

Server/Workstation

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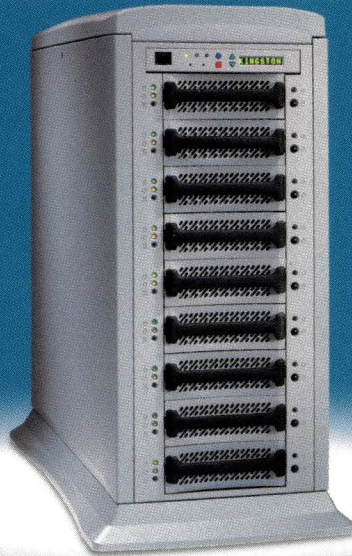
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Storage: Disk Drives



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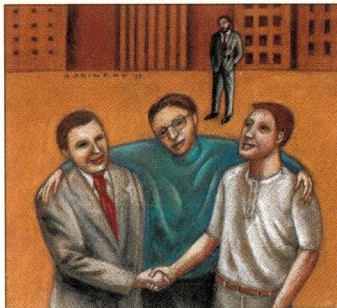
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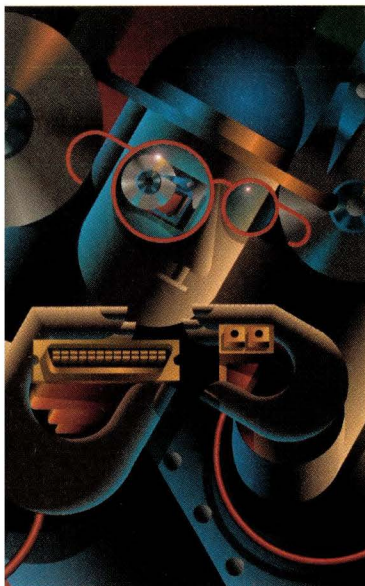
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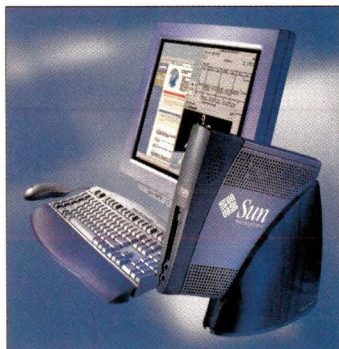
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SCSI Stays Inside the Box – For Now

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Sun's New Appliance Is a Ray of Sunshine

Sun has learned from and fixed the problems associated with the JavaStation NC and has created a truly zero-administration desktop appliance.

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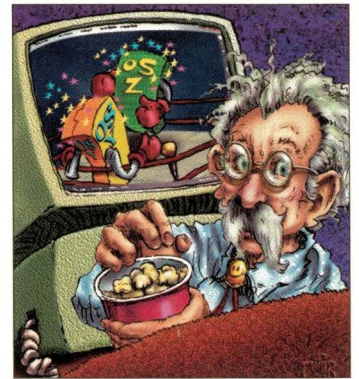
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Faster... Faster...

A change is as good as a rest, as they say, so our resident UNIX guru takes the plunge and migrates from an aging SPARCstation II to a new Ultra 10.

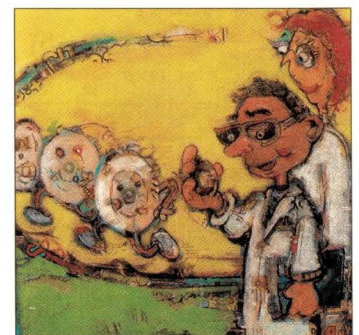
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The first of a two-part look at disk drive technology, one of the least understood elements of computers.



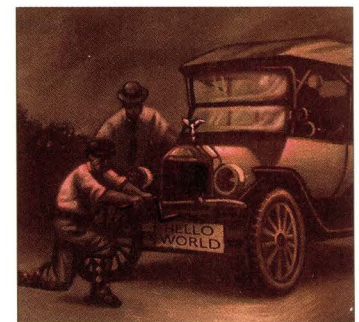
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Exploring Active Directory

We continue our introductory consideration of Windows 2000 with a detailed look at the Active Directory facility.



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Back to Basic(s)

The Jeffs help a couple of friends advance past the 1970s and dip their toes into UNIX.



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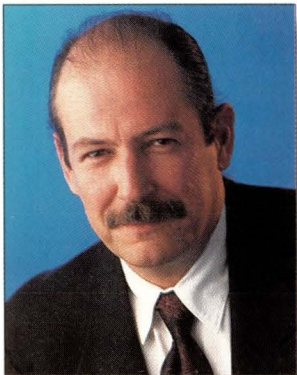
Postal: Models Inc.

The goal this month is to take the basic functionality from the MailWatcher client we built a couple of months ago and merge it into the Swing framework we built last month.

COMING NEXT ISSUE
ERP for the Enterprise

EDITORIAL

dpryor@cpg.com



Still a SCSI World

The perennial storage question is upon us once again. Every year about this time, when everyone begins to think of the IRS, W2s and 1099s, we at *SW Expert* start to wonder about how

our interfaces are taxing our system performance. Don't you?

For the past three years, we've been told to throw out the SCSI and ring in the Fibre. This year, the suppliers are strongly hawking Fibre Channel. "Go to any enterprise-class storage vendor these days and you will get a hard sell on a Fibre Channel-attached storage subsystem, rather than a SCSI-attached one," says Alexandra Barrett in this month's cover story, "SCSI Stays Inside the Box – For Now," Page 52. There's the rub. "Attached" is the key word. Although Fibre Channel interfaces appear to be capturing an increasing share of the market, if you look under the hood you'll see that more than 90% of all disk drives that ship with high-end multiuser-class storage solutions remain SCSI-based. So says International Data Corp., a market research firm based in Framingham, MA. The research outfit says that a 1999 survey of server and workstation hard disk drive shipments suggests only about 6% of drives in this class ship with Fibre Channel interfaces. SCSI maintains 92% of the market (the remaining drives ship with IBM's Serial System Architecture, SSA).

So what's the story behind this apparent incongruity. It might have something to do with the growth of storage area networks (SANs) and network-attached storage. The faster, more scalable Fibre Channel interface seems to have become an irresistible force in IT shops. As Alex says, "Fibre Channel delivers far better cable lengths (up to 10 kilometers with fiber-optic cable) than SCSI ever could. In addition, Fibre Channel provides good performance (200 MB/s full duplex), reliability, scalability and networkability, to name a few."

But the SCSI forces haven't been resting. With the ratification of the Ultra3 specification, many of these advantages have disappeared. According to Alex, today's top-of-the-line Ultra3 SCSI drives spin out data at 160 MB/s. So given single-ported 100-MB/s Fibre Channel drives, the latest generation of SCSI drives are faster than their Fibre Channel counterparts.

It seems that we will live with these two interfaces for some time. Fibre Channel will remain the host-to-storage option, while SCSI remains in the box—for now.

Doug Pryor

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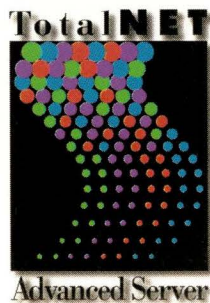


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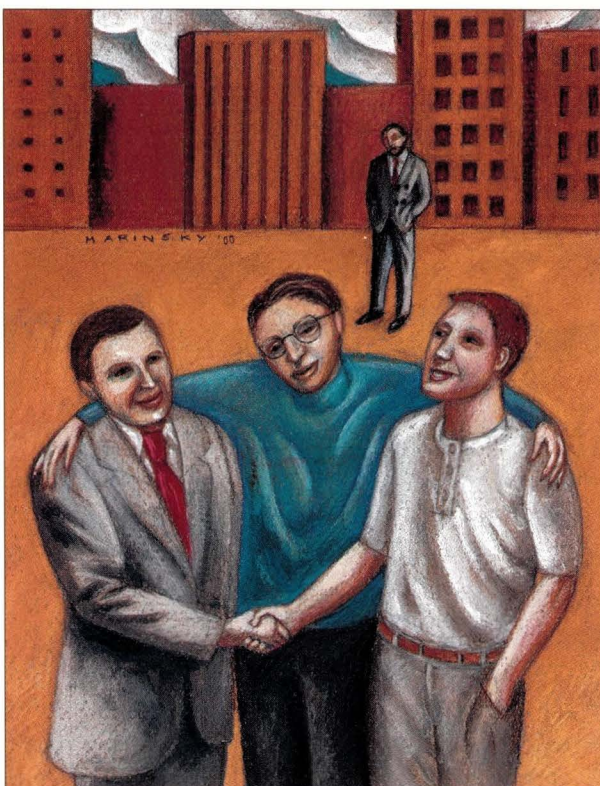
Straddling the fence when it comes to hardware vendors, SAP AG, the Walldorf, Germany-based supplier of enterprise resource planning (ERP) software, recently strengthened its bond with the industry's top two hardware suppliers: IBM Corp., Armonk, NY, and Hewlett-Packard Co., Palo Alto, CA. The agreement with IBM improves the integration between Big Blue's DB2 database management system (DBMS) and R/3, SAP's ERP product line, while the HP venture focuses on bringing the two companies' e-commerce strategies closer together.

The agreements are extensions to already strong connections between the vendors. "IBM and HP account for a large percentage of SAP's revenue, so it makes sense that the company would want to work more closely with these vendors," says Katherine Jones, senior analyst of enterprise business applications at market research firm Aberdeen Group Inc., Boston, MA.

Users should also benefit from the agreements because, according to SAP, they should lead to easier deployment and better integration of SAP software on IBM and HP hardware.

IBM and SAP plan to ratchet up global marketing and development around IBM's DB2 Universal DBMS. The product has been in an intense battle with SQL Server from Microsoft Corp., Redmond, WA, and Oracle from Oracle Corp., Redwood Shores, CA, for the top DBMS spot. The IBM-SAP pairing will give users the option of deploying SAP applications and DB2 on a wider range of operating systems. IBM announced plans to expand DB2 beyond its own

operating system earlier this year—it agreed to integrate R/3 and versions of DB2 running on Windows NT/2000, Solaris, and Linux, as well as its own AIX, OS/400 and MVS operating systems. In addition, SAP says it will make DB2 its preferred platform for database applications, and the two companies will collaborate on future software development.



JANE MARINSKY

Aberdeen Group's Jones views the agreement as a slap in the face for Oracle, the DBMS and financial system supplier that had been SAP's primary platform. "Oracle has been known to enter into sales situations with SAP and later use bait and switch tactics to move users over to Oracle applications along with the Oracle database, effectively elbowing out SAP," Jones says.

Oracle's unique position as both a database vendor and an applications

vendor does make for murky relationships with software vendors such as SAP. And Oracle has tuned its own DBMS to work best with its applications. Yet, SAP says it still has strong ties with Oracle. "We've had a strong OEM relationship with Oracle and plan to continue...our extended IBM relationship should have no impact on it," says Stephan Rossius, a global partner director at SAP.

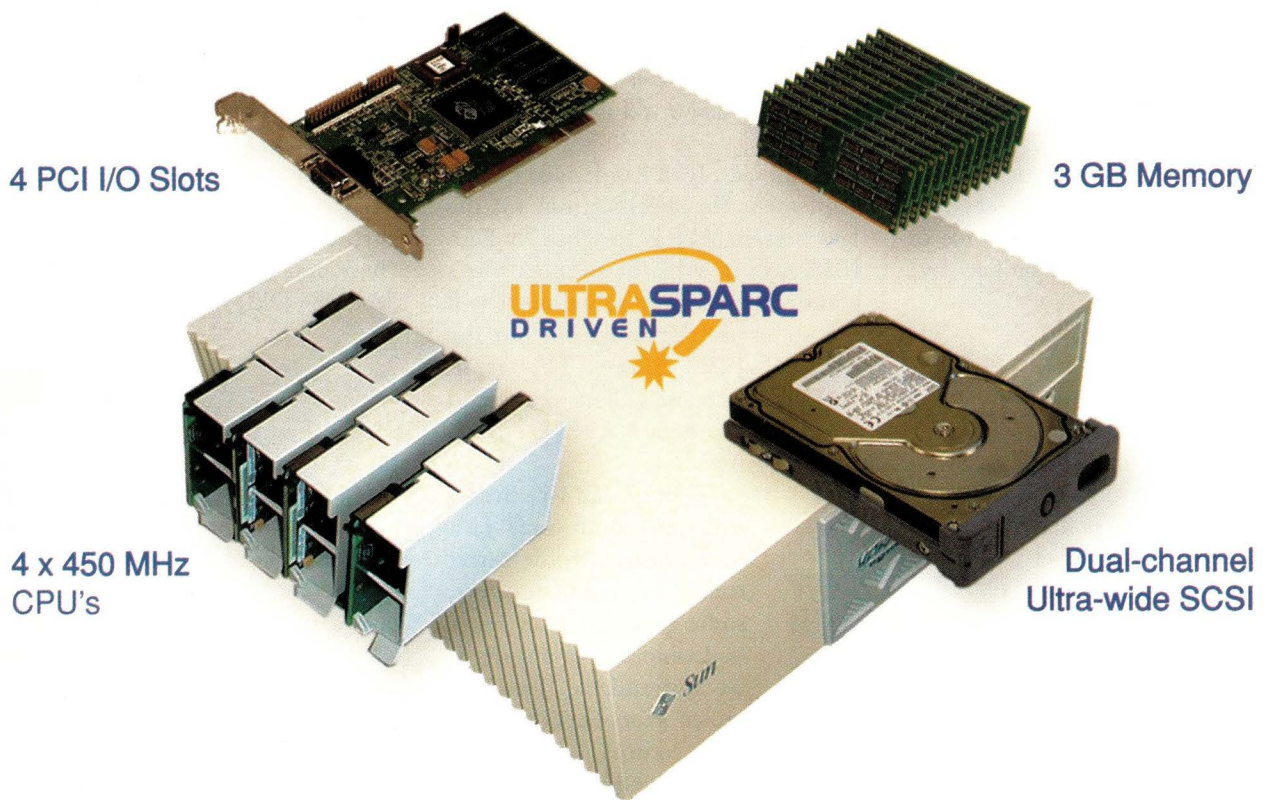
The HP announcement centers on emerging e-commerce opportunities. mySAP.com, which was unveiled in June, is the company's portal where clients can link with customers and suppliers to purchase products. The new agreement has two major ingredients. First, SAP will integrate HP's E-speak electronic deal-making software with mySAP.com. "We needed to improve our electronic commerce integration capabilities and HP had the strongest offering available," says Mayur Shah, executive vice president of SAP's high-tech independent business unit. SAP plans to integrate E-speak's dynamic brokering capabilities into future mySAP.com Workplace and Marketplace products.

Second, HP plans to use mySAP.com as its corporate portal to link employees, customers and business partners. HP is one of SAP's largest customers and uses R/3 to support 45 product lines featuring more than 3,000 products, the company says. The agreement will enable HP and its suppliers to access SAP's business management software. As part of the agreement, HP's IT organization will work with SAP on an ongoing basis to enhance mySAP.com in areas such as product life-cycle management, business intelligence and planning and optimization.

The two companies have had a close

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relationship for more than a decade. Both HP and SAP claim that 6,000 installations of SAP's R/3 have been completed on HP systems, and more than 100 businesses are outsourcing the management of their R/3 environments to HP.

"Throughout the years, SAP and HP have benefited from a close relationship," says SAP's Shah. "Our latest agreement seems to insure that will continue in the future."—*paul korzeniowski, freelance writer*

Sun Pulls Java from Standards Process

As the final version of Java 2 Platform, Enterprise Edition (J2EE) was being released in December, Sun Microsystems Inc., Palo Alto, CA, created a bit of a stir by withdrawing it from the ECMA standardization process. In doing so, Sun, for the second time in one year, changed its plans on how Java will become a standard.

The final release of J2EE was unveiled the same day Patricia Sueltz, president of software products and platforms at Sun, let it be known at the Java Business Expo in New York City that Java will not be submitted to the ECMA (originally known as the European Computer Manufacturers Association) in Geneva, Switzerland. Earlier in the year, Sun withdrew the Java platform from the Joint Technical Committee 1, an International Organization for Standardization (ISO) committee. Sun claims it withdrew Java from the ECMA standardization process in order to protect the integrity of the Java technology and the investment made in it by the worldwide community now using Java.

As an alternative, Sun says, it will instead use its own Java Community Process (JCP) to develop future versions of J2EE. "Sun has a covenant with 2 million Java technology developers and over 200 licensees who are commit-

ted to driving compatibility forward. Sun is committed to maintaining compatibility across implementations of the Java platform," says Sueltz. "We encourage the community to compete on implementation, not on standards."

Sun's decision was frowned upon by some of its partners, in particular, Armonk, NY-based IBM Corp., a major supporter of Java and Sun's efforts until now. In a prepared statement to IBM developers, Rod Smith, vice president of Java software at IBM, said: "We do not support Sun's decision to withdraw from the standards process. We had hoped that this second attempt to create a Java standard, via ECMA, would proceed rapidly and secure a Java standard for the software developer community. We believe a standards process managed by a single vendor will not work in the long term."

As a result, IBM has decided to only implement the specifications for the Java Servlets API as specified by Sun. IBM says it will not support Sun's branding strategy at this time—it will use the code, but not the J2EE brand. This is in response to Sun's decision to charge a 3% fee for J2EE branding.

Though IBM is clearly unhappy about Sun's Java moves of late, the developer community is mixed. In fact, some developers say Sun's leadership with Java needs to be applauded. "Java has grown exponentially under Sun's control," says Jerason Nabes, programmer with Accelerated Genetics, a Baraboo, WI-based company that provides genetics products for the development of

farm stock. "If anything is to be believed, it is that Java would not have developed as quickly under ECMA's control vs. Sun's control."

These opinions are echoed by Rickard Öberg, software architect with dreamBean Software, a team of programmers from Linköping University in Sweden. "The most important factors of Java evolution are continuous growth of functionality and WORA [Write

Once, Run Anywhere]," he says. "Sun knows this and, in my opinion, they're doing a good job with the JCP, which is an open-process model to add new features." He adds, "If Sun wants to keep the control of Java [the language], that's fine with me. They've done a good job so far."

The final release of J2EE comprises four pieces: The platform specification, which explains the APIs that must be provided with all versions of J2EE, including full descriptions of the support levels expected from each operating system; the reference implementation used to validate the specification—the reference implementation itself is not a product; the Technology Compatibility Kit, which allows developers to ensure consistent J2EE implementations across various vendor offerings and helps users port enterprise applications; and J2EE BluePrints, which includes documentation and examples from Sun and its partners that describe and illustrate "best practices" for developing and deploying J2EE applications.—*ptc*

Apache Tackles XML

The Apache Software Foundation, the same group that introduced the world to its popular Web server software via an open-source license, now has its sights set on the latest technology to capture the industry's imagination—eXtensible Markup Language, or XML. In November, it formed the Apache XML Project (<http://xml.apache.org>) to develop open-source XML and eXtensible Stylesheet Language (XSL) tools.

The reported goal of the Apache XML Project is to provide commercial-quality, standards-based XML tools that are developed in an open and cooperative fashion; to provide feedback to standards bodies such as the Internet Engineering Task Force (IETF) and the World Wide Web Consortium (W3C) from an implementation perspective; and to organize XML-related activities with other Apache projects.

Why XML? Because the foundation says it was asked to look at the new technology. "The main impetus for the project was a couple of vendors

Though IBM is clearly unhappy about Sun's Java moves, the developer community is mixed. Some say Sun's leadership with Java needs to be applauded.

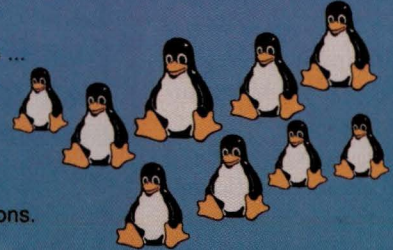
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approached us with some code they were interested in [making available via] open source," says Brian Behlendorf, president of the Apache Software Foundation. "And there had been an undercurrent. [People were saying] 'Boy, it would be interesting if Apache did something in this XML space with a predominant interest in keeping the XML standards process.'"

The newly formed group already has the support of some major players, including IBM Corp. Armonk, NY, and Sun Microsystems Inc., Palo Alto, CA. Both companies have contributed their XML parsers to the project: IBM has donated its XML4J and XML4C parsers and Sun has donated its Java Project X and XHTML parser. The Apache XML Project will then attempt to take the best technologies from both companies and create a new and improved XML parser.

Behlendorf says the Apache Software Foundation plans to oversee open-

source projects concerning XML in much the same way it handles HTTP; namely, without any one vendor taking over the effort. "We will implement standards as defined by various other [standards] bodies. Our hope is that it will allow companies to just use these utilities," he says.

IBM subsidiary Lotus Development Corp., Cambridge, MA, as well as other software developers, including Bowstreet, Portsmouth, NH, DataChannel Inc., Bellevue, WA, and Exoffice Technologies Inc., Burlingame, CA, have contributed technology for the creation of open-source XML tools. Noticeably absent from the project is Microsoft Corp., particularly because the company has put a great deal of effort in developing

XML schemas through its BizTalk platform. But, Behlendorf says, the Redmond, WA-based software giant is welcome to participate, as is any other software vendor. "If Microsoft wanted to contribute as a participant in that pro-

cess, they can do so. They can start engaging the community just like any other company," Behlendorf says.

The donation of technology by companies like IBM and Sun is being praised by industry watchers. "It's definitely the right move," says Martin Marshall, director of research at Zona Research Inc., a Redwood City, CA-based market research firm focusing on Internet technologies. "Apache has credibility everywhere, and giving away source for key XML tools was a smart move."—*ptc*

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WAP, W3C Aim to Bridge Gap

The WAP Forum, a consortium of vendors that developed the Wireless Application Protocol (<http://www.wapforum.org>), and the World Wide Web Consortium (W3C), the standards body responsible for core Web standards initiatives such as HTTP and eXtensible Markup Language, or XML (<http://www.w3.org>), announced in December they have formed a formal alliance.

In particular, the alliance will work

Sun-Netscape Alliance Unveils iPlanet 6.0

Slowly but surely, the picture the Sun-Netscape Alliance, Mountain View, CA, has been trying to paint of its application server vision is coming into focus. Last month, the Alliance announced Version 6.0 of its iPlanet application server, which takes the place of Sun Microsystems Inc.'s NetDynamics product and the Netscape Communications Corp. Netscape Application Server (NAS).

Built principally on NAS, the big news about iPlanet 6.0 is that it's fully Java 2 Platform, Enterprise Edition (J2EE)-compliant. In other words, iPlanet 6.0 supports all the features of the Java 2 Platform, Standard Edition—Java Database Connectivity (JDBC), Java Naming and Directory Interface (JNDI), Remote Method Invocation (RMI) and Common Object Request Broker Architecture (CORBA) support—as well as more sophisticated services such as Enterprise JavaBeans (EJB) components, Java Servlets API, JavaServer Pages (JSP), eXtensible Markup Language (XML) deployment descriptors, Java Transaction API (JTA) and Java Message Service (JMS).

This incarnation of iPlanet also answers questions about how Sun will use technology it gained this summer when it acquired Forté Software Inc., Oakland, CA. iPlanet 6.0 includes Forté for Java, Community Edition as part of the package, filling the role

of an object-oriented integrated development environment (IDE). Forté Fusion, meanwhile, gives iPlanet XML authoring capabilities. Both Forté products are included in the 6.0 release.

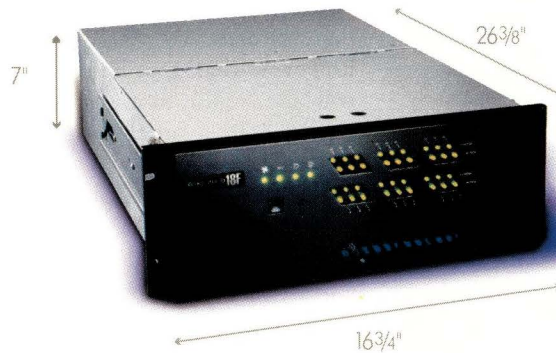
The Sun-Netscape Alliance has had to work hard not to alienate existing customers, who may or may not benefit from NetDynamics' and NAS' mutation into iPlanet. As such, iPlanet 6.0 includes promises of backward compatibility to both products. iPlanet 6.0 also makes allowances for developers who do not wish to use the Forté IDE by providing integration for Visual Café from Symantec Corp., Cupertino, CA, and JBuilder from Inprise Corp., Scotts Valley, CA. In addition, iPlanet makes provisions for developers that code HTML using Dreamweaver from Macromedia Inc., San Francisco, CA.

