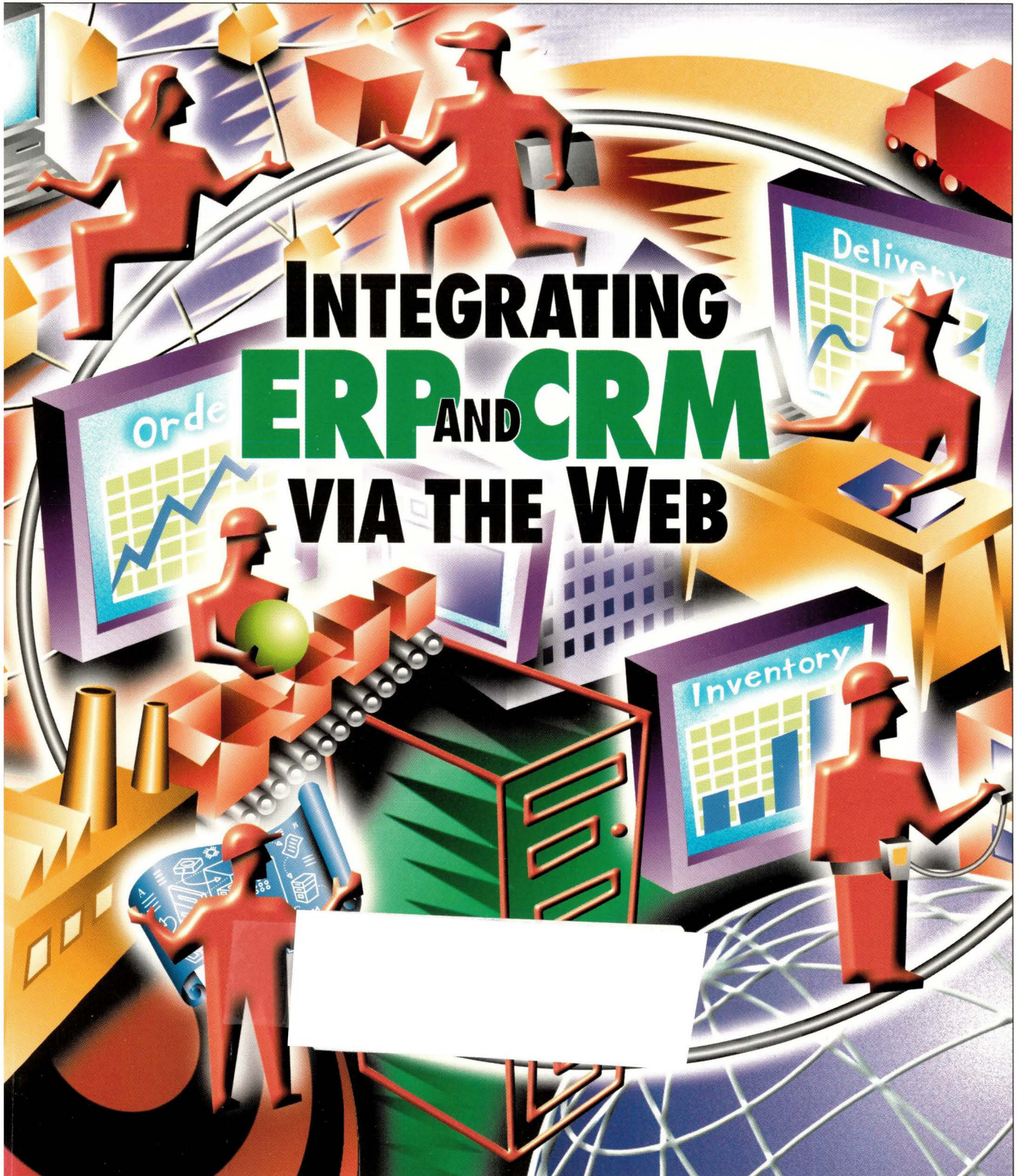


Server/Workstation

EXPERT

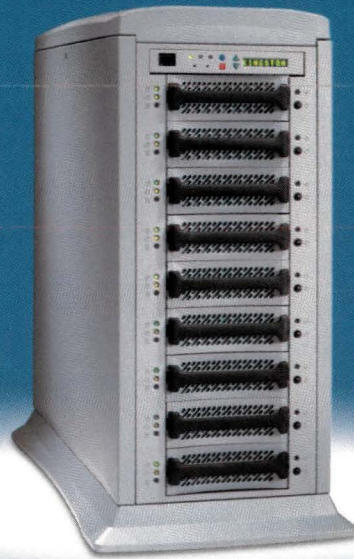
MARCH 2000
Vol. 11 No. 3 \$5.50
<http://sw.expert.com>

*Server-Based
Computing
Solutions*



Storage: Disk Characteristics

Work: Sex



SIMPLY BRILLIANT.
INTRODUCING THE
KINGSTON *info*Station™

www.kingston.com/storage

WHEN IT COMES TO INTELLIGENT STORAGE ENCLOSURES, the spotlight shines on Kingston's new InfoStation™. Perfect for RAID applications, the InfoStation is a scalable backplane expansion chassis featuring:

- Support for up to (9) 3.5" Ultra2 (LVD) drives
- A user display and control interface for drive bay configuration and system set-up
- Upgradable support for up to 4 host channels (60 devices)
- (2) redundant, hot swappable, load sharing 400W power supplies
- (4) high-pressure, variable-speed blowers in (2) hot swappable modules
- A generous 7-year warranty

With many field-upgradable options to come, such as a SCSI RAID controller board, a Fibre to SCSI bridge, and remote monitoring capabilities, the InfoStation is flexible and will grow with your future storage needs.

Call Kingston® Storage today at (888) 435-5418 to request more information about this brilliant new addition to Kingston's family of rugged and reliable Rhino® products. Mention this ad and Kingston will include a small token of appreciation in your literature packet.



Kingston Technology Company, 17600 Newhope Street, Fountain Valley, CA 92708, USA (714) 438-1850, Fax (714) 438-1847. © 1999 Kingston Technology Company. All rights reserved. All trademarks and registered trademarks are the property of their respective owners.

INTRODUCING THE TERMINAL SERVER TERMINATOR



THE CONSOLESERVER 3200 FROM LIGHTWAVE COMMUNICATIONS

The ConsoleServer 3200 delivers centralized management of your serial command ports through direct network access, multiple terminals and via modem. And, it's loaded with features that spell the end for terminal servers:

- 4 to 32 servers/devices per chassis
- Cry for Help, Word-string ID
- Up to 16 Telnet/Terminal sessions
- 10Base-T Ethernet configurable
- 64K Audit Trail per port
- Up to 4 IP addresses per chassis
- Redundant power supplies
- ID/password security
- No single point of failure or inadvertant "breaks"

Our ConsoleServer 3200 reduces down time significantly, making your life a whole lot easier.

Extending Technology into the Next Millennium

 **Lightwave Communications**
USA: 800-871-9838

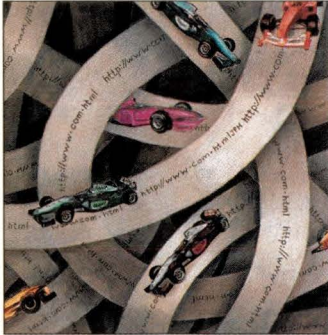
USA: 203-878-9838 • Europe: +49 893 063 810

Circle No. 2

Visit Us at lightwavecom.com
In Europe at office@lightwave.de

Server/Workstation EXPERT

The leading publication for server-based computing solutions



PAGE 6



PAGE 46



PAGE 53

Contents

6 News

Includes: Capacity on Demand; Sun Server: Going Once, Going Twice...; Linux Community Targets IA-64; Web Growth Shakes Network Core.

46 Cover Story

by George Lawton

Integrating ERP and CRM via the Web

From loading dock to manufacturing, from business logic to business process—integrated ERP and CRM can provide the tools to keep a company humming along.

Departments

4	Editorial	58	Server/Workstation Marketplace
53	New Products	72	Advertisers' Index

COMING NEXT ISSUE

Object Development
in a Distributed World

BONUS DISTRIBUTION

For Advertisers of the April Issue:

*Spring Comdex,
Chicago, IL*

SERVER/WORKSTATION EXPERT Magazine (ISSN# 1524-4849) is published monthly by Computer Publishing Group, 1340 Centre St., Newton Center, MA 02459. Telephone (617) 641-9101. Periodicals Postage Rates paid at Boston, MA, and at additional mailing offices. Posted under Canadian IPM #0235873. This publication is free to qualified subscribers as determined by the publisher. Subscription rates are \$60 per year in the United States, and \$75 (surface mail) and \$125 (air mail) outside the United States. Subscription requests can be sent to Circulation Department, SERVER/WORKSTATION EXPERT Magazine, 1340 Centre St., Newton Center, MA 02459, or electronically mailed to circ@cpg.com.

POSTMASTER, please send all address changes to SERVER/WORKSTATION EXPERT Magazine, Circulation Department, 1340 Centre St., Newton Center, MA 02459. Please allow 6-8 weeks for change of address. Include your old address as well as new—enclosing, if possible, an address label from a recent issue. All rights reserved. © Copyright 2000, Computer Publishing Group. No part of this publication may be transmitted or reproduced in any form by any means without permission in writing from the publisher.

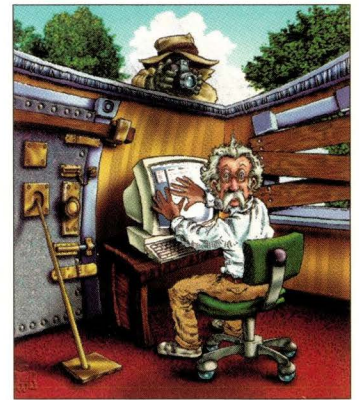
Material for publication should be sent to the attention of Doug Pryor at the above address or electronically mailed to dpryor@cpg.com. Letters sent to the publication become the property of the publication and are assumed to be intended for publication and may be used so. All information herein is believed to be accurate to the best of our ability.

16 Ask Mr. Protocol

by Michael O'Brien

Mr. P.'s Unnerving Sense of Security

Everyone's all hot on privacy and Internet security. Encryption is the new sacrament. But aside from credit card numbers, why should we even care? Mr. P. says, maybe you shouldn't.



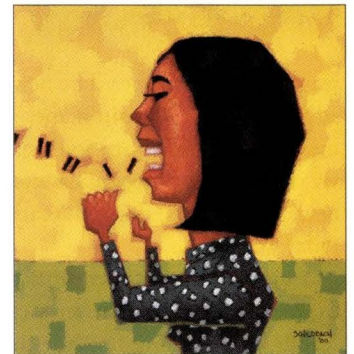
PAGE 16

22 UNIX Basics

by Peter Collinson

To Quote or not to Quote

A reader's question about quoting characters in the shell is the catalyst for this month's column on the mechanics of UNIX.



PAGE 22

28 Storage

by Alan Benway

Heading into the Wilderness

Last month, we looked at the major physical and logical aspects of disk drives. This month, we examine the operational and performance characteristics of disks.

34 N'Tegration

by Eileen Frisch

All in a Day's Work

Our resident 'Jane of all trades' resolves a couple of rather unusual requests from users.



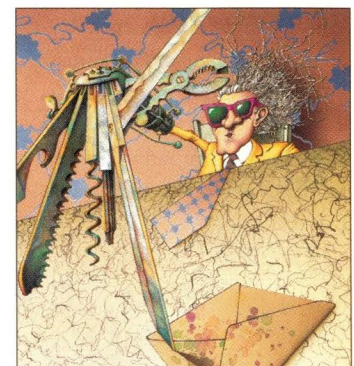
PAGE 37

37 Work

by Jeffreys Copeland and Haemer

Sex

This month, the Jeffs try to answer the unanswerable: 'Why is sex always the same?'



PAGE 41

41 Java Class

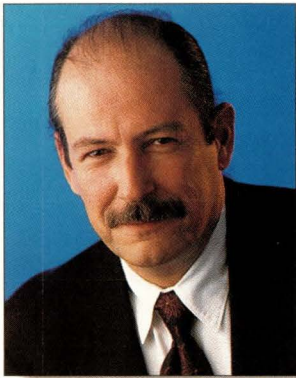
by Jim Frost

Postal: You Have Mail

In this our fourth installment in the construction of Postal, an IMAP client, we finally get to the point where we can actually read an email message.

EDITORIAL

dpryor@cpg.com



Reinventing the Wheel

How's this for an observation that will live in infamy: "Everything that can be invented has been invented." So said Charles H. Duell, Commissioner of the U.S. Office of Patents, in 1899. He obviously was not a dot commer. The new turks seem to believe nothing has been invented until it has a domain name. The truth is surely somewhere inside these extremes. For evidence, turn to this month's cover story, "Integrating ERP and CRM via the Web," by George Lawton. None of the practices George talks about are new, however, the implementations have changed to reflect the wired nature of today's businesses.

Enterprises have been tracking the flow of goods throughout the company from raw materials to inventory levels from time immemorial. If archeologists search long enough, I'm sure they'll find cave drawings of prehistoric supply chain theories. So what's new? It's not what is being done. It's how it's being done. Over the last decade or so, enterprise resource planning systems have simply automated the process. When these kinds of capabilities are integrated into the Web, it makes the whole production and delivery process transparent. George says, "It simplifies the process of finding out what is holding up deliveries, and when coupled with knowledge management systems can be used to determine overall bottlenecks to the process of delivering goods and hence getting paid for them. When these kinds of applications are made available on the Internet, it enables customers to answer those nagging questions on their own, without burdening internal employees." ERP streamlines and codifies business process. It's the automation that's new. It's the transparency to management that's new.

Of course, the next logical step is to make that business process transparent to suppliers and customers. In walks CRM. "The most straightforward model of integration between ERP, customer service and Web elements is simply the extension of an existing business into cyberspace," says George. "Ideally, you want to provide a single space where customers can shop and gain information from back-end systems about recent purchases and their status." To find out how many companies are reinventing themselves, take a look at George's story on Page 46. Just remember, the wheel's patent may have expired.

Doug Pryor

SW EXPERT

March 2000

Vol. 11 No. 3

Publisher	S. HENRY SACKS shs@cpg.com
Editor-in-Chief	DOUGLAS PRYOR dpryor@cpg.com
Managing Editor	LISA BUCHER lisab@cpg.com
Technical Editor	IAN WESTMACOTT ianw@cpg.com
Contributing Editor	SIMSON L. GARFINKEL
Staff Editor	SUZANNE HILDRETH sjh@cpg.com
Production Editor	MICHAEL LETTS mletts@cpg.com
Art/Production Director	JOHN W. KELLEY JR. jwk@cpg.com
Senior Designer	BRAD DILLMAN bdillman@cpg.com
Production Assistant	ROY PORTER roy@cpg.com
Circulation Director	DEBORAH MOORE dm@cpg.com
Promotions Manager	TOM BROWN tom@cpg.com
Accounting Manager	ROBIN YEARWOOD robin@cpg.com
Office Manager	TINA JACKSON jamal@cpg.com
Business Manager	SUSAN R. SACKS srs@cpg.com

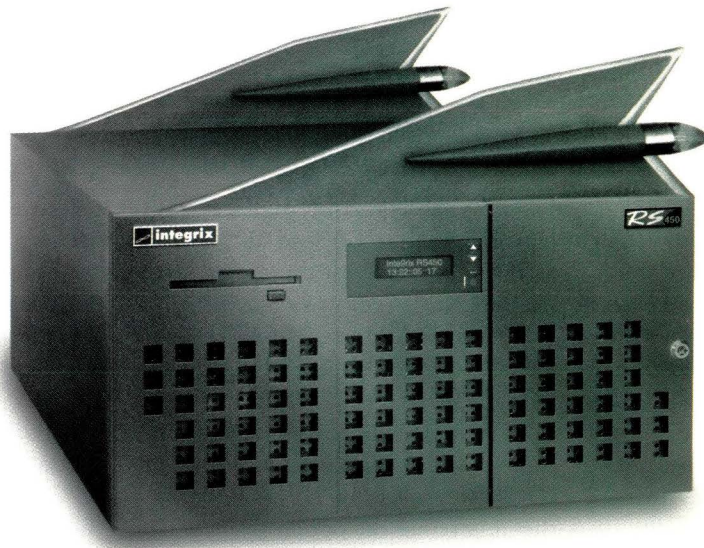
World Wide Web
<http://www.cpg.com>

EDITORIAL OFFICES

1340 Centre St.
Newton Center, MA 02459
(617) 641-9101



Printed in USA



Sure, if that's what you want.

Customized solutions.

That's why people like working with Integrix. You see, we have the experience and capability to do some pretty remarkable things. Take our RS450 UltraSPARC® server for example. As your network enterprise grows, space becomes more valuable. So we've designed the RS450 to provide the highest processing power available in the most compact form factor. It works seamlessly with your existing environment, and even without the tailfins, the RS450 is one of the most powerful, scaleable and affordable servers on the market today. If you have unusual network requirements (and who doesn't), visit us at www.integrix.com or call **800-300-8288** and ask how we can customize a solution for you.



Server/Workstation NEWS

Visit Our Web Site <http://sw.expert.com>

Capacity on Demand

Borrowing an idea from the mainframe world, Sun Microsystems Inc. and Hewlett-Packard Co., both based in Palo Alto, CA, have begun offering their UNIX customers the ability to order servers with dormant CPUs and activate them later when the extra processors are needed. The idea is to allow customers to add processing power almost instantaneously in response to unexpected surges in usage.

Sun Capacity on Demand (COD) customers can purchase fully configured Sun Enterprise 10000 (Starfire) servers with some of the processors turned off. The customer initially only pays for the number of active CPUs shipped with the system, but can opt to pay to "turn on" the extra processors at a later date if they are needed. Likewise, purchasers of HP's L-Class, N-Class and V-Class servers who subscribe to the company's Instant Capacity on Demand service, or iCOD, can purchase fully loaded servers but pay for the processors incrementally when they decide to use them.

HP began offering the option in February, while the Sun service has been available since November. Sun's program applies only to customers of the high-end 64-way Enterprise 10000 servers. However, Jamie Ens, group manager for the Sun Data Center and High-Performance Computing Products Group, says a management mandate has been given to eventually expand the program to the rest of Sun's Enterprise server line.

Les Wilson, worldwide mission-critical server solutions manager for HP, says he expects the iCOD offering to be most popular with the midrange

N-Class servers and predicts that between 15% to 30% of all N-Class servers will ship with the option once the program gets underway.

Although Armonk, NY-based IBM Corp. has offered Capacity Upgrades on Demand for its S/390 mainframe servers since January 1999, this is the first time such a program has been available for UNIX servers. Both HP and Sun say they're offering the option to meet the needs of Internet-focused customers who often need to upgrade hardware

it more important for companies to be able to upgrade their systems quickly. "If you're doing e-commerce, this is an effective way to ensure you can handle these peak loads. As e-commerce becomes more and more prevalent, I believe that this is going to be a fairly basic requirement," Iams says.

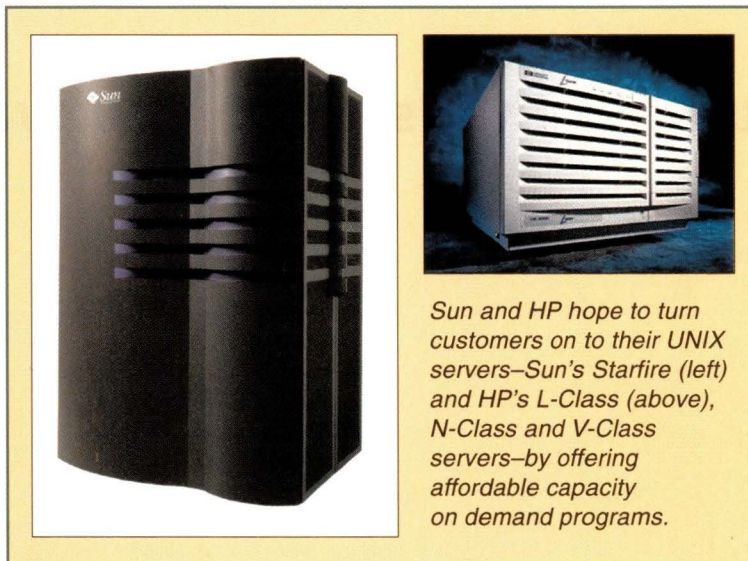
Neither program is free. Both Sun and HP customers pay a premium for the service. Sun customers must purchase a Starfire server with at least 20 CPUs installed and enabled. Additional CPUs can be added to the system under the COD plan at a price of \$50,000 per four-way board and \$27,500 per CPU

when enabled. Ens says that for a customer to purchase a board with four processors the traditional way—by simply ordering it and waiting for delivery—the price tag is about \$152,000. A COD customer, on the other hand, will pay \$160,000 for the same board by the time all four processors are finally activated.

Sun does make one exception to the 20-CPU minimum, Ens says. Under the COD plan, a customer

can purchase a 20-CPU Starfire with only eight CPUs enabled for \$390,500. But the price for enabling the CPUs in that configuration is considerably higher: \$66,500 per CPU. For comparison, a 20-way Starfire with all 20 CPUs enabled would cost approximately \$1.05 million. According to Ens, the special configuration was made available for customers "who really need a Starfire system for its mainframe-class reliability and manageability features, but for whom the entry price [of a fully configured 20-way system] is prohibitive."

In contrast to Sun, HP doesn't charge extra for COD processors. Instead, HP



Sun and HP hope to turn customers on to their UNIX servers—Sun's Starfire (left) and HP's L-Class (above), N-Class and V-Class servers—by offering affordable capacity on demand programs.

within hours, or even minutes.

"What makes this so important now is the unpredictable nature of [Web site] demand," explains Ens. "In the past, people had a pretty good idea of what their workload was and could plan accordingly. Now, in the world of the Internet, you have a much more difficult time trying to figure out what will happen when you put up a new page or new service on your Web site. Will you get a thousand hits or a million? There's no way to predict."

Tony Iams, analyst with D.H. Brown & Associates Inc., Port Chester, NY, agrees that Internet demands have made

Unbelievable!

Picture your Sun Ultra 2 configured with
4 Ultra II 450 MHz CPU's & 3 GB of Memory



Cycle Computer Corporation

CALL FOR INFORMATION: 1-800-672-1200



customers pay a monthly fee of approximately \$150 per COD-ready processor. When a customer is ready to purchase the CPU, however, they pay only what the going rate for the CPU is at the time of activation. "Since prices tend to go down, it offers some price protection to the customer," HP's Wilson says.

Because both vendors typically introduce new and upgraded processors on a regular basis, Iams says the capacity on demand programs could become a burden to Sun and HP whenever they debut new technology. "If a new processor comes out, it's going to be a bit of a challenge for the vendor to deliver because new processors are initially at a premium, and at the same time, the yield is still a little low. But they'll still have to ship the processors off to all these [capacity on demand] customers who aren't really paying for them," Iams says.

However, that may be a small price for Sun and HP to pay to retain its customer base. Capacity on demand programs make it harder for a customer to switch to a competing platform, says Tom Henkel, research director at Gartner Group Inc., Stamford, CT. "It reduces the likelihood that the customer will entertain alternate proposals. There is an installed base protection to this that will ultimately benefit Sun and HP."

While Henkel says both programs are definitely a step in the right direction, he believes they would be more valuable if they included on-demand upgrades for other aspects of the system such as storage, and not just CPUs.

"In their current state, both focus solely on CPU expansion. They don't put much emphasis on maintaining a balance in the system, nor do they provide you with any good tools to help maintain the balance of a system moving forward. Good performance on a system really is a combination of things, CPU performance coupled with the appropriate amount of memory, coupled with the appropriate disk capacity and I/O bandwidth. These programs create an environment where a customer can arbitrarily add CPUs to the system, which

may not always deliver the desired performance improvement," Henkel explains.

Sun does offer a separate Storage Capacity Lease program in which customers can lease fully configured Sun StorEdge arrays but opt to use, and pay for, just one-third of the capacity for the first year. HP has also said it plans to eventually expand its iCOD program to include other server components such as memory and I/O, as well as storage subsystems and HP's HyperPlex server clusters.

Down the road, Henkel sees the possibility of vendors offering temporary upgrades to server capacity; a sort of rental approach to CPU upgrades. "Right now, you can turn a CPU on, but not off. The potential exists here that you could have some capacity to add CPUs for a brief moment in time, such as during a spike in demand on a Web server or during the monthly [accounting] book closings. It could create new options for customers in purchasing capacity." —*sjh*

Capacity on demand programs make it harder for a customer to switch to a competing platform.

Sun Server: Going Once, Going Twice...

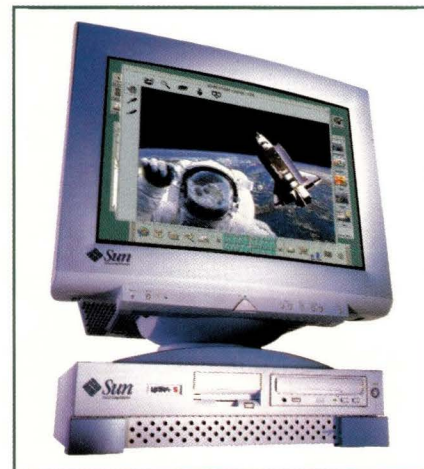
Looking for a deal on a Sun Microsystems Inc. server or workstation? You might want to check out the online auction site run by San Jose, CA-based eBay Inc. In December, Sun, Palo Alto, CA, began a pilot program to sell new servers, workstations and storage products on eBay (<http://www.ebay.com>), a consumer-oriented auction site that deals in everything from antique furniture to Pokémon trading cards.

During an initial test period, from mid-December through the end of January, Sun put up 500 Ultra 5 workstations, 100 E250 servers and an unspecified number of StorEdge storage products. Sun may expand its sales to other, unspecified online auction sites, depending on the success it has on eBay, says Sun Public Relations Director Doug van Aman. "It's a kind of rolling strategy that we're evaluating as we go along."

eBay, a Sun customer, carries on its Web site items ranging from jewelry and collectibles to used cars. It also offers a host of computer gear, including servers and mainframes. But most are sold used or offered by resellers. For a UNIX manufacturer to sell new equipment via eBay is something new.

John Butler, president of AnySystem.com, a Glen Rock, NJ-based leasing company that deals in Sun equipment, says he was surprised to see Sun selling brand-new servers and workstations on the auction site. "eBay isn't really a business-to-business site. It's more like a yard sale," says Butler, who sells used Sun equipment via eBay. "It seems odd for a company that has a premier distribution channel to turn around and do this."

Why is Sun auctioning off its workstations and servers on a site that is largely known for consumer-oriented products?



As part of a pilot program, Sun put 500 Ultra 5 workstations (above), 100 E250 servers and several StorEdge storage products up for auction via eBay in December and January.

According to van Aman, Sun wants to target a more entry-level type of buyer than it has in the past. "One of the things we think the auction community provides is an opportunity to reach folks we might not otherwise reach and bring them into the Sun family a little faster than we otherwise might," he says. These prospective customers are likely to have the technical savvy to configure a UNIX workstation or server, says van Aman, but may consider Sun systems to

Nice computer.

Accelerated-X™ graphics system software lets you run Solaris x86 on the latest laptops.

The Problem.

You want to buy a new laptop with a fast, powerful graphics chip and a big screen. But Solaris x86 doesn't run on it *precisely* because of that new graphics hardware. Now what?

The Answer.

The industry's best X server for Linux and UNIX® systems: Laptop Accelerated-X Display Server. It seamlessly replaces the Xsun server in Solaris x86, offers unmatched graphics performance at TrueColor, PseudoColor and IndexedColor, and provides stable operation and support for the latest, hottest graphics hardware on PC laptops.

The Source.

X_i Graphics, Inc. has been providing the industry with Accelerated-X™ graphics support software for over six years. It's our specialty: premium commercial software that comes with virtually unlimited free customer support. New graphics support modules can be downloaded free. Visit our Web site for technical and performance details and a list of supported laptops.

www.xig.com

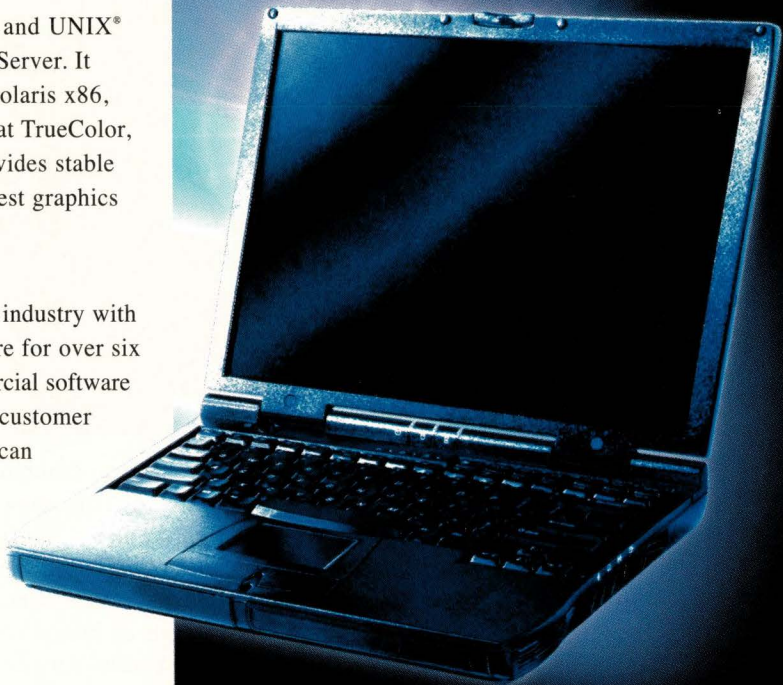


X_i Graphics, Inc.

Circle No. 21

Will it run Solaris?

WITH
IMPROVED
PCMCIA
SUPPORT



Accelerated-X™
Performance to the power of x

be beyond their small-company budgets.

That's not always the type of buyer Sun's attracting on eBay, however. iTransact.com, an e-commerce payment processing and authorization firm based in Salt Lake City, UT, has purchased Sun servers and other equipment from Sun resellers, but recently bought two Ultra 5 workstations—and also bid on a server—on eBay because the potential price savings are so attractive. “The cost savings is the primary reason [for bidding on Sun equipment],” says iTransact Chief Technical Officer Matthew Jones. “We have quite a bit of experience in Solaris hardware, so we can save a bundle by purchasing from Sun at auction.”

For example, a new Sun Ultra 5, 360-MHz UltraSPARC-III processor with a 19-inch flat-screen color monitor and Solaris 7 preinstalled sold for prices ranging from \$2,275 to \$2,375, although it lists for \$2,600. An Enterprise 250 workgroup server, meanwhile, that lists for roughly \$27,000 went for \$20,000. The only services bundled with the Sun products are standard warranties—a one-year warranty for workstations and three-year warranty for E250 servers. However, in the future Sun may consider including more extensive services with the products, van Aman says.

The decision to auction products via eBay could upset Sun's resellers, who might perceive the move as an attempt by Sun to undercut the channel. Bev LeBoeuf, director of marketing for Rave Computer Association Inc., a Sun reseller based in Sterling Heights, MI, says Sun needs to be careful about offering its products for far below list prices. “If they go dropping prices on eBay to the point where they're taking the new products and raffling them off, that will hurt them,” says LeBoeuf, adding that such a practice would send a confusing message to resellers who might, in turn, have to reevaluate their price policies.

However, she doesn't believe any of Rave's customers are likely to turn to eBay for major IT purchases. “I know that some of our customers have considered buying online, but rarely have they considered buying from an auction site—especially if they want a new system.

Refurbished, maybe. But when they're buying a new system, they want to be catered to. They want the bells and whistles,” says LeBoeuf. “Auctions cannot take the place of the service provided by a value-added systems integrator.”—*sjh*

Linux Community Targets IA-64

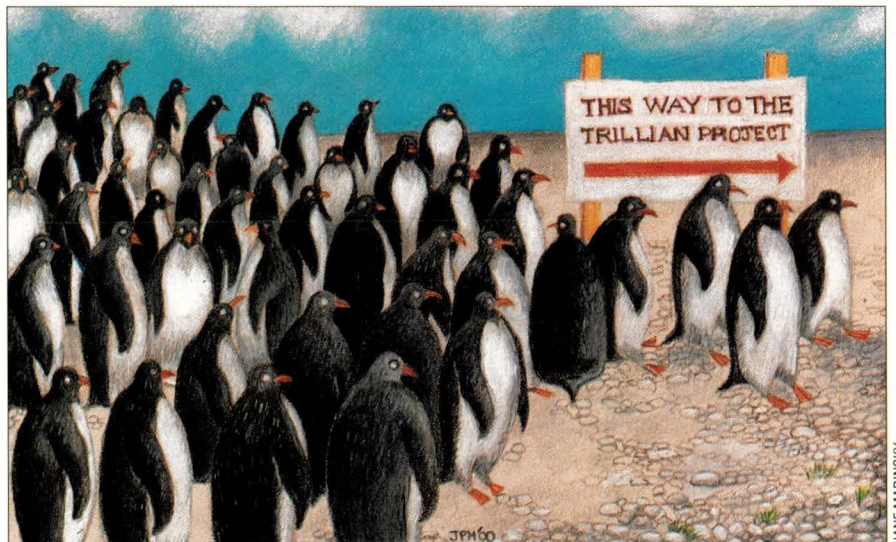
In an effort aimed at keeping Linux on par with commercial UNIX platforms, a group of computer industry vendors are developing a Linux port for Santa Clara, CA-based Intel Corp.'s forthcoming IA-64 architecture.

