Web, the company says.

Jconfig is a tool that allows administrators to remotely configure and administer all Hummingbird applications. It also allows sysadmins to remotely access and modify any Windows NT/95 desktop file, access the Windows system registry, modify environment variables, display system information, and log off and reboot a remote desktop.

Exceed 6.0 will display any X application on either Windows 3.x, 95 or NT clients. A single-user license is priced at $545 (site licenses are also available).

Hummingbird Communications Ltd.
1 Sparks Ave.
North York, Ontario
Canada M2H 2W1
http://www.hummingbird.com
Circle 108

Load-Balancing Software

IBM has released load-balancing and IP traffic management software called Interactive Network Dispatcher 1.2. The software is designed to enable multiple

Web servers to efficiently function as a single system and allows Web traffic to be distributed to machines located around the world, IBM says.

Interactive Network Dispatcher reportedly monitors and balances requests to available Web servers in real time, so that if one fails or is taken off-line for maintenance, service isn't interrupted. IBM says the Interactive Network Dispatcher can distribute traffic between two servers to an unlimited number of servers or processors.

Systems administrators can use the software to centralize systems management across multiple sites and servers. Also, Interactive Network Dispatcher can start automatically, without administrator intervention, and provide dynamic reconfiguration without having to stop and restart the product, the company says.

In addition, it features the ability to define multiple server-fed metrics, such as CPU utilization, Direct Access Storage Device (DASD) and network I/O. Customers have the option of using either Web site server load or server-to-client proximity, also known as ping triangulation, which offers additional criteria for balancing traffic across multiple mirrored sites. Java Runtime Environment (JRE) 1.1 also ships with the product.

Interactive Network Dispatcher 1.2 is available for AIX, Solaris and Windows NT at $1,500 per Web server, and can be downloaded from IBM's site, `http://www.ibm.com`. Interactive Network Dispatcher is also available for IBM's 2216 router platform.

Contact local sales office

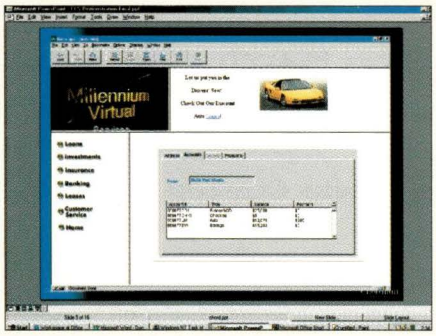
Consumer Interaction System Unveiled

Chordiant Software has introduced Chordiant Customer Communications Solution (CCS) 1.4, a real-time consumer interaction system. With CCS 1.4, businesses can tailor responses from customer service methods to fit a customer's specific product interest and follow company policies and procedure, Chordiant says. CCS is designed to integrate with phone, Web, fax and email systems.

CCS 1.4 automatically delivers to the customer service agent all of the relationship information and processes needed to

personalize each transaction. The system includes four role-based applications designed for consumers, customer service representatives, business analysts and managers of service, sales or operations, and hundreds of classes and subclasses of business objects, which deliver common business processes and tailor workflows to meet the specific application requirements of consumer-based companies, the company says.

In addition, the system comes with a visual object-oriented workflow editor designed for adding new processes, products or services, and support for an expanded set of customer entry points, including the use of Java-based thin clients and NCs.



CCS 1.4 supports servers running various operating systems, including Solaris, AIX, HP-UX, IRIX and Windows NT. CCS works with NT and Java-based clients. It comes with a minimum of 250 seats priced at $750,000 for the server and client.

Chordiant Software Inc.
1810 Embarcadero Road
Palo Alto, CA 94303
http://www.chordiant.com
Circle 109

Data Movement Suite Out

OmniEnterprise Version 2.3, a data movement product suite, is now available from Praxis International. With OmniEnterprise, long data types such as images, documents and other complex data stored in databases as binary or text files, can be transferred between databases, the company says. These long data types can be used to provide online product capabilities, verify user authenticity and consolidate customer or product information for use by help desks.

The OmniEnterprise suite includes OmniReplicator (asynchronous change replication); OmniCopy (snapshot copy); OmniLoader (extra/load synchronization); and OmniDirector, a GUI that is designed to enable companies to model distributed information flow and monitor data movement across an enterprise.

OmniEnterprise 2.3 includes a validation process that reportedly discovers conflict and error scenarios before running the data movement request and improves performance in collision detection during operations, the company says.