Finally, the iPlanet application server boasts caching and sophisticated load-balancing technologies, which reportedly yield significant performance improvements when using JSP, Java Servlets and EJB components. For example, special caching techniques employed by iPlanet in how it implements JSP resulted in a 30% performance improvement over a standard JSP implementation, the Alliance says.

Pricing for iPlanet 6.0 is \$35,000 per CPU. It is scheduled for full release in March.—*alexandra barrett, contributing editor*

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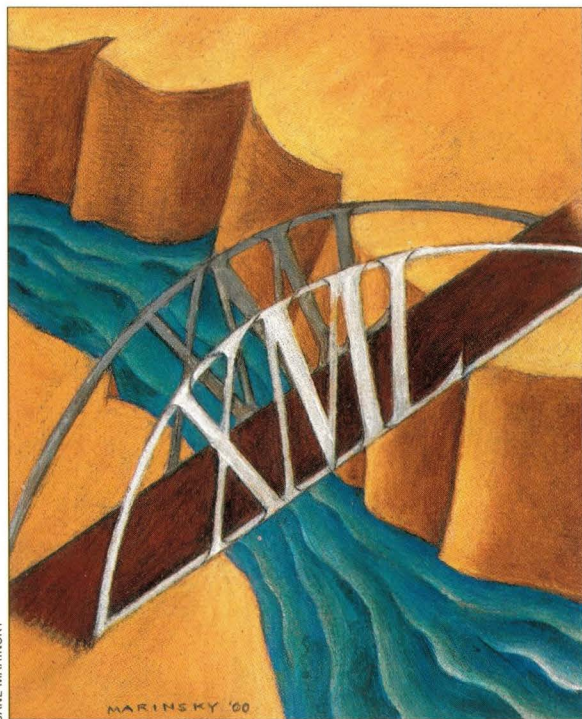
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on incorporating features of WAP Forum's Wireless Markup Language (WML), an XML-based application used to code Web pages for delivery to limited-capacity wireless devices, into XHTML, a next-generation markup language that aims to bridge today's HTML with XML.

For W3C, maintaining a single markup language—XHTML—that can be used with any number of Web devices is critically important. “The Web is nothing else than a universal information framework,” says Janet Daly, a W3C spokeswoman. As such, it



JANIE MARINSKY

must remain culturally independent, ability independent and device-independent, she says. “Ultimately, we want there to be one Web markup language that everyone can use.”

Also on the alliance's radar screen are the W3C's Platform for Privacy Preferences (P3P) project, a specification for maintaining user privacy, and Composite Capability/Preference Profiles (CC/PP), a device-profiling protocol, which would allow Web servers to download content appropriate to the capabilities of the device that requested it—whether it is a cell phone, personal information manager, desktop computer, or some other device that hasn't been conceived of yet, Daly says. In

addition, the alliance will tackle the W3C's Synchronized Multimedia Integration Language, or SMIL (pronounced “smile”), which, according to Daly, presents “unique obstacles for the wireless world.”

In many ways, work the W3C has done on its Web Accessibility Initiative has primed it for the needs of the wireless world. “There are many synergies between these two groups. It's all about limitations, whether it be a person's [limitations] or a device's,” Daly says.

WAP Forum's involvement with the Web-centric W3C comes at a time when the line between the Web and the wireless world is becoming increasingly blurred. In 1997, only about 46,000 U.S. wireless subscribers were capable of receiving Web data. By 2002, however, that number will have swelled to more than 6 million subscribers, says Callie Pottorf, research analyst with the Framingham, MA-based International Data Corp. (IDC) wireless and mobile communications service.

The WAP protocol is also rapidly gaining in visibility and clout. For example, in December, Microsoft Corp., Redmond, WA, announced

that its Microsoft Mobile Explorer (MME) platform, which includes a dual-mode microbrowser that is capable of displaying either HTML or WAP 1.1 content, and other Microsoft offerings such as Exchange Server and MSN Mobile Services, will support WAP 1.1.

Although the two groups have different organizational goals, they do enjoy a largely overlapping membership, Daly says. Because of this, news of the consortium's new-found kindred wasn't news at all for some analysts. “[The WAP-WAC alliance will serve as] an enabler of what WAP has been doing all along,” IDC's Pottorf says.—*ab*

High-Speed Chase

With Web pages containing more complex graphics information—increasingly, even video—users are upping their network access speeds. Although dial-up connections, which have a top speed of 56 Kb/s, were sufficient just a year or two ago, this is no longer the case.

Digital Subscriber Line, or DSL, is emerging as one popular choice among Internet service providers (ISPs). In its December 1999 report, “The High-Speed Stampede: U.S. ISPs Roll Out xDSL Service Faster Than Expected,” Cahners In-Stat Group, a Newton, MA-based market research firm, reports that 1.35 million users purchased the service in 1999 (10% more than expected at the start of the year). “The DSL rollout is literally a stampede, as ISPs rush to compete with cable companies and find ways to boost their operating margins,” says Rick Miller, senior analyst with Cahners In-Stat. DSL and cable modems are the two most likely replacements for dial-up connections as the most popular Internet access option. Both offer 50 times more bandwidth than dial-up systems.

As they work with more complex information and higher speed connections, users will need faster desktop and server systems to process the information, and that could lead to upgrades of existing systems or new system purchases, Miller says. “A user doesn't want to run a DSL connection on an Intel 486 system; the hardware would become a significant bottleneck,” he says.

The need for faster systems has not yet been apparent because the race between DSL and cable modems is in the early stages. Each option has strengths and weaknesses.

DSL, which comes in several flavors, offers users as much as 8 Mb/s of bandwidth. The allure of the technology is that it is designed to operate over twisted-pair telephone lines used for dial-up modems, so installation and maintenance are simple. Another plus is highly competitive ISPs view DSL as a way to differentiate themselves. Many have been rolling out new services with attractive pricing, ranging from \$40 to \$150 per month. These services are proving to be quite popular with small-

What's stopping you from making more money?



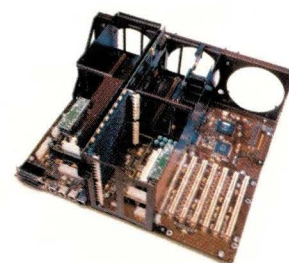
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and medium-size businesses, as well as telecommuters.

The biggest deterrent has been the inability of carriers to put the proper infrastructure in place to support their services. To deploy DSL, a carrier must install new modems at both ends of a twisted-pair line. Because Internet connections require higher quality connections than traditional voice communications, existing wiring may not support DSL services. Estimates vary as to how much of the current wiring needs to be replaced.

However, ISPs are moving quickly to test the limits of existing wiring. "Carriers know that many customers are eagerly awaiting DSL deployments," Miller says. In some cases, they have been too eager. Cahners In-Stat says GTE Inter-networking Inc., a Burlington, MA-based ISP, is the leading DSL service provider. The company exceeded its plans to deploy 50,000 DSL lines by

the end of 1999, and in fact, the firm had to stop advertising its services in certain markets because demand was exceeding supply, according to a company spokesperson.

GTE, along with other entrenched

Annual U.S. ISP DSL Equipment Expenditure	
Year	Expenditure (in U.S. dollars)
1999	381.7 million
2000	774.9 million
2001	1.36 billion

Source: Cahners In-Stat Group, Newton, MA

local exchange carriers such as Bell Atlantic, New York, NY, Bell South Corp., Atlanta, GA, and U.S. West Inc., Denver, CO, have been marketing DSL services within their large customer bases. In addition, start-up competitive local exchange carriers

(CLECs), such as Covad Communications Co., Santa Clara, CA, North-Point Communications, San Francisco, CA, and Rhythms NetConnections Inc., Englewood, CO, have been able to build thriving businesses based largely on DSL. Moreover, Cahners In-Stat found these companies are making more on their services than other more established carriers.

The influx of new services has lead to a dramatic increase in DSL equipment purchases. Cahners In-Stat predicts that U.S. ISP DSL equipment purchases will rise from \$381.7 million in 1999 to \$1.36 billion in 2001 (see "Annual U.S. ISP DSL Equipment Expenditure").

Cable modems represent DSL's most significant challenger. With their networks already reaching millions of residential customers, cable television suppliers have been able to build significant Internet access businesses quickly. Cox Communications Inc., Atlanta, GA, MediaOne, Englewood, CO, and Telecommunications Inc., Englewood, CO (recently acquired by AT&T Corp., New York, NY), are some of the companies focusing on this market.

These suppliers must address limitations with their network infrastructures for their services to be widely accepted. The network equipment used to deliver cable television services was originally built for one-way connectivity—the local operator downloading information to customers. So although users could download information from the Internet, they would not be able to perform simple functions such as sending email. Many cable companies have been upgrading their networks to support two-way communications. But making the necessary changes requires a huge financial investment, so cable modem services are currently available only in a limited number of areas.

With both cable modem and DSL suppliers racing to increase their network reach, users will have more high-speed network access options in a few years, says Miller. "Since customers want faster Internet access, vendors able to deliver it will experience significant growth during the next few years," he says.—pk

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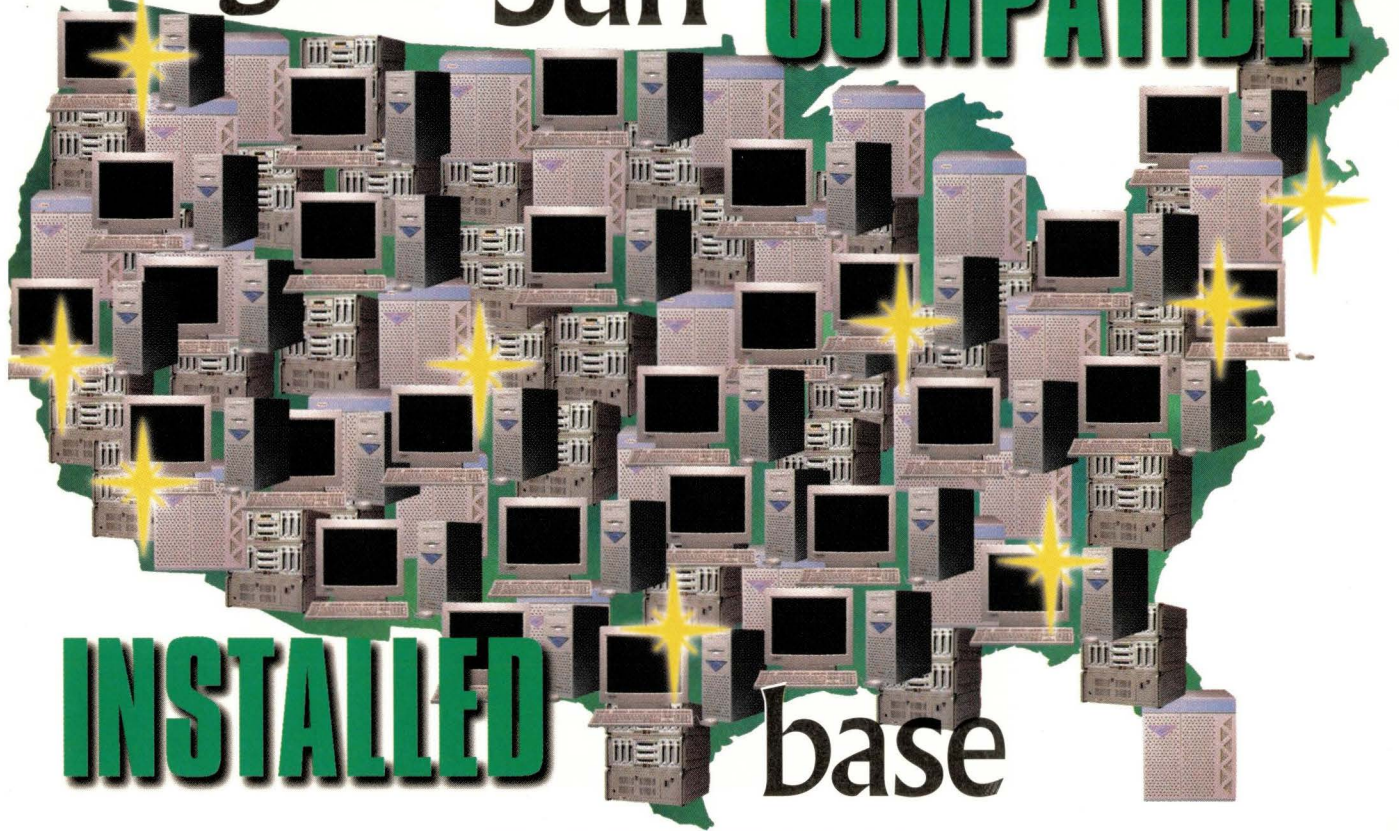
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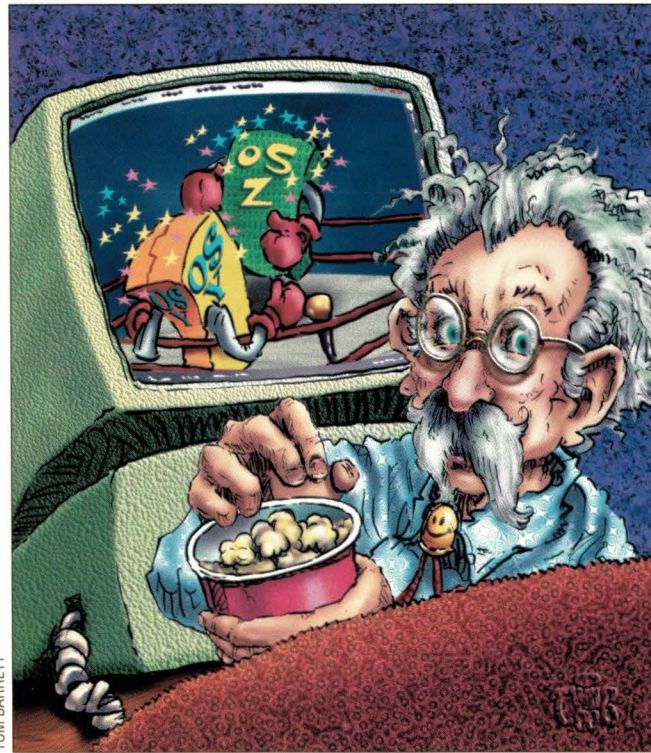
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Ask Mr. Protocol

by Michael O'Brien



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Mr. Protocol's Complex Life

Q: Listen, you bum, I asked you three days ago to come straighten out my router problems and I haven't heard squat from... say, what's this? Mr. Protocol is watching television! I didn't think he knew broadcast television existed.

A: Amazing, isn't it? Whatever goes into picking a Nielsen family, Mr. P. definitely isn't it. Besides, you're right. He doesn't know the first thing about broadcast television. He thinks *The Partridge Family* is a bunch of birds. But, you know, there's just no telling. He did wander by once when I was watching a kinescope of the old *Steve Allen Show* and he sat right down and watched it. Laughed his fool head off, especially when Steve put on the flameproof suit with 2,000 marshmallows sewn onto it and had them toasted by a flamethrower. I guess it just goes to prove that the classics are universal.

No, this isn't broadcast television he's watching. I guess you could call it cable TV, because it is coming in on the same

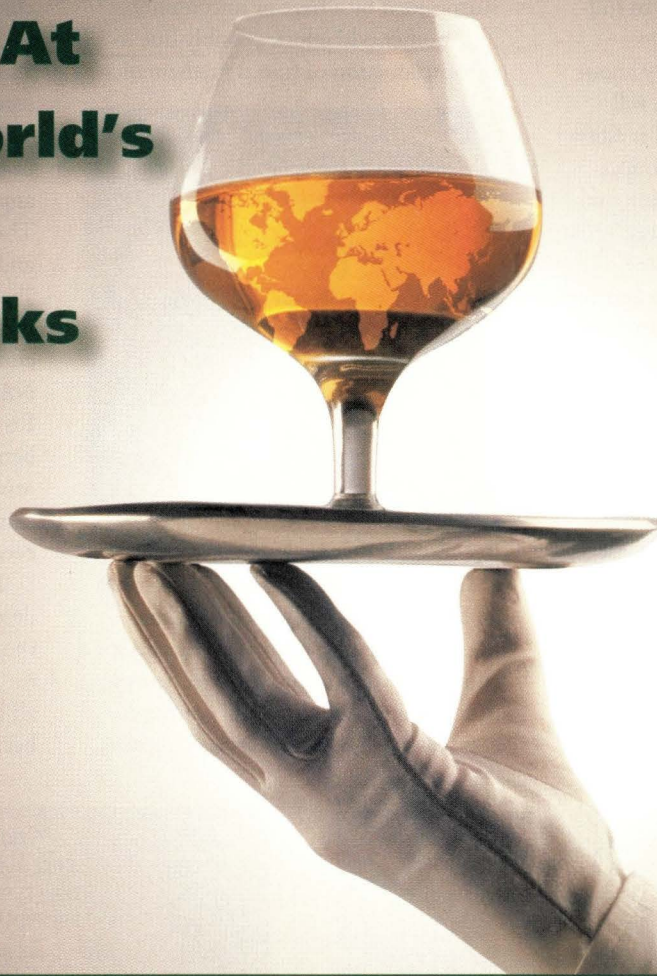
cable as the stuff I watch on TV, but you'll note he's sitting in front of a PC. He's hooked into the Broadcast.com 300-Kb feed of NASA Television, and he's watching the Mars Polar Lander not respond. He isn't too worried about this because Mars and everyday life are equally remote to him. What interests him are the protocols used to talk to the lander. The notion that the lander might be silent because it currently exists only as small pieces of burned and twisted wreckage strewn across the Martian landscape is foreign to him. He's convinced there's a protocol error in the data stream from Earth, and as soon as they fix it, the lander will forgive all and speak up. I pointed out to him that according to protocol, the lander's supposed to speak up first, but this made him so uncomfortable that I dropped it.

We're watching it together, though, he and I, because for an event like this, network television is absolutely useless. What little live network coverage exists is skimpy and not announced in advance.

Furthermore, it's dominated by talking heads who are absolutely ignorant of anything about the story they're covering, whose only job is to prevent dead air and whose only distinguishing property is that dead air would be better than them.

NASA TV is much preferable because if nothing is happening, it shows dead air, consisting of a card showing the next time something's scheduled to happen. Unfortunately, you can't get NASA TV on most cable systems, though you can get it if you have the right kind of satellite hookup, or a high-speed Internet connection. NASA TV (<http://www.nasa.gov/ntv>) feeds its signal to all comers. Several organizations in turn feed the signal to the Internet, though only one, Broadcast.com, does so continually. The others only feed during special events. Further, Broadcast.com is capable of feeding at extremely high rates, so those with cable modems or the higher level Digital Subscriber Line

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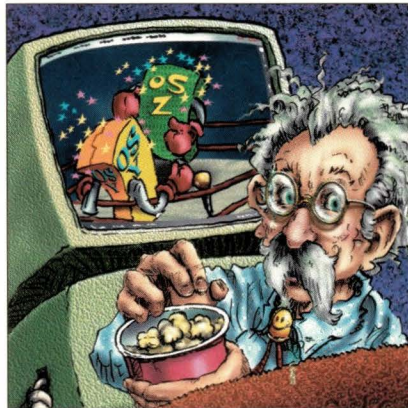
Ask Mr. Protocol

(DSL) connections can see streaming video at 300 Kb/s. This gives quite a respectable picture, which only begins to break down when enlarged to full-screen size.

Mr. Protocol ranted recently about compression algorithms, and a full-screen view of a 300-Kb signal is edifying in this regard. Currently, codecs (coder-decoders, the compression and decompression parts of streaming video software) concentrate only on the differences between one video frame and the next. This means that backgrounds are crisp. People's bodies and faces look more or less normal. Everything that's moving, though—be it a person's head, their hand, a car, whatever—is surrounded by an aura of instability, fuzzing out the edges. As soon as the object stops moving, the fuzz goes away. Because more modern codecs are able to determine that an entire area has moved, the interiors of moving objects remain crisp. It's only the moving edges that grow hazy. The effect lends televised press conferences an aura of irreality, as the

crisp person at the podium (spokespeople don't move much) deals with an audience of bobbing heads, each surrounded by a haze of uncertainty.

Another odd effect, possibly due to the introduction of fractal mathematics



to codecs, is that static pictures aren't static. A static picture, giving notice that a press conference is to begin on the hour, flickers and squirms as the codec continually tries to produce the best picture. Previous codecs would converge in a few seconds to a truly static picture,

but the one in use for broadband transmissions at Broadcast.com never seems to converge, always trying slightly different color values hither and yon, and keeping the cable modem data light flickering in a frenzy of activity. It's very odd, and somewhat unsettling.

The irony is that Mr. P. is using all of this brilliant technology to track an apparent failure of brilliant technology. The Mars Polar Lander mission follows, and is an apparent victim of, NASA's "better, faster, cheaper" approach to mission planning. Congress has made it clear that the current primary mission of NASA is to cut costs, which it has done. Recent Mars missions have indeed been better, faster and cheaper than any space missions in the past, the only downside being a failure rate ten times greater than ever before.

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their part was a real stinker. We do not vote directly on every budgetary expenditure on the part of government. We do not, for example, vote for or against a budgetary item to upgrade the technology used in the Deep Space Tracking Network used to communicate with the Martian mission vehicles. We do not vote for or against the use of Linux in the Mars Pathfinder. The affairs of government were sufficiently complex in 1789 that the framers of the Constitution felt it far better to allow a representatively elected assembly to meet regularly in order to deal with all this and let the ordinary citizen control things at the ballot box and just get on with their lives, that being mostly farming back then.

Well, guess what? Things have only gotten worse. Congress represents us, but Congress is more or less forced to let various government agencies run with the ball, with only spotty supervision, things being far too complex to manage otherwise. So Congress worries about money, NASA worries about money and sometimes the cheaper way doesn't work. In fact, the previous mission to Mars failed because two different contractors were using two different units of measurement, English vs. metric, and nobody noticed.

This is what systems integration and testing is all about. What's that loud buzzing noise in your ears?

Mr. Protocol is glad you asked.

Most buzzwords like "systems integration and testing" exist solely because corporate mission statements have to say something that isn't going to upset anybody. Even those most likely to be upset aren't, because they don't know what systems integration and testing means, and strongly suspect nobody else does either. And mostly, they're right.

Systems integration and testing is the stuff you do that looks like it costs a boodle of money, and looks very much like you're spinning your wheels and accomplishing absolutely nothing except wasting taxpayer money (mostly because the only projects big enough to really, really need it are funded by taxpayers), but which if you don't do it, by golly, things blow up. A lot.

Now, Mr. Protocol freely admits that

launch failures are by far the most spectacular show that modern technology has to offer. In fact, he figures that if you could arrange to hold them on a regular basis and sell tickets, you could recover at least the cost of the vehicle, if not the payload. I've given up trying to explain to him why this won't happen, which scares me a little, because sometimes even the things I don't give up on really happen anyway.

Play Nice and Integrate!

Be that as it may, the tricky part in actual use of most modern technology is not just what happens when the technology meets the real world, but when the technology has to play nice with other technologies. That's where the nasty stuff really creeps in.

Let's take a simple example.

Mr. Protocol downloads so much stuff off the Internet that I do believe he's the only person ever to be named an unindicted conspirator in the attempted theft of an Ampex Terabit Memory System, back before you could put an equivalent amount of storage on plastic down at Fry's. That being the case, it should be no surprise that the machine I use to poke gingerly into his domain ran out of disk space. In fact, it galloped out of disk space and ran about 10% into negative numbers before anyone could rein it in.

I put off upgrading as long as possible, actually because I'd been through this before with Mr. P. and it was not a pleasant process. The whole concept of limited storage is beyond his perception. He thinks the Internet spontaneously generates everything on demand.