The Trillian Project, made up of nine Linux and UNIX vendors, as well as Intel, has been working since last April to deliver a finished port in time for the release of Intel's Itanium chip, the first iteration of the IA-64 architecture, later this year. In August, the group demon-

and Intel—plus four Linux distribution vendors, which joined the project in December. Those new members are Red Hat, SuSE Inc., Oakland, CA, TurboLinux Inc., Brisbane, CA, and Caldera Systems Inc., Orem, UT.

The group's ultimate aim is to have a production release of the Linux port ready for the launch of the Itanium chip later this year. “The goal of the project is to achieve a technology that is clean enough and neutral enough that anybody can use it in the great Linux tradition,” says Mike Tiemann, founder of Cygnus Solutions and newly appointed chief technical officer of Red Hat.

Ports of Linux already exist for 64-bit RISC architectures, including Palo Alto, CA-based Sun Microsystems Inc.'s UltraSPARC and Houston, TX-based Compaq Computer Corp.'s Alpha chip. A 64-bit Linux will be most useful for organizations engaged in technical computing with Linux, or those with very



JANE MARINSKY

strated its kernel booting on an Itanium simulator at the LinuxWorld trade show in San Jose, CA, and in February, it released its first development port at the LinuxWorld trade show in New York, NY. The port is available at <http://www.kernel.org/pub/linux/kernel/parts/ia64>.

The group comprises six original members—Cygnus Solutions Inc., Sunnyvale, CA (recently acquired by Red Hat Inc., Durham, NC), Hewlett-Packard Co., Palo Alto, CA, IBM Corp., Armonk, NY, SGI, Mountain View, CA, VA Linux Systems Inc., Sunnyvale, CA,

large databases that require a lot of memory. While 32-bit computers address 4 GB of main memory, 64-bit architectures can address 18 million GB of memory, vastly improving performance in applications that require huge amounts of memory.

“One of the biggest, if not *the* biggest, 64-bit payoffs is large memory databases, or in-memory databases. The idea is that if you stick the database in memory, it's a lot quicker than having it on disk. You can grow these in-memory databases much bigger than just two gigabytes,” says Greg Weiss, analyst at

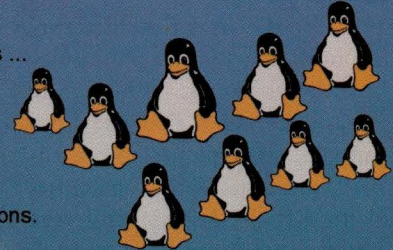
DCG Computers, Inc.

When You're The Best, Your Clients Will Brag About You!

"DCG is the most experienced company today providing Alpha/Linux solutions ...
... DCG has the expertise and the knowledge to provide excellent Linux solutions,
as evidenced by their new Beowulf offerings. There's simply no other company
that can confidently provide this class of solution.

While others talk about providing a Beowulf solution, DCG delivers it! "

Bruce Faust
Founder of Carrera Computers and NekoTech, both of whom provide Alpha solutions.



"It is this level of service that makes all the difference to us.
With computer systems available from a multitude of firms,
at almost commodity prices, it is quality of a vendor's service
that distinguishes it from the rest of the pack.
This is where DCG Computers really stands out."

MIT, Cambridge, MA

"DCG Computers provided us with a highly cost effective
means to perform scientific computations.
We found DCG Computers to be competent, prompt and courteous
in providing us with this machine. It is our intention to do
more business with DCG Computers and have recommended
DCG Computers to our colleagues here at NASA Ames.

...I recommend DCG Computers, Inc.
to anyone wishing a cost effective purchase of a Beowulf Cluster."

NASA Ames Research Center

Alpha
processor

LINUX AND
BEOWULF
SPECIALISTS



**Building the
Fastest Systems
in the World**

Tel:603-622-7171 Fax:603-622-7272

For a complete list of solutions visit us at www.dcginc.com

SUPPORT FOR LINUX, DIGITAL UNIX, OPENVMS, AND WINDOWS NT

All trademarks and registered trademarks are the sole property of their respective owners

D.H. Brown & Associates Inc., Port Chester, NY.

Besides large memory, the port will support a variety of other enterprise features, such as symmetric multiprocessing, or SMP (to enable multiple processors to share memory), clustering and large file systems.

A port for the IA-64 architecture benefits both the Linux community and Intel, says Weiss. "The Linux group wants to show that they can grow into increasingly scalable hardware platforms and 64-bit capabilities like all the RISC UNIXes, while the Intel crowd wants to appeal to technology-savvy developers and e-commerce sites, which have adopted a lot of Linux technology," he says.

One obstacle that Weiss feels could impede the rapid adoption of Linux for the IA-64 architecture is a lack of high-availability (HA) Linux solutions to support the increased capacities of the 64-bit chip. "Often, these types of [64-bit applications] are so critical that companies want high-availability solutions that protect not just against OS failures, but also against hardware and application failure. Those [HA solutions] are only in the early stages on Linux," he says.

But Red Hat's Tiemann believes the fast pace at which Linux has risen to commercial prominence will also produce HA solutions to meet new customer needs. "In Boston, they say, 'If you don't like the weather, wait 15 minutes,'" Tiemann says. "With Linux, it's, 'If you don't see the solution you want, check back in three months.' There are developers around the world working on every interesting problem."

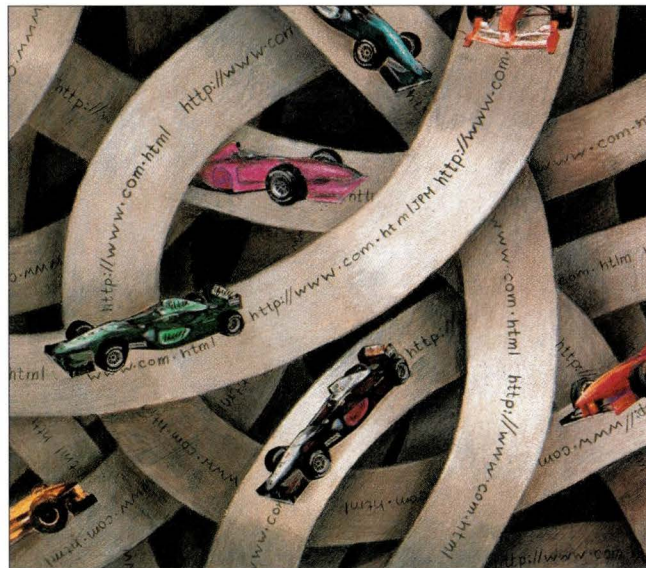
Bill Claybrook, research director for Linux at Aberdeen Group Inc., a market research firm in Boston, MA, says the Linux industry will need to produce a wider range of high-end applications than currently exists on Linux in order to take full advantage of a 64-bit Intel Linux port. "No one has found a killer app for 64-bit [architectures], except for some of the database applications that require large chunks of memory," Claybrook says. "Outside of data warehousing and technical computing, there are not a lot of applications [that can

use a 64-bit Linux port]. But that will change. At the rate at which people are taking to Linux, who knows what will be available in six months."—*sjb*

Web Growth Shakes Network Core

Cisco Systems has been on a bit of an acquisition binge recently, its latest acquisition being that of the optical systems business of Italian firm Pirelli S.p.A.

In December, Cisco Systems Inc., San Jose, CA, announced it would be the latest attendee to join the fiber-optic party. The company unveiled its plan to dole out \$2.15 billion for the Pirelli business. "Cisco had a gaping hole in its product line and the Pirelli acquisition fills it," says Andrew McCormick, senior analyst with Aberdeen Group Inc., a Boston, MA-based market research firm.



JANE MARINSKY

Pirelli sells Dense Wave Division Multiplexing (DWDM) equipment that helps carriers boost bandwidth to 10 Gb/s over fiber-optic lines. Such technology has become strategic because corporations are chewing up Internet bandwidth so quickly that carriers see network usage double every three to six months. The rapid rise has created dramatic transmission increases in carrier and Internet service provider (ISP) core networks, which are the areas where data is collected and shipped over high-speed, long distance lines. Traditional multi-

plexing technology does not have sufficient power to meet these new demands, so increasingly, carriers are turning to fiber-optic technology like DWDM.

How much success Cisco—which says it can't comment on the acquisition until it is completed—will have in this market is unclear. Traditionally, the company's strength has come from its enterprise data network equipment. However, corporations have been increasingly off-loading network functions to carriers during the past few years, and as a result, Cisco has been focusing more on the carrier market.

To be a top player in that market, according to analysts, a company must offer core network equipment. "Carriers tend to build their networks from the core out, so a decision to go with one vendor's core system can lead to sales of hundreds or even thousands of add-on devices," says Michael Arellano, analyst with Degas Communications Group

Inc., a New York, NY-based telecommunications market research firm.

With essentially an empty core network product portfolio, Cisco has been on an acquisition spree, buying three start-ups since last summer. In August, Cisco paid \$7 billion for Cerent Corp., a Petaluma, CA-based maker of equipment that consolidates differ-

ent types of information to be sent over fiber-optic lines, and \$450 million for Monterey Networks Inc., a Richardson, TX-based company that has developed a technique to squeeze more data onto fiber-optic lines. In December, Cisco spent \$126 million for PipeLinks Inc., also in San Jose, CA, which makes routers that connect the Public Switched Network (PSN) to the Internet.

Along with Pirelli, these acquisitions provide Cisco with the components needed to deliver a complete end-to-end fiber system. "Cisco thinks its

What's stopping you from making more money?



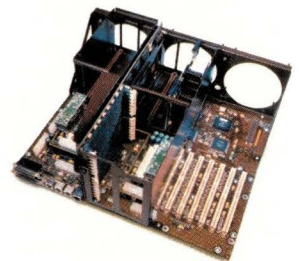
Reliable AXmp+ embedded server solutions from Sun Microsystems and Bell Microproducts keep network traffic zipping right along.

Every time a system goes down, so does profitability. That's why it's important to call Bell Microproducts — the premier distributor for Sun Microsystems' reliable SPARCengine™ ULTRA™ AXmp+ motherboards.

The ULTRA™ AXmp+ features a whopping 4GB RAM capacity — twice that of the original AXmp — to give plenty of headroom for running more revenue-generating applications. What's more, the extremely reliable combination of SPARCengine™ processors and the robust Solaris™ operating environment keeps those valuable applications up and running. Add to that the scalability of four-way multiprocessing, the cost-effectiveness of PCI-bus compatibility, and the convenience of a standard, 19-inch rack-mount format and you have a solid foundation for embedded applications.

Thanks to our strategic partnership with Sun Microsystems, Bell Microproducts can deliver ULTRA AXmp+ embedded server solutions any way you want — components, kitted, or integrated solutions.

So call us now at (877) 919-BELL (2355) and ask for the AXmp+.
You'll receive a FREE gift and be eligible to win a Sun Microsystems workstation
(a \$10,000 value)! You can also register online at www.bellmicro.com.



*The Sun Microsystems SPARCengine™
Ultra™ AXmp+ Motherboard*



© 1999 Bell Microproducts, Inc. and Sun Microsystems, Inc. All rights reserved. Sun, Sun Microsystems, the Sun logo, Solaris, and Ultra are trademarks or registered trademarks of Sun Microsystems, Inc. in the United States and other countries. All SPARC trademarks, including the UltraSPARC Driven logo, are used under license and are trademarks or registered trademarks of SPARC International, Inc. in the United States and other countries. Products bearing SPARC trademarks are based upon an architecture developed by Sun Microsystems, Inc. All other product and corporate references may be trademarks or registered trademarks of their respective companies.

For more information

call 877-919-BELL (2355)

or visit us at www.bellmicro.com

 **BELL MICROPRODUCTS**

Circle No. 7

future battles will be with Lucent [Technologies] and Nortel [Networks Inc.] for the carrier networks, and now has the products that interest these companies," says Aberdeen Group's McCormick.

The Pirelli acquisition offers other benefits, too. "Cisco has not had as much of a presence in Europe as it has in the U.S., so the company will get a boost in name recognition because Pirelli is well-regarded there," McCormick says.

For Pirelli, the deal enables the company to focus more on select niches. "Pirelli wasn't having much success in the network equipment space and now will be able to focus on its components and undersea fiber-optics businesses,"

says McCormick. As part of the agreement, Cisco plans to invest \$100 million for research and development in optical components and cable transmission systems.

To what extent the companies will benefit from the multitiered agreement, only time will tell. Though Cisco now has the products to make inroads into the telecommunications core network space, success isn't guaranteed. "Lucent and Nortel have been selling to carriers for years, understand what they desire and have sales and distribution groups to cater to them. Cisco has little experience there," says Degas Communications' Arellano.

Aware of its limitations, Cisco has

been making changes to its corporate structure. The company has already established a division to focus solely on carrier system sales, and has been building a sales and service team specifically for that group.

Another challenge is the need to pull all of the pieces it has acquired together into a cohesive product set. "Carrier core networks rely on the most complicated networking technologies, so integrating four different product lines will not be easy," says Aberdeen Group's McCormick. "In the past, Cisco has been able to successfully integrate its acquisitions, but now faces its most difficult challenge."—*paul korzeniowski, freelance writer*

Support for Open-Source Programmers

Open-source software developers may want to take advantage of a suite of free services available at SourceForge (<http://sourceforge.net>), a new Web site sponsored by VA Linux Systems Inc., a Sunnyvale, CA-based maker of Linux-based servers and workstations. SourceForge contains an assortment of developer freebies, including file storage space, source code management software, chat, email, mailing lists, message forums, task management software, bug tracking and backup services for open-source projects.

Much like an application service provider (ASP) offers online access to software, SourceForge serves up development tools and applications to registered users via X Window and a `ssh` (secure shell) account.

According to Chris DiBona, VA Systems' Linux evangelist, the SourceForge site is available to anyone with an open-source project who is willing to offer the finished product under one of the software licenses approved by the Open Source Initiative (OSI), a nonprofit organization that is dedicated to managing and promoting the open-source definition for the good of the community—specifically through the OSI Certified Open Software certification program. "Anything that anyone wants to write that's open source goes up there. It's mostly for the Linux [operating systems], but we're not political about it," says DiBona. "If it's targeting Windows or BeOS or the Mac, we don't mind."

Offered at no cost to developers, the site has so far attracted more than 1,150 projects, most of which came to the site via word of mouth, DiBona says. Projects include a Java text editor, a window manager for X Window, a Linux kernel for comput-

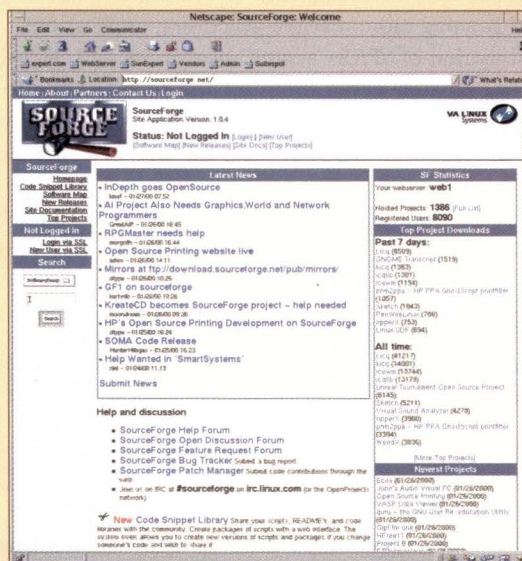
er devices with less than 3 MB of RAM, a virtual model of the solar system and a program to automate the task of submitting URLs to Internet search engines.

Jim Phillips, a Sugarhill, GA-based developer who is leading the `gnuTaxes` project to create an eXtensible Markup Language (XML)-based tax preparation application, came to SourceForge after hearing about it on a Linux forum. "I knew I'd need a place to host my site and mailing lists, and a place to store the [source code management] database. But I didn't know much about how to set those up. I think now that we have services like SourceForge, the concept of starting an open-source project will seem much less daunting and we'll see more people willing to try it," Phillips says.

To handle the demands placed on the site by the 1,150-plus projects and 6,500 registered users, VA Linux has equipped SourceForge with 1.3 TB of disk space and 11 servers. One of

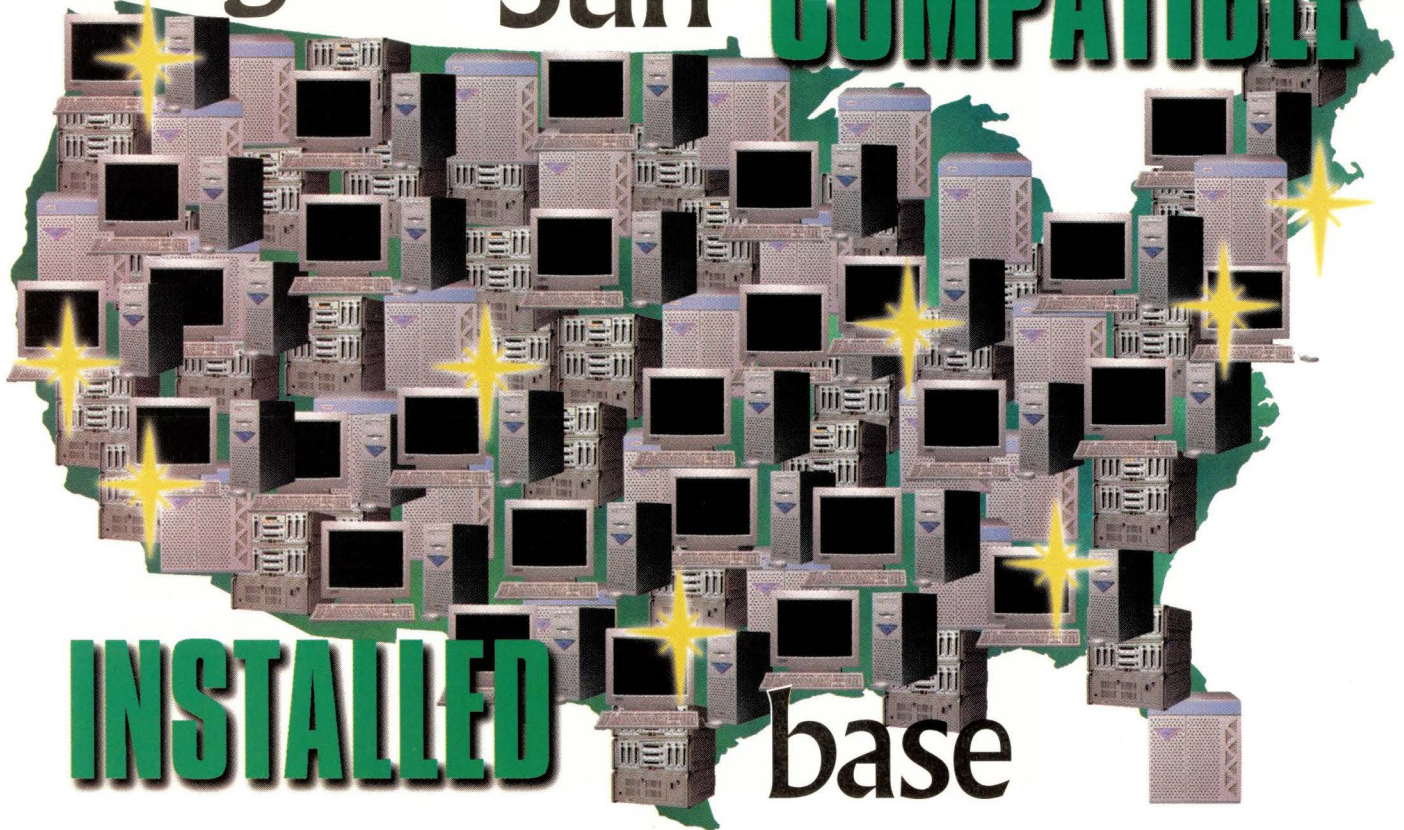
the chief benefits to VA Linux, says DiBona, is an opportunity to test the company's hardware products in a high-transaction environment. "As a leading Linux-on-hardware provider, we need to know the issues that our customers go through every day. The more we learn about large-scale installations [like SourceForge], the better," says DiBona. "This is almost a lab environment for us. And the recognition we get is great for the company."

SourceForge isn't the only site to offer free software and services to open-source developers, however. Another site, Xnot (<http://www.xnot.com>), also offers free Web space, source code management software, FTP file storage, bug tracking and other services to open-source developers.—*sjh*



The SourceForge Web site is a free service for developers of open-source software projects.

largest Sun[®] **COMPATIBLE**



INSTALLED base

Single, Dual or Quad Processors

SERVERS

And the numbers just keep on growing. Tatung has 10's of thousands

of high quality workstations, servers and storage systems installed across North America and is second only to SUN in SPARC-based computing.

Rely on Tatung for a broad line of powerful workstations and servers that use the latest in 100% Sun UltraSPARC microprocessors and are priced less than comparable Sun systems.



All Tatung systems are manufactured in the U.S. and are available across the country from our regional sales offices.

Visit our web site www.tsti.com or call 1-800 659-5902 today for the nearest office and we will power up a system for you.

WORK STATIONS

Desktop and Rackmount Solutions for Commercial and Industrial Applications



Tatung's full line of UltraSPARC workstations, servers and storage.



The Intelligent Choice in SPARC Computing Solutions

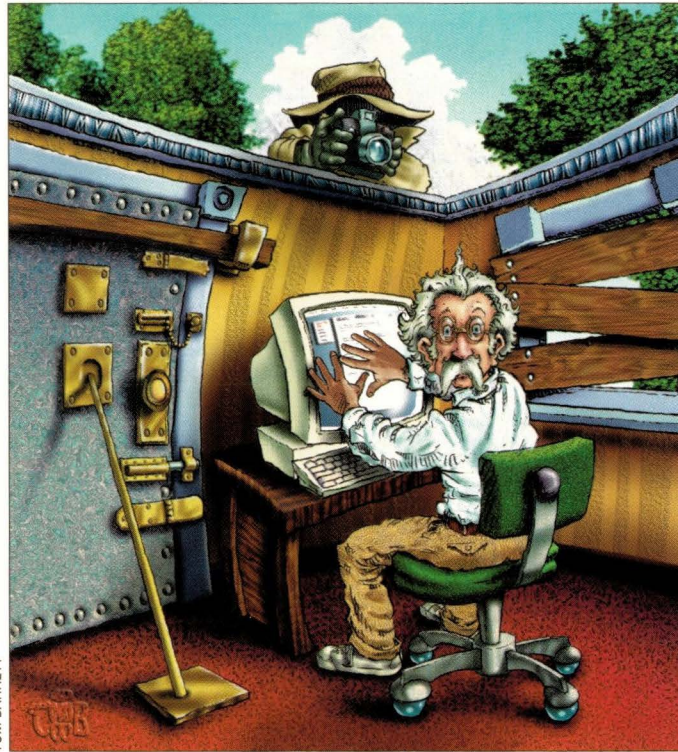
Phone 1-800-659-5902 or (408) 383-0988

email — mkt@tsti.com

website — www.tsti.com

Ask Mr. Protocol

by Michael O'Brien



*"Don't tell anybody!...
Pass it on."*

– A future head of
corporate security

*"Why not tell me your secret?
With two of us to keep it,
it'll be twice as secret."*

– A gentleman of the
Fourth Estate

*"You're known by your
enemies. Make good ones."*

– "Hercules and the
Amazon Women"

Mr. P.'s Unnerving Sense of Security

Q: *Everyone's all hot on privacy. Encryption is the new sacrament. There is no God but Phil Zimmerman, and Bruce Schneier is his prophet. Or maybe it's the other way around. Anyway, would you please tell me why I should bother about any of this? Aside from my credit card numbers, why should I even care?*

A: Here's an amazing answer: maybe you shouldn't.

There are two basic rules to security considerations of any sort, computerized or otherwise: 1) The effort put into security should be consonant with what you're trying to protect, and 2) a steel front door does no good if the back wall of the house is missing. Or, putting it another way, security should be appropriately scaled, and it should be applied evenly. Sort of like a good coat of paint.

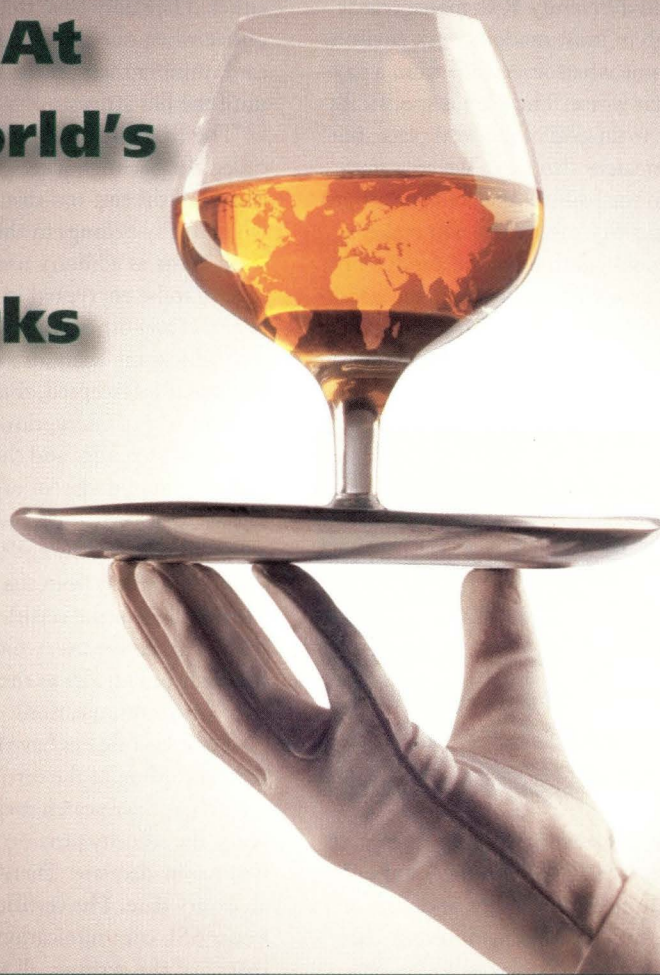
There is nothing inherently good about security. It is a negative concept: it exists, in its entirety, for purposes of prevention. In a perfect world, the entire apparatus could go away and it would

be unmourned. Security people are peculiar and are best avoided whenever possible. They are suspicious and nasty-minded. On days when you're scheduled to deal with a security person, the best thing to do is to call in sick. The best face you can possibly put on a security briefing is that it fills in that time before lunch that you would otherwise have spent clipping your toenails. And while security manuals are ubiquitous, free and generally mandatory, no one ever gives you a manual on how to deal with security people so that you come out ahead, mostly because the pinheads in management would assign the task of writing such a thing to the experts: the security people, who after all, are there to help you. Right. They're there to keep the corporate secrets secure and your welfare is definitely a secondary consideration, one which would be on the same level of urgency as replacing the company parking sticker on your car, except these are the people responsible for that whole debacle in the first place,

and typically, parking decals rank in importance several levels above food and water.

What they don't tell you is that security departments are, in fact, staffed by very nice people who operate by a set of rules laid down by raving maniacs known as "security experts," whose world view is only slightly more thoroughly skewed than that of your average serial killer. And in every corporation there is someone with a title like "Assistant to the Vice President of Human Resources," or "Deputy Ombudsman," or even "Corporate Intellectual Property Liaison," whose chief duty in life—one which is never, ever written down as a formal policy or job description—is to keep the security department firmly in check and repair the damage that it continually does. Only in this way does the corporation keep functioning. Management sees him as a necessary evil, employees see him as a running-dog lackey and the security department would see him as a Communist if it weren't so clear that

RADWARE – Served At The World's Finest Networks



The Web Server Director (WSD) family of products – premier products in global Internet traffic management.

Today you may have one Internet location and tomorrow 100. Make sure the traffic management solution you pick can grow with your network.

RADWARE's award winning load balancers are optimized for global as well as local traffic management.

Products like the Web Server Director (WSD) add scalability, optimize use of your resources and provide fault tolerance to any local or global server farm.

For the best in Internet traffic management, always ask for RADWARE.

U.S.A. Offices: RADWARE Inc. Toll free: 1-888-234-5763 e-mail: info@radware.com
International Headquarters: RADWARE Ltd. e-mail: info@radware.co.il

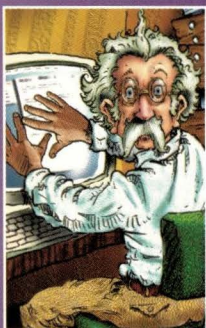
<http://www.radware.com>

Always On-Line

**RAD
WARE**

he's the Antichrist. His pay is unspectacular and everyone dislikes him. The only reason he stays on the job is that his internal vision of what would happen if he left terrifies him.

Security people see the world differently. Risk management is their life. It is difficult enough in most modern work environments to see any positive outcome whatsoever aside from a paycheck. Security people have it far worse. Their job is specifically not to pay any attention to the main goal of the workplace, but to pay attention to whatever threatens that goal. We see someone slip on a puddle of water in the hallway and we concentrate on the immediate damage. A security-minded person makes a note to put another song and dance, with graphics, about "slips, trips and falls" into the next annual security briefing, and goes back to read the *Morbidity and Mortality Report* to see what percentage of people who slip on the way to the water fountain do not survive the experience.



The certificates built into the first Web browsers to use SSL communications expired on January 1, 2000, so all sorts of old Web browsers have suddenly started popping up warnings about expired certificates.

It is from this mentality that information security springs. It is the job of banks, for example, to make certain they, and only they, have the ability to wire hundreds of millions of dollars on deposit with them to and from various other institutions. Historically, this has been done very simply: bank employees pick up the telephone and use verbal passwords for authentication.

The Internet needs a bit more. But what? Mr. Protocol is cautiously glad you asked.

The only people who bother with information security considerations are those who believe they would suffer if others gained access to information that they hold without their permission. This theory provides a rich area of exploitation for the paranoid. It's also common sense for everybody, to some degree. The most obvious example of this is the credit card. Security at the time of use is basically nonexistent, therefore, the only security available is to deny knowledge of the credit card number. We keep them secret. We only keep them moderately secret, instead of lock-the-card-in-a-bank-vault secret, because in order to make the whole thing work, legislation had to be passed limiting people's liability in cases of forged charges. Otherwise, no one would dare use the things. The credit industry as a whole eats the differential in fraudulent charges, then turns around and collects interest on the unpaid balances to offset the losses and make a thundering profit.

However, we still keep the numbers moderately secret. This means that we don't send credit card numbers in email, at least, most of us are sufficiently paranoid not to. Electronic commerce on the Web, however, is only practical with credit card

accounts, which means that people have to be able to transmit the numbers over the Web without great risk of them being stolen. Stolen credit card numbers don't have to be diverted, either. They only have to be copied in transit, so that while we notice when our credit cards are gone from our wallet, a credit card number theft on the Internet is an invisible crime, at least until the bill arrives.

The first line of defense against this is a piece of software called the Secure Sockets Layer (SSL), which Mr. P. has discussed in the not-too-distant past. This is a piece of software which really belongs in the operating system, but which instead exists as a library used by applications. It permits a TCP session to be encrypted in a secure fashion. Credit card numbers and any other sensitive personal information can be sent with some assurance over such an encrypted connection because if intercepted, the packets look like random garbage.

This sort of encryption requires that a secret be shared between the sender and the receiver. The basis of this key is a medium-sized glop of organized cryptographic information known as a "certificate," which in turn is digitally "signed" by a known trustworthy entity. Digital signatures are a pattern of numbers derived from the certificate, which demonstrate that the numbers in the certificate proper haven't been tampered with. This certificate, which is built into the application when it is distributed, acts as the basis for the shared secret used to encrypt communications.