Upgrades, Enhancements, Additions...

■ ISL Decision Systems has announced Version 4.0 of its Clementine data mining software. Enhancements include new visualization techniques whereby the user can save any table as a separate object, giving the user greater flexibility in filtering data and allowing different data mining techniques to be used. Also, Clementine 4.0 includes two new association rule algorithms, as well as Ross Quinlan's C5.0 Rule Induction algorithm. Clementine is available for Solaris, HP-UX, IRIX, Digital UNIX, VMS and Windows NT. Pricing starts at $20,000 for a single-user license (quantity discounts are available). **ISL Decision Systems Inc.**, 630 Freedom Business Center, King of Prussia, PA 19406, *http://www.isldsi.com*. **Circle 110**

■ Acucobol has announced substantive upgrades to three of its COBOL development tools. Its pure graphical COBOL compiler, Acucobol-GT, is now in Release 3.2 and features multithreading, modeless windows, file servers for both UNIX and Windows NT, a full set of graphical controls and the ability to execute GUI programs in a non-GUI environment. Acu4GL is a tool that interfaces COBOL programs to relational databases such as Informix, Oracle, Sybase, and ODBC-compliant databases such as Microsoft SQL Server. Version 1.3 expands the list of data formats that the interfaces can store and retrieve. Finally, Acucobol has upgraded its remote COBOL file system for client/server environments. AcuServer 1.3 can now build and access Vision Version 4 files. All Acucobol products work on a variety of platforms, including most UNIX. Pricing is variable; contact company for details. **Acucobol Inc.**, 7950 Silverton Ave., Ste. 201, San Diego, CA 92126, *http://www.acucobol.com*. **Circle 111**

■ Storage Computer's Series:73 and Series:74 OmniRAID SuperServer storage arrays now include an Xtramirroring feature for user-selectable file-level mirrored data protection of mission-critical information. Xtramirroring reportedly allows users to select the information they want replicated at the data-set level, instead of mirroring an entire array. This added capability is designed to offer better utilization of storage space on each array. With Xtramirroring, OmniRAID SuperServers offer RAID levels 0, 1, 3, 5 and 7 data protection at the data-set level. Pricing for the arrays starts at $110,000. **Storage Computer Corp.**, 11 Riverside St., Nashua, NH 03062, *http://www.storage.com*. **Circle 112**

■ Wind/U 4.1, the latest release of Bristol Technology's cross-platform development software, offers support for ActiveX Template Library and OpenGL, as well as support for Stingray Software's Objective Grid and Objective Toolkit MFC components for UNIX. With Win/U 4.1, developers can write applications on Windows 95 or NT and deploy them on a range of platforms, including SunOS, Solaris, HP-UX, Digital UNIX, IRIX, AIX and OpenVMS. Wind/U 4.1 costs $12,000. **Bristol Technology Inc.**, 241 Ethan Allen Hwy., Ridgefield, CT 06877, *http://www.bristol.com*. **Circle 113**

■ ParaSoft has announced Version 4.0 of its Insure++ development tool for C/C++ applications. Insure++ 4.0 adds a technology called Mutation Testing that automatically rewrites code during testing with the aim of uncovering more bugs. Through Mutation Testing, Insure++ creates an equivalent version of the code in a temporary file, which it uses to search for hard-to-find bugs, particularly algorithmic-type errors. Other enhancements include faster compilation, smaller binaries and support for threads on Digital UNIX 4.0, HP-UX 10, AIX 4.x and Solaris. Licenses for UNIX versions of Insure++ 4.0 cost $1,995, and Windows versions start at $299 per copy. **ParaSoft Corp.**, 2031 S. Myrtle Ave., Monrovia, CA 91016, *http://www.parasoft.com*. **Circle 114**

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Circle No. 40

OmniEnterprise supports several databases running on Solaris and SunOS, as well as AIX, HP-UX, MVS on mainframes and Windows NT. Specifically, OmniEnterprise supports databases from Oracle, Informix and Sybase, and Microsoft SQL Server and DB2. Pricing ranges from $2,500 to $90,000 per source, depending on configuration.

