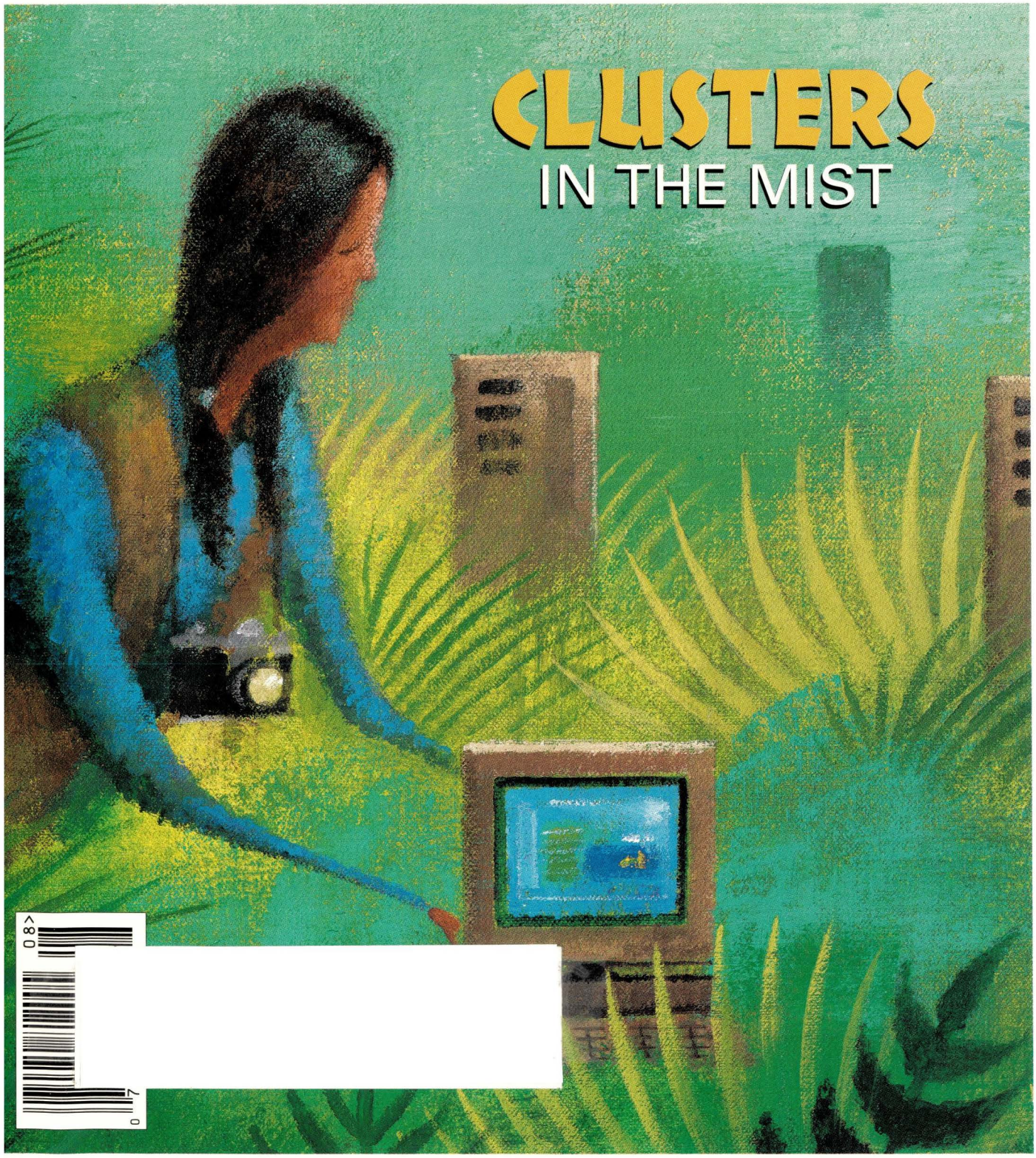
Incorporating RS/Magazine

August 1997 Vol. 8 No. 8 $5.50

SUNEXPERT

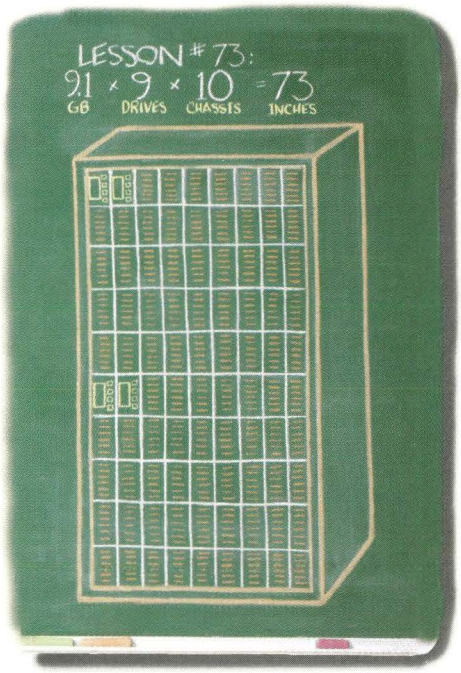
The Server/Workstation Magazine for UNIX/NT IS Managers



eviews: RAID 7 Storage, LSF

NTegration: Exploring New Territory

Artecon's New RAID Math



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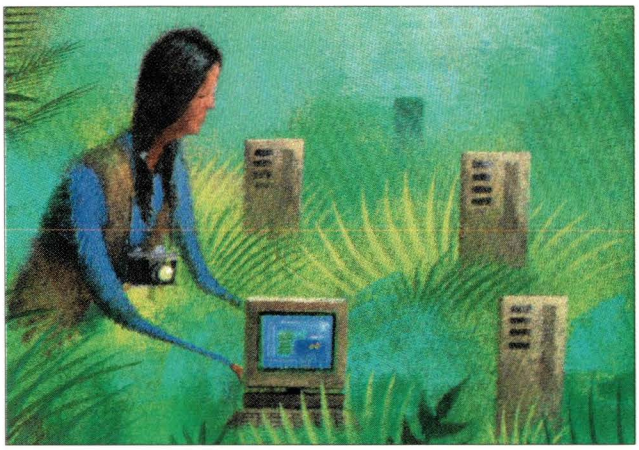

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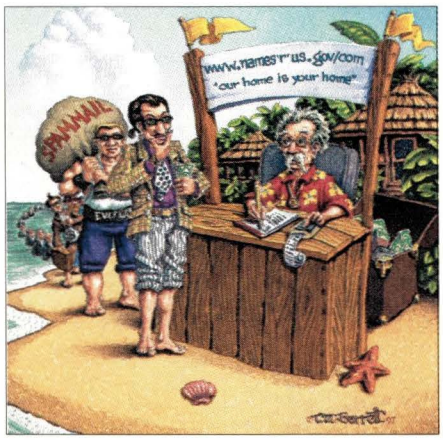

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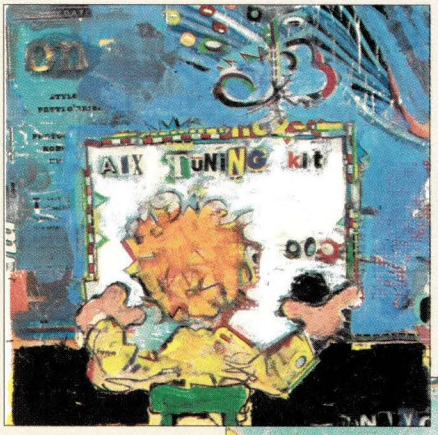

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EDITORIAL

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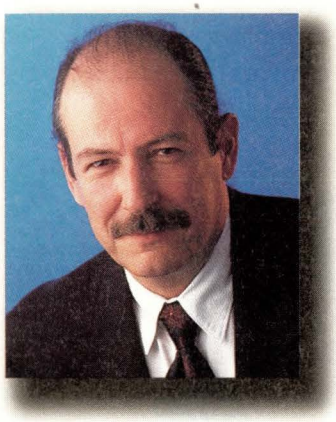

Clusters and Coverage Changes

With apologies to Dian Fossey, her pioneering research and her mysterious fate, we borrowed the title and some of the imagery for this month's cover story, "Clusters in the Mist," from *Gorillas in the Mist*. Staff Editor Alex Simeonides discovers that clusters are a conundrum for many users and administrators. "Nestled somewhere between distributed computing and massively parallel systems, clusters are a source of deep confusion in IT circles. Not only are we not quite sure what a cluster looks like, but we are even less confident about what that cluster can do," she says.

Although confusion reigns, there seems to be three basic impulses behind the decision to implement clustering. According to Alex, "A common commercial use for clusters is to maximize the efficiency of compute resources–sometimes referred to as workload management." Load-balancing or scheduling software divides tasks and distributes them to the most appropriate node in the cluster. Job scheduling can be based on a job's priority level, or a node's CPU capacity, for example.

A second impetus–and source of confusion about clusters–could be called the yearning for parallelization. "Clusters are beginning to take on the parallel processing workload usually relegated to massively parallel processing (MPP) systems like those from Cray Research Inc. and Thinking Machines Corp.," Alex says.

The third, and to me, most compelling reason for clustering is availability. I think Alex is right when she says, "commercial UNIX users yearn for the same 99.9% uptime that they could depend on from their mainframes. So it didn't take the world long to realize that clusters, with their multiple nodes, are inherently less vulnerable to failure."

Some of you noticed the new tag line on last month's cover. Just under *SunExpert* is the line "The Server/Workstation Magazine for UNIX/NT IS Managers." Don't take it to mean that all the editors at *SunExpert* have lost their heads over NT. What the tag line and this month's new column–NTegration–mean is that we are aware of the appearance of NT boxes in many of our readers' workplaces. We feel that we can help the UNIX users and managers get along with these Redmond rascals. One reader at a Hatfield, PA, architectural firm who saw the line says, "I appreciate the additional coverage of NT planned. For better or worse, it's taking the world by storm." NT is certainly getting the lion's share of press coverage. I don't agree, however, that it's taking the world by storm, but I do believe it will be a chore to live with it.

Doug Pryor

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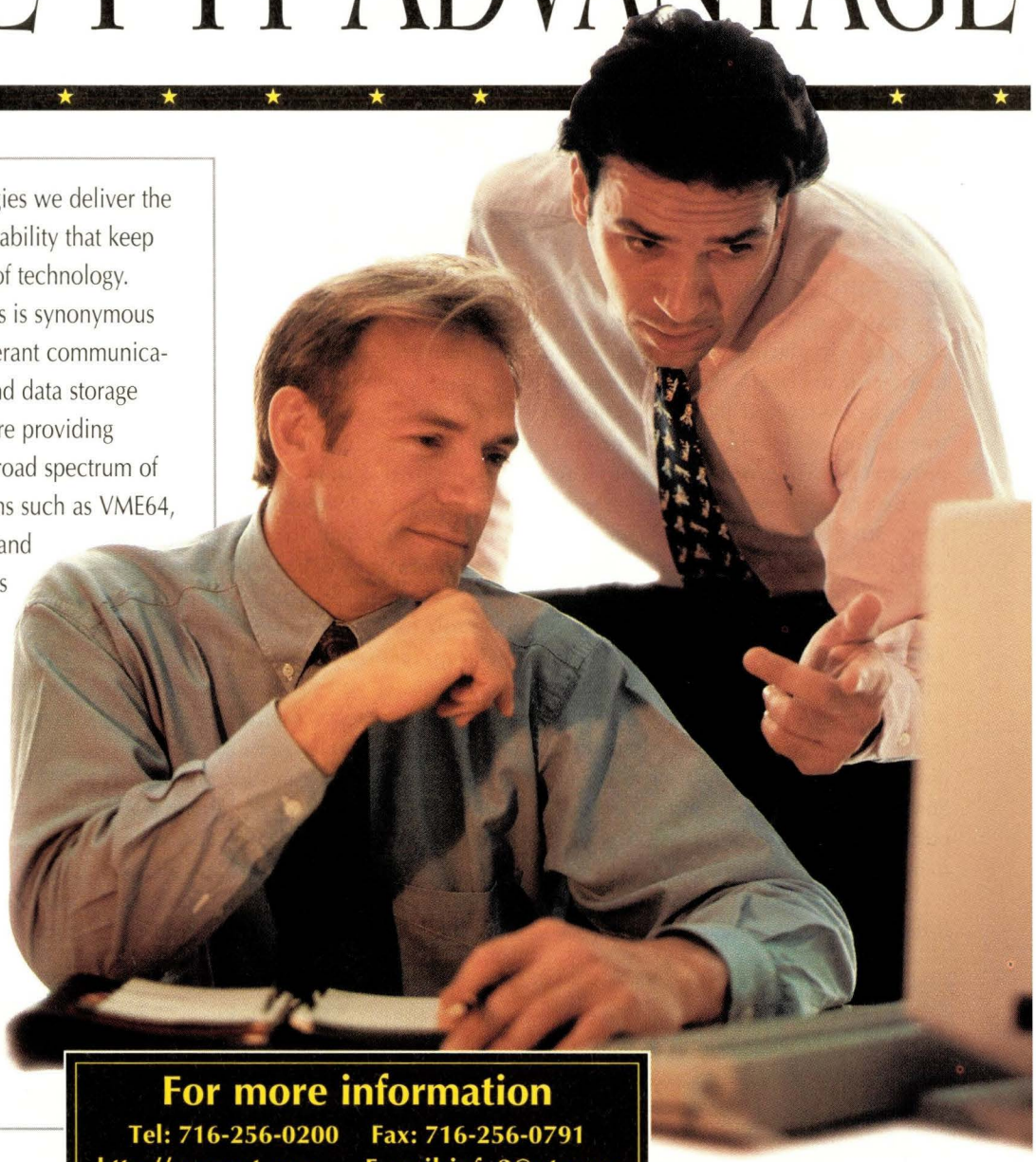

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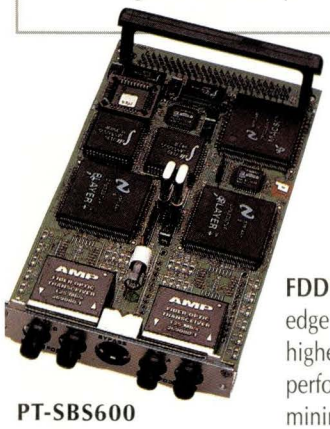

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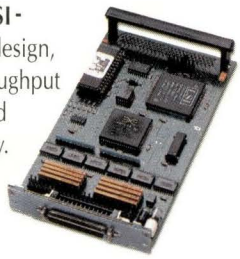

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SunExpert NEWS

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Sun Embraces PCI, Will Continue SBus Support

In July, Sun Microsystems Inc. finally confirmed a rumor that had been circulating the industry for months, if not years–that it will adopt the industry-favored PCI bus architecture in future systems over its current, proprietary SBus. Rounding out the announcement was the PCI-based Ultra 30, as well as a host of Sun-certified PCI network interface cards (NICs) from Sun and its partners.

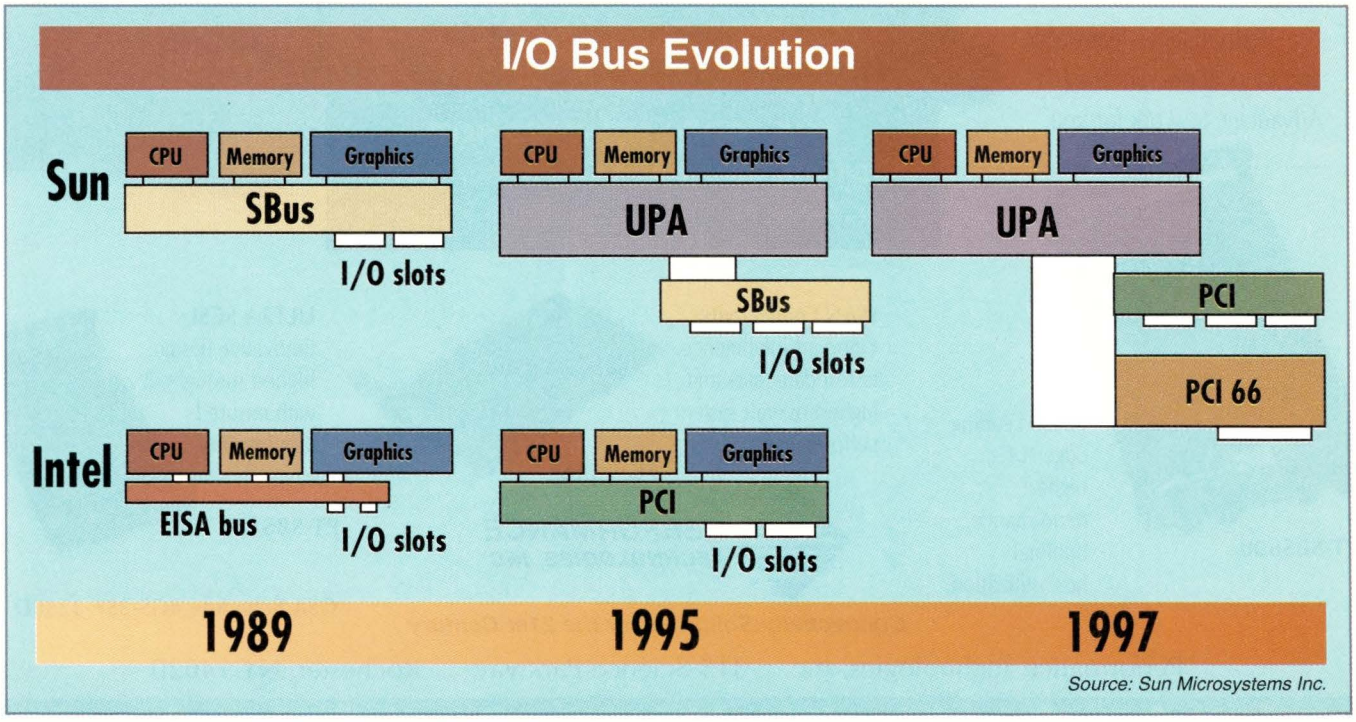
Sun's existing installed base of 3,000,000 SBus-based systems, meanwhile, will not suffer, company officials say. "We understand that customers have legacy hardware," says Steven Moustakas, director of network product marketing at Sun. Not only will Sun continue to support SBus hardware, but it will continue to introduce new SBus cards.

With this PCI announcement, Sun is thus joining the ranks of other UNIX vendors such as IBM Corp. and Digital Equipment Corp., but more notably, it is joining the ranks of manufacturers of systems based on Intel Corp. chips. This, by all accounts, marks a major turning point in Sun's history. Among other things, analysts believe that adopting an industry-standard architecture will allow Sun to compete against less-expensive Intel platforms based on price. Sun's previous performance was enough to keep PC systems off the desktop; these days, with Pentium chips getting faster and faster, those performance figures hold less clout.

Customers should not expect a dramatic drop in pricing in the near future, Sun says. "Of course, it depends on what the market will bear," Moustakas says. Nor should users anticipate any dramatic performance increases from the new PCI Ultras, says Charles Andres, group manager for I/O technologies at Sun. Sun's current PCI implementation performs at speeds comparable to the SBus (about 80 MB/s).

However, Andres points out that Sun's PCI implementation performs between two and three times better than Intel PCI implementations. This is due in part to the kind of PCI that Sun has implemented: the latest and greatest Version 2.1 of the specification (see `http://www.pcisig.com`). Sun's PCI features a 64-bit address space, where Intel is still at 32 bit. And in the near future, Sun aims to become the first vendor to introduce 66-MHz PCI systems, as opposed to Intel's 33 MHz. To that end, Sun Microelectronics Inc. has designed a controller chip that runs at two frequencies: 33 MHz, for today's generation of cards, and 66 MHz, for the next. "At 66 MHz, we expect to see 200 MB/s of actual–not theoretical–performance," Andres says.

Of course, whether or not the new Ultra 30 is the right product for you depends on whether the right NICs are available. To date, only a small number



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Circle No. 42

Sun's Third-Party Vendors

Who are the third-party vendors?
The I/O Technologies group within Market Development Engineering at Sun has been working with more than 100 third-party vendors and OEMs for the past three years to ensure a wide range of PCI products are available to Sun's customers.

Companies that have committed and demonstrated working PCI cards for the Sun network include:

Adaptec Inc., 691 S. Milpitas Blvd., Milpitas, CA 95035
Aurora Technologies Inc., 176 Second Ave., Waltham, MA 02154
Bit-3 Computer Corp., 8120 Penn Ave. S., Ste. 548, Minneapolis, MN 55431
DGM&S Inc., 1025 Briggs Road, Ste. 100, Mt. Laurel, NJ 08054
Dataware Technologies Inc., 222 Third St., Ste. 3300, Cambridge, MA 02142
Dialogic Corp., 1515 Rte. 10, Parsippany, NJ 07054
Digi International Inc., 1101 Bren Road E., Minnetonka, MN 55343
Dome Imaging Systems Inc., 400 Fifth Ave., Waltham, MA 02154
Engineering Design Team Inc., 1100 N.W. Compton Drive, Beaverton, OR 97006
Fore Systems Inc., 174 Thorn Hill Road, Warrendale, PA 15086
General Signal Networks, 10 Lyberty Road, Westford, MA 01886
Ikon Corp., 2617 Western Ave., Seattle, WA 98121
National Instruments Corp., 6504 Bridge Point Pkwy., Austin, TX 78730
Performance Technologies Inc., 315 Science Pkwy., Rochester, NY 14620
Southland Media Systems Inc., 1200 Crossman Ave., Sunnyvale, CA 94089
Tech-Source Inc., 442 S. N. Lake Blvd., Ste. 1008, Altamonte Springs, FL 32701–*as*

of PCI cards come equipped with Solaris drivers, all of which fall within the networking realm. Sun's PCI NIC cards currently include the SunFDDI/P SAS (Single Attached Station), SunFDDI/P DAS (Dual Attached Station), SunTRI/P (Token Ring Interface), SunHSI/P (High-Speed Serial Interface), SunSAI/P (Serial Asynchronous Interface), SunSwift/P (10/100 Ethernet with SCSI), SunFastEthernet/P (10/100 Ethernet), SunQuad FastEthernet/P and the SunGigabitEthernet/P. An ATM card is in development.

More cards are on the way as third-party vendors that dealt in SBus transfer to PCI (see "Sun's Third-Party Vendors"). "This transition has been under way for a couple of years now, and we've been working with SBus vendors to let them know this was coming," Andres says.

Will existing PCI card manufacturers jump into the Solaris fray? "I doubt it," says David Van Beveren, chief executive officer at EIS Computers Inc., a vendor of Solaris X86 and, now, the PCI-based Fusion model. "As Sun showed with Solaris on Intel, you really need to go out and recruit card manufacturers to write the drivers; only a few will do it on their own."

Should any PCI card vendors want to write Solaris drivers, however, Sun will not hamper them in any way. "We'll work with anyone who's willing to write and support a Solaris driver," Andres says. That includes the use of loaner machines, source licenses and technical support.

It will undoubtedly take a while for Sun and its clientele to get into the PCI swing of things, but as EIS' Van Beveren points out, users still have a lot to look forward to. "With today's SPARC systems, you just can't add memory for $7 per MB; you just can't add a 6-GB hard drive for $400," Van Beveren says. Even if PCI card vendors take their cues from UNIX software pricing and opt to charge more for cards with Solaris support, customers will still be able to enjoy the substantial cost savings associated with PC form factor peripherals.–*as*

Solaris Revamp

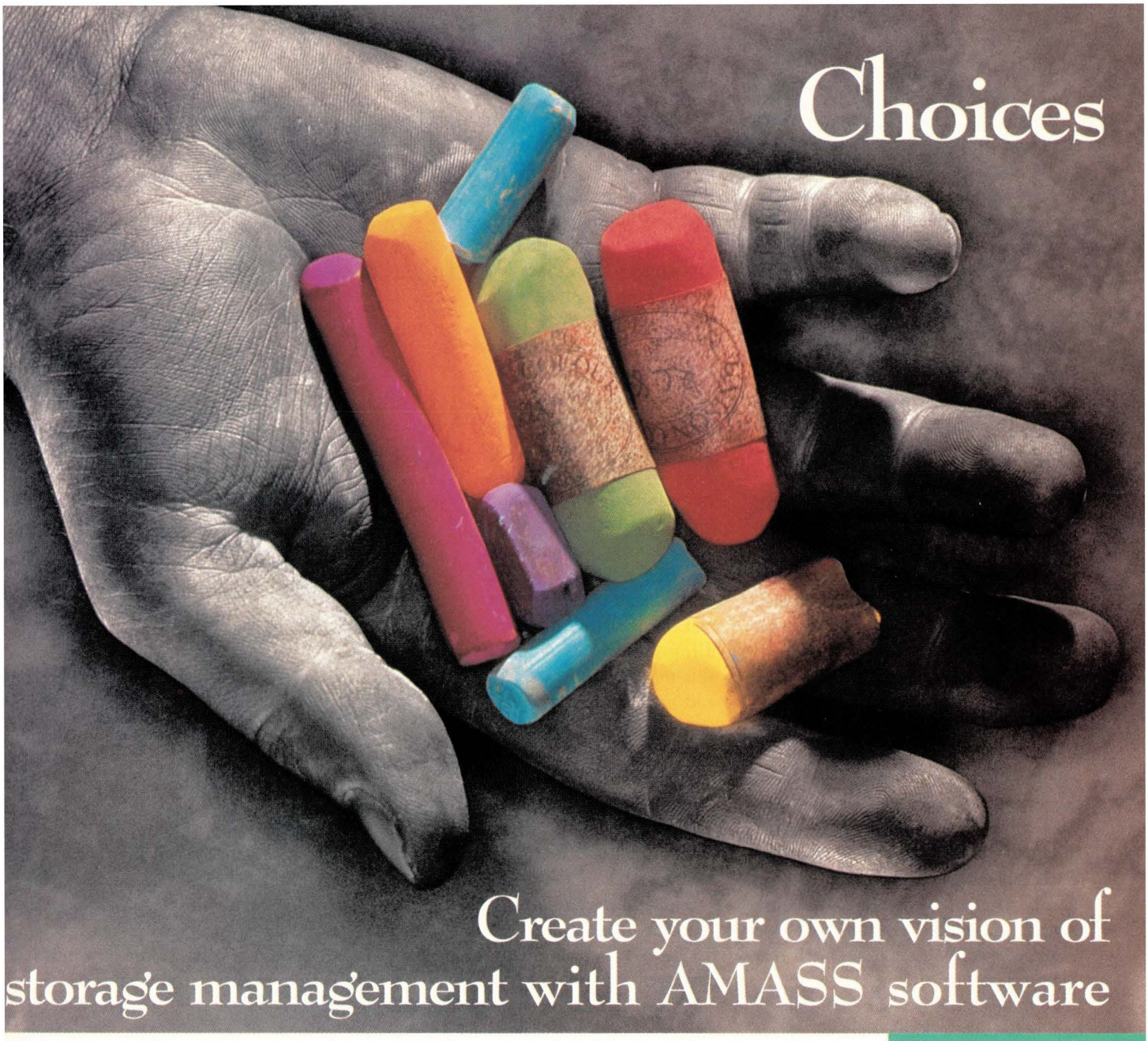
When SunSoft Inc. released its comprehensive upgrade to Solaris in June, it also released a lot of marketing hype. But according to users and industry observers, the hype is, in this case, warranted and actually welcome. Warranted because SunSoft has put the performance and scalability features into the operating environment that bring it up to par with its competitors in terms of enterprise computing capabilities. Welcome because Sun hasn't been known as a marketing powerhouse until the past year, and some say it's nice that the company isn't hiding its technological light under a bushel anymore.

SunSoft hasn't forgotten its bread and butter, the Internet. With Solaris 2.6, the company is leaning heavily on the "WebTone" analogy, which it describes as a "constant, seamless, global [Internet] connection...accessible from anywhere, from any device," and its so-called Solaris Millennium road map for the operating system, which refers to its continued efforts to connect users to the Web. Indeed, the company repeatedly calls this release "Web-enhanced Solaris."

Industry analysts are perfectly happy to hear Sun throw out marketing buzzwords, especially since the slew of new and enhanced features in Solaris can back up the talk. "WebTone is really just a marketing term, but what is behind it is of great importance," says Robert Dorin, senior analyst at The Aberdeen Group Inc., Boston. "They state that Java code runs as fast as C code in this release. If they can deliver the ease of use of Java along with the clustering features, failover features and year 2000 features, they are delivering things that people have to think about. Sun is not sitting still technologically. They are recognized as the network computing leader, and rather than rest on those laurels, they're extending their leadership into the enterprise arena."

Briefly, Solaris 2.6 includes the following new features:

- NFS Failover to provide continuous file access in the event of server failure.
- High Availability Clustering, the latest clustering release from SunSoft.
- Near-linear scalability of up to 64 processors.
- Integrated Sun WebServer to provide integrated Web access, and built-in WebNFS for Web access using the NFS protocol.



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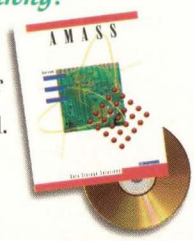

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Circle No. 17

• Enhanced TCP/IP stacks, which have been optimized for the Internet.

• Enhanced I/O for faster handling of large amounts of data from memory to storage, resulting in a 1.4-GB/s bandwidth.

• Performance that is three and a half times faster in terms of peak multiprocessing than Solaris 2.5.1.

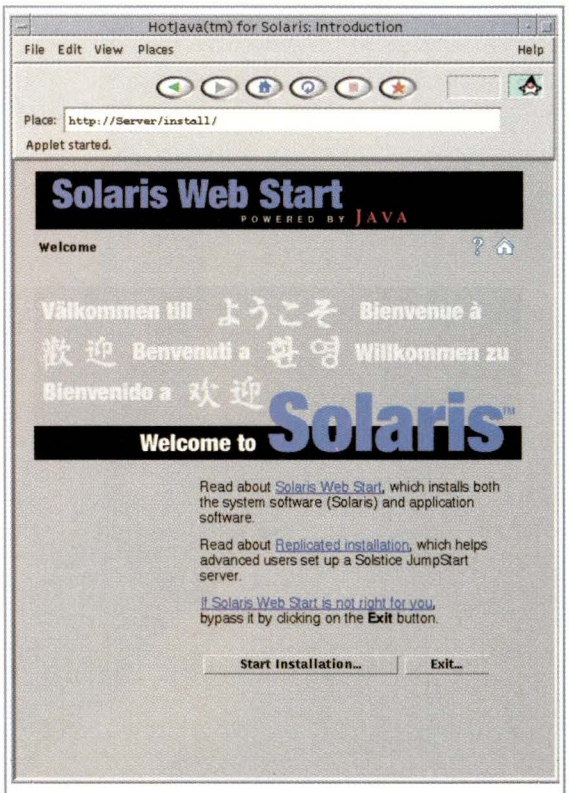
In addition, Sun is taking a new modular sales approach–undoubtedly with one eye on the Windows NT sales model–and has announced a subscription pricing scheme on Solaris. This is part of the company's efforts to reach a greater number of corporate users by offering things like the operating system and development tools separately.

According to Brian Croll, director of server software products for SunSoft, this new way of selling the operating environment is intended to put it on more corporate networks. "We have by far the best operating environment infrastructure available, and the challenge is to present it in a way that a wider audience will find useful. This is more than a dumbed-down Solaris. What we've done is made the operating system real easy to install on the network. But some users also want to write scripts when they install it on more complex networks. We want to be able to target specific user bases with this release," Croll says.

Aside from this new sales spin, Sun is hoping to make a push into new markets where competitors such as Hewlett-Packard Co. and Digital Equipment Corp. are already established. "Even as Sun is talking about WebTone and 'the network is the computer,' and these other marketing slogans, they are also saying, 'OK, we need to sell Solaris to a bank, and compete with [competitors like] HP in that area,'" says Aberdeen's Dorin. "Solaris was not quite as far ahead as HP's or DEC's UNIX in those areas. As far as running SAP or Informix databases in the financial environment, IBM and some of the others are ahead of Sun, because of Sun's heavy focus on the Web. I like what Sun's doing with this release. In enterprise computing, they're filling in some checkmarks with the support for larger file sizes and the HA features," Dorin says.

Support for large files is one feature that is welcomed by Sun sites such as The SAS Institute, Cary, NC, a data warehousing company. Solaris can now work with files up to 1 TB in size. For companies involved with data mining, with its huge file sizes, this enhancement is very attractive. That, coupled with improved I/O, sold SAS on the new release.

"One thing we need is large file handling capability," says Gary Hutchinson, systems administrator at SAS. "Our applications can look at five files as if they're one file, and our users want real, native large file handling. Solaris used to be able to handle up to 2 GB, and now it can handle up to 1 TB. That's a significant leap in file size. It also can handle direct I/O, which gets around the buffering to use memory better, and sequential files. It gets around the internal buffering and caching."



Solaris Web Start is a Java application that installs Solaris and application software.

Hutchinson goes on to say that the scalability that SunSoft has been touting for years has slashed the company's development time.

"Solaris' scalability has spoiled our developers. What used to take 16 hours to build now takes two hours. We recently went from the E2000 to the E5000 server, so from six to 10 processors. And with Solaris 2.6, we got that eight-fold decrease in build times," Hutchinson says.