These certificates have finite lifetimes. The theory behind that, according to the certificate authorities, is that progress in cryptographic research means that beyond a certain period of years, the security provided by the certificate's encryption will become inadequate. Therefore, the certificate is created with an expiry date. The certificates built into the first Web browsers to use SSL communications expired on January 1, 2000, so that as of this writing, all sorts of old Web browsers have suddenly started popping up warnings about expired certificates. Although the advice given just about everywhere is "Update your browser," this isn't always practical, and, in fact, it is possible to pop the old certificate out and install a new one without retiring the browser.

Thus the Web is provided with reasonably secure communications.

Security's in the Eye of the Beheld

Most people never have to move beyond that. However, if one looks around, it isn't hard to find folks who, as much as they might wish it, don't fall in with what "most people" need. Take email. There are the people who send things via email that they'd rather not have read by people other than the intended recipients. Some of these people are working on sensitive technology in big-money start-ups, for example, or are exchanging email about contract negotiations, email that the people on the other side of the table would just love to read. Then there are the people who need to keep their email secret from the CIA, the NSA, the NRO, the FBI, the Trilateral Commission, the UFOs and all seven clones of Lee Harvey Oswald. No, really! Security isn't in the eye of the beholder. It's in the eye of the beheld.

Because the audience is smaller, there are fewer obvious tools available. Aside from certain closed-architecture products (you go all or nothing: everybody buys the same package), there are some solutions around. One of the most popular is Phil Zimmerman's Pretty Good Privacy. PGP is a strong encryption package based on public-key technology, and has for years been the center of a particularly enlightening zoo centered around the export policies of the United States. The U.S. government, as a few jungle tribesmen may not know, regards encryption technology above a certain strength as a munition. PGP and bazookas fall into the same export category. Interestingly, it is still possible to export PGP without an export license, although not a bazooka, because the source code for PGP can be printed into a hardbound book and freely shipped around the world, thanks to the First Amendment to the Constitution of the United States, guaranteeing freedom of speech. It is more difficult to do this with a bazooka. It is not legal, however, to export the same book if it has a pocket inside the back cover containing a diskette with the identical contents of the book on it, in magnetic form. Machine-readable source code is a no-no. Only human-readable source code is allowed. I swear, as Dave Barry says, "I am not making this up."

This has led to the creation of T-shirts with a highly compact Perl program printed on them, which does strong encryption, or would, if you typed it in. On the front of the shirt is the text of the Perl program. On the back of the shirt is the same program in a (machine-scannable) bar code. This makes the T-shirt legally a munition, a distinction the T-shirt loudly advertises (it's a very busy design).

Given PGP, and a mail program that knows how to use it (such as `exmh`), it is possible to exchange email with someone also fitted out with a PGP-capable mail system, so long as the two of you have managed to exchange the public keys required by the encryption system. Keys are big numbers. Very big numbers. When you hear about 56-bit keys, or 1,024-bit keys, they're referring to how many bits it takes to hold the number. The bigger the key, the longer it takes to crack the encryption. How big is big enough? That's a moving target. Right now, 1,024-bit keys are probably big enough. And 2,048-bit keys will probably be good for decades, unless a general attack is discovered that makes it possible to break the particular encryption algorithm being used.

Key distribution, as it's called, is always the weak link in such systems. That's why technical conferences often have "key-signing parties," in which people gather in a room merely to exchange public keys so they can later send one another encrypted mail. The public key is put on an overhead projector, the person stands up and says, "Hi, I'm really Joe Blow, and sure enough, that's my public key." People write it down. And on and on. Usually, the keys are distributed in electronic form too, to save writing, but for the truly paranoid, there's nothing like getting it firsthand.

This gives us secure Web commerce and secure email. Aren't there more general tools?

Yes, there are. Secure Web page traffic is built on a software library called IPSec, which stands, funnily enough, for Internet Protocol Security. It is a library that permits two systems

to establish an encrypted TCP session. As mentioned above, it should be part of the kernel, but isn't. In the next version of IP, IPv6, it will be part of the standard, and the software library will hopefully go away—everyone will be able to establish encrypted TCP connections over IPv6.

On the user end of things, there's the Secure Shell. `ssh` is a protocol specification being developed under the auspices of the Internet Engineering Task Force (IETF) to permit encrypted interactive sessions. `ssh` acts as a replacement for Telnet, supporting an interactive shell session across the network. Not many people use Telnet anymore, so `ssh` isn't exactly taking over the world. However, it does a number of other things, which make it mind-bogglingly useful. The real model for `ssh` is `rsh`, the old Berkeley Remote Shell application that nobody in his right mind runs on the open Internet anymore because it's a rampaging security hole masquerading as a convenient remote command execution facility. `ssh` has a similar user syntax, but the security isn't in the same universe as `rsh`. There is strong authentication of both the client and server identities, and strong encryption of everything sent over the connection.

In addition, `ssh` also provides a utility called `scp`, or Secure Copy, which does the job that `rcp` did, in a secure fashion. It can transfer one or more files over the Internet, using the same strong authentication and encryption as `ssh`.

Saving the best for last, we ask "Who needs a shell prompt? I want X Window!"

The answer is `ssh` covers that base too. The protocol has a general facility for forwarding connections. One connection type that can be forwarded is a connection to an X server. To the user, it looks easy. Open a `ssh` session with the remote system and start running X Window commands. The `ssh` client and server connections will forward the X connections of the client X programs to the X server on your local machine. The bonus is the X Window protocol packets that move over the Net are encrypted. No one can read your X session, and no one can spoof it. This is the only secure way to run an X session over the Internet of which Mr. Protocol is aware.

Creating a Data Haven

These tools of institutionalized paranoia don't do anything that you can't already do faster and cheaper without all the security schlog. Who needs it?

One answer is to be found in Neal Stephenson's novel *Cryptonomicon*. In this story, an American company is formed by a group of maverick high-tech experts whose purpose is to found a "data haven" on a South Pacific island, whose sovereign status allows customers around the world to use it as an extremely high-security repository for data beyond the reach of national and international governmental authorities. Mr. Protocol has mentioned years ago that such an idea seemed obvious. As Stephenson points out, the only real technical problem is the provision of a very high-bandwidth data pipe to connect the repository to the rest of the world. Now, Slashdot (<http://slashdot.org>) is reporting that the South Pacific island state of Nauru is attempting to become just such a repository. Actually, it turns out that Nauru is being

Ask Mr. Protocol

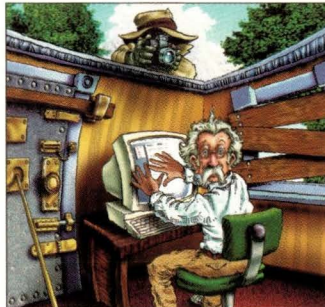
used (primarily) by Russians to funnel a conservatively estimated \$50 billion out of Russia and back in again, money that actually does not even transit Nauru, whose telecommunications facilities alternate between poor and broken. Still, reality is getting close to fiction here. And, as Stephenson points out, the customers lining up to use such a facility would be corporations and big-time criminals. In the case of Nauru, it would appear its depositors are both at the same time.

One doesn't have to be the Russian Mafia to want data security, though. Those security departments do work in the interests of their corporations because there really are people out there who would like to rip off data. With the end of the Cold War, brush wars are popping up. The principles behind these do have stringent security requirements, and international political movements (above and below ground) just love the new encryption technologies. Hometown corporations are increasingly the target of real-life economic spies looking for a free high-tech boost for their own hometown markets.

Mr. Protocol has always recognized that security through obscurity is a poor replacement for real security when real security turns out to be necessary. However, a very small pebble on a very large beach is usually secure no matter what. The new encryption technologies and capabilities probably

aren't of use to private individuals for anything beyond credit card transactions. Privacy in the United States is going to hell in a handbasket, as anyone who reads Lauren Weinstein's Privacy Forum is aware (<http://www.vortex.com/privacy>). However, most of the data we'd like to keep private, such as our medical and banking records, aren't really under our control to begin with.

Corporations have a lot more to lose, because they do control their information. If you work on anything you don't want the competition to see, and you want to work on it from home, then `ssh` and its ilk are a mighty fine idea. ➔



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.

Aim High With IntraServer SCSI & Network I/O Peripherals For Solaris™ SPARC™ and Solaris x86 Systems!



IntraServer offers a complete line of PCI I/O Peripherals, including Ultra Wide SCSI, Ultra2/LVD SCSI, 10/100 Ethernet and CompactPCI™ adapters. If you're looking for quality products, high performance, and solid support call IntraServer or one of our resellers.



IntraServer Technology, Inc.
Seven October Hill Road
Holliston, MA 01746 U.S.A.

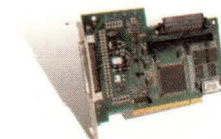
Please call us at:
Toll-free: 888.429.0425
Phone: 508.429.0425
Fax: 508.429.0430 (U.S.)

© 2000 IntraServer Technology, Inc. All other trademarks are the property of their respective owners.

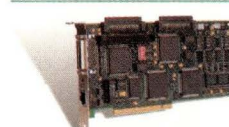
Website: www.intraserver.com



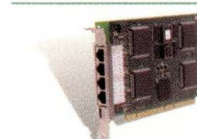
Circle No. 11



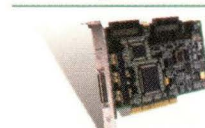
**3000
SERIES**
Ultra Wide SCSI



**4000
SERIES**
Ultra Wide SCSI
10/100 Ethernet



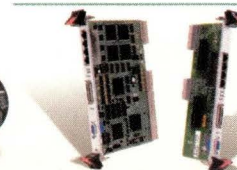
**5000
SERIES**
Four-Port 10/100
Base-T Ethernet



**6000
SERIES**
Ultra2/LVD SCSI

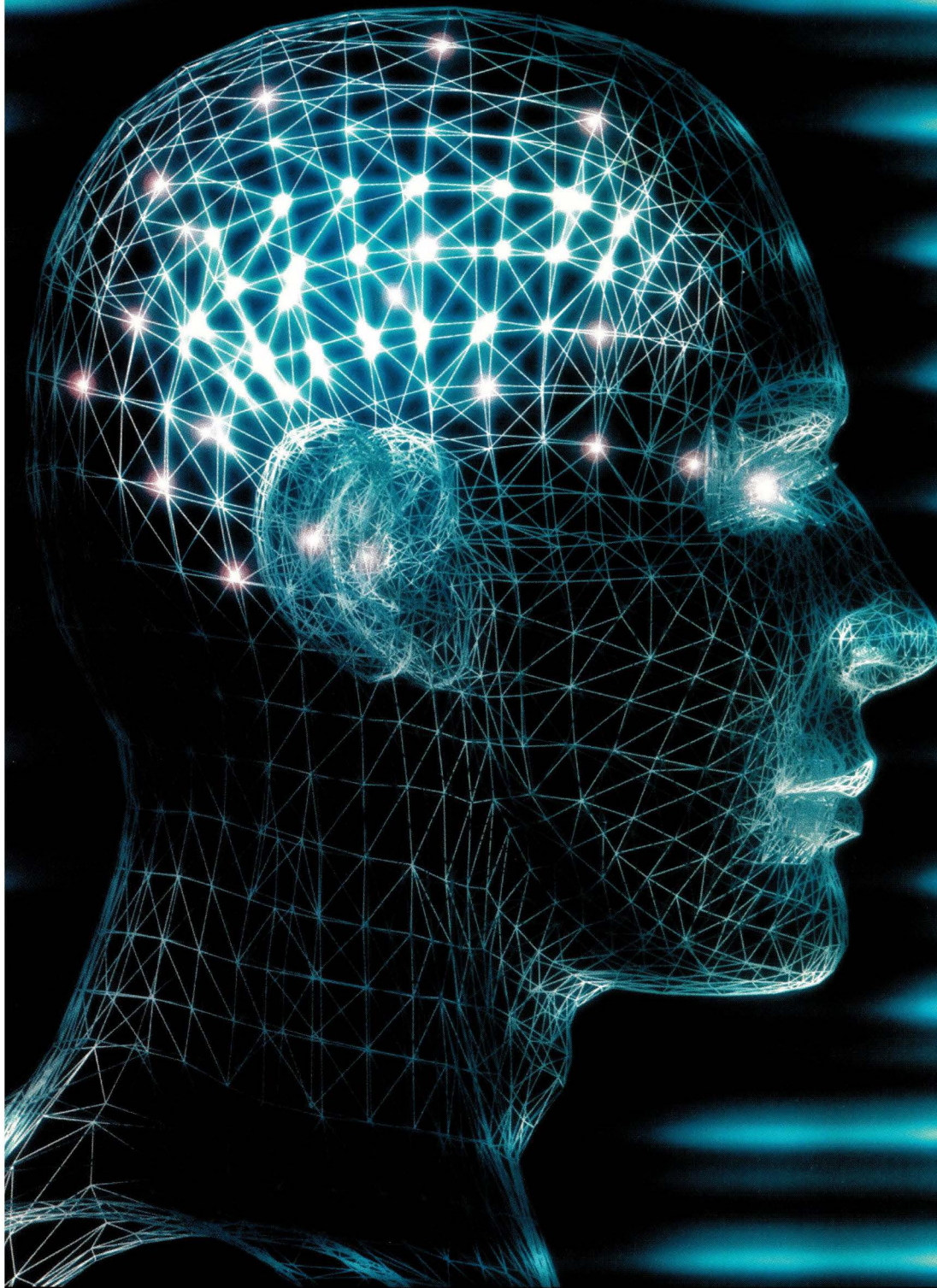


**6200U2C
CompactPCI
SERIES**
Ultra2/LVD SCSI



**8000C
CompactPCI
SERIES**
• Two Ultra2/LVD SCSI
• Four 10/100 Ethernet
• VGA Video Connector

Redapt relates



Redapt™ Systems & Peripherals relates to you, the discerning, intelligent buyer looking for the best prices, the best quality, and the best service when it comes to pre-owned Sun Microsystems hardware, peripherals, and software. Redapt means results you can bank on: Redapt Sun equipment goes through rigorous testing, is guaranteed, and is backed by a knowledgeable staff that adapts, at a flash, to your specific needs.

Let us relate to you and fulfill your specific Sun needs—quickly, accurately, and affordably.

Contact us today at **1-888-800-5633** or visit us on the Web at **www.redapt.com**.

redapt systems & peripherals

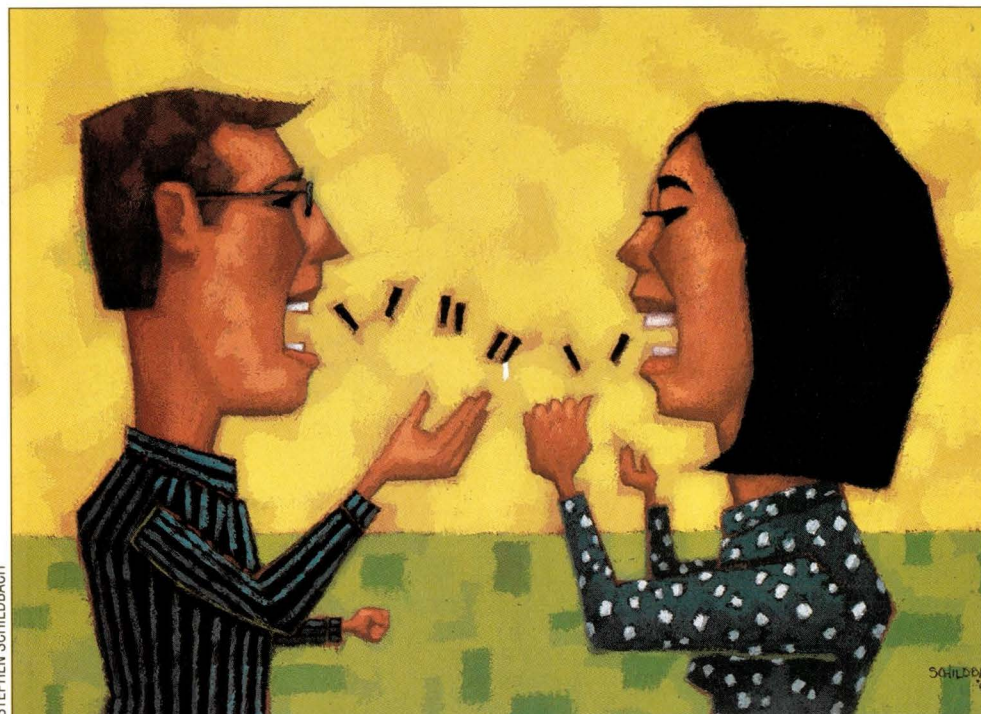
Synonymous with quality when it comes to all things Sun™.

© 2000, Redapt Systems & Peripherals, Inc. Redapt is trademark of Redapt Systems and Peripherals, Inc. Sun is a trademark of Sun Microsystems, Inc.

Circle No. 5

UNIX Basics

by Peter Collinson, Hillside Systems



To Quote or not to Quote

I was engaged in the difficult exercise of deciding what to write this month, when I was saved by Sivaram Neelakantan, who sent me email asking a question about some examples in Kernighan and Pike's excellent book, *The UNIX Programming Environment* (see "Further Reading," Page 27). Sivaram was working through the book and needed a little explanation. The email gave me the chance to pull the book from my shelf and look at it again. For a book written in 1984, it's still completely relevant. If you don't have a copy, then put it on your present list for your next available festival of receiving goodies.

Sivaram's question concerns quoting characters in the shell, making sure the commands you run are supplied with the correct arguments. The topic touches on the way that UNIX systems work, and I think every UNIX user needs some understanding of the mechanics to help clarify why things are the way they are.

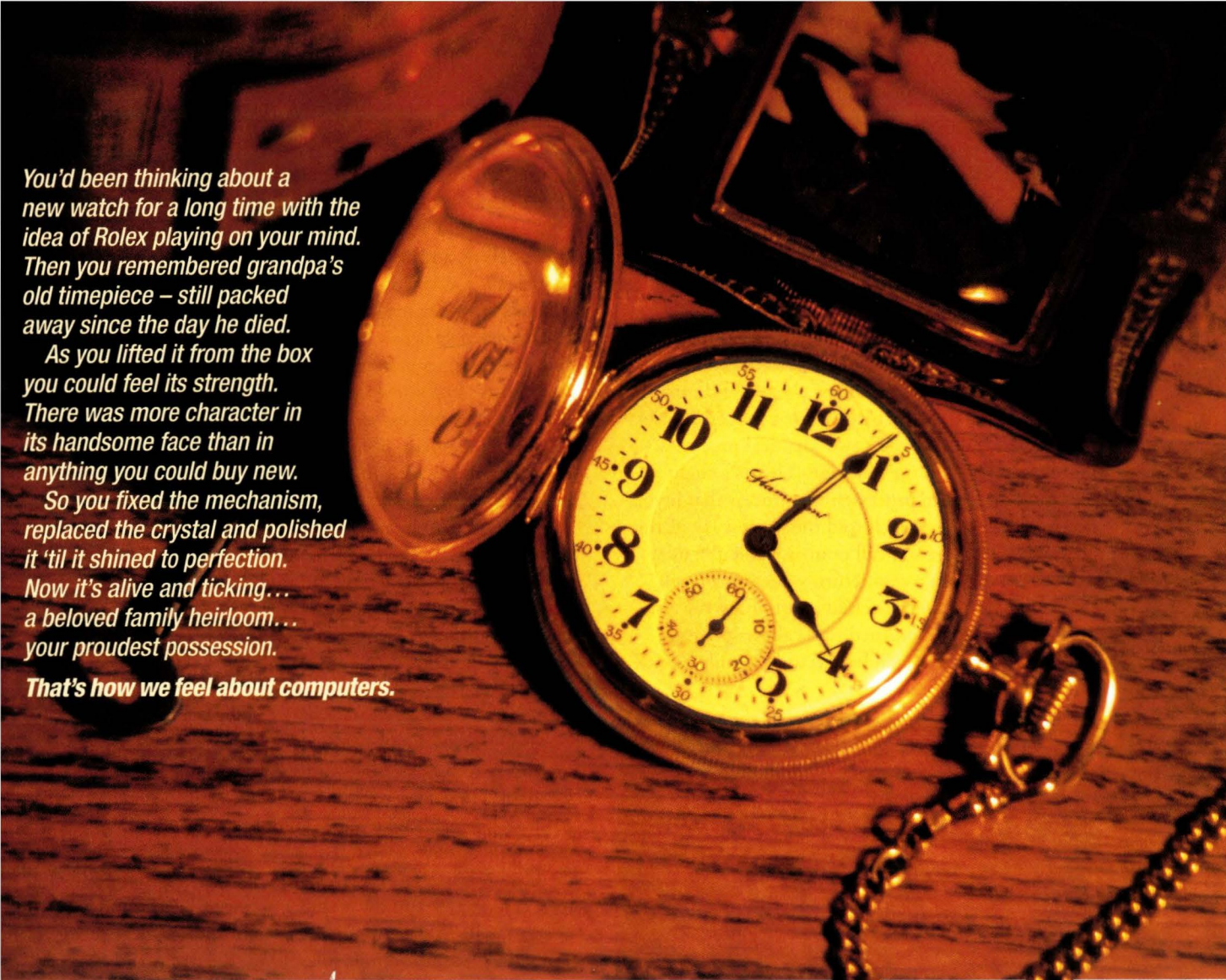
UNIX was designed to allow users to invoke commands by typing characters into a program whose job is to launch commands. The program is called the user's "shell" because it's the outer casing of the operating system, providing an interface to allow the user to get their job done. At the time UNIX was designed, it was a curiosity that the user's shell was a normal program with no special privilege. Up to that point in most operating systems, the functions of the shell were provided as part of the operating system, as a top layer of the onion skin, as it were.

UNIX threw away the notion of onion skins and the system is essentially two levels: the kernel, which is resident all the time in the memory of the machine, and above that we have many user processes. The kernel is responsible for controlling the hardware and providing a standard set of interfaces as "system calls" to the user processes. Essentially, the kernel provides support for the way each user

process communicates with the outside world. For example, the kernel maintains file system structure. Processes use system calls to access files and are able to deal with them as linear sequences of bytes without worrying about how files are implemented, or where the blocks of each file are actually placed on the disk.

The kernel also provides support for processes, generating an illusion of how the world works that's often called the "process model." A keystone of the model is that processes think they are a single program running in an empty machine. This virtual machine has memory for storing the binary code of the program that makes the process work, and also for storing any data the process may use. Since the beginning, UNIX has been able to share the code sections of processes, so if there are five shells running, there will be only one live copy of their code resident in the machine.

User processes are all "equal," that



You'd been thinking about a new watch for a long time with the idea of Rolex playing on your mind. Then you remembered grandpa's old timepiece – still packed away since the day he died.

As you lifted it from the box you could feel its strength. There was more character in its handsome face than in anything you could buy new.

So you fixed the mechanism, replaced the crystal and polished it 'til it shined to perfection. Now it's alive and ticking... a beloved family heirloom... your proudest possession.

That's how we feel about computers.

New isn't always better.

When it comes to delivery, timing is everything.

We do everything in our Repower to meet your delivery needs – within a few days... sometimes overnight. The fact is, we can Repower your system, integrate and custom configure it to your specifications and get it to you in record time... usually faster than anyone else. At prices that will take you back in time.

Check us out at www.radiantresources.com for aggressive pricing, net specials – and the chance to configure and instantly price systems in your own good time.

What a difference a day makes

Recently we got a call from an IS guy in a Fortune 100 Company. He needed an E4000 – *at any price*... within 24 hours... by Friday of Memorial Day weekend! And none of his vendors – neither OEM nor VAR – could deliver. You can imagine how wound up he was by the time he called us, especially since he wasn't even our client.

But we turned on the Repower of Radiant, processed his order and hand-delivered it to him in time to meet his impossible deadline. Made him look like a hero. And he's been thanking us with business ever since.

So start saving your company time and money with Repowered equipment from Radiant.

'Cause like the classic elegance of grandpa's old watch, you'll find the benefits of our quality and service utterly timeless.

Call Toll-Free – 800-500-7675

**Radiant Resources, Inc.**

Repowered Computers For The Next Generation

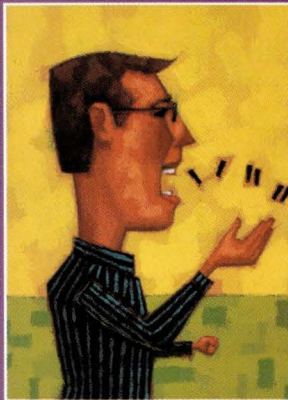
1913 Atlantic Avenue, Suite R-3
Manasquan, NJ 08736
973-442-5555
Fax: 973-442-5550
www.radiantresources.com

Major Credit Cards Accepted.

is they are all programmed to the same model and compete for system resources equally. As George Orwell points out in *Animal Farm*, it's a feature of human existence that "some are more equal than others." This is true of processes run by the root user, we give such processes the ability to circumvent system security that is provided by the file system.

Creating New Processes

We know that a live UNIX system is a resident kernel and a bunch of running user processes. Any process can use the appropriate system calls to create a new process and cause it to run a new program. The first step is for a process to use the `fork()` system call. It creates two identical processes, both running in parallel in the machine. There's a slight difference between the two processes: the process that invoked the `fork()` call, the *parent*, is told the process ID of the new process when the `fork()` call returns, while the new process, the *child*, is given a zero return value from `fork`. Because both the parent and the child are running the same code, the difference in the returned value allows the programmer to create code that will be executed in only one of the two processes.



Like many other programs, UNIX shells read a line of text typed in by the user, do something with the text and then loop waiting for another line.

Actually, on some occasions, the `fork()` call is the end of the story. There are several applications where a program wants to replicate itself. For example, Web servers often run several instances of themselves to ensure that there is always a process listening for a new request for data.

If the process wants to start a completely different program running, then the child portion of its code will use the `exec()` system call to inform the kernel of this desire. The system libraries provide several flavors of interface for the `exec()` call, if you are interested, then

```
$ man -s 2 exec
```

will supply the complete story. I'm avoiding the full gritty details here for simplicity. The basic `exec` system call has several arguments. The first argument is the pathname of the file that contains the binary of program that is to be loaded. The remaining arguments are text strings that are passed into the running program when it is started by the kernel.

The file that contains the binary that is to be loaded must

have its permissions set up to allow execute access for the user that owns the process doing the `exec()` call. If the permissions are OK, then the kernel will dismantle the process image that's using the `exec()` call and will load the new file into memory. The new process will have the same process ID as before, and will inherit several aspects of the process model, such as extant open files for its standard input, output and error channels.

Immediately before the new process begins running, the program arguments from the `exec` call are placed into the new process in a known place so that it may access them if it wishes. The process sees a count of the total number of arguments that have been passed, named in most literature as `argc`, and an array of strings, named `argv`. This allows us to pass text strings from parent to child, and for the child to interpret them in any way that makes sense to the programmer. Incidentally, the first string is conventionally the name of the command being invoked. Because the argument strings are accessed by an array, and arrays in the C language are numbered from zero, programmers think of this as the "zeroth" argument.

Shells

OK. We have a mechanism to create new processes and the ability to pass argument strings into the new running program. How does a shell use this? As I said, a shell is not a special program. Like many other programs, UNIX shells read a line of text typed in by the user, do something with the text and then loop waiting for another line. In the simplest case, shells treat the text as a command name and a set of arguments to that command. Interpretation of the text is done using a set of inbuilt rules. Once the command has been determined, the shell will `fork` to generate a new copy of itself, create all the arguments for the `exec` system call and start the process the user requested.

Generally, the parent shell will wait patiently for the new child process to finish before attempting to read another line from the terminal. I say "generally" because if we end the input line with an ampersand, then the parent doesn't wait. Once the `fork()` has been called, and the child is busily setting itself up, the parent will read another line from the terminal.

I said that when you type the line of input, the shell interprets it according to its own set of inbuilt rules. The rules have not changed a great deal since the days of the first shell. Shells take the line of input from the user and break it into "words" that are separated by spaces or tabs. The first word on the line is taken to be the name of the command, the remaining words are each separate arguments that are passed into the command. So, when we type

```
$ cp one two
```

the `cp` word is the command name, and the shell will locate the command file that goes with the name. The remaining strings are passed into the `cp` command as arguments; the zeroth argument will be `cp`, the first argument will be the

string one, and two will be the second argument. The `cp` command interprets the first argument as the source file for copying and the second as the name of a destination to which to copy the data.

Of course, the shell can do more than just take our input and process it. The earliest form of additional processing provided by the shell was shell *globbing*, the expansion of stars and question marks in file names. It gained its name from the file `/etc/glob`, which was the discrete program used as a shell “helper” in early systems. When the shell encountered a star or question mark, it ran `/etc/glob` to do the work of expanding file names.

It’s important to understand that the globbing function happens *before* the `exec` system call is made. For example, when you type

```
$ echo a*
```

the shell looks for all the files starting with “a” in the current directory, sorts the resulting list into alphabetic order and passes the complete list of file names as parameters into the `exec` call. Expanding the names in this way means that file name expansion doesn’t need to be coded into every command, it exists only once in the shell. However, this method can sometimes have confusing results if you are not clear when it happens as the process is created.

Similarly, I/O redirection happens in the child code after the `fork()` and before the `exec()`. When we type

```
$ echo a* > out
```

the shell arranges that the `echo` command is run with its standard output set to the file `out`. Setting up the new output channel happens after the `fork` and before the `exec`. A side effect of this mechanism is that the destination `out` file is created *before* the command is executed. This can sometimes be counter-intuitive. An attempt to add the contents of one file to the end of another might reasonably be written as:

```
$ cat a b > a
```

but this fails (usually horribly) because the shell will open a new file called `a` *before* the `cat` command is executed. Opening a new file with the same name as one that exists results in truncating the file to zero length. The `cat` command will now copy a zero-length file `a` and the contents of `b` to `a`. Bill Joy implemented an option (the `noclobber` option) in `cs`h to prevent the I/O redirection option from destroying an extant file, so I guess something horrible happened to him at some point.

Quoting

Using white space to separate the words on a command line is convenient largely because the space bar is a large friendly area at the bottom of the keyboard. In fact, in most shells, the word-separation characters are specified in a shell variable, allowing the user to change the character set should

they wish. However, most people stick to the default.

Generally, the use of white space as a separator has meant that, on UNIX, we don’t use file names that contain embedded spaces. You are at liberty to create a file with any name you wish, and you are able to create files with embedded spaces, however, to handle them with the extant shells you need to know how to include a space in the middle of an argument string for a command.

As this article has progressed, we’ve also begun to build up a list of special characters (meta-characters) that the shell uses for its own purposes: `*`, `?`, `&`, `<`, `>` and so on. There are more. For instance, I’ve not mentioned shell variables that are invoked by placing a dollar symbol before the variable name. For example, for Bourne shell and derivatives

```
$ DEST=/usr/share/man
$ ls $DEST
```

or for `cs`h and derivatives

```
% set DEST = /usr/share/man
% ls $DEST
```

In both cases, the shell expands the variable “in place” to be its contents before the `ls` command is executed. The command that’s run is

```
ls /usr/share/man
```

It’s clear that a method of quoting is required to allow us to pass all the characters that form part of the shell’s syntax into commands, while stopping the shell from doing what it normally does with the characters. There are, of course, several methods of doing just this.

UNIX uses the backslash character in many applications to be an escape character. It usually means “take the next character literally, don’t treat it as a special character.” All shells permit the use of backslash in this manner. For example,

```
$ echo \$DEST \> fred
```

will print

```
$DEST > fred
```

Things begin to get more exciting when you are using a command that uses meta-characters. Let’s try and find the values for the dollar symbol from `/usr/pub/ascii` using `grep`. Our first attempt might be

```
$ grep $ /usr/pub/ascii
```

The shell will leave a single dollar character alone and will pass it into the `grep` command unchanged. However, if you try this, you’ll find that it lists all the lines in the file. (Pause here and see if you know why, before reading on.)

The argument to `grep` is a regular expression, and the

dollar sign is one of the meta-characters used in a regular expression match: `$` matches the end of the line. By definition, each line in the file has an end-of-line character, so this regular expression matches all the lines. The single `$` argument won't do what we want, we need to use backslash to get a dollar into the program:

```
$ grep \$ /usr/pub/ascii
```

This again lists all the lines in the file. Why? Well, when the shell sees a backslash it reads the next character and discards the backslash, so this command is essentially equivalent to the first attempt. We need to get a backslash and a dollar sign into `grep`:

```
$ grep \$\$ /usr/pub/ascii
```

The shell passes `\\$` as the match expression into `grep` and the command will find all the lines containing a dollar symbol.