So, with a deep sigh, it was off to the candy store, and home again with one of those nice silver baggies full of gigabytes.

The first thing I had to do was to distract Mr. Protocol. The one thing I didn't need was his help. In fact, I was rather counting on a firm condition of no assistance from him as an absolute prerequisite. I knew that certain Web sites, as a way to spoof spam bots that search sites for email addresses, create programmed links that generate an infinite number of Web pages full of bogus email addresses. I therefore casu-

ally mentioned to Mr. P. that I had found a site with a bunch of addresses on it and wondered idly if he knew any of them.

That took care of that.

The only tricky part about any of this is that Chez Protocol runs a dual-boot system. One side runs a recent release of FreeBSD, because it has a very stable network stack and because Mr. Protocol's amanuensis has been running BSD UNIX for far too many years to want to gratuitously switch. I don't want Mr. P. anywhere near a machine that can't handle a load of 3,000 users.

In the other half of its brain, the system runs Windows. This experimental oven lets Mr. Protocol bake out the latest plug-ins, spend far too much money on games (he prefers plot-based games to shooters) and actually write this column (Lotus WordPro).

Do you remember what we said about technologies being stropky if they rub up against one another? Yep, it can happen here.

Few people today remember that computers used to have HALT instructions. PCs never halt. In the ultimate emergency, they drop down to low-level executable code contained on the motherboard that directs the processor into a reboot operation. This low-level code dates from the PC stone age and has some limitations. One of those limitations is that this BIOS, as it's called, can only access the first 1,024 cylinders of a disk. On a typical disk, this means that the operating system must lie wholly within the first gigabyte of storage on the disk.

On Chez Protocol's dual-boot system, this meant both operating systems had to be crammed at the front of the disk somehow. There was another limitation too: Windows insists on occupying the first bootable partition on the disk. Therefore, the only possible way to lay out the disk was to put a small Windows partition at the front, then a big FreeBSD partition with the kernel at the front and an extended partition after that for the rest of the Windows storage.

The previous installation of Windows was Windows 95, and it had files

Ask Mr. Protocol

in the C:\WINDOWS directory dating back to Norton Desktop on Windows 3.1. It had to go. This was going to be a clean install of Windows and FreeBSD.

Right! Let's go. Bolt in the disk, hook it up, lay Windows down first. No problem. Zoom! Windows installed itself and took over the whole disk.

Hmmmm.

Back off and try again. Fire up the bootable diskette of Windows 98 we made during that last attempt. Run FDISK, the Microsoft disk partitioner. Create reasonable-sized C: partition of 780 MB. Install Windows. Perfect!

Put in bootable FreeBSD CD-ROM. Oh look! The install program finally has all the bugs fixed. This is great. Go into the disk partitioner. Yep, there's the C: partition all right. Put nice big FreeBSD partition next to it. The root file system fits nicely in the first gig of the disk, so no BIOS booting problems. Simply swimming.

Go back to Windows, run FDISK. It sees the C: partition all right, and it sees

the FreeBSD partition too, although it lists the type as UNKNOWN. Who cares? It sees it. Ask to create an extended partition. Hmm, that's odd. It says the C: partition takes up 9% of the disk. The UNKNOWN (FreeBSD) partition takes up 51% of the disk, that's about right. So why is it offering to make an extended partition that covers 88% of the disk? That can't be right.

Override it. Tell it to make it 40% of the disk. It does it. Things look great. Put a logical drive into the extended partition. No problem. Boot full Windows. No problem. Start loading stuff into the new drive. Still no problem.

Reboot FreeBSD. Big problem. The root file system seems to be OK, but everything else is smashed to bits. This isn't good. Reinstall FreeBSD. Load a bunch of stuff off CD-ROM.

Reboot Windows. What's this? The logical drive in the extended partition has disappeared entirely.

Repeat this process until thoroughly nauseated. Boot, boot, smash, smash.

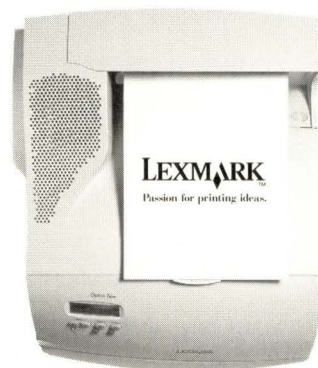
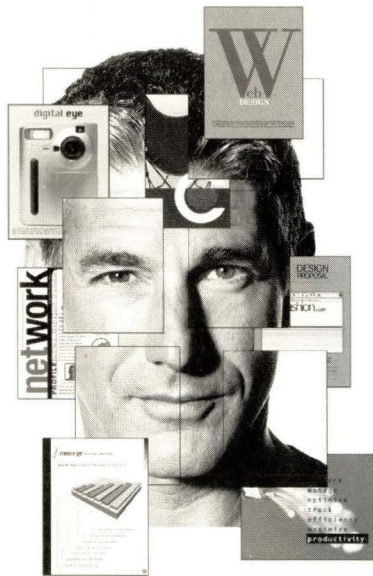
Try something different. Use the

FreeBSD partition maker to make the logical partition. This works. However, the FreeBSD partition maker can't create a logical Windows-style drive in the extended partition. Need FDISK for that. Sigh heartily, run FDISK. FDISK sees the partition, all the numbers are right. Hooray! Create logical drive. Hmm. It says the biggest logical drive I can make in that 4.8-GB partition is one whole megabyte in size.

Scream. Run around in rage.

Drive to local candy store and buy what works: PartitionMagic from PowerQuest. This software product successfully understands the partitioning, makes the correct extended partition, creates the logical drive, and while it's at it, corrects a minor fluff that the BSD partition maker had left lying around in the partition table...or maybe FDISK did it, who knows? Interestingly, although PartitionMagic gave the FreeBSD partition a color code that said, "This is a partition type with which I cannot deal," it did correctly identify it as a FreeBSD/386 partition.

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Ask Mr. Protocol

After the fact, the finger points with only a little wobbling at FDISK as having some bizarre sort of overflow problem.

The point: It took two and a half days and a piece of third-party software just to allow two operating systems to live amenably on one disk drive.

This is what happens when technologies are forced to play together. Theoretically, the problems of running two operating systems off a single disk are well understood. In fact, the new disk drive replaces a 2-GB drive, which also had a dual Windows/FreeBSD installation on it but which lacked the extended partition that apparently triggered the bug in FDISK.

The Chez Protocol Windows installation is, given Microsoft's reputation, remarkably stable, mostly because the only new software ever installed on it generally consists of games. Similarly, the FreeBSD installation is, as is usually the case with FreeBSD, steady as a rock. Within their own purviews, these technologies operate reasonably well. (OK, in the case of Windows, you can just say it operates.) However, an attempt to combine them, even in well-documented circumstances, caused all hell to break loose.

Is it any wonder that multiple contractors trying to build "better, faster, cheaper" space probes are apparently only contributing to the litter problem on the Martian surface?

That's what general systems integration and testing is about. ➔

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@cpq.com.

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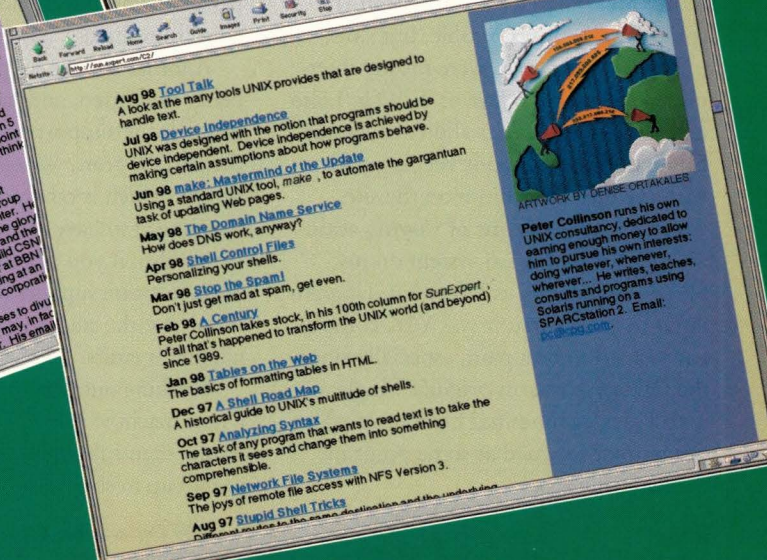
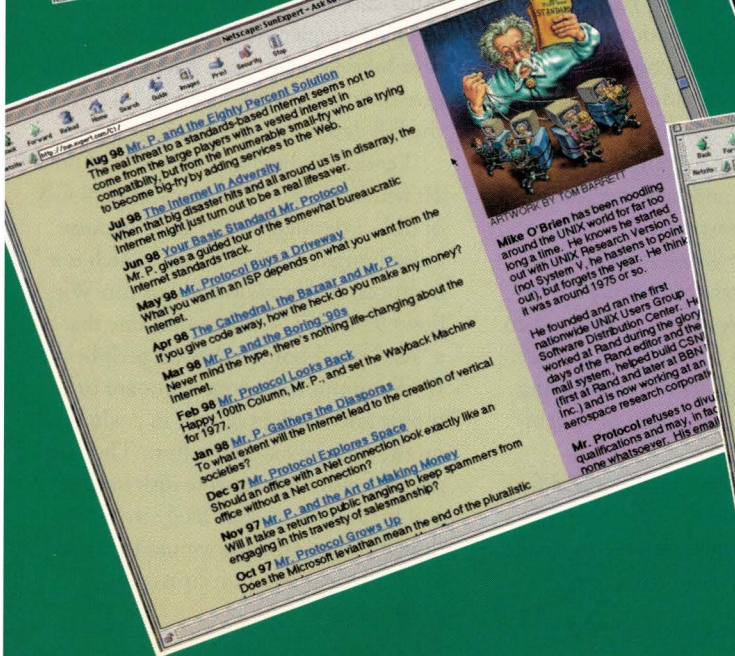
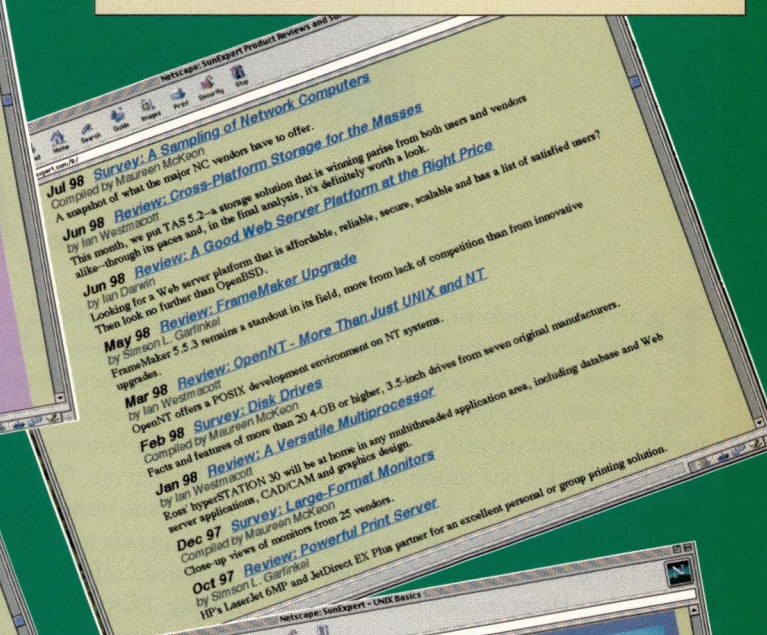
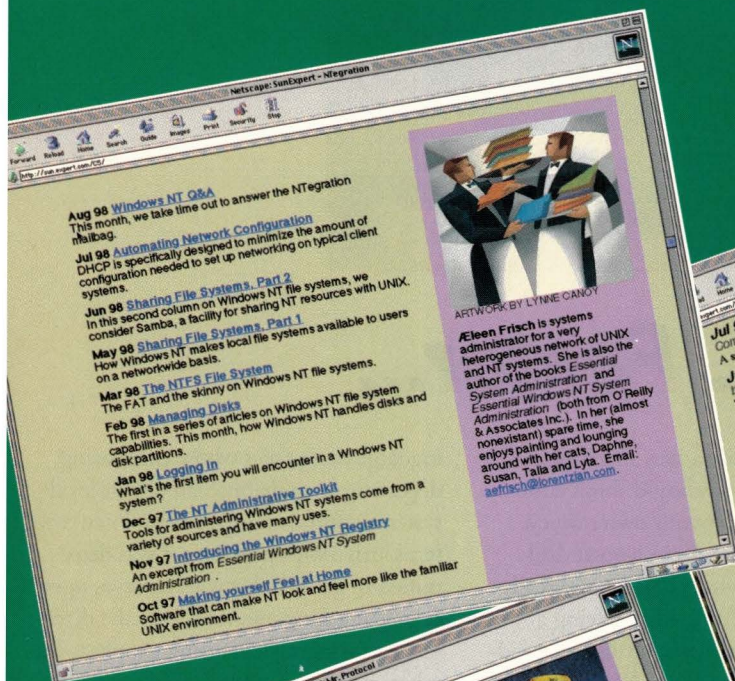
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UNIX Basics

by Peter Collinson, Hillside Systems



STEPHEN SCHILDBACH

Faster... Faster...

Part of my personal millennium plan was the upgrading of my aging SPARCstation II. I've had a Sun Microsystems Inc. workstation for 10 years, starting with a Sun386i and migrating for one reason or another to the SPARCstation II. I also tried to keep up with operating system changes, spurred on to some extent by writing this column. However, Solaris 2.6 was nearly more than a SPARCstation II could handle. It was usable, but slow in spots. Those spots were mostly interpreted systems like Java or Tcl/Tk. I also had the feeling that its ability to handle Ethernet traffic was not keeping pace with the other machines on the site, which are all Pentiums of varying antiquities. The Solaris 2.6 system on my SPARCstation II was left to rot. Upgrading it to ensure that it was Y2K-compliant seemed to be a pain, especially since the CD drive was an original "single speed" device inherited from some older system that I owned at some point in the past 10 years.

I decided to buy a new machine, something that you should think about quite hard when it's your own money. However, I can't say I put a great deal of thought into what choices were really available to me. I'm used to having a SPARC and wanted to continue. I decided to upgrade to an Ultra 10. Some of my reasons simply came down to engineering. I hoped that I could move my personal working environment with no pain from the old system to the new.

Another issue is support. I'm used to being supported, and have availed myself of hardware support several times in the past 10 years. When the machine breaks, which is rare but deeply annoying, I need to have someone rush out to fix it. Also, if you pay for maintenance, Sun's software support is worth having, if only for the steady stream of system patches it emits.

Working out what options I had for a new machine turned out to be much harder than I thought. Sun seems to be geared up to shift boxes to uncomplain-

ing large companies whose purchasing departments probably blame their local systems administrators if several new systems arrive with problems. I was determined to go into this with my eyes open and kept asking questions that the diverse range of perfectly charming people at the other end of the phone could not answer. I was left to piece together my own set of possibilities, rather than having someone give me the answers I needed. I'll omit the full details to spare Sun's blushes.

I ended up buying a 400-MHz Ultra 10 with 256 MB of memory and 18 GB of disk. I decided on the latter because I also bought a SunPCi card, which is a coprocessor that allows you to run Windows 95 or NT 4.0 on a machine that is a "real" processor, but has no peripherals. It takes input from your keyboard or mouse and displays output in a window on the X11 server on the host. The card uses the Sun disks to store disk images, and because these were likely to be big, I thought that extra disk would be a good idea. A wise thought, it turns out.

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When the new system arrived, the big change for me is its speed of operation. The machine is considerably faster than the SPARCstation II. As a nontouch typist, whose inaccuracy in typing means the most used key on my keyboard is Delete, speed makes a huge difference. My typing is constrained by seeing the characters being echoed back to me to confirm that my hands are in the correct place and I'm hitting the correct keys. I am now creating text much more speedily than before, although choosing the correct words takes the same amount of time.

My initial fears that I would hate Sun's nonoptical mouse have proved groundless. The roller-ball mouse is light and easy to use. It comes with a soft nonshiny mouse pad, and that might be the reason for its success. Actually, another design win with the mouse is that it plugs directly into the keyboard and there is only one cable between the keyboard and the tower box on the floor. Of course, Sun's been doing this for aeons, but good, thoughtful design is always worth mentioning.

The machine's high-quality graphics allow me to have a larger screen area in terms of pixels, and this is a win. It would be nice if Sun gave us some three-dimensional system applications to show this off—how about a 3D tree viewer for the file system?

Solaris 7

On the surface, Solaris 7 isn't a great leap forward for the general user. This is a good thing because great leaps tend to break old software. I'd kept my Sun version of `sendmail` in line (or nearly so) with those versions being made available by Sendmail Inc. Creating the `sendmail` setup for the machine was easy: just take the old control file in `m4` and type `make`. I then realized that Sun's `sendmail` now supports the BSD "hash" format files, and I could change some of the older setup I used previously.

Installing the system and placing it on the Internet was easy. The only real gotcha on Solaris 7 is the Domain Name System (DNS), which uses the more recent control file format.

Whenever you move from one system to another, problems are created by the local changes you've made. Over the years, I'd tried hard to keep all my changes in `/usr/local`. Where I could not do this, because I was tailoring some standard system file, I left a marker. Whenever I alter a system configuration file, called say `fredrc`, I'll retain the original one in `fredrc.orig`. One reason for this is to allow immediate backtracking, the other is that you can scan the file system to find what you've altered. Before hacking on the new machine, it's a good idea to ensure that any change you made originally is still required and that there isn't some other new way of achieving the same end.

If you keep all your local commands in `/usr/local/`, then this whole tree will hopefully port intact into the new system. When I set up my new machine, I crossed my fingers and simply copied my old `/usr/local` from Solaris 2.6. To my considerable relief, programs have mostly worked. I didn't want to do massive recompilation of my personal tool set on day one.

There are some funnies. I use Brent Welch's `exmh` as a mail user agent and this depends on Tcl/Tk. Initially, the program didn't appear to work as expected and I blamed the Tcl/Tk setup. I found a precompiled Solaris 7 pair of packages on the Scriptics Corp. Web site and installed them. The new binaries

didn't seem to make much difference. Then I realized that the dynamic link loader wasn't looking in the right place, so fronting the various `exmh` user programs with shell scripts that set `LD_LIBRARY_PATH` cured the problem. I also suspect the way mailboxes are locked on Solaris 7 has changed from the method used by Solaris 2.6. I haven't had a chance to check this yet.

I have also found that the BSD `locate` program suite doesn't seem to work as expected. I wrote about this program in my article, "Moving to Solaris" (*SunExpert*, May 1996, Page 20). The idea of the program is that you build a searchable list of files on your system every day (or so). Building the list is easy, you just do a `find` to locate every file in the file system and store the list. The `locate` system has a couple of magic programs that build a hash table from this list and a command called `locate` that accesses the hash table to search and print file names.

The search functionality was included in the `find` command on the BSD system releases, so you could say

```
$ find .html
```

to find all the files that contained the string `.html`. However, POSIX didn't bless the functionality in the `find` command and it was revived in a new non-POSIX command called `locate`. I find the action of the command invaluable, especially on new systems where I am always looking for files. My body keeps typing the old `find` command, so I have created a shell function:

```
function find
{ if [ $# -eq 1 ]
  then
    /usr/local/bin/locate $1
  else
    /usr/bin/find "$@"
  fi
}
```

This allows me to invoke the command using the old syntax.

For some as yet undiscovered reason on Solaris 7, either the hash table is built incorrectly or the `locate` program doesn't work. Either way, when I type `find` to invoke my shell function or `locate` to call the command directly, I am presented with garbled file names. However, the machine is now fast enough that I've replaced the lookup program by a call to `grep` that simply scans through the list of files that are recreated every night. I've added the `-i` option to `grep` to make the general search string case-independent.

I really have had no other problems. When my Sun C compiler arrives (another story I won't bother you with), I plan to slowly migrate from binaries compiled on the old system to binaries that are compiled on the new. I am unsure that I will need the 64-bit functionality of the new system for any of my programs, however.

Good Things

I said that Solaris 7 doesn't present many changes for the user. This is somewhat unfair. There are changes, but they are generally subtle. For example, the manual pages are now distributed in

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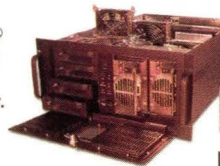
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Standard Generalized Markup Language (SGML) and not `troff`. The `troff` versions can be compiled from the SGML.

The SGML format (or “DTD,” which is the three-letter acronym for such things) is SolBook, a subset of the DocBook DTD. The benefit here is that the Answerbook system understands SGML, and the manual pages are now accessible directly from that system. The `man` command has been altered to understand both formats, so there is, or should be, no problem installing traditional manual pages. I have just today started leafing through a new book on DocBook from O’Reilly & Associates Inc. (see below for more information).

The Common Desktop Environment (CDE) has, I suppose, “progressed.” It seems much more resilient than the previous version. When you changed things in the previous version, it was often prudent to log out and in again to reset the various dynamically created control files; the new version seems to permit alterations on the fly with no adverse effects. There are some new features. The first thing you’ll notice is that the Front Panel has acquired color and dynamic movement. I went with the flow and moved everything from my old home directory to the new, *except* the old `.dt` directory. The `*C.dt\FP` directory is the configuration and working area for CDE. By not taking my old one, I started the new CDE from scratch.

Many of the bugs in CDE that I mentioned in my CDE articles (see “Common Desktop Environment,” *SunExpert*, June 1996, Page 22, and “Customizing CDE,” June 1997, Page 30, <http://sw.expert.com/C2/SE.C2.JUN.97.pdf>) have been fixed, and the resulting product is considerably more usable than before. For example, if you move about the file system in the file manager and open a terminal, the working directory of the terminal is set to the place you are looking at in the file manager window. One bug has not been fixed: I want to be able to tell the various page imaging programs that my pages are designed to work on A4 and not letter-size paper. The fact that this has not been changed is not surprising because an American engineer once pronounced it “not a bug.”

There are a bunch of new things in CDE that make point and click somewhat more of a reality. You can create a file in a bookmarks directory (which lives in `~/dt/bookmarks`) that can be clicked and passed as a URL into the running version of Netscape. These files contain the URL of the target, and can be created by dragging some text that is a URL into the bookmarks directory. The directory is “magic.” Here, you can create files that contain a URL, which will turn into an action that when clicked loads Netscape and takes the user to the specified site.

You can create “cards” that again are stored in a private directory in `~/dt`. These form an electronic address book, so you can select a name (whether it be a person, a machine or a Web page), click and be directed to the target address using the appropriate technology—email, `rlogin` or Netscape. The address book format is based on the Vcard standard that’s used by some palmtops to act as electronic contact cards.

I still have a niggly that CDE tools tend to plonk things into your home directory. For example, if you create an action using the Action Editor, it creates the working file in `~/dt/types`. However, it places the “action button”—the file you are supposed to click on—in your home directory. You can move this to some-

where that’s hidden away and things still work. Actually, I’ve created a directory `~/dt/appmanager/personal` to hold these buttons. This directory pops up in the Application Manager window as a folder named `personal` and is exactly the right place to store private actions. However, if I try to edit one of these actions, the Create Action GUI whinges about it not being created by itself. The trick is to find the actual action file in `~/dt/types` and drop that onto the editor. However, when you save the file, it creates an action button on your home directory again. It seems safe to delete this and use the one you created earlier in the `~/dt/appmanager/personal` directory. All this is confusing and is a mess that needs mending.

Working Out What’s Happening

With any new system, I seem to spend time working out what’s happening and trying to impose the way I want to work onto the ideas that the system designers *thought* I might like to work. The basic sources of information are the Answerbooks and the `man` pages. Although, as I’ve noted before in these pages, there are several commands that you can see on a `ps` listing that simply are not documented at all. CDE is notorious for having undocumented commands and, on some occasions, inspired guesswork has to be used to find out what the commands do and why they are failing.