As far as the "Web-enhanced" descriptor goes, SunSoft hasn't forgotten its Internet-oriented infrastructure. Industry observers also say the latest release is another SunSoft response to Microsoft Corp.'s Web-related enhancements to Windows NT.

This is the first Solaris release to rely heavily on browsers, which are standard for installation on a single machine or entire network, with the help of the Web Start Java interface. Browsers can also be used to manage Solaris, including printing and systems management, so systems administrators can manage networked environments from systems anywhere on the network. SunSoft has enhanced the environment's built-in authentication, data integrity, data privacy and single sign-on capabilities. As for Java, this is the first release that integrates the language, producing unprecedented CaffeineMark numbers (13,920), which measure the speed of Java execution and sample 2D graphics, says SunSoft. Solaris also now includes HTTP, Java IDL, IIOP, as well as the HotJava browser, Java Virtual Machine, JIT Compiler and Integrated Java APIs.

The revamped subscription pricing scheme entitles customers to receive upgrades automatically over a two-year period. Pricing starts at $129 per desktop in groups of 100. A four-way server costs $695.–*jsw*

Fault-Tolerant Server on Solaris

Invincible Technologies Corp.'s decision to migrate its Lifeline servers from the Digital Equipment Corp. (DEC)

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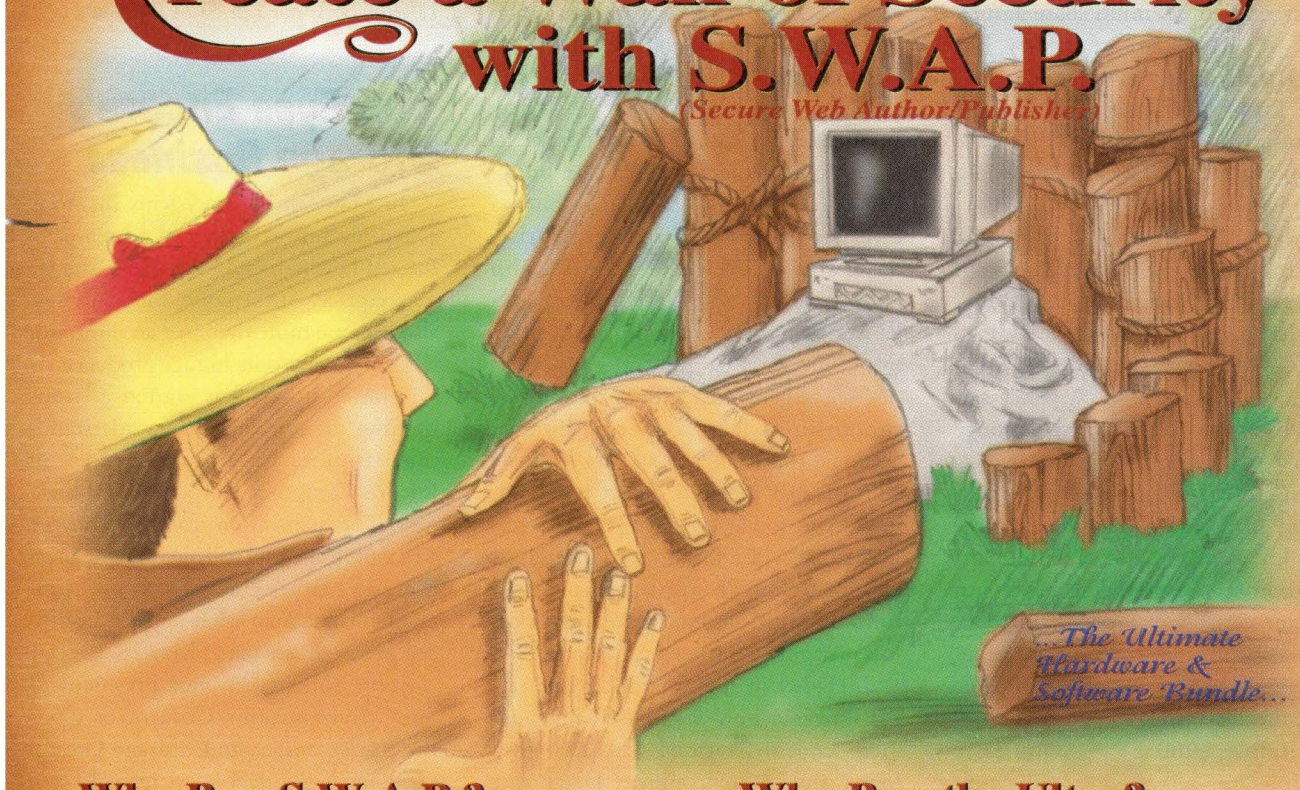
(Secure Web Author/Publisher)



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Circle No. 5

Alpha platform to SPARC systems running Solaris is a testament to Sun Microsystems Inc.'s mind share among UNIX shops. "Our company has grown tremendously in the past couple years," says Arun Taneja, Invincible's vice president of marketing. "Had we been on Solaris all that time, we would have grown twice as much."

Explains Ken Kutzer, Invincible's marketing manager, "We go into a lot of potential sales situations, and everyone is impressed with what we have to offer, but they don't want to bring DEC hardware into their network. They say, 'Come back and talk to us when you're on Sun.'"

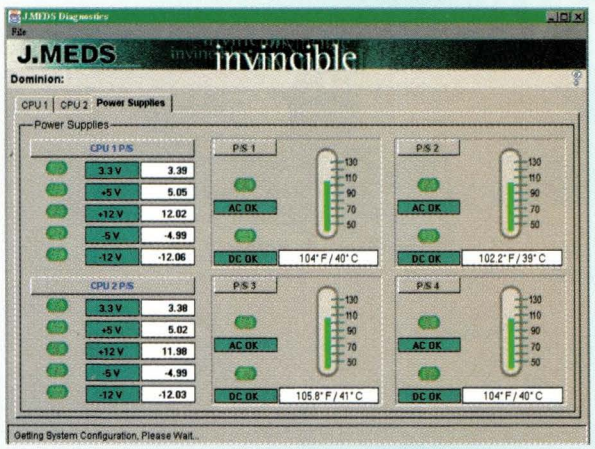
Invincible Technologies, based in Medway, MA, is in the business of selling highly available and fault-tolerant application servers and storage. Its Sun server line consists of the Lifeline 2000, a highly available one- or two-way server with fully redundant hardware, eliminating the dreaded "single point of failure." The Lifeline 2000 SFT (Symmetric Fault Tolerant) server adds application and system-level availability. Composed of two one- or two-node CPU subsystems, the SFT is essentially a shared-disk cluster, packaged in a single box. SFTnet (pronounced "safety net") software provides failover and recovery capabilities for a select group of applications or an operating system failure.

Like its competitors in the high availability (HA) market, Invincible offers failover for Oracle Corp. databases, Web services and, most often, NFS. "We compete against Network Appliance [Inc., Santa Clara, CA] and Auspex [Systems Inc., Santa Clara, CA] heavily in that space," Taneja says. Sun's Full Moon clusters also provide NFS failover, as do software offerings from Verity Inc., Mountain View, CA, and Qualix Group, San Mateo, CA. Where Invincible distinguishes itself from its larger competitors is its focus on bringing high-availability to smaller–but no less worthy–niche markets. In particular, Invincible offers application failover services for ClearCase, a popular configuration management product from Pure Atria Corp., Cupertino, CA.

"We've generated a lot of business by supporting ClearCase," says Taneja. "Our best customer is a ClearCase site whose VOB [version object base] was just down for a few days." Taneja says Invincible will add application failover to other select applications over time–applications that its competitors will probably continue to overlook.

Included in the Solaris Lifeline server line is a new Java-based management console, termed J.MEDS (Java Management Environment Diagnostic Subsystem), which shows diagnostic information on hardware elements such as power supplies, fans and disk drives. Also, Lifeline storage, in the form of the company's Ultimate-5 RAID storage subsystems, will support the emerging FC5000 Fibre Channel disk array product from CLARiiON, a division of Data General Corp., Westborough, MA.

As far as price/performance goes, a single Lifeline 2000 configuration yields LADDIS (Legato, Auspex, Data General, DEC, Interphase, Sun) performance of 4,300 I/Os per second, with a base unit cost of $1.57 per MB. Storage is scalable to just over a terabyte. Pricing for the Lifeline SFT starts at $121,000.–*as*



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Sun Eyes Encore's Storage Business

In May, Sun Microsystems Inc. took a step toward becoming a lead player in the red-hot high-end data center storage marketplace. At the same time, Sun may also become more than just an integrator when it comes to its storage products.

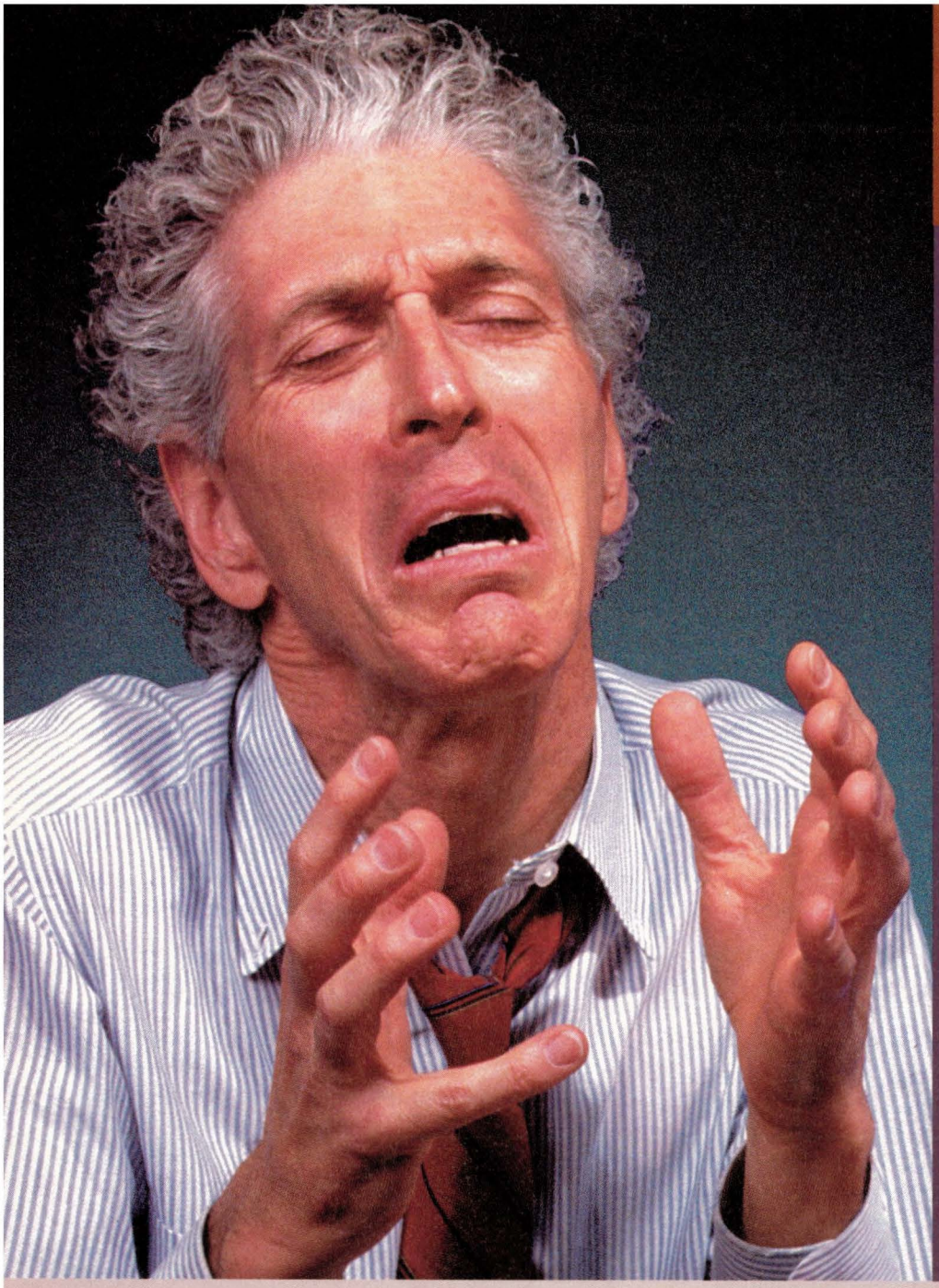
The company has signed a "nonbinding memorandum of understanding" to purchase all of the assets of Encore Computer Corp.'s storage business. The acquisition, for an estimated $185 million, was still pending at press time, so neither company would comment further than what appears in official press releases dated May 28.

John Shoemaker, vice president of Sun Microsystems Computer Co.'s Enterprise Server and Storage Group, says that if the deal goes through, Sun would gain "a group of employees with expertise in delivering solutions and support for the uninterrupted, transparent sharing of information across different computer platforms."

Products that Sun would get include Encore's DataShare software, which lets a company's mainframes and servers share data through a common storage system. The software eliminates the need for bulk file transfers across the network or between storage systems, a slow and laborious procedure. Sun will also get the Infinity SP storage line, which delivers high-speed, massively scalable I/O storage and throughput, Encore says.

Sun now uses storage products from Symbios Logic, among other vendors. Acquisition of Encore's products would give Sun its own line of high-end storage products, which analysts say would probably coexist with the company's current product offerings.

"This acquisition is major for a couple of reasons," says John MacArthur, program director for storage subsystems research at International Data Corp., Framingham, MA. "One is the size of the investment, which reveals Sun's commitment to the storage business.



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Sun said last year that they want to be a leader in enterprise storage, and this way they'll be able to go head-to-head with enterprise storage vendors, not just with systems integrators."

Encore, based in Ft. Lauderdale, FL, will use the proceeds to pay off a debt and outstanding convertible preferred stock held by Gould Electronics Inc., a subsidiary of the Japan Energy Corp., according to a statement made by Kenneth G. Fisher, chairman and chief executive officer of Encore.

"Going forward, Encore will be a restructured entity with an improved financial position. It is anticipated that the company will be positioned in new growth markets in communications and the World Wide Web," Fisher says.

IDC's MacArthur says that not only will Sun gain expertise in data sharing through this acquisition, but Encore will get access to Sun's strong distribution channel. "I've spoken with users who've said they're very interested in Encore's technology, buy they don't know where to buy it."*–jsw*

IBM Targets ISPs

The young Internet service provider (ISP) market now has a new supplier in its corner, IBM. With the introduction of the IBM Scalable E-Mail Server, Big Blue has introduced a messaging package designed for use by ISPs. The move is an indication that IBM is targeting the nascent market more aggressively.

"I think the least important aspect of the announcement, at this stage, is the product," says Mark Levitt, analyst at market research firm International Data Corp., Framingham, MA. "I don't mean to put down the product. It appears to have what it needs to succeed. I'm saying that being that it is IBM and coming out and targeting a new market, that is what is important."

The Scalable E-Mail Server combines the RS/6000 line with a suite of electronic messaging software developed by Soft-Switch, a division of Lotus Development Corp. "Fundamentally, it's a very sound architecture that is highly available and highly scalable," says Marni Ehrlich, global solutions executive for IBM's Internet solutions group. "It allows an ISP to serve business-class customers wanting bulk mail service and also consumer business on one standard platform."

The Scalable E-Mail Server offers ISPs the ability to cluster mailboxes and protocol servers using the IBM High-Availability Clustering Management Protocol (HACMP). These clusters appear as single entities and can be maintained and extended without disrupting service, IBM says. Also, it is X.500- and LDAP-compliant, allowing directories to be interconnected across multiple servers, and query other X.500 directories. Multiple customer realms (with unlimited vanity names) are offered per server as well as anti-spamming features, such as filters and exclusion lists, to filter unwanted mail.

With the new messaging product, ISPs can offer their customers temporary message forwarding; distributed administration, allowing each customer a means to manage their own user lists;

Sun to Extend Java RMI with IIOP

Those of you who thought the distributed computing battle was between CORBA and ActiveX are wrong: It's between CORBA and ActiveX and Java. Netscape Communications Corp. and company have vocally pledged their support for the CORBA-based IIOP transport protocol (Common Object Request Broker Architecture and Internet Inter-Orb Protocol, respectively) as the foundation for their Internet-enabled distributed computing architecture. Meanwhile, Sun Microsystems Inc.'s JavaSoft subsidiary–a Netscape ally–includes and recommends an alternate scheme, Java Remote Method Invocation (RMI) for writing distributed applications.

After much "market research," however, JavaSoft has conceded to pressure from the CORBA community that the Java community is in fact confused over which architecture they should use, and that they would be well served by compatibility between the two frameworks. To that effect, JavaSoft announced in June that it would include Java Interface Definition Language (IDL) in the next version of the Java Developer's Kit, due out by the end of the year. Java IDL essentially reads Java classes and outputs them in a CORBA-compliant format, which will let developers build distributed CORBA applications that use Java objects. JavaSoft also announced that it would extend RMI to support IIOP, in addition to Java Remote Method Protocol (JRMP), RMI's favored transport protocol.

JavaSoft is adamant that it will continue to support and enhance RMI, and that Java IDL and IIOP support do not indicate that JavaSoft will forgo RMI in favor of CORBA. Quite to the contrary: JavaSoft has announced that it will work with the Object Management Group to add RMI-like capabilities to CORBA–not the other way around.

"If you can do A, B, C and D with CORBA, you can do A, B, C, D, E, F and G with RMI," says J. P. Morgenthal, Java computing analyst at nc.focus, a Hewlett, NY-based network computing and Java consulting firm. Functionality such as distributed garbage collection and pass-by-value–two key features of RMI–are not yet available in CORBA.

So who does this benefit? "It benefits the industry," says Morgenthal. "This is another sign of the Javatization of CORBA," he says. "The problem with CORBA is that if you have to make a large number of calls over the wire, you have no performance whatsoever. Java, on the other hand, runs locally, which can give you a five- to seven-time speed increase."

From a developer's standpoint, however, the message is sit tight. If you are developing pure Java applications, it behooves you to continue using RMI. If you are a CORBA developer who wouldn't mind adding a Java object to your application, it will probably be another couple of years before that becomes a viable alternative.*–as*

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Designing in Cyberspace

Thanks to a new Web browser interface for IBM's ProductManager–its product data management (PDM) system–an organization can now provide enterprisewide access to design information. Featured with this new interface is expanded integration with the latest release of Dassault Systèmes' CATIA CAD Solution 4.1.8, a design and product development environment.

PDM systems typically manage information about a product throughout its life cycle. This information includes digital files, scanned images, text and database records. Now, ProductManager features, such as query, create, open, delete, check-in, check-out, extract and view, are accessible through a Java-enabled Web browser, allowing access to product data.

Also, with integration to CATIA through the product's new CDM-PM feature, ProductManager is one step closer to what IBM describes as providing a means for designing in cyberspace. "As you start to do more and more in cyberspace, you start generating tremendous amounts of data," says Rishi Madabusi, IBM's chief technical consultant for CATIA. "You need to manage that data. You need to manage versions of that data, and you need to manage building materials."

The IBM ProductManager's new browser interface provides enterprisewide access to design information.

IBM says the latest integration couples the graphical product structure management and design-in-context function of CATIA Data Management with the configuration management, change control and development management features of ProductManager. "What we're hoping is that we will truly enable collaboration for access, change, notification and modification right through the enterprise for small and large companies," Madabusi says.

Both CATIA and IBM's ProductManager run on Solaris, AIX, HP-UX and SGI IRIX. CATIA/CADAM Solutions are developed by Dassault Systèmes. IBM is a partner with the company offering product marketing and customer support.–*ptc*

and mailbox quota enforcement, with customizable warning messages based on configurable thresholds, IBM says. In addition, there is instrumentation for SNMP-based management and universal client access from POP3, SMTP and the soon-to-be-released IMAP4 mail clients.

The product is currently being used by just a handful of customers, but IBM plans to make it available on a larger scale later this year. Pricing will be announced at that time. The question now is if the product will work as promised and if it will meet the needs of ISPs requiring online maintenance and backup while providing continuous availability to their customers. "The only way of knowing is by rolling it out and handholding with a major customer until you fix the inevitable bugs that come up," IDC's Levitt says.

IBM sees the product as competing directly with more established products like Intermail from Software.com. "What has been announced on paper is one-to-one competition with Intermail," says Valdir Koha, president and CEO of Software.com, who is a little skeptical that a new product can step in and meet all of an ISP's needs. "Intermail is the result of practical day-to-day operations. The IBM product is a concept right now."

A problem Koha sees with the announcement is the claim that the Scalable E-Mail Server can service a million users while running on only four RS/6000 F50 machines. "We claim that we are running a million users because we are running a million users at AT&T WorldNet. It is a calculation on their side," Koha says.

While IBM may be new to the budding market and doesn't have much of a track record in this field, it's not a startup. "They have technology and sales presence in a lot of different markets because they are IBM," says Levitt. "The combination of their software and hardware is hard to beat."–*ptc*

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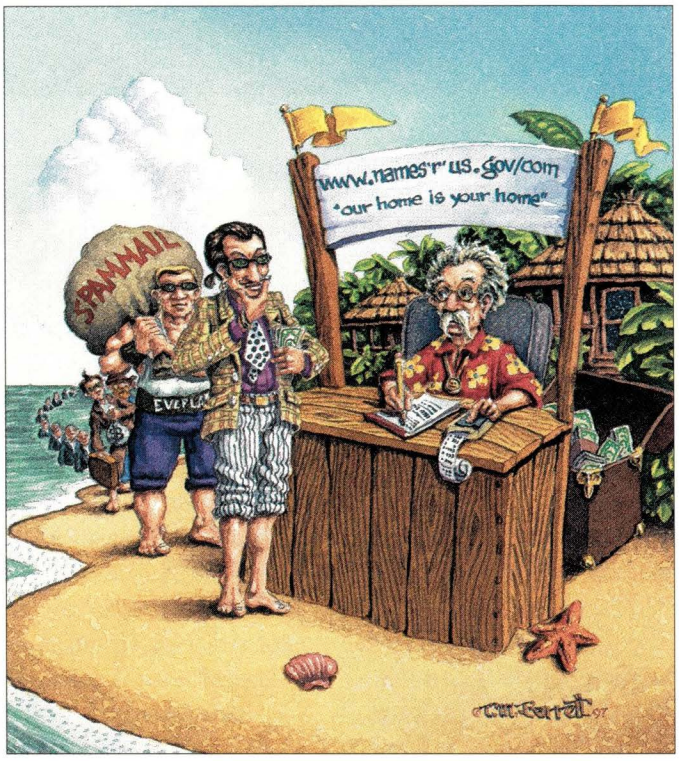
Circle No. 31

by Michael O'Brien



TOM BARRETT

"What we're trying to do is help the Kingdom of Tonga skip the industrial revolution."
– Eric Gullichsen

"The ineffable name."
– What a cat has

"I will gladly repay you on Tuesday for a name today."
– Internet name shopper

The Isle of Names

Q: *Good heavens. Where's Mr. Protocol? Where are we?*

A: We're in a cybercafe. I couldn't take it a minute longer. Mr. P. decided that a return to basics was in order, so he pulled out RFC #1 and started reading. Then he wanted me to quiz him. Then he pulled out RFC #2. Same thing. By the time he got up to RFC #12, with only about 2,000 to go, I hit the road. So here I am sitting around with a bunch of first-time Websters (some of them quite good-looking, so I think I'll stay awhile), old-time hackers and the occasional denizen with a real liquid java IV drip in his arm, trying to figure out when it'll be safe to go home again.

So, since my terminal was at home, I was forced to read an actual newspaper. Passing over the front page and the editorial section with a shudder, I found myself in the sports section. Sensing imminent vapidity, I rapidly went on to the business section. It read like a cyber-journal. Most of the news was Internet-related. Some of it was surprising. Interrupted occasionally by the first-timers ("Does he really *look* like that?"), I pulled in some interesting tidbits.

Consider the problems of the Internet Domain Name System. As Mr. Protocol has reported in the past, the DNS is a bit of a political football these days. Naming things in general is an unsolved problem on the Internet, in fact. People were never supposed to use raw host names. However, although a very large amount of work was put into "directory services," which is what Internet people call "the names we call things by instead of the names the programs have to use," none of the implementations gathered enough general support to become widely deployed, except perhaps for some corporation-size X.400 services. The real directory services in "X-dot-land" are covered by X.500, so perhaps these don't count.

URLs on the Web haven't fared much better. The Web's inventor, Tim Berners-Lee, never intended for users to deal with raw URLs. He expected that a Universal Resource Name service would be created to map human-readable names to URLs. This hasn't happened yet. It may, someday, in which case a great deal of weight will be removed from the Domain Name System. As it is, the hostname section of URLs is the only tie that corporations have between their corporate identities and their hosts.

Mr. Protocol has already written about the result. The second-level domain name space, where the corporate parts of host names typically live, is a battlefield, and volleys have even been launched at the top-level domain name space. An ad hoc committee, cleverly called the Internet Ad Hoc Committee, has recommended the creation of several new top-level domains, and while some of them may seem silly or even overlapping (`.biz? .firm?`), it may serve to stem the tide for awhile.

Now, we see in the business section

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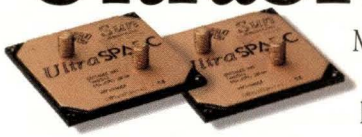

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27GDA

Circle No. 39

of the paper that two Dudes With Credentials have come up with another solution. These two fellows live, or at least work out of, an old ferryboat docked in Sausalito, CA, a location well-known to some as the stomping grounds of (at least) Stewart Brand, creator of the *Whole Earth Catalog* and most recently the author of the brilliant work *How Buildings Learn*. There's something about Sausalito. These two dudes, Eric Gullichsen and Eric Lyons, have come up with a new solution.

For reasons best not gone into here (at least, not until I've talked Mr. P. into a travel budget for the investigation), these two fellows are the Internet expertise for the sovereign Kingdom of Tonga. Tonga, be it known, is a very sovereign kingdom, being the only Polynesian country that was never colonized, and possessing a literate, educated populace...and a teeny gross national product.

Now it turns out that Tonga has one very valuable resource that it is just beginning to mine. The rest of the world gave it to them free and clear, and they're ready. What could that be?

Mr. Protocol might be glad you asked, but the ginger beer in this place is way beyond his ability to cope, so he's not here.

The Domain Name System has, in addition to the top-level domains we deal with every day, a whole raft of top-level domains corresponding to just about every country in the world. These "ISO country codes" were originally devised for another purpose, but they now serve to carve up the non-U.S. parts of the Internet, and also some of the U.S. domains too. These "geographical" domain names are based not on who you are, but where you are. In the United States, these names are handed out by geographic region all along the hierarchy, so that the Web site for someplace in Venice, CA, might be `www.frobozz.venice.ca.us`. However, it's up to each country to carve up its own domain space, and Tonga has taken a refreshingly original approach.

They're selling it off.

The Internet is a federation with many more players than countries. It is almost inevitable that some countries will try to use national sovereignty in the face of international pressure to glean some profit from the Internet.

Offshore Registration

To see how this works, let's look at auto insurance. California has a mandatory insurance law. In one of the most outrageous articles ever published in `ca.driving`, one fellow laid out a way to avoid paying the rather steep California auto insurance rates.

Step 1: Form a Liberian corporation with a Swiss factor. This, he said, is easier than it sounds and does not involve a possibly fatal trip to Liberia. It does involve a trip to Switzerland but, hey, you always wanted to see Europe, and about one year's auto insurance premiums should pay for the trip.

Step 2: Transfer title to the car to the Liberian corporation.

Step 3: Make yourself a duly registered employee of the corporation.

Result: You can forget about collision insurance. You break it, you pay for it. But, in terms of liability to others, you're the employee. Liability resides in the corporation of whom you are the representative. And, if anyone tries to go after the corporation, the Liberians don't care. The Liberians don't care with oak leaf clusters.

Mr. Protocol knows of no one silly enough to have tried this. But it does illustrate the point about offshore registration. Why is it that all the tankers that sink seem to be registered in Liberia? Because that's the cheapest flag to fly, that's why. Mr. Protocol suggests you think of this before signing up for a cruise on a ship flying the Liberian flag.

So what about Tonga? Well, head on over to `http://www.tonic.to`. There, you will find a completely automated Web server that will issue you your very own second-level domain name under `.to`. All you need is a valid credit card.

Mr. Protocol, before he disappeared in a haze of ancient RFCs, thought this was a brilliant solution. YHOS (Your Humble and Obedient Servant), on the other hand, smelled a rat and dug a little deeper. What about copyright and trademark issues, of the sort that have caused Network Solutions, the registrar of the better-known domain name spaces, more than a few sleepless nights? A short email exchange later elicited the response that all domain names under `.to` are issued on a first-come, first-served basis. This leads to the question: Is the Kingdom of Tonga a signatory of the Berne Convention? Excellent question. If not, guess what? It's first-come, first-served.

Cute, eh? Offshore domain name banking, tax-free and regulation-free.

The implications of this bear some examination. Suppose things go to the wall in the trademark wars? OK, it's easy enough for MacDonald's to nab the teenager who puts up a Web page at `www.macdonalds_deathburgers.to` and reduce him to a grease spot, but what about when The Broadway Stores and the Broadway Theater District Redevelopment Association start duking it out? No U.S. court has jurisdiction over Tonga.

Now, one could just about see the Powers That Be banding together and causing all packets to be cut off from the dangerous rogue nation of Tonga, but who's to say the name server for `.to` is anywhere near the island of Tonga? It would (or might) be subject to the laws of the country where it resided, unless it were, say, in the Tongan Embassy to some well-connected country.

The legal world is slow to catch up with the network world. Physical isolation is no longer a barrier that separates the signatory section of the world from the countries that, for historical and geographical reasons, have previously been forced to go it alone, and which have adapted to that lifestyle. The telecommunications world has, until now, been a closed fraternity, where countries desirous of telephone service dealt with the Consultative Committee for International Telegraph

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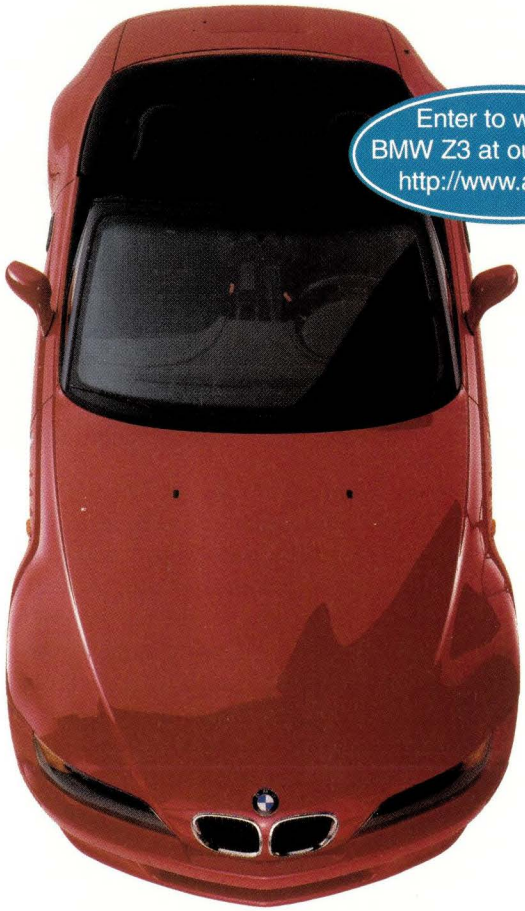

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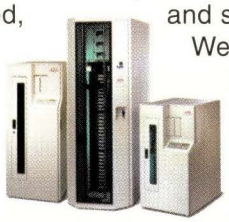

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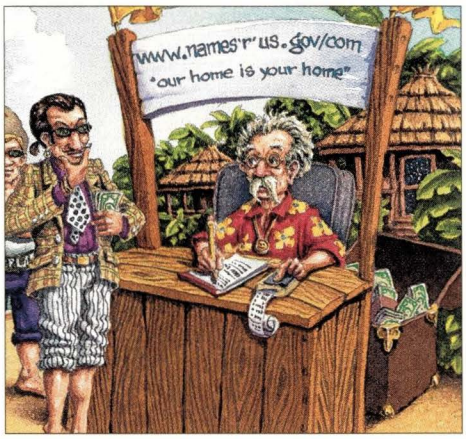
Circle No. 9

and Telephone (CCITT) or the International Telecommunications Union (ITU) if they wanted phones, and took on the consequent obligations of international monetary settlements on an all-or-nothing basis. The Internet is a different kettle of fish, a federation with many more players than countries. It is almost inevitable that some countries will try to use national sovereignty in the face of international pressure to glean some profit from the Internet.

This is not to say that the current marketing move on the part of the Kingdom of Tonga is harmful or even irresponsible. In fact, it lends itself to a certain whimsy, such as mail addresses like `boys-market@easy.to.get.to` or `mail-me@if.you.want.to`. The possibilities (in English, anyway) are endless.



Other possibilities are less welcome. The only reason the Liberian auto insurance scam, or some variant thereof, hasn't been tried is that the notion of forming a Liberian corporation with a Swiss factor strikes most Americans as so bizarre as to be unimaginable. That, in turn, is because most Americans will never get to Switzerland.