Using backslash like this can get tedious, especially in long strings. It would be better to have a way of quoting chunks of text without having to worry about what it contained. Shells provide two ways of doing this. First, you can enclose some text in single quotes:

```
$ echo '$DEST > fred'
```

The output from this is the same as the previous `echo` example, however, the source is clearer and less cluttered. The contents quoted by the string will be passed intact through to the command as a single argument after the quotes have been removed. The only character that cannot appear inside a single-quoted string is a single quote. However, quoting in shells is an area of great divergence, different shells implement things in different ways. For example, consider the following command:

```
/bin/echo 'a\\b'
```

I'm using `/bin/echo` to avoid the use of any shell built-in `echo` function. Because single quotes are supposed to pass things through unchanged, then you might expect to see this print `a\\b`. However, a little experimentation with the shells on my machine produces the following:

```
/bin/sh: a\b
/bin/ksh: a\b
/bin/csh: a\b
/bin/bash: a\\b
```

I am unsure whether `bash` is wrong. It has probably done the right thing, rather than simply following what the Bourne shell did. In all the shells, the escape character is actually not useful inside single quotes. A backslash cannot be used to insert a single quote. On balance, I'd prefer to see the shells leave my double backslash alone.

There are occasions where you would like to pass a single

argument to a command, perhaps including spaces, but have the benefit of variable substitution. Using double quotes around a string achieves this, so

```
$ echo "$DEST > fred"
```

will print

```
/usr/share/man > fred
```

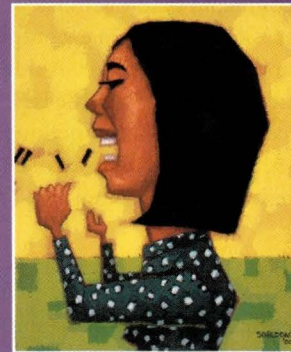
assuming that the content of `DEST` is unchanged from the previous setting above. You can use double quotes to force the quoting of a single quote:

```
$ echo "It's a single quote"
```

Another useful trick is to realize that shells are text-processing languages and will perform string concatenation for you. I often use combinations of quotes to ensure that complex and lengthy strings are left alone by the shell, except where I want things to happen. For example,

```
$ echo '$DEST = "$DEST Doesn't it?'
```

will generate one argument to the `echo` command. Combinations can become indecipherable if you're not careful. Most of these tricks are only needed when you are attempting to get complex statements involving meta-characters into some of the super tools like `sed` or `awk`.



Quoting in shells is an area of great divergence, different shells implement things in different ways.

When you are creating complex scripts for the super tools, then you should avoid using `csh` for your scripting language. One reason is that the Bourne shell and its derivatives handle newline characters in a much more flexible manner. To get a newline into a quoted section in the Bourne shell, you just include it:

```
echo 'Here is a
newline'
```

You'll find that `csh` is line-oriented and insists on a backslash before the newline character to achieve the same effect. Even then, things don't work too well. If I am writing `awk` scripts

UNIX Basics

for the Bourne shell, I'll often write things like the following:

```
awkprog='
    {sum = sum + $5}
END    { print sum}'
/bin/awk "$awkprog"
```

This lays out the awk program in a readable manner, and passes it into the command cleanly in a shell variable. Incidentally, the command is intended to be used to count the bytes in a directory:

```
$ ls -l | sh aw
```

where aw holds the script above. The awk command in the script processes data from the standard input channel of the script. If you attempt to do this in csh, then you need to add backslashes at the end of all the newlines in the single-quoted section:

```
set awkprog = '\
    {sum = sum + $5}\
END    { print sum}'
/bin/awk "$awkprog"
```

But the program blows up when the awk command is invoked. The sad fact is csh doesn't like embedded newlines in variable contents.

You'll also find that combinational quoting in csh is pretty broken. Again, things that you can do trivially in the Bourne shell just don't work in csh. For example,

```
echo "dollar \$"
```

works in sh, but not in csh.

I gave up writing scripts in csh aeons ago, for these and other reasons. If you want to learn to write scripts, use the Bourne shell. Your scripts should be portable to all the machines in the world. One caveat: some of the Bourne shell clones haven't implemented quotes in exactly the same way as the original program.

Further Reading

The UNIX Programming Environment, by Brian W. Kernighan and Rob Pike, is published by Prentice Hall Inc., 1984, ISBN 0-13937-681-X. More reasons to hate csh can be found in Tom Christiansen's csh article reproduced in *UNIX Power Tools*, by Jerry Peek, Tim O'Reilly and Mike Loukides, published by O'Reilly & Associates Inc, 1997, ISBN 1-56592-260-3. →

Peter Collinson runs his own UNIX consultancy, dedicated to earning enough money to allow him to pursue his own interests: doing whatever, whenever, wherever... He writes, teaches, consults and programs using Solaris running on an UltraSPARC/10. Email: pc@cpq.com.



LOTS OF HITS KNOCKING YOU OUT?

Fight back with **digitalNATION**,
the world's leading dedicated
server company.

Put our world-class data center
in your corner.

- Uninterruptible power supply with 99.8% network uptime
- Connections to more than a dozen Internet backbones
- Total control over your server
- Industry's best performance guarantee
- 100% Cisco-powered network®
- Server monitoring 24/7
- All server hardware and maintenance provided
- 50 GB transfer/month
- Dedicated 10 MB connection
- Over 5 years experience hosting Sun® dedicated servers

LET US BUILD YOU A CUSTOMIZED
SUN DEDICATED SERVER OR...

CONSIDER THIS FEATURED SUN PACKAGE:

Ultra 2 — Dual
256 MB
9 GB SCSI — Drive 1
9 GB SCSI — Drive 2
4 IPs
Apache webserver
\$1,500 Monthly

NT®, LINUX® AND COBALT® SERVERS ALSO AVAILABLE.

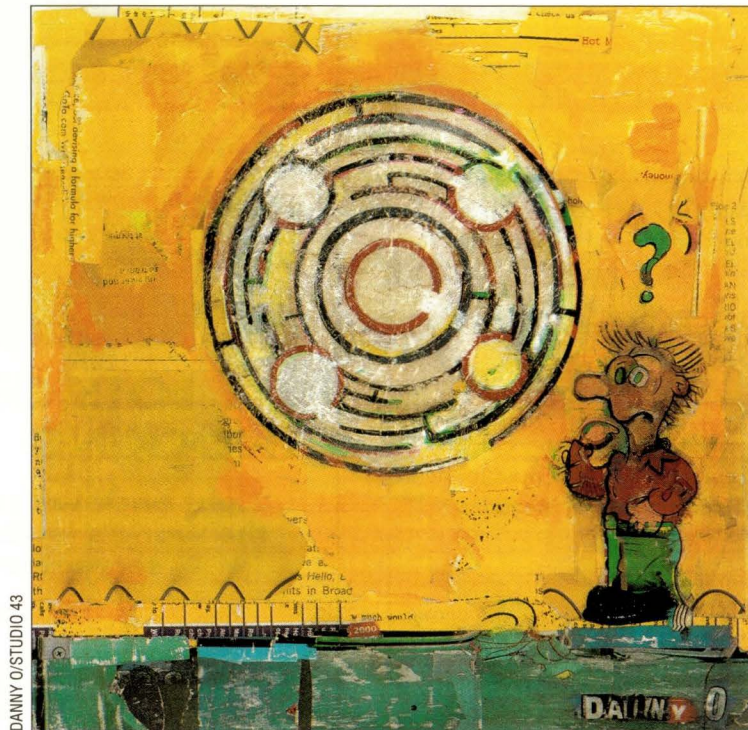
 **digitalNATION**
A VERIO COMPANY
877.565.1999
(Toll Free)
5515 Cherokee Avenue
Alexandria, Virginia 22312
email: sales@dn.net

www.dedicatedserver.com

Circle No. 12

Storage

by Alan Benway



Heading into the Wilderness

The journey continues. Last month, we looked at the major physical and logical aspects of disk drives. This month, we'll examine the operational and performance characteristics of disks. We will be moving into territory that is off the well-trodden path covered by most publications. This is a very important part of our journey, as it lays much of the critical foundation needed later in our analysis of storage solutions. It is the science of this area that is most abused by marketing truth twisters in their product claims. Though they may do so out of ignorance (as I have found to be the case), it still results in false claims that lead to poor storage decisions based on erroneous information. So slip on your heavy chaps and gloves (nasty thorns out there!), sharpen your machete and let's go!

First, a few definitions are needed to make sure everyone's compass needle points north.

I use either "disk" or "drive" to refer to a physical disk drive device; sometimes, one term just works better than

the other. When I use the terms "storage devices," "storage solutions," "storage systems" and so on, I am referring to a packaging of disks, cabinets, power supplies and (perhaps) controllers that present some type of multidisk solution over one (or more) connection bus to a host computer.

A "bus controller" is the intelligent hardware interface board (or card/adaptor/paddle, if you prefer) that connects the host computer's I/O bus to storage devices. This includes all of the various types of parallel copper SCSI bus controllers (such as those from Adaptec Inc., DPT, QLogic Corp. and Mylex Corp.). Others include Fibre Channel-based interfaces such as Fibre Channel Arbitrated Loop (FC-AL), Fibre Channel Switch (FC-SW), IBM Corp.'s Serial Storage Architecture (SSA) and Apple Computer Inc.'s FireWire.

The term "drive controller" will be used to refer to the embedded control logic and cache found on every disk drive. As you will see next month, there's an implicit set of features (such as multi-

tasking and error detection/correction) associated with the mention of either SCSI or Advanced Transfer Adapter (ATA) controllers.

I use the term "ATA" to refer to any device that uses any of the various integrated drive electronics (IDE) protocols. These include enhanced IDE (EIDE), ATA-2, ATA-3, Ultra33-ATA and Ultra66-ATA. Note that none of these devices use host-based controllers, instead they connect to the host's I/O bus via buffering logic. The operating system's ATA drivers do most of the work.

I use "SCSI" to refer to any device or controller that uses one of the many SCSI protocols. These include Fast SCSI (SCSI 2), Ultra SCSI (SCSI 3) or Ultra2 SCSI (SCSI 2). All of these devices require host-based controllers, and the devices do most of the work. This is the opposite of ATA devices.

A "disk partition" is the contiguous group of blocks (SCSI) or cylinders (EIDE) that are defined to be a single named space. A disk will have one or more partitions defined, depending on

THE MOST IMPORTANT INVENTIONS OF THE 20TH CENTURY ARE BACKED-UP ON QUALSTAR TAPE LIBRARIES.



"Every Patent in the United States is processed at RTIS Government Services. That says it all for why backup and retrieval are important. We did considerable investigation before choosing Qualstar libraries with Sony AIT tape drives. The performance has been outstanding"

David Allingham Network Administrator, RTIS Government Services

We couldn't have said it better ourselves. Call today and discover why the leading IT Professionals worldwide are choosing Qualstar.



1-800-468-0680

TEL: (818) 592-0061 • FAX: (818) 592-0116

E-MAIL: sales@qualstar.com • WEB: www.qualstar.com

QUALSTAR®

SIMPLY RELIABLE

AIT is a registered trademark of SONY.

The Tape Library Experts

its size and the limitations of the file system in use. Partitions are primarily a tool for managing disk space, such as keeping the operating system, applications and data separate—not to mention controlling space-greedy end users.

My use of the generic term “file system” refers to the basic functionality provided by all file systems used on open systems. Basically, a file system is the software that provides the connection between the operating system and data. Every disk partition will have a file system, except for some special cases like raw partitions for databases or swap areas. There may be multiple file systems in use on a host computer, and each partition may use a different file system. A file system establishes the storage structure and fault-detection mechanisms, and controls the movement of data in and out of this storage structure. File systems include UNIX File System (UFS), Veritas Journaling File System (VXFS), Journaling File System (JFS) and Advanced File Systems (ADVFS) for UNIX, and File Allocation Table (FAT/FAT32) and Windows NT File System (NTFS) for Windows.

I will mostly refer to SCSI devices in my examples from here on in, with specific references to EIDE devices when appropriate. Because EIDE disks are not suitable for use in storage systems such as RAID—they excel as independent disks on a desktop system—I will stop referring to them once these “foundation” columns are behind us.

A Typical I/O Operation

Let's look at a typical I/O operation. The application program initiates an I/O request (of one or more records) to the operating system. The operating system in turn hands off the request to the specified file system, which initiates a driver call to the appropriate bus controller (such as a SCSI controller card). The controller firmware then issues a series of commands to the disk's on-board controller (in the case of ATA disks, this driver call is made directly to the disk controller). The commands passing between the bus controller and the disk controller are a function of the bus protocol in use. The disk receives a command to seek to the address of a particular 512-byte block of data (the atom-

ic unit of data on a disk) and to transfer the next n blocks from that starting point. It is the file system that controls this address, whether it is the physical block address (SCSI) or the virtual geometry address (ATA).

For the purposes of this column, let's assume that the application record size is 8 KB and the underlying file system is configured with an 8-KB record size. When the application requests a record, the file system posts an atomic 8-KB read to disk and this is turned into a single sequential read operation (starting block, plus n blocks) on a disk of 16 blocks. (Because the block size for the file system has been set at 8 KB, every I/O operation will act against a sequential group of 16 disk blocks. These are atomic units of I/O and cannot become fragmented, although the blocks within a large file can be.) The total time to deliver on this 8-KB read request can be viewed as the sum of queuing phase + command phase + access phase + transfer phase + file system phase.

The *queuing phase* is the time spent in the I/O request queue of the driver (host software), or in the request queue on the bus controller (firmware). Heavy traffic will cause an increase in the total service time for this request (as seen in `iostat` on some UNIX systems). This can add tens or even hundreds of milliseconds to your I/O request.

The *command phase* is a series of status and setup conversations between the controller and the drive logic at electronic speeds (limited by the data and signaling rate of the connection bus). This phase consumes only a few microseconds, however, and can be ignored.

The *access phase* is the sum of seek time + settling time + rotational latency. Rotational latency is the time it takes for the beginning of the sector of interest (on this track) to show up under the head. This is where the primary I/O bottleneck occurs; the other major bottleneck is at the request queue on the bus controller. This phase is in the tens of milliseconds, a very long time by CPU standards.

The *data transfer phase* is the time to read, decode and copy all of the data and checksum bits of each of the 16 sequential 512-byte blocks of the request into the drive's cache buffer. Here, the data blocks are assembled, compared to check-

sums and sent to the controller. Note that file system records (but not necessarily the file) aren't going to be fragmented because this is the smallest unit of I/O available to the operating system. (Reader tip: I/O system performance requires a careful balance among the application record size, the file system block size and the “chunk” depth and width of a RAID volume. They must all be even multiples of one another, for example, 2 KB/8 KB/32 KB.) The transfer time of this phase will be a function of the spindle rpm; there are also a few microseconds consumed during the cache buffering and checksum tests and the transfer time over the bus that can be ignored.

The final phase is what I refer to as the *file system phase*, where data blocks returned by the drive are stashed by the bus controller driver into a file system memory buffer. The file system then receives a completion interrupt from the driver and signals to the application (via another completion interrupt from the operating system) that its I/O request has completed. This is also a tiny amount of time, but I mention it here for this overview to be complete. For raw or direct I/O calls, where there is no file system, the data blocks coming from the drive are sent directly by the driver to the application's buffers.

I/O Performance Issues

Any discussion of disk performance is a balance of two separate and opposing metrics, each of which characterize a type of bandwidth. These are maximum I/O operations per second (IOPS) and maximum sustainable data transfer rate (measured in MB/s). IOPS is meant to characterize the maximum number of small block read/write operations that a disk or storage system can sustain over a period of time. This is the figure of merit often used in the UNIX world, especially in the context of databases. Think of IOPS as the crankshaft torque (or the force that enables acceleration in a vehicle).

The term “data transfer rate” can describe either the maximum burst rate, or sustainable transfer rate achievable from a storage device. It was primarily used by mainframe and supercomputer vendors, where large block sequential operations were typical. This is the most

Storage

commonly quoted specification on large disk systems. Think of the transfer rate as crankshaft horsepower (top speed limited to the balance point where airflow drag equals the amount of work available as horsepower).

IOPS Numbers

IOPS is a potentially interesting number quoted by storage vendors. However, it must be looked at carefully because there's a great deal of manipulation of this number. As such, it is impossible to directly compare IOPS numbers across vendor product lines. Nevertheless, some basic I/O performance parameters can be calculated based on the laws of physics. Consider the long-standing industry definition of IOPS—something flat-out ignored by many vendors—which requires that there be a separate and unique read or write request for a certain number of blocks (usually four, or 2 KB) from disk. An IOPS rating is the rate at which a disk controller can accept and respond to I/O commands from a bus controller. This includes the complete command, access and data transfer phases that determine the upper rates at which commands can be processed.

When a disk is commanded to seek a particular sector address and to read (or write) the next 100 sequential sectors, this is but a single I/O operation. If the heads were directed to reposition 100 times, then that would be 100 I/O operations as far as the disk controller is concerned. It is misleading to rate such a sequential operation as 100 IOPS because the accepted definition of an I/O operation is that there must be a unique read or write command associated with each one. However, many vendors will use this improper method to rate their products. Worse, I have been told (by two trusted storage engineers) that some RAID vendors resort to something that goes well beyond mere truth twisting. These vendors will report a benchmark from writing a single block to cache in the RAID unit and then, in a loop, reading that same block back as many times as it can in a few seconds. The IOPS rating is nothing more than the time to read back a cached block from the RAID controller, but the vendors characterize this as the overall system response. While this type of measurement is useful for mea-

suring the limits of bus and controller performance, it is neither a valid nor honest IOPS measurement of the storage system. Only a single block ever gets written to disk, and nothing is read from disk!

Here's how to determine a disk's sustainable IOPS rating for yourself. The average access time is the sum of average seek time + average rotational delay. Average seek time is defined by industry convention to represent a head stroke across one-third of the disk cylinders. For example, for the aging Seagate Technology Inc. Barracuda ST19171WD Ultra Wide 9-GB disk—a typical workhorse drive found in many vendor's storage systems—the average access seek time is 9.9 msec. The average rotational delay is $7,200 \text{ rpm}/60 = 120$ revolutions per second (rps). Then, $1 \text{ second}/120 \text{ rps} = .0083333$ of a revolution per second. Finally, $8.333 \text{ msec}/2 = 4.17 \text{ msec}$ is its average rotational delay (assuming one half revolution per seek on average). So, average access time is $9.9 \text{ msec} + 4.17 \text{ msec} = 14.07 \text{ msec}$. The maximum theoretical random IOPS figure for this

drive is calculated by dividing 1,000 msec by 14 msec, which equals 71.4 IOPS per disk. In other words, about 71 unique random I/O requests per second can be handled by this particular disk. The average long-term overhead on this disk (such as thermal calculation) is about 8%. Thus, $71.4 \times .92 = 65.7$ is the statistical average usable IOPS for the ST-19171WD disk in random access mode. This is how Seagate (and the industry at large) rates its raw disk drives. Therefore, if you have 10 of these disks on a SCSI channel, and they are striped together as a RAID-0 volume in software (no RAID hardware caching effects), the maximum theoretical random IOPS rate would be about 714 IOPS short term and 657 IOPS long term.

One vendor's engineers debated with me that this Seagate disk (which the vendor uses in its RAID box) is capable of 110 to 120 IOPS. You can see that they were only considering the number of revolutions per second and working with that as their peak IOPS number. I strongly disagree. This ignores the issues of head movement, settling time and rota-

GOOD TOOLS ARE JUST THE BEGINNING...

Sun recognizes that you need more than a good set of tools to develop your products. So we created **Sun Developer Essentials™ Subscriptions** to provide you with a comprehensive development solution:

- APIs
- Environments
- Technologies
- Software Previews
- Education
- Latest Information on Sun Innovations
- Software Updates
- Single Payment CD Subscription
- ...and Much More!

Foundation Edition \$195*

The essential set of tools and technologies for developing products on the Java™ platform and Solaris Operating Environment™ software.

Professional Edition \$995*

The Professional set of cross platform tools for developing products on the Java™ platform and Solaris™ Operating Environment software - plus all the features of the Foundation Edition package.

Enterprise Edition \$2,995*

The complete set of advanced cross-platform tools for creating and deploying client-server and web-based applications in an enterprise environment - plus all the components of the Professional Edition package.

*Prices and availability subject to change without notice and do not include shipping and handling.

Sun Developer Essentials Subscriptions
Subscribe Today.

www.sun.com/developers/essentials.html

Refer to Offer Code DE006 when ordering

Circle No. 14

©1999 Sun Microsystems, Inc. All rights reserved. Sun, Sun Microsystems, the Sun logo, Sun Developer Connection, the Sun Developer Connection logo, Sun Developer Essentials, the Sun Developer Essentials logo, Solaris, Solaris Operating Environment, the Solaris logo, Java and the Java Coffee Cup logo are trademarks or registered trademarks of Sun Microsystems, Inc. in the United States and other countries.



subscribe

FREE
3-MONTH EXTENSION TO
NEW SUBSCRIBERS OF SUN
DEVELOPER ESSENTIALS



tional latency, as well as the fundamental and long-standing industry definition of IOPS. Their 110 IOPS value would only be true in the case of a single I/O command working in sequential access down a cylinder. The marketing literature for this RAID unit quoted a 4,600 IOPS rating (with 35 disks, two host-side SCSI channels and dual-controllers each with 128 MB of cache). Furthermore, it stated that this was achieved in uncached, random access mode. This is quite impossible. Under perfect conditions, the drives by themselves are only capable of a maximum of 2,485 IOPS. While a smart RAID controller with well-managed cache can improve the IOPS number over that of software RAID somewhat, a 185% improvement is just not possible under the conditions stated. If this test condition were restated as a “write-heavy load, write-back caching enabled and most of cache reserved for writes,” then I could accept their claim.

One final note regarding IOPS (I will return to this topic when discussing RAID systems in a future column): A single large I/O request issued by the application, such as a 4-MB record from a seismic data file, will be expanded into multiple requests at various places before actually reaching the disk's controller. On a system with a SCSI-attached hardware RAID unit, this includes the file system (record size, maximum I/O request size and so on), the SCSI controller (maximum number of blocks in a single request) and the RAID controller (generating the requests for the individual drives in the RAID stripe set). When we get to talking about RAID, I will post a comparison chart of RAID units on *SW Expert's* Web site using current data and vendor metrics, such as IOPS, and what limits physics suggests. This will certainly be interesting!

Data Transfer Rates

Data transfer rate is also referred to as data bandwidth, or effective bandwidth, and it characterizes the delivery horsepower of an I/O device. Bandwidth is how much data can be moved over time, whereas IOPS is how many I/O commands (generally, the minimum size possible) can be performed over a period of time. The instantaneous burst rate of a block of data from within a disk drive's

on-board cache onto the SCSI bus can hit 34 MB/s on a Ultra Wide SCSI disk (or 17 MB/s on a Fast Wide SCSI disk). While the latest high-performance drives can achieve sustainable transfer rates (sequential mode) of 17 to 25 MB/s, the rate for most 7,200-rpm disks currently deployed in storage systems is about 7 to 10 MB/s. This rate depends on which of the disk's cylinders the data blocks are located (remember that “outer is faster”).

The transfer rate for a particular disk drive is a function of rpm, track density, the number of surfaces in a single cylinder and the internal rate at which the logic can process data (read or interpret flux changes on the media). Low-cost disks trade performance for capacity by using a minimum number of platters (hence, fewer surfaces per cylinder), a slower and cheaper motor (usually 4,500 rpm) and a minimum amount of intelligence and cache in the on-board controller. The logic that was left out would typically include most or all of the optional SCSI high-performance features, such as scatter-gather I/O operations, as well as far more advanced and effective cache management. Owing to a reduced parts quality, these drives usually have less than half of the mean time between failure (MTBF) ratings seen in more expensive drives.

Consider the following SCSI bus example: In order to deliver a sustained transfer rate of 34 MB/s over a single Ultra Wide SCSI bus, the I/O operation would require the use of six data disks working in tandem in a RAID stripe set. A five-data disk set (at $5 \times 7 \text{ MB/s} = 35 \text{ MB/s}$) cannot sustain 34 MB/s, given the need to perform some track seeks on some of the drives during the I/O operation. However, a six-disk set ($6 \times 7 \text{ MB/s} = 42 \text{ MB/s}$) can generally sustain this performance under large file sequential conditions. This assumes a defragmented file system and that all data blocks are found in sequential logical blocks on the RAID stripe.

A storage system can either deliver a high IOPS rate or high transfer rate, but never both. Why is this? In order to achieve high IOPS numbers, there must be very small I/O requests (2-KB blocks). Owing to the inefficiency of managing the overhead of all these tiny requests, the disk engines never

get up to speed. Consider the Seagate disk drive mentioned earlier: Even using 71 IOPS as the upper limit, with 2-KB transfers, this is a mere 142 KB/s. Can you say floppy disk?

On this same disk, consider the case where a single large file is to be read. If there is no space-fragmentation issue, then a single I/O command is issued—a starting block address and a block count. At this point, the maximum transfer rate is (mostly) limited by the following:

- The maximum memory buffer size that the I/O driver can handle in a single atomic request.
- The number of such requests that can be scheduled in the driver queue (for SCSI, between 32 and 256).
- The internal transfer rate of the disk (7 to 10 MB/s for older drives, or up to 25 MB/s for some of the latest drives).
- The instantaneous loads on the bus (other unrelated disk traffic).

There are very few IOPS available in this mode of operation because the data transfer phase consumes most of the bus cycles. A bus (ATA or SCSI) can only be in one phase at a time, and only one disk at a time can be active on the bus in either a command phase or transfer phase (more on this next month).

It should now be clear how IOPS and transfer rates are opposing forces and that both have deterministic limits that are founded on science, and not marketing hype. If a vendor tries to tell you that its “magic cache” overcomes these physical limitations, pour a cup of McDonald's thermonuclear coffee in their lap! It's said that humor is good for your soul (nobody said anything about *their* soul).

In this leg of the journey, we have pushed through some very thorny brush on the edge of the Storage Wilderness. But we have just begun. Next month, we'll begin pushing into the forest, where we will examine connection technologies and their many problems—especially copper SCSI, with its many problematic bus-length and termination issues. See you then! ➡

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

From 20 to 200 servers, only a scalable Power Array™ gets reliability done *right*

**SYMMETRA
REBATE!!!**
Get your mail-in coupon today at
promo.apcc.com Key Code r646z

APC Symmetra® Power Array™: N+1 redundancy for 100% uptime

Data access is critical to both your internal and external customers. Now that applications like messaging, Web integration and E-commerce are deemed mission-critical, losing power to your storage and processors is not an option.

You need to be ready for the unexpected. APC's Symmetra Power Array is the single most highly available UPS in the marketplace. Since power problems are the leading cause of downtime, make sure you're prepared.

Consider how Symmetra protects your business:

N+1 redundancy design assures continuous availability –

If a module fails, the others instantly begin supporting the full load.

Scalable power – Additional 4 kVA modules can be added to expand to 16 kVA of power capacity (4 unit frame is expandable to 8 kVA)

Serviceable while load is up and running – Additional battery modules increase runtime and all the modules are hot swappable, meaning no downtime.



Now you can easily manage power to your systems. APC MasterSwitch™ in your communications and computer racks can save you time and money by helping your staff to manage power proactively.



PowerView™ is a hand-held control panel for network administrators that configures and controls UPSs in rack, computer room, and datacenter environments.



Installing or reconfiguring your modular Power Array couldn't be any simpler.



"Not having a Symmetra in place would have resulted in lost data, corrupted hard drives and lost time to recover. The Symmetra system has more than paid for itself during this one outage."

- Bob Lesher and Charlie Bise, Information Technology, Exel Logistics

APC is a leader in the field of power availability. Our technology grows with your business and can help power protect your new applications as you roll them out. Contact APC today and let APC's Legendary Reliability™ work for you.

**APC Symmetra® Power Array™ was
recently granted US Patent No. 5,982,652.**

APC®
Legendary Reliability™



Enter to **WIN A FREE Symmetra Power Array. Register now.** All entrants will receive a FREE Power Availability Kit.

To order: Visit <http://promo.apcc.com> Key Code r646z • Call 888-289-APCC x1481 • Fax 401-788-2797

©2000 American Power Conversion. All Trademarks are the property of their owners. SY4A9EF-USc • PowerFax: (800) 347-FAXX • E-mail: apcinfo@apcc.com • 132 Fairgrounds Road, West Kingston, RI 02892 USA



LOUISE GOLDENBERG

All in a Day's Work

As systems administrators, we are expected to be Jacks or Janes of all trades. Any problem a user encounters, it seems, is fair game to bring to us, and attempting to solve them is just part of the job. As a result, I spend more time than I would like rearranging furniture and cleaning up toner messes. Recently, however, I had a couple more unusual requests from users, which I'll share with you here.

Printing the Euro

A user from the marketing department needed to print the symbol for the new euro currency, and he couldn't figure out where to get it. The computer system in question was running Windows NT Version 4.0 without any service pack upgrades. It turns out that vanilla Windows NT does not include support for this character. Support for the euro may be added by installing any recent service pack;

alternatively, a specific fix for this deficiency may be downloaded from Microsoft Corp.'s Web site (<http://www.microsoft.com/ntserver/nts/downloads/archive/nteuropatch.asp>). In either case, the euro symbol is then added to three standard TrueType fonts: Arial, Courier New and Times New Roman. The keystroke sequence required to enter a euro character is Alt-0128 (type 0, 1, 2 and 8 on the numeric keypad, while depressing the Alt key).

For most situations this solution is sufficient. In this case, however, the user wanted PostScript font support for the

symbol—that is, a Type 1 font: “*serious typographers don't use TrueType fonts.*” Fortunately, Adobe Systems Inc. has developed a family of fonts containing the euro symbol, which it makes freely available (see <http://www.adobe.com/type/eurofont.html>). The package contains three fonts, each consisting of a single character: Euro Sans (a sans serif font identical to the official character adopted in Europe), Euro Serif (a version of the symbol designed to look good with serif fonts) and Euro Mono (a version designed to work with fixed-width/monospaced fonts).

Figure 1 illustrates the six versions of

Figure 1. Euro Symbol in Various Fonts

14 PT Times New Roman	The price is € 5.67.
13 PT Arial	The price is € 5.67.
12 PT Courier New	The price is € 5.67.
14 PT Minion/Euro Serif	The price is € 5.67.
13 PT Futura Medium/Euro Sans	The price is € 5.67.
12 PT Lucida Sans Typewriter/Euro Mono	The price is € 5.67.

the euro symbol mentioned here. The first three lines show the TrueType font versions, and the final three lines display the Adobe euro fonts used in conjunction with three common Adobe fonts (of the corresponding types). The specific font sizes used are not significant and were selected in order to present the various typefaces at approximately the same physical size.

Network-Based Palm Pilot Synchronization

The other unusual request I received recently was from a user who wanted to synchronize the data on his 3Com Corp. Palm Pilot personal digital assistant (PDA) with his desktop from a different system on the network. Normally, this PDA product operates in the following manner: information may be entered either on the handheld device or via the application program running on the user's workstation (its name is Palm Desktop). Periodically, the user performs a procedure known as a HotSync through which data in the two locations are updated with respect to one another (synchronized). During this process, the Palm Pilot typically connects to the desktop computer via a serial port either by resting in a cradle that is directly plugged into the port, or by connecting to the computer via a special modem designed to accommodate the PDA device.

In this case, the user did not have an unused serial port on his workstation. Instead, he had to continually swap devices as needed to share a single serial port. However, there were many free serial ports on other systems throughout the network. What he wanted was to be able to use one of the free ports to connect to and synchronize his Palm Pilot data with his own workstation.

It took only a bit of research on the Palm Pilot Web site to determine that what he wanted was possible. In fact, meeting his request was remarkably easy via a procedure known as a network HotSync. Under this scheme, a Palm Pilot user can perform a HotSync operation from locations which are network-accessible with respect to his target computer system. All the software required for this functionality is freely available from the Palm Computing site (see <http://www.palm.com/custsupp/downloads>). In this case, the user first had to upgrade the operating system on the Palm Pilot itself, to PalmOS Version 3.3. Once the upgrade was completed, installing the network HotSync facility required several components: the latest Palm Desktop and HotSync Manager software (Versions 3.0.3 and 3.0.4, respectively) and the network HotSync update module for the PDA device (which is required for some but not all models of the Palm Pilot). The various software components all include excellent instructions for their installation.