My usual sequence of actions when I am trying to understand what is happening is to first type the `man` command. When I find nothing, I revert to the Answerbooks and search for the string. If that fails to yield anything, then maybe a `find` (or `locate`) for the file name will show you that there’s a text file, or a manual page that’s not showing up in the `man` command. If that fails, then you need to investigate the binary. Point the `strings` command at it; sometimes, there’s a help message or some other form of identification that may help you deduce where the program fits into the world.

When everything else fails, but you think running the command is an option (sometimes it isn’t, so be careful), then the `truss` program is your friend. The job of `truss` is to print out all the system calls that a particular process has made. Remember that a UNIX process talks to the outside world via system calls, so the ability to print what system calls have been executed and their parameters can tell you quite a bit about what a process is or isn’t doing. There are two useful command-line forms:

```
$ truss command
```

This runs a command and prints all the system calls it makes. To try this, say

```
$ truss ls .
```

and `truss` will print quite a small amount of information. It prints the information to the error channel, so if you want to capture all the output to a file, you’ll need to say

```
$ truss -o file ls .
```

If you now examine that file, you’ll find that the first part of the

UNIX Basics

program worries about loading the runtime libraries into the process address space. You can see several lines like the following:

```
open("/usr/lib/libc.so.1", O_RDONLY) = 4
fstat(4, 0xFFBEECD4) = 0
mmap(...
```

The sequence is the dynamic loader creating the remaining parts of the process by mapping parts of the library into its memory. You need to skip past all these lines to find the work that the process is doing. For `ls`, the work starts here

```
time() = 945189387
ioctl(1, TCGETA, 0xFFBEF14C) = 0
```

The program establishes the time, and then looks at its standard output channel using the `ioctl` system call. Actually, it's trying to find out if its standard output channel is a terminal; this call will fail if the standard output is a regular file. Remember that `ls` gives you output in columns when the standard output is a terminal. The program continues

```
brk(0x000269C8) = 0
brk(0x0002E9C8) = 0
```

The `brk` system call obtains some memory for the process to work in. Now things get interesting.

```
lstat64(".", 0xFFBEF0C8) = 0
open64(".", O_RDONLY|O_NDELAY) = 3
fcntl(3, F_SETFD, 0x00000001) = 0
fstat64(3, 0xFFBEF008) = 0
```

The `64s` here are all special system calls that take 64-bit arguments rather than 32-bit ones. The `lstat64` call is the same as the `fstat` call, except it's given the name of a file for which to return details and `lstat` doesn't follow symbolic links, so I guess it's checking for symbolic links. It decided that it doesn't have one and opens the file, which is a directory. It then sets the "Close on Exec" bit in the file descriptor using `fcntl`. I'll guess that the code uses a standard directory reading routine that does this and the `fstat`. The program finishes

```
brk(0x0002E9C8) = 0
brk(0x000309C8) = 0
getdents64(3, 0x0002E6D8, 1048) = 176
getdents64(3, 0x0002E6D8, 1048) = 0
close(3) = 0
ioctl(1, TCGETA, 0xFFBED1E4) = 0
write(1, "# c d e 3 . m s # c...", 31) = 31
lseek(0, 0, SEEK_CUR) = 4379
_exit(0)
```

It reads the directory contents and prints the data.

I feel it's worth going through the output of a simple command in some detail to show you what you can deduce from looking at the output. It's rare to get into this level of detail.

Mostly, I use `truss` to find what files a process is opening.

There are many options for `truss`, and you should read the



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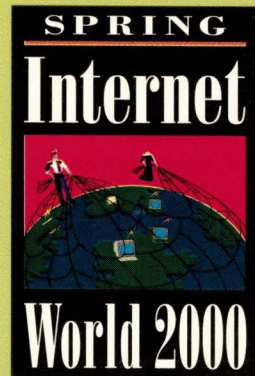
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UNIX Basics

manual page. Here are a couple that I use more often than not.

The `-p` option is followed by a process ID. It will trace the running process, assuming that you have appropriate ownership rights. The switch is useful when you have a process that's running away and you want to find out why. I tend not to just kill a runaway because what has happened will certainly happen again, and by killing it you are destroying the evidence. You may not be fixing the problem. Beware that `truss` will slow down the process that it's tracing so that it can print the information about each system call. So using `truss` to trace processes that are dependent on time can have unwanted effects.

Normally, `truss` will only report on one process, and if that process forks to produce a child, then the information in which you are interested may not be available. The `-f` option allows `truss` to track any children of the process that you are tracing, and this can be very helpful when looking at daemon processes that do their work by generating a new process. This was how I originally figured out how Solaris 2.6 locked mailbox files.

Solaris 7 provides some new functionality for `truss` that can be used to remove some of the guesswork that I have entered into above. I should say that I wrote the guesswork text before using this feature. The `-u` option is followed by a shared library name, or a comma-separated list of shared library names, and will show the entry and exit from each of the routines that are invoked. Here's the bit at the start of the `ls` program:

```
-> libc:time(0x0, 0xff3338f0, 0x0, 0xff33723c)
time() = 945192671
<- libc:time() = 0x38567edf
-> libc:isatty(0x1, 0xff3338f0, 0x0, 0xff33723c)
ioctl(1, TCGETA, 0xFFBEF154) = 0
<- libc:isatty() = 1
-> libc:getopt(0x1, 0xffbef22c, 0x13c40, 0x0)
```

It shows that the program called the `time` routine and then `isatty` to work out if it was talking to a terminal. You may recall I deduced the call to `isatty` by knowing how it worked. As I said, you'll probably never need to get to this level of detail with `truss`, but it is one tool that can help you investigate the mysteries of what is happening on your machine.

Further Investigation

The Scriptics site from which I obtained my precompiled Solaris 7 binaries of Tcl/Tk is <http://www.scriptics.com>. The new book on the DocBook SGML DTD is *DocBook, The Definitive Guide* by Norman Walsh and Leonard Muellner (published by O'Reilly & Associates, 1999, ISBN 1-56592-580-7). →

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 an UltraSPARC/10. Email: pc@cpg.com.

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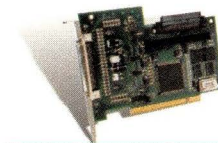
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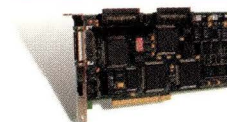
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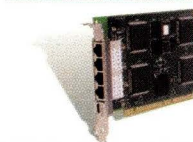
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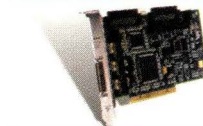
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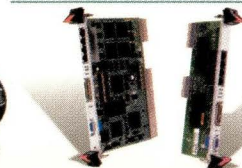
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Storage

by Alan Benway



The Journey Begins

Disk drives seem to be the least understood elements of computers for most users. Choosing a disk from the dozens available is often done on the basis of a single specification—usually either access time or cache size. Many users are completely unaware that these “performance” figures are meaningless by themselves.

Disks are holistic devices—a sum of the parts—where no single attribute determines performance or quality. There are several physical and logical components to every disk. One must research the product data sheets at a vendor’s Web site to determine the performance potential of a disk, and not merely rely on the published access time or cache size. But you have to know what you’re looking for and how to interpret spec sheet data in order to make use of it. We will try to shed some light in this area, both this month and next month, as we investigate disk drive technology.

Keep in mind that while the following explanations sound simple, much of

the underlying engineering involved is staggering. Our expectations regarding these devices are equally staggering. We expect that a disk with 8.6 billion bytes of storage—think of all the people in the world, plus all of China and India added in again—will a) cost a paltry \$130, b) plug in and work every time and c) deliver excellent performance and function error-free for several years.

Physical Components

Let’s begin with a discussion of what collection of parts it takes to create a disk drive. There are six major physical components in every drive:

- Motor assembly and drive case
- Magnetic platters
- Head and actuator assembly
- Control logic and cache board
- Bus interface logic
- Power supply

It is useful (but somewhat of an oversimplification) to think of a particular packaging of a motor, platters, heads and control logic as the basis of a vendor’s

family of models (for example, the Western Digital Corp. Caviar series), where the specific model (type and capacity) of the disk is determined by the interface logic glued on and the number of platters installed.

The motor assembly includes the drive case, motor, spindle and bearings. Of all the attributes that these pieces may have, most people ignore all but motor speed measured in revolutions per minute, or rpm. Keep in mind that there exists a substantial range in the quality of motors and bearings for which there is no specification, but there may be some related discussion in the vendor’s product information. In general, the higher the rpm, the faster the performance will be. So why aren’t there any 150,000-rpm disks, you ask? Why do speeds fall into just a few ranges; where 5,400, 7,200, 10,000 and (soon) 13,000 rpm are the most typical? There is tremendous engineering difficulty in pushing up the rpm. Among other things, as the rpm increases, motor-generated heat rises, bearing



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smoothness becomes a critical issue and aerodynamic flutter created at the outside edges of the disk platters becomes a real problem.

The magnetic platters are thin metal alloy discs (the substrate) that are covered on both surfaces with a magnetic media coating onto which the magnetic heads write. These surfaces are extremely uniform and highly polished for smoothness. There will be one or more platters fixed to the motor spindle in a pancake-style stack, depending on the capacity desired. The surface quality affects things such as the recording density, error rates and head flying height. Areal density is the figure stated for how many bits can be successfully (they are of no interest if they are unsuccessful!) crammed onto every square inch of the usable surface area. Platter manufacturing, along with head and bearing technology, is the area of high science of disk manufacturing.

There are heads attached to an actuator assembly in every disk. This unit is like a dinner fork with the handle attached to a pivot and the magnetic heads connected at the ends of the tines. The actuator assembly passes the heads back and forth over the platter surfaces in a very precise manner under the control of a voice coil (the name carried over from audio speaker terminology). There will be one head for each data surface and two heads attached to either side of each of the middle tines. The vendor's data sheet for the drive will say how many heads there are for data, as well as information on the speed of the positioning coil that moves the head assembly back and forth.

The positioning speed is described as access time. A data sheet will provide the figures for single track-to-track steps, full surface swings and average access time. The most accurate determination of average access time would be the average of all possible track seeks. Most often, this value is the time it takes to seek one third of the arc across the surface, including the settling time upon arrival at the target track. This estima-

tion typically is fairly close to the more rigorous version. For longer seeks, there is an acceleration period followed by a braking period. The heads are not normally moved in a constant linear motion because access times would end up being much higher overall. If it is a high-end drive, there will be some vendor commentary on the wonderfulness of its head technology on the data sheet as well.

By the way, be sure to install drives so that they will end up being either bottom-side down or on a side. Consider how internal drives will end up once the system is in use. For example—something I see all the time, I'm afraid—a user may tip their desktop case on its end next to their desk, with the result that the drive(s) will be upside down! Never install disk drives in such a way that they end up being upside down, and avoid tipping at 90 degrees nose down or up. Some vendor data sheets warn you not to do so because some positions are very hard on the drive bearings and actuator coil and cause heat-dissipation problems.

The control logic and cache board is mounted on the bottom surface of a disk case. This is the CPU, buffer memory and CPU firmware that control all the operations of the disk unit. This includes the mechanical functions of the motor speed and the actuator positioning, as well as the various electronics required to operate the magnetic heads and turn the bits on the media into usable data. In a nutshell, for a read command, the heads sense changes in flux patterns on the media, this itty-bitty signal (high-tech term—remember it!) is boosted by head amplifiers and runs through noise filters, signal shapers and boosters to determine what was recorded there. This reconstructed data is assembled in a buffer in cache, and then compared to the sector checksum. Once all of the sectors requested in this I/O operation are in cache, the data is ready for bursting to the host.

There are many different cache management methods, and in general, the more expensive the drive, the more intelligent

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NTegration—Exploring Active Directory
Work—Back to Basic(s)
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High	Medium	Low
170	171	172
173	174	175
176	177	178
179	180	181
182	183	184
185	186	187
188	189	190
191	192	193

Storage

the cache. A drive with a lesser amount of intelligent cache will outperform a lower IQ drive that has considerably more cache. So do not compare drives merely on the basis of cache size! Low-cost drives use their cache as simple monolithic read or write buffers. More expensive drives employ "adaptive" or "segmentation" strategies to manage cache. These techniques make far more effective use of the cache space, and increase the probability of read hits from cache owing to superior read-ahead algorithms. I highly recommend *Understanding I/O Subsystems*, by Andrew W. Wilson and W. David Schwaderer (published by Doone Publications, 1996, ISBN 0-9651911-0-9) for further reading, as well as disk white papers on some of the vendor's sites (see "Recommended Reading," Page 36).

The bus interface logic is a chip set and a bus connector on the same board as the control logic and cache that provides the connection to the host disk controller. Alternate versions of this logic section can support the various connection technologies (or bus protocols). At present, there are three basic types of interface logic, each with many alternate versions. At the most simplistic level, these are the integrated drive electronics (IDE), SCSI and Fibre Channel Arbitrated Loop (FC-AL) interfaces. These will be dealt with in detail in a future column, so I'll mention them only in passing here.

The power supply section is fairly minimal—a drive pulls +12 and +5 volts DC from the power connector. There are voltage dividers to step down these inputs to the values needed, but presenting high-quality power to the drive is important. Disks in PCs receive endless abuse from the sloppy voltage levels supplied by the extremely poor quality (inadequate filtering, unregulated and vulnerable to changes on the input side and so on) power supply in the host computer. (Strong suggestion: PC builders, take a look at the section on power supplies at <http://www.pcpowercooling.com> for the real thing, especially if you have internal SCSI devices. More on this in a future column.)

Some other physical attributes worth considering include both the operating and nonoperating values for temperature, shock and altitude. Disks don't appreciate being hot (laptop PC in the desert?), bounced around (disks in military vehicles?), or left gasping for air above 10,000 feet. Disks are not sealed, but have a breathable membrane separating the platter/actuator chamber from the outside world; otherwise, they would burst when shipped as air freight (think hot dog, microwave, four minutes!). The heads require a minimum amount of air pressure to properly fly above the platter surface (usually at the square root of the diameter of a gnat's whisker, give or take a tenth of a micron). At altitudes above 10,000 feet, there isn't enough air pressure to guarantee correct flight operation.

Logical Concepts

Enough on the physical parts. Let's move on to the logical concepts. There are several conceptual elements to consider, especially when investigating performance:

- Drive geometry
- Blocks per disk
- Cylinders per drive
- Usable heads (or data surfaces) per drive



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- Tracks per cylinder
- Sectors per track
- Recording technology and zones
- Internal serial transfer rates
- Drive logic IQ

Every disk has geometry. On a PC's motherboard in the BIOS setup, you will see this represented as CHS, or Cylinders, Heads and Sectors, for motherboard-attached IDE drives. These values are not the real ones, but are the "translated geometry" reported by the disk to the BIOS to overcome various disk-addressing features in Mr. Gates' operating systems. SCSI drives are presented (via the SCSI controller) as a continuous string of 512-byte blocks to the host, whether it be UNIX, Windows or Mac OS. IDE disks have onboard controllers and talk directly to the operating system's enhanced integrated drive electronics (EIDE) driver via the simple electrical buffering logic on the motherboard known as the IDE connector. An operating system requests blocks from a SCSI controller and physical (but fake) sectors from EIDE/Advanced Technology Attachment (ATA) devices.

The number of heads in a drive is a function of the desired capacity of a disk model from a drive family. As a rule, the larger drives in a family have more platters and heads.

A track is the single concentric ring on a platter that passes under a stationary head. These, as well as sectors, are created by low-level formatting. There may be between 5,000 and 15,000 serial bits (actually, flux variations in the magnetic fields) that pass under a single head for a unique positioning of the actuator assembly. The bit density of the track is directly related to

the surface's areal density.

Each track is divided into a number of 528-byte (varies) sectors that each hold 512 bytes of data (a block on a SCSI disk), as well as 16 bytes (varies) of sector timing and addressing information and sector data (such as Error Correcting Codes, or ECC) checksums. The number of sectors per track is not fixed on a surface, but varies owing to the effects of circumference, recording methods and zones. There are often one or more spare sectors in each track to avoid having to relocate the entire track for a single bad sector.

The notion of cylinder is a function of the magnetic heads. As a result of low-level formatting, all of the heads attached to the actuator arm line up vertically on the same track on each platter. This group of vertically aligned tracks, which can be written to or read without moving the arm, is called a cylinder. A set of cylinders is known as a cylinder group. Usually, there are one or more spare cylinders of tracks configured at the end of each cylinder group so that a bad track does not have to be "spared" to the pool at some unused innermost tracks of a disk as in the old days (severely increasing access times). (Reader tip: This is an option that can be set when creating some UNIX file systems, and it can affect the performance of a RAID unit to some degree.)

Our discussion of recording methods will be brief, as it is a lengthy and complex subject. Suffice it to say that the technique used to write data to the media is described as the recording method, and it has a significant impact on bit density and error rates. Mostly, you will see vendors list one of several methods, such as Run Length Limited (RLL) or Partial

RECOMMENDED READING

- *The Book of SCSI: A Guide for Adventurers*, by Peter M. Ridge (published by No Starch Press, 1995, ISBN 1-886411-02-6). Probably the best book written about SCSI.
- *Sun Performance and Tuning: Java and the Internet, 2nd Edition*, by Adrian Cockcroft and Richard Pettit (published by Sun Microsystems Press, 1999, ISBN 0-13-095249-4). Superb. Sun-centric, but universally valid concerning lower and middle-level I/O topics.
- *Configuration and Capacity Planning for Solaris Servers*, by Brian L. Wong (published by Prentice Hall Inc., 1997, ISBN 0-13-349952-9). Sun-centric, but excellent middle and higher level operating system I/O concepts.
- *The RAIDbook, 6th Edition: A Handbook of Storage Systems Technology*, by Paul Massiglia (Ed.)/RAID Advisory Board (1997, ISBN 1-57398-028-5). Good book to have. Contains information on a variety of RAID topics.

RECOMMENDED WEB SITES

- **Adaptec Inc.** – <http://www.adaptec.com/products/guide/index.html> and <http://www.adaptec.com/support/index.html>. Manufacturer of high-performance SCSI, connectivity and network products. See the company's "White Papers" and "Other Installation Tips" pages.
- **Granite Digital** – <http://www.scsipro.com>. Manufacturer of SCSI cables, terminators and other high-performance accessories.

- **IBM Corp.** – <http://www.storage.ibm.com/resources/index.htm>. See Big Blue's storage resources pages.

- **Maxtor Corp.** – <http://www.maxtor.com/technology/index.html>. Manufacturer of PC storage products. See Maxtor's "Technology Index."

- **Seagate Technology Inc.** – http://www.seagate.com/support/kb/disc/index_papers.html. Manufacturer of disk/tape drives and other storage-related products. See the company's "Disc Technology Papers."

- **Western Digital Corp.** – <http://www.western-digital.com/acrobat/welcome.html>. Manufacturer of EIDE and SCSI disk drives. See the company's "Technology Library" (in PDF).

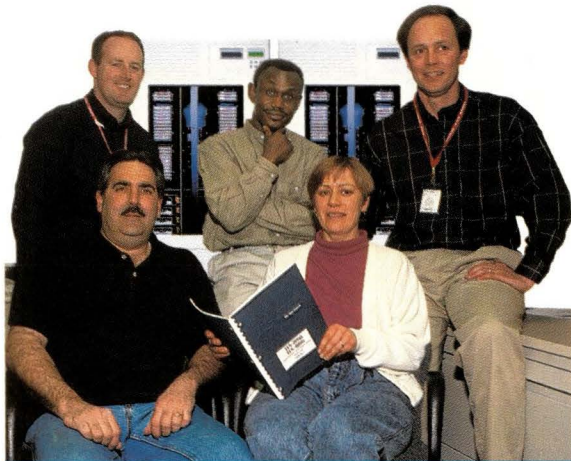
- **The RAID Advisory Board (RAB) Inc.** – <http://www.raid-advisory.com>. The RAB is an industry association that is devoted to promoting the understanding and use of leading edge storage technologies through its education, standardization and classification program.

- **The SCSI Trade Association (STA)** – <http://www.scscita.org>. The STA was formed to help educate OEMs, resellers and IT professionals about SCSI and help shape the future of SCSI to ensure performance and compatibility.

- **StorageReview.com** – <http://www.storagereview.com>. A must-see. Contains reviews of hard disk and storage-related products.

- **The PC Guide** – <http://www.pcguid.com>. Contains detailed PC reference information. PC-centric, but superb.

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Response Maximum Likelihood (PRML). It doesn't really matter to the average end user, but it might be exciting stuff to the most devoted disk geeks. The main thing to understand is that the data density is constant on the disk. Because the physical circumference of a track varies from the much smaller inner cylinder (highest number) to the largest, outermost cylinder zero, the amount of data that can be stored on each track varies by at least 2 to 1.

However, to maintain some sanity in this world of changing circumferences, the concept of zones was introduced. The number of sectors per track slowly increases from the smaller inner tracks to the much larger outer tracks. However, this is not a linear change because it would take a change over several tracks to fit one more sector. A surface is often broken up into several zones, each having a fixed number of sectors per track; hence the term that most people quickly eyeball and then skip over—zone bit recording. Now you know what that means (party trivia, right?). Zones are groups of cylinders, usually each with the same number of tracks, that have the same number of sectors per track based on what is found on the smallest, or innermost, cylinder in that zone. There may be 10 or more zones defined on a surface in order to minimize lost real estate, so to speak. The vendor might not even provide this information on its data sheet.

In addition to spindle rpm and bits per track, is a very important spec known as internal transfer rate (ITR). Simply put, this is the rate at which usable data can be read from the

surface and stashed in cache awaiting transfer to the host. The reverse would be true for writes, except that a sector checksum is also generated. As the amount of data per track varies with the zone, the figure for ITR is specified as a maximum/minimum rating for the surface. This is perhaps the most important drive spec because it tells you the maximum rates that data can be assembled in the cache buffer independent of the host I/O bus rate. If a drive can only manage transfers (data and format information) of 80 Mb/s, or less than 10 MB/s, then it does not help at all (for this one drive) if the host interface is the much faster ATA-66 or 80-MB/s Ultra 2 SCSI. Yet most disk drive advertising ignores this fundamental law of physics, and the speed of the connection bus is always quoted as if you ought to expect that level of performance from the disk. Tch, tch! Naughty of them.

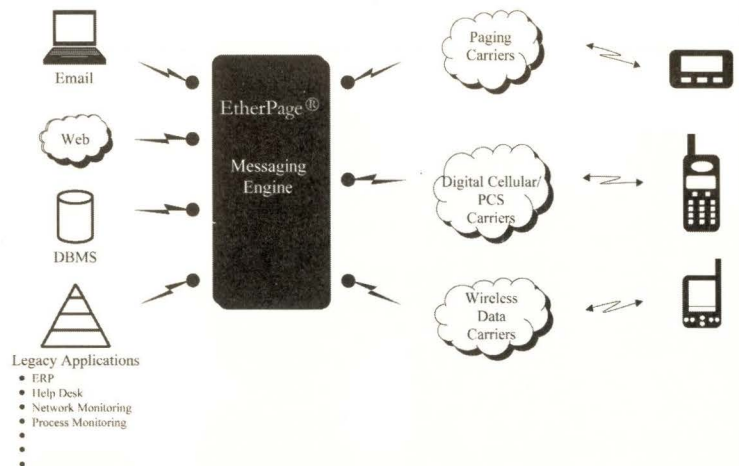
We shall continue our discussion of disk drive fundamentals next month, when we address the topic of I/O operation basics, and the tricky—and opposing—concepts of I/Os per second (IOPS) and sustainable transfer rates. These are the underpinnings of knowledge needed later in order to dissect storage systems, as well as make sense of them and the vendor's claims. Are they genuine, or more truth twisters?

See you then. ➔

Alan Benway, a 20-year veteran of the computer industry, is presently employed by a large database company located in Silicon Valley. He can be reached via email at abenway@cpq.com.

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Exploring Active Directory

If everything remained on schedule, Windows 2000 should be available for purchase as you read this. Last month, we surveyed this new version of Windows NT, examining some of its most important features. This month, we'll continue our introduction to Win2K by looking at the Active Directory facility in some detail. (One caveat: The information and screenshots in this column are based on the final beta version of Windows 2000; hopefully, not much will have changed in the released version.)