Imagine some clever fellow who forms the Liberians 'R' Us Web site, only a credit card required, at some Swiss server. Better yet, there's all the offshore gambling being set up. This is the first enterprise to cause some semiofficial grumbling about the possibility of introducing the first judicially enforced cutoff of routing services. However, as the fellow says, "The Internet regards censorship as damage, and routes around it." All it takes is a server in Liberia announcing itself as a route to gambling in the Seychelles or wherever the hot spot is this week. And when the U.S. courts mandate that Liberia be cut off in turn, a server in Uruguay announces that it's a route to Liberia, while Paraguay, not to be outdone, puts up a server that routes directly to the Seychelles...all for a certain behind-the-scenes consideration, mind. It's rather like the way OPEC worked only for a while, until somebody not within immediate shelling range decided they needed the money.

This is a key point: The telephone world is a closed fraternity, with one point of contact. As far as telephones are concerned, the ITU is a world government. It is the child of the several governments of nations that have combined by treaty to set it up and give it the power of "us or nobody."

No such power exists for the Internet. None has yet been established, and none may ever be. The Internet Engineering Task Force (IETF) and the Internet Society (ISOC), which has a membership in the ITU, govern the standards by which the Internet is built and run, but they do not govern the traffic that moves over the Net, nor the services provided. While the governments and courts of the major industrialized countries will have considerable influence over its shape and conduct, there are areas where that influence will be reduced to the shadier techniques of political influence and negotiation. From a technical standpoint, one might say the Internet regards the entire legal system as a source of dropped packets, nothing more.

Eventually, one might foresee that different segments of the Internet will actively be at war with one another. The beginnings of this can already be seen in the battle against email spam that is heating up. Because just about all of the email spam originates in the United States, no one thinks it odd that the U.S. Congress is debating a couple of bills to either regulate or outlaw spam email, or that the email spammers are banding together to form an organization to promote self-regulation.

No one seems to have considered at any length the fact that spam emailers who do not choose to submit to either legal or self-regulation may simply move their operations offshore. They don't even have to physically move themselves to do it, either. All it takes is an enterprising type in, say, an ex-Soviet republic, agreeing to forward email. In fact, ITU or no ITU, at least one ex-Soviet republic discovered with some surprise that almost all of its international telephone traffic was coming from international fee-per-minute call traffic (what in the United States would be called "900 numbers") being directed their way by telephone scammers who had rented the numbers and then lit up pagers all over the United States with requests to call the numbers.

Over the next few years, the Internet will lurch its way toward some sort of international equilibrium. The telephone came to international prominence during the glory days when the First World exercised some sort of international equivalent of Manifest Destiny. Today's more pluralistic international environment, in conjunction with the federated nature of the Internet, is going to result in some very interesting splinter movements. These will become more and more apparent not just in the coming years, but in the coming months.

The opening shot has already been fired by the Kingdom of Tonga. ⊷

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

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

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

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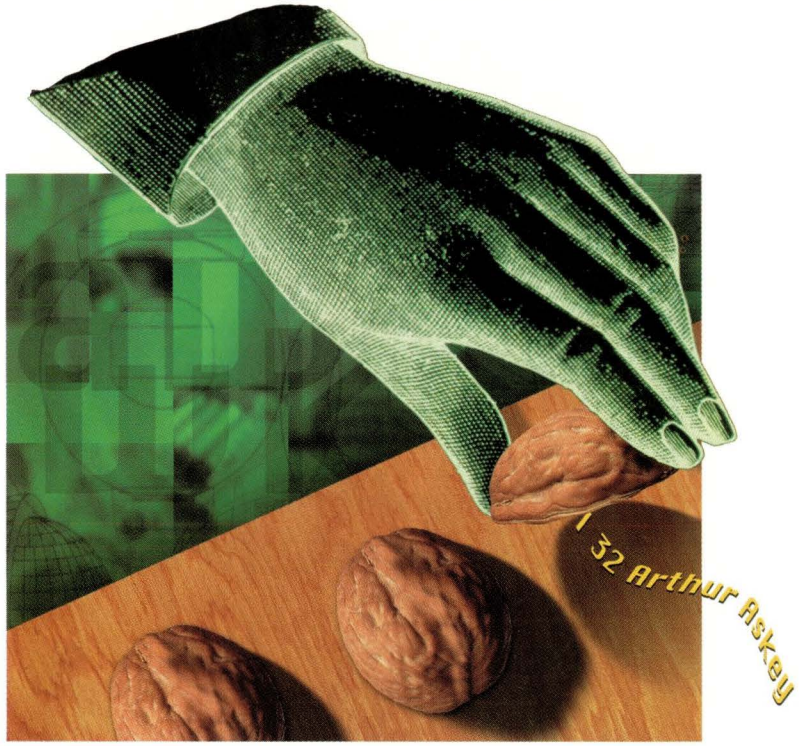

MICHELLE FRIESENHAHN WILBY

Stupid Shell Tricks

Well, a piece of helpful email arrived when I was entering the panic state that my family recognizes as "the need to find something to write about." The mail message asked for help in processing some data. The data was a text file that looked like this:

```
aba1893 1 32 Arthur Askey
gcb2130 1 47 Geoffrey Boycott
dac2124 1 93 David Carter
jcc3245 1 43 John Clark
arc3337 1 39 Andrew Crewe
sjc3840 1 50 Simon Croft
afc6681 1 32 Anthony Cronshaw
```

etc.

The problem was: How could you swap the order of the text on the lines so that the full name of each person appeared at the start of each line, rather than at the end? Oh, by the way, columns one through three are *always* fixed length.

This problem can be solved a great many ways on UNIX, so I thought it would be illuminating to look at some of the different approaches and describe the little bits of underlying knowledge that you would need to solve the problem. Incidentally, while thinking about the problem, I've come to the conclusion that I didn't send the simplest method to my inquirer. But, hey, it worked. Eventually.

Your First Port of Call

If you're dealing with text in space-separated columns, then `awk` may be your first port of call. Like many UNIX tools, `awk` reads and writes text data, applying a program that specifies regular transformations to the information as it passes through. The `awk` input scanner splits each source line into a set of columns. By default a column is delineated by white space, some unknown number of spaces or tabs. A line in a basic `awk` program has the form:

match `{ commands }`

A complex program can consist of several *match* statements, each followed by a set of commands that are executed when the match succeeds. For large scripts, the commands are stored in a file and executed when needed. However, I think most people use `awk` to generate that useful single command that is entered on the command line on the fly.

The *match* part of the command is a test of some sort that is applied to the data in the current line. If the test is successful, then the commands within braces are executed; otherwise they are not. The *match* part of the `awk` command can be empty and, in this case, the commands are applied to every input line.

For our current task, we only need to know a couple of statements in the `awk` language. We are going to apply the `awk` commands to every line, so we need to know nothing about the *match* part of the program. Well, that's not quite true. The `awk` input scanner splits the lines of data into columns, and we need some way to refer to those columns in the

```
corp:/acctg >ls general.ledger
UX:ls: ERROR: Cannot access general.ledger:
No such file or directory

corp:/acctg >ls payroll.1qtr
UX:ls: ERROR: Cannot access payroll.1qtr:
No such file or directory

corp:/mfg >ls inventory.cont
UX:ls: ERROR: Cannot access inventory.cont:
No such file or directory

corp:/mfg >ls order.entry
UX:ls: ERROR: Cannot access order.entry:
No such file or directory
```

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Circle No. 16

commands section of the program.

The authors of awk borrowed from the UNIX shell to provide a way to specify particular columns. When you supply arguments to a shell script, you can refer to them in the script using the "positional parameters" notation: The first argument is $1, the second $2 and so on. The dollar notation is used in awk to refer to a column in the input data, with $1 being the first column, $2 the second, etc.

The whole input line can be referred to using $0. So a simple awk program that just copies its input to its output is

```
$ awk '{print $0}' file
```

This is a shell "one-liner." The awk program has no match string and is quoted with single quotes to prevent the shell from attempting to expand the $0 argument. The program is a single print statement. Each line is read and then printed, and the print statement will add a new line.

We can instantly solve our problem by using the print statement and the column specification to re-order the columns in the original data:

```
$ awk '{print $4,$5,$1,$2,$3}' file
```

When the line is printed, the commas that separate the fields are replaced by the current output field separator. This will ensure that a space is placed to separate the output fields. Omitting the commas in a print statement is a common awk mistake. The language is aimed at processing strings, so it's legal to place two variables next to each other on the input line, concatenating their values. As a result, the program will still work, but the spaces that separate the columns will be stripped from the output.

If you want to do something a little more fancy with the output then you can replace the print statement with a formatted print statement:

```
$ awk '{printf "%s %s:%s:%s:%s\n",
                        $4,$5,$1,$2,$3}' file
```

I've split the line for printing purposes. You should type it in on a single line. Here, the format allows us to add colons to separate the columns on output. We must also add a new-line character (\n) to force each output line to be printed on a separate line.

You can specify the input separation character on the command line, and this can be helpful when processing colon-separated text databases such as the password file. This one-liner prints all the names from your password file, which, as you know, is a colon-separated text database:

```
$ awk -F: '{print $1}' /etc/passwd
```

Well, that solution worked OK. It would be somewhat harder to use awk if each person's name field contained more than just a first and last name. It can get tricky in awk when dealing with data that has a variable number of columns.

The Shell Solution

The shell offers a solution to our original problem too. The solution proposed here will work for the Bourne shell, sh, the Korn Shell, ksh, and GNU's bash; it will need rethinking for csh. The key to the shell solution is the read command. This shell built-in command allows us to read data and load it into a shell variable. So our simple copy input to output program becomes

```
cat file | while read line
do
    echo "$line"
done
```

Here, we are taking advantage of the ability of the shell to pipe data from a program into a while loop. Actually, we could have also said

```
while read line
do
    echo "$line"
done < file
```

which makes the while loop take its data from a file, but I find this less readable than using an extra process cat to pipe the data into the loop.

The while loop is controlled by a test that is placed after the word while on the line. The test is actually a command that is run and must complete successfully for the statements enclosed between do and done to be executed. Once the test command fails, the looping ceases. So in the example above, a successful read command will take one line of data from its input and load it into the line shell variable. If there is no data, read will fail and the loop will terminate.

The sole statement in the loop is an echo command that prints the contents of the line variable. I've quoted the argument to echo from habit. I prefer to quote shell variables that contain strings.

The read command can also be used to scan its input line, splitting the data into separate variables. The solution to our original problem is

```
cat file | while read c1 c2 c3 name
do
    echo "$name $c1 $c2 $c3"
done
```

Again, I've used quotes in the echo command to specify that the output should contain a single space between columns.

Notice that the read command has only four arguments and not five. The read command will scan the line, putting the first three words into the first three variables, and will place the remainder of the line into the last variable, name. This is a convenient feature, intended to ensure that data is never lost. I'm exploiting the feature to place the two (or more) space-separated parts of the person's name into a single variable.

The shell will normally split its input line into words using spaces, tabs and new lines to determine where each word starts and stops. You can change the separator character by meddling with the IFS shell variable. The variable con-

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Circle No. 47

tains the set of characters that the shell uses to separate words; it's usually set to three default characters: space, tab and new-line. If you change the value of this variable, it's a good idea to save its original value and reset it afterwards. Here's the password file example written in a shell script:

```
oIFS="$IFS"
IFS=":"
cat /etc/passwd |
while read name rest
do
    echo "$name"
done
IFS="$oIFS"
```

The first statement saves the original version of the IFS variable so that we can reset it later. We then set the IFS variable to be just a colon character, and execute the loop. The read statement will now use a colon character to split the input line. The name variable will be set to the first colon-separated item in the password file, the login name. By setting IFS to just a colon character, we are assured that fields in the password file that contain embedded spaces will each be treated as a single field and will be placed in a single shell variable, should we be interested in them.

You must be careful when dealing with the IFS shell variable, because it's used all the time by the shell when parsing command arguments. When the shell is interpreting commands, it treats the whole line as a single string and goes through a well-defined sequence of text replacements. First, it replaces any shell variables by their value. Next, it executes any backquoted commands to load their output into the line. For example, look at the echo command in

```
prwd='/bin/pwd'
echo I am here: `$prwd`
```

In the echo command, the shell first replaces $prwd with its contents, creating a command enclosed in backquotes (`/bin/pwd`). Next, it looks for commands in backquotes, which of course it finds, and executes the command that the backquotes enclose. The output of the command replaces the backquoted section. In our example, the backquoted part of the line is replaced by the current working directory.

The shell now has a long string that needs to be broken up into nonblank words that each become an argument to the command that it is about to execute. The shell uses the contents of the IFS variable to define which characters are "blanks" and which are not. Having broken the line into several separate chunks, the shell looks for file names to expand using the standard shell * and ? metacharacters. In the example, there are none and so the echo command will be called with four arguments: I, am, here: and the name of the current directory.

Now consider what happens when I say:

```
IFS=':'
prwd='/bin/pwd'
echo I am here: `$prwd`
```

Well, it might seem logical to think that the script would stop working because I have completely removed the space, tab and new-line characters from the IFS string. When loading commands, the shell continues to deal with the default set of characters as if they were present in the IFS variable. This makes sense. It allows us to set IFS to process data with specific separators without having to write scripts that use that particular separator in their code.

However, you *will* see different output from the echo command. The colon character after here is now a separator, and so will not be passed into the echo command as part of the argument list. The colon character is now behaving like a space, so it's perfectly OK, but perhaps not rational, to type

```
echo:I:am:here:`$prwd`
```

and you will see the same output as before. Being rational is a subjective judgment. I've come across people who have used the ability to set IFS characters to impose some other job control language style on the shell.

Incidentally, the IFS function has been used several times to attack and subvert shell scripts. The attacks usually center around definitions like

```
CP=/bin/cp
...
$CP old new
```

This looks very innocuous. However, because the IFS variable is in the environment, we can set it to something odd before we execute the script and obtain some interesting results. For example, if we call the script adding a slash character to the IFS string, then the CP variable will be defined as

```
bin cp
```

and the $CP line will be executed as

```
bin cp old new
```

We have suddenly introduced a new command into the script, one that the author didn't intend to be there, called bin. If the shell script is running as root, I can define a private program called bin that is actually a shell program, and with any luck I'll have an interactive shell running with superuser privileges.

The solutions are twofold: First, always place your definitions in quotes so they cannot be subverted by the IFS variable; second, always define a PATH variable that specifies a known set of search directories in publicly available scripts. I've also seen some scripts that explicitly set their IFS variable to ensure that what they are processing is what the author intended.

The sed Command

Let's return to the original problem. When I received the email, my first take on a solution was to use the sed command. The sed command is another UNIX supertool that reads data and transforms it using a set of commands. In the case of sed, the commands are based on those found in the

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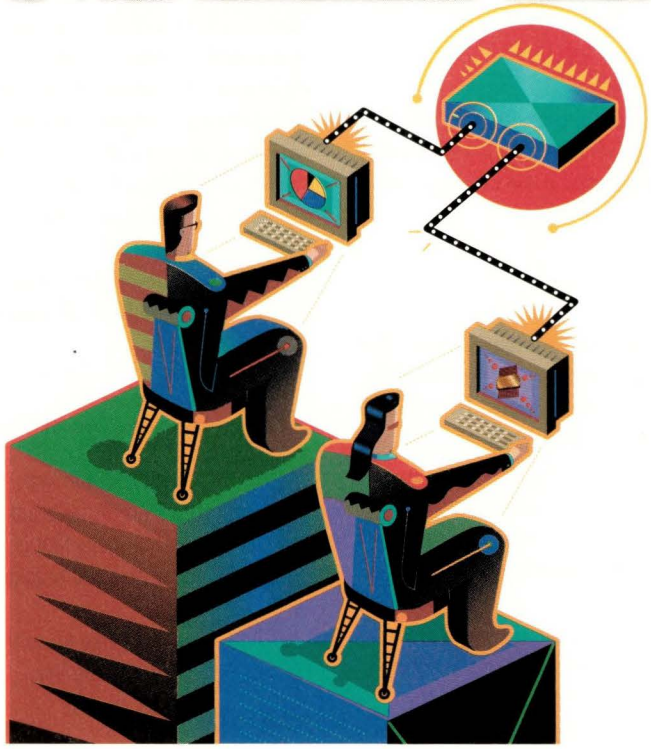

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Circle No. 26

original UNIX editor, ed. Like ed, commands in sed have the general form:

address command

where the address field is optional. If the address field is missing, the command is applied to all the lines of data passing through the editor. In sed, the address is used to select the lines to which you wish to apply the commands. The command that I intend to use is the *substitute* command,

```
s/old/new/
```

which looks on a line for old text and changes it to the new. Because we are going to swap the input data around, we will use a regular expression for matching purposes. Before we look at the matching operation, let's examine how we will create the data on the output line, taking the input data and reordering it.

The key to the reorder operation is what POSIX calls *back references*. If we place a portion of a regular expression inside the special character sequence

```
\( ... \)
```

(where the ellipsis denotes any regular expression), then we can refer to that portion of the regular expression again using a backslash followed by a single digit. So, if we create a substitute command like:

```
s/\(...\)...\(...\)/\2 \1/
```

The \1 will be replaced by the text that was matched in the first bracketed section on the left-hand side of the s command, and the \2 will be replaced by the text that was matched by the second section. Essentially, we've reordered the data on the line.

The solution to the problem is now a matter of writing a regular expression that will match the data that we want to include in each section. In fact, there are several ways to match the data in the example at the beginning of the article. I'm going to discuss two of them.

First, my correspondent pointed out that the data at the start of the line is fixed in length. In fact, there are 13 characters at the start of each line that need to be placed at the end, so we can use the repetition specification to match them:

```
.\{13\}
```

If we break this magic sequence down, we'll find a period (pronounced "dot") that will match any character. This is followed by the number 13 inside the quoted braces, which means match the previous character 13 times. Thus, the combination matches any sequence of 13 characters. This expression deals with the first part of the regular expression. The remainder of the line is of variable length, and so we can use the .* idiom, any character (dot) repeated zero or more times (star). We can now put the command together, ensuring that the pattern is anchored at the start of the line (^ the caret character) and also at the end of the line ($):

```
sed -e 's/^\(.\{13\}\)\(.*\)$/\2 \1/' file
```

Now, that's pretty unreadable, but as I've said before in previous columns, regular expressions are WORN–write once, read never. Take a deep breath and have a look at it. You should see the two sections that match the parts of the line in which we are interested, enclosed in \(...\) brackets allowing the section to be inserted on the right-hand side.

This was not the expression I used when I replied to the original mail. Repetition specifications were invented fairly recently, and so I don't readily think of them as a possibility when constructing regular expressions. Also, I was too lazy to count the number of characters at the start of each line.

I decided to match each of the columns in the data, using a square bracket repetition:

```
[^ ]*
```

Square brackets are used to match a single character position in the original data. You normally see them containing a list of characters that can appear at that position. When the list starts with a caret, it negates the list, matching any character except for the values in the list. So the list of options above matches any character except space. It's followed by a star, meaning that it will match zero or more repetitions. The combination will match any number of non-space characters.

Using this construction, we can match each individual column. But I'll leave the full solution to the problem as an exercise for the reader because the result will be too long to print here. As a hint, the password example is

```
sed -e 's/^\([^:]*\):.*$/\1/' /etc/passwd
```

The regular expression here matches:

^	The start of the line.
\(	The start of the bracketed expression.
[^:]*	Any character that is not a colon, repeated indefinitely.
\)	The end of the bracketed expression.
:	A colon.
.*	Anything else up to the end of the line.
$	The end of the line.

Finally

There are undoubtedly other ways of solving this problem. Incidentally, if you are fired by religious fervor to send me the appropriate Perl one-liner, please don't. I admit that I do tend to ignore Perl in this column because I try to talk about programs and features that everyone will find on their machine. Thanks to Hank Etlinger for the email that prompted this column. ➸

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

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Circle No. 1

by Richard Morin, **Technical Editor**

JUDE MACEREN

A Successor for SunOS

Given my feelings about (ehhh...) Solaris and (argggh!) AIX, it is probably best that I avoid discussing them at any length in this journal. Faithful readers will no doubt recall, in any case, that I am strongly inclined toward The BSD Way, with leanings toward the GNU toolkit. Hence, my local Suns all run SunOS, rather than Solaris.

Although these systems work very well, I have begun to notice some annoying limitations. For starters, SunOS is unable to support the Domain Name System without resorting to YP (Yarrgh, Ptui), with all its amusing little security holes. Actually, one can load some modified libraries as a workaround, but this has always struck me as a bit cheesy. Similarly, I can find and install the GNU tools, but it would be better if I didn't need to bother.

The real crunch, however, is just around the corner. SunOS, being based on 4.2BSD, is limited to eight partitions per disk and 2 GB of disk space per partition. Although this was very expansive a decade ago, it is now starting to be a relevant limit. Seagate Technology Inc., for example, already has a 23-GB drive available and other vendors cannot be far behind. In addition, the new drives are available with Wide SCSI interfaces, which are not supported by my current (SPARCstation 2) hardware.

If I have to change hardware, however, perhaps I should rethink my whole strategy. What are my alternatives in powerful, inexpensive BSDish systems? Looking over the prices for Sun hardware, I am not convinced that there are any stupendous deals to be had. So, I head over to the local PC emporium for some reconnaissance.

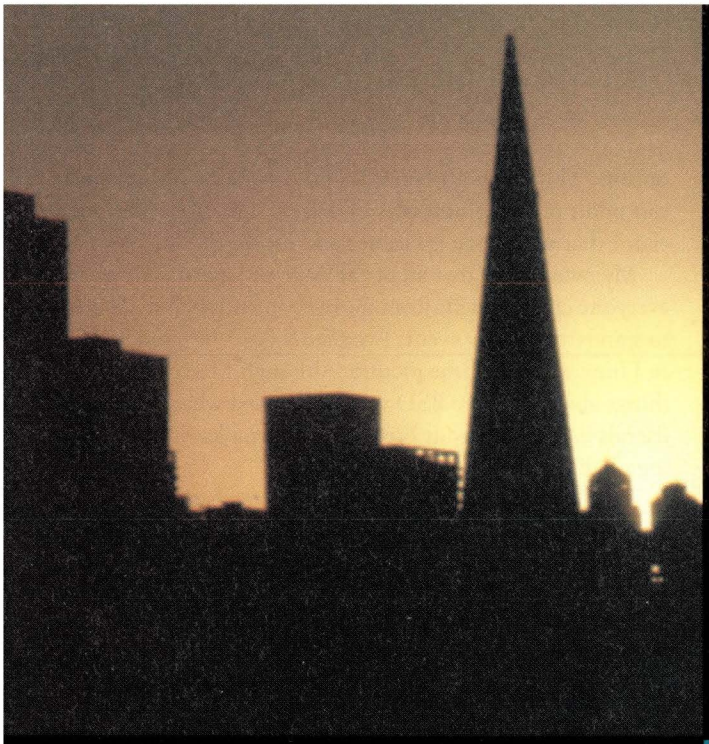
Shopping around a bit, I find that I can put together a rather powerful system for about $1,000. This buys a 200-MHz Pentium, 64 MB of RAM, PCI bus cards for Ethernet, graphics and SCSI adapters and so on. In short, I can build an economical system that leaves my SPARCstation 2 kicking feebly in the dust. Now all I have to do is find an operating system.

BSD-Based OS Options

Most commercial UNIX vendors have abandoned BSD, lured by the commercially attractive prospects of unification under the banner of SVR4. Notwithstanding some annoying differences between SVR4 (e.g., Solaris) and SVR4.2 (e.g., UnixWare) variants, this strategy has been largely successful. Sun is making pots of money selling Web servers, and its commercial clients seem to be happy.

Nonetheless, BSD is far from dead. While the commercial world was busy merging BSD features into System V, Kirk McKusick and his compatriots at the University of California at Berkeley's Computer Systems Research Group (CSRG) were tightening all the screws on the final BSD release: 4.4BSD. Their work included support for large disks, different file system models and a number of other useful features.

In addition, they fought their way through some rather dicey legal thickets, with the result that most of 4.4BSD was cleared for distribution as free software



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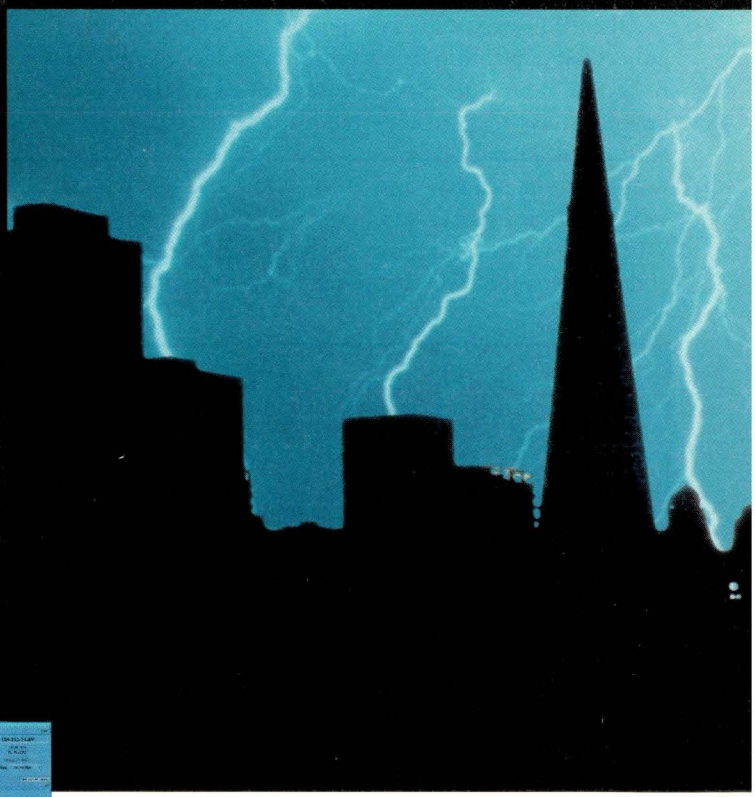

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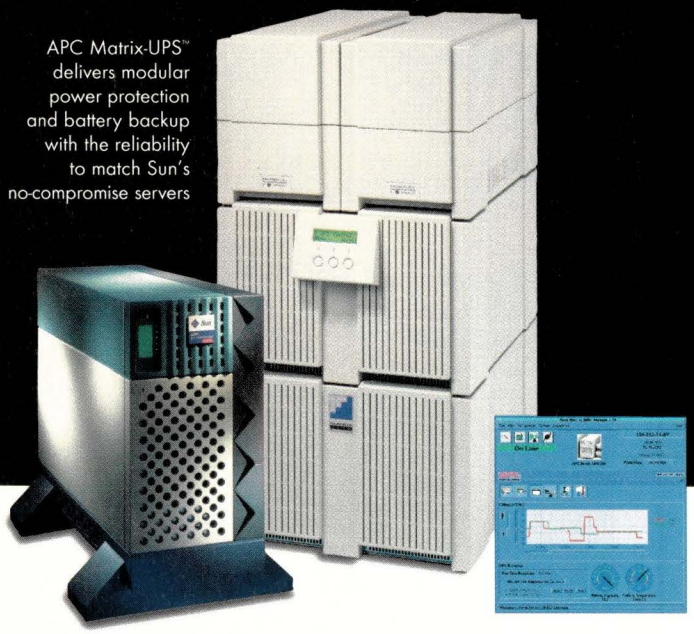

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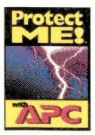

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Circle No. 3

(as 4.4BSD-Lite). All of this took time, however, leaving an opening for Linus Torvalds, a Finnish graduate student, to produce the "Linux" kernel, fold in the user-mode tools from the GNU System, and capture the majority of the mind share for "free UNIX" systems. (For more information about Linux, see the Linux International Web site, `http://www.li.org`.)

In any event, 4.4BSD-Lite can now be obtained in several installable versions. The freeware distributions include FreeBSD, NetBSD and OpenBSD (`http://www.*bsd.org`). A highly regarded "commercial"–though source-available–version is also available from BSDI (see `http://www.bsdi.com`).

Historically, the FreeBSD Project has concentrated on making 4.4BSD easy to use. To make this possible, given very limited resources, the project concentrated on the Intel platform. Recently, however, it has expressed some interest in supporting the DEC Alpha. NetBSD, in contrast, has always been a multiplatform family of ports. It currently supports more than a dozen architectures.

OpenBSD started life as a spin-off from NetBSD, but the project has gone off in its own directions since then. OpenBSD tries to provide the best features of all the free UNIX systems. It has adopted code and features, for instance, from both FreeBSD and Linux.

Aside from a common BSD heritage, these systems share a somewhat centralized approach to software development. Where the Linux community boasts hundreds (thousands?) of developers, the BSD groups tend to get by with mere dozens. This has both benefits and drawbacks. Linux users can point to larger numbers of drivers, but BSD proponents claim that their code is cleaner and more reliable.

My own take is that all of the systems have merit and that everyone could benefit from more cooperation and adherence to standards. In any event, I wanted a BSD-flavored system, so Linux was out of the picture. Although I have heard good things about all three BSD variants, I liked what my hackerish friends had to say about FreeBSD's general levels of engineering quality.

I also liked what I had heard during my chats with Jordan Hubbard, the nominal head of the FreeBSD Project, and was interested in exploring the FreeBSD Ports Collection. As a result, I decided that the new box would run FreeBSD.

FreeBSD Ports Collection

Porting software tends to be a rather solitary activity. You pick up the "standard" distribution of a package, "munge" it until it appears to work on your system, then start using it. If you feel particularly generous, you might package up the binaries and/or source code and upload them to an FTP archive. Really thoughtful porters send patches back to the package's authors, who may or may not include them in future releases.

The Ports Collection is an attempt to reduce the amount of duplication in porting software. Instead of distributing ported software, the Collection's maintainers have compiled a body of porting documentation and instructions. The documentation is

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helpful, should something break, but it isn't the real heart of the system. The key point is that the porting instructions are meant to be used directly by the recipient's machine!

After downloading and unpacking the Ports Collection "tarball," a FreeBSD user is able to request that a given package be built and installed on the machine. The Ports Collection code then performs all the required FTPing, compiling and installation. And if the desired package requires other packages, the Collection's scripts bring them in, as well.

I wish I could say that the Ports Collection is a general solution to the vast swamp of UNIX porting issues. Unfortunately, it is not. The Ports Collection only supports the needs of FreeBSD (and, to a lesser degree, OpenBSD), so it is unlikely to work at all on AIX, Solaris or even SunOS systems. On the other hand, there is nothing to keep interested parties from extending the Collection. In fact, the FreeBSD folks are quite open to the possibility. So, if you're interested, let them know!

The Birth of Freebie

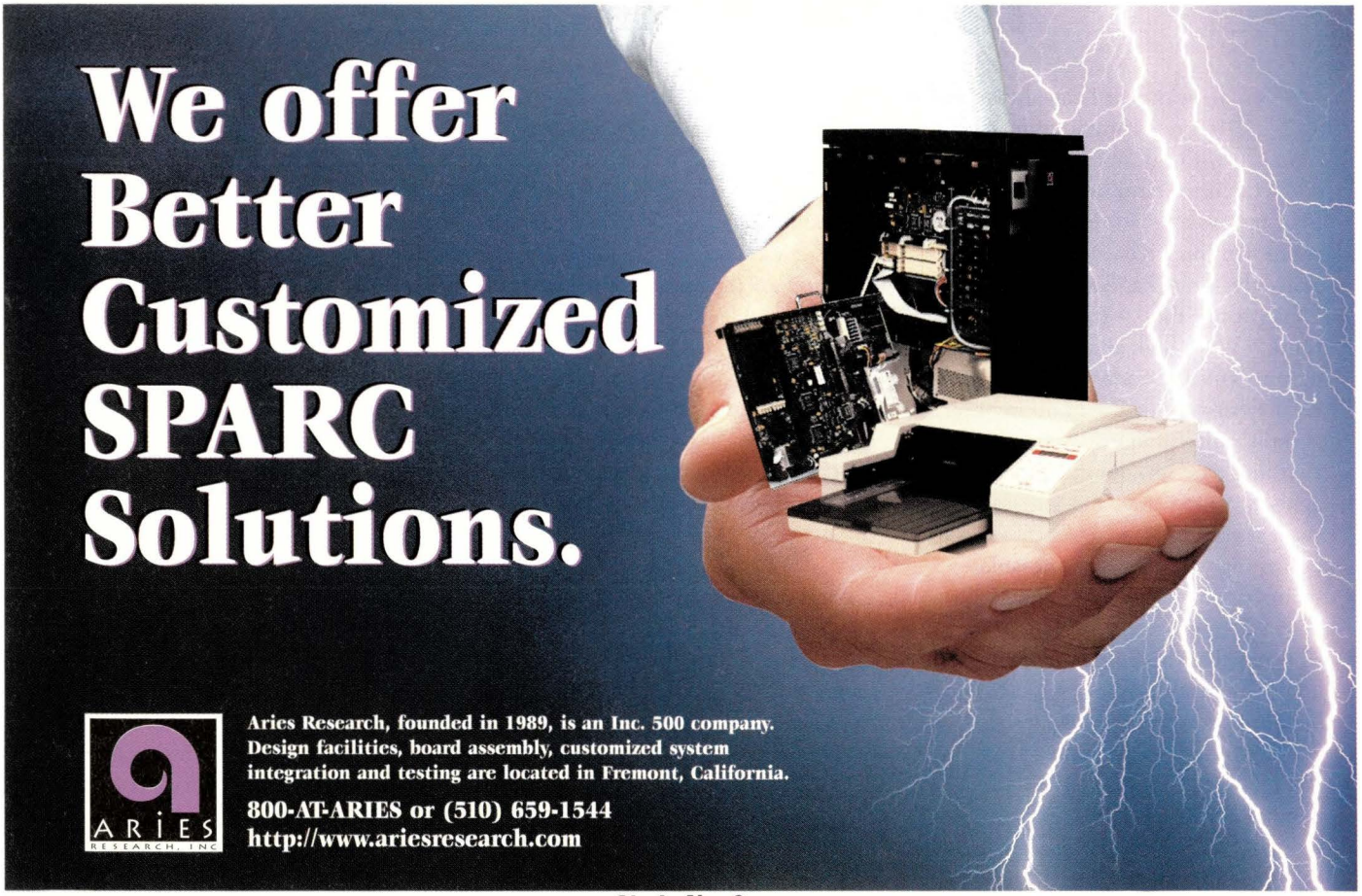
After assembling the hardware described above, I loaded in the FreeBSD CD-ROM. One or two idiot mistakes later, `freebie.cfcl.com` was a running system. As expected, it is very fast and acts a lot like SunOS. The areas where it differs are mostly due to 4.4BSD's improvements over 4.2BSD. For instance, I can no longer edit encrypted passwords into `/etc/passwd`. On the other hand, maybe I shouldn't have been doing that anyway.