Once all of this was installed, setup for the user was relatively straightforward. First, within the Palm Desktop application, the HotSync Manager was configured for network HotSync oper-

ations by selecting the **HotSync-> Setup** menu path, navigating to the Network panel, selecting the desired Palm Pilot username and clicking on the TCP/IP Settings button to specify the primary computer for that user. The latter is accomplished by specifying the appropriate hostname, IP address and subnet mask settings. (Note that this step may also be performed on the PDA itself, as we will see.)

Second, we enabled network HotSync operations within the HotSync Manager by right-clicking on its icon in the Windows NT desktop tray (lower right corner of the screen) and checking the network option (see Figure 2).

Third, the Palm Desktop software needed to be installed on the computer through which the PDA device will communicate with its primary system (we will refer to this system as the HotSync server). Note that none of the user data need be present here, but the application itself is required. Make sure the HotSync Manager on the HotSync server system is configured to be automatically started whenever the system boots. If a direct connection to this computer is being used, then a Palm Pilot cradle will need to be physically connected to one of its serial ports. Alternately, the Windows NT Remote Access Service (RAS), or other dial-up facility, will need to be set up on the system.

Finally, the Palm Pilot device itself requires some configuration, which is illustrated in Figure 3. All of this is accomplished via the HotSync utility found on the device (which was updated earlier in the process). Configuration occurs via the tool's Options menu. The Primary PC Setup item brings up the dialog illustrated on the left in Figure 3 and offers an alternative method for specifying the location of the primary computer with which this device should be synchronized. Also, we need to specify a network HotSync via the LANSync Prefs menu item; the resulting dialog contains two buttons for selecting a network-based or local HotSync operation (labeled LANSync and Local HotSync, respectively).

Additional configuration steps depend on the connection method. If the Palm Pilot is to be directly connected to the HotSync server, then the Local button on the utility's main screen must be selected and the pop-up menu below the HotSync icon should be set to Direct Serial.

Figure 2. Enabling Network HotSync Operations

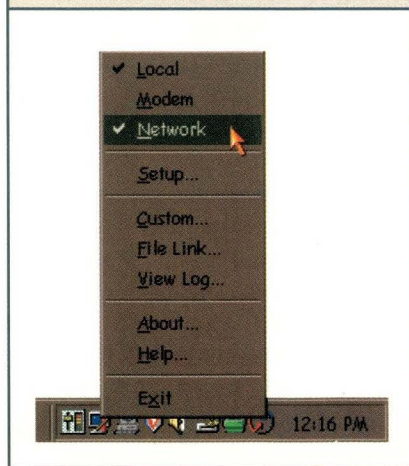
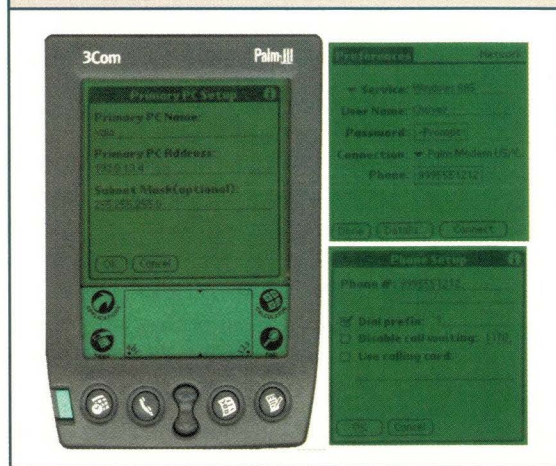


Figure 3. Configuring the Palm Pilot for a Network HotSync



If a dial-up connection is to be used, it needs to be set up via the utility's Modem Sync Prefs and Connection Setup menu items. The former should be set to Network, and the latter should be set to whatever connection method is appropriate (see the Palm Pilot documentation for full details). In addition, the Modem button on the main screen should be selected and the two additional fields that appear below the HotSync icon should be used to specify the phone-dialing and user authentication settings required to make a dial-up connection to the network.

The two screens on the right in Figure 3 (Page 35) display the resulting dialogs and illustrate typical settings used for a Windows NT RAS connection. The upper dialog specifies that a) username Chavez will be used for the RAS connection, b) a prompt will be issued for the password at connection time and c) a Palm Modem will be used as the connection device, dialing the specified telephone number. The lower dialog displays additional settings, which may be used to further customize the phone-dialing procedure.

The network HotSync facility is reasonably sophisticated in its ability to locate the target primary computer system. It includes the Palm Name Resolution Protocol (PNRP), which attempts to locate the specified computer in several ways (attempted in increasing order of complexity): through direct communication, via a broadcast to the appropriate subnet, or by contacting a Domain Name System (DNS) server and scanning plausible local subnets (used when no subnet mask has been specified). The Palm Pilot Web site also offers a docu-

ment for systems administrators who need to set up this facility, which describes the PNRP protocol and also includes an excellent troubleshooting section.

Note that once you've taken the time to set up a HotSync server, any number of users can take advantage of it (because no user-specific information is required on that system).

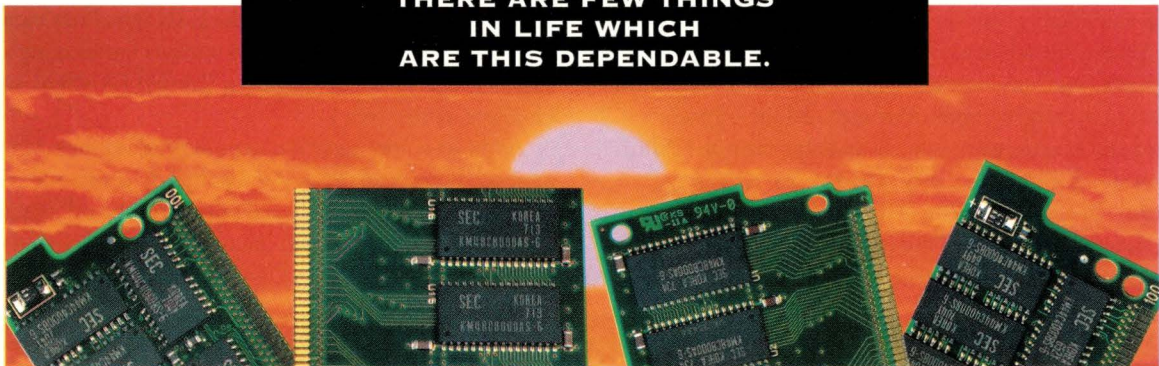
The final wrinkle in this process occurred when the user informed me that he wanted to use different HotSync methods at different times. This is not a problem, but it was necessary to ensure that he knew how to reconfigure his Palm Pilot unit to select among the various HotSync options. As is frequently the case, user education is the first and last step in solving any systems administration problem.

How About You?

I'm sure many readers have equally interesting tales to tell about unusual requests they have faced. If this is true for you, please drop me a line by email telling me about it. I'll share any particularly good ones in a future column. →

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

**THERE ARE FEW THINGS
IN LIFE WHICH
ARE THIS DEPENDABLE.**



WE HAVE A FEW OF OUR OWN.

Xcel Technology's Sun® workstation memory upgrades are the most dependable come rain or shine. Xcel manufactures the best quality, pricing, availability, compatibility, service and support, into each and every Sun upgrade. All Sun® upgrades are engineered and manufactured in-house to meet exact OEM specifications. Xcel offers a lifetime warranty, toll-free tech support, and 100% customer satisfaction for all Sun products. All products are tested in the machines they were actually designed for,

this guarantees 100% compatibility. Xcel technology manufactures its Sun upgrades in 32MB, 64MB, 128MB, 256MB, 512MB, and 1GB modules as well as 2GB, 4GB, 9GB kits. All workstation upgrades are guaranteed compatible for your Sun workstation system. Xcel Technology provides advanced qualified PCB's, same day assembly and shipping, build-to-order programs, contract assembly, component sales, custom packing solutions, design and engineering, PCB sales, private label

manufacturing, and advanced testing. Xcel Technology will develop a customized solution to meet yours or your customer's needs. For 24/7/365 support and service access Xcel's Internet site at www.xceltechnology.com. For more information on the latest Xcel Technology Sun memory upgrade solutions, please call an Xcel Account Executive at 800.288.1518.

If you don't, you may get scorched.



105 N. Point Drive, Lake Forest, CA 92630
U.S.: P 949.461.7095 F 949.859.8780 800.288.1518
ASIA: KRON ELECTRONICS P 011.822.589.0469 F 011.822.589.0434
www.xceltechnology.com

Work

by Jeffreys Copeland and Haemer



ERIC MUELLER

*“Plus ça change,
plus c’est la même chose.”*
– The French

“Vive la différence.”
– Also the French

Sex

Our question for the month is, “Why is sex always the same?” (You may not infer anything from this question about the quality of either Jeff’s social life. Shame on you. Now, read on.)

In elementary school, we’re taught that one *X* and one *Y* chromosome makes you a man, and two *X* chromosomes make you a woman. This is (mostly) true in humans. Actually, it’s (mostly) true in mammals. Move outside mammals, though, and it’s a brave old world. Birds are just the opposite: roosters are *XX*, hens are *XY*, for example. (In the literature, the sex chromosomes from such “backwards” systems are called *W* and *Z*, so that a rooster would be *WW* and a hen *WZ*, but that’s just a mnemonic device.)

Sex in butterflies is done just like sex in birds, but fruit flies are like us. Well, sort of. Girl flies are *XX* and boy flies are *XY*. Fly into the odd corners of the *Drosophila* personals ads, though, and differences emerge. In mammals, having

a *Y* chromosome makes you a male: people with two *X*’s and a *Y*, Klinefelter’s syndrome, are male; people with one *X*, but no *Y* chromosome, Turner’s syndrome, are female. In flies, it’s just the opposite, two *X*’s makes you a female: *X0*’s (flies with one *X* and no *Y*) are boys and *XXY*’s are girls.

Sure, this will win you points in Trivial Pursuit (Sex-Determination Edition), but so what? Think for a second: How could you ever turn one system into another?

(And how in the heck will the two Jeffreys turn this into a software column? Patience. We’ll get there. Relax and enjoy the ride.)

This is a wonderful puzzle. Sex is very important; species that don’t reproduce successfully suffer instant extinction. Yet, though flies and butterflies share a common ancestor (which must have had some sex-determination scheme) they’ve managed to evolve completely opposite ways to decide what sex they are. We’re much closer

to birds than either of us is to insects, but our sex-determination scheme is the same as the fly’s investigating the bottle of homebrew next to our terminal. Both are completely backwards from the system used by the magpie squawking outside our window, or the sphinx moth getting ready to pop out of the pupal case we’re keeping on our windowsill.

Oh, but life gets weirder.

Praying mantises, which we enjoy in our gardens, have one *X* and several *Y* chromosomes. That is, females have two *X*’s, while males have one *X* and a handful of distinct *Y*’s—each *Y* is different, and every male has one of each kind.

Other species turn this on its head and have several different *X* chromosomes, but only one *Y*. Each female may have, say, three different pairs of *X*’s, while her mate has three *X*’s and a single *Y*.

Some animals, like the voles getting ready to hibernate as we write this column, have gotten rid of their *Y*’s completely: one sex has two *X*’s and the

other has one. Each of the spiders that invade our office has several *X* chromosomes. Females might have six, while males have three—but no *Y*. The ants trying to take up residence in our kitchen are odder still: they have no sex chromosomes at all. Females have two of every chromosome; males have only one of each.

But there's a constant thread running through all of this. Despite this wild diversity, there are always exactly two sexes: male and female. One has one sex-chromosome makeup, the other has a second. Also, one sex makes two kinds of gametes (germ cells) in equal numbers, and the other only makes one. All human (or fly) eggs have an *X* chromosome, but each Jeff makes two kinds of sperm: *X* sperm and *Y* sperm. On the other hand, if we were birds, we'd only make one kind of sperm, but our mates would make two kinds of eggs.

In spiders with three sets of *X* chromosomes, spider moms always make eggs with three *X*'s, while spider dads make sperm that have either three *X*'s or no *X*.

Ants, bees and wasps take this to an extreme. Effectively, every chromosome is an *X*: an egg has one full set of chromosomes. Fertilized eggs (ones that get an additional full set from dad) become daughters, unfertilized eggs (ones that get no set from dad—effectively, an “empty sperm”) become sons.

“Stop,” says the one of us trained as an engineer. “I’m missing something. If it’s an empty sperm, what triggers the ‘life starts’ magic? Or is that a religious question beyond this column’s scope?”

“You’re missing nothing,” the geneticist replies. “It’s done with mirrors. There are lots of interesting consequences, but they’re more than we need to set up the problem.”

The regularity means that when you mate a male and a female, you get two kinds of offspring: sons and daughters. And the production of equal numbers of two kinds of gametes by one sex means that there are the same number of sons as daughters.

A good rule of thinking about nature is, “When something’s constant, look closer: it might be important.” Why is sex always the same?

The Exception that Proves the Rule

Here’s another good rule of thinking about nature: “The exception proves the rule.” If something’s odd, look closer, it may help you understand the norm. During a casual afternoon in the dusty stacks of his local university library, Haemer stumbled on a report that one population of Central American fish—a swordtail, for you tropical fish types—has three different flavors of sex chromosomes: an *X*, a *Y* and a *Z*. Here’s how sex-determination works:

1. Each individual only has two sex chromosomes: *XY*, *YZ*, *XZ* and so on, but not *XXX*, *XYZZ*, or anything else with more than two.
2. If you carry a *Z*, you’re a female.
3. Otherwise, if you have a *Y*, you’re a male.

This gives us these possibilities:

Chromosomes	Sex
YY	Male
XY	Male
XX	Female
YZ	Female
XZ	Female

What about *ZZ*? Can’t happen. A *ZZ* would have to get a *Z* from mom and a *Z* from dad. But swordtails with *Z*'s are never dads.

This is very different system with lots of odd pairings. *XX* x *YY*, for example, gives all sons, while three-quarters of the offspring of *XZ* x *XY* will be daughters.

(Yes, this is very strange. It simply adds to our respect for J.B.S. Haldane, the father of theoretical population genetics, who observed that life is not just stranger than we imagine, but

Listing 1. The Mendelian Factor

```

1  #!/usr/local/bin/perl -w
2  # $Id: Mendel.pm,v 1.5 2000/01/06 02:39:48 jsh Exp $

3  package Mendel;
4  use strict;

5  use vars qw($VERSION @ISA @EXPORT);
6  require Exporter;
7  @ISA = qw(Exporter);
8  @EXPORT = qw(cross gametes genotypes zygote);
9  $VERSION = "1.00" ;

10 use Nhash;

11 sub cross {
12     my ($f, $m) = @_;
13     my %cross;

14     my @fg = gametes($f);
15     my @mg = gametes($m);
16     $f = 1/(@mg*@fg);

17     foreach my $fg (@fg) {
18         foreach my $mg (@mg) {
19             $cross{zygote($fg,$mg)} += $f;
20         }
21     }
22     new Nhash %cross;
23 }

24 sub gametes {
25     split //, shift;
26 }

27 sub genotypes {
28     my ($type, %phenes) = @_;
29     my @list;

30     foreach (keys %phenes) {
31         push @list, $_ if $phenes{$_} eq $type;
32     }
33     @list;
34 }

```


stranger than we can imagine.)

Hmm. So why don't more species have this array of options, or for that matter, others?

Three Hypotheses

We can suggest three hypotheses for this sexual monotony.

First, maybe all equilibrium states have only two sex chromosomes.

If we start out with a certain proportion of each type and let random mating happen over many generations, what will be the ratios of the different types at equilibrium?

Perhaps all such equilibria eliminate all but two of the sex chromosomes. If so, we've caught a species in transition from one sex-determining system to another.

Second, maybe there are equilibria with all three chromosomes, but they're unstable.

This is subtly different from the first hypothesis. To see the difference, consider an *XX/XY* system, which has a very stable equilibrium. Even if hunters kill 90% of elk stags in the fall, moving the sex ratio to 10-to-1, the sex ratio of calves the following spring will be 50-50.

Imagine, however, some more complex system that produces reasonable equilibrium frequencies so long as the frequencies of each type stay within a narrow range, but wanders off into never-never land if there is heavy predation on one type. Maybe we've caught a system that will stay like this for a while, but is ultimately fated to become a two-chromosome system.

Third, maybe there's a stable equilibrium, but the sex ratio isn't 50-50.

Why would this matter? In the 1920s, Sir R.A. Fisher, father of modern statistics (Fisher invented, for example, the variance), advanced the following, subtle argument: Imagine a species with a vast excess of females. The average father has many more children than the average mother. Next, suppose one father carries a mutation that gives him a higher proportion of sons than average; such a father will have more grandchildren than the other males of his generation. Because this means he'll pass more copies of his genes on to future generations than his contemporaries, the muta-

```

35 sub zygote {
36   my ($mom, $dad) = @_;
37   return $mom lt $dad ? $mom . $dad : $dad . $mom;
38 }

39 1;

40 --END--

41 =head1 NAME

42 Mendel - Simple Mendelian genetics

43 =head1 SYNOPSIS

44 use Mendel;

45 @g = gametes('XY');
46 print "gametes of 'XY' are @g\n";

47 @z = zygote('X', 'Y');
48 print "fertilizing 'X' with 'Y' gives: @z\n";

49 my %sexes = (XY => 'M', XX => 'F');
50 my @males = genotypes('M', %sexes);
51 print "males are @males\n";

52 $a = cross('AA', 'Aa');
53 print "crossing 'AA' and 'Aa' gives: $a\n";

54 =head1 DESCRIPTION
55 Mendel.pm provides operations of simple Mendelian genetics.
56 This is where the descriptions of the individual operators go.

57 =head1 AUTHORS

58 Jeffrey Copeland <copeland@alumni.caltech.edu>
59 Jeffrey S. Haemer <jsh@usenix.org>

60 =head1 SEE ALSO

61 perl(1) Nhash(1)

62 =cut

```

tion he carries will spread through the species, increasing the proportion of males in the population.

If there is an excess of males, the argument goes the other way. These combine to select for systems with a 50-50 sex ratio.

A normal *XX/XY* system gives a 50-50 sex ratio: half sons and half daughters. Does this choose-two-out-of-the-three-candidates system give us a 50-50 sex ratio? If not, then natural selection will select for changes in the sex-determining system.

At last! Questions we can answer with a program. Time for software.

What Do You Get When You Cross...

Rather than brute-force simulating the sex ratio, and its changes from one generation to the next, we'll begin by making a small module to do arbitrary Mendelian crosses (see Listing 1).

Lines 1 through 9 are relatively straightforward. You'll find them, or ones like them, in many modules. Take a look at the `perlmod` documentation for details.

Line 10 brings in the `Nhash.pm` module, which we use to handle numeric hashes (hashes in which the keys are strings, but the values are all numbers). We'll go through the code for this in some detail next month. For now, we'll say that our module needs this because the function `cross()` takes a pair of parental genotypes as its input and returns a hash containing the different types of offspring and their individual frequencies. The remaining lines define four simple functions:

- `cross()` – (see above).
- `gametes()` – which lists the gametes produced by a genotype.
- `genotypes()` – which lists the genetic types that correspond to a particular “look” or phenotype.

• `zygote()` – which shows what you get when you fertilize a sperm with an egg.

Does it work? Listing 2 shows the test program stolen from the documentation, lines 44 through 53, followed by its output.

Listing 2. Test Program

```
#!/usr/local/bin/perl
# $Id: t0,v 1.3 2000/01/06 02:40:36 jsh Exp $

use Mendel;

@g = gametes('XY');
print "gametes of 'XY' are @g\n";

@z = zygote('X', 'Y');
print "fertilizing 'X' with 'Y' gives: @z\n";

my %sexes = (XY => 'M', XX => 'F');
my @males = genotypes('M', %sexes);
print "males are @males\n";

$a = cross('AA', 'Aa');
print "crossing 'AA' and 'Aa' gives: $a\n";
```

And here's its output:

```
gametes of 'XY' are X Y
fertilizing 'X' with 'Y' gives: XY
males are XY
crossing 'AA' and 'Aa' gives: (AA => 0.5, Aa => 0.5)
```

Promises, Promises...

Next time, we'll show you `Nhash.pm` and use `Mendel.pm` to solve the problem we posed. This gives you a whole month to think about it.

Meanwhile in the corrections department, two astute readers, M. Leo Cooper

and Franklin P. Witte, noticed in our January column ("Calendar Pages," Page 43, <http://sw.expert.com/C9/SE.C9.JAN.00.pdf>) that we managed to define the most familiar mathematical constant in the world to be 3.1415929... instead of 3.1415926.... They caught an error that has been in that code for nearly a decade, and we thank them.

Until next month, happy trails. →

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

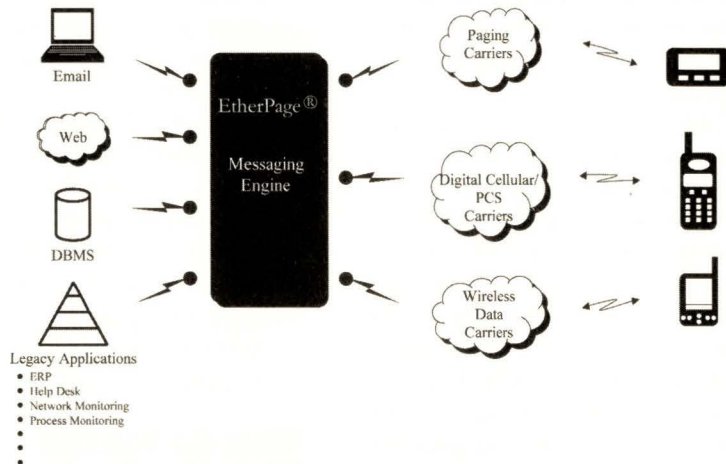
Jeffrey S. Haemer (jsh@usenix.org) works at QMS Inc. in Boulder, CO, building laser printer firmware. Before he worked for QMS, he operated his own consulting firm and did a lot of other things, like everyone else in the software industry.

Note: The software from this and past Work columns is available at <http://alumni.caltech.edu/~copeland/work> or alternately at <ftp://ftp.expert.com/pub/Work>.

Wireless Messaging Gateway Provides Robust, Reliable Delivery of Messages Anytime, Anywhere

MobileSys™

- Integrates seamlessly with network monitoring tools, help desks, and other legacy applications
- Extremely reliable: designed for mission-critical, 24x7 applications
- Highly scalable

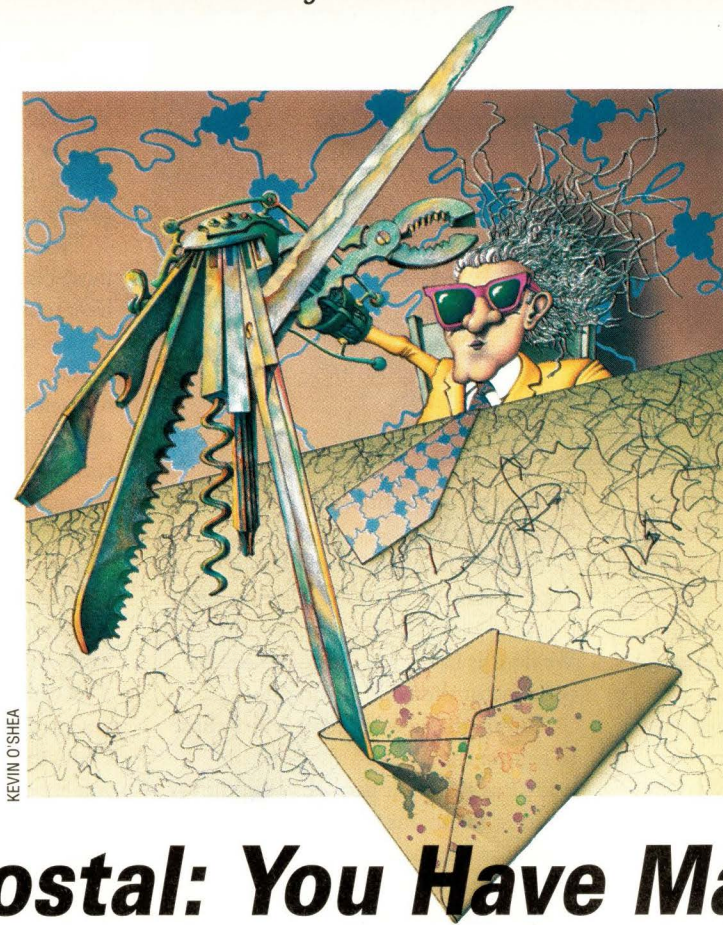


Tel: (650) 934-9006

www.mobilesys.com

Java Class

by Jim Frost



Postal: You Have Mail

In this our fourth installment in the construction of Postal, an Internet Message Access Protocol (IMAP) client, we finally get to the point where we can actually read an email message.

The complete code for this month's column can be found at `ftp://ftp.expert.com/pub/JavaClass/03.2000/postal.tar`. This implements several more pieces of functionality: the message folder selector in the left-most pane, message selection in the top-right pane and message body viewing in the lower right pane. This results in a version of Postal that can be used to browse an entire IMAP message store, although it does a poor job of handling Multipurpose Internet Mail Extensions (MIME) messages, so you'll want to avoid looking at things with attachments (especially large attachments).

Owing to space considerations we will only cover the code to select a message and view its contents this month. Next month, we'll look at how the `FolderSelector` uses the `JTable`

component to allow the user to walk through the IMAP folder tree.

Up to now, Postal has been using Swing running in backwards-compatibility mode with Java Development Kit (JDK) 1.1.x. This was largely because I do most of my development on Linux and the Java 2/JDK 1.2 port has long been a work-in-progress on Linux. Recent releases of the Linux JDK 1.2 from the open-source development group Blackdown (`http://www.blackdown.org/java-linux/`) were approaching production quality, but had nagging bugs, particularly in the Just-In-Time (JIT) compiler. All this changed in December, when Sun Microsystems Inc. took the Blackdown effort, cleaned it up a bit and added a JIT compiler from Inprise Corp. The result is a Linux version of Java 2 that is both fast and robust, a tremendous step forward.

This news was not without a bit of political incorrectness, however. Despite the fact that most of the work on the

Linux port was done by Blackdown, Sun neglected to make any mention of that effort in the original press release (see `http://linuxtoday.com/stories/13385.html`). This was such a breach of etiquette that I feel it should be mentioned even though Sun has long since apologized (see `http://www.computerworld.com/home/news.nsf/all/9912083sunlinux`). While I can only praise Sun for releasing source code (even with the tight restrictions of the Sun Community Source License, it's much better to have the code than not), it is something else to take the work of others and tout it as one's own. I can only hope Sun has learned its lesson and will henceforth give credit where credit is due, particularly when it gets the work for free.

Another reason for moving to JDK 1.2 is that Sun has finally produced a JDK with a working debugger. For the first time since Java hit the streets, the Java debugger is actually useful, and many third-party debuggers should now

Listing 1. The MessageSelector Constructor

```
public MessageSelector (Dispatcher dispatcher)
{
    MessageSelectorModel model = new MessageSelectorModel (dispatcher);
    JTable table = new JTable();
    table.setModel (model);

    // set the model up as the list selection listener for the table.
    // this is done because it knows how to convert the row indices
    // into Message objects for further delivery.
    table.getSelectionModel().addListSelectionListener (model);
    table.getSelectionModel().setSelectionMode (
        ListSelectionModel.MULTIPLE_INTERVAL_SELECTION);
    setLayout (new BorderLayout());
    add (new JScrollPane (table), BorderLayout.CENTER);
}
```

work much better as well. I can't tell you how happy that makes me, debugging with `System.out.println()` got tiresome back in 1995.

In celebration of this turn of events, and because there were some bugs in the JDK 1.1-compatible Swing library we have been using so far that affected this month's code, this column marks the point at which we abandon JDK 1.1 in favor of Java 2. Fortunately, this allows us to make use of the new collection classes that became standard in Java 2.

Eanie, Meanie, Minie, Moe

Last month, we put together a table model that would pull message summary information out of a JavaMail message folder for display in a `JTable`. This month, we go the next step, enabling the ability to select a message from the `JTable` and see its contents in the message view frame.

Swing components manage selections using a selection model. It's the job of this model to keep track of what has been selected and to notify any concerned objects of changes in the selections. In theory, this is a nice way of allowing users to drop in their own selection policy management and handling. Unfortunately, the implementations do not always live up to the promise of the design, and nowhere is this more true than the standard selection model for the `JTable` component. You'll see what I

mean as we work through the code to handle selections.

The first thing we need to do is set up a component to listen for selection events from the `MessageSelector`'s `JTable`. We do this in the `MessageSelector` constructor shown in Listing 1.

You might be wondering why I chose to register the `MessageSelectorModel` as the event listener. Well, the `JTable` maintains the selection information as a set of indices into the table. This is rather inconvenient for most of the application; most things aren't interested in which table rows are selected, but rather the messages they represent. The table model maintains the mapping between the row number and the message it represents, so it is natural to have it listen for the event, convert it into the appropriate `Message` object and send

a new event containing the reference to the `Message` object.

Listing 2 shows the implementation of the `ListSelectionListener` interface that handles the selection event coming from the `JTable`'s selection model. It is here that we start seeing the warts in the selection mechanism.

First, notice that the table's selection model is a `ListSelectionModel`. You have to wonder why a two-dimensional table is using a one-dimensional selection model. This model maintains only the row selections; there is another, part of the `TableColumnModel`, that maintains the column selections. There is no externally visible model for maintaining cell selections. This design is worse than odd, it's nonsensical. Luckily, we're not interested in individual cells but rather whole rows, so this selection model works reasonably well for us.

If only that were the only poorly designed part of the selection system. Ordinarily, when you receive an event you expect the event to contain useful information for handling the event. This would appear to be true of the `ListSelectionEvent`, but in truth it's not. The index information in the `ListSelectionEvent` is completely worthless; if you inspect it while changing the selection back and forth between two rows, you'll see that the information is often identical despite the fact that different components are being selected. As a result, the `ListSelectionEvent` is

Listing 2. ListSelectionModel Implementation in MessageSelectorModel

```
public void valueChanged(ListSelectionEvent event)
{
    if (messages == null) {
        dispatcher.fireMessageSelectionEvent (null);
        return;
    }
    ListSelectionModel selectionModel = (ListSelectionModel) event.getSource();

    // Collect all the selected messages
    ArrayList selectedMessages = new ArrayList (8);
    for (int i = 0; i < messages.length; i++) {
        if (selectionModel.isSelectedIndex(i))
            selectedMessages.add(messages[i]);
    }

    if (selectedMessages.size() == 0)
        dispatcher.fireMessageSelectionEvent (null);
    else
        dispatcher.fireMessageSelectionEvent (selectedMessages);
}
```


only useful for indicating that the selection has changed; you have to determine what changed some other way.

Fortunately, the selection model implements methods that make it possible to ask about the selection status. Unfortunately, it doesn't have something so convenient as a method to retrieve the whole set of selected rows at once. We do this ourselves by simply looping through all the rows and accumulating the `Message` object for each row that is marked as selected. This is not particularly efficient, but it gets the job done and works well enough for what we need. Once we have a set of all the selected `Message` objects, we call `Dispatcher.fireMessageSelectionEvent()` to tell everyone about it.

A Pocketful of Objects

Notice that we accumulate the `Message` objects using an `ArrayList`. This is one of the new collection classes that was introduced in Java 2. It provides essentially the same functionality as the `Vector` class, but is somewhat more efficient.

Java 2 contains a number of interfaces for generic collection types, including `List` (an ordered collection), `Map` (a collection whose elements are indexed by a key) and `Set` (an unordered collection). There are different implementations of each—for instance, `ArrayList` and `LinkedList`—so that you can pick an appropriate implementation for the task at hand. This is a drastic improvement over the very limited collection capabilities of JDK 1.1 and earlier.

It might be more architecturally clean to use a `Set` instead of a `List` to notify `MessageSelectionListeners`; after all, selections are not really ordered. One limitation of the `Set` collections is that there is no way to iterate through them without creating another object—either an array of the objects in the set, or an `Iterator` object. Generally speaking, I like to avoid the creation of unnecessary objects, particularly in code that will be exercised a lot, so I opted for the `ArrayList` because iteration can be managed by indexing into the array.