What Is Active Directory?

Active Directory is a comprehensive facility used by Win2K to collect, store and disseminate information about all objects within its scope. As such, it is the underpinning of all the major organizational and functional structures in Win2K: domains, user accounts and so on. Active Directory is part of the mechanism by which domains are implemented and user account attributes are defin-

ed and stored. In addition, Active Directory and its associated querying capabilities provide information to users about available services and resources.

From a marketing point of view, Active Directory is described in terms of the features and benefits it brings to the Win2K environment. The most important of these are providing an enterprise-wide single logon for users and a hierarchical, unified system management framework designed to ease administrative requirements/burdens for large sites.

In terms of implementation, Active Directory's most important components are its schema (the set of definitions of objects and their attributes); the global catalog containing information about every object within its scope; and its data replication mechanism by which information is propagated throughout an organization.

Active Directory is based on the Lightweight Directory Access Protocol (LDAP). LDAP is implemented for several UNIX operating systems and is

itself derived from the earlier DAP and X.500 protocols. LDAP use has become increasingly prevalent in the past couple of years because it provides many benefits as an enterprisewide information system: It is very general, it is easily extensible for local needs and it provides good security via its use of access control lists (ACLs) on objects and Secure Sockets Layer (SSL) encryption for network communication.

At this point, it is instructive to look briefly at a sample LDAP record for a user account from a UNIX system:

```
dn: uid=chavez,o=SomeCo,c=US
uid: chavez
cn: Rachel Chavez
objectClass: posixAccount
objectClass: account
gecos: Rachel Chavez
userpassword: {crypt}xxxxxxxxxx
loginShell: /bin/tcsh
uidNumber: 278
gidNumber: 250
homeDirectory: /home/chavez
```

The first line of the record defines it as an object (dn stands for distinguished name); in this case, it is a user account. The remaining lines specify the object's attributes, most of which are fields from a standard UNIX password file entry. In addition to this familiar information, LDAP can also store and make available an arbitrary number of additional attributes (many are already defined, and sites can add their own to fulfill their unique needs).

Active Directory's roots in LDAP can be seen clearly in the Windows 2000 User Information dialog. User accounts have gained a considerable number of additional attributes over NT 4.0. Some of these are illustrated in Figure 1.

The window on the left shows the Telephones panel, where various telephone numbers for the user can be entered; other users can then query this information from Active Directory (provided permissions allow them to do so). The window on the right shows the Organization panel; if the fields within it are filled out for every user, then a company's entire organizational chart/structure can essentially be made available and queryable via Active Directory.

Installing Active Directory via the installation wizard provided with Win2K is straightforward. Before you decide to do so, there are couple of considerations to take into account in your planning. First, you need to decide on your entire enterprisewide domain organization (see "Forests and Domains"). Second, in selecting the computer system for Active Directory, note that the data and transaction logs must be stored on separate disks—as is usual for a database system—so you will need to select an appropriately configured computer. It is also prudent to make sure there is an abundance of free disk space available for both of these components.

Once installed, Active Directory provides three new items within the Administrative Tools program group: Active Directory Domains and Trusts, Active Directory Sites and Services, and Active Directory Users and Computers. The Win2K domain may run in one of two modes. Mixed mode provides compatibility with NT 4.0 and is designed for an environment containing both kinds of domains. The other mode is native mode in which these compatibility features are removed. Windows 98 systems need client software in order to be able to interact with and query Active Directory.

Forests and Domains

One of the most important changes that comes with Win2K is a significantly altered domains scheme. Win2K supports a hierarchical scheme of domains. This is in contrast to NT 4.0, where any structure imposed on distinct domains was defined by the administrator and implemented manually via one-way trust relationships. In Win2K, domains are organized into tree-structured units with parent-child relationships existing between

Figure 1. Windows 2000 User Information

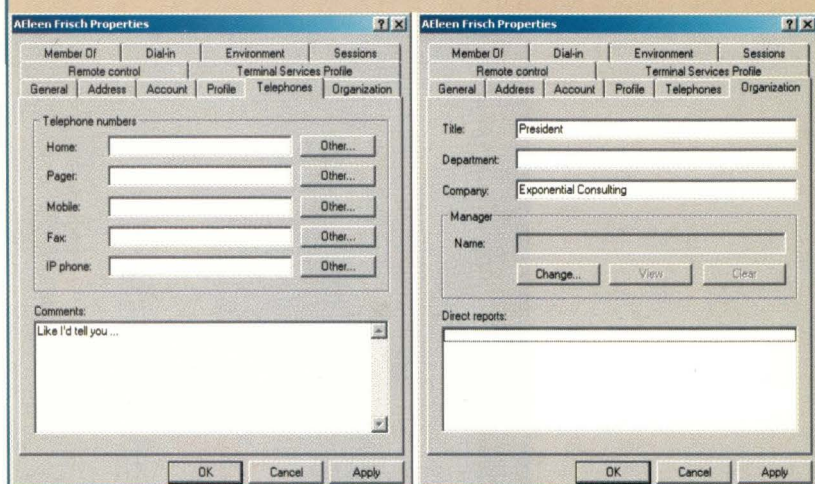
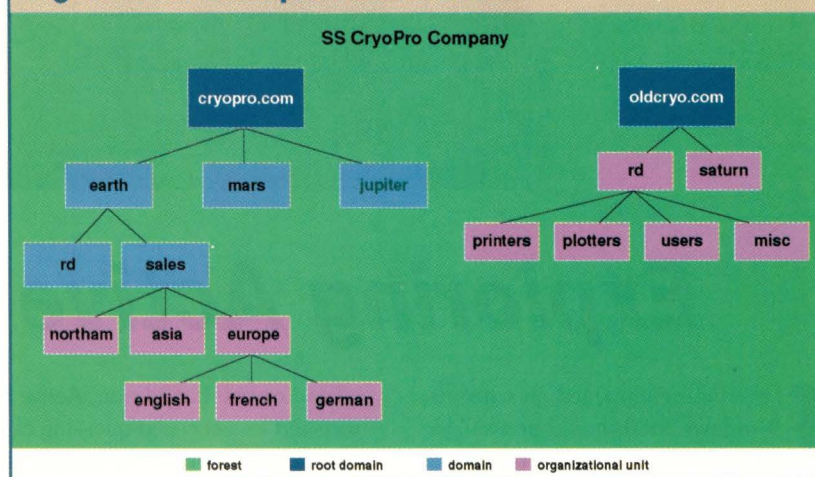


Figure 2. An Example Win2K Forest



domains at different levels. Trust relationships are inherently two-way, and they are implicitly transitive. For example, if domain A trusts domain B, and domain B trusts domain C, then a two-way trust relationship automatically exists between domain A and domain C (the opposite was true under Windows NT 4.0).

Many security-related controls are still applied at the domain level (for example, password controls). Accordingly, as before, domains create barriers—security, administrative, resource access—between groups of users. However, organizations will find they do not need as many domains under Win2K as they had under NT 4.0 (as we will see).

Win2K domain trees typically correspond to a single Domain Name System (DNS) namespace. Domain trees begin at a root domain and branch out from there. As a result, the root domain must be created first before any other domain designated to be one of its children (or other descendant). Many companies will require only a single domain tree. However, multiple domain trees may be created, and a collection of domain trees is known as a forest.

Figure 2 illustrates a simple Win2K domain structure for the SS CryoPro Company. This organization has two DNS

domains for historical reasons owing to a previous merger. The two DNS domains become domain trees rooted at `cryopro.com` and `oldcryo.com`. The former domain tree contains three first-level subdomains, `earth`, `mars` and `jupiter`, which each contain child domains. Figure 2 shows `rd` and `sales`, the child domains of `earth`. The `oldcryo.com` domain tree comprises a single domain. The `sales` and `oldcryo.com` domains are further divided into *organizational units*.

Organizational units (OUs) are subunits of a domain, which are again arranged in a hierarchical structure. OUs inherit properties from their domain and from parent OUs higher up the OU tree. The purpose of OUs is to ease and compartmentalize administrative responsibilities and duties. As such, they are simply a way of subdividing a domain. This subdivision can be based on whatever factors make sense for an organization: resource type, geography, business function and so on (Windows NT 4.0 resource domains often become OUs under Win2K). Note that OUs are simply containers; users, resources and so on do not belong to an organizational unit but simply reside within it.

In Figure 2, the `sales` domain contains two levels of OUs. The first is organized on the basis of geography, `northam`, `asia` and `europa`, and the `europa` OU contains three OUs defined by language. The `oldcryo.com` domain is also structured into OUs. The first level of OUs contains one OU based on geography (`saturn`) and another based on business function (research and development, `rd`), and the latter is further subdivided into four OUs based on resource type.

This new domain structure necessitates changes to the scheme of group types present in NT 4.0. In Win2K, there are two types of groups: security groups (collections of users that can be treated as a unit in security contexts) and distribution groups (functioning as mailing lists). There are also three group scopes: domain local groups (members come from the local domain, and permissions may be applied to the group only

within the local domain), global groups (members come from the local domain, but permissions may be applied to the group anywhere within the domain tree) and universal groups (members can come from anywhere and permissions may be applied anywhere). Universal security groups are allowed only when the domain tree is operating in native mode (no Windows NT 4.0 compatibility features).

Delegating Administrative Authority

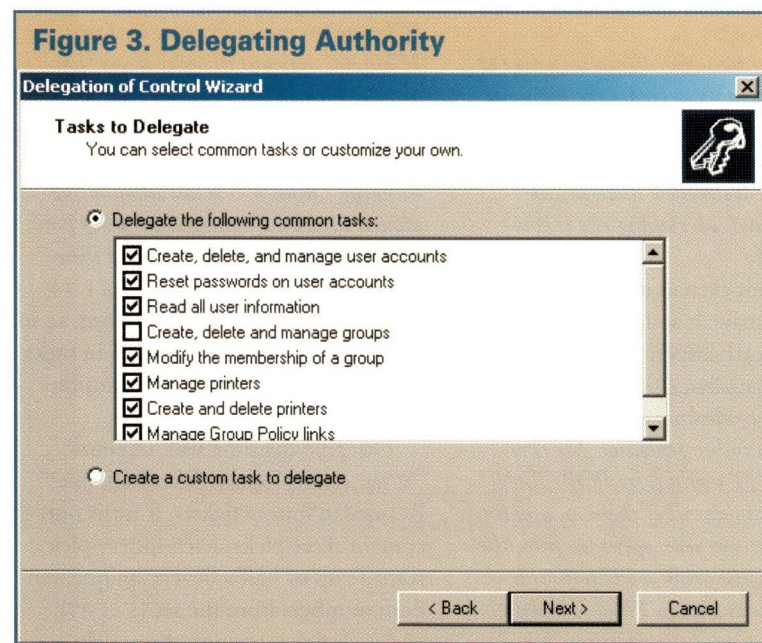
Administrative responsibility for an organizational unit can be delegated. Figure 3 shows the corresponding dialog. As you can see, the specific tasks to be delegated can be specified in considerable detail, and customized tasks may also be created.

Win2K domains are controlled by multiple equivalent domain controllers (rather than by a designated primary domain controller, or PDC, and multiple backup domain controllers). However, there are a few designated master domain controllers responsible for specific aspects/components of Active Directory: schema master (storing the underlying object structure), domain naming master (adding/removing domains/trusts), relative ID master (object creation), PDC emulator (backwards compatibility with NT 4.0) and infrastructure master (group management).

Win2K also defines another type of entity to which administrative authority may be delegated: a site is a named group of subnets that is treated as an administrative unit. Sites are designed to reflect the geographical layout of the computers within an organization. A site boundary assumes a slow WAN link between the two sites. Accordingly, Active Directory-related data replication is handled differently within and across sites. Replication is compressed and scheduled between distinct sites to minimize traffic across the slow link and occurs via a designated bridgehead server. Sites also have security settings associated with them, which specify permissions for administering the site within Active Directory.

If these changes seem substantial to you, you are correct.

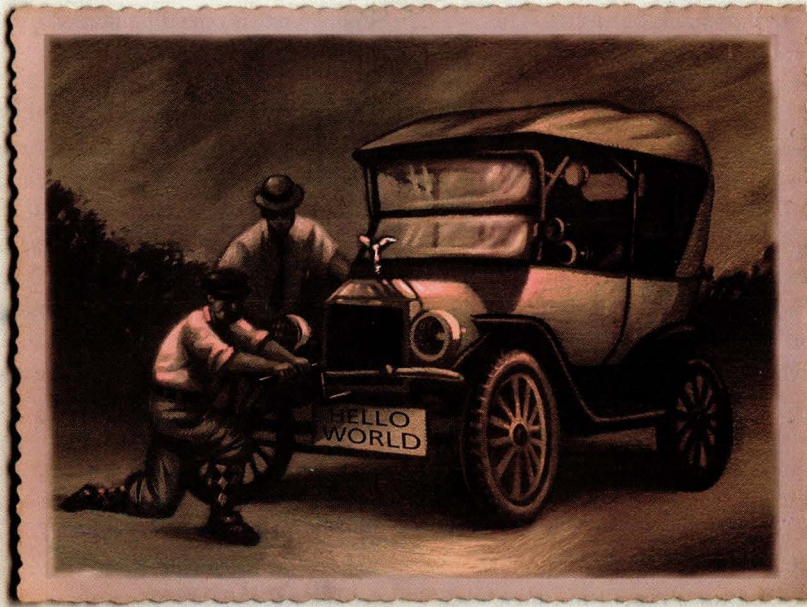
Win2K does bring significant, nontrivial changes to the Windows NT environment. However, be reassured that they are not as overwhelming as they may seem at first. In many cases, your existing domain structure maps easily onto the Win2K scheme. Active Directory seems much less intimidating once you realize it is essentially LDAP (as implemented by Microsoft). If you're familiar with LDAP, Active Directory will become familiar very quickly. If not, this is probably a good time to read up on it because it's a protocol that is emerging in many computer environments. ➔



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Work

by Jeffreys Copeland and Haemer



ALEX GROSS

"UNIX... is not so much a product as it is a painstakingly compiled oral history of the hacker subculture. It is our Gilgamesh epic."
— Neal Stephenson, "In the Beginning was the Command Line," 1999

Back to Basic(s)

We have been working with UNIX for so long that we sometimes take it for granted. This column is for people who have been so immersed in non-UNIX systems that they haven't yet advanced to the 1970s. Yes, we mean in systems like Windows and MVS.

Lottery Numbers

A couple of months ago, we received a note from a Romanian friend who wanted to dip her toes into UNIX. She had spent most of her professional career working on DOS/Windows boxes, and was ready to try something new. She wrote to us, asking for advice.

A good place to start, we decided, was to attack a simple problem she'd already tried elsewhere.

Why a simple problem? Brian W. Kernighan and Dennis M. Ritchie explain, in the first section of the first chapter of *The C Programming Language* (published by Prentice Hall Inc., now in its second edition, 1988, ISBN 0-13-110370-9):

1.1 Getting Started

The only way to learn a new programming language is by writing programs in it. The first program to write is the same for all languages:

*Print the words
hello, world*

This is the basic hurdle; to leap over it you have to be able to create the program text somewhere, compile it successfully, load it, run it, and find out where your output went. With these mechanical details mastered, everything else is comparatively easy.

And it's not even as easy as Kernighan and Ritchie make it sound. Our friend recounts an early experience:

I remember when I first met Visual C++, I only wanted to make a simple random lottery number generator. My first steps into the IT world were FORTRAN, COBOL, assembly, all of them on a mainframe. After many years spent far from the IT world, I came across a PC with this idiotic Windows system. I had to learn C, so I thought of this little program. OK, I

thought of it, read a book of C (Ritchie and Kernighan)—of course, I didn't read it all, I tried to follow the steps. Alas! By no means could I have guessed where the C compiler was. I had to first make a project, then change all kinds of settings that were "Chinese" to me, or better said, I was "Chinese" to them. In order to get that beast to write the lottery numbers on the screen (ON A BLACK SCREEN!), I had to waste days on end, helpless and clueless, thinking I must be the last idiot on the planet. Finally, I managed it: using Borland C++ 3.0, of course, because there was no rand() function in Visual C++.

This problem was well-defined, so it seemed worth trying on UNIX in order to show her what a UNIX-y solution would look like.

Our first question was, of course, "What does a lottery ticket look like?" Romanian lottery tickets, it turns out, contain three picks. Each lottery pick is made up of half a dozen, unique, random numbers from the set {1... 49}, and each ticket requires three picks.

Here's an example:

```
15 42 16 28 7 40
8 13 34 31 20 17
18 16 38 49 10 12
```

(We suspect that any single, matching pick is a winner, but because we're not going to actually buy a ticket, not having the Romanian lei to spread around, we don't care if we're wrong.)

/bin/sh

Here's what we did, step-by-step:
First, we wanted to count to 49:

```
$ seq 49
1
2
3
...
```

Then, we needed 49 random integers:

```
$ for i in $(seq 49); do echo $RANDOM; done
12978
17637
31835
...
```

Next, we added line numbers:

```
$ for i in $(seq 49); do echo $RANDOM; done | nl
1 21931
2 9178
3 24191
...
```

Then, we sorted them numerically by the second field:

```
$ for i in $(seq 49); do echo $RANDOM; done |
> nl | sort -n +1
41 623
46 984
28 1596
...
```

Next, to get our seven out of 49, we grabbed the top seven:

```
$ for i in $(seq 49); do echo $RANDOM; done |
> nl | sort -n +1 | head -7
33 786
34 1384
16 1414
11 2496
23 2684
35 3180
3 3404
```

And, of course, we just wanted the indices:

```
$ for i in $(seq 49); do echo $RANDOM; done |
> nl | sort -n +1 | head -7 | awk '{print $1}'
```

```
30
34
25
1
11
31
40
```

Well, that did what we wanted, so we made it into a program:

```
$ echo "for i in $(seq 49); do echo $RANDOM; \
done \
| nl | sort -n +1 | head -7 | \
awk '{print $1}'" > lottery
$ chmod +x lottery
$ lottery
1
11
42
36
17
14
41
```

Voilà.

You need three sets? Sure. We just start the process again by running it three times:

```
$ for i in $(seq 3); do lottery; done
6
24
25
49
1
35
21
25
43
28
2
23
14
32
15
17
44
43
33
13
29
```

But we don't like that format. So let's put each pick on a separate line:

```
$ for i in $(seq 3); do lottery | fmt; done
22 12 17 44 47 23 21
27 8 17 34 35 33 18
4 17 32 16 47 25 6
```

(Oh heck, we just looked back at the problem specification and realized we only want six random numbers between 1 and 49, not seven. Whatever shall we do? We'll leave this as an exercise for even the least experienced of our readers.)

We could do all this interactively, and nearly instantly, because the UNIX shell lets you recall and edit command lines. Although POSIX only guarantees vi-like editing commands, the shells we've used also provide an emacs-like mode in case you like that better.

When this feature first became widely available in the late 1980s, it quickly changed the way we interacted with the shell.

Our typical approach is now to do much of our shell-level programming on the fly. At each step, we recall and edit a previous command, mostly just appending a new filter to do something new to the data.

Because a good UNIX filter takes its input from `stdin` and writes to `stdout`, we often test what we write from the

keyboard and watch the results on the screen. When we are finally satisfied, we capture what we have been doing and turn it into an executable shell script. (We use this same process in a substantial amount of our Perl programming.)

UNIX is full of tiny tools that filter and transform text. The sense we get when we're programming is one of popping together little, existing tools, looking at the output, and then adding some new transformation to get to the next stage.

Production Code

But what if we wanted "production" code?

The answer is: we'd do the same thing. For a straightforward task like this, the most important factor to consider is development time. As Tom Christiansen says:

Q: What's the difference in speed between an application in Perl and an application in C++?

A: About three weeks. :-)

It is, however, worth enhancing our program a bit. Listing 1 shows a production version that adds comments, does its own formatting and takes an optional command-line argument to specify how many picks to generate.

One noteworthy feature of this code is the internal documentation. We have simply co-opted Perl's `pod` format. The various `pod` tools encourage you to keep documentation and code in the same file so they'll stay in synch, and produce a wide variety of documentation formats from a single, well-defined input format. They work for our shell script, too, because the `exit` statement at the end of our executable code prevents the shell from trying to interpret the documentation, while the various `pod` tools (`pod2html`, `pod2latex`, `pod2man`, `pod2text`, `pod2usage` and `podselect`) will ignore everything before the first `pod` directive.

A Good Programmer Can Write FORTRAN in any Language

If you've tried running this code, you may see that we've glossed over a step. In our examples, we've used a utility called `seq`. This trivial, yet amazingly useful UNIX tool isn't found in the POSIX standard, or even on most UNIX distributions. It should be clear what it does: `seq` counts. We first saw `seq` used in *The UNIX Programming Environment* by Brian W. Kernighan and Rob Pike (published by Prentice Hall, 1984, ISBN 0-13-937681-X), but we now use it so much that we'd be lost without it. In fact, we were, just the other day.

A few weeks ago, we were asked to help judge a practice ACM programming contest. While waiting for the contestants' entries to be submitted, we did what we do compulsively: write code. We sat down with another judge, Dan Crawl, to explore how we might solve one of the programs in the

Listing 1. Production Code

```
#!/bin/sh
# Romanian lottery program:
#   print lottery tickets with NPICK picks (default 3)
#   each pick is 6 random, non-repeated integers from 1..49
# $Id: lottery,v 1.6 1999/11/27 00:24:46 jsh Exp $

pick1() {
    RANDOM=$RANDOM          # reset the seed
    for i in $(seq 49)      # 49 random numbers
    do
        echo $RANDOM
    done |
    nl |                    # index the numbers
    sort -n +1 |            # randomize indices by sorting random data
    head -6 |               # grab the first 6
    awk 'print $1' |        # now throw away the sort key
    fmt                     # and put all 6 on one line
}

case $# in
    0) N=3 ;;
    1) N=$1 ;;
    *) echo "usage: $0 [npicks]" 1>&2 ; exit 1 ;;
esac

for j in $(seq $N)
do
    pick1
done

exit

#####

=head1 NAME

lottery - print "6 from 49" lottery picks

=head1 SYNOPSIS

B<lottery [npicks]>

=head1 DESCRIPTION

B<lottery> prints B<seq> lottery picks, one per line (default: 3)

Each pick is six, non-repeated integers out of 1..49.

=head1 SEE ALSO

sh(1)

=head1 AUTHORS

Jeffrey L. Copeland <copeland@alumni.caltech.edu>
Jeffrey S. Haemer <jsh@usenix.org>
```

shell (more on this anon) and immediately ran into a brick wall: the machine we were working on didn't have `seq(1)`.

When you're hacking, getting there is all the fun. We shifted gears and wrote a `seq`. Listing 2 shows what we came up with.

Here, too, we show our colors. For us, programming in UNIX feels like bolting together prefabricated parts from a brilliantly designed erector set. Many of our workaday tasks can be done in minutes with the right pieces at hand. Sometimes, however, in the midst of our work, we discover we don't have something we need. Rather than go back to the drawing board to redesign a custom solution (say, in Visual C++), we simply pause to manufacture the missing part, then pop it into place.

Occasionally, this approach pushes us over the edge. One of the problems in the programming contest was to count the atoms in a formula, such as tetraethyl lead, $\text{Pb}(\text{CH}_3\text{CH}_2)_4$, and produce output something like the following:

```
C: 8
H: 20
Pb: 1
```

Our first reaction was to consider a pipeline with these steps:

1. Replace each distinct element with a distinct prime, turn the numbers into exponents, and everything else into multiplications, like this: $2 * (3 * 5^3 * 3 * 5^2)^4$.
2. Pipe the expression to `/usr/bin/bc` for evaluation.
3. Pipe the result to `/usr/games/factor` for prime factorization.
4. Reverse the transformation in Step 1.

That's deeply warped.

