

What's in storage for you?

BY DAVIS D. JANOWSKI AND KAREN J. BANNAN

"SERVER01 EXTREMELY LOW ON DISK space!" Administrators cringe when these words pop up on the screen. Perhaps they already knew they were running out of storage, but the formidable task of upgrading has been enough to keep them from doing anything about it. In order to get that extra storage capacity, the server has to be shut down—kicking off employees or customers. In a 24-hour world, where downtime means lost productivity or business, that's unacceptable.

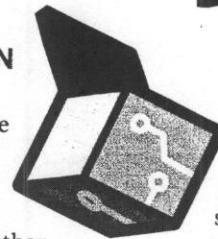
For this reason, smarter companies anticipate their storage needs well, and that often means overbuying on equipment now to avoid interruptions later as the business grows. That attitude—and the increasing storage appetite of corporate networks and Web servers—has led to a boom in the data storage market. Sales of storage disk systems will climb from \$39 billion this year to \$53 billion in 2004, according to market research firm IDC.

So what's in storage for you? That question means different things to different people. Any chief corporate officer probably views storage as the

essential repository of the company's precious data—the lifeblood of daily business and the catalyst for new business strategies. On the other hand, from an IT manager's point of view, storage can be an enormous burden—a complex maze of network architecture, technologies, and devices to navigate through.

Network storage vocabulary has been all but dominated by two acronyms: NAS and SAN. The first refers to *network-attached storage*, the second to *storage area network*. NAS represents a device or cluster of devices, dedicated to storage, residing on a LAN. SANs, on the other hand, rely on separate Ethernet or Fibre channel-based equipment that communicates with the LAN.

SANs, which are much more complex and expensive than NAS solutions, essentially constitute a second network. They offer several advantages: SANs let you store and retrieve data without encountering gridlock, assign storage space easily, and scale storage resources when necessary. They also greatly relieve the LAN of storage-related traffic.



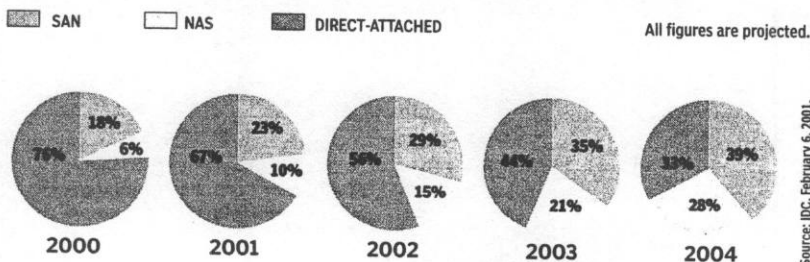
SANs rely on Fibre Channel network connections, which can move data at speeds as high as a gigabit per second to storage devices that may be located several miles away.

According to IDC, NAS and SAN together will claim two-thirds of the storage market within three years, twice their share today. The Storage Networking Industry Association (SNIA) was founded in 1997 to support the intelligent development of the storage industry and to develop means of interoperability. Similarly, the Infiniband trade association has brought together network and computer giants such as Cisco, Compaq, 3Com, and over 200 other companies to shape standards and formulate a new approach to network architecture.

On the following pages, we explore the storage options available today. We also look at outsourced storage, an option for businesses that may prefer not to deal with storage technology and management requirements internally. PC Magazine Labs has tested the features and storage performance of an inexpensive server appliance and two midrange NAS devices. We also reviewed a high-end device that can serve as a NAS or SAN device.