I also have some reading up to do, if I hope to take advantage of Kerberos, the Union File System and some of the other nice features that 4.4BSD provides. I have already managed to create and use a 9-GB FTP mirroring partition, however, so I think I'm making progress.

Aside from the usual slew of manual pages, FreeBSD comes with a great deal of online documentation in the form of Web pages. Even though these are available on the FreeBSD Web site, I copied the pages over to a local machine so they would be readily available in an emergency. There is also the excellent set of 4.4BSD manuals available from O'Reilly & Associates Inc. and USENIX.

I also recommend O'Reilly's topical books covering the various UNIX subsystems. Finally, if you are interested in the internals of the 4.4BSD kernel, you need look no further than *The Design and Implementation of the 4.4BSD Operating System* (McKusick, Bostic, et al, Addison Wesley Inc., 1996, ISBN 0-201-54979-4). ⊷

Richard Morin *operates Prime Time Freeware (*`ptf@cfcl.com`*), which publishes mixed-media (book/CD-ROM) freeware collections. He also consults and writes on UNIX-related topics. He may be reached at Canta Forda Computer Laboratory, P.O. Box 1488, Pacifica, CA 94044 or by email at* `rdm@cfcl.com`.



Circle No. 6

by S. Lee Henry

HANK OSUNA

Inside Run States

One way that I can always impress computer neophytes with my system wizardry is to allow them to stand behind me as I boot my system. While the messages run down the screen, I murmur dispassionately "hmm" and then in a slightly higher tone "ahhh." Immediately, they think, "Wow, look at all that complicated stuff and she understands it." Little do they suspect that the booting process is really quite straightforward. After all, anything a person doesn't understand appears complicated and magical, especially if you throw in a bunch of numbers along with unpronounceable strings of characters.

If I then proceed to explain to my admirers that this computer doesn't only know "on" and "off" but has eight possible run states, they will likely smile weakly and nod their heads at roughly half the normal speed. Little do they know that run states can simply be thought of as particular configurations of running processes.

The init Process

Of course, I know that the `init` process, which runs as long as the system is running, is responsible for ensuring that all the necessary processes are running when they are needed. All the messages filling up my screen are just the result of a very predictable sequence of things that must happen before my system is ready for use. Any wizardry evident during this process belongs to the good design and not any particular prowess on my part.

The `init` process is itself controlled through commands provided in a typical colon-separated initialization file (e.g., `/etc/inittab`). The four fields in `/etc/inittab` are the entry name, the `init` states in which the command–in the fourth field–should be active, one of the ways in which the command can be run (e.g., wait for it to finish or not) and the command itself.

My favorite line in the file is this:

```
s2:23:wait:/sbin/rc2 >/dev/console 2>&1 </dev/console
```

I like this line because (a), run state 2 involves a lot of familiar processes starting and stopping, and (b), the entry "23" causes me to pause while I sort out its meaning. "Ahhh," I say (this time with genuine feeling), "this line is tells me that the processes required in run state 2 [invoked with the script `/sbin/rc2`] must also be running in run state 3!"

The options for the third field are also rather interesting. If the field says "wait," it means that `init` should wait for the command to complete before moving on. This is the most commonly used option. The `sysinit` option means that the command is run before `init` ever tries to access the console.

Notice the absence of run states when `sysinit` is specified. Some commands in the `inittab` file are specified with the option `respawn`. This means just what it suggests–the process is started

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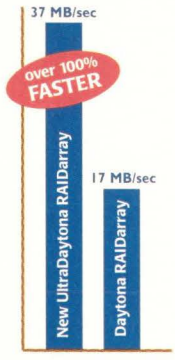

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Circle No. 15

when the system enters the particular run state and is respawned if it stops running. This ensures that some processes, like the one that keeps your console in touch with reality, continue running despite whatever else happens on the system.

Less often used options include:

`Off`	Kill the named command.
`Once`	Execute the command when entering the run state, but don't wait for completion.
`Ondemand`	Equivalent to `respawn`.
`Powerfail`	Execute if `init` receives a power fail signal.
`Boot`	Only run at boot time, and don't wait.
`Bootwait`	Only run at boot time, and wait.
`Initdefault`	The state to enter at startup (usually "3" for multiuser).

The rc? Scripts

The `/sbin/rc?` (i.e., `rc0`, `rc1`...) scripts are higher level scripts run only by `init`. Whenever the system boots or a privileged user issues the `init` command (e.g., `init 2`), the `init` process runs the appropriate script(s) as defined in the `/etc/inittab` file. These higher level scripts, in turn, invoke any number of `start` and `kill` scripts in the corresponding directories (e.g., `/etc/rc2.d`).

Could you modify the `/etc/inittab` file to do "interesting" things with your system? Well, yes, but most of the time, you'll change the processes that run in any particular run state by creating and installing run scripts in the `/etc/rc?.d` directories. These scripts control the operations of the system at a much finer granularity than the `/sbin/rc?` scripts. Each starts or stops a particular process or set of related processes.

The proper way to add run scripts to the system is to add them to the `/etc/init.d` directory and create hard links in the directories that correspond to the run state in which they should be invoked. These commands, therefore, relate the files that have the same associated inode by generating a list of run scripts in `/etc/init.d` (where they all should reside) along with the files in the `/etc/rc?.d` directories that are hard-linked to them. Let's see what scripts are set up in these directories on a typical system. To display the scripts in a useful format, I ran the commands shown below:

Figure 1. Start/Kill Script Data Sample

```
/etc/init.d/autofs
/etc/rc2.d/S74autofs
/etc/rc0.d/K69autofs
/etc/rc1.d/K68autofs
-----
/etc/init.d/nfs.client
/etc/rc2.d/K65nfs.client
/etc/rc2.d/S73nfs.client
/etc/rc0.d/K75nfs.client
/etc/rc1.d/K80nfs.client
-----
/etc/init.d/nfs.server
/etc/rc2.d/K60nfs.server
/etc/rc3.d/S15nfs.server
/etc/rc0.d/K66nfs.server
/etc/rc1.d/K65nfs.server
-----
```

```
psycho> foreach runscript (`ls /etc/init.d/*`)
? echo $runscript ? set INODE=`ls -i $runscript | awk '{print $1}'`
? find /etc -inum $INODE -print >> /tmp/rs
? echo "-----" >> /tmp/rs
? end
psycho> cat /tmp/rs
```

Figure 2. mktab awk Script

```
BEGIN { FS = "/" } { if (NR == 1) {
    print "Proc                0                1                2                3"
    print "==============     ==============   ==============   ==============   ==============="
    }
if ($0 == "-----") {
    print COL[-1] COL[0] COL[1] COL[2] COL[3]
    for (RUNSTATE = -1; RUNSTATE <= 3; RUNSTATE++)
        COL[RUNSTATE] =     "                "
    }
else {
        RUNSTATE = substr($0,8,1)
        if (RUNSTATE == "i")
                RUNSTATE = -1
        PROC    = $4
        BLANKS  = substr("                                ",1,15-length(PROC))
        COL[RUNSTATE] = PROC cat BLANKS
    }
}
```

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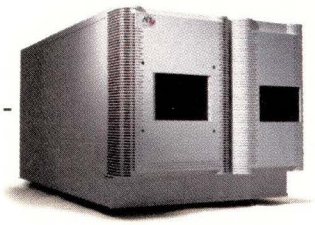

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The file names in the `/etc/rc?.d` directories start with an "S" or "K" (for start or kill) followed by a two-digit number that controls the relative sequence number for running the script. Whenever the system enters a state (e.g., 0 or 2) the `rc?` script(s) specified in `/etc/inittab` will execute the scripts in the corresponding `/etc/rc?.d` directory that start with "K" (stop argument) and then those that start with "S" (start argument). Example data collected with the commands I listed earlier is shown in Figure 1.

The "K" scripts kill processes that should not be running in that particular run state. The "S" scripts start those processes that should be running.

Each group of linked files in Figure 1 is separated by a line of dashes. I processed this file through the script shown in Figure 2 (i.e., `awk -f mktabs /tmp/rs`), which results in the table shown in Figure 3.

Notice that processes are killed but none are started in state 0 (firmware). Many start processes are invoked in run

Figure 3. Run States and Scripts

Proc	0	1	2	3
ANNOUNCE	K00ANNOUNCE	K00ANNOUNCE		
MOUNTFSYS		S01MOUNTFSYS	S01MOUNTFSYS	
PRESERVE			S80PRESERVE	
README				
RMTMPFILES			S05RMTMPFILES	
acct				
asppp	K47asppp	K47asppp	S47asppp	
audit	K42audit	K42audit	S99audit	
autofs	K69autofs	K68autofs	S74	
autofs autoinstall			S72	
autoinstall				
buildmnttab				
buttons_n_dials-setup				
cron	K70cron	K70cron	S75cron	
devlinks				
drvconfig				
gsconfig			S91gsconfig	
gtconfig			S91gtconfig	
inetinit			S69inet	
inetsvc			S72inetsvc	
leoconfig			S91leoconfig	
lp	K20lp		S80lp	
mkdtab				
nfs.client	K75nfs.client	K80nfs.client	S73nfs.client	
nfs.server	K66nfs.server	K65nfs.server	K60nfs.server	S15nfs.server
perf			S21perf	
rootusr				
rpc	K85rpc	K67rpc	S71rpc	
rtvc-config			S92rtvc-config	
sendmail	K57sendmail	K57sendmail	S88sendmail	
standardmounts				
sxcmem				
sysetup			S20sysetup	
sysid.net			S30sysid.net	
sysid.sys		S71sysid.sys		
syslog	K55syslog	K55syslog	S74syslog	
ufs_quota				
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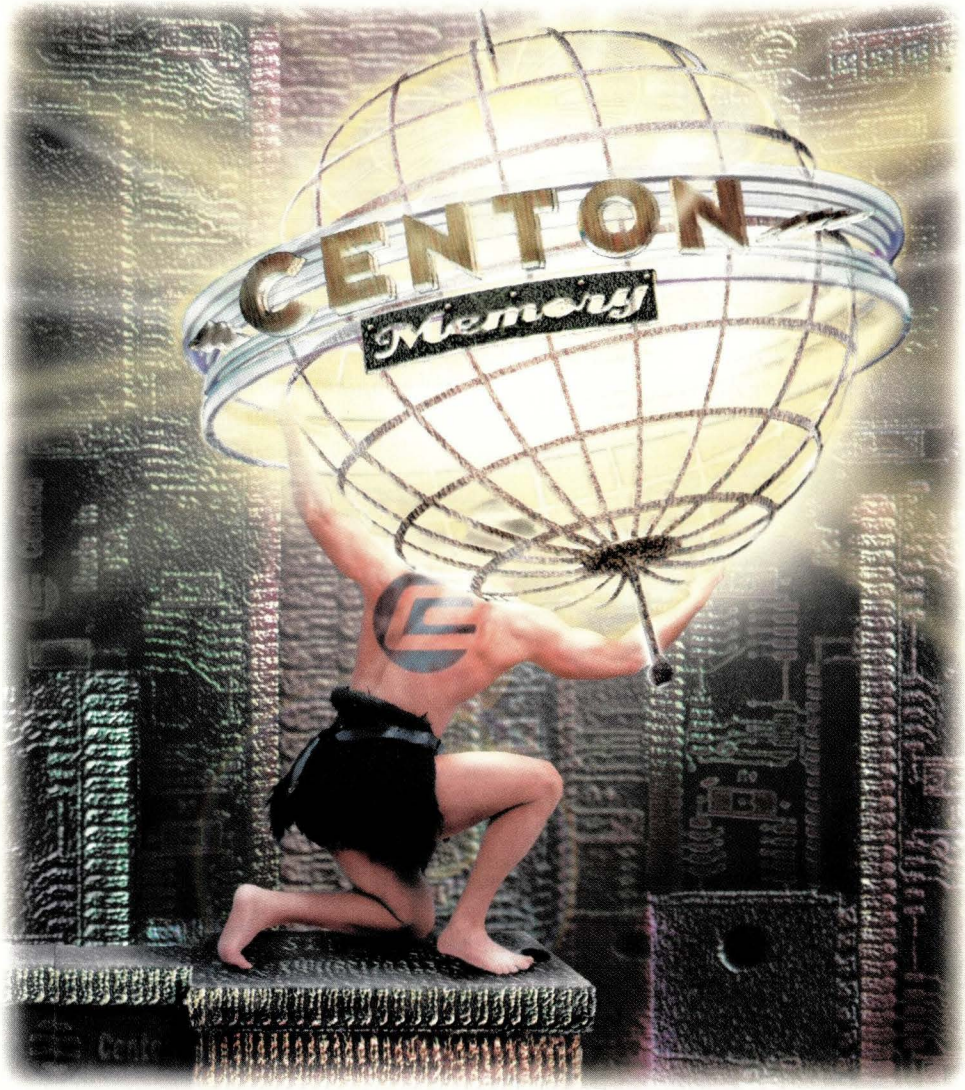

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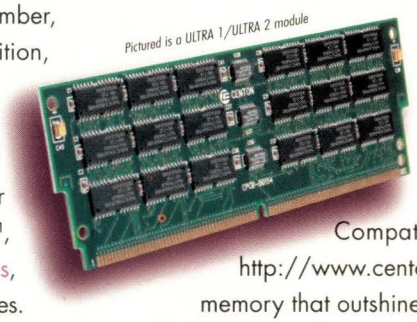

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state 2 (multiuser without shared file systems). However, almost no processes are started in run state 3 (multiuser); this is because both the `/sbin/rc2` and `/sbin/rc3` scripts are run when the system enters run state 3. Also notice that most of the services started in run state 2 are killed in run states 0 and 1. Whenever there is a start and kill script for the same process in the same `/etc/rc?.d` directory, the process is killed and then restarted.

Another interesting feature of the `rc1`, `rc2` and `rc3` scripts is their use of the `who -r` command to determine the current and previous run states. An excerpt from `/sbin/rc2` is shown in Figure 4. Notice how the actions taken depend on the response from `who -r`. The kill scripts are only invoked when the previous state was not "S" or "1" and the state being moved into is "2" (keep in mind that `/sbin/rc2` is also run when entering run state 3). The output from this command will look roughly like this:

```
psycho% /usr/bin/who -r
    .    run-level 3  May 18 10:13     3   0   S
```

The `x$9` value (ninth field in this output) is "S" and the `x$7` value is "3."

Whether or not you're trying to dazzle your friends, the proper configuration of run state scripts will allow you to best take advantage of `init`. ➸

S. Lee Henry *is on the board of directors of the Sun User Group and works as a security services engineer for Infonet (where no one else necessarily shares any of her opinions). Her current running state is California. Like her readers, she gets lots of email. Send her more by addressing it to* `slee@cpg.com`.

Figure 4. Excerpt from /sbin/rc2

```
set `/usr/bin/who -r`
if [ x$9 = "xS" -o x$9 = "x1" ] then
        echo 'The system is coming up. Please wait.'
        BOOT=yes
elif [ x$7 = "x2" ] then
        echo 'Changing to state 2.'
```

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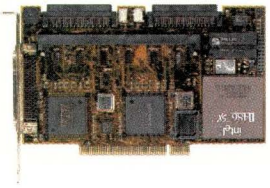

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by Æleen Frisch

ERIN TERRY

Exploring New Territory

Welcome to a new column in *SunExpert* devoted to the Microsoft Corp. Windows NT environment. The information in this column will be specifically focused for experienced UNIX users who find themselves needing to use or administer Windows NT systems as well. The number of people in this category seems to be increasing steadily over time.

Professionally, I'm a systems administrator (among other things) responsible for a variety of systems. The majority are UNIX systems of various types, but I manage an increasing number of Windows NT systems and a few other types as well. Like many UNIX people, I initially approached Windows NT with distaste and trepidation, and my first experience was not a pleasant one. I logged into a Windows NT system for the first time in early 1994. At that time, I had a lot of trouble getting the system to perform adequately and to behave in general. As a result of those first few encounters, I became extremely negative about the environment and did not touch a Windows NT system again for about three years. Last year, one of my clients needed to consider Windows NT again for their software, and I had to install Version 4 on a few systems.

Fortunately, I can now report that the current version of Windows NT is a workable operating system that is much, much improved from its early incarnations. While it is far from perfect and is missing more than a few essential features, it has its share of good points as well. At the moment, I am neither a fan nor a foe of Windows NT. My attitude–and that of this column–is best characterized by paraphrasing Marc Antony:

I come neither to praise NT nor to bury it.

You can count on me to tell it like it is.

Given my background, this column will primarily focus on information useful to systems administrators, although we'll consider nonadministrative topics from time to time. I'll also work hard to ensure that ordinary users will find much of it helpful as well.

This column is devoted to helping you find your way around the Windows NT user interface (which is the same as that used by Windows 95). We'll begin with the basics and then go on to look at some techniques and shortcuts that make getting things done easier and more efficient.

User Interface Basics

We'll start with a quick tour of the Windows NT desktop, beginning in the upper left corner of the screen with the `My Computer` icon and proceeding counterclockwise.

The `My Computer` icon serves as a starting point for all of the resources available on the local system: file systems, printers, system settings, floppy disks and so on. Opening it reveals icons for accessing each of them. There are several icons in the column underneath `My Computer`. The most important of them are:

- `Network Neighborhood` – Allows access to computers on networks with which the local host can communicate.
- `Recycle Bin` – Interim limbo

location for deleted files. You can delete items by dragging them into the `Recycle Bin`. By default, these items remain there until you explicitly empty the bin and so can be retrieved if desired.

The gray bar that runs along the bottom of the screen is known as the *taskbar*. The `Start` menu is located to its left (i.e., in the lower left corner of the screen). It contains submenus leading to commonly used tools and commands, recently accessed files, system settings, general Windows NT online help and a file system-searching facility somewhat analogous to the `find` command. It also allows access to the `Run` dialog box, which is a quick way to execute a command, start an application or display a directory listing.

Figure 1. The tray displays icons for quick access to some system services.

Icons for current applications run along the length of the taskbar until you reach the lower right corner of the screen. The area to the right of the taskbar is called the *tray*. It displays the current time as well as icons enabling quick access to some system services. A sample tray is illustrated in Figure 1. The tray on this system includes icons for accessing the sound subsystem, a screen capture utility called SnagIt and the printing subsystem. The exact icons it contains vary with the subsystems that are currently active and the configuration of and specific software installed on the system.

Windows provided by this user interface have similar capabilities to vanilla X windows: They can be iconified, blown up to full-screen size, moved, resized and closed via a menu accessed by clicking in the upper left corner of the window. The icons in the upper right corner provide another method for some of the operations. The underscore icon minimizes (iconifies) the windows, the windows (box) icon toggles between normal size and full-screen mode, and the X icon closes the window.

There are also standard keystrokes defined for window operations:

- Alt-space: Opens the window manipulation menu (known as its *system menu*). The various commands may then be accessed via a single letter (R for restore, M for move, S to change its size, N to minimize the window, X to maximize its size (full-screen mode) and C to close it.
- Alt-F4: Can be used at any time to close the currently active window.
- You can cycle through the various current windows using either the Alt-Tab or Alt-Esc key combination.
- The Tab key cycles through the various fields in a dialog box or sections of a window in the forward direction. The Shift-Tab key combination returns to the previous field or window area.

Double clicking on an icon opens it, as usual, as does pressing the Enter (Return) key when one is selected. Right

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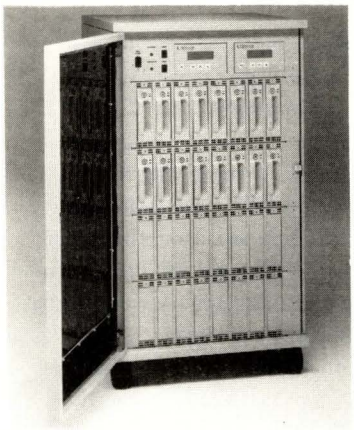

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clicking–clicking using the right mouse button–on an item brings up a context-specific menu of operations for that item; the final item on this *shortcut menu* allows you to display and specify the item's properties. Right click on `My Computer` to access the `System Properties` dialog box. Right click on the desktop to get to the `Display Properties`. Right click on the `Recycle Bin` to change the default file deletion behavior.

In fact, right clicking to manipulate an object works in many places within Windows NT; if you want to manipulate something, say, a process in the `Task Manager` list and you can't find a way to do so, try right clicking on the item.

The user interface has two graphical modes for displaying the contents of directories (as well as a command-line interface). The default mode is to browse the directory: By default, the directory is displayed as a set of icons in a window (although you can switch to a Detail view, including file sizes and modification dates, via the window's `View` menu). Opening a subdirectory in this mode results in another window containing that directory's contents by default. (This mode works like the Macintosh user interface.) This is the default view mode.

The other mode is known as Explorer mode, and it operates like the Windows 3.1 File Manager utility. Its windows are divided into two halves vertically. The left side displays the system directory tree, and the right side lists the contents of the selected directory. You can open a directory in Explorer mode by holding down the Shift key when you open it.

Basic file operations can be performed either from the command line or by dragging icons from one location to another. You start the command line by running the `cmd` command via the `Run` facility (under the `Start` menu).

Tips for Working Smarter

I think you'll find the basics of working with the Windows NT user interface quite straightforward. However, you may find that they are a bit long-winded and tedious at times. In this section, I'll pass along some tips and tricks for getting things done more quickly, with minimal fuss (and mouse clicks).

First, here are some useful key combinations for accessing items from the desktop:

- Control-Esc opens the `Start` menu.
- The Backspace key moves up one directory level when browsing.
- Shift-Delete (instead of just delete) bypasses the `Recycle Bin` for the current delete operation. You can also make this the default behavior by changing the `Recycle Bin`'s properties (right click on it and choose `Properties` from the shortcut menu). Unfortunately, there is no way to make the confirmation messages that remain go away, but a carriage return immediately appended to the delete command makes them less annoying.
- Some dialog boxes contain multiple panels (known as *tabs*). Control-Tab moves forward through the tabs in turn, and

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Control-Shift-Tab moves backward through the set of tabs.

Here are some tips for working with desktop items and browse windows:

• Shift-clicking in a window's close box (upper right corner) closes that window and all its dependent children.

• Alt-double clicking on an item immediately opens its properties dialog box. Pressing Alt-Enter when an item is selected produces the same result.

• Holding the mouse over the time in the desktop tray displays the date. Right clicking on the time allows you to set the date and/or time.

• When an item is selected, holding down the Shift key while right clicking on it adds the `Open with` item to its shortcut menu. This item may be used to open a file with any desired application rather than its default application. For example, clicking on a Microsoft Word document, Shift-right clicking and then entering `E W O` opens the file with the Wordpad editor instead of Word (the `E` selects `Open with` from the shortcut menu, and `W O` selects the Wordpad application from the resulting list).

• When browsing a directory, holding down the Control key when opening a subdirectory displays its contents in the current window rather than creating a new window. You can also make this the default behavior using the `Options...` item under the `View` menu. In general, the Control key reverses whatever default behavior you have selected.

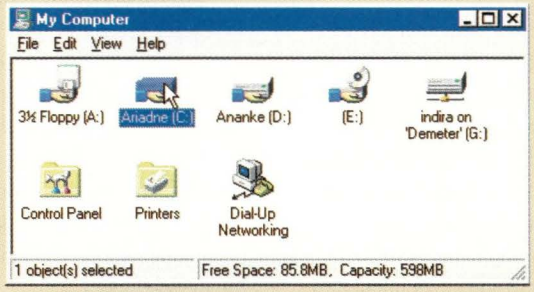

Figure 2. File system capacity, amount of free space and object(s) selected are displayed in the 'My Computer' window.

The `Run` facility (accessed from the `Start` menu) can be used to quickly initiate and perform a variety of activities, depending on the type of item you specify in its dialog box:

• A command: Runs that command.

• `cmd`: Opens a command window.

• An executable name: Starts that application (for example, `winword`), provided that the executable file resides in a directory contained in the search path.

• A document name: Starts the application associated with the document and then opens the document.

• A directory location: Displays a browse window for that directory.

There are also quick ways to get information about, and to manipulate, files and directories:

• Holding down the Control key while dragging an item forces a copy operation (depending on the context, moving the file and creating a shortcut–hard link–to it are often the default operations when an item is dragged).

• Dragging an item to a new location with the right mouse button produces a menu of operations when it is released, allowing you to specify whether you want to copy it, move it, create a link to it or cancel the operation.

• Clicking on the icon corresponding to a disk partition under `My Computer` displays its total capacity and current free space in the display area at the bottom of the window (see Figure 2). Access the partition's properties to display the amount of used space (and avoid doing the math).

• Access the properties dialog for a folder (subdirectory) to view the total number of files within that subtree and the total amount of disk space that they consume.

Finally, the Windows keys located next to the Alt keys on many current PC keyboards also provide quick access to many system features:

• Win-R opens the `Run` dialog box.

• Win-F opens the file and directory searching utility.

• Win-M minimizes all currently open windows. You can also right click on the taskbar and select `Minimize All Windows` from its shortcut menu to perform the same operation.

• Win-Shift-M reverses a Win-M operation.

• Win-Break opens the `System Properties` dialog box.

• Win-*X* selects desktop items whose names begin with the specified letter in turn each time it is pressed. Once an item is selected, pressing Enter opens it, and Alt-Enter opens its properties dialog box as usual.

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Using Command Mode

All versions of Windows, including Windows NT, are structured around mouse operations. However, they do include a command mode as well. On Windows NT systems, you can access this by entering the `cmd` command into the `Run` dialog box. This is a better method of starting a command window than using an MS-DOS prompt icon for two reasons: It is faster, and the resulting window is easier to customize.

By default, the command opens an 80-by-24-character white text on black background window. However, you can change certain aspects of its appearance and functioning. To customize the command window, right click in its upper left corner when it is open and choose `Properties`. The resulting dialog has four tabs:

- The `Layout` panel allows you to set the window size and window buffer size (the size of the scrollable region).
- The `Options` panel sets command history length (previous commands may be retrieved via the up arrow key). It also enables you to select insert mode as the default editing mode for previous commands (instead of overwrite mode), and to enable quick edit mode for copying and pasting text within a window (you do so by highlighting the desired text with the left mouse button, and then pasting it at the cursor location by right clicking twice).
- The `Font` and `Colors` panels let you select the desired font and color combination. Colors may also be set via the `/t` option to the `cmd` command.

Windows NT commands support I/O redirection via the usual notation: `>`, `>>`, `<` and `|`. They also support a few Bourne shell-like constructs: `1>`, `1>>`, `2>` and `2>>` (where unit 2 is `STDERR`). The `0>` form is equivalent to a pipe.

Commands may be joined with `&&` and `||` for conditional execution as in the Bourne shell, and parentheses may be used for grouping. An ampersand character (`&`) is used to separate distinct commands on the same line, and a space, comma or semicolon may be used to separate command arguments.

Finally, the caret (`^`) is used as a general escape character as well as to continue a command onto a second line.

An Invitation

I want this column to be useful to you. Please send me email about topics you'd like to see discussed or any other reactions you have to this and future columns. My email address is `aefrisch@lorentzian.com`. I'd love to hear from you.

Æleen Frisch *is systems administrator for a very heterogeneous network of computers and workstations. She is also the author of the book* Essential System Administration *(O'Reilly & Associates Inc., now in its second edition). In her spare time, she enjoys painting and lounging around with her cats, Daphne and Sarah. Email:* `aefrisch@lorentzian.com`.

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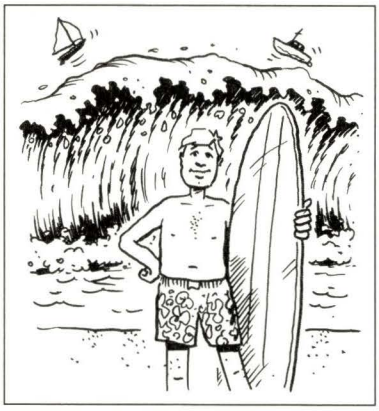

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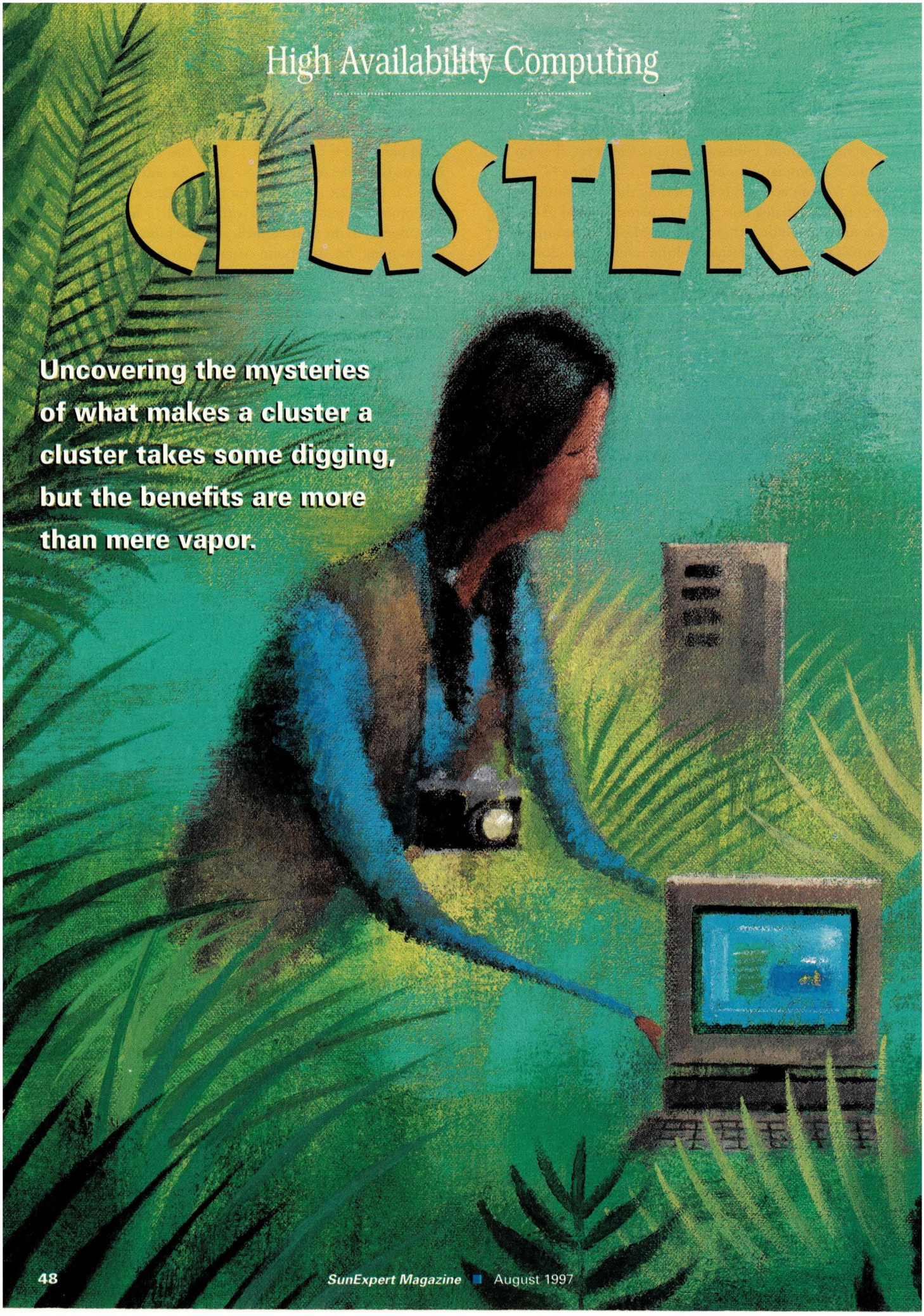
CLUSTERS

Uncovering the mysteries of what makes a cluster a cluster takes some digging, but the benefits are more than mere vapor.