When drunk enough on Green Chartreuse, Haemer will confess to having written an entire object-oriented language in the shell [Jeffrey S. Haemer, "A New Object-Oriented Programming Language: sh," *Proceedings of the USENIX Summer 1994 Technical Conference, Boston, MA.*]

Two (or More) Can Play at this Game

Here's a chance to try your hand. Last week, we got a note from another Windows-bound friend, Michael Mendelson, who said he, too, wanted to start playing with UNIX. When we sent him our Romanian lottery story, he responded with a similar story of his own, culminating with a 154-line C program that he'd written early in his career to randomize the lines of a file. In his note, he says, "I'm sure you could write this one in half the lines from the shell. I'd like to learn some of those tools."

His program reads in a file, shuffles the lines into random order, overwrites the original file with the result and announces the file has been randomized.

How small a shell solution can you come up with? Our first cut took about 15 lines. Let us know how much better you can do. We'll pass on your results to Michael.

Last, we received a note from an observant reader who points out that the anonymous "A picture is worth a thousand words," with which we began our November and December columns ("Pictures," November 1999, Page 38, and "Slides," December 1999, Page 36), is actually a quote from Fred R. Ballard in *Printer's Ink*, March 10, 1927. We're

Listing 2. Homemade seq

```
#!/usr/bin/perl -w
# $Id: seq,v 1.3 1999/12/13 19:38:13 jeff Exp $

use strict;

my $usage = "usage: $0 [start] end"
    unless @ARGV == 2;
unshift @ARGV, 1 if @ARGV == 1;
die $usage unless (@ARGV == 2);

foreach ($ARGV[0]..$ARGV[1]) {
    print "$_\n";
}

=head1 NAME

    seq - print a sequence

=head1 SYNOPSIS

    seq [start] end

=head1 DESCRIPTION

C<seq> generates sequential integers

By default, it starts counting at 1.
For example,

    $ seq 3 5
    3
    4
    5

=head1 BUGS

By little more than a lucky accident,
C<seq>
does odd, sometimes useful things
with non-integer arguments.
Not obvious that this is a bug.
Try this, for example:

    $ seq cat dog

=head1 AUTHORS

Just a re-implementation of something used
in Kernighan and Pike, but never written
in there.
Maybe it's part of Plan 9 or something.

Dan Crawl <crawl@cs.colorado.edu>
Jeffrey S. Haemer <jsh@usenix.org>
Jeffrey L. Copeland <copeland@alumni.caltech.edu>
```

always pleased when our humble efforts reach the desks of the literate and well-read. Happy trails! ➡

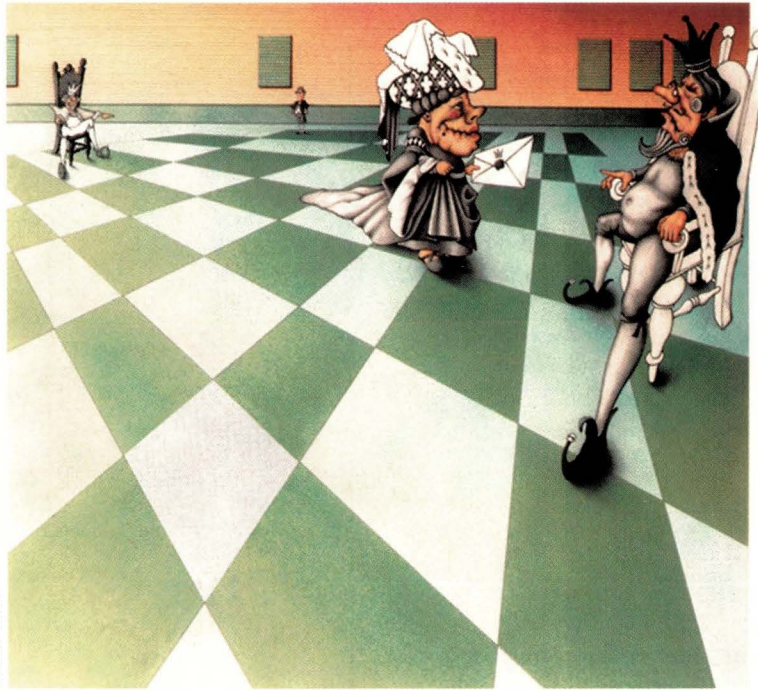
Jeffrey Copeland (copeland@alumni.caltech.edu) is currently living in the Pacific Northwest, where he spends his time writing UNIX software in a large development organization and fighting damp rot.

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> or alternately at <ftp://ftp.expert.com/pub/Work>.

Java Class

by Jim Frost



Postal: Models Inc.

Last month, we built a basic Swing application frame to support Postal, our long-term project to build a Java-based IMAP email client (see “Postal: Getting Framed,” January 2000, Page 49, <http://sw.expert.com/CA/SE.C10.JAN.00.pdf>). The goal this month is to build enough framework into the application to allow us to populate the message summary table with the contents of an IMAP email folder on a mail server. In effect, we will take the basic functionality from the MailWatcher client we built a couple of months ago (see “Going Postal,” December 1999, Page 43, <http://sw.expert.com/CA/SE.C10.DEC.99.pdf>) and merge it into the framework we built last month. In the process, we’ll learn about the Model/View/Controller design pattern used by many Swing components.

The complete code for the portion of the Postal application we have completed so far is at <http://ftp.expert.com/pub/JavaClass/02.2000/postal>.

tar. To conserve space, only the sections of the application code we are actively discussing are presented here.

A Little Housecleaning

Last month, we created the `Postal` class, which performed double duty as both the application’s main window and the `main()` method used to start up the application. This overloading was convenient, but as each of the features grows in complexity we’ll end up with two major code sections—one involved with initialization and the other with GUI display—that are not really related.

This month, we split off the initialization code from the `Postal` class into a new `Main` class to head off any confusion that might otherwise result from this overloading. This results in a small change in the way the application is invoked; rather than having the Java Virtual Machine invoke the `main()` method in `Postal`, it will invoke it in `Main`. The startup script has been modified to reflect this change.

The Server Object

The first new object we need is one that will load and save the session properties needed by a JavaMail session so we can easily reconnect to the server each time Postal starts up. Ideally, we would also like to be able to configure the session without having to build a lot of GUI elements up front so that we can start seeing results with a minimal amount of code. Last, we would like to hide most of the complexity of setting up and working with a JavaMail session. It is the job of the `Server` object, shown in Listing 1, to accomplish these things.

The code to establish a session and make basic requests of the email server was taken directly out of the MailWatcher application we built in the December column. A few basic methods have been created for connecting to the email server and extracting basic information such as a `Folder` object. All of this should look very familiar if you read the December column.

Java Class

To accomplish our goal of providing persistence, we use a `java.util.Properties` object. This object happens to be the same object used by JavaMail for configuring a session, but that's not the primary reason we use it. Rather, the `Properties` object has the ability to load and save its state to an I/O stream in a plain-text format. We could have used serialization to perform this task, but the serialization file format is complex and we would have had to write code to create the serialized object file (see "Part of a Complete Breakfast," October 1999, Page 44, <http://sw.expert.com/CA/SE.C10.OCT.99.pdf>, if you would like more information on Java object serialization). By using a `Properties` object, we can use any available editor to configure the `Server` object.

In the future, `Postal` will contain code to create a series of `Server` objects, one for each email server configured. In the short term, though, we just need the ability to talk to a single server. To accomplish this, we instantiate a `Server` object in `Main.main()`, loading the configuration options for "mailhost" from the `mailhost.properties` file that is located in the directory in which `Postal` was invoked. To configure this version of `Postal` for your particular email server, you should edit this file and change the settings as appropriate.

Message in a Bottle

As is the case with most modern applications, `Postal` is written as a series of relatively simple objects that cooperate to form an application. `Postal` is designed around a central object, the `Dispatcher` (see Listing 2, Page 48). Components that are interested in various events, or that can provide a particular service, register themselves with the `Dispatcher`. Any component that knows about something interesting, or that needs something done, tells the `Dispatcher` about it and the `Dispatcher` in turn tells everyone who has registered.

Listing 1. The Server Class

```
public class Server
{
    private Dispatcher dispatcher;
    private Properties sessionProperties;
    private Session mailSession;
    private Store mailStore;

    public Server(Dispatcher dispatcher, String serverName)
        throws IOException
    {
        this.dispatcher = dispatcher;
        sessionProperties = new Properties();
        FileInputStream in = new FileInputStream(serverName + ".properties");
        try {
            sessionProperties.load(in);
            mailSession = Session.getInstance(sessionProperties, null);
        }
        finally {
            in.close();
        }
    }

    public void close()
    {
        if (mailStore != null) {
            try {
                mailStore.close();
            }
            catch (MessagingException e) {
                dispatcher.fireErrorEvent("Warning: Can't close mailstore", e);
            }
        }
    }

    private void connect()
    {
        // Get the mail store for the user
        mailStore = null;
        try {
            mailStore = mailSession.getStore();
        }
        catch (NoSuchProviderException e) {
            dispatcher.fireErrorEvent("No support for the
            " + sessionProperties.getProperty("mail.store.protocol") + " protocol");
            return;
        }

        try {
            // Connect to the message store
            mailStore.connect(sessionProperties.getProperty("mail.host"),
                sessionProperties.getProperty("mail.user"),
                sessionProperties.getProperty("password"));
        }
        catch (MessagingException e) {
            dispatcher.fireErrorEvent("Cannot connect to
            " + sessionProperties.getProperty("mail.host"));
            mailStore = null;
            return;
        }
    }

    public Folder openDefaultFolder()
    {
        return openFolder(sessionProperties.getProperty("default.folder"));
    }

    /** Retrieves the specified folder from the mail store. If there is a problem,
     * this returns null and throws an error event. */
    public Folder openFolder(String folderName)
    {
        if (mailStore == null)
            connect();
    }
}
```

Continued on Page 48

```
if (mailStore == null) // connection failed for some reason
    return null;
Folder mailFolder = null;
try {
    // Get the folder for the user
    mailFolder = mailStore.getFolder(folderName);
}
catch (MessagingException e) {
    dispatcher.fireErrorEvent("Cannot find folder " + folderName);
    return null;
}

try {
    // open the folder
    mailFolder.open(Folder.READ_WRITE);
}
catch (MessagingException e) {
    dispatcher.fireErrorEvent("Cannot open folder " + folderName);
    return null;
}
return mailFolder;
}
}
```

Listing 2. The Dispatcher Class

```
public class Dispatcher
{
    /** Set of objects that are interested in error events. */
    private Vector errorListeners = new Vector(5);

    /** Set of objects that are interested in folder selection events. */
    private Vector folderSelectionListeners = new Vector(5);

    public void addErrorListener(ErrorListener newListener)
    { errorListeners.addElement(newListener); }

    public void removeErrorListener(ErrorListener oldListener)
    { errorListeners.removeElement(oldListener); }

    public void fireErrorEvent(String message)
    { synchronized (errorListeners) {
        int len = errorListeners.size();
        if (len == 0)
            System.err.println(message);
        else {
            for (int i = 0; i < len; i++) {
                ErrorListener listener =
                    (ErrorListener)errorListeners.elementAt(i);
                listener.handleError(message);
            }
        }
    }
}

    public void fireErrorEvent(Throwable t)
    { synchronized (errorListeners) {
        int len = errorListeners.size();
        if (len == 0)
            System.out.println("Internal error (" + t.toString() + ")");
        else {
            for (int i = 0; i < len; i++) {
                ErrorListener listener =
                    (ErrorListener)errorListeners.elementAt(i);
                listener.handleError(t);
            }
        }
    }
}

    public void fireErrorEvent(String message, Throwable t)
    { synchronized (errorListeners) {
        int len = errorListeners.size();
        if (len == 0)
            System.out.println(message + "(" + t.toString() + ")");
    }
}
```

This design makes it very easy to create new connections between components; all a component has to do to work closely with other components is to fire or listen to appropriate events through the central object. The application components don't know anything about each other so it is easy to swap one implementation for another, or to support multiple features that do the same job in different ways. If new connection types are needed, it is simply a matter of adding a few methods to the Dispatcher object; all other objects already have references to the Dispatcher, so they are capable of making use of these new capabilities without other infrastructure changes.

This design decision will become terrifically important as the amount of code in Postal grows. It will make it possible for us to isolate changes to as few files as possible, and to be sure that a change in one area will not break code in another. Even in the short term it's useful, giving us a centralized point to send error messages.

Model/View/Controller

The Swing components are designed around the Model/View/Controller (MVC) design pattern. This pattern breaks up a GUI element into three components: the model, which determines how data is supposed to be displayed; the view, which renders the model; and the controller, which manipulates the other two.

This design makes GUI elements a lot more flexible. You can, for instance, have multiple views on the same data. If you find that a different view (say, a pie chart) fits better than the one you originally picked (say, a bar graph), you can swap one for the other without changing anything else in the application.

Swing provides standard implementations of the model and view portions of the MVC design pattern, as well as a series of hooks. Because of this, controller objects can hear about user interactions and tell the model and/or view components what to do about them.

Java Class

Embedded within our Postal application frame is a `JTable` (a view) that is intended to display a summary of messages within an email folder. The `JTable` consults a `TableModel` object (a model) to determine what to render. The main job of the `TableModel` is to answer the questions "How big is this table?" and "What data should I display in this cell?" when asked by a `JTable`, and to send notifications to any interested table(s) when cell data has changed.

When a new `JTable` is created, it comes with a default `TableModel` that is little more than a grid in which to place data objects. For a simple application that only has to display static data this is enough, and in fact, we used this default model to set up some dummy messages for display in last month's version of Postal. But most applications display data that is changing either as a result of user interaction or some outside event. Most applications, therefore, create their own `TableModel` objects in order to have fine-grained control over what the `JTable` is displaying. Most of these custom models extend `AbstractTableModel` so that they need only implement the basic data retrieval methods.

Postal has one major table, used to display a summary of each message in a particular email message folder. This table is embedded within the `MessageSelector` component that is part of the Postal application frame. Because we want this table to display message summary data, we need to create a table model that will convert a set of `Message` objects extracted from a `Folder` object into rows for the table, and attributes of each of those `Message` objects into columns in the table. This is the job of the `MessageSelectorModel`, shown in Listing 3.

Our table model only implements four of the `TableModel` methods:

- `getRowCount()` returns the number of messages in the folder.
- `getColumnCount()` returns the number of message attributes we want the table to display. These include the

```
        else {
            for (int i = 0; i < len; i++) {
                ErrorListener listener =
                    (ErrorListener)errorListeners.elementAt(i);
                listener.handleError(message, t);
            }
        }
    }

    public void addFolderSelectionListener(FolderSelectionListener newListener)
    { folderSelectionListeners.addElement(newListener); }

    public void removeFolderSelectionListener(FolderSelectionListener oldListener)
    { folderSelectionListeners.removeElement(oldListener); }

    public void fireFolderSelectionEvent(Folder selectedFolder)
    {
        synchronized (folderSelectionListeners) {
            int len = folderSelectionListeners.size();
            for (int i = 0; i < len; i++) {
                FolderSelectionListener listener =
                    (FolderSelectionListener)folderSelectionListeners.elementAt(i);
                listener.folderSelected(selectedFolder);
            }
        }
    }
}
```

Listing 3. The MessageSelectorModel Class

```
public class MessageSelectorModel extends AbstractTableModel
    implements FolderSelectionListener
{
    /** Names of each of the columns in the message selector table. */
    private static final String[] columnNames = {
        "Status",
        "From",
        "Subject",
        "Date"
    };

    private static final int STATUS_COLUMN = 0;
    private static final int FROM_COLUMN = 1;
    private static final int SUBJECT_COLUMN = 2;
    private static final int DATE_COLUMN = 3;

    /** The event dispatcher that tells us what folder to look at, and
     * which we use to tell other components which message to show. */
    private Dispatcher dispatcher;

    /** The JavaMail folder that we are to display. */
    private Folder folder;

    /** The last set of messages that were displayed in the folder. */
    private Message[] messages;

    public MessageSelectorModel(Dispatcher dispatcher)
    {
        this.dispatcher = dispatcher;
        // listen for any folder selection events
        dispatcher.addFolderSelectionListener(this);
    }

    /** Refresh the messages in the message list. */
    public void refresh()
    {
        messages = null;
        try {
            if (folder != null)
                messages = folder.getMessages();
        }
        catch (MessagingException e) {
            dispatcher.fireErrorEvent("Unable to retrieve messages from folder", e);
            messages = null;
        }
    }
}
```

Continued on Page 50

Java Class

```
// notify our table view that our contents have changed
fireTableDataChanged();
}

/** Converts a set of message flags into a string that we can display. */
private String statusFromFlags(Message message)
{
    StringBuffer status = new StringBuffer();
    try {
        if (message.isSet(Flags.Flag.ANSWERED))
            status.append('A');
        else if (message.isSet(Flags.Flag.DELETED))
            status.append('X');
        else if (message.isSet(Flags.Flag.DRAFT))
            status.append('?');
        else if (message.isSet(Flags.Flag.FLAGGED))
            status.append('!');
        else if (message.isSet(Flags.Flag.RECENT))
            status.append('N'); // new
        else if (message.isSet(Flags.Flag.SEEN))
            status.append('R');
    }
    catch (MessagingException e) {
        dispatcher.fireErrorEvent("Unable to determine message flags", e);
        return "-";
    }
    return status.toString();
}

// Superclass method overrides

public int getColumnCount()
{ return columnNames.length; }

public String getColumnName(int column)
{ return columnNames[column]; }

public int getRowCount()
{
    if ((folder == null) || (messages == null))
        return 0;
    return messages.length;
}

public Object getValueAt(int row, int column)
{
    if ((folder == null) || (messages == null))
        return null;
    Message message = messages[row];
    try {
        switch (column) {
            case STATUS_COLUMN:
                return statusFromFlags(message);
            case FROM_COLUMN:
                return message.getFrom()[0];
            case SUBJECT_COLUMN:
                return message.getSubject();
            case DATE_COLUMN:
                return message.getSentDate();
            default:
                return null;
        }
    }
    catch (MessagingException e) {
        dispatcher.fireErrorEvent("Unable to determine "
            + getColumnName(column), e);
        return null;
    }
}

// FolderSelectionListener interface implementation

public void folderSelected(Folder newFolder)
{
    folder = newFolder;
    refresh();
}
}
```

status flags for the message, its sender, its subject line and the date the message was sent.

- `getValueAt()` returns the value that should be displayed in a particular table cell; the row indicates which message and the column indicates which property. A set of constants defines which column is associated with which property.

- `getColumnName()` returns the text to be shown at the top of the each column. This isn't the only way that you can define table column headings, but it's the easiest.

The Flow of Events

At this point, we have all the components we need to extract data from the email server and feed it to the message selector table for display. All we need to do is hook them together.

In order to determine which email message folder it needs to model, the `MessageSelectorModel` implements the `FolderSelectionListener` interface (see Listing 4) and registers its interest in folder selection events with the `Dispatcher` component during instantiation. This allows it to hear from any component that would like to display a folder's contents—any such component is acting as a controller.

Eventually, Postal will have a folder selection component, but for now we fake it: the `Main.main()` method (see Listing 5) instantiates a `Server` object, extracts its default folder (whose name is found in the `mailhost.properties` file) and fires a folder selection event by calling `Dispatcher.fireFolderSelectionEvent()`.

The `Dispatcher` then calls the `folderSelected()` method on each of the `FolderSelectionListeners` that have been registered, including the `MessageSelectorModel`. This call notifies the `MessageSelectorModel` that it should

Java Class

Listing 4. The FolderSelectionListener Interface

```
public interface FolderSelectionListener
{
    /** Method that is called whenever a new folder is selected for display. */
    void folderSelected(Folder folder);
}
```

Listing 5. The Main.main() Method

```
public static void main(String[] args)
{
    Dispatcher dispatcher = new Dispatcher();
    Postal postal = new Postal(dispatcher);
    postal.show();

    // create a server from the mailhost.properties file and
    // fire a fake folder selection event.
    Server server = null;
    try {
        server = new Server(dispatcher, "mailhost");
        dispatcher.fireFolderSelectionEvent(server.openDefaultFolder());
    }
    catch (IOException e) {
        dispatcher.fireErrorEvent("Cannot open server properties for mailhost", e);
    }
}
```



now model the contents of the default folder, and it repopulates itself with a list of messages from this new folder.

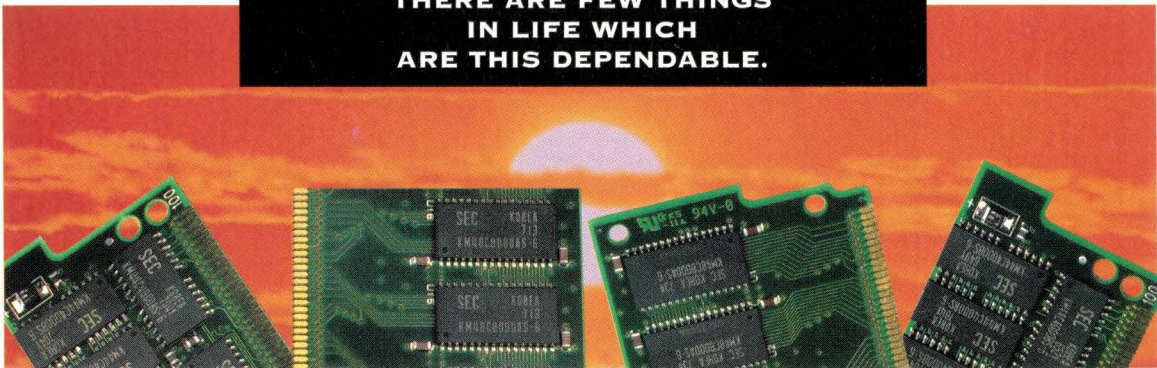
Once it has updated its list of messages, the MessageSelector Model has to notify the associated JTable that is displaying them of the change. It does this by calling `fireDataChangeEvent()`, causing the JTable to refresh itself and the new message summaries to be displayed for the user.

Voilà. Postal can now display a message summary in a neatly organized and scrollable table.

Next month, we'll implement the email folder selector and a simple version of the message viewer, giving us most of the functionality needed in a mail reader. Stay tuned. ☛

Jim Frost is a software engineer specializing in Java technologies and strong opinions. He may be reached at jimf@frostbytes.com.

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Circle No. 21

SCSI STAYS INSIDE THE BOX—FOR NOW

Don't believe the hype! SCSI still reigns in the storage market. Even with the market share of Fibre Channel drives doubling each year, it'll be several years before they outship their SCSI counterparts.

Go to any enterprise-class storage vendor these days and you will get a hard sell on a Fibre Channel-attached storage subsystem. And that's as it should be.

If there's one thing IT has learned over the past couple of years, it's that there are terrific advantages to implementing storage area networks, or SANs, and that using Fibre Channel to connect servers and storage is a great way to proceed. In the context of SANs, Fibre Channel delivers far better cable lengths (up to 10 kilometers with fiber-optic cable) than SCSI ever could. In addition, Fibre Channel provides good performance (200 MB/s full duplex), reliability, scalability and networkability, to name a few.

But look a little deeper inside a SAN-enabled storage subsystem and chances are you will find that its hard disk drives are not connected to the storage subsystem's backplane and controller via Fibre Channel, as you might expect, but via tried-and-true SCSI.

In fact, more than 90% of all disk drives that ship

by Alexandra Barrett



Storage Technologies

with high-end multiuser-class storage solutions are SCSI-based, according to International Data Corp. (IDC), a market research firm based in Framingham, MA. A 1999 survey of server and workstation hard disk drive shipments predicted that only about 6% of drives in this class would ship with Fibre Channel interfaces, while SCSI drives would maintain a good 92% of the market (the remaining drives shipped with the Armonk, NY-based IBM Corp. Serial System Architecture, or SSA, interface).

Which is not to say that Fibre Channel drives are a lost cause, far from it. But it's going to take some time before they successfully overtake their SCSI counterparts. Even with the market share of Fibre Channel drives doubling each year, IDC does not expect Fibre Channel drives to outship SCSI drives until 2004.

Compare these statistics to Fibre Channel's success as a connectivity agent between systems and storage. For example, EMC Corp., known for its high-end Symmetrix storage subsystems, estimates that it already ships 60% of its systems with a Fibre Channel interface. In the next 12 months, close to 100% of Symmetrix systems will ship with a Fibre Channel interface, predicts Jim Rothnie, senior vice president and chief marketing technical officer at the Hopkinton, MA-based company.