Listing 3. The `MessageViewer` Class

```
public class MessageViewer
    extends JScrollPane
    implements MessageSelectionListener
{
    private Dispatcher dispatcher;
    private JEditorPane editor;

    ////////////////////////////////////////////////////
    // Constructor //
    ////////////////////////////////////////////////////

    public MessageViewer(Dispatcher dispatcher)
    {
        this.dispatcher = dispatcher;
        dispatcher.addMessageSelectionListener(this);
        editor = new JEditorPane();
        setViewportView(editor);
    }

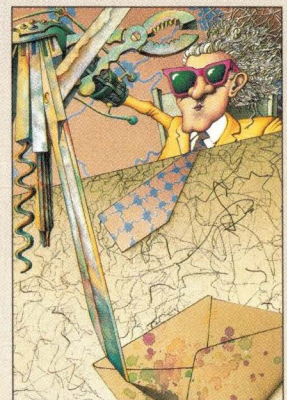
    ////////////////////////////////////////////////////
    // Methods //
    ////////////////////////////////////////////////////

    /**
     * Clears the contents of the panel.
     */
    private void clear()
    {
        editor.setText("");
    }

    ////////////////////////////////////////////////////
    // MessageSelectionListener implementation //
    ////////////////////////////////////////////////////

    /**
     * Populates the panel with the contents of the selected message.
     */
    public void messageSelected(ArrayList messageList)
    {
        if (messageList == null) {
            clear();
            return;
        }
        if (messageList.size() != 1) // ignore multi-row selections for now
            return;
        clear();
        Message message = (Message)messageList.get(0);

        // Retrieve the message contents by requesting an InputStream
        // data source and reading it into the editor component.
        InputStream messageData = null;
        try {
            messageData = message.getDataHandler().getInputStream();
            editor.read(messageData, null);
        }
        catch (IOException e) {
            dispatcher.fireErrorEvent(e);
        }
        catch (MessagingException e) {
            dispatcher.fireErrorEvent(e);
        }
        finally {
            if (messageData != null) {
                try {
                    messageData.close();
                }
                catch (IOException e) {}
            }
        }
    }
}
```



Try Out The Latest Software

free software
full demos
software you can try
new applications
latest software
games

Try It NOW!

Visit the Sun Solutions NOW! Web Site to find new and exciting solutions for the Solaris™ and Java™ environments by Sun's third-party software vendors. Check out the latest applications and stay current on new technologies as they hit the market—sometimes even *before* they're in full release.

Over 500 Software Products

This is the largest collection of downloadable demos and trial software written for Solaris and Java on the Internet. We've added the complete Sun Solutions Catalog with over 14,000 product listings.

www.sun.com/downloads

Circle No. 18



BONUS TO ADVERTISERS OF THE FOLLOWING ISSUES

April 2000
SPRING COMDEX
Chicago, IL

June 2000
JavaOne
San Francisco, CA

San Workshop
Toronto, Ontario

Java Class

Now, Java purists will say that I shouldn't worry about creating temporary objects because they're cheap. There's some truth in that, but practically speaking, most Java applications spend a lot of time in the heap allocator and garbage collector. Until Java Virtual Machines (JVMs) improve to the point where this is not the case, it's advisable to avoid creating lots of throw-away objects.

The Envelope, Please

Now that we have the message selector firing off selection notifications, we need to listen for them and display the message contents. This is the job of the `Message Viewer` shown in Listing 3 (Page 43).

At the moment, the `Message Viewer` is as simple as we can make it: it's a `JScrollPane` with an embedded `JEditorPane`. Its constructor stitches the two together and registers itself with the `Dispatcher` as being interested in message selection events.

From there on in, all control of the `Message Viewer` is via events sent from the `Dispatcher` to the `Message SelectionListener` interface. All of the dirty work is performed by the `messageSelected()` method. It clears the `JEditorPane` if the selection is cleared and fills it with the message's contents when a new message is selected.

In the future, this method will have to inspect the message to handle various message types and attachments, but that is for another day. In this first implementation we just get an `InputStream` for the message body and read it into the `JEditorPane` using the very convenient `read()` method.

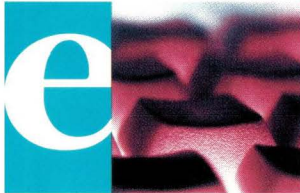
Let's Put this One to Bed

Next month, we will investigate the `FolderSelector` panel, which is a `JTree` and associated `Model` objects. With that functionality in place, we have a fairly complete IMAP message browser and we can start working on the dialog boxes and other frills that will make `Postal` look and feel more like a product and less like a prototype. ➔

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



ICe. INTERNET COMMERCE EXPO®



Put your finger on the **PULSE** of eBusiness.

SAVE \$100! REGISTER NOW!
www.iceexpo.com

MARK YOUR CALENDAR AND MAKE YOUR RESERVATION FOR **ICe BOSTON 2000** – the most comprehensive forum focused exclusively on the explosive eBusiness market.

More Than 50 Conference Sessions. Learn from the real-world experience of eBusiness movers and shakers. Find out how to turn eBusiness solutions into bottom-line success in 6 focused tracks.

14 In-depth Tutorials. Build your eBusiness knowledge.

150 Exhibitors. Meet face-to-face with the people who are creating breakthrough products and services.

ICe Expo “Best of” Awards.

Keynotes. Attend rousing presentations by visionaries who are shaping the future of eBusiness.



CONFERENCE: MARCH 27-30

EXPO: MARCH 28-30

WORLD TRADE CENTER, BOSTON

ICe/Boston 2000

Visit or call today: www.iceexpo.com / 1-800-667-4423



Platinum Sponsors:

Informix



Gold Sponsors:



envi^{ve}

NEUVIS



Conference Sponsor:



Owned and Managed by:



Media Sponsors:







INTEGRATING ERP AND CRM VIA THE WEB

BY GEORGE LAWTON

From loading dock to manufacturing, from business logic to business process—integrated ERP and CRM can provide the tools to keep a company humming along.

Today the commercial Web is used primarily as a tool for advertising; companies put up sites with product and company information. The focus seems to be more on form—cool graphics, animations and whiz-bang special effects—than on delivering maximum value to the end user. The real benefit both to the customer and the enterprise will come when companies are able to integrate their entire business processes with the Web in a customer-centric manner.

The most commonly conceived method of integration can save a company time and provide customers with better service. But integrating existing business processes with the Web can also enable entirely new models of doing business, provide sophisticated statistical information to customers, help manage distributors and track quality throughout the entire production life cycle.

Enterprise resource planning (ERP) systems enable a company to track the flow of goods throughout the organization from raw materials to inventory levels. When

these kinds of capabilities are integrated with the Web, it makes the whole production and delivery process transparent. It simplifies the process of finding out what is holding up deliveries and, when coupled with knowledge management systems, can be used to determine overall bottlenecks to the process of delivering goods and getting paid for them. When these kinds of applications are made available on the Internet, it enables customers to answer those nagging questions on their own, without burdening internal employees.

Tom Straub, chief executive officer of Interlink Communication Systems, a Clearwater, FL-based computer equipment reseller, says his sales people used to spend the beginning of each day answering questions from the previous day's customers about the status of their shipments. Now that the company has made this information available on the Web, 90% of these queries are answered online, freeing sales staff to focus on generating additional revenue.

The most straightforward model of integration between ERP, customer service and Web elements is simply the extension of an existing business into cyberspace.

Customer relationship management (CRM) systems enable a firm to provide specific services to each individual customer. At one end, it may just involve creating a dynamic Web page that shows customized pricing and products based on a user's location, status and preferences. At a much more sophisticated level, it could be used to create a personalized one-to-one experience to give the customer a sense of being cared for and to open up new marketing opportunities based on the preferences and history of the given customer.

David Volpe, vice president of product marketing and management at Cambridge, MA-based Art Technology Group (ATG) says, "Today, what happens is that companies expose their applications in a sort of silo approach. If you need support, you are talking to the support group. If you are talking

to sales people, you are talking through a different channel. There are all these channels into the back-end systems. What we believe is happening is that companies have to evolve to provide a seamless view of the company to the customer."

ATG software enables a company to gather information about a customer's preferences and surfing patterns in order to deliver a one-to-one shopping experience tailored to surfers' individual needs. "Now when you do cross-selling and up-selling, it is based on my history as a customer," Volpe explains.

All of the major ERP vendors, including Baan USA Inc., Santa Clara, CA, PeopleSoft Inc., Pleasanton, CA, SAP America Inc., Newtown Square, PA, and Oracle Corp., Redwood Shores, CA, have begun adding CRM and Web capabilities to their existing products. In addition, a number of smaller tier players have introduced products with CRM and ERP functionality built-in as an integrated package.

Dirk Gorter, vice president of business development at Compuware Corp., Farmington Hills, MI, says, "It is not just Web-enabling the business, it is really about being able to integrate all of your business processes across all of these environments. The approach we take is componentizing the different pieces and then assembling them again to make sure they really support your business process."

Extending the Store Online

The most straightforward model of integration between ERP, customer service and Web elements is simply the extension of an existing business into cyberspace. Ideally, you want to provide a single space where customers can shop and gain information from back-end systems about recent orders and their status (see Figure 1). For example, Interlink has integrated Fargo, ND-based Great Plains Software Inc.'s Dynamics ERP application with the Web and a sophisticated customer interface to enhance the sales process and enable its existing sales staff to handle more business.

The application incorporates accounting, warehouse management and tracking of orders from the company through freight forwarders and shippers. This enables customers to buy products over the Internet, view order and account status and drill down to the smallest level of detail. The basic system is

MODELS FOR INTEGRATING ERP AND CRM VIA THE WEB

Figure 1. Straight E-Commerce

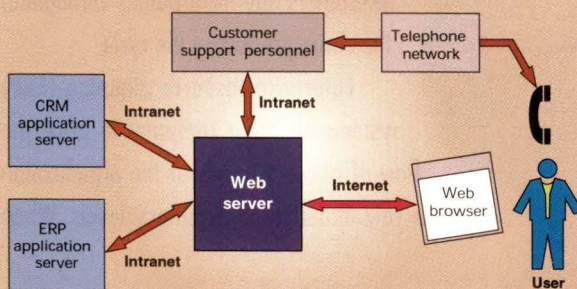
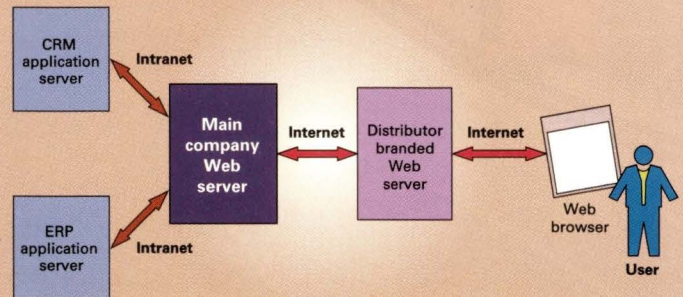


Figure 2. Distributor-Enhanced E-Commerce



Enterprise ERP

based around Microsoft Corp.'s back-end software and uses a Component Object Model (COM) infrastructure for communication between components.

The company is also in the process of integrating its Gold Mine CRM software with an automatic call distribution system linked to the Web. This system will enable potential customers to click a button on the Web site and be connected to a live sales representative within seconds.

"We set out to take a very large, very robust information site we were maintaining on the Internet and convert it to a commerce site. My inclination was to make it as simple as possible. We did not want to gut the application and replace it. As we got closer to what we wanted, the only way we could provide the features we wanted was to build some kind of bridge and make it part of one total system," Interlink's Straub says.

Merging these pieces together was not easy, which in a way is good, Straub says, because there are tens of thousands of resellers like Interlink and this process serves as a sort of barrier to additional competition in this realm. The challenges were both technical and financial. The company has invested more than \$1 million in getting the commerce site fully integrated and operational. But now that the basic infrastructure is in place, Interlink will be able to use it to launch other ventures. For example, Interlink is getting ready to launch <http://www.govstore.com>, a Web site for federal, state and local government purchasing.

The basic <http://www.interlinkweb.com> site itself has been up for one year, and during that time, the company has transitioned 20% of its business to self-service sales. Furthermore, 90% of routine questions about shipments are now handled online. "If you call one of our agents, they just look it up on the system. You are using a human being as a computer peripheral," Straub says. "The customer can see every detail themselves without bothering my sales person."

Straub believes a lot of folks will fail because they'll launch their business as a purely online venture. "You need to view

the new world and old world together. I think we are on the verge of a culture shift of how we push a product. It is not just the 'Amazon.com order' online mode. It is a blend of computers with real live human beings."

Enabling New Business Models

By integrating ERP capabilities with sophisticated customer interfaces, wholesale companies can open up new models of sales and distribution (see Figure 2). For example, Advanced Tachyon Technologies, Santa Rosa, CA, wholesales health supplies and equipment to more than 4,000 distributors around the globe. It wanted to create a Web site that would enable distributors to sell its products online, without fear of losing customers directly to Advanced Tachyon or other distributors.

The company has set up a Web site (<http://www.planet-tachyon.com>) using e-commerce software from Maestro Commerce, Westmont, IL, that enables customers to place orders from any of the distributor's customized Web sites. Each of these sites has the same information as the main site, but contains their distributor's own logo and design. Once a customer has purchased something from a particular distributor, every time they buy something else, the distributor gets a commission regardless of whether the customer goes to another distributor's Web site or the main company site. The Maestro application is available for sale, or as a hosted application for \$500 per month.

In addition, some distributors, such as massage schools or alternative healers, carry a number of products that are not part of the Advanced Tachyon line. All of these can be listed on the distributor's Web site, and Tachyon notifies the distributor when an order for one of these products is made. Furthermore, the Web site is customized for each user, depending on their chosen language, currency and location. Only items stocked within one of the closest distribution centers are listed on the dynamically generated Web page.

Once a set of items is ready to be purchased, the site rec-

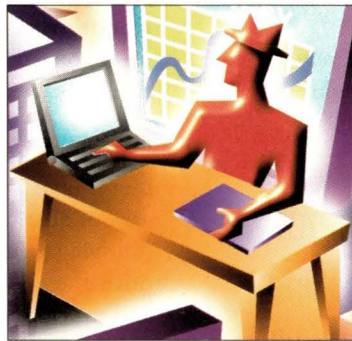


Figure 3. Data Warehousing-Enhanced CRM

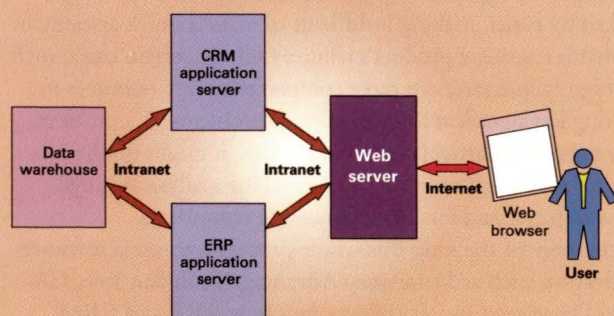
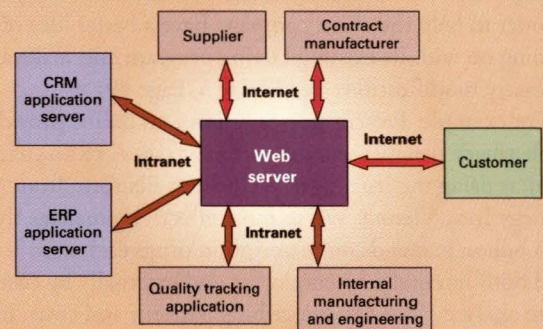


Figure 4. Tracking Quality Throughout Supply Chain



ommends other items that have been purchased by people with a similar mix of items in their shopping basket. The idea is to help sell customers on products that they may find useful for their needs but had not thought about, the company says.

This is such an incredibly powerful model that could be used for everything from high-tech goods to household items. In the bricks-and-mortar world, companies may be unwilling to advertise their wholesaler's Web site for fear of losing business to the Web. But if each store can be assured a commission on sales to existing customers, they are more likely to advertise the wholesaler's site. Consequently, the customer could have access to a much wider selection of goods than might be displayed in the typical storefront, and both the wholesaler and retailer could be assured of increased revenue.

"The application gives a Web interface to not only the commerce transactions, but to how you interact with the data and how you build relationships on the Web," says Eric Shishko, president of Maestro Commerce.

Another potential application of ERP/CRM integration with the Web lies in tracking quality of service issues from a product's creation, through deployment and use.

David Wagner, chief executive officer of Advanced Tachyon says, "Our challenge was to see what motivates the distributor to selling and what causes them to stop or back off. They worry about market share and how it is stolen and how big customers migrate to larger distributors or the manufacturer." Wagner adds that Maestro Commerce played a key role in enabling this new model of distribution and customization.

Wagner also advises other developers: "Know your customer and know the barriers they will have in front of them and solve them before they ever see the problem. Learn to talk directly to the customer and not the audience. Most Web sites don't take into consideration that the person they are talking to is an individual and is there for one particular reason. They use a kind of shotgun effect, instead of taking people to what they need based on who they are."

Integrating Statistical Data

CRM does not need to be limited to individuals who are tracking orders. At the high end, organizations that provide multiple services to clients can also provide trend-analysis data in order to help the client company have a better idea of what is going on with its existing buying program and make any necessary modifications (see Figure 3, Page 49).

For example, Prescription Solutions, an online provider of pharmacy benefits services (<http://www.rxsolutions.com>), is using the Intelligent E-Business Platform from MicroStrategy Inc., Vienna, VA, to more effectively manage the \$1.5 billion it spends on prescription drugs each year. It is used both internally by employees and externally by customers to analyze physician prescribing patterns and costs. In the

process, Prescription Solutions expects to better manage pharmacy trends, lower healthcare costs and provide better services for customers.

"Our belief is that we needed an e-business solution to more effectively manage the one and a half billion dollars that we spend on prescription drugs each year," says Paul Miller, chief financial officer of Prescription Solutions. "The system is not only ensuring that our members receive the appropriate medications, but it is also saving us money, which we consider icing on the cake."

The Web application allows users, including pharmacy directors, physicians, medical group directors, managed care executives and consultants, to access more than 75 predefined reports that contain relevant and timely information to implement corrective measures. Users can also create custom reports that track specific areas of concern and call up data from anywhere in the world.

This information can include information about drugs, or trends in drug use by members in order to track the impact of various pharmacy programs. "The better we understand what is driving pharmacy expense—be it utilization, dosage creep or price—the more able we are to address [HMO] benefit design and structure early in the process. This is the kind of valuable insight that is resulting in better care for our members and lower healthcare costs," Miller says.

Before deploying MicroStrategy's software, Prescription Solutions had a difficult enough time doing the analysis on its own, much less making it available to customers in a customizable and timely way. "Previously, when we tried to understand why pharmacy costs were going up in a certain drug category, we had to perform labor-intensive and time-consuming analysis that took weeks or months. By the time we began the analysis, the data was one or even two months old. Using MicroStrategy Web, it now takes us hours to analyze the data and get answers," Miller says.

Tracking Quality of Service

Another potential application of ERP/CRM integration with the Web lies in tracking quality of service issues from a product's creation, through deployment and use (see Figure 4, Page 49). In the production of any goods, there are many different variables and inputs that can affect the final product and its use for years into the future. If a company can ascertain that a given component is the weakest link in the quality chain, it can proactively find a replacement before the weak link affects customers.

In most enterprises, this kind of information is typically tracked by paper, making it difficult to make a quick assessment of what is causing a product's failure. Only in certain cases, such as a high failure rate, can most companies devote resources to tracking less significant but important problems. If a problem emerges with a particular production run, it might not be evident for years, and only after a painstaking analysis through reams of paper and lots of embarrassing complaints.

One way of tracking this whole process is to use a software application such as Datasweep Advantage from San Jose, CA-based Datasweep Inc. It collects data from ERP and CRM

systems throughout a product's entire life cycle to help design engineers, production engineers, field engineers and customers track the parts and processes that go into a product and help solve problems both proactively and retroactively.

One of the first companies to deploy this new software has been Intuitive Surgical Inc., Mountain View, CA. The company makes the da Vinci Surgical System, which is used to perform minimally invasive surgery deep inside the body through a small hole (1 centimeter vs. 30 centimeters for heart surgery, for example) and a virtual reality interface. Quality control for such a complex system is absolutely critical.

Intuitive's entire manufacturing process system is currently controlled by three key applications: A product change collaboration system called Agile Workplace from Agile Software, San Jose, CA, which specifies current design parameters; a product ordering and inventory management tool called MFG/Pro from QAD Inc., Carpinteria, CA; and Datasweep Advantage, which automates the manufacturing and parts tracking process. Although the three applications use different back-end databases, they do share information with one another.

Before Datasweep, Intuitive used a manual system to track the manufacturing process, record anomalies and record the configuration information indicating the serial and lot numbers of parts that went into a given surgical instrument. Don Chamberlain, document control manager at Intuitive Surgical says, "This created a mountain of paper. It was fine as far as keeping a record goes, but it was clear to me that this was not a very good workable long-term solu-

tion. We had a problem with legibility of serial numbers and the sheer mountain of paper."

At the end of the build process, the manufacturing supervisors and a quality engineer would audit the paper to make sure all of the proper fields had been filled out. But this audit never actually did any kind of evaluation on the process or parts that went into a product because it was too cumbersome.

Chamberlain explains, "Since it was on paper, it is not useful. You could not do any analysis without a tremendous amount of clerical work to extract some useful information."

For other people anticipating the deployment of a similar system, Chamberlain adds, "I am a big believer in rapid prototyping and getting the system running, and that is the approach we took. On the other hand, it would have been nice if we had the time and resources to have done a little more homework in figuring out exactly what our requirements were. If when deploying this you assigned some dedicated IS personnel and provided a chance to get everyone involved on the same page, that would make life a little easier."

Scaling the Application

Companies should be wary of just slapping a Web front end on an ERP application and calling it a day. Anne Thomas, editor-in-chief of Boston, MA-based research firm Patricia Seybold Group's *Distributed Computing Monitor* says, "The most important thing to remember is that ERP systems and the existing back-end systems were designed to support somewhere on the order of three to 300 concurrent users. They are not designed to support the volume of people on the Web.

COMPANIES MENTIONED IN THIS ARTICLE

Agile Software Corp.

1 Almaden Blvd.
San Jose, CA 95113
<http://www.agilesoft.com>
Circle 150

Art Technology Group

25 First St., Second Floor
Cambridge, MA 02141
<http://www.atg.com>
Circle 151

Baan USA Inc.

2350 Mission College Blvd., Ste. 1300
Santa Clara, CA 95054
<http://www.baan.com>
Circle 152

Compuware Corp.

31440 Northwestern Hwy.
Farmington Hills, MI 48334
<http://www.compuware.com>
Circle 153

Datasweep Inc.

1 Almaden Blvd., Ste. 600
San Jose, CA 95113
<http://www.datasweep.com>
Circle 154

Great Plains Software Inc.

1701 38th St. S.W.
Fargo, ND 58103
<http://www.greatplains.com>
Circle 155

Maestro Commerce

800 Quale Ridge Drive
Westmont, IL 60556
<http://www.maestrocommerce.com>
Circle 156

Mercury Interactive Corp.

1325 Borregas Ave.
Sunnyvale, CA 94089
<http://www.merc-int.com>
Circle 157

MicroStrategy Inc.

8000 Towers Crescent Drive
Vienna, VA 22182
<http://www.microstrategy.com>
Circle 158

Oracle Corp.

500 Oracle Pkwy.
Redwood Shores, CA 94065
<http://www.oracle.com>
Circle 159

PeopleSoft Inc.

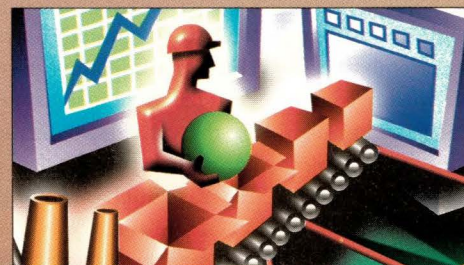
4460 Hacienda Drive
Pleasanton, CA 94588
<http://www.peoplesoft.com>
Circle 160

QAD Inc.

6450 Via Real
Carpinteria, CA 93013
<http://www.qad.com>
Circle 161

SAP America Inc.

3999 West Chester Pike
Newtown Square, PA 19073
<http://www.sap.com>
Circle 162



Providing a direct link is likely to overwhelm those back-end systems. You don't want to have 20,000 users logging into your SAP system."

Thomas recommends a tiered approach in which the Web server runs on a separate server and caches all of the data from the working ERP server. This way, only the changes need to be sent between the two servers daily, or hourly, and the ERP system is left to focus on its relatively smaller base of internal users running the native ERP applications.

The other problem with direct integration is that customers tend to have different needs from those of employees. "Chances are you are not going to be using the same interface and transactions that would be used by an internal user," Thomas says. Back-end ERP systems were not necessarily designed with the end customer in mind. "You need to create a mirror around it that can present data in different ways for the users," she says. "The customer is looking at it as a management or self-service tool for order tracking or account management."

The information needs to be extracted from the back-end systems and put into a different form and then staged to support the client environment. From the back-end point of view, it looks more like a batch process than a continual flood of new requests.

John Wurfl, CRM evangelist at SAP America says, "Traditional ERP processes were resident on a single platform. Now we are going to an *n*-level mode, which means that I can have an infinite amount of processing depending on my IT architecture."

Adapting the Test Environment

Integrating ERP and CRM applications with the Web necessitates a new type of testing. Although the vendor of each product may have already done all of the functional testing to make sure the interface works as designed, it is common for companies to customize the application, which has the potential to introduce problems. Jim Hare, senior manager of product marketing at Sunnyvale, CA-based Mercury Interactive Corp., maker of Web-based testing and reporting tools, says, "The important thing about packaged applications is that people think they should be able to use them out of the box. The reality is that yes, the ERP vendors have already tested these systems, but customers rarely use them out of the box."

Another testing issue is that the interconnection between the different components creates data dependencies between the applications that can only be uncovered through rigorous testing or embarrassing customer complaints after the fact. "What you are trying to do is test the business process. Most customers will probably use the same customizations as SAP provides, but the most important part is the data dependencies. You might want to test those same business processes with a variety of input data," Hare says.

Load testing of all the different pieces working in concert is also important to ensure communication between the different

components does not overwhelm the system. Hare says, "You really want to emulate a day in the life of the ERP/CRM systems. The more real-life planning that goes into it, the better the assessment."

Once the systems are deployed, Hare suggests that even an innocuous change could dramatically affect performance. You have to look at the combined effect of what is happening when people are doing CRM data entry and online transactions.

Another issue involves making sure the data into the system is flowing where it needs to correctly. "Testing becomes not just a one-time opportunity, but you also want to monitor the application even in production," Hare says.

He recounts how one company had set up a Web form to collect information from potential customers, only to find later on that leads were not getting fed into the CRM system. "It ended up being a complete disconnect. It was not until someone looked into it that they saw there were generating a lot of opportunities, but not closing any business," Hare says.

Even after the application is deployed, it's not a bad idea to test its performance periodically to determine what kind of experience the customer is having. This is important because thanks to advertising efforts, you might find that more customers are using the system than you had planned, or that growth was faster than anticipated.

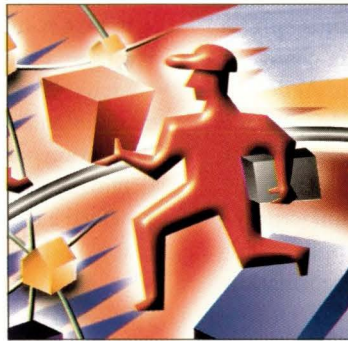
Overcoming the Challenges

Janet Gould, analyst with Plant Wide Research, San Clemente, CA, sees many challenges in integrating ERP and CRM systems via the Web. First, there is the challenge of making the applications seamlessly work together. There will be companies that want to bring together applications that cannot, or should not, come together. This can be a major problem following a merger. "There are applications that are not really as compatible as others" she says. "The whole trick is finding an integrator that knows what is compatible with what, and not just because a vendor says they are."

Another challenge is that this is not just an information technology phenomenon. Gould explains, "An IT person is not going to just walk in and handle a telco center. They need to think about having specialists in more areas."

Gould stresses that integration between ERP and CRM systems is an issue that is going to be vital to the competitive nature of every company large and small and that it will be vital along the supply chain because customers' customers are going to be involved. "It is going to be a universal issue to all of the companies and they are going to have to deal with it in order to make sure they have a smooth operation," Gould says. ➔

George Lawton (<http://www.glawton.com>) is a writer, researcher and consultant based in Brisbane, CA. He has written for *IEEE Computer*, *Knowledge Management Magazine*, *Software Magazine* and *Wired*, among others.



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.

Content Development, Management Tools

InterWorld has released two tools for e-commerce design and development, Dev Station 3.0 and Design Station 3.0.

Dev Station 3.0 is a development environment designed for developers to customize and extend the functionality of InterWorld's Commerce Exchange environment using C++, Java and COM. It reportedly allows developers to manage everything from presentations to objects. In addition, it allows developers to extend objects, view data schemas and analyze relationships, the company says. Through built-in wizards, developers can add attributes to business objects, visualize relationships between business data and manage query strategies, InterWorld says.

Design Station 3.0 is a content management tool built to allow Web designers to manage the process of creating, staging and deploying dynamic content.

It comes with a drag-and-drop environment to generate HTML, a set of configurable templates and a content management feature that offers a workflow and approval structure for use by a team of developers, InterWorld says. It is included with Dev Station.

Design Station 3.0 and Dev Station 3.0 run on Solaris and Windows NT. Contact company for pricing.

InterWorld Corp.

395 Hudson St., 6th Floor

New York, NY 10014

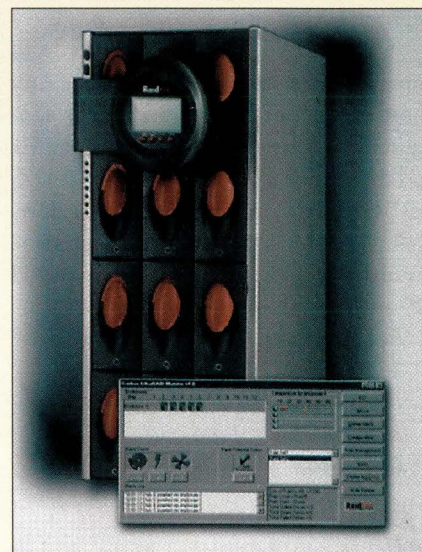
<http://www.interworld.com>

Circle 101

Host-Independent LVD RAID System

Raidtec has unveiled the FlexArray HI (host-independent) 12 RAID Ultra2 low-voltage differential (LVD) storage system, designed for server-attached storage, clustering, e-commerce, data warehousing and imaging applications.

The FlexArray HI 12 is said to offer



1.7 TB of storage capacity, providing cost-effective RAID fault tolerance. A fully configured system can support 24 SCSI LVD drives at less than five cents per MB, Raidtec says. The FlexArray HI 12 model supports 12 hot-swappable 3.5-inch Ultra2 LVD drives (full-

File Server Aimed at CPU-Intensive Applications

The new enterprise-class Aerial AXmp+ SuperServer from PerifiTech is reportedly designed to support processor-intensive applications such as industrial and artistic video editing, document management, medical imaging, transactional processing databases and network infrastructures.

The new server can support up to four Sun Microsystems Inc. UltraSPARC II processors, available in speeds of 300-MHz/2-MB cache, 360-MHz/4-MB cache, 400-MHz/2-MB cache and 400-MHz/4-MB cache. The UltraSPARC II processors support a variety of

graphics features, including pixel masking, motion estimation and discrete cosine transformations. Additional server features include support for 4 GB of ECC EDO memory and peripheral expansion provided through six 64-bit PCI slots. The 5U rack-mount chassis also includes redundant 450W hot-swappable power supplies.

Data storage is facilitated via an integrated Aerial Intelligent Array 3000 RAID subsystem. The Array 3000 supports up to six Ultra Wide or Ultra2 SCSI channels and RAID levels 0, 0+1, 3, 5, or Just a Bunch Of Disks (JBOD). Fault tolerance is implemented through the use of PerifiTech's Aerial 9-, 18- and 36-GB Hot Swap Disks. The SuperServer also includes the company's patented SCSI Enhancement Technology, which features hard disk acceleration and an Ultra2 SCSI adapter.

The Aerial AXmp+ SuperServer is priced starting at \$21,999 for a system equipped with a single Sun UltraSPARC II 300-MHz/2-MB cache processor and 128-MB memory.

PerifiTech Inc.

1265 Ridge Road

Hinckley, OH 44233

<http://www.perifitech.com>

Circle 100



or half-height), dual hot-swappable power supplies and fans, and RAID levels 0, 1, 0+1, 3 and 5. Software support is provided by Raidtec's RAIDman GUI-based management and configuration tools.

The FlexArray HI 12 is host- and operating system-independent. Any host server operating system that supports the Ultra SCSI interface can be used, including Solaris, AIX, HP-UX, IRIX, UnixWare, Linux and Windows NT. The FlexArray HI 12 system is available in either deskside tower or 4U 19-inch rack-mount configurations.

Raidtec Corp.