IN THE MIST

by Alex Simeonides, Staff Editor

Nestled somewhere between distributed computing and massively parallel systems, clusters are a source of deep confusion in IT circles. Not only are we not quite sure what a cluster looks like, but we are even less confident about what that cluster can do.

Yet everyone and their brother seems to be hawking some sort of cluster "solution" these days: Sun Microsystems Computer Co. (SMCC) with its Full Moon initiative, Microsoft Corp. with its Wolfpack APIs and, most recently, Data General Corp. with its cluster-like AV 2000 line of servers. This new generation of clusters, vendors tell us, will solve all our problems, whether they be reliability, scalability, manageability or price/performance.

If your eyes glazed over while reading this list, well, of course, they should have. Clusters can in theory provide all of those benefits and in practice have been known

PAUL ZWOLAK

to offer a few of them in tandem. But, as the saying goes, if it sounds too good to be true, it probably is. If marketing were really being straight with us, this list of purported benefits would be accompanied by more than a few provisos.

What's a Cluster?

Anyone who's bothered to look into clusters will tell you that clusters come in a bewildering variety of shapes and sizes. At one end of the spectrum, Tandem Computer Corp., Cupertino, CA, uses a form of clustering to achieve performance and fault tolerance in its Himalaya online transaction processing (OLTP) server, which can consist of literally thousands of processors. Closer to home, Sun's two-way (for now) Ultra Enterprise Clusters provide failover capabilities for a handful of applications like NFS. Specifically, what can these diverse examples possibly have in common?

When push comes to shove, what differentiates a cluster from a vanilla LAN configuration is the kind of software you run on your cluster.

"When I talk about clusters," says Gregory Pfister, author of the book *In Search of Clusters* and senior technical staff member at IBM Corp.'s Austin, TX-based RS/6000 division, "I mean a collection of full computers treated as a single, unified resource." In other words, if you were to separate the individual nodes in a cluster, they could function on their own. Each node comes complete with its own processor(s), memory and a full copy of the operating system. Taken together, the cluster appears as one system to the outside world and can either work as a team on a single problem (i.e., parallel processing), or transparently balance a load of processes among the individual nodes.

From a hardware perspective, a typical low-end commercial UNIX cluster might look like two complete computers, each with a private local disk to store the operating system software; a shared storage disk; a private network connection for exchanging status, or "heartbeat" information; and access to a public service network running a network protocol such as Ethernet, FDDI or ATM, used to connect to network clients. In environments where reliability is important, the disks are typically mirrored (RAID Level 1) and the network connections are redundant (see Figure 1).

If you're paying attention, you're probably thinking to yourself that this cluster example doesn't sound too different from, say, your run-of-the-mill server farm. In many ways, you're right. In fact, one of clustering's most oft-touted virtues is that a cluster can be assembled from readily available, off-the-shelf hardware components, or–better yet–from workstations that already reside on your network. Of course, depending on what you plan to do with your cluster, this sort of impromptu hardware assembly may or may not be appropriate.

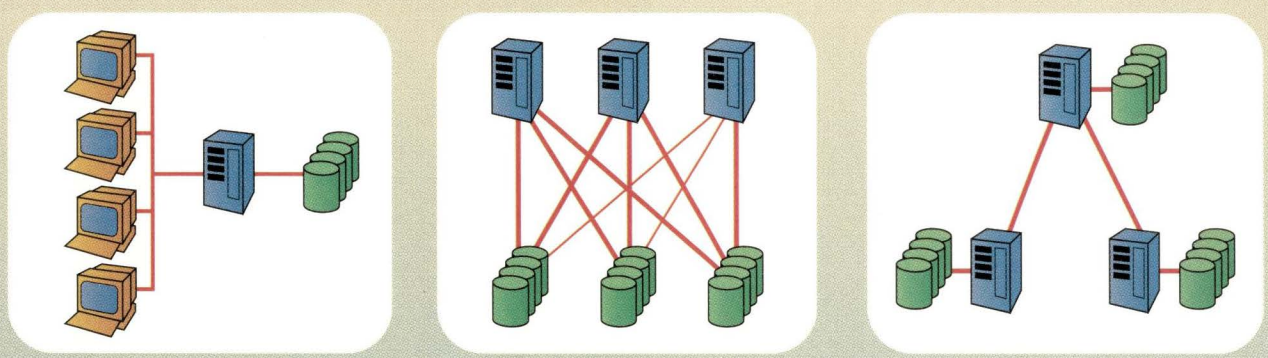
System vendors, on the other hand, downplay this characteristic and typically place very stringent hardware requirements on their clusters. As a potential customer, you will be presented with a list of certified disks, server models, networking schemes and so on. For example, in order to run Sun's Solstice HA software, you must be equipped with two specific Ultra Enterprise Server models, and either a SPARCstorage Array (SSA) or Multipack disk subsystem.

However, when your vendor insists on pushing a particular hardware design, do not think that they are trying to dupe you into buying a more sophisticated system than you really need. Even though clusters can assume very open-ended, even simplistic hardware designs, making them run in a reliable manner is another story.

"What makes clustering so hard to do," says Dan Kusnetzky, director of the Client/Server Operating Environments Program at market research firm International Data Corp. (IDC), Framingham, MA, "is that there are all kinds of error conditions and unforeseen problems that developers have to take into account." Sometimes, a vendor can only guarantee the *end* (barn-burning OLTP, for example), by way of some very specific, optimized hardware *means*.

But when push comes to shove, what differentiates a cluster from a vanilla LAN configuration is the kind of software

FIGURE 1. CLIENT/SERVER HIERARCHY VS. CLUSTER PEER FILE SYSTEMS



Client/server
One-level hierarchy

Cluster, Peer access
Physically shared disk

Cluster, Peer access
Shared access by I/O shipping

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INKTOMI: BIG USERS, BIG DATA

Most people who spend any time on the Web are familiar with HotBot (*http://www.hotbot.com*), the "HotWired Search Engine." What most people do not know is that HotBot is powered by a parallel database application. The search engine, designed and implemented by Inktomi Corp., San Mateo, CA, runs against a coupled database cluster of–for the time being–26 Sun Microsystems Computer Co. Ultra 2s, connected by a high-speed Myrinet network (160 MB/s) from Myricom Inc., Arcadia, CA.

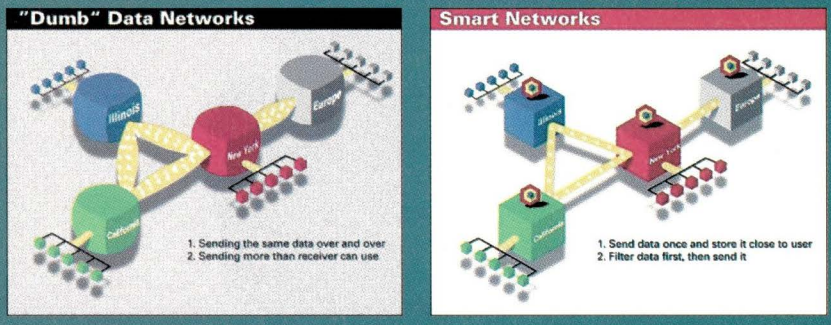
According to Kevin Brown, vice president of marketing at Inktomi, the main argument in favor of using clusters in search engine applications is the unpredictable growth curve of the Internet. "In the networked world, you have the ability to go from zero users to millions of users in a matter of a few days." Similarly, the number of documents on the Web, which HotBot indexes, also grows at tremendous rates. "We need the ability to scale to a larger database, as well as to scale to increased user traffic."

Internet demographics also point the way toward parallelism: "In the old days of parallel processing, we had few users and big data," Brown says. For example, while a weather-forecasting application might consume truckloads of data, chances were that the application did not need to consider any user other than the job's owner. "These days, we have big data and big users," Brown says. HotBot fulfills millions of query requests a day, on an index of 50 million documents, and growing.

The Inktomi architecture assumes a front end that intercepts incoming queries and redirects them to the appropriate cluster nodes, each of which "own" a segment of the database index. Node A, for example, references the index of search words starting with the letter A; node B does the same for the letter B and so on. The results of the query are sent back to the front end, which generates the HTML and returns it to the end user.

While the technology is inherently interesting, what makes Inktomi especially happy is how little money it took to assemble the necessary hardware: Brown says the HotBot equipment cost the company around $2 million–a fraction of what it would have cost to purchase a supercomputer–but that it indexes almost two times the number of documents as AltaVista, its closest competitor. "We're looking at between three to five times price/performance here."

Of course, a big part of Inktomi's magic is its ability to write the necessary parallel applications–a job that, by all accounts, is hard to do. As a n ext step, therefore, Inktomi will begin selling a turnkey "Traffic Server," an Internet cache aimed at Internet service providers who want to reduce their telecommunications charges. "There are estimates that between 40% and 80% of data requests over the Internet are redundant," says Brown. "Our partner OzMail in Australia runs the local search engine Anzwers (*http://www.anzwers.com*). By using a cache to store their data, they estimate that they are saving between 25% to 30% on recurring telecom charges."–*as*



The Inktomi architecture (right) assumes a front end that intercepts incoming queries and redirects them to the appropriate cluster nodes.

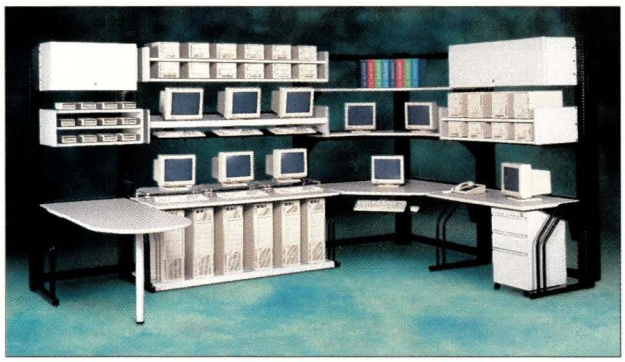
you run on your cluster. As Pfister writes in *In Search of Clusters*, "Hardware provides potential, and potential alone; fulfillment lies in the software." To that end, let's take a look at the some of the software applications that are available to commercial cluster users.

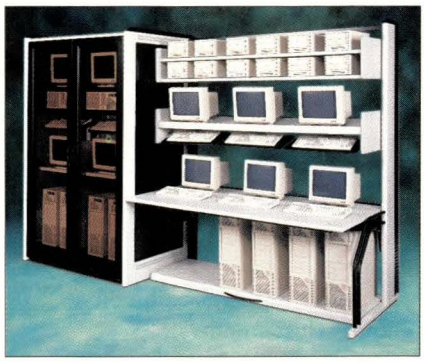
The Quest for High Availability

Availability, reliability, whatever you want to call it, the commercial UNIX users yearn for the same 99.9% uptime that they could depend on from their mainframes. So it didn't take the world long to realize that clusters, with their multiple nodes, are inherently less vulnerable to failure than an all-or-nothing symmetric multiprocessing (SMP) server. As a result, a whole new class of software has sprung up: HA (high availability) software.

Availability is hands down the single most important factor driving cluster sales in midrange UNIX environments, experts say. This is reflected in the attendant marketing focus of most preassembled cluster solutions. "I'd say that 99% of people need clustering for reliability reasons," says Eric Schott, who manages Digital Equipment Corp.'s Digital UNIX cluster and storage management efforts. Phil Sullivan, cluster marketing manager for IBM's RS/6000 division, estimates that only 10% to 15% of cluster purchases are made to run a parallel database, the likes of Oracle Corp.'s Oracle Parallel Server. And in the Sun market, things are no different, says Victor Nemechek, worldwide practice leader at SunService, SMCC's service and consulting arm. "At the outset, a cluster definitely reflects a safety-first mentality," Nemechek says.

Over





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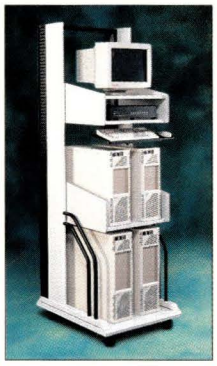

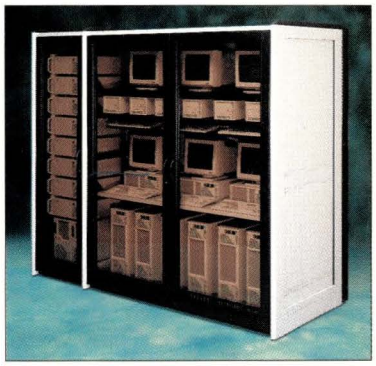

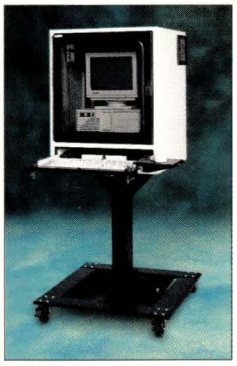

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How then do you achieve this highly available state? Specifically, what sort of software do you need to run, and what does it promise you?

In general, availability clusters are running some sort of failure detection software on all the nodes. This software broadcasts each individual node's application and system-level status information to the other nodes in the cluster–the so-called heartbeat. Once a fault has been detected, the remaining healthy nodes in the cluster initiate action, for example, induce a power-on reset, or relaunch the application on another cluster node(s).

F5 Labs' BIG/ip does not market itself as a clustering product but, instead, as a single-purpose turnkey system running on an optimized UNIX OS.

System vendors typically bundle a failover product with clusters, for example, IBM with High Availability Cluster Multi-Processing (HACMP), Hewlett-Packard Co. with MC/ServiceGuard, and Digital with the TruCluster Availability Server. Sun's high-availability offering is part of the company's management suite, Solstice HA. In its current release, 1.3, Solstice HA is able to detect a system- or application-level fault in one of two sister nodes and then restart the application on the sibling. Application failover is only available on special "cluster-aware" applications, namely, NFS and Internet Services, and optionally for Oracle 7, Sybase Inc. SQL Server 11 and Informix Software Inc. Online 7.

Third parties also sell cluster failover software for the UNIX midrange market. These include Veritas Software Corp., Mountain View, CA, with its FirstWatch product, and Qualix Group Inc., San Mateo, CA, with QualixHA+. Unlike the hardware vendor solutions, these packages are not limited to a single platform and, in many cases, can support a greater range of cluster-aware agents. In addition, both Veritas and Qualix provide an open API for anyone who wishes to add failover capabilities to a nonsupported application.

Load-Balancing Clusters

Another common commercial use for clusters is to maximize the efficiency of compute resources–sometimes referred to as workload management. This is typically achieved by running some sort of load-balancing or scheduling software that assigns jobs to the most appropriate node in the cluster at the given time. Scheduling can be based on any number of possible criteria, the most common of which includes a job's priority level, or a node's CPU utilization.

Take, for example, two cluster-enabling products that do not market themselves as such: BIG/ip from F5 Labs Inc., Seattle, WA, and Resonate Dispatch from Resonate Inc., Mountain View, CA. These products, which play in the Web server market, address a large site's need to dynamically assign incoming HTTP requests to a particular server, without the end user being made aware of the fact. BIG/ip is a Web "appliance" (in this case, a single-purpose turnkey system running on an optimized UNIX operating system). Resonate Dispatch is a pure software solution, which runs on Sun Solaris. Both products do essentially the same thing. According to F5 Labs, BIG/ip enables "a series of stand-alone servers to act like a single scalable server delivering content to a user fast and reliably."

Other, more traditional, examples of these sorts of applications include batch job queuing and interactive login. Batch processing and clusters seem to be tailor-made for one another, particularly in the realm of compute-bound scientific and technical applications. Commercial batch jobs, on the other hand, typically place heavy I/O demands on the system, which a given cluster's hardware configuration may or may not be designed to handle. Interactive login, whether it be to an OLTP or database subsystem, or user login into an operating system, is also a very common use of clustering.

Today's market supplies several off-the-shelf commercial products to fill these needs. IBM, for example, has the LoadLeveller. Sun, meanwhile, bundles a third-party offering with its Ultra HPC (High Performance Computing) servers, called LSF, or Load Sharing Facility, from Platform Computing Corp., Toronto, Ontario (see "RAID 7 Storage Unit and Load-Sharing Tool for Clusters," Page 58). Again, like the Veritas and Qualix failover products mentioned above, one of LSF's principal virtues is the fact that it runs on a variety of hardware and operating system platforms. According to Songian Zhou, Platform's chief technical officer, support for heterogeneous systems should top a potential customer's list of priorities. "If I were an IBM shop, I'd be very worried about going with HACMP. What if one day I were to want to add a non-IBM node?" Zhou says.

A key benefit of these workload management applications is that they enable you to take advantage of your cluster resources without needing to change the underlying applications in any way. This, as we'll see in the next section, differs dramatically from the other commercial class of cluster applications: parallel applications.

Parallelizing Clusters

In the past five years, processor speeds and interconnect bandwidth have both increased to the point where clusters are beginning to take on the parallel processing workload usually relegated to massively parallel processing (MPP) systems like those once made by Cray Research Inc. and Thinking Machines Corp. Granted, MPPs still play an important role, especially for Grand Challenge problems–problems whose solution the U.S. government considers to be of major scientific or commercial value, but that require teraFLOP levels of computation. However, in lesser technical, academic and commercial

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realms, clusters are an increasingly viable (and comparatively cheap) system on which to deploy parallel applications.

In the scientific realm, there are a number of parallel applications to choose from. In the commercial world, however, you can count them on one hand: Oracle Parallel Server, Sybase MPP and Informix Online XPS (Extended Parallel Server). These parallel databases appeal to heavy OLTP, data warehousing and data mining sites that require a high level of uptime.

Oracle uses a decidedly different architecture than Sybase or Informix in its cluster implementations; Oracle relies on a "shared-disk" architecture, whereas Informix and Sybase take the "shared-nothing" approach. Yet all three are attempts to solve the same problem: How can you enhance a database so that it is not subject to either the scalability limitations of an SMP system or, for that matter, the risk of SMP downtime?

With an SMP system, the minute your database becomes too big for its britches, your only option is to buy another, faster machine. "This is what the industry refers to as the 'forklift upgrade,'" explains Scott Rupel, vice president of marketing at G2 Networks Inc., Los Gatos, CA, maker of Fibre Channel products. "You need a forklift to come in and pick up the old machine and bring in the new one." Clusters, on the other hand, let you avoid that trauma: To extend your cluster's performance, simply introduce another node into it. Also, no matter how many mirrored disks, redundant power supplies or hot-swappable fans you equip your SMP server with, if the system experiences a software fault, no level of hardware redundancy is going to bring your data back up online.

In a Sun cluster, running a parallel database requires that you equip your nodes with basic cluster management software–Sun's PDB (Parallel Database) software. Synchronization between the nodes, on the other hand, is handled directly by the database–in Oracle's case, by its Distributed Lock Manager, and in case of Informix and Sybase by an interserver messaging protocol. These coordination efforts are at the heart of what makes programming in parallel so difficult.

Database vendors have already done the work of making their software parallel for you, which makes the prospect of running a parallel application feasible to a substantial portion of large organizations. But beware, experts say, you'll still need some specialized knowledge about how to partition your database, and how to administer it in a cluster environment. Without that foundation, you could actually make the database run slower than before!

In the End...

This is not the last you'll hear about clusters. If in the past, hardware vendors preferred to direct performance-impaired clients toward ever larger SMPs, these days, performance and availability demands have arguably exceeded the architecture's ability to deliver. Vendors are catching on to this fact, as well as tuning into the market's frustration with the two-year life span typical of open systems hardware.

And don't worry if your pet application doesn't appear on this list of commercial cluster uses, with both Microsoft and Sun promising to deliver cluster APIs in the next year, don't be surprised to see a whole new class of applications running on this emerging architecture (NetDoom, anyone?). ⊸

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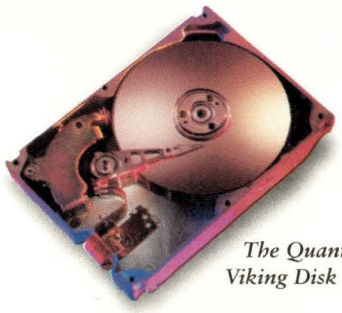

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RAID 7 Storage Unit and Load-Sharing Tool for Clusters

by **IAN WESTMACOTT**, Technical Editor

We tested a RAID system that, properly configured, can all but guarantee against the loss of data, and a simple way to get increased computing power from a cluster of networked systems.

Storage Computer RAID 7 Storage Server

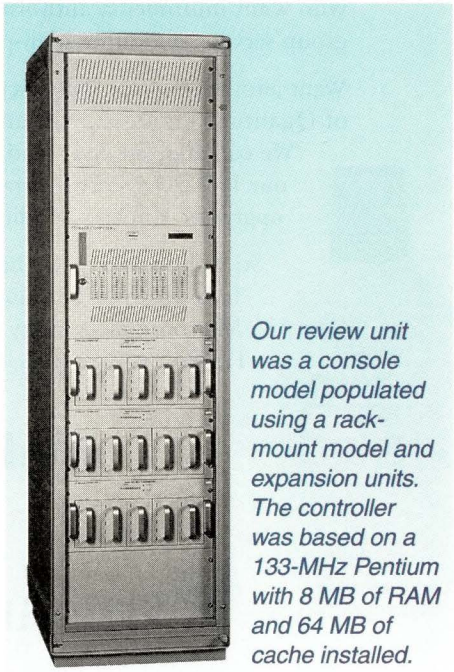
The Storage Computer Corp. RAID 7 Storage Server comes in three models: a desktop unit that accommodates two host channels and up to 12 disks, a rack-mount unit with up to four host channels and 27 disks, and a console unit with up to 12 host channels and a total of 48 disks. The controllers are based on an Intel Corp. Pentium processor with up to 32 MB of RAM (8 MB standard) and up to 64 MB of cache memory. Both single and differential SCSI host channels are available in wide and narrow formats, in addition to Ultra SCSI and FC-AL. All three models are modular and come in $3^1/_2$- and $5^1/_4$-inch disk versions, with expansion units sold separately. Options include nonvolatile RAM cache, to cache data during power outages and system failures, and Storage Administrator SNMP management.

RAID 7 refers to a patented Storage Computer architecture in which data is block-striped across the array of disks, with parity information written to a single dedicated drive or striped across any subset of drives in the array. This RAID architecture is said to perform large reads and writes faster than Level 3, and small reads and writes faster than Level 5 (see "RAID Level 7"). The RAID 7 Storage Servers employ a scalable distributed cache memory design and a real-time operating system environment with real-time performance monitor and system diagnostics.

Our review unit, a console model, was populated using a rack-mount model and expansion units. It had an R3x, 18-slot, $3^1/_2$-inch disk rack-mount model and one R3E, 9-slot, $3^1/_2$-inch expansion unit. Only the R3x was populated with drives, however, for a total of 18 drives. The controller was based on a 133-MHz Pentium with 8 MB of RAM and 64 MB of cache installed. Also included was a VGA monitor/keyboard module connected to the controller for monitoring and configuration. We connected the server to a Tatung Science & Technology Inc. U2-2200 running Solaris 2.5 for testing.

At 24 inches wide by $35^1/_2$ inches deep by 61 inches high and weighing approximately 500 lbs., the console model requires a little preparation for installation. Ventilation flows from the rear to the front, so the unit may be placed side-by-side with other equipment. The console model requires a 120-volt 30-amp twist lock power feed (the 220-volt version requires termination supplied by the user). With a large array of ventilation fans and disks, the unit outputs a noise level up to 90 dB. Thus, the console unit is best installed in a data processing center or other environmentally controlled computer room.

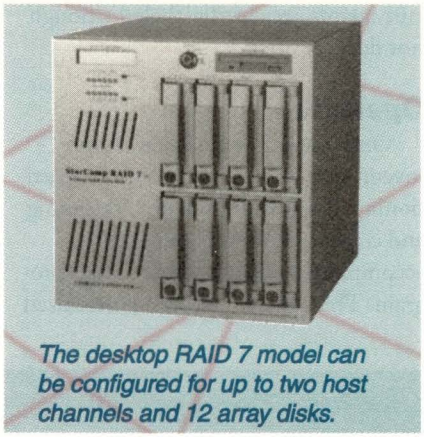
If the unit is ordered with disks (either SCSI I or SCSI II with internal termination are usable), these are provided separately, and must be installed



Our review unit was a console model populated using a rack-mount model and expansion units. The controller was based on a 133-MHz Pentium with 8 MB of RAM and 64 MB of cache installed.

by the user or by Storage Computer. Storage Computer performs on-site installation at no extra charge. The installation amounts to simply sliding the disks into disk slots. Each slot has its own key for securing the disk. The console unit also has a lockable glass panel door. Once the disks are installed, diagnostics and inventory must be performed, followed by configuration and parity generation. Each controller includes a $3^1/_2$-inch floppy disk drive, and the setup and diagnostics programs are provided on MS-DOS diskettes.

The entire procedure is straightforward, and we had the unit up and running in several hours (most of this time was spent running diagnostics and inventory). We found the user manual to be lacking, however. Although it outlines the procedure fairly well, it does little to explain functionality. For example, the total drive capacity of the unit may be partitioned among the available host channels and the SCSI IDs within those channels. Setting a channel/ID to zero allocated space disables that SCSI ID, while setting it to some positive number enables the ID. This is not explained anywhere in the documentation, and we spent some time looking for enabling/disabling switches for the IDs (after encountering ID conflict problems).



The desktop RAID 7 model can be configured for up to two host channels and 12 array disks.

Besides the floppy drive, the front panel includes a 48-character LCD status display. This panel provides runtime status, initialization and error messages. In addition, each drive slot includes LED activity lights with six states to indicate various states of the drive. Each of the hot-swappable power supplies, including a hot spare, also has an LED indicator for failure, and a ventilation fan failure is indicated by all power supply LEDs illuminated simultaneously. The RAID 7 provides a 4,800-baud serial port for remote TTY serial connections to collect Performance Monitor information. A PC/AT DIN keyboard connector and VGA video connector are also provided.

The Performance Monitor utility provides access to system messages, host channel statistics (including transmission speeds, errors, record size, etc.), disk statistics (number of reads/writes, etc.) and system activity statistics (including drive, cache and host activity). The manual is fairly complete in addressing troubleshooting and failure resolution. It also includes brief instructions for specific host types, including Sun Microsystems Computer Co. SPARC/Solaris, Hewlett-Packard Co. HP 9000/HP-UX, IBM Corp. RS/6000/AIX, Digital Equipment Corp. Alpha/Digital UNIX and Intel/DOS systems. The manual also provides a 24-hour bulletin board number and FTP site for Storage Computer.

Our unit arrived with differential SCSI I/O boards, and we needed single-ended to use with the U2200. Storage Computer promptly sent us the correct boards, and installing them

RAID Level 7

Storage Computer, a RAID Advisory Board (RAB) member, has submitted its RAID 7 description to the RAB. The RAB and its *RAIDbook* define various RAID nomenclature, such as RAID levels, to help users in buying decisions. Each RAID level describes a storage architecture, so that different level numbers indicate different architectures and not necessarily their relative merits.

RAID Level 7 is intended for transaction-processing-request-intensive and data-transfer-intensive applications. Inquiry transaction processing, office automation and online customer services are examples of such applications. Applications with large data objects, such as CAD and GIS, are also suitable for Level 7.

According to the definition, a RAID 7 array must have the following characteristics:

- The array must behave functionally as a single disk.
- The array must continue to function (respond to application I/O requests) in the event of a single member drive or path failure.
- The array must be capable of member disk reconstruction concurrently with application I/O.
- The array must be capable of simultaneous I/O operations whose data addresses map to distinct array members.
- The array management software must be capable of asynchronously managing a central memory component, distributed CPUs, dedicated drive buffers, distributed hosts, high-speed bus on each host interface and a control bus.

Optional RAID 7 features include:

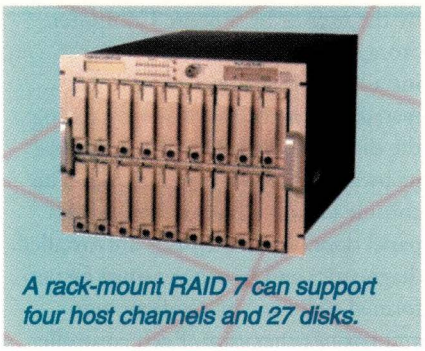
- Cold, hot, warm and automatic swapping failed disk replacement modes.
- Support for I/O performance enhancements (e.g., logging).
- Support for heterogeneous drive types and sizes in the same array.
- Support for expanding array without full reinitialization.
- Redundant components.
- Support for multiple virtual disk partitioning.
- Support for multiple hosts.
- Automatic hot-spare power up.
- Automatic reformatting.
- Support for single or multiple drive parity.

Because each member of a Level 7 array has independently controlled memory and CPU resources, many small I/O requests may be performed concurrently and independently, and large I/O requests achieve higher transfer rates because involved member disks can transfer data concurrently.–*iw*

gave us an opportunity to get inside the unit. Engineering inside the unit was impressive. We did not come across even the slightest manufacturing defect, and all components are both easy to get at and easy to replace. Each module in the console is mounted on locking gliders, so these are easily accessible. Cable management was good (with up to 48 disks, there are a lot of cables) and circuit boards are clearly labeled (though not documented).

Operation

Once the drives are installed and inventoried, system configuration (partitioning of drives, RAID level, operating and communication parameters) is accomplished with a software setup program. This software writes a customized boot file for the unit and so can be run on any Intel PC or the internal CPU if a monitor/keyboard is attached. The boot file is written to an MS-DOS diskette used to boot the system.



A rack-mount RAID 7 can support four host channels and 27 disks.

The system configuration setup software is full-screen (text), menu-based and fairly intuitive. Systemwide parameter options accessible via the setup program include data drive count, stripe granularity, DRAM and SRAM prefetch, reconstruction mode (offline, force write through, low- and high-priority interleave), speed, parity check options, SCSI format command response and whether to negotiate drive sync. Target parameters include host channel, target ID and LUN, write acknowledgment, host type and operating system, and SCSI features such as sector size, command tag queuing support, SCSI mode and width. Setup configurations can be printed and saved.

After creating a configuration boot image, the system is booted using the image. You then attach and boot the host and mount the drive(s). While running, the front-panel LCD display indicates status, and the drive LEDs indicate activity and state. Continuous status messages are sent to the video and serial ports, and the Performance Monitor screens are accessible with hot keys.

Performance

Running in RAID Level 3, the unit performed 50-MB UFS writes at an average 10.42 MB/s, and (10) concurrent 10-MB UFS writes at an average 7.41 MB/s. Raw 80-MB writes to the array achieved 10.76 MB/s. The UFS numbers indicate out-of-box application-level performance for applications that perform

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Circle No. 32

disk I/O through the file system. Some applications do not use the file system, but rather perform raw reads and writes to the disk. Most notable among these are larger database applications.

When faced with a disk failure, the system does not produce any audible alarm, but the front-panel LCD and attached monitor indicate drive failure, and the failed drive's LED glows red. The system will attempt to reconstruct the failed drive on a hot spare automatically if so configured, and progress is indicated on the front-panel LED and attached monitor. When a failed drive is replaced, the system is supposed to detect this and commence reconstruction. However, in our tests, the system failed to detect a replaced drive until a system reboot was performed. After reboot, reconstruction commenced normally.

The RAID 7 Storage Server is designed for large, high-availability applications, and is well equipped for the job. With a large range of hardware and software options, including WAN failover options, the system is easily tailored for most physical and logical requirements.

Overall, the system is well constructed with high-quality parts, accessible components and good engineering. Management and diagnostic software is well-thought-out and easy to use. Properly configured for an application, this system can all but guarantee against the loss of data and can be tuned for impressive performance.

RAID 7 Storage Server

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Circle 162

Platform Computing Corp. Load Sharing Facility (LSF)

In March, Sun Microsystems Computer Co. announced the Ultra HPC (high-performance computing) servers, a set of systems based on the Enterprise Server line, with bundled components targeting the high-performance and technical markets. One of the primary components of these packages is the Load Sharing Facility from Platform Computing Corp., which provides system software to use collections of servers in various ways. We took LSF Version 3.0 for a test drive around a heterogeneous network to gauge its functionality and usability.

LSF is a suite of components that may be installed in various combinations. The suite includes LSF Base (the only required component), which includes the network servers, the LSF API and load-sharing tools; LSF Batch, which provides distributed batch job scheduling; LSF JobScheduler, a production distributed job scheduler; and LSF MultiCluster, which enables multiple LSF clusters to share workloads. All components run in a cluster of systems, which may be heterogeneous.

Supported platforms include Convex Technology Center C-Series; Cray Research Inc. J90, T90 and C90; Digital Equipment Corp. Alpha/AXP; Hewlett-Packard Co. HP 9000 and Exemplar; IBM Corp. RS/6000 and PowerPC; Intel Corp. systems running Linux 1.2.13 with ELF binary support or Microsoft Corp. Windows NT; and Sun SPARC. Required disk space ranges from 1 to 100 MB, depending on the system.

The LSF suite of components constitutes a complete distributed system software execution and development environment. On top of the supported operating systems, LSF provides load-sharing and resource management servers, an API for these services and a set of utilities and applications.