STORAGE SYSTEMS MARKET FORECAST

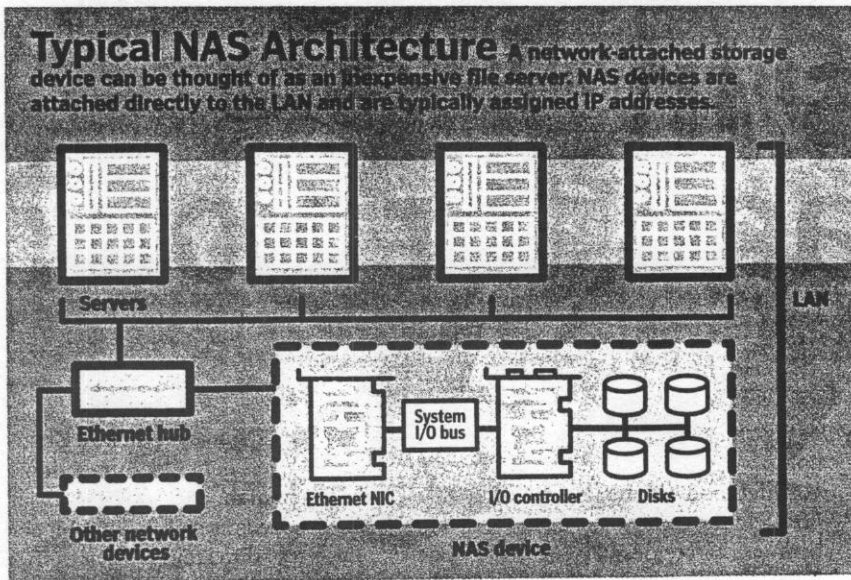
The numbers below reflect IDC's preliminary 2000 Storage Disk Systems Market Forecast, which will be published later this year. IDC is forecasting that SAN and NAS storage will represent 67 percent of storage disk systems sold in 2004, versus 24 percent of those sold in 2000.



Reviewed in This Story

We examined four levels of storage for business, ranging from \$1,495 to over \$100,000.

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The Server Appliance Option

Server appliances are at the lowest end of the spectrum of NAS devices. Unlike the other storage solutions in this story, server appliances aren't dedicated add-on storage devices. They provide a place for storage on a network, but they're relatively inexpensive—most server appliances cost less than \$2,000—because they lack redundant hardware and high-performance components. If high reliability or big-time performance is crucial to your business (and you're willing to pay for it), you should seek a higher class of NAS. But because server appliances assume a host of other network duties and are fairly easy to install and manage, they make an excellent choice for smaller businesses and remote offices with limited IT resources.

Server appliances are equipped to take on many duties in a workgroup environment. Typical services include network address translation (NAT), proxy, DHCP, e-mail, Web servers, DNS, firewall, and VPNs. In short, appliances provide almost anything a small business or remote office needs to get a small network with Internet connectivity up and running. Products in this market include offerings from Cobalt, Compaq, Extended Systems, and Sun-Rebel.com. (For more on these products, see "Ready, Set, Server" in the *PC Magazine* issue of December 15, 2000.)

ESOFT INSTAGATE EX

We tested the eSoft InstaGate EX server appliance as a representative of this class of device. In terms of hardware, the Insta-

Gate (ranging from \$799 direct for 25 users to \$2,199 for 250 users), like most other server appliances, is essentially a PC (500-MHz Intel Celeron processor, 64MB of RAM, 10.2GB hard drive, dual Ethernet NICs) in a custom case running the Linux operating system. The InstaGate uses Linux's built-in network services to provide the network features summarized above, as well as the Linux Samba freeware to simulate a Windows NT file server. In addition to SMB (Session Message Block) networking, the InstaGate supports AppleTalk and NFS clients.

Installing the InstaGate is a straightforward task. We got our test unit configured and serving files to Windows 2000 and Windows 98 network clients in 45 minutes. eSoft provides an auto-discovery utility, followed by a configuration wizard. Once the box is accessible over the network, it can be administered through the InstaGate's excellent browser-based menus. Although suitable for most small-office needs, the InstaGate was significantly slower than our Dell workgroup-class PC server. (eSoft Inc., Broomfield, CO; 888-903-7638; www.esoft.com.)—Russ Iwanchuk

Workgroup NAS

Any e-mail administrator can empathize with Paul Shane, a senior network administrator with Milliman & Robertson Inc., a Seattle-based actuarial consulting firm. Shane, who works in the company's Radnor, Pennsylvania, office, faced a serious dilemma. All of the over 120 employees at his location use their Lotus Notes data-

base as a virtual paper trail, providing them immediate access to a blow-by-blow account of their projects and progress. This dependence caused the Notes database to grow exponentially, reaching more than 600MB of storage per user.