1360 Union Hill Road
Alpharetta, GA 30004
<http://www.raidtec.com>

Circle 102

Fibre Channel/Gigabit Ethernet Monitoring

Snoop GBIC from Finisar is the latest release of the company's Gigabit Interface Converter (GBIC) transceiver module for Fibre Channel and Gigabit Ethernet networks. Snoop GBIC is said to have the same data integrity, temperature stability and reliability of Finisar's standard GBICs. However, it adds an electrical test port for monitoring critical network connections without interruption.

A GBIC integrates four functions—a transmitter, receiver, built-in diagnostics and a snoop path—in a single package. Snoop GBIC is designed to directly replace standard GBIC components in switches, hubs or other network ele-



ments, and supports data transmission rates of 1.25 Gb/s, Finisar says.

Snoop GBICs are currently available for multimode fiber with SC connectors. Single-mode fiber and copper versions are planned, the company says. Pricing starts at \$1,000 for a multimode Snoop GBIC with built-in tests and diagnostics.

Finisar Corp.

1308 Moffett Park Drive
Sunnyvale, CA 94089
<http://www.finisar.com>

Circle 103

Small Solaris Server Saves Space

The Starion ST-10R from Gulfcoast Workstation is a 2U rack-mount Solaris server aimed at telecommunications companies and Internet service providers (ISPs). Up to 20 Starion ST-10R servers can be installed within a single 72-inch rack.

The ST-10R comes with one CD-ROM, one floppy drive and a Fast Ethernet port. It features a Sun Microsystems Inc. Ultra AXi motherboard and UltraSPARC-IIi processors, available in speeds ranging from 270- to 440-MHz. It also comes with DIMM memory (from 128 MB to 1 GB), a PCI graphics board, a quad Ethernet PCI board and one or two 9.1-GB hard drives. It also ships with a license for either Solaris 6 or 7. It is priced starting at \$3,750.

Gulfcoast Workstation Corp.

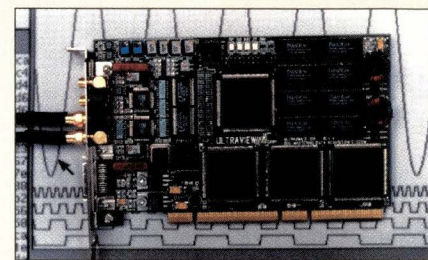
2210 Tall Pines Drive, Ste. 220
Largo, FL 33771
<http://www.gcw.com>

Circle 104

Analog-to-Digital Board with 64-Bit PCI DMA

Ultraview has released the ADDA12-100DMA and AD8-100DMA boards, which it says are the first data-acquisition boards with 64-bit PCI direct memory access (DMA) transfers that can continuously store analog data directly into system memory at sustained speeds of 100 MB/s.

Designed for high-speed and low-jitter operation, the boards are ideal for defense, scientific, industrial and medical applications, Ultraview says. Their



ability to produce high throughput directly to system memory enables new applications to be created in digital radio, continuous spectral analysis and medical imaging, the company says. Even in systems with only 32-bit PCI slots, the ADDA12-100DMA achieves continuous 80-MB/s transfers to system memory.

A software interface allows users to write software for all PCI-bus SPARC platforms running Solaris 7. A Windows 2000 software package will be available soon. The ADDA12-100DMA performs 12-bit analog-to-digital (A/D) conversion at 50 megasamples per second (Ms/s), or dual 25 Ms/s, and 14-bit A/D at 10 Ms/s. It costs \$4,495 and includes drivers and sample programs for Solaris 7.

The AD8-100DMA performs 8-bit A/D at 100 Ms/s, or dual 50 Ms/s, and costs \$3,995.

Ultraview Corp.

34 Canyon View
Orinda, CA 94563
<http://www.ultraviewcorp.com>

Circle 105

High-Performance SCSI/Fibre Channel Arrays

Distributed Processing has introduced RAIDstation7 Ultra160 SCSI and Fibre Channel storage arrays, the company's latest generation of high-performance SCSI and Fibre Channel solutions for servers and workstations.

The RAIDstation7 Ultra160 SCSI storage array supports the Ultra160 SCSI standard, which features a maximum data transfer rate of 160 MB/s per channel, Distributed Processing says. The RAIDstation7 Fibre Channel storage array supports dual loops (100-MB/s data transfer per loop), SCSI enclosure services and copper/fiber-optic connections. In addition, it supports Cyclic Redundancy Check and Domain

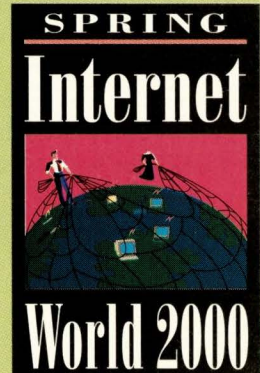
Los Angeles Convention Center
Los Angeles, CA

Conference: April 3-7, 2000

Exhibits: April 5-7, 2000



THE SEVENTH ANNUAL

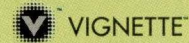


www.internet.com

Don't miss the
Computer Hope Benefit,
at Paramount Studios, the biggest bash
the Internet industry has ever seen!

For information and tickets, visit
<http://events.internet.com/spring2000>

Sponsored by:



First the Internet.

T h e n t h e W o r l d .

**The world's largest event dedicated to
e-business and Internet technology.**

For online registration savings:
Visit www.internet.com/registerspring

To request a brochure:
Call 1-800-500-1959 or e-mail siwprogram@iw.com

To exhibit:
Call 203-341-2884 or e-mail twalsh@iw.com

PRODUCED BY:



OFFICIAL SPONSOR:

**INTERNET
WORLD**

MEDIA SPONSORS:

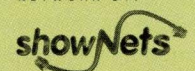
internet.com

boardwatch

CORPORATE SPONSORS:



NETWORK BY:



Code: S03

New Products

Validation features for ensuring data reliability, the company says.

Both the Ultra160 SCSI and Fibre Channel arrays are available in tower or 19-inch rack-mount AC-powered models, the company says. They support seven hot-swappable SCA-2 hard drives and speeds up to 15,000 rpm. In addition, both models include three hot-swappable cooling modules, two front-loading autosensing power supplies and failure notification via an audible alarm.

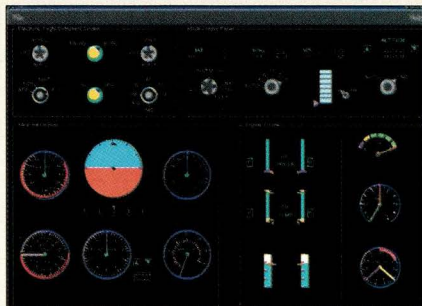
The Ultra160 SCSI storage array costs \$3,492 and the Fibre Channel array costs \$5,325 for both tower and rack-mount configurations. DC-powered versions of both products will be available first-quarter 2000.

Distributed Processing Technology

140 Candace Drive
Maitland, FL 32751
<http://www.dpt.com>
Circle 106

New GUI Tools for Motif

KL Group, a provider of Motif interface components and widgets, has released XRT/gauge, a comprehensive collection of widgets, comprising several dials and gauges.



XRT/gauge includes the following components: Circular Gauge, Circular Dial, Linear Dial, Linear Gauge, LED Icon, LED Numerical, Percent and XRT Professional Developer's Suite (PDS). XRT/gauge enables you to quickly build control panels, data displays, process controls and simulation environments.

Because XRT/gauge widgets are customizable, they can be used in environments with specialized requirements such as aerospace or manufacturing. XRT/gauge widgets measure the value of a property or attribute and display this information in a format appropriate to the particular application environment.

XRT/gauge is now available as an individual product or as part of the PDS 2.0 Suite. Pricing for XRT/gauge starts at \$1,995 for a single-user license, or \$5,995 for a widget included in the XRT Professional Developer's Suite. It runs on all leading UNIX and OpenVMS platforms, including SunOS 4.1.x, Solaris 7, Digital UNIX 3.2+ (including Tru64 UNIX), Ultrix, HP-UX, AIX 4.2+, IRIX 5/6.2+ and Alpha/VMS.

KL Group Inc.
260 King St. E.
Toronto, Ontario
Canada M5A 4L5
<http://www.klgroup.com>
Circle 107

Upgrades, Enhancements, Additions...

■ Bluestone Software has announced complete support across its entire product line—including its Total-e-Business platform, Sapphire/Web Application Server and XML Suite Integration Server—for Sun Microsystems Inc. Java 2 Platform, Enterprise Edition (J2EE). Bluestone says its decision to support Java-Server Pages (JSP), the Enterprise JavaBeans (EJB) component architecture and the Java Servlets API—core enterprise technologies which are unified in J2EE—simplifies enterprise application development by providing a comprehensive set of component services without complex programming. Developers will also reportedly benefit from Bluestone's "in-process" methodology for hooking JSPs to JavaBeans and EJB via an eXtensible Markup Language (XML)-based interface within a single Java Virtual Machine (JVM). By employing one JVM to execute all application tasks, Bluestone says it enables e-business applications to run faster and more efficiently. Contact company for individual product information and pricing. **Bluestone Software Inc.**, 1000 Briggs Road, Mount Laurel, NJ 08054, <http://www.bluestone.com>. **Circle 108**

■ The Rave Systems Rackmount-AXmp from Rave Computer Association now scales to 4 GB. The product, which is designed for use in telecommunications servers, Internet service provider (ISP) environments, or specialized industrial applications, integrates Sun Microsystems Inc.'s 64-bit four-way Ultra AXmp motherboard into a ruggedized 5U 19-inch rack-mount chassis. It also includes integrated dual-channel Ultra Wide SCSI and six PCI slots, four at 33 MHz and two at 66 MHz. The Rave Systems Rackmount-AXmp standard chassis configuration

features four 5.25-inch shock-mounted drive bays, a 600W power supply and three cooling fans. It comes preinstalled with Solaris 7 and is priced starting at \$14,000 for a base system with one 400-MHz UltraSPARC-II processor, a 40-speed CD-ROM, 18-GB disk drive and 256-MB memory. **Rave Computer Association Inc.**, 36960 Metro Court, Sterling Heights, MI 48312, <http://www.rave.com>. **Circle 109**

■ Quallaby, a provider of scalable network analysis and reporting software, has introduced an updated version of its flagship product, Proviso 1.2, which now includes support for Oracle Corp. and Sun Microsystems Inc. systems. The upgrade is designed to provide network service providers with enhanced data handling capabilities that enable faster provisioning of new customers and services, Quallaby says. Built on the Oracle database, Proviso 1.2 is said to allow service providers to easily merge network information with customer information for efficient and accurate billing and guaranteed service-level agreements (SLAs). Proviso comprises three modules: Proviso Manager, which manages network devices and polls network data according to performance and SLA metrics; Proviso Report, which provides drill-down and customized reporting and offers a wide range of output options; and Proviso Library, which provides service-optimized report templates. Proviso 1.2 runs on either Solaris 2.6 or Windows NT 4.0 and supports Sun A1000 RAID hardware/software and Oracle 7.3.4 Enterprise Edition. Pricing starts at \$30,000 and depends on configuration. **Quallaby Corp.**, 59 Composite Way, Ste. 400, Lowell, MA 01851, <http://www.quallaby.com>. **Circle 110**

Decisions, decisions.

Solutions, solutions.

All business is e-business this April in Chicago.



Now that you know your business is definitely headed for e-business, you need to compare the products and services that will get you there. Welcome to COMDEX/Spring 2000 and WINDOWS WORLD.

This is the event where IT professionals, corporate managers, developers and distribution professionals find the solution-building technologies they need to compete in the Internet economy.

And this is the event that added special programs on Linux, e-comm management, infosecurity and wireless technologies — just to make sure you'll be as competitive as possible.

With all the technology choices out there, you only have one more decision to make. Be there.

**technology
decisions
for the internet
economy**

**Don't miss COMDEX/Spring and WINDOWS WORLD,
co-located with LINUX Business Expo.
April 17 - 20, 2000 • McCormick Place, Chicago**

**To register for your FREE expo pass or to learn more about the events,
go online today. Interested in exhibiting? Call Arnie Wolfson at
781-433-1573 or e-mail arnold_wolfson@zd.com.**

www.comdex.com

Server/Workstation Marketplace

The high-impact, cost-effective and powerful advertising section reaching over **100,000** technical product specifiers and buyers.

To advertise call Carol Flanagan at **(508) 839-4016** Email: caflanag@aol.com

RS/6000 **Sun Microsystems**

AS/400 **HP9000**



www.flagshiptech.com

FLAGSHIP
TECHNOLOGIES INC.

BUY, SELL, RENT, LEASE

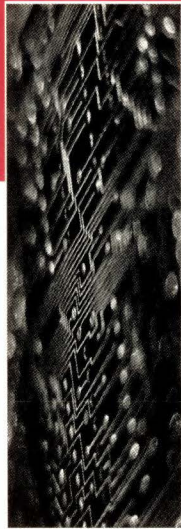
Flagship Technologies is your best source for AS/400, RS/6000, HP9000 and Sun Microsystems equipment and service. We staff certified technicians, supply new and used parts, offer OEM parts, and conduct advance exchange as well as complete upgrades.

Minneapolis (AS/400, RS/6000 & Sun Micro) . . . **800-416-8900**
612-516-1300

Atlanta (HP9000) **888-740-4600**
770-569-8188


Circle No. 402

NuProducts from Nu Horizons!




Provide your customers with best-in-class product and service!!
Call Nu Horizons Electronics, an authorized Sun Microsystems Distributor, for all of your microelectronics needs.

- **Motherboards**
- **Processor modules**
- **Memory**
- **Solaris and JAVA OS**
- **I/O Cards**
- **and more....**



AUTHORIZED MICROELECTRONICS DISTRIBUTOR



NU HORIZONS ELECTRONICS CORP.
Call 1-877-NUHO-SUN
Open from 9:30AM to 8:00PM EST
www.nuhorizons.com/sunsales
EMAIL: sunsales@nuhorizons.com

Circle No. 320

G-2 Systems

....the intelligent choice!

Sun Microsystems and more . . .

- Systems
- Spares
- Repairs/Advance Exchange
- Peripherals
- Best Power UPS's
- Export Specialists

Buy...Sell...Trade

Major Credit Cards Accepted

G-2 Systems, LLC
2 Henshaw Street
Woburn, MA 01801

sales@g-2systems.com
www.g-2systems.com

Tel: 781-937-0010
Fax: 781-937-0808

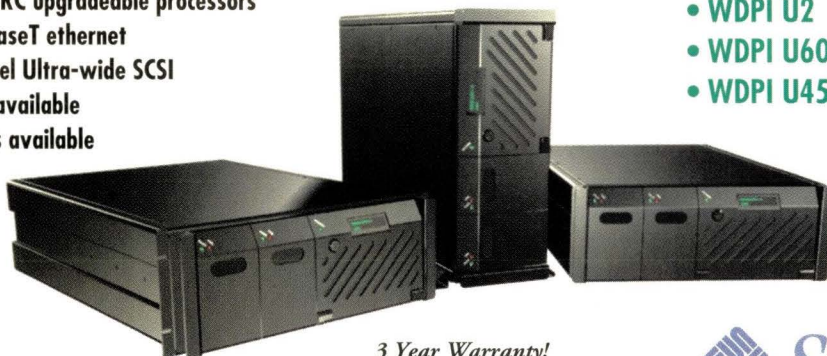
Circle No. 346

SW Expert ■ March 2000

New Sun Compatibles!

- Original Sun Ultra AXI/AXMP motherboard
- Original Sun UltraSPARC upgradeable processors
- Integrated 10/100 BaseT ethernet
- Integrated dual-channel Ultra-wide SCSI
- Maintenance options available
- Custom configurations available

- WDPI U5/U10
- WDPI U2
- WDPI U60/U250
- WDPI U450



BUY • SELL • LEASE
PARTS • REPAIR • TRAINING

3 Year Warranty!
More Chassis Styles Available!



Authorized
Microelectronics
OEM

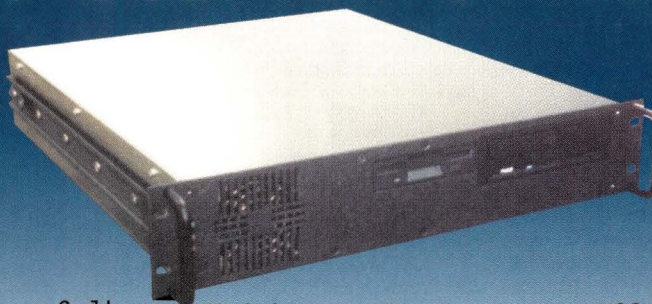


www.wdpi.com 800-553-0592 **DATA PRODUCTS** E-mail: info@wdpi.com

Circle No. 363

Starion ST-10R Rackmount Server

Pizza Box vs. Starion ST-10R



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

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



GULF COAST
WORKSTATION

800.587.7882
www.gcw.com

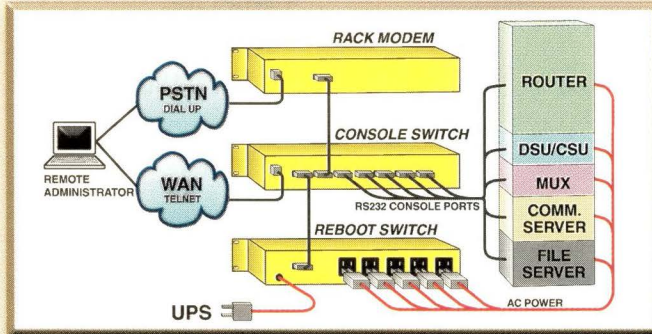
We Deliver Sun Solutions



Circle No. 376

Remote Trouble-Shoot & Reboot

- ✓ Dial-up and telnet access to Remote Sites
- ✓ Select Multiple Console/AUX Ports
- ✓ Reboot power on selected devices



When it comes to Remote Site Management, no one offers more choices to access multiple console/AUX ports and/or reboot power than NetReach products from Western Telematic. We offer the flexibility you need to mix and match equipment for small or large remote management strategies. NetReach products are now installed in thousands of network sites world wide. Our customers know they can depend on our superior quality and reliability for their mission-critical operations.



**western™
telematic inc.**

(800) 854-7226 • www.wfi.com

5 Sterling, Irvine, CA 92618-2517
Facsimile: (949) 583-9514



Console/AUX Port Managers

Remote access to multiple RS-232 Console/AUX Ports
• TCP/IP (telnet) and dial-up (modem) • Continuous off-line buffering • Password Protected • Any-to-Any Port Matrix Switching • AC or -48V DC power options
• Various models from 4 to 64 ports



Intelligent Remote Power Switches

Reboot "locked-up" network equipment
• AC and -48V DC versions • Password, Site ID, Plug Labels • On/Off/Reboot power switching



Rack Mount Modem

Single modem for Dial-up access to console ports
• AC and -48V DC powered • 33.6Kbps V.34+
• Requires only one 19" rack space

Circle No. 324



E.L.I. SYSTEMS inc.

Refurbished SUN Equipment

139 Hampshire St., Cambridge, MA 02139

System Specials

Ultra 2, 200 MHz, 20" monitor, 3D F/B, 128 MB Ram, 4.2 GB	\$7,300
Ultra 30, 20" monitor, 300 MHz, 128 MB, 3D, 4 GB disk	6,000
Ultra 1/170E, 20" monitor, 3D, 64 MB RAM, 2.1 GB disk	2,650
Sparc 20, 85 MHz, 20" monitor, GX F/B, 64 MB RAM, 2.1GB disk	1,800
Sparc 5 model 110, 20" monitor, GX F/B, 64 MB RAM, 2.1 disk	1,500
Sparc 10, 16" monitor, GX F/B, 40 MHz, 64 MB RAM, 2.1GB disk	1,000

Sun Base Systems

E250/450 Enterprise	Call
Ultra 2	5,200
Ultra 1/170E	1,500
Ultra 30	2,000
Sparc 20	450
Sparc 5 110	550

Monitors

16" Sony color	\$125
17" Sony color	300
19" Sony color	325
20" Sony color	400

Call 1-800-447-1156

PHONE 617-547-1113
FAX 617/354-1417

CPU Modules

X1188A 200 MHz, 1MB cache	\$700
X1190A 250 MHz, 1 MB	1,700
X1191A 300 MHz, 2 MB	2,600
X1192A 360 MHz, 4 MB	3,000
X1194A 400 MHz, 2 MB	3,400
501-2953 SM 81	450
Ross HyperSparc modules	Call
Sparc 10/20 CPU's	Call

Memory

X70002A (2x32) 64 MB Kit	\$330
X7003A (2x64)128 MB Kit	450
7004A(2x128)256 MB Kit	800
7005A (2x256)512 MB Kit	2,600
X7022A 256 MB RAM Kit	400
X7023A 1 GB RAM Kit	3,400

Disk Drives

Seagate 1GB N/WC	\$150/125
Seagate 2.1 GB N/WC	250/200
Seagate 4.2 GB N/WC	325/350
Seagate 9.0 GB N/WC	550
Seagate 18 GB	1,000

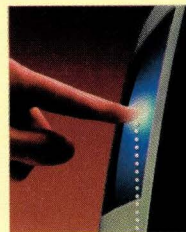
Call for Additional Items

motherboards, SBUS cards, graphics cards, PCI solutions, disk storage options, RSM storage options, and network connectivity

PHONE 617-547-1113
FAX 617/354-1417

E-MAIL sunsales@eli.com
WEB http://www.eli.com

Circle No. 394



Get in Touch with Trident.

TOUCH SCREEN TECHNOLOGY EXCELS AT Simplifying computer input
Saving space
Supporting fast, frequent computer operations
Reducing maintenance costs and down-time

AND NOW, YOU CAN HAVE TOUCH WITHOUT MODIFYING YOUR EXISTING APPLICATIONS. TRIDENT'S TOUCH SOLUTIONS INCLUDE
Touch-configured monitors, X terminals and Netstations
Touch screen integration with your monitors
Touch screen hardware and driver software
All major touch technologies
Rack mounting or ruggedized NEMA enclosures and kiosks with touch
Touch application software development services

TRIDENT'S TOUCH SOLUTIONS WORK WITH
UNIX Workstations X Terminals UNIX PC's
DOS & Windows Netstations Macintosh

Trident puts you in touch.™

TRIDENT

TECHNOLOGY SOLUTIONS

TRIDENT SYSTEMS INC. email: touch@tridsys.com
TEL 703.273.1012 url:http://www.tridsys.com/cpg
FAX 703.273.3763

Circle No. 411

Comtek Computer Systems

Specializing in :

SUN

SUN Microsystems & Peripherals

In-house OEM Depot Repair

Same Day Advance Exchanges

Spare Parts & Systems Sales

System Lease and Upgrade Programs

Inventory Mgt Programs

- Same day shipping
- One year warranty
- In house technical support
- Authorized Software Support Provider Agent
- On hand inventory
- Customized supply solutions to meet your needs
- **We can handle all your SUN needs**

Comtek Computer Systems

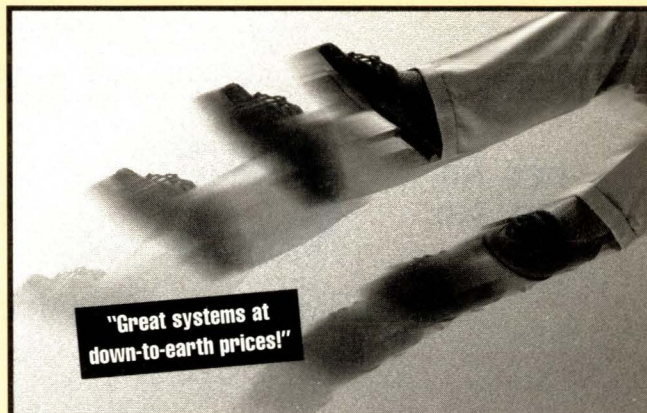


"The first choice in SUN Support"
Give us a call so we can put our highly trained staff to work for you.

1-800-823-4450

WWW.Comtekcomsys.com

Circle No. 385



Customer Blown Away By Low Prices

Work Stations • Servers • Peripherals • Parts
Sales • Rentals • Leases • Exchanges • Repairs
Maintenance • 120 Day Warranty

Call today to buy, sell or trade SUN, HP and
Silicon Graphics equipment with Security!



2340 County Road J. • White Bear Lake, MN 55110
651/653-5200 • 651/653-4300 • Sales@Securitycomputer.com

Circle No. 388

X7004A	\$720	NEW
X2244A	\$3700	NEW
X2580A	\$8900	NEW
E6500, BASE SYSTEM	\$74,000	USED
A1000 STORAGE 218GB	\$20,750	NEW

NOTE: New Equipment Features 1Yr. Returns To Trinicomp Warranty

SUN[®] Specials

Ultra 80

- 450 MHz CPU
- 256MB memory
- PGX32 graphics
- 9GB drive
- Sound card
- Country kit

\$18,500

New, with 1 Yr. Return to Trinicomp warranty



TriniComp
SYSTEMS

2 Centennial Drive, Peabody, MA 01960

fax: 978-531-6037

email: sales@trinicomp.com

Call 978-531-7366
www.trinicomp.com

All trademarks are property of their respective companies

Circle No. 420

QUICK RESPONSE TO YOUR INFORMATION REQUESTS

For more information on the products/services advertised in this section, please circle the appropriate reader service number(s) on the reader inquiry card located elsewhere in this issue. OR

You can E-mail your requests for more information using the reader inquiry card numbers.

Here's how:

E-mail address: **ica@ica.cc**

Include

1. Magazine name and issue date
2. Your name and address
3. Reader inquiry numbers, separated by commas, for which you need more information.

LOWEST PRICES ON MEMORY

DEC, HP,
IBM, SGI



SUN, ROSS
SIMMS, DIMMS

Clearpoint Enterprises, Inc.

Save time, money dealing directly with Manufacturer

"If My Memory Serves Me Right
...It Must Be Clearpoint"

25 Birch St.
Milford, MA 01757

(800) 253-2778

(508) 473-6111

Fax (508) 473-0112

www.clearpoint.com

Email: memory@clearpoint.com

Circle No. 362

anything & everything **4Sun**

On Line ...
www.anythingsun.com

410-820-8100
Ames Sciences, Inc.
501 South Street, Easton, MD 21601
Fax 410-820-8179
sales@anythingsun.com

Circle No. 331

**UNIVERSAL
CAPITAL
FUNDING**

SUN MICROSYSTEMS
WORKSTATIONS
PRINTERS SERVERS MEMORY
OPTIONS DISK TAPE

800-883-9339
BUY • SELL • RENT • LEASE •
UPGRADE • EXCHANGE

UNIVERSAL CAPITAL FUNDING
15695 Medina Road, Plymouth, MN 55447
VOICE (612) 551-9309 FAX (612) 551-9311
EMAIL: lyonts@winternet.com

Circle No. 431

SPATCH

alphanumeric paging
software for UNIX & NT

Sends text messages
to pagers and phones
from applications, users,
intranets, and e-mail.

Easy Application Integration
Interactive User Interface
Intranet/Internet Paging
E-mail Forwarding

Starting at only \$199

THE HYDE COMPANY

phone 770/840-7377
www.spatch.com
spatch@hydeco.com



Circle No. 453

SYSTEMS & CPU's

Ultra 1/170E-C3D-128mb-2.1GB-CD-F1.....	\$ 2,995.00
Ultra 2/1167E-C3D-128mb-2.1GB-CD-F1.....	\$ 6,995.00
Ultra 2/2300-C3D-128mb-2.1GB-CD-FL.....	\$12,995.00
Ultra 60-300mhz-C3D-128mb-4.2GB-20".....	\$ 8,495.00
Ultra 60-360mhz-C3D-128mb-4.2GB-20".....	\$ 9,195.00
Enterprise 450 Dual 300mhz	\$15,200.00
Enterprise 250 Dual 300mhz	\$ 9,995.00
Enterprise 4000 0Base	\$12,500.00
S5/170mhz-64mb-2.1GB-CD-FL.....	\$ 1,995.00
S5/85-32-1.05GB-TX1N.....	\$ 850.00
X1191A 300mhz Ultraspac cpu	\$ 2,850.00

MEMORY & DISKS

Sun 1GB SS520	\$ 135.00
Sun 2GB SSV20Ultra	\$ 275.00
Sun 4GB SS520Ultra	\$ 565.00
Sun 9GB UltraArray	\$ 850.00
Sun X7004A 256mb kitUltra	\$ 995.00
Sun X7022A 256mb EX000EX500.....	\$ 895.00
Sun X7023A 1GB memory kit EX000EX500.....	\$ 3,495.00
Sun Storage Array 112 no drives.....	\$2,250.00
Sun Storage Arrays.....	Call

GRAPHICS

TX1/TX4/MGX+ 4mb 24 bit	\$175/\$595/\$275
Creator/Creator3D	\$325/\$695

ENTERPRISE

EX000 X2601A system board	\$ 3,895.00
EX000 X2611A I/O board	\$ 4,750.00
EX000 X2560A 336mhz4mb cpu.....	\$ 5,495.00
EX000 X2550A 250mhz4mb cpu.....	\$ 2,695.00
EX000 X2570A 400mhz4mb cpu.....	\$ 8,890.00

Axil Ultra 2 base system 0mb \$1,495.00!! Qty limited
Performance Technology UFW scsi sbus \$275.00 New!!

Large inventory of hardware including spare parts, workstations,
peripherals, memory, and 3rd party products.

Industry leading 18 month warranty

Check our web page for weekly specials - www.gshiis.com

Email: sales@gshiis.com techinfo@gshiis.com

* Call for full product line and availability. * Trades accepted, and purchase
options available on all excess used equipment.



GSH Intelligent Integrated Systems, Inc.
95 Fairmount Street Fitchburg, MA 01420
Tel: (603) 529-7880 Fax: (603) 529-7884

Circle No. 353

WANTED TO BUY

SUN

Cash Paid Now For

All Enterprise Servers
Ultra 1 & 2, 30 & 60

SUN Disk & Disk Arrays
Memory & Enterprise options

SAVE on OFF LEASE & REFURBISHED SYSTEMS

Systems available for sale, lease or rent

CALL NOW FOR QUOTE

DATALEASE

(800) 456-6233
FAX (714) 632-9248
sales@datalease.com

Circle No. 454

HAVING TROUBLE FINDING IT PROFESSIONALS?

Look no further...

Let the EXPERT work for you!

Advertise to 100,000+ IT professionals*...

* Software Developers, Systems Analysts, Website Developers, Systems Integration Managers, Engineering Managers, Network Directors, etc.

Call Carol Flanagan at
(508) 839-4016



Customer's Head Spins Over Great Deals

Call today to buy, sell or trade SUN, HP and Silicon Graphics equipment with Security! Unbeatable service, unbeatable value -- No wonder so many people are going ape.



2340 County Road J • White Bear Lake, MN 55110
651/653-5200 • 651/653-4300 • Sales@Securitycomputer.com

Circle No. 401

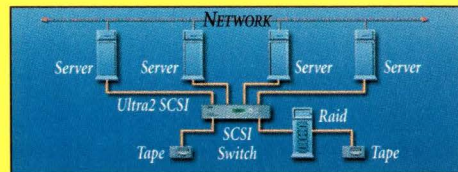
Solutions For Networks!



SCSI Switches

SHARE SCSI PERIPHERALS BETWEEN MULTIPLE HOSTS

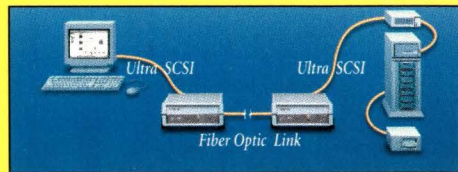
- Easily reconfigure servers and SCSI devices on a network
- 6x4, 4x2, 2x2 SCSI port switching
- LAN Port Connection



SCSI Fiber Optic Extenders

CENTRALIZE SCSI DEVICES FOR EASIER MANAGEMENT

- Locate tape backups in one place
- Secure backup devices
- Remote RAID mirroring
- Extends cable distance up to 10 km



SCSI Booster/Expander

INCREASE FLEXIBILITY IN LOCATING SCSI DEVICES

- Expands SE/LVD bus
- Up to 80 Mbyte/sec throughput
- Improves signal quality
- MSCS cluster compatible



Corporate Headquarters
APCON, Inc.
17938 SW Upper Boones Ferry Rd.
Portland, OR 97224, USA
Phone (503) 639-6700 Fax (503) 639-6740

Regional Sales Office
APCON, Inc.
Santa Clara, CA — USA
Phone (408) 727-7022
Fax (408) 727-7024

www.apcon.com

e-mail: info7@apcon.com

Circle No. 442

Professional abilities are like fine jewels.