Load Sharing, Batch Queuing

If you are familiar with systems such as Distributed Queuing System (DQS), Network Queuing System (NQS), Parallel Virtual Machine (PVM) or Aggregate Computing Inc.'s Netshare, then the operation of LSF will be nothing new. The central idea behind distributed queuing, load sharing and virtual machine systems is to use a collection of distinct computers and their resources as a single, virtual computer. This is accomplished by defining a set, or cluster, of computers, either all of the same type (homogeneous) or of various types (heterogeneous), as the virtual machine. Each member of the cluster runs server software that monitors the resources of the member (CPU load, free memory, etc.), communicates with other servers in the cluster, and performs tasks on behalf of the cluster. In this case, LSF Base performs this functionality.

Once the cluster is defined and the servers are up and communicating, the cluster may present itself to users as a single virtual machine offering a number of different services. In other words, the virtual machine may present itself as one large computer possessing the sum total resources of its constituent members. A cluster containing six single-CPU machines with 128 MB of memory and four dual-CPU machines with 256 MB of memory may act as a single shared memory parallel processor with 14 CPUs and 1,792 MB of memory. Systems such as PVM work along these lines.

The LSF API provides some support for parallel applications, by allowing tasks to be executed remotely, either synchronously or asynchronously. In addition, the LSF Batch component has facilities for supporting PVM, MPICH (a Message Passing Interface implementation by Argonne National Laboratory and Mississippi State University supporting both TCP/IP and IBM's Message Passing Library), and IBM Scalable POWERparallel 2 parallel operating environment jobs. Wrapper scripts and starter programs are provided with the distribution.

Another service such a virtual machine might offer is batch queuing, much like batch processing performed in mainframe systems. The virtual machine may define one or more queues to which jobs may be submitted. Jobs in the queue are executed in batch, as with any normal batch queuing system. The advantage of the virtual machine is that it is a distributed queuing system with load sharing built in. That is, when the machine goes to execute a job in the queue, it can run that job on the cluster member with the lowest load, for example.

Furthermore, queues and jobs may have attributes associated with them. For example, you might specify that a job may only run on a machine with at least 128 MB of free memory. Or in a

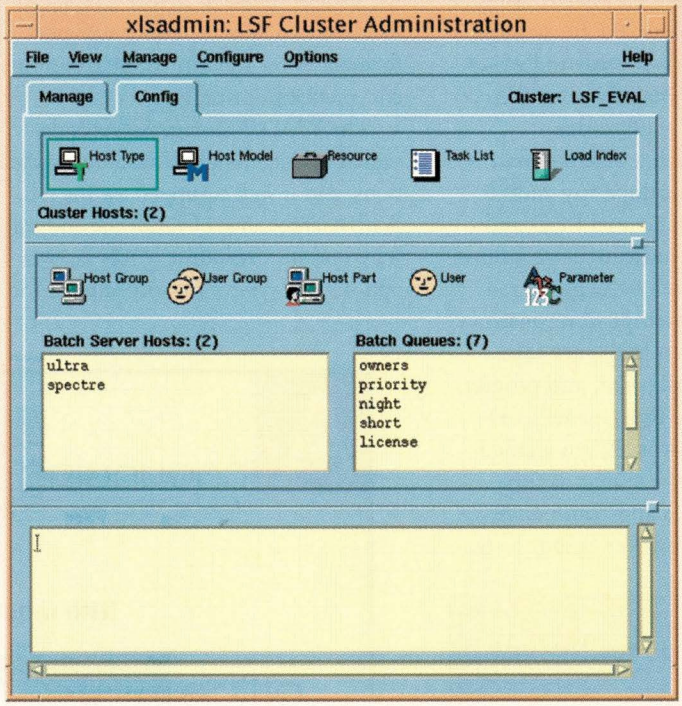

Figure 1. Cluster administration with Platform Computing's LSF is as simple as point-and-click.

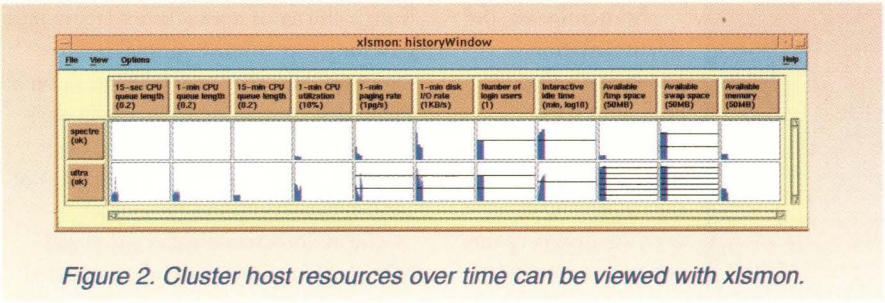

Figure 2. Cluster host resources over time can be viewed with xlsmon.

heterogeneous cluster, you might specify that a job only run on a SPARC CPU or AIX operating system. Special queues may be set up that only run their jobs on particular machines or at particular times (such as night or weekend hours), and both queues and jobs may be assigned priorities that affect their scheduling. Distributed batch queuing functionality is provided by LSF Batch and LSF JobScheduler.

LSF Concepts

With LSF, a cluster is created by installing the LSF Base component on each of the computers that will be members of the cluster. LSF Base provides basic load-sharing facilities, including the Load Information Manager (LIM) for member resource management, the Remote Execution Server (RES) for providing remote execution services, the LSF API and basic utilities for running load-sharing applications. Also included with LSF Base are `lstcsh`, a load-sharing version of the `tcsh` command shell, and `lsmake`, a load-sharing `make` utility. `Tcsh` transparently executes commands on faster or slightly loaded hosts, and `lsmake`, based on GNU `make`, supports parallel execution (much like `dmake`).

While members of a cluster may make use of cluster resources, other computers on the network that are not part of the cluster may also use cluster resources. The distinction is that jobs or applications running on the cluster may use resources of any cluster member except nonmembers. Thus, low-performance or heavily loaded computers may use cluster resources without participating in the cluster itself.

The LSF Batch component provides distributed batch queuing on top of, and by way of, LSF Base system services. A set of cluster members (they need not all be members) are designated as batch servers, one a master and the rest slaves. The batch servers are the machines on which batch jobs may be run (unlike remote execution, which may use any cluster member). LSF Batch also interoperates with NQS, by configuring LSF Batch queues to forward jobs to NQS hosts.

The batch system defines one or more batch queues, to which batch jobs may be submitted. For each defined queue, a large number of tunable batch resource parameters may be set, such as the times at which jobs in the queue may run, the priority (nice) level at which jobs in the queue are executed, load thresholds such as how much CPU time, memory and file space a job may use, which users can submit jobs to this queue and so on. Once the batch hosts and queues are defined, users may submit jobs. The batch system schedules queued jobs for execution based on a complex analysis of the job attributes, queue attributes and batch server attributes.

The LSF JobScheduler component adds calendar and event-driven scheduling to the LSF Batch component. Central to the JobScheduler is the ability to define arbitrary events, which may then trigger the execution of batch jobs. For example, you may set up a batch job that backs up a system to tape, and then "schedule" that job to execute whenever the tape drive goes online. The tape drive going online is an event, which triggers the execution of the job. Other types of events include time events defined by calendars, job events such as the starting or completion of a job, and file events in which a file's status changes (updated, deleted, created and so on).

LSF 3.0 supports Microsoft's Windows NT operating system on Intel Pentium-compatible hardware. LSF on NT requires the use of domain accounts, the NT file system and fixed IP addresses (no Dynamic Host Configuration Protocol). In addition, user passwords must be maintained in an LSF database as well as usual NT user management.

While LSF supports mixed UNIX and NT clusters, LSF on NT has the following restrictions: no support for remote execution, NQS, checkpointing, resource limits other than CPU time, account mapping, job control actions, NT user groups or interactive batch jobs. There is no MultiCluster support on NT, and there are no GUIs.

Installation, Documentation

If you have ever used any type of virtual machine or distributed batch system, particularly in a heterogeneous cluster of servers and workstations, then you know that installation, configuration and

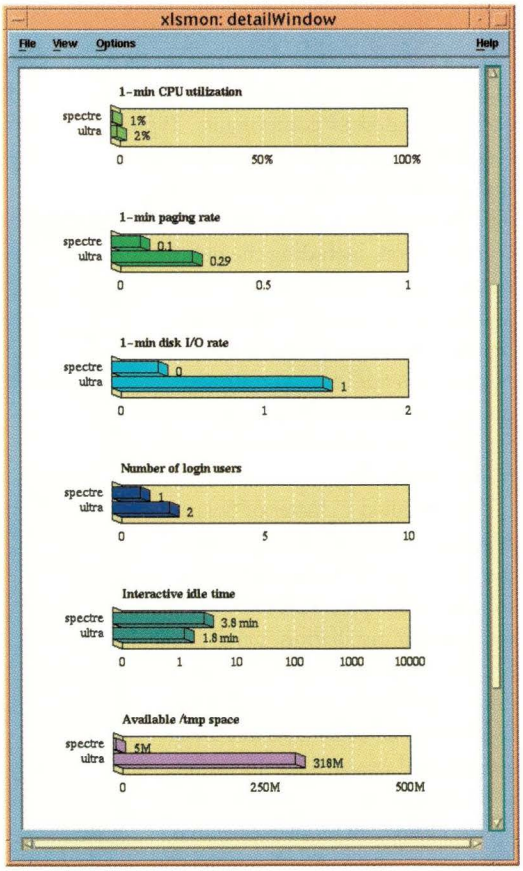

Figure 3. LSF includes utilities that offer detailed resource utilization figures.

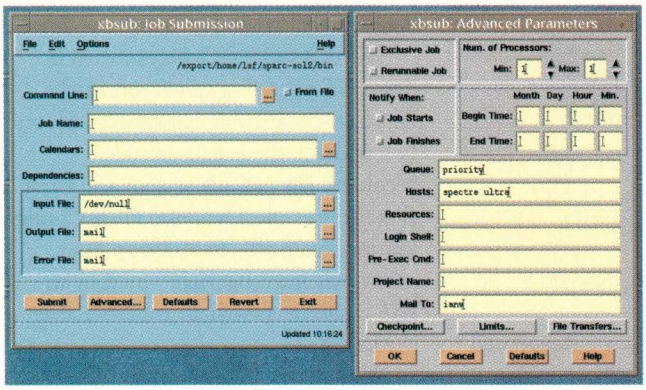

Figure 4. The xbsub utility can be used to define and submit batch jobs.

debugging is tricky at best, and downright maddening on average. I recall the installation of DQS on a 50-workstation cluster of AIX, IRIX, Ultrix and OSF/1 systems required the better part of a month to work out all the kinks. One of the greatest services a commercial product of this type could provide is simplification of installation and management.

With LSF, we found something in between. The UNIX versions of LSF are distributed in compressed TAR format, while the NT version is provided in ZIP format. For each host type (including NT), a complex script file is run on each cluster member to set up and configure each of the desired components. Typical installations will also NFS-mount the distribution on all cluster members. The install script guides you through configuration, including the definition of cluster members, host types and resources (example usable configurations are provided for common systems). In addition, you must update your TCP/IP configuration for LSF services. FLEXlm is used for runtime licensing.

We installed a cluster of Solaris, AIX and NT systems, which took the better part of a day. We were somewhat disappointed with the script-based installation, particularly because the documentation is sometimes vague regarding installation issues (in such cases we chose whatever seemed reasonable). However, at the end of the day, when we fired up the cluster, all services operated flawlessly, and no reconfiguration or customization was required. This in itself is worth the price of admission.

As mentioned, the documentation is somewhat vague in spots and is not extensive for administration, use or development. However, all aspects of the system are covered, and reasonably savvy users should have no trouble.

In addition to numerous command-line utilities for submitting batch jobs, remote job execution and system management, LSF includes a number of graphical user and administrator tools. The `xlsadmin` utility (see Figure 1) allows you to manage and configure the cluster, and the `xlsmon` utility offers historical (see Figure 2) and detailed (see Figure 3) resource utilization figures. Users may use the `xbsub` utility (see Figure 4) to define and submit batch jobs, and JobScheduler batch calendars may be created with the `xbcal` utility (see Figure 5).

Summary

Products such as Platform Computing's Load Sharing Facility offer a simple way to obtain greater computing power from a cluster of networked systems, and go a long way toward optimal use of resources. Jobs that may take weeks on a single large system may execute in days or hours on a cluster of systems. Users and administrators obtain a fine grain of control over computing resources.

Clean documentation, centralized holistic management, tightly integrated tools and support are what you pay for, and are well worth the price. Powerful batch processing (particularly with the JobScheduler component) and seamless remote execution are the hallmarks of LSF. Rather than application software running on top of the system, LSF is system software effectively implementing a distributed operating system, with the network servers, API and utilities. ⊸

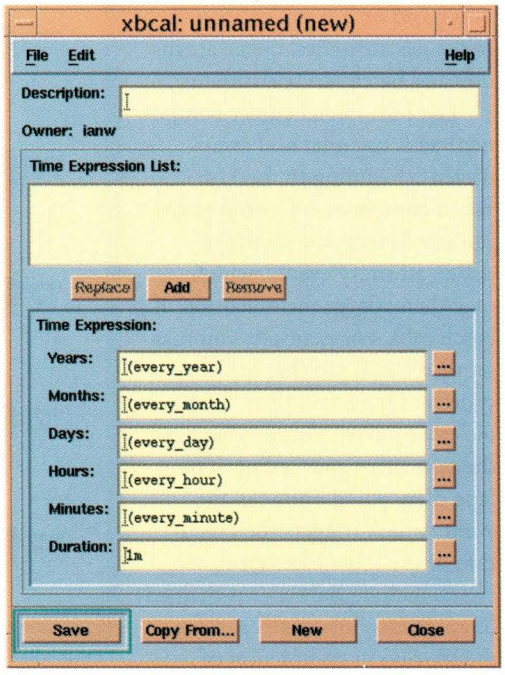

Figure 5. JobScheduler calendars can be created with xbcal.

Load Sharing Facility

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Circle 163

RS/Magazine

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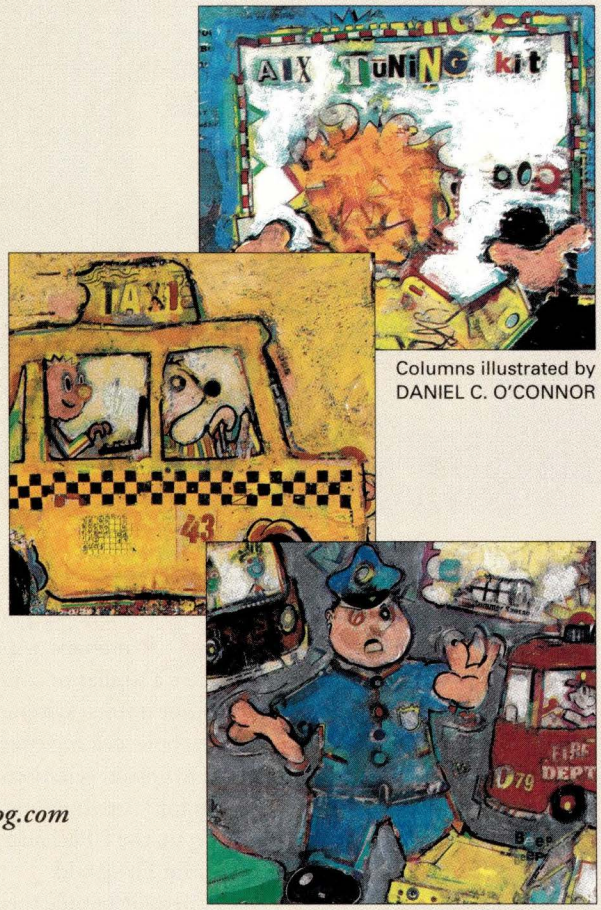

Columns illustrated by DANIEL C. O'CONNOR

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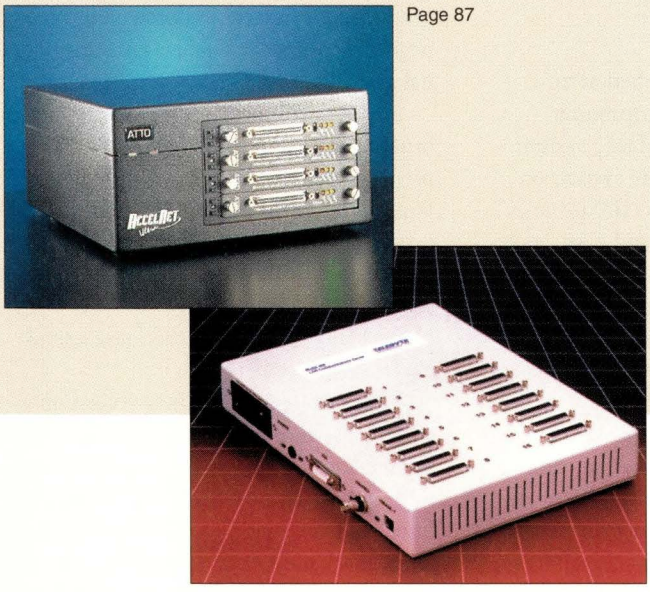

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Software Development East
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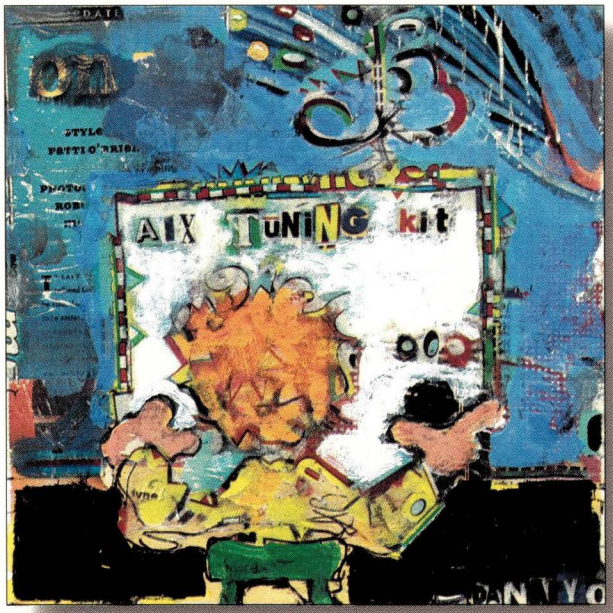
by Jim Fox



A More Elaborate Monitor

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

Q: I enjoyed your article on the Argus monitor (April 1997, Page 67). Is there a similar or comparable program to monitor normal system functions? I'd like to know how well my system is running and be able to answer questions such as: Are the disks full? Are there any looping processes using up the CPU? and so on. AA

John Fitzgerald
Carson Manufacturing Inc.

A: Last month, we looked at an excellent tool, appropriately named `monitor`. It displays basic system status information for a single system on an ASCII display, such as a vt100 or an X terminal. `monitor` is quick and easy, and particularly useful for diagnosing a system already in some trouble because it has a very short start-up time. This month, let's turn to a much more elaborate, graphical monitoring tool: `xmperf`.

`xmperf` will monitor and display just about every system statistic you can think of, including per process statistics. Because you have to set up the latter by process ID, `xmperf` is only useful for long-running processes. `xmperf` displays its results on an X11 screen.

Despite its apparent complexity, it is exceptionally easy to configure. You can do everything right on the screen through a series of menus. In practice, I tend to use the on-screen menus to create new windows, but use a text editor to fine-tune the graph positions and sizes. `xmperf` runs only on AIX, but it can be used to monitor other kinds of UNIX systems as well. `xmperf` is an IBM product, so you have to purchase it directly from the company. There is an `xmperf` manual available, but it's really not necessary.

`xmperf` will display statistics in any combination of graph styles: bar, line, skyline, pie chart and speedometer (see Figure 1). As you can see from Figure 1, which is really just intended to show examples of the graphs, you can put together a complex and useless display quite easily.

Let's look at some of the more useful chart types:

- Recording strip – These record on a continually moving strip and include bar, skyline and line styles. They show a short history and are most useful for those attributes that vary widely with time. On my systems, that's most everything. Consequently, this is the chart style I use most often.
- Speedometer-style pie chart – This is

A *wizard's apprentice*
AA *super user*
AAA *wizard*

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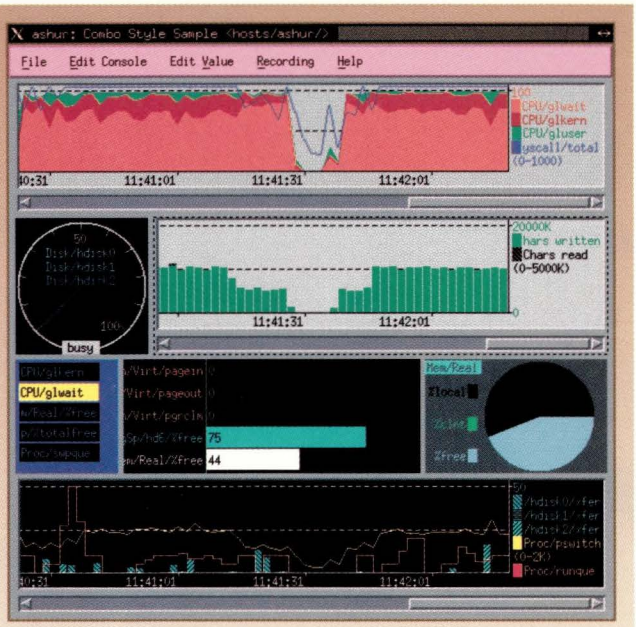


Figure 1. This example shows all the different charts supported by xmperf. Shown is an I/O-bound system.

a circular graph with one or more radius lines whose positions indicate values around the circle. It is most adept at displaying attributes that are smoothly varying, as there is no history.

• State lights – These amount to on/off warning lights. You can tie them to any of the statistics that `xmperf` monitors. If you can define a critical value for a measured attribute, user CPU greater than 80%, for example, you might attach a state light to it. Whenever the watched value goes over (or under) the selected value, the light changes color. State lights are often combined with other graph displays.

I've found that `xmperf` won't start correctly the first time I run it. There's an associated daemon on each system that actually collects the statistics and, apparently, that daemon is sometimes a little slow to get going. If you run `xmperf` and get some message about "no hosts responding," just try again.

Your next problem, after getting `xmperf` running, is to make some useful graphs. It comes with several examples, but they appear to be intended more to show `xmperf`'s capabilities than to be genuinely useful to you.

Let's look at some of the statistics you want to watch (these will be the same that our old friend `monitor` displays):

1. First, you want to monitor your CPU. One possibility is shown in Figure 2. It shows a system sometimes idle and sometimes completely I/O-bound. I find a bar chart works best. `xmperf` will stack the bars on top of one another, which works well for this chart. In addition to a stacked bar chart, you can add a couple of line graphs to the same display. They are easily distinguishable from the bars and often show how different system attributes affect one another. Figure 2 has a "number of system calls" as a line chart superimposed on the bars.

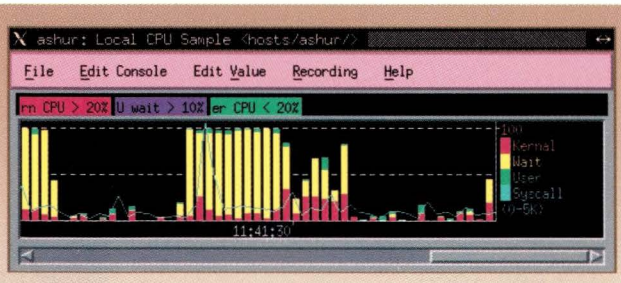
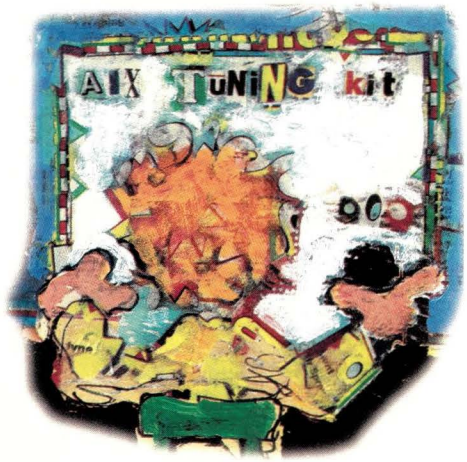


Figure 2. This is a sample CPU monitor. The system shows a sometimes idle, sometimes I/O-bound system.

This example also has three state lights that come on when some threshold has been crossed. You must set these thresholds carefully, depending on your expected load, otherwise the indicators won't mean much.

2. Paging. My systems normally do very little paging, so the continuous monitoring of paging activity isn't all that useful to me. However, I could see the benefit of a paging state light on some configurations.

3. Disk activity. Either the strip charts or speedometers can be used to monitor and display disk activity. I find that on some systems disks are often idle for long periods, then uniformly busy for long periods. For this kind of situation, I like the speedometer. It can show several disks in a small space, or can show several attributes for a single disk.



4. Network I/O. `xmperf` monitors scores of network statistics, for all interfaces and protocols. I find the line graph style of the strip chart works best for me.

Set up some monitors that watch indicative statistics on your system and see what they look like under various loads. Soon you'll be able to tell what the system is doing just by looking at that monitor. Remember, you won't be able to figure out what's wrong with your system unless you know what it's supposed to look like.

Where to Go from Here?

First, you might check out the other features of `xmperf`. It has an optional 3D display, which takes up a little too much real estate for my taste. It also has recording and playback capabilities that you might find useful.

Second, you'll want to make use of your newfound skills and try to make the system run faster. Check out a couple of excellent books on AIX performance tuning. You're ready for them. The first is *AIX Performance Tuning*, by Frank Waters, published by Prentice Hall Inc., 1996 (ISBN: 0-13-386707-2). The other is an upcoming book by Rudy Chukran, to be published by Addison Wesley Inc. (ISBN: 0-201-63382-5). It's due out this fall. Both of these authors know their stuff. ⊸

by John S. Quarterman

Haiti and Internet Governance, Part 2

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

Last month, we described how the top-level domain (TLD) HT for Haiti was owned by the Haitian nonprofit network organization REHRED (`http://www.ht.refer.org/rehred/domaine/`) for one week before it was reassigned to the commercial Internet service provider (ISP) Focus Data (`http://www.haitiworld.com`)–which has ties to a U.S.-based multinational ISP and telephone company–by the Internet Assigned Numbers Authority, IANA (`http://www.iana.org/iana`). IANA said it had received a fax from the Haitian government asking it to do so.

In reassigning the HT domain in this manner, IANA did not follow the guidelines of process set forth in its own documentation, RFC 1591 of March 1994 (see `http://ftp.internic.net/rfc/rfc1591.txt`). Instead, it announced a new rule (which we quoted) that IANA said was already in place:

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

And it turns out that this isn't the first time such a TLD switch has occurred; the same thing apparently happened with DO, for Dominican Republic (for more information, see `gopher://gopher.funredes.org:70/11/english/M3/M3.4/M3.4.14`). Jon Postel, the head of IANA, told me that HT would not be a precedent for national government intervention in such a decision, although he did not name the previous precedent.

IANA apparently didn't ask for clarification of the fax from the Haitian government, as it is not clear from the wording of the fax itself (which we quoted) that a transfer of the domain was actually requested. In addition to these irregularities, there is no visible trail of correspondence between IANA and Focus Data, nor has IANA responded to any requests from REHRED for clarification.

Some people in Haiti and elsewhere in Latin American and the Caribbean (ALyC) have understandably gotten the impression that IANA is either directly helping a U.S. corporation at the expense of a Haitian organization, or has been duped into inadvertently doing so. While I personally find it hard to believe that IANA or Jon Postel could be up to anything underhanded, the

point is that the actions of IANA in this case have been so politically inept that it would be almost impossible for people in the region *not* to have such suspicions. IANA's lack of transparency and responsiveness has done nothing to assuage such suspicions.

We have a situation in which there are concrete allegations with documentary evidence that IANA is not following its own rules, neither the old ones of RFC 1591 nor the new one it has made. IANA refuses to change its position. So, who reviews IANA? To whom may the parties involved turn for relief?

Internet Society

The most obvious answer may seem to be the Internet Society, or ISOC (`http://www.isoc.org`), which has at least nominal review authority over the Internet Architecture Board, or IAB (`http://www.iab.org`), and may perhaps have similar review authority over IANA. ISOC has repeatedly been sent copies of correspondence about this situation and several times been asked directly to intervene. As of this writing, ISOC has not responded at all. If ISOC has any authority over IANA, it has chosen not to exercise it.

A distinction is sometimes made between the technical Internet bodies, such as the Internet Engineering Task Force (IETF) and IAB, and operational ones, such as IANA and Internet International Ad Hoc Committee (IAHC). However, it's interesting to note that Jon Postel is both head of IANA and the RFC Editor. The distinction does not seem to be very strong.

InterNIC

Because InterNIC (`http://www.internic.net`) is the registrar for new top-level domains, it might seem appropriate for InterNIC to speak to IANA. But actually IANA can, and does, tell InterNIC what to do in such cases, for which InterNIC is merely a scribe. And InterNIC has so far failed to respond to requests to get involved.

Internet DNS Names Review Board

According to RFC 1591, the answer is the IDNB:

"The Internet DNS Names Review Board (IDNB), a committee established by the IANA, will act as a review panel for cases in which the parties can not reach agreement among themselves. The IDNB's decisions will be binding."

Unfortunately, there is no evidence that the IDNB has ever existed. Despite searching for the committee, I have been unable to find any RFCs published by IDNB, any Web pages for it, and no mention of it in any other documents. Nor has IANA confirmed the existence of IDNB.

Internet International Ad Hoc Committee

The Internet International Ad Hoc Committee (`http://www.iahc.org`), which has been set up to deal with new registries for international top-level domains, might seem a likely review board for IANA. I asked Dave Crocker, a member of IAHC, about this, and he says: "Of course I didn't respond on HT. I and the IAHC have nothing to do with it. Our scope is gTLDs [generic top-level domains]. The ISO country-code domains are beyond our scope."

I also tried asking Crocker, in his capacity as someone who has been involved for a long time in the IAB and in Internet processes, who the parties in this HT situation could turn to for relief. He returned no answer to that question.

Since the these events began, IAHC has subsequently dissolved itself in favor of the interim Policy Oversight Committee (iPOC), which will eventually become the Policy Oversight Committee (POC). For more details, see `http://www.iahc.org`. The names may have changed, but whatever it's called, IAHC, iPOC or POC, still has no charter to oversee national top-level domains.

Is There an ALyCNIC?

There is Réseaux IP Européens, or RIPE (`http://www.ripe.net`), which acts as an overall Network Information Center (NIC) for Europe, and there is APNIC (`http://www.apnic.net`), which is the NIC for Asia Pacific. So it would seem appropriate to turn to ALyCNIC for mediation in a dispute of this kind, including discussions with IANA. But there is no ALyCNIC. Why not, after more than five years of annual ALyC networking forums that have claimed such a NIC as a goal, is a mystery to me. I think that if people in ALyC don't want this kind of thing to happen again, they need to stop talking about it and do it.

So who *does* review IANA? In the case of national top-level domains, no one. IANA is the apex of the Internet governance hierarchy. Jon Postel is the pope of IANA. There is no appeal. We don't even know what college of cardinals elected him.

Origins of IANA

How did IANA get this authority? IANA's Web pages claim it is chartered by the Internet Society and the U.S. Federal Networking Council (FNC). IANA predates ISOC, so that part is a rewrite of history and not of much significance. IANA appears to have been created by the FNC. I believe I have seen mail from Jon Postel in a public mailing list that says IANA is funded by the U.S. government. So, in two senses, IANA is simply an agent of the U.S. government. In that capacity, presumably IANA is subject to review by the U.S. president, courts and Congress.

In a more important sense, IANA has the authority it has because it always has, and because it is headed by Jon Postel, who is one of the oldest of the Internet Old Boys. He's been publishing RFCs about assigned numbers since at least 1972, and his first RFC was in 1970, according to the RFC index.

For a long time, it was useful for the Old Boys to simply delegate one of their number to handle a given area of Internet activity. Dictatorial powers were actually an advantage in coordinating fractious researchers, when such powers were lodged in someone everyone trusted, such as Jon Postel. They didn't call him the Internet Numbers Czar for nothing.

But the world is different now, and the Internet is *very* different. What worked in a smallish community mostly composed of researchers and academics doesn't work so well in a

larger world of every kind of people you can think of, many of whom view the Internet as a utility, not a technical experiment. Not only Internet users, but also Internet providers have multiplied out of all recognition from just a few years ago. As a result, there is bound to be contention over allocation of even the most innocuous aspects of the Internet.

IANA continues to act as it did in the old days. IANA can, and does, make rules as it likes, when it likes, without any previous announcement, or even any announcement after a rule change. There is also no obviously available record of who has requested what domain changes from IANA, nor what IANA replied to such requests. These things used to be advantages; they aren't any more.

The biggest problem with this HT domain situation is that IANA by its actions is chipping away at its own authority. It risks being seen as merely a U.S. government agency implementing arbitrary policies to benefit only U.S. corporations. That is not what many people, both in ALyC and elsewhere, think the Internet should be about. It is especially dangerous in this period when everyone from individuals to corporations to governments of all sizes has discovered that the Internet is valuable and wants to control it (see "The Internet Goes to Harvard," *RS/Magazine,* November 1996, Page 21, or `http://www.mids.org/mn/610/`).