Praxis International Inc.
245 Winter St.
Waltham, MA 02154
http://www.praxisint.com
Circle 115

24X CD-ROM Changer

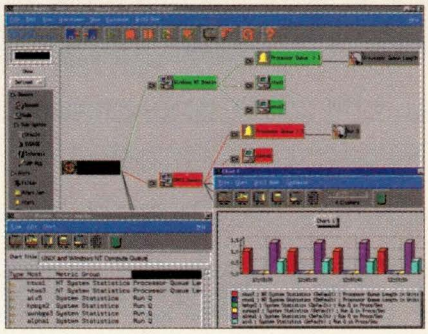
Pioneer's DRM-6324X CD-ROM changer features a 24X six-disk removable magazine that reportedly allows users to store extensive amounts of data off-line in CD-ROM libraries. The DRM-6324X is an external desktop device designed for both single-user and workgroup applications in which large amounts of data need to be catalogued off-line, but referenced frequently. The magazine protects CDs from accidental damage or loss, the company says.

The DRM-6324X supports all major CD standards and formats. It features a SCSI-2 interface and supports SCSI-LUN (logical unit numbers). List price (which includes one removable six-disk magazine and an offer for one free additional magazine) is $495.

Pioneer New Media Technologies Inc.
2265 E. 220th St.
Long Beach, CA 90810
http://www.pioneerusa.com
Circle 116

Performance Assurance for UNIX/NT

BGS Systems has unveiled BEST/1 for Distributed Systems, a performance assurance product for UNIX and NT systems. BEST/1 is said to provide real-time monitoring and automated response for pinpointing and diagnosing performance problems, historical analysis, and graphical reporting on application and system performance. In addition, it provides "what-if" modeling and capacity planning to predict the impact of change on existing applications and resources, BGS says.



BEST/1 reportedly uses a single collection agent for each managed system. Because this single agent can serve multiple BEST/1 management consoles, several departments can access different views of the same data to resolve performance issues without adding overhead or creating excessive network traffic, BGS says.

It also provides real-time response management for applications instrumented with the Application Response Management (ARM) API. BEST/1 for Distributed Systems has integrated support for Oracle, Sybase, Informix, SQL Server, Microsoft Exchange and SAP R/3. Pricing starts at $500 per managed node.

BGS Systems Inc.
One First Ave.
Waltham, MA 02254
http://www.bgs.com
Circle 117

Fault-Tolerant Tape Library

Breece Hill Technologies has released a new automated tape library architecture, DataIQ, for its Saguaro Series of automated data libraries.

The DataIQ architecture is reportedly designed to create a high-availability environment through the following features: user-replaceable modules to minimize or eliminate downtime; the capacity to install up to 12 DLT drives in a single library unit; isolation of a failed drive from other library operations, allowing the failed drive to be taken off-line without disrupting operations; hot-swappable drives and power supplies; Picker-Assisted-Cartridge-Eject (PACE) technology to prevent the plastic leader on a tape cartridge from being accidentally caught in the drive door (a mishap that can destroy the data on a cartridge); CartMove cartridge migration to enable up to eight Saguaro library enclosures to be connected so that they appear to the host as a single storage volume (this minimizes the impact of a failure within a single library module); and multihost capability to give network users access to the library through a secondary server, should a primary server be taken off-line, the company says.

Pricing for the Saguaro Series tape libraries starts at $61,000.

Breece Hill Technologies Inc.
6287 Arapahoe Ave.
Boulder, CO 80303
http://www.BreeceHill.com
Circle 118

IT Resource Tracking Tool

IT Charge Manager software, a tool for tracking IT resources, is now available from SAS Institute. IT Charge Manager reportedly allows IS managers to track IS costs and usage trends, providing both detailed and summary reports in graphical and/or tabular formats.

An add-on product for SAS' IT Service Vision resource management product for UNIX and NT systems, Charge Manager supports a variety of chargeback methodologies. Through its AccountView reporting facility, Charge Manager provides both user-defined reports and standard reports, such as charges by customer, charges by item and charges by shift, SAS says. Contact SAS for pricing.

SAS Institute Inc.
SAS Campus Drive
Cary, NC 27513
http://www.sas.com
Circle 119

Clarification

In "Sun Fortifies Image Library, Speeds Up OpenGL" (November 1997, Page 6), we reported that if developers wish to use VIS without writing applications with XIL, they must write VIS instructions directly in assembler.

According to Sun, however, "If developers wish to use VIS without writing applications with XIL, they can either use C macros, available from the developer's kit, or mediaLib, a low-level multimedia library specifically designed for accessing the power of VIS. Both are available for free online at `http://www.sun.com/sparc/vis`."

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