But look deeper inside that Symmetrix box, and try as you might, you will not find a single Fibre Channel disk drive.

"It is quite possible for a storage ven-

dor to be quite Fibre [Channel]-centric, but still use SCSI drives," says Stephen Edel, statistical marketing manager for server-class disk drives for the IBM Storage Division in San Jose, CA.

For some people, this dual personality comes as somewhat of a surprise. By now, it was assumed that Fibre Channel disk drives would have achieved a greater degree of penetration. Among industry analysts, it's theorized that many companies buying SAN storage devices simply assume these boxes come equipped with Fibre Channel drives and are surprised to find SCSI drives instead, says Denise Levitas, research analyst at IDC.

Slow Going for Fibre Channel

So what exactly is it about Fibre Channel drives that has kept their adoption rates down, even as Fibre Channel continues to beat out SCSI as a host-to-storage system mechanism?

Simply put, the technical advantages of Fibre Channel drives are not compelling enough to have hastened their adoption. And any inroads that Fibre Channel drives have made, have been cut short by advancements in the SCSI specification.

That wasn't always the case, says Philip Black, co-chief executive officer at Dot Hill Systems Corp., a Carlsbad, CA-based vendor of SAN-enabled storage products (Box Hill Systems Corp. and Artecon Inc. merged last year to form Dot Hill). A couple of years ago, Fibre Channel drives offered significantly better performance than any high-end SCSI drive could hope to deliver. Operating at 100 MB/s (200 MB/s full duplex), Fibre Channel drives ran circles around the then top-of-the-line Ultra2 SCSI hard disk drive incarnations, which topped out at 40 MB/s.

However, the ratification of the Ultra3 SCSI specification has dramatically minimized the performance gain you get from going with Fibre Channel drives. Thanks to a feature of the Ultra3 specification called double transition clocking, today's top-of-the-line Ultra3

SCSI drives have doubled their performance from 80 to 160 MB/s. That is, given single-ported 100-MB/s Fibre Channel drives, the latest generation of SCSI drives are actually faster than their Fibre Channel counterparts. And at the very least, they are comparable.

In fact, the Ultra3 SCSI specification has brought all sorts of goodies to SCSI drives. For example, cyclic redundancy checking enables better error checking by seeking out single and double bit errors. Domain validation, another Ultra3 feature, ensures the connection by first negotiating the connection speed between SCSI components, much in the same way that analog modems negotiate line speed. Ultimately, this lowers the total cost of ownership by reducing the number of errors that occur on the bus, IBM's Edel says.

Both system and drive manufacturers have doubts as to the absolute utility of the two remaining Ultra3 features, and as such, they have yet to be implemented in any disk drives. Packetization, for one, allows for commands in data packets to be sent at the full speed of the bus with the aim of reducing overhead. Quick arbitration selection, or QAS, meanwhile, goes hand in hand with packetization, and enables SCSI to recognize other QAS devices in line for the bus and hand the bus over without appealing to the controller first.

But while packetization advocates claim that on heavily loaded buses in particular, these features can reduce SCSI overhead by as much as 50%, many system vendors argue that these performance improvements do not yet justify the additional cost of redesigning system and storage components. Eventually, SCSI disk drive manufacturers will implement packetization widely, predicts Joel Hagberg, senior director of storage products at Fujitsu Computer Products of America Inc., San Jose, CA, but it may not be until the advent of Ultra4.

What's in a Name?

And now for a word about Ultra3 naming conventions: In order for a disk drive to qualify as an Ultra3 SCSI device, the specification stipulates that it must implement at least one of the five defined features. In an attempt to clarify



EMC estimates that in the next 12 months, nearly 100% of its high-end Symmetrix enterprise storage subsystems will ship with a Fibre Channel interface.



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which Ultra3 features a disk drive supports, manufacturers have settled on the name Ultra160 to indicate disk drives that support the following three features: double transition clocking, cyclic redundancy checking and domain validation. When IBM releases drives with packetization and QAS, sometime in the latter half of this year, these full Ultra3 drives will be referred to as Ultra160+.

Ultra3 features aside, SCSI has many other attractive characteristics when compared with Fibre Channel. With 12-meter cable lengths, SCSI is usually seen as entirely sufficient "inside the box," and indeed, within the same room.

But above and beyond any technical benefits, SCSI is a well-known technology that has been around for years. "Engineers are very comfortable with the prospect of getting a SCSI device to work; whereas many people still grapple with Fibre Channel interoperability problems," Fujitsu's Hagberg says.

"SCSI is entrenched," says IBM's Edel. "It dominates the storage world and continues to get better." Which is not to say that Fibre Channel disk drives have no place in the world of enterprise-class storage. Fibre Channel drives have a number of features which can prove very desirable given the right environment.

With SCSI on the inside, a storage subsystem is limited to 15 drives per channel. Not so with Fibre Channel. It is not unreasonable to find storage arrays that hold 40 to 50 Fibre Channel drives.

For example, the cable lengths SCSI offers cannot compare to the lengths Fibre Channel offers, which when run over fiber-optic cable, span up to 10 kilometers. That is, even in a JBOD (Just a Bunch Of Disks) configuration, disk drives can be directly attached to a server located on the other side of town.

Fibre Channel drives also figure prominently in very large storage subsystems where it is desirable to house a lot of drives within the same casing. With SCSI on the inside, a storage subsystem is limited to 15 drives per channel, with seven or eight being a more realistic number. Not so with Fibre Channel. While the specification calls for up to 126 devices on any single Fibre Channel

loop, it is not unreasonable to find storage arrays that hold 40 to 50 Fibre Channel drives.

Implementing Fibre Channel drives also has some significant reliability benefits. Because Fibre Channel is a serial vs. bus architecture, it is possible to hot plug drives without bringing down a loop. Compare this to SCSI, where pulling a drive is considered "bad karma," says Scott Rupple, vice president of marketing at JNI Corp., San Diego, CA, a designer and supplier of Fibre Channel hardware.

Some storage subsystems take advantage of the dual paths to a Fibre Channel drive for performance purposes. By sending data and commands over one loop, and status over the other, you get a speed improvement. Those dual paths can also be used to send redundant data, eliminating a single point of failure and improving overall system reliability.

Other technical benefits of Fibre Channel drives over SCSI include unique worldwide addressing, which allows any disk anywhere in the world to be identified uniquely. In addition, Fibre

Channel disk drives make for very efficient RAID, says IBM's Edel. That's because the drives themselves implement enhanced eXclusive OR (XOR) RAID parity functions—XDWRITE and XPWRITE—which bring down the number of bus transfers necessary for performing reads, writes and modifies from six in the SCSI world to two with Fibre Channel.

Also, from a wiring point of view, the Fibre Channel interface is much smaller and simpler than SCSI's large and unwieldy ribbon cables. "Fibre Channel is a much cleaner looking cable system," says Fujitsu's Hagberg. For people who value tidy wiring jobs, this can be a small but important consideration.

Taken together, the advantages of



In addition to capacities of 36.4 GB and average seek times as low as 5.2 msec, Fujitsu's 10,000-rpm MAG3xxx Series enterprise disk drives include several enhancements: expanded 2-MB cache (Ultra2 SCSI), 4-MB cache (FC-AL), reduced acoustic levels and high-performance dual-processor design.

Fibre Channel disk drives can really add up, especially in data-intensive, bandwidth-hungry environments. For example, one company that has really jumped on the Fibre Channel bandwagon is Avid Technology Inc., Tewksbury, MA, developer of nonlinear video editing software used to edit 97% of prime-time television shows. The company also sells a turnkey storage solution called Avid Unity, which is based on Fibre Channel-based Clariion disk arrays (originally developed by Data General Corp., Westboro, MA, and recently acquired by EMC).

Nonlinear editing happens in real-time, explains Jim Frantzreb, senior product marketing manager at Avid, and requires every bit of bandwidth you can get your hands on. "As disk drives get faster, our life has gotten much easier. If editing over the network is becoming practical, it's because the bandwidth needed to move video in real-time is finally there."

Why Buy Fibre?

But when push comes to shove, it's not the technical details that are selling disk drives. All things being equal, the decision to go Fibre Channel or SCSI is more of a business decision than anything else, insiders say.

This is true even at the OEM level. EMC, for example, insists that acquiring Data General, and hence the pure Fibre



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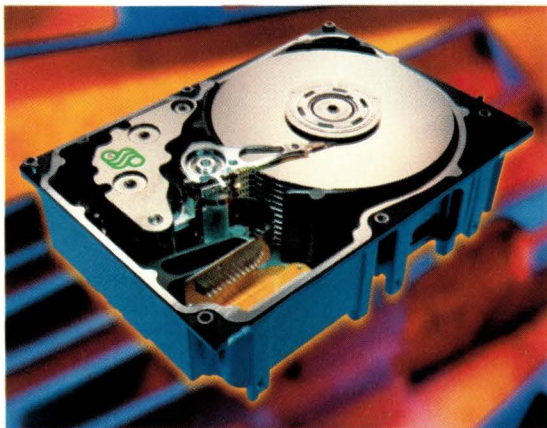
Storage Technologies

Channel Clariion storage business, had nothing to do with the fact that Clariion makes use of Fibre Channel drives. "We were interested in Clariion because they had a good lower priced midrange system. We couldn't care one way or the other whether they use Fibre Channel drives or not," EMC's Rothnie says.

At the enterprise level, risk-averse IT managers are wary of migrating to an untested technology when SCSI works so well for them. With huge capital investments in SCSI-based storage systems, as well as years of experience working with them, it's no surprise to find that many IT managers are playing it safe with their storage systems. "Businesses have a very high SCSI comfort level," says Fujitsu's Hagberg.

Not only is SCSI comfortable, but Fibre Channel is uncertain. Still a relatively young technology, many people perceive Fibre Channel as being hampered by interoperability issues. At Fujitsu, for example, priorities for Fibre Channel drive products are connectivity and interoperability first, performance second, Hagberg says.

The fact that there are interoperability issues is not surprising because so few manufacturers have been shipping Fibre Channel drives. This is another factor holding back more conservative customers. "Until the third quarter of 1999," says IDC's Levitas, "Seagate [Technology Inc.] was the only company to have a shipping Fibre Channel drive product."



Seagate's fourth generation of enterprise storage products, including the 10,000-rpm Cheetah 73 (above), support capacities of 73.4 GB in a 3.5-inch form factor with a choice of either Ultra160 SCSI or 2-Gb/s Fibre Channel interface.

Another factor hampering Fibre Channel disk drive adoption rates has been concerns over Y2K issues. According to Dot Hill's Black, many Wall Street IT directors, for example, were under strict orders not to purchase or install anything that could be construed as "new technology" until after the threat of Y2K had passed. Speaking back in December, Black said, "Year 2000 is a gate, and when that gate opens, the strict 'no new technology' edict will go away."

And while SCSI drives will continue to outship Fibre Channel drives for the foreseeable future, estimates of Fibre Channel disk drive growth rates are misleading, according to Black. Sure, SCSI disk drives will continue to ship for years to come because organizations will continue to add disk drives to their existing storage systems. However, Black believes that IT personnel will increasingly see the wisdom of going with pure Fibre Channel storage subsystems for new installations, to the point where he anticipates selling approximately one half pure Fibre Channel disk subsystems by the end of 2001.

IDC's Levitas says new storage systems will increasingly feature pure Fibre Channel. IDC, however, does not gather data to support that presumption.

So, if the technical merits of a Fibre Channel over SCSI drive have not proved entirely convincing thus far, they soon will. SCSI, Black says, is nearing

the end of its life cycle, whereas Fibre Channel is just beginning. In SCSI, performance is directly related to cable length. Eventually, SCSI cable lengths will simply get too short to continue increasing performance. With Fibre Channel, on the other hand, vendors are already talking about impending 2-Gb Fibre Channel implementations (200 MB/s over a single port, or 400 MB/s maximum), and 4 Gb isn't far behind.

Beyond any technical details relating to Fibre Channel over SCSI, Fibre

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Channel drives will soon become cheaper to manufacture than SCSI drives, predicts EMC's Rothnie. "Fibre Channel's connector is very small, whereas in SCSI, the mechanical package is relatively expensive [to manufacture]."

When is that shift in cost scheduled to occur? Probably not for another couple of years, says Rothnie. "But we are prepared to make the switch at any time. We have systems up and running right now with Fibre Channel drives." It would appear, therefore, that it's just a matter of time. →

Alexandra Barrett is a Massachusetts-based freelance writer specializing in computer industry topics.

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by IAN WESTMACOTT, Technical Editor

Sun has learned from and fixed the problems associated with the JavaStation NC and has created a truly zero-administration desktop appliance.

When the industry first started talking about network computers (NCs) the hype sounded good. These inexpensive desktop boxes would have just enough functionality to support standard protocols and perform I/O. In addition to a cheap price tag, NCs would be easy to maintain and have a low total cost of ownership. Riding on the promise and popularity of the Java language, NCs would support Java and we would live in a world where applications and data were downloaded and executed locally.

Enter the JavaStation, Sun Microsystems Inc.'s first attempt at the network computer. While a few vendors were able to capitalize on the NC hype, the JavaStation languished. It was plagued by performance problems, complicated maintenance and Sun's too narrow view that Java alone would satisfy all the needs on the desktop. (Sun wouldn't send us one for review.)

But as the JavaStation floundered, the market as a whole was learning that NCs could not be as thin as hoped, nor as cheap, if you wanted to support UNIX,

Windows, Java and the Web. In fact, successful NCs look and cost a lot like PCs, or fancy X terminals, so it's not surprising that NCs have not made significant inroads on the desktop.

Enter Sun Ray 1, Sun's second attempt at the desktop appliance (shying away from the network computer and thin client monikers). This time around Sun aims to solve problems encountered

by the JavaStation, particularly performance, maintenance and heterogeneous access. The Sun Ray 1 represents thinking and architecture 180 degrees from that of the JavaStation and, according to Sun, offers zero desktop administration, uncompromising performance and seamless heterogeneous access. We took a pair of Sun Ray 1 appliances for a spin to evaluate these claims.

Architecture

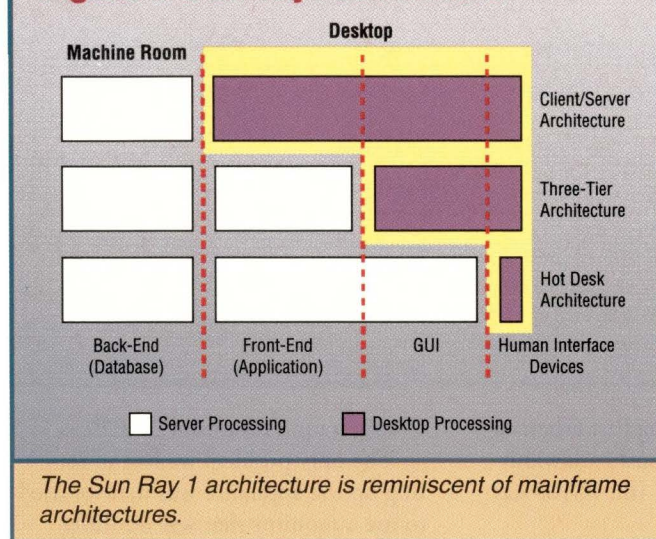
To achieve these goals, the Sun Ray architecture partitions the network differently than traditional client/server or three-tier architectures (see Figure 1). The Sun Ray 1 appliance does not perform any application processing at all. There is no operating system or application software on the desktop. This is why the appliance is called a zero-administration client: There is nothing to install or configure. The appliance implements a network stack for communications and an interface protocol, called Sun Ray Hot Desk protocol, similar to Citrix Systems Inc.'s Independent Computing Architecture (ICA), to display bits on the monitor and communicate mouse and keyboard events with the server.

It is the Sun Ray server that performs all the processing,



Sun Ray 1 represents Sun's new thinking about desktop and network appliances.

Figure 1. Sun Ray Architecture



sending only screen updates to the appliance. This architecture is similar to Citrix's MetaFrame technology for Windows NT except that the client is not an application that runs on top of some operating system, rather it is implemented in the firmware of the Sun Ray 1 appliance.

Unlike an X terminal that uses operating and application software and needs enough memory to hold the software, as well as a processor fast enough to run the software, Sun Ray 1 uses no operating software beyond the network and Hot Desk protocols in the firmware. For this reason, Sun Ray 1 needs only enough memory to hold a screenful of information and a processor fast enough to support a reasonable refresh rate and network communication. The minimal hardware requirements reduce the cost of the appliance, while the minimal software requirements reduce its overall administration.

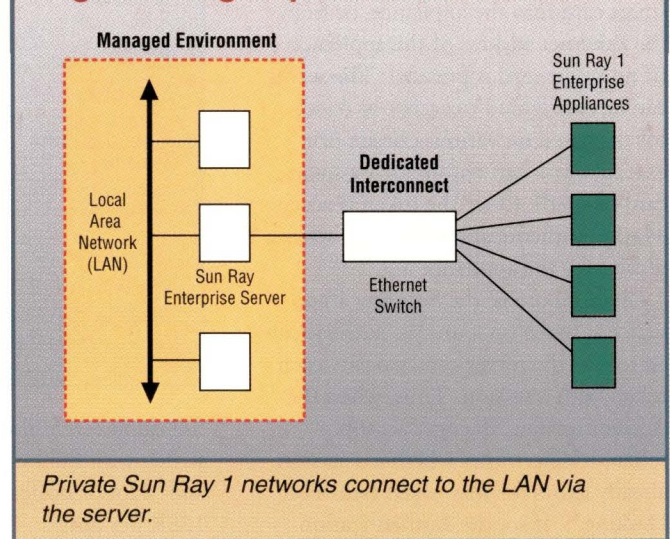
Of course, pushing all the processing onto the server affects the requirements of both the server and the network. Although any Sun SPARC server running Solaris 2.6 (or later) may be used to host the Sun Ray server software, you need enough memory space and processing muscle to support all the appliances you wish to deploy (see "Suggested System Configurations," Page 62). The Sun Ray server is responsible for implementing virtual terminals, so that applications may communicate

with the Sun Ray 1 as though it were a normal terminal. The server software translates the calls to the virtual devices (such as frame buffer, mouse and keyboard) into the low-level Hot Desk protocol sent to the appliance.

Although Sun claims that the Hot Desk protocol uses less bandwidth than the X protocol (as we have seen with the ICA protocol), the Sun Ray server does not communicate with the appliances using the local area network (LAN). Instead, a dedicated interconnect is provided by means of an Ethernet switch connecting the server to the appliances (see Figure 2). The server then acts as a sort of router between the appliances and the LAN—it's not really a router, since it is the applications on the server which communicate over the LAN, not the appliances themselves. Using this scheme, all appliance communication is removed from the LAN, the appliances are easier to configure and manage and each appliance has more or less guaranteed bandwidth to the server.

Moreover, if 100-Mb/s Fast Ethernet is used for the switched connection between server and appliances (recommended by Sun), then each Sun Ray 1 can support full-screen streaming video from the Sun Ray server. This requires CAT5 wiring, which may make adoption of the architecture more difficult. But Sun Ray or not, if you are not already wired for 100 Mb/s, your net-

Figure 2. High-Speed Interconnect



Private Sun Ray 1 networks connect to the LAN via the server.

work strategy should include it. You can run Sun Ray on 10-Mb/s switched topologies (shared 10 Mb/s is not supported because the server requires a dedicated connection to each appliance), but multimedia and intensive graphics may suffer.

The Server

Sun sent us an Enterprise 250 with two 400-MHz processors and 2-GB RAM to act as our Sun Ray server. Our server was running Solaris 7 and was equipped with two 10/100BaseT network adapters (one for the LAN and one for the appliance interconnect). All that was left for us to do was install and configure the Sun Ray server software. As usual, this is supplied as a Solaris package, along with the required Sun Directory Services (SunDS; a 10,000-entry license is included with Sun Ray), Lightweight Directory Access Protocol (LDAP) client libraries and Sun Web-Server (required only for Web-based administration).

For swap space, Sun recommends 1 GB for the server, 1 GB for the first four appliances and 64 MB for each appliance thereafter. Our server was configured with 2-GB swap to support our two Sun Ray 1 appliances.

The Sun Ray server software comprises several components. The Authentication Manager is responsible for identifying and authenticating Sun Ray 1 appliance users. Each appliance

Product Review

supplies a token to the Sun Ray server, which is derived either from inserting a smart card into the appliance, or from the Ethernet address of the appliance (if no smart card is present). The server can be configured to accept or reject tokens based on various criteria (for example, you can require that a smart card be used). Once the token is accepted, the Authentication Manager starts a session for the appliance.

Because use of the Sun Ray 1 appliance is based on a unique authenticated token, the server can associate each token with a session. Thus, when the Authentication Manager accepts a token, it determines whether a session already exists for that token (see "Hot Desking"). If so, the Authentication Manager connects to a Session Manager, informing it to start the session and connect it to the appliance presenting the token. If no session exists for the token, the Session Manager creates a new one by starting an X server and connecting it to the appliance. The user is then presented with the CDE `dtlogin` screen.

The Sun Ray server executes all display rendering by providing a virtual device driver for each rendering API (such as X11) to applications. The server sends pixel-based screen updates to each appliance. The virtual device drivers make this completely transparent to applications.

The Sun Ray server includes both command-line and Web-based administration tools for managing both Sun Ray 1 appliances and Sun Ray users. Basic procedures, such as listing all currently connected appliances and listing or editing desktop properties (such as physical location), are available. User accounts and authentication are implemented via Solaris UNIX mechanisms, but with the Sun Ray software you can identify users with tokens, for example.

The Interconnect Fabric

To connect our two Sun Ray 1 appliances to the E250 server, Sun sent us a Netgear FS108 eight-port Fast Ethernet switch (\$189 price tag). We connected this to one of the Ethernet cards on the server and to each appliance with CAT5 cable. Sun recommends any

Suggested System Configurations

SYSTEM	PROCESSOR	MEMORY	NUMBER OF SESSIONS
Enterprise 2	2x200 MHz	512 MB-2 GB	5-25/CPU
Enterprise 450	4x300 MHz	2-4 GB	20-30/CPU
Enterprise 4500	8x336 MHz	4-8 GB	30-45/CPU

In general, 32- to 64-MB RAM per active session and a sessions-to-CPU ratio of 20 to 1, according to Sun, which has been confirmed with beta testers by Boston, MA-based Aberdeen Group Inc. Processing intensive applications may reduce the sessions-to-CPU ratio.—iw

full-duplex, nonblocking Fast Ethernet switch with full bisectonal bandwidth and "a lot of buffering" (the FS108 has 128K per port).

The Appliance

The appliance includes 24-bit graphics, supporting 1,280-by-1,024-dpi resolution at 76 Hz, and an HD15 monitor port. Sun offers 17-, 19- and 21-inch monitors, though most monitors that implement VESA's display data channel command interface (DDC2B), extended display identification data (EDID) standard will do. There are four USB ports, two used by the Type 6 keyboard and crossbow mouse. A 10/100-BaseT Ethernet port, NTSC/PAL RCA video input port, CD-quality I/O and microphone/headphone jacks are also included. An ISO-7816-1-compliant smart card reader rounds out the appliance's inputs.

The unit itself measures a mere 4 by 11 by 12 inches (WxDxH) and weighs in at just under 4 pounds. The appliance is more or less rectangular, but sits vertically tilted in a plastic stand. Equipped with a flat-panel monitor, the Sun Ray 1 is rather unobtrusive. The appliance is EnergyStar-compliant.

To set up the appliance, you plug in the monitor, mouse and keyboard, and connect the power and network cables. That's it. Absolutely no software installation or configuration. Thanks to the dedicated server interconnect, no IP addresses, netmasks, domains or routers need to be specified. When the appliance powers up, it gets the necessary information, such as IP address, directly from the server using Dynamic Host

Configuration Protocol (DHCP).

The only problem we had in setting up the appliance was that we tried to use a monitor that was not fully VESA-compliant. Because the appliance could not determine the monitor characteristics, a signal was not established. Compliant monitors worked without a hitch, however. If you connect a monitor that cannot handle the default resolution of 1,280 by 1,024, the appliance automatically establishes a virtual desktop of that size. You can either use the virtual desktop, or have the server use a lower resolution for that appliance.