The situation is actually worse than that. The Internet has often prided itself on being independent of governments and self-governing. IANA has been seen as a key Internet governance organization, both in keeping the Internet running and in keeping governments out. If IANA has now invited governments in to directly dictate major and highly visible aspects of the Internet (national top-level domains), IANA is thereby damaging both its own usefulness and the Internet itself.

What Can Be Done?

Obviously, RFC 1591 needs to be rewritten; this is one of the few things on which all parties agree. However, that begs the question of by whom, because if IANA alone updates its own procedures document, the question of review of IANA has not been addressed. The issues of how IANA makes its own rules and of transparency to IANA's decision-making processes also need to be addressed.

As far as resolving this case of the HT domain, evidently there are only three ways out:

1. IANA can restore the previous registrar of HT and follow the procedures of RFC 1591 to decide who should be the registrar. It's true this would be contrary to IANA's new rule, but if IANA can make a rule at will with no warning, it can unmake a rule, too. IANA may think its authority rests on not backing down, but at this point IANA would gain more moral authority by admitting it made a mistake and undoing it.

2. The government of Haiti can send another communication to IANA clarifying its previous fax.

3. Some higher authority can step in to review the situation. But there is no higher authority.

Regardless of what happens with the HT domain, it seems IANA has compromised itself sufficiently that it is time for an oversight body. Who should that be? The missing IDNB could be created, but of course that begs the questions of how and by whom. IAHC could expand its charter to include national top-level domains, but it seems determined not to do so. InterNIC is about to lose its monopoly on international top-level domain registrations because of IAHC, not to mention its contract with the National Science Foundation, regarding the domains it manages. InterNIC was never supposed to be a policy-making organization anyway, so it's not appropriate.

The only existing bodies that seem capable of taking a hand are ISOC or the IAB. Will one of them please raise its hand?

Input and Acknowledgments

I thank everyone concerned for their input and their patience. This article is nonetheless from my point of view and represents no other party. I hope that this document may in some way assist in improving Internet governance. ➸

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Circle No. 30

by Jim DeRoest

Have OS, Will Travel

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

Everyone knows what a boon a laptop can be when you're on the road. Whether it's Internet access back to the office, making last-minute changes to a presentation or just killing time in the airport lounge playing the back nine at Troon North, a portable computer is the programmer's best friend when traveling away from home.

Until the recent proliferation of x86 implementations of UNIX, those of us accustomed to UNIX environments have usually had to leave our favorite pet at home. UNIX portables have tended to be expensive and did not adequately support other operating systems. The ability to run multiple OSs is a real issue for me because I use and support more than one in my daily work routine. That's not to say price isn't an issue too!

An x86-based laptop offers a nice solution to these problems. It's relatively low cost and can run everything from Windows and OS/2 to the many flavors of UNIX such as Solaris, SCO, Linux and most BSD variants. Unfortunately, it's missing a critical piece in my "must have" OS collection, and that is AIX.

PowerPC-based laptops provide a "partial" solution to this dilemma. I say "partial," in that the solution largely depends on whether or not you require full compatibility with legacy Intel operating environments and how far you're willing to dig into your pocketbook.

The IBM Power ThinkPad solves my main OS requirements, these being AIX and Windows NT. The ThinkPad provides all of the same features I expect from AIX when running on much larger POWER and PowerPC architectures. Windows NT on the Power ThinkPad gives me access to my favorite desktop tools and is interoperable with other networked Windows computers. It takes a little resourcefulness to get x86 16- and 32-bit applications to run on the Power ThinkPad, but, in most cases, it can be done. More about this later. Like many of its portable predecessors architected for UNIX, the Power ThinkPad does cost more than other laptops, but it does a much better job supporting Intel operating systems. The same is true for other PowerPC-based portable computers.

The Model 860 is the latest and greatest implementation of the Power ThinkPad. It is based on the 166-MHz PowerPC 603e chip with Level 1 and Level 2 cache and a 64-bit memory bus. Its recent predecessors, the 820 and 850, were based on the 100-MHz 603e.

The Model 860 has memory capacity up to 96 MB, a 12.1-inch, 1,024-by-760 thin

film transistor (TFT) active matrix color screen with integrated GT20 graphics adapter, removable hard drive, Trakman III mouse, two PCMCIA slots, serial and parallel ports, external VGA interface, integrated multimedia and a SCSI-2 interface. PCMCIA network cards include a 28.8-Kb/s modem, 10base2 and 10baseT Ethernet and token ring. Standard multimedia hardware includes a video in port, stereo speakers, microphone and CD-ROM.

I have a Power ThinkPad 820, which is a bit slower than the 860 but is packed with most of the same interface and multimedia features. I have yet to run into a situation where I've been lacking some interface or connection capability when interfacing to other systems while on the road. The built-in multimedia features make the ThinkPad an ideal platform for presentations and demonstrations. My only configuration recommendation is that you go full-blown regarding memory and disk options.

I really like the quick-change disk setup. You simply flip the keyboard up while pressing two switches located on the front of the laptop. The hard drive just plugs into a slot in the lower corner–no screws or panels to mess with. Disk options include 810-MB and 1.2-GB formats. I use two 1.2-GB disks: one for AIX 4.2 and the other for Windows NT 4.0. I've seen some technotes regarding dual boot configurations, but I've found it easy to just swap drives when I want to use another OS. You'll find it pretty tight trying to fit both AIX and NT on a single 1.2-GB disk.

AIX 4.2

The current IBM Direct and IBM Austin Web pages (see Table 1) list the ThinkPad Model 860 shipping with AIX Version 4.1.5. I've been running AIX Version 4.2 on my Model 820 for about nine months without any problems. This includes a full install of the AIX 4.2 server bundle plus a number of additional filesets on a single 1.2-GB hard drive. Once I had found an adequate `/tmp`, `/var` and paging space configuration for my application set, I still had about 300 MB of memory left for local applications and files. You can certainly go leaner by installing the client bundle and trimming out unwanted applications and documentation. Additional disk space can also be added using external SCSI drives or NFS mounting via the network. This configuration allows me to develop and test server software intended for our larger production machines. Limitations related to running AIX on the ThinkPad include no diagnostic mode and a limited set of drivers for third-party PCMCIA cards.

AIX Common Desktop Environment (CDE) really shines on the ThinkPad. Support for multiple workspaces, configurable launch pad, file and application object management provide a natural desktop akin to what you would expect from any Windows laptop. Install AIX Ultimedia services to make use of the audio and video capabilities incorporated into the Power ThinkPad. These include voice recognition and desktop control. Voice control is really cool when doing presentations. "Good

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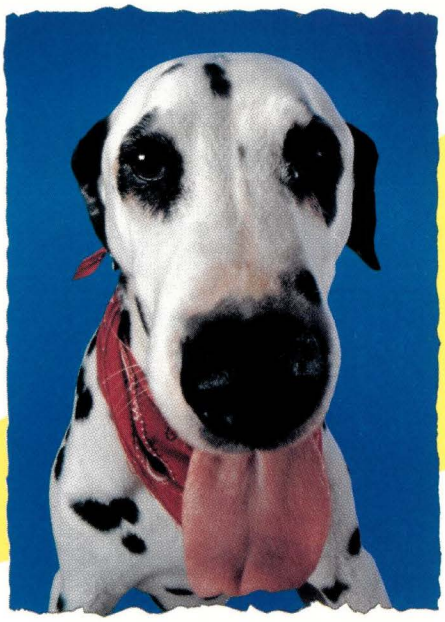

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Circle No. 43

morning HAL. Please launch Netscape and access the Web site for today's demonstration." AIX also provides battery and power management for the ThinkPad. For example, flip the power switch while AIX is running and the power management system will shut the system down gracefully before powering off.

Windows NT 4.0

Even with all the desktop and multimedia features provided by CDE and Ultimedia services on AIX, I still prefer using desktop tools in a Windows environment. No problem. I just plug in my Windows NT 4.0 Workstation disk and boot. I was quite surprised to find that the NT port supported the multimedia hardware available on the Power ThinkPad, and that I could use third-party PCMCIA devices such as the MegaHertz 28.8-Kb/s modem. Finding drivers has always been a problem when using similar architecture configurations in the past. You can either obtain Windows NT from IBM when you order ThinkPad, or you can buy it off the shelf at your local computer store.

The Windows NT Workstation operating system installation media from Microsoft includes PowerPC binaries in the PPC directory. PowerPC versions of the NT service packs are also available from the Microsoft Web page. Note that vanilla Windows NT from Microsoft does not include power management software for the ThinkPad. However, I see that the IBM Direct advertisement for NT 4.0 on the Power ThinkPad 860 says it includes power management. I hope this is true, because I've been trying to get power management support from IBM for months.

I know what you're thinking, "What about Windows applications?" There are a growing number of Windows applications that have been compiled to run natively on the PowerPC architecture. You'll find a list on the Microsoft home page (see Table 1). A Windows on Windows (WOW) subsystem is also provided for 16-bit x86 emulation, which will run most legacy Windows applications reasonably well. To contrast native versus emulated support, you'll find that the 32-bit PowerPC version of Internet Explorer will behave much better than running 16-bit x86 version of Netscape under WOW emulation. Imagine that!

For 32-bit x86 emulation, Microsoft recently made a beta version of its Windows x86 (Wx86) subsystem available for testing. I've been using Wx86 for about three months and have found it to work at least as well, if not better, than the 16-bit WOW subsystem. For example, I'm running the full 32-bit Office 97 suite on my Model 820. I've also installed a number of graphical Win32-based games that work under Wx86. When installing a 32-bit Intel application, select the Wx86 option, which installs the software into a directory named "Program Files.Wx86." You can download a copy of the `wx86.exe` file from the Microsoft Web site (see Table 1).

User Experience

I've been using the Power ThinkPad for about a year and have a few words of advice for those of you thinking about

Circle No. 24

getting one of these boxes. I already mentioned that you should go for a full memory and disk configuration. I've found that my Model 820, maxed out at 48 MB of RAM, is probably the minimum memory I'd recommend when running AIX and NT. I'd also recommend using 1.2-GB hard drives over the 810-MB option. Both operating systems will consume a large amount of disk space for paging and applications.

If you're going to regularly carry a ThinkPad around with you, then consider one of the laptop cases that includes straps for use as a backpack. At 8.5 pounds plus additional batteries, drives, charger and cables, the system weighs a bit more than what I normally like to pack in a briefcase. I carry my ThinkPad back and forth between home and the office, and I have found a backpack to be the easiest way to transport it.

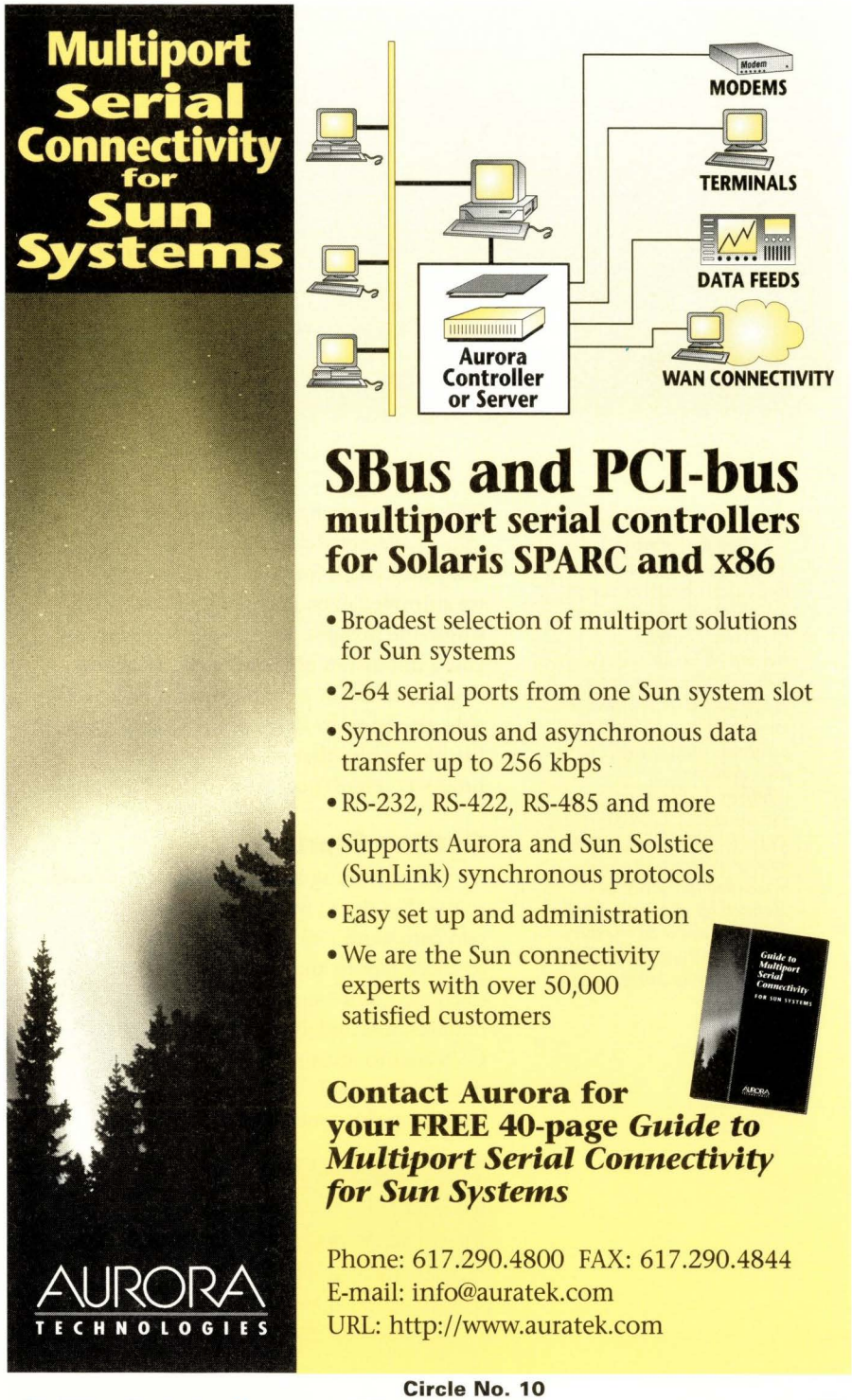
Next, consider carrying extra batteries. Even with power management, the 820 consumes large quantities of battery power when running the color TFT display and hard drive. When you're doing a lot of paging, you don't get much opportunity to spin the drive down. I've been told a number of times when doing presentations that I can't plug the VGA port of my laptop into LCD Panels or projection systems. The claim is that display resolution under AIX is too high for the device. My experience is that this hasn't been the case. After a few minutes of convincing the audio/video technician to give it a try, it always seems to work without a hitch. I've used the system to display foils using PowerPoint under NT, then done a quick reboot into AIX for an accompanying demonstration.

One more comment: You'll never have to worry about a heater on a cold winter's day if you've got a Power ThinkPad on your lap. When IBM officials say these machines are "Red Hot" AIX systems, they're not kidding!

An Intel x86 laptop still edges out the Power ThinkPad when it comes to available operating systems, however, there are other OS options to consider. PowerPC ports of OS/2 Warp Connect, Solaris, BSDI, Linux and other UNIX variants are available or in the works. I'm seriously considering adding a few of these to my collection as soon as I find room for more drives in my backpack. I just wish IBM would make this easier by providing an x86 version of AIX. It wasn't that long ago that AIX was available on the PS/2. I'm showing my age here. Anyway, I'm just happy that if I can't have an operating system that will run all my favorite applications, at least I can have a computer that will run all my favorite operating systems. ➸

Table 1. Useful Web Links

- http://www.austin.ibm.com/hardware/portables/index.html
- http://www.microsoft.com/ntworkstation/x86.htm
- http://www.austin.ibm.com/pspinfo/psm952j.html
- http://www.sun.com/solaris/2.5.1/index.html
- http://linuxppc.org/



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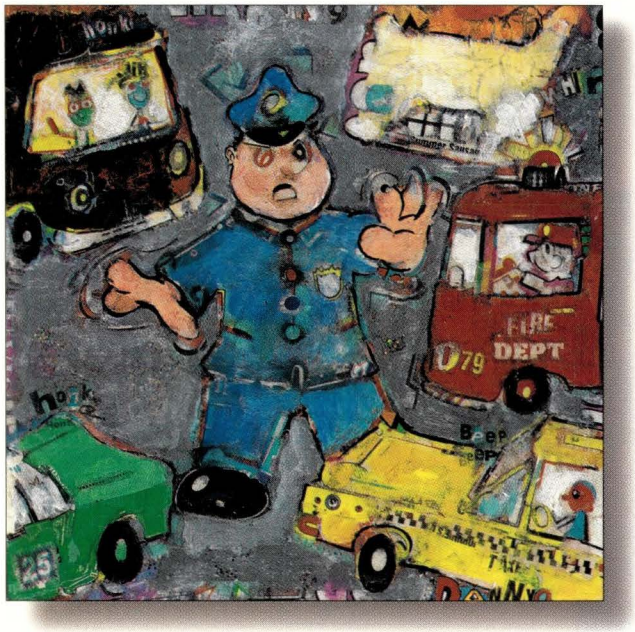
by Jeffreys Copeland and Haemer



Practical CVS, Part 1

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Last month, we sketched an overview of Revision Control System, or RCS, for you. In the process, we stumbled over, and pointed out, RCS' single-file myopia. In closing, we promised you a discussion of Concurrent Versions System, or CVS, a widely used, freely available extension to RCS, built to handle the file hierarchies that we all use to build products. Here it comes.

Getting Started

The nice thing about RCS is that it's easy to use. For the most part, all you need are two commands, `ci` and `co`, which are used to check files in and check files out, respectively. As you'd expect, dealing with trees requires, unavoidably, more work. Still, CVS tries to mirror RCS' simplicity and doesn't do so bad. We'll illustrate this by beginning the same way we did last month:

```
$ echo "Use the right tool for the job." > jeff
$ cvs ci jeff
cvs commit: No CVSROOT specified!
   Please use the '-d' option
cvs [commit aborted]:
   or set the CVSROOT environment variable.
```

We want to draw your attention to two noteworthy things about our example: First, the command we used, `cvs ci`, is similar to the command we would have used for RCS (there is also a `cvs co`). While these and other features of CVS use easy-to-remember analogs to RCS, `ci` is an *argument* to the command `cvs`, not a command on its own.

(We could tell you that for RCS you need to learn two commands, but for CVS, you only need to learn one. However, if we could say something like this with a straight face, we'd be working in marketing, making a lot more money.)

Second, the above example didn't work. We did something that seemed like it made sense, but it didn't. Normally, we'd shrug and say, "First time for everything," try the exact same thing a couple more times–we're not in marketing, we're in software–and then, when all else failed, read the manual.

In this case, CVS told us what to do. This is an important principle of software design: *Don't just say what's wrong, say how to fix it!* Contrast the SunOS usage message

```
sed: Unknown flag: X
```

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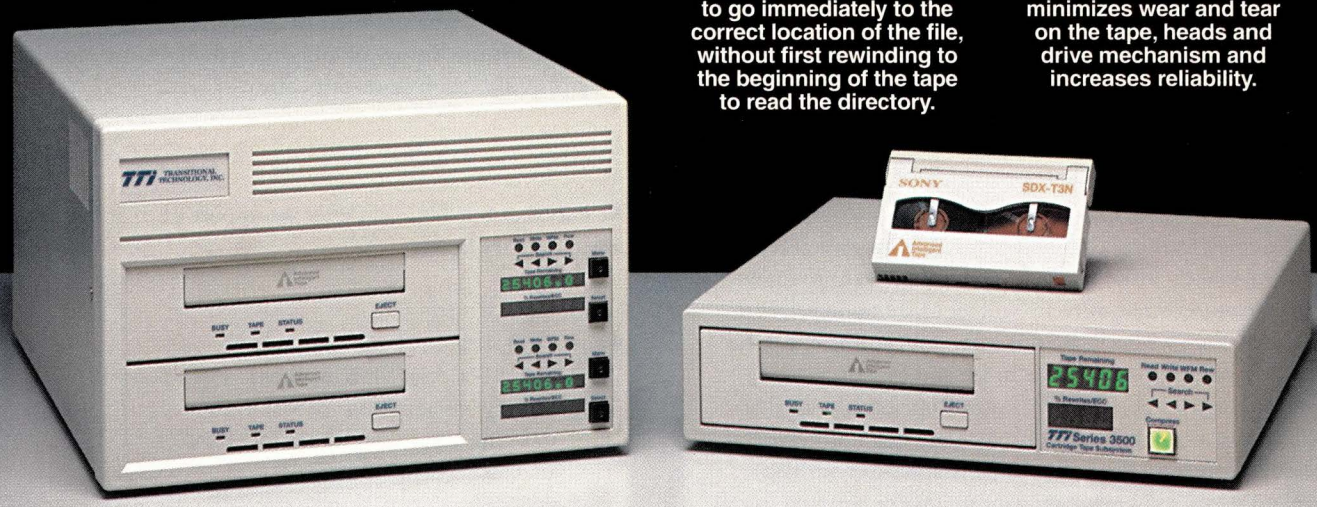

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with the Linux usage message

```
Usage: sed [-nV] [--quiet] [--silent]
   [--version] [-e script]
   [-f script-file] [--expression=script]
   [--file=script-file] [file...]
```

This principle has a long history in UNIX and has been clearly set out on many occasions. Although we try to use standards-conforming library functions, we steer clear of the POSIX `getopt()` interface because it doesn't force a usage message.

In contrast, our Perl programs routinely have lines like this:

```
getopt('LSMFT') or die $usage;
```

The module `Getopt::Std` doesn't automatically emit "Hey! Don't do that" messages, so we feel better about using it.

So let's try taking the advice CVS offers.

```
$ CVSROOT=/cvs; export CVSROOT
$ cvs ci jeff
cvs commit: cannot open CVS/Entries for reading:
   No such file or directory
cvs commit: nothing known about 'jeff'
cvs [commit aborted]:
   correct above errors first!
```

Progress. Now we're making new mistakes.

We enjoy learning by making mistakes for several reasons. First, we make a lot of mistakes, so it's important to know from the outset what software will let us shoot ourselves in the foot before we do it. By this assay, CVS turns out to be relatively safe. Second, we like to see and decode as many error messages as possible. We know from experience that we'll see them again; if we don't generate them ourselves by accident, someone else will invariably appear at our door demanding to know what they mean. (We're tempted to call all this "Learning by not doing." However, if we yielded easily to temptation, we'd be in politics, making *a lot* more money.)

So what's really going on here? CVS is designed to let you work with collections of files. To do so, you need to keep those collections in a repository. The environment variable `$CVSROOT` points at the root of this repository. You can have more than one repository, but each repository can hold many unrelated collections.

The first time we ran `cvs`, we hadn't designated a repository. Now, we've designated a repository, but the commands `cvs ci` and `cvs co` only work on source code collections that have already been put into the repository. To put a collection of files into the repository, you need to use the command `cvs import`.

We could try importing the file `jeff`, but that wouldn't show off CVS' ability to deal with file *collections*, so let's put in something bigger. First, we'll grab a copy of the entire `/etc` directory:

```
$ cp -r /etc/ .
```

Next, we'll import it:

```
$ cvs import etc
cvs [import aborted]: /cvs/CVSROOT:
   No such file or directory
```

Again, a new error message. This one's telling us that CVS uses a suite of administrative files, all of which it expects to find in the directory `$CVSROOT/CVSROOT`. (We think the choice of names is genuinely horrible. We didn't write CVS; we just use it. If we could think up good names for things, we'd be in advertising and making lots more money.)

We could show you how to create these administrative files by hand, but the command `cvs init` does the job for you (see Figure 1). We'll postpone explaining what each of the files shown in Figure 1 are, but note for now that almost all of them are under RCS control. In this case, "under RCS control" also means "under CVS control." With a nice self-referential twist, CVS allows you to work with its administrative files as a legitimate CVS collection.

What do we mean by "almost all"? `CVSROOT/history`, for example, has no associated RCS file because it's a file containing the entire history of everything done to any repository under `$CVSROOT`. It starts out empty.

```
-rw-rw-r--  1 jsh  rd  0 Jun  2 12:17 cvs/CVSROOT/history
```

We'll look at this file again after we import `etc`. Speaking of which, let's try again:

```
$ cvs import etc
Usage: cvs import [-d] [-k subst]
  [-I ign] [-m msg] [-b branch] [-W spec]
  repository vendor-tag release-tags...
   -d Use the file's modification time
      as the time of import.
   -k sub  Set default RCS keyword
      substitution mode.
   -I ign  More files to ignore (! to reset).
   -b bra  Vendor branch id.
   -m msg  Log message.
   -W spec Wrappers specification line.
```

Figure 1. Creating Administrative Files with cvs init

```
$ cvs init
$ ls -RFC $CVSROOT
CVSROOT/

/cvs/CVSROOT:
checkoutlist     cvswrappers,v   loginfo,v    rcsinfo
checkoutlist,v   editinfo        modules      rcsinfo,v
commitinfo       editinfo,v      modules,v    taginfo
commitinfo,v     history         notify       taginfo,v
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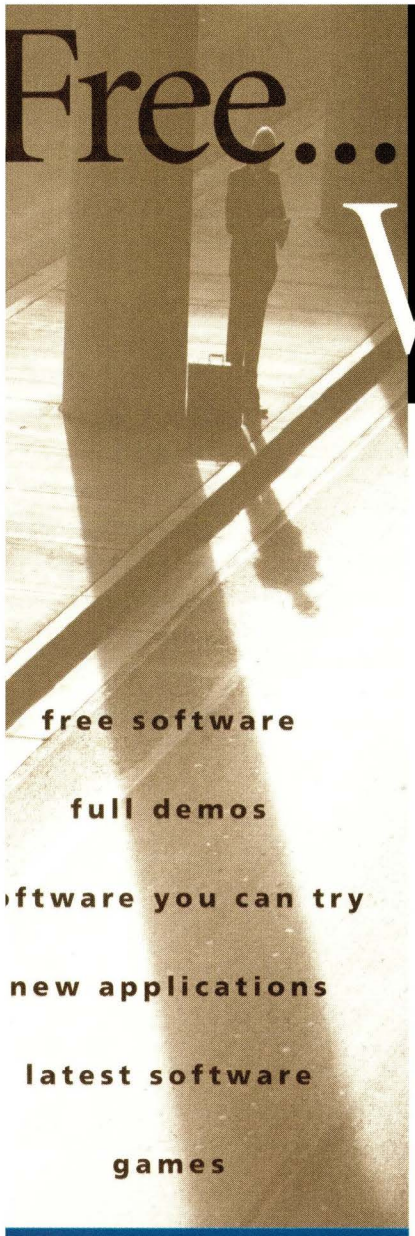

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We're getting close now. The usage message from `cvs import` tells us that we're just calling it with the wrong arguments.

What are the arguments? `repository` is where to put it under `$CVSROOT`. But where to put *what*? CVS is built to understand trees. By default, operations are performed on whatever directory you're in and all its subdirectories. If we say `cvs import`, for example, we'll actually import everything under our current working directory. This means we have to make sure we do a

```
$ cd etc
```

The arguments `vendor-tag` and `release-tag` are there to let us keep track of large releases of software from other people. Most of the time, we're focused on keeping track of large collections of software that we're developing ourselves and want to release. Sometimes, however, we begin with a code base from somewhere else–a vendor that we've paid to develop something, or even a different branch of our own company. `vendor-tag` lets us identify the source.

What about `release-tag`? In some situations, we need to be able to handle massive updates from the original vendor. If we begin with a source release from Acme Software, for example, work on a customized development of the package for six months, and then get an upgrade from Acme, we want a place to store the upgrade, exactly as supplied by the vendor, before we begin merging the changes into our customized version. With these tags, we can do that.

In our case, we'll call the "vendor" Jeff and the release "initial," like this:

```
cvs import etc Jeff initial
```

Aha! Suddenly, we're editing a file containing the following lines:

```
CVS: ----------------------------------------------------------------------
CVS: Enter Log. Lines beginning with 'CVS:' are removed automatically.
CVS:
CVS: ----------------------------------------------------------------------
```

This is what CVS does to ask you for a log message. It's the same idea as the RCS prompt

```
enter log message, terminated with single '.' or end of file:
>>
```

with three twists:

1. CVS automatically puts you into whatever editor is specified by the variables `$CVSEDITOR` or `$EDITOR`.
2. By default, CVS uses one comment for all imported files. This is a theme that we'll see again in `cvs ci`, and flows from the idea that CVS operations deal with collections, not just individual files.
3. CVS gives you starting text for the comment. Any line that starts with `CVS:` never goes into the RCS file, so none of the lines labeled `CVS:` get saved in any file. However, anything you type, above or below it, will become a log comment for every file you're importing.

The lines in the above example are hard-wired into CVS, but they're just the defaults. In general, the default comment files that the editor brings up come from one of the administrative files. Here's how it works:

The file `$CVSROOT/CVSROOT/rcsinfo`, for example, contains a two-column list of regular expressions and template files. If the name of the directory your file is in matches the regular expression, CVS uses the corresponding template to initialize your comment–a catch-all expression, `DEFAULT`, matches any directory that isn't otherwise matched. If we want to provide forms for fill-in-the-blank-style comments, we can put those forms into template files.

CVS is built to understand trees. By default, operations are performed on whatever directory you're in and all its subdirectories.

After the comments go in, and we exit the editor, CVS fills the screen with a series of lines like this:

```
N etc/passwd
I etc/passwd~
N etc/rmt
I etc/rmt.old
```

The files marked `N` are new files in the repository and the files marked `I` are being ignored. CVS has customizable rules about which files it ignores, but the defaults are so reasonable that we have never had to modify them. After all this is done, we have a repository with an RCS file that corresponds to each file we imported:

```
$ ls $CVSROOT
CVSROOT
etc
$ ls $CVSROOT/etc/pass*
/cvs/etc/passwd,v
```

Working with Files in the Repository

The Source Code Motel: Your files check in, but they never check out. – Anonymous

Seems like it took forever, doesn't it? Well, we *could* have tried reading the manual first, but that wouldn't have been as much fun. Let's review what we did to get started:

1. We created a place to store the repositories, then set `$CVSROOT` to point at it.
2. We initialized the `$CVSROOT` directory using `cvs admin`.
3. We went to the tree of sources we wanted to check in.
4. We said the magic words: `cvs admin etc Jeff initial`.
5. We put in a comment and exited the editor.

Is working with them as much of a hassle as getting them in, or is there a way to get something back out?

Try this:

```
$ cd ..
$ rm -rf etc    # That's 1705 files -- GONE!!!
        # A power tool is not user-friendly
$ cvs co etc    # Whew.  They're back.
cvs checkout: Updating etc
U etc/aliases
U etc/aliases.db
...
cvs checkout: Updating etc/X11
...
cvs checkout: Updating etc/rc.d
U etc/rc.0
...
cvs checkout: Updating etc/rc.d/init.d
U etc/rc/init.d/httpd
```

One command lets us check out the entire repository as many times as we want:

```
$ cd /tmp
$ cvs co etc
cvs checkout: Updating etc
U etc/X11
...
```

Is it really all there? Sure.