They improve when placed in a world class setting.

SAUDI ARAMCO

At the Saudi Arabian Oil Company (Saudi Aramco), an unsurpassed international work-force and "can-do" teamwork have helped build one of the world's greatest explorers, producers and exporters. Top-flight North Americans are joining forces with Saudi Arabs and other nationalities from around the world to achieve even greater success. Take your place in this global partnership in Saudi Arabia, as Saudi Aramco meets tomorrow's leadership challenges.

EDP System Analyst - F17-108245

Requires a BS in Computer Science or Engineering, coupled with 10+ years related experience. Thorough knowledge of AIX (internals/tuning) and UNIX is a must, as well as mastery of "C" language and Shell programming. A background with SP2 and PFS is preferred. Solaris and SunOS experience a plus. Candidates must demonstrate effective analytical and verbal/written communication skills.

This senior technical staff member will be responsible for AIX operating system installation, performance tuning, customization, problem determination and resolution, to include interfacing with outside vendors/computer operations/users; file system management including creating, maintaining, repairing, backing up and recovering file systems; PFS installation and support; Utility script and "C" program design/implementation; software evaluation; documentation of operational procedures; preparation/conduction of in-house presentations; and training others in company standards.

EDP Systems Analyst/UNIX Administrator - X11-108334

Requires a BS or BA in Computer Science or Management Information Systems and a minimum of 5 years experience in computer systems/working in an IS/IT environment. This position works independently to maintain all aspects of the UNIX environment. Candidates must have knowledge of the following: SUN hardware platforms; SUN HA cluster setup/troubleshooting, SUN Enterprise Volume Manager and SUN Net backup; E10k server and System Service Process (SSP) Administration performing domain sizing/configuration; Solaris UNIX, including performance, tuning and networking; Network topology and protocol including ATM/Ethernet/Gbe/TCP/IP; ATM and GigabitEthernet network interfaces; Bourne and C shell scripts writing; Veritas Volume Manager; System Security; BMC monitoring tool background.

EDP Systems Analyst/SAP Basis Administrator - X11-108391

Requires a BS/BA in Computer Science or Management Information Systems with a minimum of 2 years experience in SAP Oracle remedial DM administration. In addition, must possess SAP/Oracle experience in a SUN UNIX environment, OS command line, vi editor, and knowledge of the following: NFS; troubleshoot/configure new releases of R/3 system; implement/troubleshoot R/3 (SAPGUI) desktop components; R/3 performance tools to monitor DB and SAP software for resource constraints related to DB; configure CCMS.

As a Saudi Aramco employee, you will receive a very attractive compensation package including comprehensive benefits. For consideration, please send a resume/salary history to: **Aramco Services Company, Dept. 06E-SWEXPT, in one of the following ways: E-mail: resumes@aramco.com (please cut and paste rather than send an attachment); Fax: (713) 432-4600; Mail: P.O. Box 4530, Houston, TX 77210-4530.** For a full listing of available positions, visit www.aramcoservices.com

ATLANTIC
PERIPHERAL SYSTEMS
 "SUPER" SPARC™ VALUES!

MEMORY

64MB SS20	\$250
64MB Ultra 1	\$275
128MB Ultra 2	\$495
256MB Kit Ent. Server	\$1,095

STORAGE

2.1GB SGT 'cuda Int/SCSI	\$425
4.3GB SGT 'cuda Int/SCSI	\$650
9.0GB SGT 'cuda Int/SCSI	\$950
9.0GB SGT Cheetah Int/SCSI	\$1,295

SPECIAL!

23GB SGT Elite Int/SCSI	\$1,895
-------------------------	---------

WORKSTATIONS

SS Ultra 1, 2 — CALL FOR QUOTE!
 NOW! VISIT OUR WEBSITE!
WWW.ATLANTICPS.COM
 912-929-7099 FAX 912-929-7098
 E-MAIL: atlanticps@mindspring.com

Circle No. 340

**"When it comes to service,
 SCS doesn't monkey around!"**



**Customer Goes Ape Over
 Great Service**

Call today to buy, sell or trade SUN, HP and Silicon Graphics equipment with Security! Unbeatable service, unbeatable value -- No wonder so many people are going ape.



2340 County Road J. • White Bear Lake, MN 55110
 651/653-5200 • 651/653-4300 • Sales@Securitycomputer.com

Circle No. 438

EXA-"Bitten"??
 Extend your EXABYTE Warranty

EXB-820x, 12 hr Repair (6 mo war): \$ 250
 "Hot Swap" Repair (6 mo Warr.): \$ 300
 EXB-850x, 12 hr Repair (6 mo war): \$ 350
 "Hot Swap" Repair (6 mo Warr.): \$ 400

DLT-"Bitten"!!
 DLT-2000, DLT 4000, DLT4700: Call

SUN Microsystems W/S
 Buy, Sell, Spare Parts, Repairs



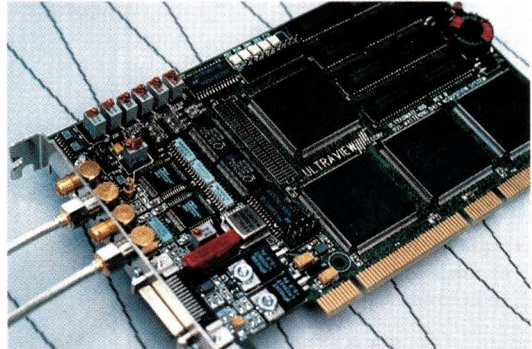
West Coast Computer
 Exchange, Inc.
 11167-A Trade Center Drive
 Rancho Cordova, CA 95670

Call: 916-635-9340 or FAX: 916-635-9485
 Catalog at Web Site: www.wccx.com
 email: sales@wccx.com

Circle No. 368

FAST PCI DMA A/D

64 Bit DMA



100 MS/s DATA ACQUISITION
 Acquire hundreds of megabytes of continuous analog data directly to Sun memory.

- AD12-100DMA - Dual 12-bit 25 MS/s A/D
- ADDA12- 100DMA - Dual 12-bit 25 MS/s A/D
 + Dual 14-bit 15 MS/s D/A
- AD8-100DMA - Dual 8-bit 50 MS/s A/D (or single 8-bit 100MS/s A/D)

ULTRAVIEW CORP.
 34 Canyon View
 Orinda, CA 94563
 Tel: (925) 253-2960

www.ultraviewcorp.com
 sales@ultraviewcorp.com
 Fax (925) 253-4894

Circle No. 375

**Do your customers
expect YOU to
predict the future?**



add 96 dial ports at San Jose POP in Q1
add 2 web servers at Paris site in Q2
add DS3 at Boise site in Q3

www.clairvoyant.com/swe

Capacity Planning

for e-commerce
and Internet-
based networks

Clairvoyant
tel 408.861.1110
fax 408.861.1117

Circle No. 447

RENT TO OWN

SUN E250

\$355/mo*

1 x 400MHz Processor
256Mb Memory • 18.2Gb Disk
PGX32 Graphics • 32x CD-ROM
Keyboard Kit
Solaris 7 Media

* Lease for 36 months with \$1.00 buyout
or purchase for \$9,995. Subject to supply
on hand and credit approval.



(800) 456-6233

FAX (714) 632-9248
sales@datalease.com

Circle No. 455

**FILL THOSE
IT
POSITIONS**

Please call Carol Flanagan at
(508) 839-4016

Sun & HP

BUY SELL TRADE Workstations and Servers

Boards Monitors Disks Tapes Mass Storage Solutions

- ◆ Same Day Shipping
- ◆ Competitive Pricing
- ◆ Custom Configurations Available

DEPOT REPAIR CENTER

- ◆ 30% To 50% Cost Savings
- ◆ One Year Warranty
- ◆ Overnight "Swap" Service



ACC, Inc.

Advantec Computer Company

4125 Business Center Drive Fremont, CA 94538
Phone: (510) 440-9700 Fax: (510) 440-9709
E-mail: sales@advanteco.com
<http://www.advanteco.com>

Circle No. 439

Ph# 800-426-3090
 Fx# 847-317-2622
www.meridianleasing.com



570 Lake Cook Road
 Suite 300
 Deerfield, IL 60015

MERIDIAN

TECHNOLOGY LEASING SERVICES

Product Manager: Al Cosenza acosenza@meridianleasing.net 847-317-2270

Compaq Servers: 1500s, 2500s, 4500s, 5000s, 6500s and PC equipment
 DEC Alphaserbers: 8400s, 4100s, 2100s, 1000, 1000A, and Storage Works
 HP: All K Products, Workstations, Disk and Tape

Product Manager: Jason Davis jdavis@n2nsolutions.com 847-592-3969

Cisco: N2N Solutions, acquired by the Meridian Group in July, 1999, designs and supports end-to-end internetworking solutions, from systems analysis to support. A high-profile business partner of Cisco Systems, Inc., N2N Solutions is authorized to sell Cisco products and services throughout the United States.

Product Manager: Tom Haug thaug@meridianleasing.net 847-317-2198

IBM RS/6000: Servers, Workstations, Parts, and Peripherals
 Sun Microsystems: Ultra Workstations and Enterprise Servers

From leading-edge connectivity to commonplace data center solutions, The Meridian Group is a mainstay in the competitive information technology (IT) leasing and reseller services business. We now enter our 21st year of meeting the IT needs of corporate America. Solidly positioned to take advantage of market changes and opportunity. In a hectic world, we continue to earn our clients' business by consistently delivering reliable service and leading edge technology at reasonable prices.

Circle No. 450

FacetWin

*The ultimate in
Windows to UNIX connectivity*

FacetWin makes Windows®95/NT® to UNIX integration easy and affordable. Just ask for a **FREE EVALUATION** copy of FacetWin, or check out our web site at www.facetcorp.com.

- **File & Print Services**
No need for NFS or ftp... files and printers on UNIX systems simply appear as local resources to your PC, and are ready to use!
- **Terminal Emulation**
World class terminal emulation from the terminal experts that brought you FacetTerm®. Set up a UNIX application with a Windows icon in one minute!
- **Graphical Administration**
Graphical properties administration from Windows with context sensitive help.
- **Plus, check out these cool features:**
 - PC Backup/Restore
 - Modem Server
 - Remote Computing Support
 - Email Server

**Connecting
Windows to UNIX...
the Windows Way!**

FacetCorp

tel: 800/235-9901 • 972/985-9901
 fax: 972/612-2035
info@facetcorp.com
www.facetcorp.com

FacetWin is a registered trademark of FacetCorp. Other names are properties of their respective holders.

Circle No. 421

Your Total Solution

MOUNTING HARDWARE SOLUTIONS

ENCLOSURE SOLUTIONS

2U SERVER SOLUTIONS

RAID SOLUTIONS

From Mounting Kits to Cables to full-featured Enclosures to Custom Product, CI Design offers product that is designed to exceed your design needs. To find out how we can become your Total Solution, Contact us today!

CI DESIGN
 A Better Design • A Better World™

www.ci-design.com
 U.S.A. Costa Mesa, CA 1-800-576-5487
 The Netherlands, Maastricht, 31(0)43-358-5520
 U.K. Basingstoke 44(0)1256-332-723

Circle No. 428



R/S 6000
SAVINGS UP TO 75%

- Whole machines
- Parts
- Repairs
- Logistics management
- Features
- Upgrades

800-328-7723

Jeff Karschnik x5760
 email: jeffk@expresspoint.com

Tim Balko x5706
 email: tbalko@expresspoint.com

Circle No. 372

RS/6000

**NEW • REFURBISHED
 BUY • SELL • LEASE
 SYSTEMS • PARTS
 PERIPHERALS**

Worldwide Trade Corporation

5253 Edina Industrial Blvd.
 Edina, MN 55439
 Call (612) 831-8094
 Fax (612) 831-7018
 www.RS-6000.com
 e-mail rs6000@wavetech.net

Circle No. 342

Server/Workstation Marketplace

**MEMORY UPGRADE SOLUTIONS
 FOR YOUR
 SERVERS & WORKSTATIONS**



PROLIANT SERVERS
 &
 PROFESSIONAL
 WORKSTATIONS



ENTERPRISE
 3000-6000
 64MB, 256MB, 1GB KIT
 ULTRA
 1, 30, 60
 128MB, 256MB KIT



OCTANE
 64MB, 128MB, 256MB
 512MB KIT
 O2
 64MB, 128MB, 256MB KIT



POWER EDGE 6300 SERIES



NETFINITY
 INTELLISTATION
 RS/6000

Tel: (949) 454-9888

Fax: (949) 454-9499

email: corporate@kingmax.com



E3200



HEWLETT
 PACKARD


3000, 9000



All company logos are registered trademarks of their respective trademark owners.

Circle No. 379

The one and only source for all your IT needs



ONE SOURCE CORP

www.
onesourcecorp.
com

Circle No. 345

Why Pay More?

IBM RS/6000

SAVE OVER GOING DIRECT TO IBM

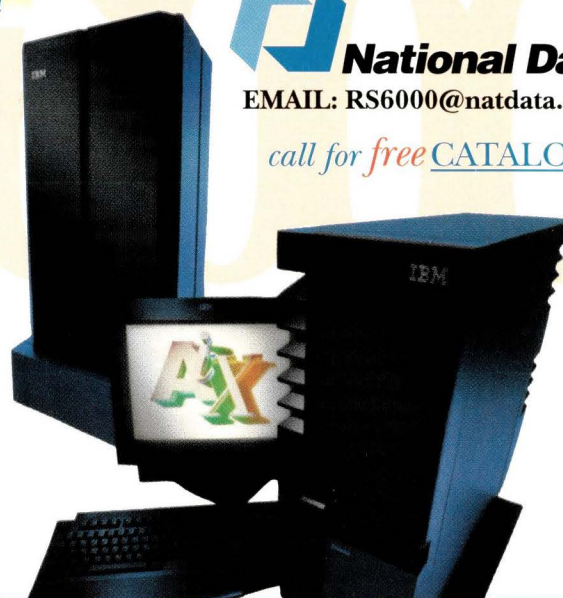
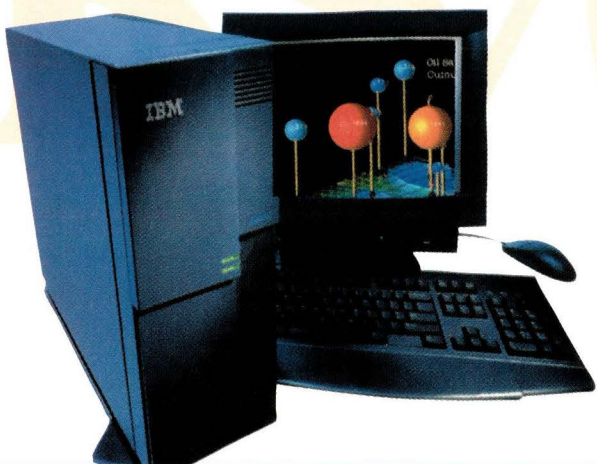
FULL LINE SUPPLIER / ALL SYSTEMS IN STOCK



National Data

EMAIL: RS6000@natdata.com

call for *free* CATALOG



CALL : 800 - 406 1811

Circle No. 343

RS/6000

BUY ~ SELL ~ LEASE

- NEW & RECERTIFIED RS/6000 PRODUCT
- IN-HOUSE TECHNICAL SERVICES
- SAME DAY SHIPPING (UNTIL 7:00 PM CST)
- UPGRADES - PARTS - FEATURES
- KINGSTON PRODUCT DISTRIBUTOR
- SHORT-TERM RENTAL/LEASE

EVOLVING

SPECIALISTS IN RS/6000
PRODUCTS & SERVICES



SOLUTIONS

1.800.294.4362

EVOLVING@EVOLVINGSOL.COM

WWW.EVOLVINGSOL.COM

3989 COUNTY ROAD 116 ▼ HAMEL, MN 55340 ▼ 612 . 516.6500 ▼ FAX: 612 . 516.6555

Circle No. 357

EXPRESS

Computer Systems

BUY - SELL - RENT SUN MICROSYSTEMS IBM RS/6000

- SYSTEMS
- PERIPHERALS
- DISK UPGRADES
- PARTS
- MEMORY UPGRADES
- PROCESSOR UPGR.

800-327-0730

Keith DiCarlo Ext. 459

Fax: 949-474-9250

kdicarlo@ecsunix.com

www.ecsunix.com

Circle No. 404

Running Out Of Floor Space?



- Rackmountable Sun AXI / AXMP
- Up to Quad CPU performance
- Ultra Wide SCSI
- 2 Year Warranty



Welcome to **Computer Connection**, your total Sun solutions provider. Desktop, and Rackmount Sun Compatibles at affordable pricing. Refurbished Sun Systems, and Servers, at savings up to 70% off list price.

Affordability

Defy your budget constraints with money saving solutions

Availability

Systems, Servers, Upgrades, Parts. One of the largest inventories available.

Reliability

Up to 2 year warranties on new and refurbished equipment.

Stability

Over 15 years providing solutions to customers ranging from fortune 100 companies to individuals

Now THAT's Better...

Introducing the best selling Sun compatible, the **CompCon E450**. Rackmountable, Quad cpu performance at 1/3 the size of the Sun E450. And for the desktop, the **CompCon U10**. Ultra Wide SCSI, and a "pluggable" cpu are just a few of its highly upgradable features.



101 First St. Utica, NY 13501
800-566-4786
www.ccny.com -info@ccny.com

Refurbished Sun Hardware up to 70% off List Price!



Circle No. 352

SUN-IBM-HP

NEW! Search our on-line catalog at
WWW.OSEXPRESS.COM

SOFTWARE	LIST	OURS
WordPerfect 7.0 1st user	495	395
Netscape SuiteSpot Pro	6995	6145
VSI*FAX Gold Fax Software	2395	1995
VSI*FAX Gold Windows Client 10-user	590	520
FrameMaker 1-user (floating license)	2500	2295
Adobe Acrobat 1-user	295	245
Informix On-Line Dynamic Server 1-usr (min. 10)	1500	call
Informix On-Line WorkGroup Serv 1-usr (min. 5)	295	call
Informix 4GL Development 1-user (min 3)	900	call
Term Communications Software	695	595
LP Plus Print Manager/Spooler 4-printer	695	575
SoftWindows MS-Windows Emulator	549	475
Spatch alphanumeric paging SW 4-user	499	425
DoubleVision Remote Support S/W	795	665
Uniplex II+ (20-user)	5500	4895
Disk_Pak Disk Optimizer/Defragger	1495	1230
Cheyenne Arcserve/Open Backup S/W	1995	1395
Legato Networker Backup S/W	2500	1950
Hummingbird PC X-Server Win NT/95	545	395
Hummingbird Maestro NFS Server - Win NT	195	169

QUANTUM DLT TAPE LIBRARIES	LIST	OURS
160/320GB, 36GB/hr, autoloader, barcodes	n/a	6995
280/560GB, 36GB/hr, autoloader, barcodes	n/a	11495

OTHER HARDWARE	LIST	OURS
HP 8GB External 4mm DAT Tape Drive	1150	925
HP 24GB External 4mm DAT Tape Drive	1550	1195
HP Laserjet 8000N, 24ppm, 16MB, 10/100BT	3279	2895
Mannesman Tally MT-661 800lpm Line Printer	7999	6795
Seagate Cheetah 9.1GB Ext. Ultra Wide SCSI	1495	875
Plextor 32X External CD-ROM Drive	395	255
Young Minds CD-Studio (ntwk CD-writer Sys.)	8339	Call
Digi PortServer II 16-port Terminal Server	2395	1890

100's of other UNIX products available!

Other Platforms: SCO, SUN X86, WIN NT, DEC, SGI, DG

Open Systems EXPRESS!™

Your direct source for UNIX, Win NT & networking products
45 Whitney Road, Suite B8, Mahwah, NJ 07430

Free Shipping! **1-800-445-9292** Fast Delivery!
(call and ask for our free catalog!)

Fax: 201-847-8899 MCV/ISA/AMEX/
E-mail: sales@osexpress.com DISCV/C.O.D./Net.

Circle No. 413

RENT THIS SPACE

Call Carol Flanagan
(508) 839-4016

RENT to OWN

SUN® E450

- 2 x 400MHz Processors
- 512Mb Memory
- PGX 32
- 2 x 18.2Gb Disk
- 32x CD-ROM • Floppy

\$998/mo*

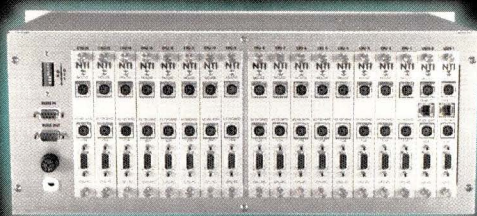
*Lease for 36mo. then it's yours for only \$1.00 - or - purchase for \$28,500.



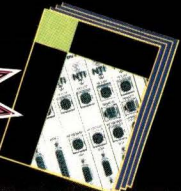
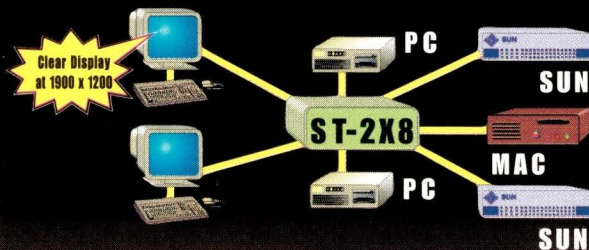
(800) 456-6233
FAX (714) 632-9248
sales@datalease.com

Circle No. 316

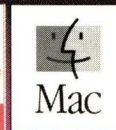
2 USERS CONTROL 8 PC, SUN & MAC COMPUTERS



- Available in sizes up to 8 users and 32 computers.
- Users have independent or shared control of up to 512 computers with optional multiplexor.
- Plug-in modules can be added or changed in the field.
- Supports laptop computers and Intellimouse.
- Smooth and responsive mouse movement.
- All keystrokes are translated across platforms - including Sun and Mac "Power" keys.



NETWORK TECHNOLOGIES INC
 1275 Danner Dr • Aurora, OH 44202
 330-562-7070 • 800-742-8324 • FAX: 330-562-1999
 E-Mail: sales@nti1.com • www.nti1.com



Mac and the Mac logo are trademarks of Apple Computer, Inc., registered in the U.S. and other countries.

Circle No. 366

Discover Solar Systems with hundreds of Suns.

Refurbished Sun Microsystems equipment at great prices. Fully-tested inventory on hand, same-day shipping, satisfaction guaranteed.



- Workstations & Servers
- Upgrades & Parts
- Storage Options
- Rental & Leasing Available
- Cycle 5 Master Reseller
- SunSoft Authorized Reseller



To buy or sell,
1-800-253-5764

Ext. 220

Outside U.S. call 1-425-222-7588 Fax 425-222-7388

<http://www.solarsys.com>



Circle No. 361

AROUND THE CLOCK and AROUND THE WORLD

We're
 Your Company's

Hottest Source For
 Buying, Selling, or
 Trading Sun™ Equipment.

For Over 15 Years...

Results Without The
 Headaches. Guaranteed.

Call today:
 248.528.6565
 Fax: 248.524.1449

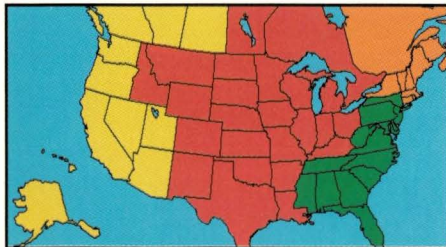
Or for easy ordering ANYTIME...
 Web: www.virtualtechnology.com
 E-mail: virtual@vwnet.com

VIRTUAL TECHNOLOGY
 Computer Products and Services

Circle No. 322

ADVERTISERS' INDEX

The Ad Index is published as a service to our readers.
The publisher does not assume any liability for errors or omissions.



New England/Upstate New York/ Eastern Canada

CAROL A. FLANAGAN
80 Worcester St., Ste. 9
North Grafton, MA 01536
Phone: (508) 839-4016
Fax (508) 839-4226
email: caflanag@aol.com

New York/Mid-Atlantic/ Southeast

JOANNA PARKER
18 Stephanie Drive, Ste. 3
Stirling, NJ 07980
Phone: (908) 542-0789
Fax: (908) 542-0782
email: joanna@cpg.com

Mid-West/Southwest/ Central Canada

LINDA LIEBICH
9600 Great Hills Trail, Ste. 150 W
Austin, TX 78759
Phone: (512) 502-3035
Fax: (512) 502-9988
email: lindal@concentric.net

California/Oregon/Washington/ Western Canada/Nevada/Hawaii/ Utah/Arizona

TARA DUDAS
30 Paseo Alba
San Clemente, CA 92672
Phone: (949) 361-4908
Fax: (949) 361-1564
email: tara@cpg.com

The Server/Workstation Marketplace Classifieds/Recruitment Ads

CAROL FLANAGAN Mgr. Telemarketing Sales
Phone: (508) 839-4016
MARY ERICSON
Phone: (508) 839-0720
80 Worcester St., Ste. 9
North Grafton, MA 01536
Fax: (508) 839-4226
email: caflanag@aol.com

<i>Reader Inquiry Number</i>	<i>page</i>	<i>Reader Inquiry Number</i>	<i>page</i>
439 ..Advantec - ACCI .....	.66	2 .....Lightwave .....	.1
331 ..Ames Sciences .....	.62	450 ..Meridian Leasing .....	.67
15 ....APC .....	.33	17 ....MobileSys .....	.40
442 ..Apcon .....	.63	343 ..National Data .....	.69
.....Aramco Services .....	.64	366 ..Network Technologies .....	.71
340 ..Atlantic Peripherals .....	.65	320 ..Nu Horizon .....	.58
7 .....Bell Microproducts .....	.13	345 ..One Source .....	.68
428 ..Ci Design .....	.67	413 ..Open Systems Express .....	.70
447 ..Clairvoyant .....	.66	13 ....Qualstar .....	.29
362 ..Clearpoint Enterprises .....	.62	6 .....Radiant Resources .....	.23
352 ..Computer Connection .....	.70	9 .....Radware .....	.17
385 ..Comtek Computer Systems ...	.61	10 ....Rave .....	.C4
19 ....Consan .....	.C3	5 .....Redapt .....	.21
20 ....Cycle Computer .....	.7	388 ..Security Computer Sales .....	.61
454 ..Datalease .....	.62	401 ..Security Computer Sales .....	.63
455 ..Datalease .....	.66	438 ..Security Computer Sales .....	.65
316 ..Datalease .....	.70	361 ..Solar Systems .....	.71
4 .....DCG Computer .....	.11	.....Spring Comdex .....	.57
12 ....digitalNation (a Verio Company)	27	.....Spring Internet World .....	.55
394 ..ELI Systems .....	.60	14 ....SunSoft .....	.31
357 ..Evolving Solutions .....	.69	18 ....SunSoft .....	.44
404 ..Express Computer Systems ...	.69	8 .....Tatung Science & Technology ..	.15
372 ..Express Point .....	.68	411 ..Trident Systems .....	.60
421 ..Facet Corp. ....	.67	420 ..Trinicomp .....	.61
402 ..Flagship Technologies .....	.58	375 ..Ultraview .....	.65
346 ..G-2 Systems .....	.58	431 ..Universal Capital Funding ....	.62
353 ..GSH Systems .....	.62	322 ..Virtual Technologies .....	.71
376 ..Gulfcoast Workstation .....	.59	368 ..West Coast Computer Exchange ...	.65
453 ..The Hyde Company .....	.62	324 ..Western Telematic .....	.60
3 .....Integrrix .....	.5	363 ..World Data Products .....	.59
.....Internet Commerce Expo .....	.45	342 ..Worldwide Trade Corporation ..	.68
11 ....IntraServer Technology .....	.20	16 ....XCEL .....	.36
379 ..Kingmax .....	.68	21 ....Xi Graphics .....	.9
1 .....Kingston .....	.C2		

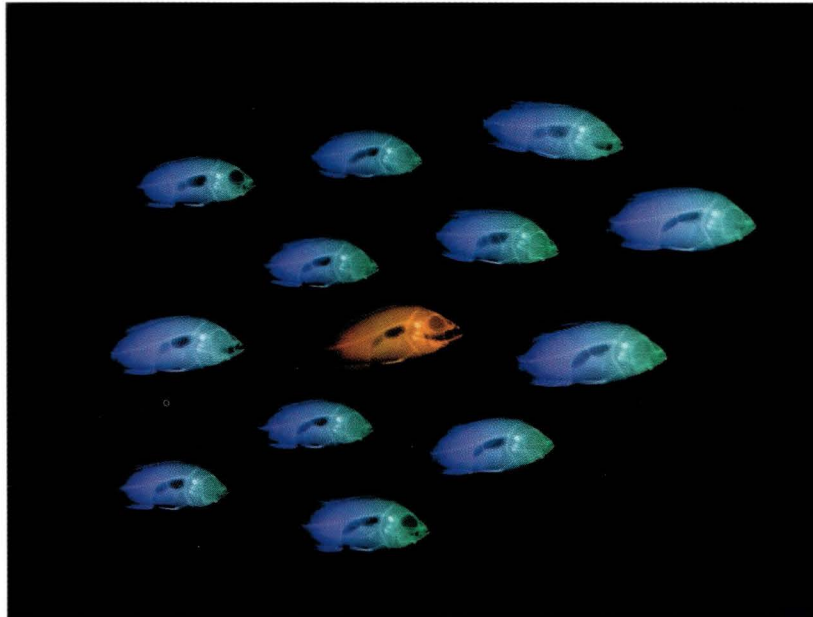
THE LINES

WE CARRY

MAKE

ALL THE

DIFFERENCE.



Individualized Storage Solutions.

Custom Designed To Meet Your Needs.

The Tandberg DLT7000



With up to a 70GB* storage capacity, (at transfer rates up to 36GB per hour), the Tandberg DLT7000 delivers maximum performance for high-end workstations, workgroup servers, and mid-range computer environments.

The Tandberg DLT7000 has full read and write compatibility with all previous DLTape™ products up to the 20/40GB level. This includes drives from other manufacturers—thus securing your investment.

Call a Consan sales tech today for aggressive pricing and put the Tandberg DLT7000 to work for you.

*Assuming 2:1 data compression
DLT, DLTape, and the DLTape logo are trademarks of Quantum Corporation

TANDBERG DATA 

The Amigo Producer 2000



It's all here—a fully automated, single recorder CD-R handling system that offers a compact, economical production system producing on-demand CD-R's in minutes!

The Amigo duplication system includes a prism, thermal full color printer for custom printing directly on your CD's. Plus the Amigo easily connects to Windows 98 or NT, and supports all CD formats.

Now available from Consan, the Amigo Producer 2000 is the tool of choice for true production applications.



R I M A G E™

CONSAN
A **GATESARROW** Company

18750 Lake Drive East
Chanhassen, MN 55317
TEL: 800-229-3475
FAX: 612-949-0453
www.consan.com

1.800.229.3475



Rave Computer Association, Inc.



**Best of both worlds -
Engine by Sun and
Body by Rave**

Rave Systems feature:

- ♦ Original Sun board platforms
- ♦ Original OEM interchangeable components
- ♦ Solaris operating system
- ♦ Certified technical support
- ♦ One year warranty

Additional Rave Services:

- ♦ Private labeling
- ♦ Flexible lease packages
- ♦ Technical support
- ♦ Extended warranty available
- ♦ On-site maintenance services
- ♦ Linux OS available



Rave Computer Association, Inc.

1-800-966-7283

More information about Rave Computer Association and our Rave Systems can be found at: www.rave.net

Fax: (810) 939-7431 E-mail: info@rave.com

Leasing Available. Call 1-800-500-7283



Rave Signature Series Systems feature Sun's latest UltraSPARC™ technology integrated into our multiple chassis options, and we use only quality components to build our systems. Every Rave Signature Series System go through extensive testing prior to shipment.

Our customers know that when they purchase Rave Systems from Rave Computer Association, they're getting quality and reliability inside and out. Call today at **1-800-966-7283** or send an e-mail to info@rave.com

Rave Computer Integrated

Options - featuring integrated Sun boards

- Redundant 4U Rackmount-AXmp**
- Redundant 6U RackMount-AXmp**
- Tower & Rackmount-UltraAXdp**



Sun, Sun Microsystems, and the Sun logo are trademark or registered trademarks of Sun Microsystems, Inc., in the United States or other countries. All other trademarks are the property of their respective companies. All SPARC trademarks are used under license and are trademarks or registered trademarks of SPARC International, Inc. in the United States and other countries. Products bearing SPARC trademarks are based upon an architecture developed by Sun Microsystems, Inc. All other products or service names mentioned herein are trademarks of their respective owners.