If information comes in too fast from the server, the appliance will automatically ask the server to throttle back. The server accomplishes this by reducing the refresh rate of the virtual frame buffer connected to that appliance. Although on a switched Fast Ethernet interconnect, we could not force this situation to occur.

Hot Desking

A rather interesting consequence of associating tokens with appliances or users (by way of a smart card) and associating tokens with sessions is something Sun calls "Hot Desking." When you first power-on an appliance, it presents its token to the server (provided there is no smart card in the reader). Because this is a new token to the server, it does not already have a session and so a new session is created and the `dtlogin` screen appears. A user may then log in and their session is associated with that appliance.

However, when you insert a smart

Product Review

card in the reader, the appliance then presents a new token to the server (based on the smart card token). If a session is associated with this token, it automatically appears on the appliance. If no session is associated, the `dtlogin` screen is displayed (or continues to display).

Now suppose Joe starts a session with his smart card at the appliance in his office. He creates some sales charts and decides he needs to ask Mary down the hall about them. Joe removes the smart card from his appliance, which then sends its own token to the server. His session disappears and the `dtlogin` screen appears. In Mary's office, she is sending an email, but when Joe inserts his card into her appliance, her session disappears from the screen and his appears. She answers his questions, and when Joe removes his card, his session disappears and hers reappears unaffected. Back in his office, Joe inserts his card and continues to work on the charts.

With smart cards, and token-based session management, users can carry their sessions around in their pockets. It doesn't make any difference which Sun Ray 1 appliance they use. Sessions can move from desktop to desktop, without users logging out and logging in. This works because sessions are completely contained on the Sun Ray server. Inactive sessions can be swapped out to disk, or automatically logged out after some period of inactivity. If the server is brought down, all sessions can be swapped out and swapped back in when the server comes up.

Performance

Based on an E250 with 2-GB RAM and two 400-MHz processors, we were not going to stress the server using only two appliances. In this configuration, with 100-Mb/s Fast Ethernet, the appliances were very speedy and responsive. There was no appreciable difference in response time between an appliance and the server console itself. In fact, you can think of the Sun Ray architecture as like having a server with multiple consoles. But those consoles can be placed much farther away, and are independent.

Session switches were very fast,

taking less than two seconds when the token changed (such as when inserting a smart card with an active session). But the server was nowhere near swapping, which would increase the latency. When we pulled the card on a session running an MP3 video file, and then inserted that card in another appliance, the video continued playing at almost the exact same frame.

Summary

Sun Ray 1 solves the performance problem by moving all processing onto the server and by providing a fast, dedicated connection to each appliance. It solves the maintenance problem by removing all software and configuration from the appliance. And it provides heterogeneous access by virtue of the access available in Solaris. For example, using Citrix's MetaFrame and ICA client for Solaris, Sun Ray 1 users have access to Windows desktops.

Sun may really have something here. It is obvious that the Sun Ray architecture places more emphasis on servers than desktops, which is what Sun really wants to sell. But the fact of the matter is Sun Ray has some valuable features to offer. A truly zero-administration desktop (barring hardware failures) is very attractive, reducing training and maintenance costs considerably. While writing this review, I was interrupted by a user who could not print from her Windows desktop. She could print yesterday, but not today. It turned out to be a software configuration problem, and we never did figure out how the configuration got messed up, but I couldn't help but appreciate the value of the Sun Ray proposition.

All configuration and management is server-based. All data and applications are server-located. Remind you of the heady mainframe days? It should. But the difference here is that users have much more control over their desktop environment with Sun Ray than they did back then.

Although adoption of the Sun Ray architecture has network infrastructure implications, Fast Ethernet is cheap and is not application-specific. Taking the Sun Ray path does not lock you into dark proprietary corners.

Sun Ray 1 Enterprise Appliance and Server

Company

Sun Microsystems Inc.
901 San Antonio Road
Palo Alto, CA 94303

Phone

(800) 555-9SUN

WWW

<http://www.sun.com/products/sunray1/>

Best Feature

Zero-administration desktop

Worst Feature

Price

Price

Sun Ray 1 Enterprise Appliance
\$499 (no monitor)
\$9.99 per month lease
(appliance only), includes five-year warranty

Sun Ray Server Software

\$499 single-CPU
\$999 Workgroup (10S, UE2, 250, 450)
\$2,599 Enterprise
(3500, 4500, 5500, 6500)

Review Configuration

E250 as tested (2x400-MHz processor,
2-GB RAM, 2x9.1-GB hard drive,
2x10/100-Mb/s Fast Ethernet)
\$28,815

Sun Ray Complete Package

Starts at \$29.99 per user/per month for
48 users. Package includes Sun Ray 1
appliances (with monitor), server
hardware, Sun Ray server software,
interconnect fabric and installation
(contact Sun for leasing options).

Circle 156

Sun has learned from and fixed the problems with the network computer and, in the process, has added unique functionality. The Hot Desking features add security, freedom and flexibility that both users and administrators can appreciate, and a zero-administration desktop simply makes sound business sense.

Unfortunately, in a rush to market, Sun had to use off-the-shelf components on hand for the Sun Ray 1 appliance. Because of this, its price tag seems a bit high. According to Sun, the price may be cut up to 50% by using more cost-effective components in the near future. →

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.

Business-to-Business Integration Tool

Active Software has released ActiveWorks 4.0, the latest version of its business-to-business integration tool.

The 4.0 release reportedly comes with reusable integration components called InterActions that define common business processes such as customer support billing, account status, bill of materials and order/inventory status. It features a graphical tool called Visual Integrator that allows users to create and link InterActions across the enterprise, automating the development cycle, the company says.

ActiveWorks also comes with Intelligent Adapters, which transfer application-specific processing from the Information Broker to the Adapter, reducing network traffic and further improving scalability and performance, the company says. It also includes Active Software's Content Filtering for Gateways, which enables users to control the

flow of information within a distributed ActiveWorks implementation.

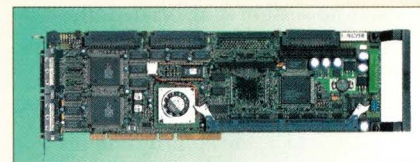
ActiveWorks 4.0 supports Compaq Tru64, as well as Solaris, HP-UX, IRIX and Windows NT. Pricing starts at \$75,000.

Active Software Inc.
3333 Octavius Drive
Santa Clara, CA 95054
<http://www.activesw.com>
Circle 101

64-Bit RAID Controllers

ICP Vortex is now shipping 64-bit PCI/Wide Ultra2 SCSI RAID controllers with optional clustering support. The new controllers join the company's existing RN series and support RAID levels 0, 1, 4, 5 and 10.

The controllers, the GDT7118RN, GDT7128RN, GDT7518RN, GDT7528RN, GDT7538RN and GDT7558RN, offer one, two, three or five Ultra2 channels and support data transfer rates of 80 MB/s per channel, with as many as 15 devices attached to each



channel on cables up to 12 meters in length, ICP says. They feature a 64-bit architecture for high data transfer rates and include a primary PCI interface clocked at 33 MHz and burst rates reaching 264 MB/s.

The controllers can be equipped with one 16-, 32-, 64- or 128-MB standard PC100 DIMM module, with or without error-correction code, ICP says. Other features include automatic cache RAM detection, multilevel delayed write and read-ahead cache with intelligent self-adjusting management and an optional battery backup module that provides 72-hour protection.

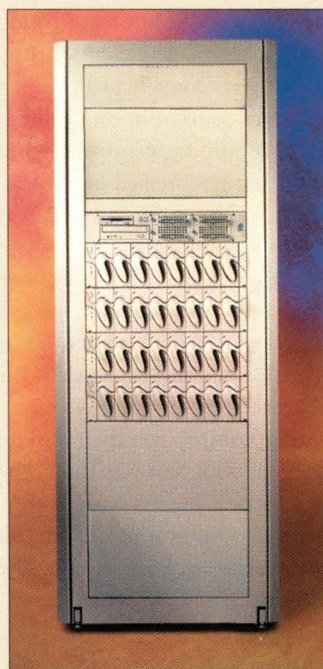
The company's new GUI tool, ICP RAID Navigator, operates under Windows 95/98/NT/2000 and is said to allow easy maintenance and setup of con-

New High-Performance File Server

RARE Systems has introduced Raser, a high-performance file server that is said to greatly increase data I/O for UNIX, Windows and Web clients.

Raser is a multiprotocol filer that is designed to provide inexpensive, scalable network-attached storage. Unlike all-in-one, general-purpose servers, RARE says, Raser allows network storage growth without increasing management complexity or reducing reliability. Raser filers attach directly to the network, allowing files to be shared by all users regardless of the network operating system they are using. Because Raser is operating system-independent, migrating files from one network to another is easy, RARE says.

Raser filers can also be used to segment applications from data. With Raser, for example, email and Internet files can be stored on their own storage system. Segmented storage simplifies storage management and can significantly improve application server performance by off-loading file I/O, the company says.



The heart of Raser is its operating system, RARE says, which consists of a multitasking kernel with multithreaded file systems for each supported network protocol. Supported protocols include TCP/IP, NFS, HTTP, as well as other special-purpose protocols like Dynamic Host Configuration Protocol (DHCP).

Raser is capable of delivering 3,000 NFS operations per second with less than 10 msec response times from an entry-level system with a single controller and six disk drives, according to RARE. Raser can scale from 100 GB to 4 TB per filer, and supports any platform that uses the aforementioned protocols, including all major UNIX platforms and Windows NT. Pricing starts at 25 cents per MB and includes unlimited clients for all supported protocols.

RARE Systems Inc.
1133 Empire Central Drive
Dallas, TX 75247
<http://www.rare.com>
Circle 100

New Products

trollers and disk arrays, as well as access to other systems via standard protocols such as NetBIOS, TCP/IP and SPX/IPX. The controllers themselves support SCO UNIX, Linux, Interactive UNIX, UnixWare, NetWare, OS/2 and Windows 95/98/NT/2000; all are I₂O-ready. Contact vendor for pricing.

ICP Vortex Corp.

4001 E. Broadway, Ste. B-20
Phoenix, AZ 85040
<http://www.icp-vortex.com>

Circle 102

High-End, Flat-Panel Monitor

MAG InnoVision has introduced the 796FD, a 17-inch monitor that uses flat-surface FD Trinitron technology. The company says the 796FD flat-panel CRT monitor features a flatter viewing surface than most traditional CRT displays. This is said to eliminate distortions produced by conventional screens.

The 796FD is targeted at engineering and high-end graphics applications, and offers a 16-inch viewable area, with a 0.24mm dot pitch and a maximum resolution of 1,600 by 1,200 pixels at 96 kHz. The monitor's screen also comes with an antiglare, antistatic and antireflection coating.

The 796FD is equipped with an E-Video button, a video performance enhancement device comprising four preset adjustment modes: full screen, more brightness, warm color and golden color. This built-in feature reportedly allows users to optimize monitor performance, particularly when playing DVD and CD programs. It costs \$349.

MAG InnoVision

20 Goodyear
Irvine, CA 92618
<http://www.maginnovision.com>

Circle 103

Scalable AIT Tape Library

AIT LibraryPro from Overland Data is described as the industry's first Advanced Intelligent Tape (AIT) library that can be customized and scaled according to individual needs.

LibraryPro is said to incorporate robotics based on the company's LibraryXpress tape library platform design, which provides modular plug-and-play



scalability. The library is available in desktop or rack-mount configurations and comes with either one or two AIT drives. The library holds 17 cartridges and boasts mainframe-class robotics, the company says. It can scale to support 10 AIT-1.5 or AIT-2 drives to provide 4.25 TB of native capacity and data transfer speeds of 6 MB/s.

LibraryPro supports a wide range of storage management software and operating platforms. Pricing for AIT LibraryPro starts at less than \$10,000, depending on configuration.

Overland Data Inc.

8975 Balboa Ave.
San Diego, CA 92123
<http://www.overlanddata.com>

Circle 104

Fibre Channel RAID Controller

CMD Technology has introduced the CRD-7240 Fibre Channel/Ultra160 RAID controller. The CRD-7240, which is designed for midrange applications and storage area networks (SANs), is a dual-redundant, hot-swappable Fibre Channel-to-Ultra160 SCSI external RAID controller that uses CMD's Titan architecture and supports most high-speed interfaces.

Key features include CMD's SAN-mask Logical Unit Number (LUN) masking for secure disk access in shared storage environments; CMD's RAID Management System software for controller configuration, management and automatic failover; CMD's AutoRebind for continuous-access environments; Ethernet support for remote configuration and monitoring; online RAID level migration and RAID set expansion for flexibility and online firmware updates; and near-instant RAID set creation to provide immediately usable data storage.

The CRD-7240 controller features two 100-MB/s Fibre Channel host inter-

faces, four 160-MB/s Ultra160 low-voltage differential (LVD) SCSI disk interfaces and support for 56 disk drives and 1 GB of high-speed cache. Contact vendor for pricing.

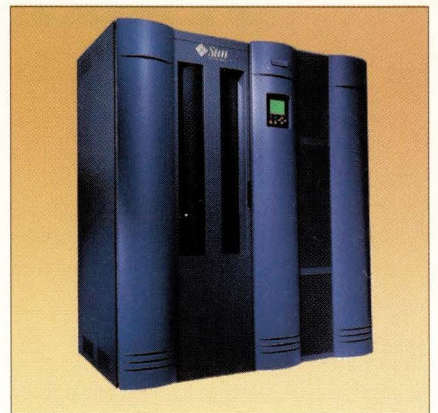
CMD Technology Inc.

19 Morgan
Irvine, CA 92618
<http://www.cmd.com>

Circle 105

Enterprise-Class Tape Library

Sun has announced the Sun StorEdge L700 tape library, an enterprise-class storage solution that is said to address increasing tape backup requirements spurred by the Internet data explosion. According to Sun, the library is one of the fastest in its class, with an average access time of 16 seconds and native throughput of 120 MB/s (or 432 GB/hour).



With a storage capacity of 14 TB, the Sun StorEdge L700 tape library is designed to meet the backup needs of large, high-end data center environments, Sun says. The system can house up to 12 high-end 9840 tape drives and 690 tape cartridges for 20-GB native capacity per tape. In addition, Sun says, hot-pluggable and redundant components provide mission-critical reliability, availability and serviceability (RAS).

Pricing for the Sun StorEdge L700 tape library starts at \$194,000 for an entry-level system with two 9840 tape drives and 396 cartridge slots.

Sun Microsystems Inc.

901 San Antonio Road
Palo Alto, CA 94303
<http://www.sun.com>

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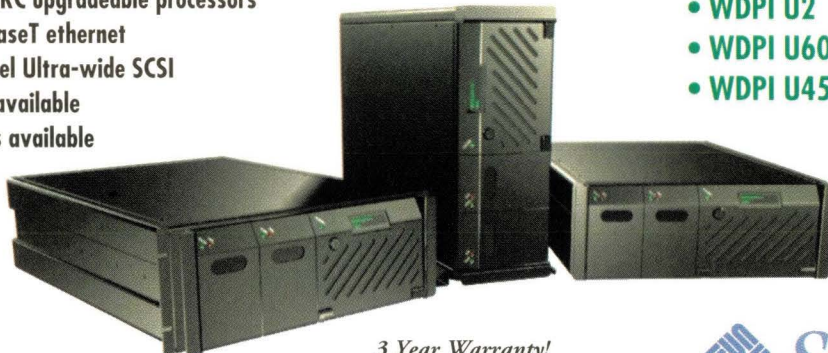
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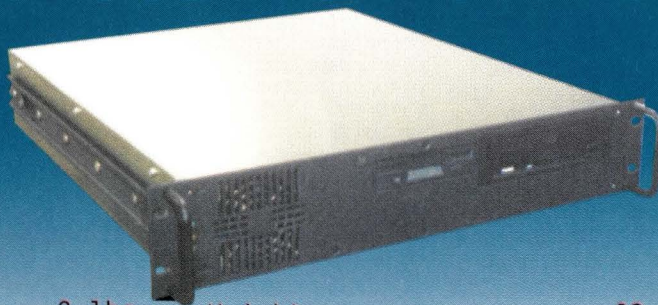
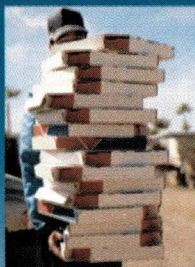


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Circle No. 363

Starion ST-10R Rackmount Server

Pizza Box vs. Starion ST-10R



Weight:2 lbs.
Width: 20.0"
Depth: 20.5"
Height: 2.5"
Speed: 30 minutes
Contents: Pizza
Uses: Container
Quantity Driver can
carry up to 16
NOTICE .. Driver carries
less than \$20.00

Weight: 28 lbs.
Width: 20.0"
Width @ Chasis: 18.0"
Depth: 20.5"
Height: 3.5"
Speed: Up to 440 MHz
Contents: UltraSparc Driven
Sun Microsystems Solaris
Uses: Cache Server
Web Server, RADIUS Server
Solaris Firewall
Quantity 20 Servers
fit in a 72" rack
NOTICE Ready to install
@ \$3,750.00



GULF COAST
WORKSTATION

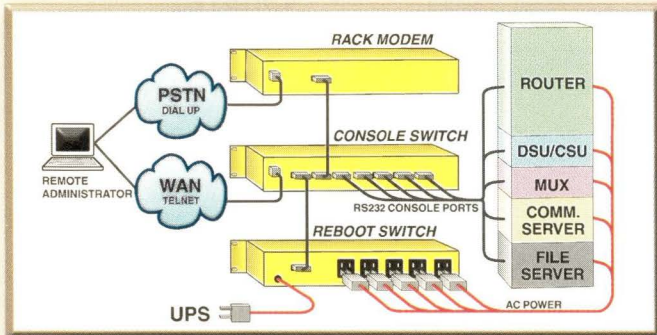
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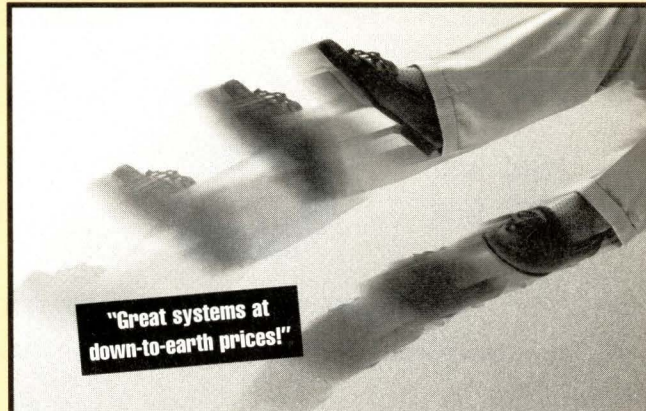


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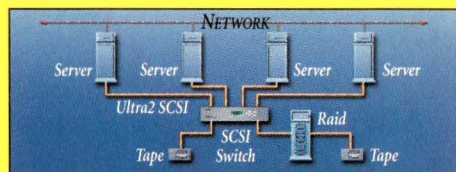
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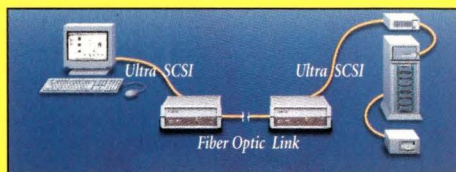
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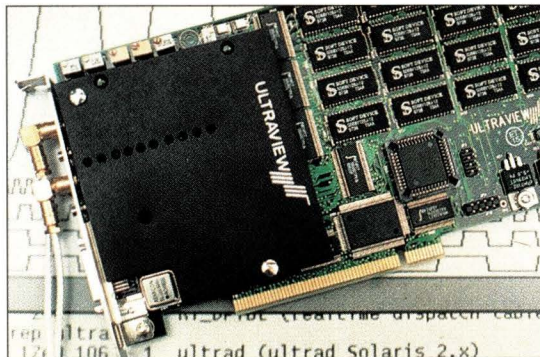
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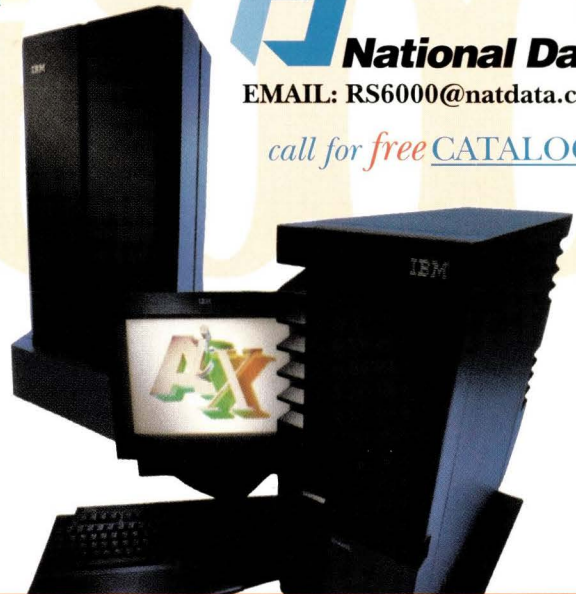
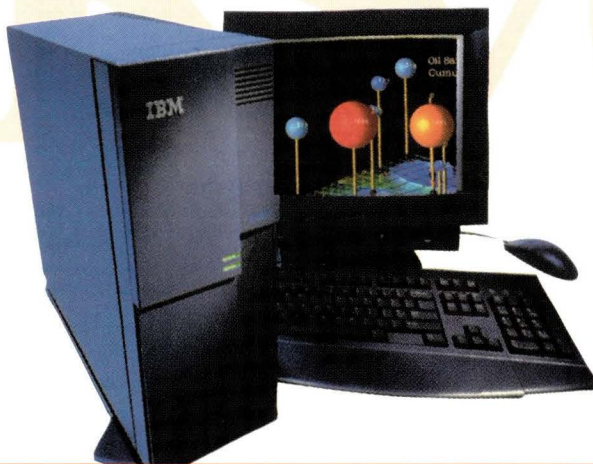
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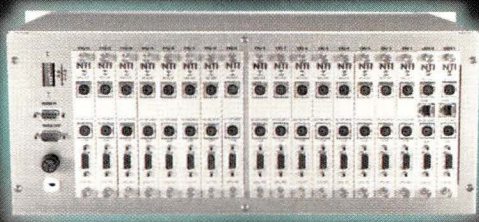
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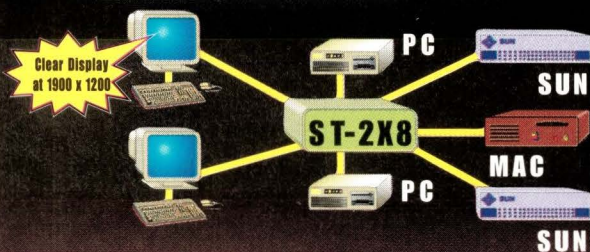
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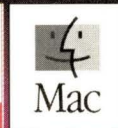
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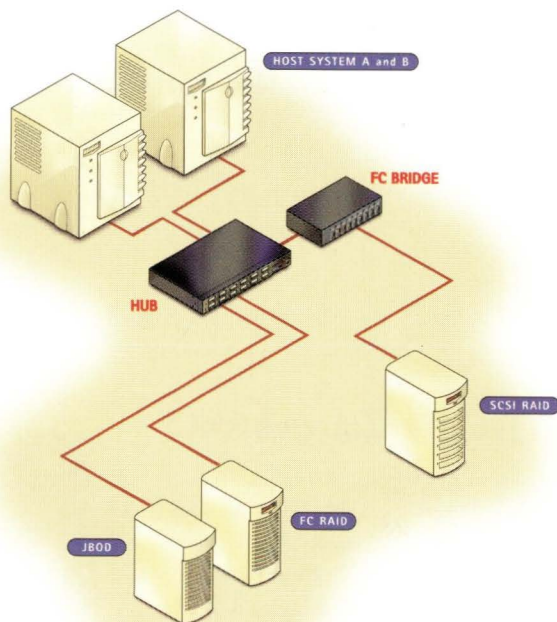
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