```
$ ls -F etc
CVS/
X11/
aliases
aliases.db
...
```

Wait. What is that directory `CVS/`? A little investigation reveals that every directory in a checked-out hierarchy has one, and that they all contain the same files:

```
$ ls CVS
Entries
Repository
Root
$ ls X11/CVS
Entries
Repository
Root
$ ls rc/init.d/CVS
Entries
Repository
Root
```

These files are not in the repository itself, but are administrative files used by CVS to keep track of where the files came from and what versions have been checked out. Here's an example, using the control files in `$CVSROOT/CVSROOT`:

```
$ cvs co CVSROOT
...
$ cat CVSROOT/CVS/Repository
/woodcock/jsh/RS/work/cvs/cvs/CVSROOT
$ cat CVSROOT/CVS/Entries
/checkoutlist/1.1/Mon Jun  2 18:17:04 1997//
/commitinfo/1.1/Mon Jun  2 18:17:04 1997//
/cvswrappers/1.1/Mon Jun  2 18:17:04 1997//
/editinfo/1.1/Mon Jun  2 18:17:04 1997//
/loginfo/1.1/Mon Jun  2 18:17:04 1997//
/modules/1.1/Mon Jun  2 18:17:04 1997//
/notify/1.1/Mon Jun  2 18:17:04 1997//
/rcsinfo/1.1/Mon Jun  2 18:17:04 1997//
/taginfo/1.1/Mon Jun  2 18:17:04 1997//
/verifymsg/1.1/Mon Jun  2 18:17:04 1997//
D
```

The `Repository` and `Root` files are obvious safeguards. If, while you're working, you change your `$CVSROOT` to point somewhere else–deliberately or by accident–the information in these directories ensures that any modifications you've made will be put back in the correct repository. Do this:

```
$ unset $CVSROOT
$ echo >> editinfo; echo >> loginfo
$ cvs ci
```

and you find yourself in the editor facing a screen that looks like this:

```
CVS: ----------------------------------------------------------------------
CVS: Enter Log. Lines beginning with 'CVS:' are removed automatically.
CVS:
CVS: Committing in
CVS:
CVS: Modified Files:
CVS:    editinfo loginfo
CVS: ----------------------------------------------------------------------
```

At this point, you insert a comment, explaining why you've placed a blank line at the end of these files, and exit the editor. When you do, you'll see something like the following:

```
Checking in editinfo;
/woodcock/jsh/RS/work/cvs/cvs/CVSROOT/editinfo,v  <--  editinfo
new revision: 1.7; previous revision: 1.6
done
Checking in loginfo;
/woodcock/jsh/RS/work/cvs/cvs/CVSROOT/loginfo,v  <--  loginfo
new revision: 1.3; previous revision: 1.2
done
cvs commit: Rebuilding administrative file database
```

Thus, the `Repository` and `Root` files let CVS remember where to check these in to, even though `CVSROOT` got

unset after you checked them out.

Understanding the goal of the `Entries` file requires thinking about bigger projects. Imagine, for a moment, a project so large that it has more than one file *and* more than one person working on it. Call those two people "Jeff" and "Jeff." Hmm. Call those two people "Zoe" and "Gillian." Consider the following scenario:

- Each developer checks out a copy of the repository file for project "fezmo."
- Zoe fixes a bug in her copy of the file `fezmo/charlie/dotsero` and checks it in using `cvs ci fezmo` (or just `cvs ci`, if she's in any directory that contains `dotsero` in one of its subdirectories. CVS will find it, realize that it's changed and check it in).
- Gillian fixes a bug in *her* copy of `fezmo/charlie/dotsero` and ... what? If there were no source code control at all, Gillian's update could overwrite Zoe's update, wiping out Zoe's work.

If you're used to RCS, you may already be saying, "Only one of them could have checked the file out for editing. That must have been Zoe, so Gillian now has to re-check-out the file for editing." But that wouldn't be practical either, because that means one person would be grabbing and releasing locks on perhaps thousands of files, and Zoe and Gillian, and every other developer, would have to keep track of exactly who had locks on which files at all times.

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Under CVS, Gillian, like Zoe, says `cvs ci`, CVS sees that `dotsero` has changed, then, before checking it in, *looks in the* `Entries` *file to see if the version Gillian checked out matches the version at the top of the tree*. Because it doesn't, Gillian gets a message that says there's a problem, and CVS points her toward another command, `cvs update`. This command will help Gillian update her version of all files in the collection, and will help her find and resolve conflicts between her changes and any other changes that have been done since she checked out her base version.

Administrative Files

CVS is easy enough to use that if it only extended RCS to let us handle collections of files and track their revisions, we'd be happy. It turns out, however, that there's a lot more to it. Some of the things CVS provides are commands and options. To show you how to take a look at what commands and options are available, we'll revert back to learning by not doing.

Try typing this:

```
$ cvs -:
```

Note that ":" is not a legal option for any UNIX command we know of, including `ls`, so we often use it to get commands to give us a usage message.

(Which reminds us of a joke that reappeared on the Net the other day: A brave knight approached an evil magician at the bridge–you've seen this *Monty Python* movie, so you at least know the form of what's coming next: The knight has to answer three questions to cross the bridge, or he will be cast into the abyss. The magician asks, "What is your name?" The knight answers, "Sir Brian of Bell." The magician asks, "What is your quest?" In a clear, firm voice, the knight answers, "I seek the Holy Grail." The magician, demonstrating just how evil he is, asks, "What four lowercase alphabetic characters are not legal flag arguments to the Berkeley UNIX implementation of `ls`?" Sir Brian, of course, hasn't the foggiest idea, which is the end of that particular knight.)

Try this, just the way the usage message tells you to:

```
$ cvs --help-commands
```

If you want to learn more about any of these commands, you can experiment with them. Or you can always do this:

```
$ man cvs
```

What else? We have mentioned some of the files in `$CVSROOT/CVSROOT`, such as `history` and `rcsinfo`, but there's more. Actually, there's a lot more, so rather than try to tackle it right now, let's wait and talk about it next time. If you want to play around with it in the meantime, you can get the CVS software from `http://www.loria.fr/~molli/cvs-index.html`.

Until then, happy trails.

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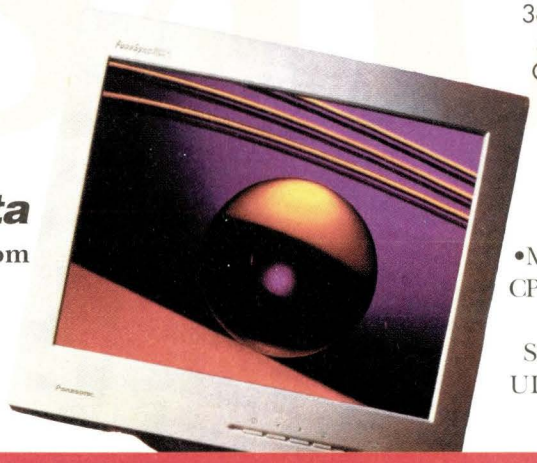

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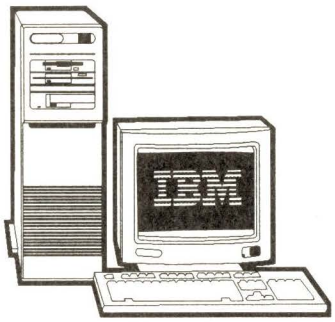

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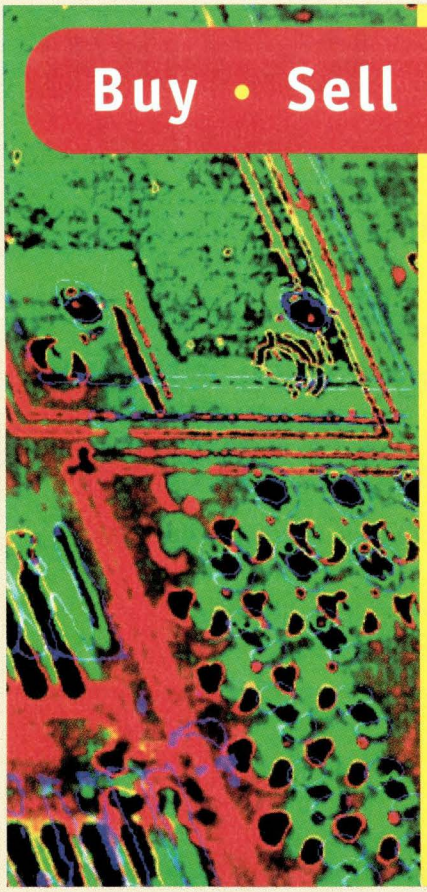

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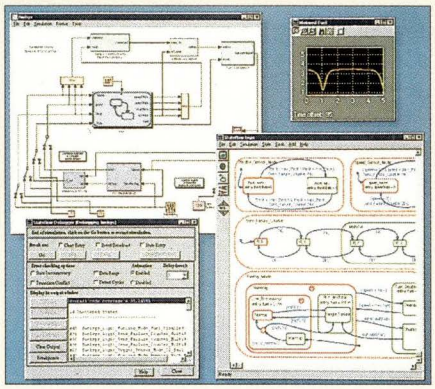
NEW PRODUCTS

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.

Code-Generation Simulation Software Out

A new graphical tool to aid engineers in designing complex control and supervisory logic systems has been announced by The MathWorks, maker of Matlab. Called Stateflow, it represents a major addition to the company's Simulink modeling and simulation environment, and to Real-Time Workshop, which helps developers in prototyping real-time embedded systems, The MathWorks says.



Stateflow reportedly offers several improvements over traditional finite state machine notations, including hierarchy, parallelism, junctions and history. When used in conjunction with Simulink, the control behaviors modeled with Stateflow are said to match Simulink's algorithmic behavior model; in fact, Stateflow diagrams can be directly incorporated into Simulink to add event-driven behaviors, The MathWorks says.

Along with the Stateflow announcement, The MathWorks announced a new, integrated release of Simulink and the Real-Time Workshop 2.1. Together, these products should provide users with an integrated, continuous and event-driven simulation environment, the company says.

Stateflow is available on Windows 95/NT, Macintosh 68K and Power Macintosh, as well as various flavors of UNIX, including SunOS, Solaris, IBM AIX, Digital UNIX, HP-UX and SGI IRIX. Stateflow and Simulink cost $1,995 each; and the Real-Time Workshop costs $9,995.

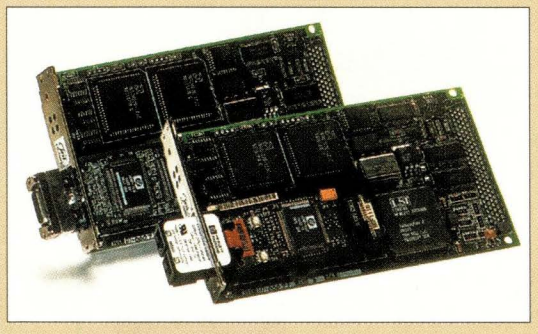
The MathWorks Inc.
24 Prime Park Way
Natick, MA 01760
http://www.mathworks.com
Circle 101

Terminal Server Reports Speeds of 115 Kb/s

The Model 466 terminal server, a so-called next-generation TCP/IP communications server from Telebyte Technology, is now available. It is aimed at the local and remote access market

Jaycor Ships Fibre Channel Line

Jaycor Networks, a subsidiary of Jaycor, has introduced a new line of Fibre Channel products that includes a hub and adapters for both the SBus and PCI bus architectures. Called FibreStar, the announcement coincides with Fibre Channel's increased acceptance into the market, as well as Sun Microsystems Inc.'s recent announcement that it will migrate to the PCI architecture, Jaycor says.



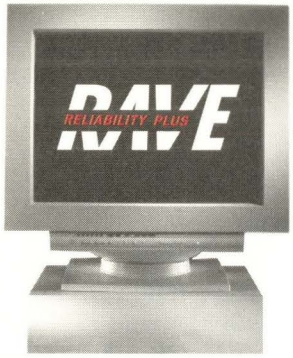
The FibreStar hub, FCH-1063, allows users to connect Fibre Channel devices in an arbitrated loop with a transmission rate of 1.0625 Gb/s (8B/10B encoding scheme), and a full-duplex data transmission rate of 200 MB/s. Equipped with nine copper ports and DB-9 style connections, users can cascade multiple hubs that support up to 127 connections. A clock recovery retiming circuit on each port removes line jitters to ensure clean transmission, the company says.

FibreStar adapter cards have reportedly undergone extensive field tests, across a wide range of applications and are designed for easy field-upgradability. Upgrading a card from a copper to an optical interface, as well as from 266 to 1,063 Mb/s, is accomplished by replacing the interface module–no further software or hardware changes are required.

The FibreStar adapter boards support switched and arbitrated loop configurations and all classes of service, including an intermix of Fibre Channel classes 1, 2 and 3. Standard networking peripheral protocols such as TCP/IP and SCSI are also supported with a collection of software drivers. In addition, the PCI version includes support for Windows NT as well as Solaris x86.

The FibreStar FCH-1063 hub costs $3,300. FibreStar adapter models are available in 266- or 1,063-Mb/s configurations, with either an optical or copper interface. Pricing starts at $1,995 for the PCI version, and $2,970 for the SBus version.

Jaycor Networks Inc.
9775 Towne Centre Drive
San Diego, CA 92121
http://www.jaycor.com
Circle 100



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Circle No. 34

New Products

segments, where it can serve remote dial-in access needs, as well as connect remote branches and help build Internet sites, the company says.

Model 466, which supports both UNIX and NT hosts, features PPP, SLIP, dial-on-demand and dial-up point of presence (POP). It also provides user authentication and call logging on Microsoft Windows NT.

Model 466 features up to four network connections per port, for a maximum of 64 connections per 16-port unit. Ports can be configured as dedicated connections, Telebyte says.

Available in four, eight and 16 DB-25 port configurations, the Model 466 is offered in either stand-alone or rack-mount units. Flash memory allows for future upgrades. Pricing starts at $999 for the four-port version.

Telebyte Technology Inc.
270 Pulaski Road
Greenlawn, NY 11740
http://www.telebyteusa.com
Circle 102

Security Software to Protect Databases

A new software offering from Protegrity reportedly allows organizations to secure sensitive data found in databases, transmitted electronically or exchanged during a transaction. The Data-Element Wrapper does this by wrapping a "layer" of security around each piece of data, rather than restricting access to it or encrypting the database as a whole, the company says.

According to Protegrity, the wrapper applied to data follows it everywhere it goes, ensuring a high level of security during transport, as well as safeguarding businesses that rely on data mining, vir-

tual workgroups and decision support.

Protegrity uses role-based operation, allowing companies to specify which employees have access to which pieces of information. Security is flexible and allows administrators to set access privileges for each employee to individual data elements or to entire data sets. The Data-Element Wrapper can be applied throughout the organization with the help of the Information Asset Manager, which Protegrity says can be easily administered by personnel with minimal background in technical security.

The Data-Element Wrapper supports various authentication methods, including passwords, security diskettes and smart cards. Encryption algorithms can also include DES, RSA or CDMF. It supports the following platforms: MVS, OS/2, DOS, Windows 3.1, 95 and NT, UNIX and OS/400, with integration into many popular databases, including DB2, Informix Universal Server and Oracle 8.

Pricing varies, but Protegrity estimates that a 1,000-seat configuration running on two central servers costs from $175,000 to $500,000.

Protegrity Inc.
5 Stamford Landing
Stamford, CT 06902
http://www.protegrity.com
Circle 103

Full-Featured Color Laser Printer Out

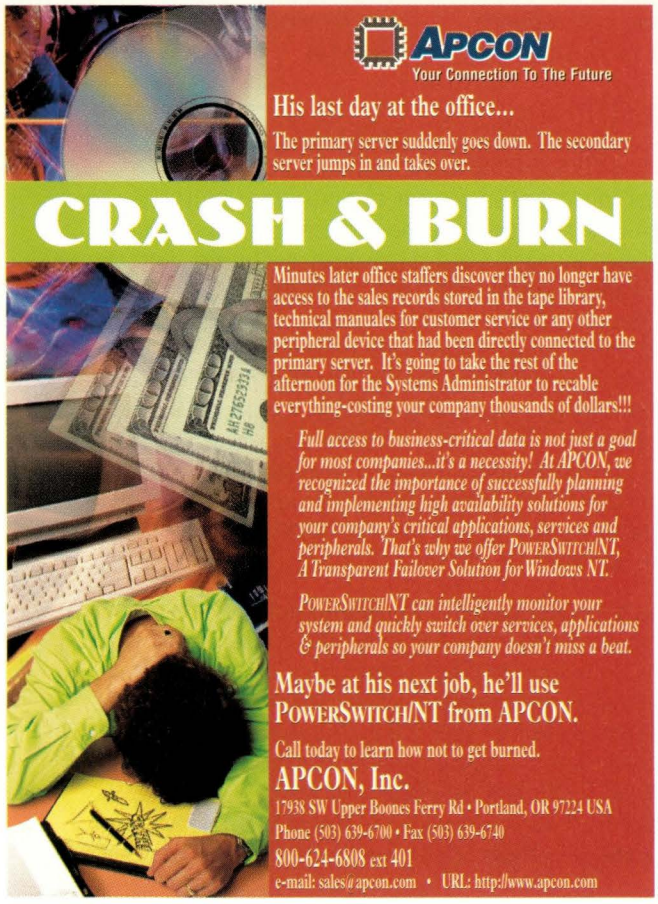
Xerox has announced its latest full-featured color laser printer, the DocuPrint C55 Color Laser Printer, aimed at networked office workgroups. According to Xerox, it bridges the low-speed ink jet printers and the high-end production color systems both in terms of price and physical size.

The DocuPrint C55's productivity-enhancing features include automatic correction of poorly scanned images; a Fax-Friendly Black feature that converts color graphics into black and white for sending via fax; automatic detection of transparencies; a double

print speed function; and a hold job function.

Other features include an embedded Web server, with which it can easily retrieve updated printer drivers, software, supplies and service information, and an optional collation function, which allows users to create multiple original prints–"mopies"–in fully collated sets, Xerox says.

On the UNIX side, a DocuPrint C55mp (network ready) includes Ethernet capabilities and Adobe Postscript for a base price of $4,995. The



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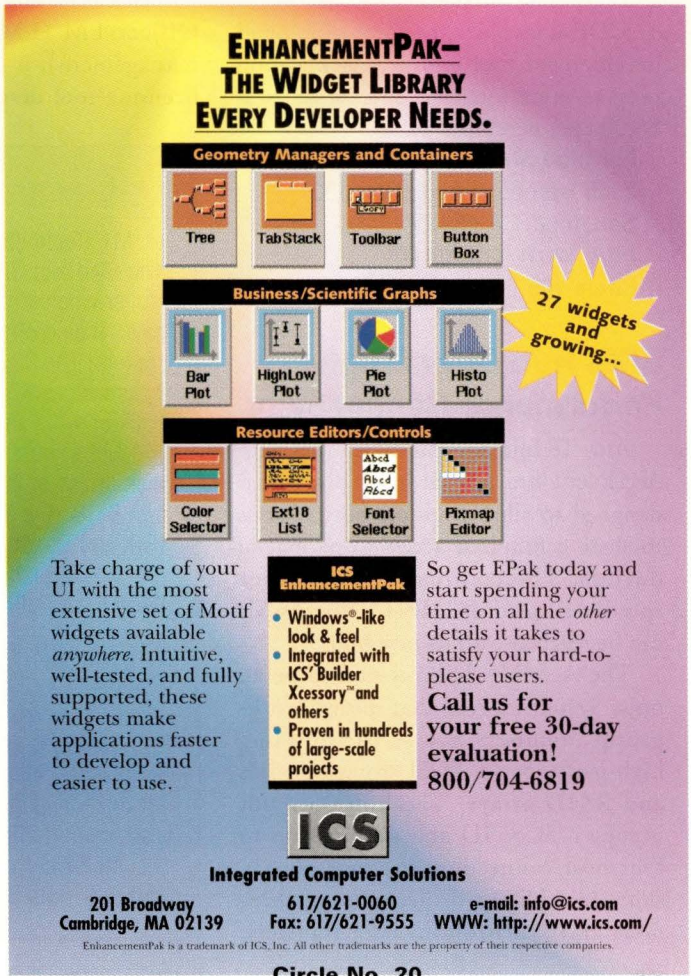

Circle No. 20

DocuPrint C55 printer also supports Microsoft Windows.

Xerox Corp.
Xerox Square 05B
Rochester, NY 14644
http://www.xerox.com
Circle 104

Tool for Building Universal Server Solutions

Formida Software has announced its Universal Development Environment (UDE), a development tool that supports Universal Server-based enterprise computing environments.

Developers can reportedly use UDE to create new applications or extend existing applications that integrate, visualize and interact with both simple and complex data. Formida says UDE extends the capabilities of users' existing IT strategies, including development tools and software, enhances current solutions or migrates them to next-generation technologies. Also, a newly developed application can be deployed across multiple platforms, the Internet and corporate intranets.

UDE is an object-oriented 4GL rapid development tool with a C application programming interface. Pricing starts at $5,000 per developer license.

Formida Software Corp.
2105 Hamilton Ave., Ste. 100
San Jose, CA 95125
http://www.formida.com
Circle 105

SCSI Hub Offers High-Performance Connectivity

Atto Technology has introduced Atto AccelNet Ultra, a SCSI-based hub that is designed to allow multiple host systems to share centralized access to peripheral devices. The company says transfer speeds of up to 40 MB/s (Ultra SCSI) can be reached with its new hub.

The AccelNet Ultra is said to be an open system device that allows workgroup members access to the same high-performance SCSI storage devices and RAID arrays. The hub does not occupy a SCSI ID and supports up to four host connections via four plug-in slots. In addition, it accepts asynchronous and synchronous data transfers,

according to the company.

Other features include hot-swappable host modules, scalability to 32 hosts, LED status indicators, support for single-ended and differential (optional) devices, fault isolation capabilities and stackable units. Pricing for the Atto AccelNet Ultra starts at $5,995.

Atto Technology Inc.
Audubon Technology Park
40 Hazelwood Drive, Bldg. 106
Amherst, NY 14228
http://www.attotech.com
Circle 106

CORBA-Compliant Software Licensing Tool

Black & White Software has released Object/LM (LM stands for license management), a commercial software licensing tool designed to facilitate the deployment and metering of distributed applications, the company says. It is an implementation of the Common Object Request Broker Architecture (CORBA) Licensing Service and supplies IDL interfaces with mappings to C++ and Java. It supports the IIOP Internet wire protocol and the MD5 license key encryption standard. Licensing models supported include concurrent, node-locked, site, metered and demo.

Object/LM includes a Produce Key Generator that generates a key module, with the information necessary to secure licensing of the various elements within the target technology. The key module is linked to Object/LM libraries and the encryption module to create a producer-specific client library, license server and User Key Generator, the company says. Users install the application license using the administration tool provided with the License Service Manager.

Object/LM is available for UNIX and Windows 95/NT. It costs $3,500 per developer and $95 per deployed host.

Black & White Software Inc.
1901 S. Bascom Ave., Ste. 700
Campbell, CA 95008
http://www.blackwhite.com
Circle 107

Upgrades, Enhancements, Additions...

■ MTI Technology has announced an upgrade to its Gladiator RAID Array line. The Gladiator 3200 RAID Array offers twice the performance of a single controller when it's configured with active/active redundant controllers, the company says. It also offers an optional configuration with active/passive redundant controllers. The 3200 comes with multiple, simultaneous RAID Levels 0, 1, 0+1 and 5, as well as 32 to 128 MB of battery-backed, mirrored, write-gathering (write-back or write-through) cache per RAID controller. It supports an Ultra-SCSI (40-MB/s) host interface and can have two to 16 Single Connector Attach (SCA) disk drives of 2.1-, 4.29- or 9.1-GB capacity, while the array can store up to 145.6 GB. The 3200 is compatible with SunOS, Solaris, IBM AIX, HP-UX, SGI IRIX and Digital UNIX. A dual-host, active/active system with 32 MB of cache and a 145.6-GB raw storage capacity costs $80,750. **MTI Technology Corp.**, 4905 E. La Palma Ave., Anaheim, CA 92807, *http://www.mti.com.* **Circle 108**

■ Rogue Wave Software has announced an implementation of its ANSI/ISO Standard C++ Library for the Solaris operating environment that can be integrated into Sun Microsystems Inc.'s Sun WorkShop product. Version 1.2.1 of Standard C++ Library is said to include updated data structures and algorithms (the STL), an Allocator class for memory management, string classes and a complex class for representing and manipulating complex numbers. Standard C++ Library 1.2.1 also supports IBM AIX, OS/2, SGI IRIX, HP-UX and Microsoft Windows 95/NT. It costs $295 for a single-user, source code license. **Rogue Wave Software Inc.**, 850 S.W. 35th St., Corvallis, OR 97333, *http://www.roguewave.com.* **Circle 109**

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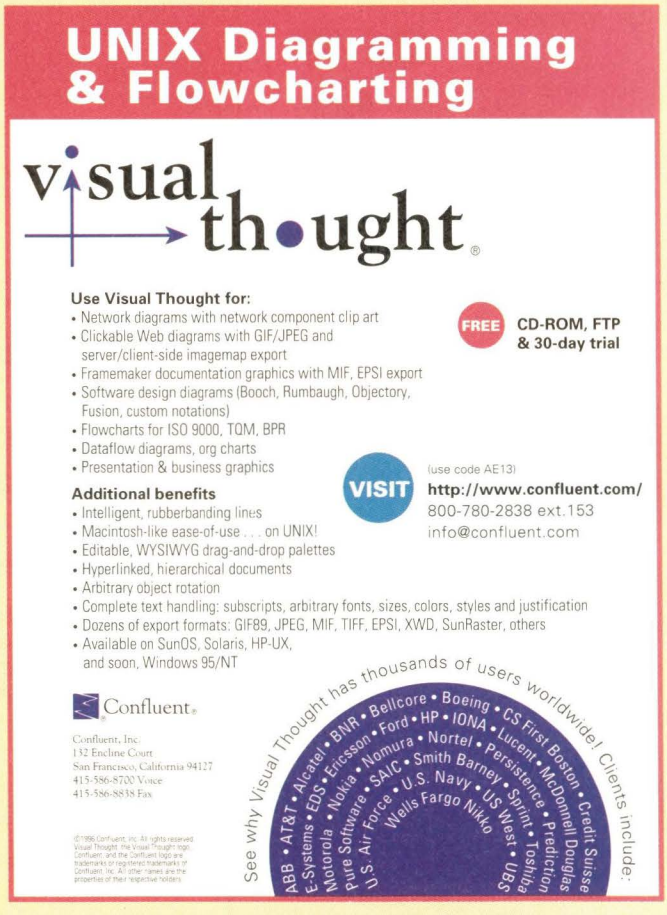

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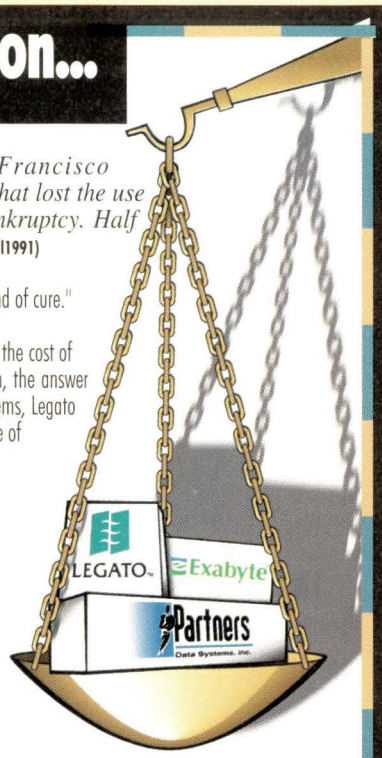

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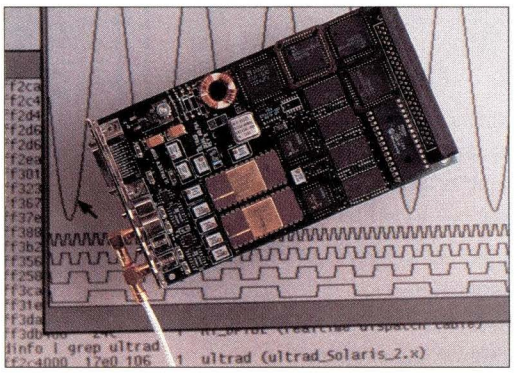

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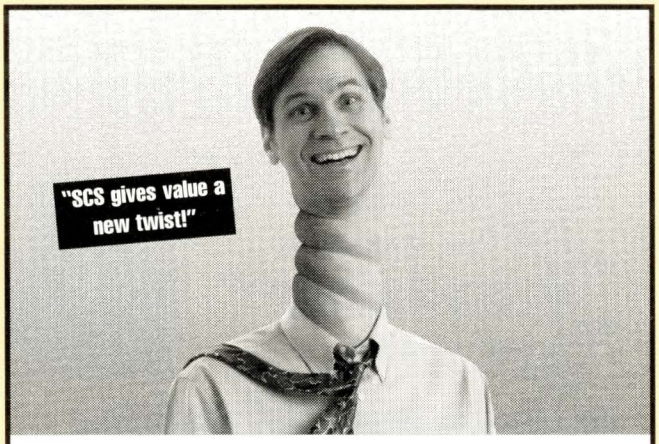

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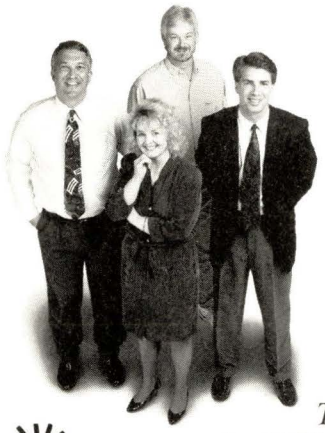

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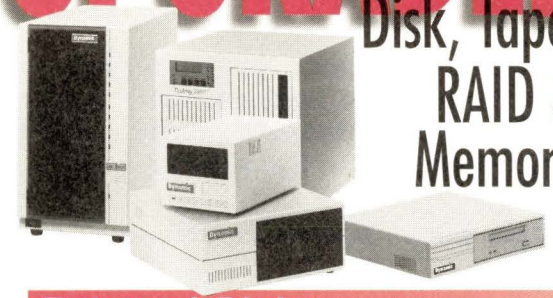

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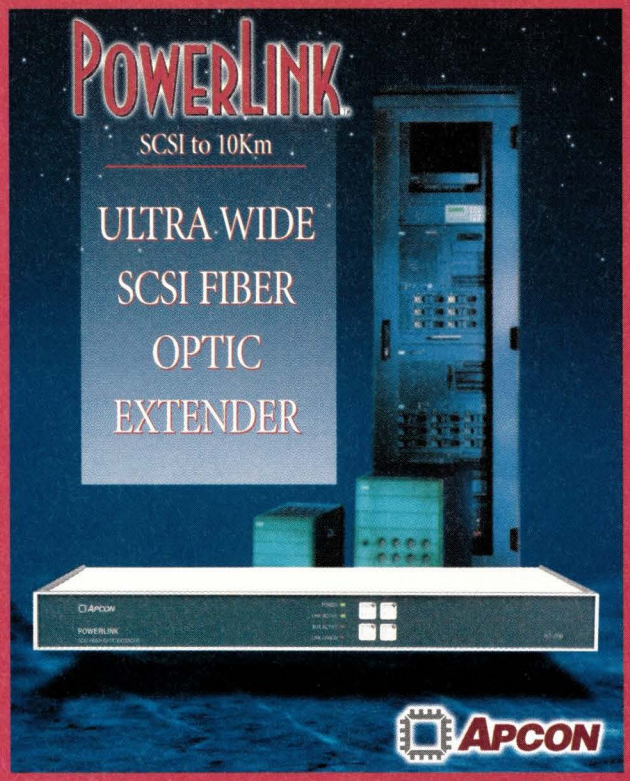

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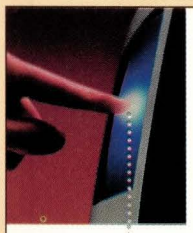

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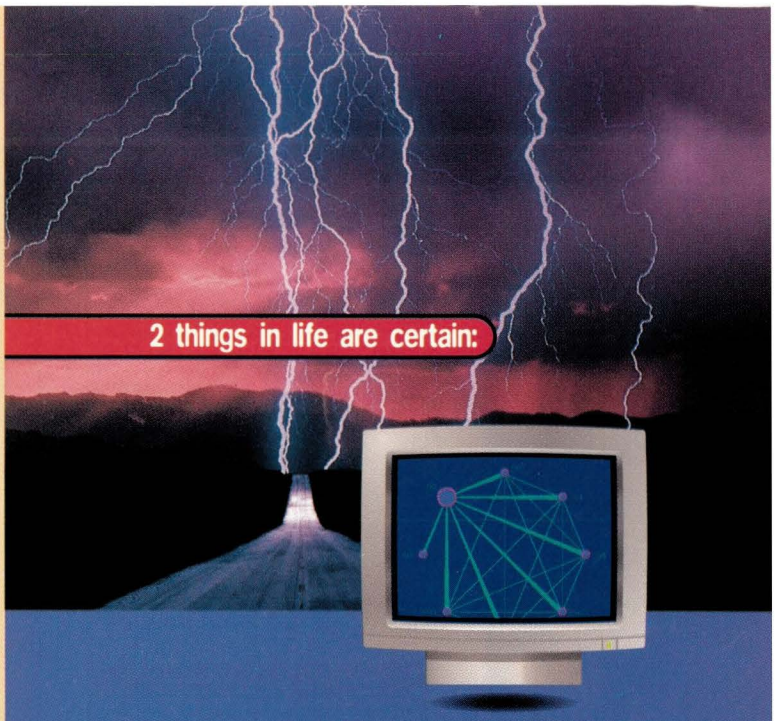

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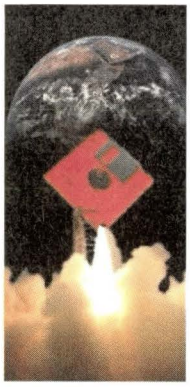

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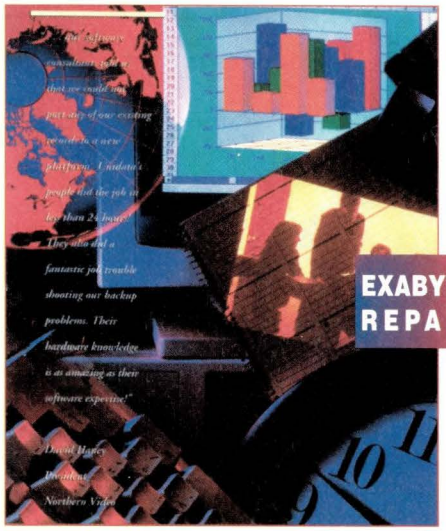

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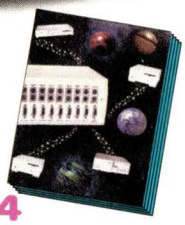

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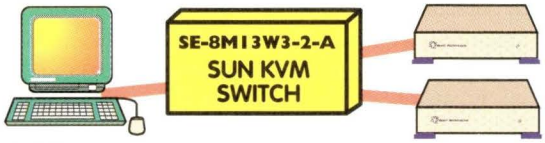

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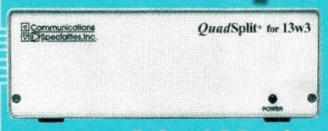

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