"Our whole business revolves around Lotus Notes, so we can't just archive things away or ask our users to delete files," Shane says. "We needed to find more space." But Shane was reluctant to increase disk space; even though his current array would have been costly and would have meant downtime for the company's staff while he configured the array. In October, though, Shane found an inexpensive option that offered the space and flexibility he needed: the Quantum Snap Server 4100.

Shane chose a product that, broadly defined, is called *network-attached storage* (NAS). The workgroup level of NAS is most suited to small and medium-size companies whose storage needs are comparatively small, ranging from a few hundred gigabytes to a terabyte. Enterprises running e-commerce software or big databases need several terabytes of storage, and they use what's called midrange NAS.

Typically, as you scale upward from workgroup to midrange NAS, you will find hot-swappable drives and cabinets that can accommodate additional drives as well as more failover options, enhanced management features, and a general increase in system complexity.

QUANTUM SNAP SERVER 4100

For small companies that want to increase storage capacity without reconfiguring existing production servers or adding new ones, the Quantum Snap Server 4100 (\$4,499 list) is a good option. A simple installation procedure, RAID support, competitive pricing, and browser-based management make this unit attractive for shops that lack in-depth IT expertise.

We had our IU, rack-mountable test device up and running in just a few minutes after plugging in the power cable and connecting the device to our test network via the integrated 10/100-Mbps Ethernet

Our contributors: Les Freed is a contributing editor of *PC Magazine*. Rob Schenk is a frequent contributor. Karen J. Bannan, Logan G. Harbaugh, and Russ Iwanchuk are freelance writers. Associate editor Davis D. Janowski and PC Magazine Labs technical director Matthew D. Sarrel were in charge of this story.

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port. Configuration was easy using the bundled CD that contains the software and a setup wizard. The device defaults to DHCP (or you must enter a static IP address), and it supports AppleTalk, IPX, NetBEUI, and TCP/IP network protocols.

The Snap Server 4100 comes in two configurations, providing either 120GB or 240GB of storage. Inside the unit you'll find either four 30GB or four 60GB IDE hard drives, depending on which configuration you buy, and both support RAID levels 0, 1, and 5.

If the Snap Server 4100 experiences a hard drive failure, though, the unit must be powered down and opened to replace the failed drive. We'd prefer a hot-swappable hard-drive option and a SCSI option for those who require a

high level of availability. The Snap Server 4100 lagged behind the Dell workgroup file server tested for comparison at PC Labs.

Security levels for local users and groups can be assigned, and the Snap Server 4100 supports security permissions down to the file and directory levels. It also integrates with Apple, HTTP, Microsoft Windows NT, NFS servers, and NetWare domains using pass-through authentication. We were able to import several users and groups from our existing Windows 2000 domain.

During the installation at Milliman & Robertson, Shane found the procedure to be simple. "We never had to take anything down," he said, "and users instantly had access to everything on the new ser-

er as if it were a directory on the existing Notes server."

Administrators can assign and manage disk quotas down to the individual-user level. Web services can be enabled, allowing users to access shared folders on the Snap Server 4100 via a browser. (Quantum Inc., Milpitas, CA; 888-343-7627; www.quantum.com.)—Rob Schenk and Karen J. Bannan

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BENCHMARK TESTS

Network Storage



If you need speed in a workgroup server, go with a traditional PC server. But in the mid-range and high-end server market, network-attached storage pulls ahead.

We used our NetBench 6.0 Standard Disk Mix, which measures throughput and average response time, to test three of the storage solutions in this story. We compared the performance of the eSoft InstaGate EX (a server appliance) and the Quantum Snap Server 4100 (a NAS device) against a traditional workgroup server: a single-processor, single-drive Dell PowerEdge 2450. We then upgraded the PowerEdge with an extra processor, more memory, and RAID 5 storage and compared its perfor-

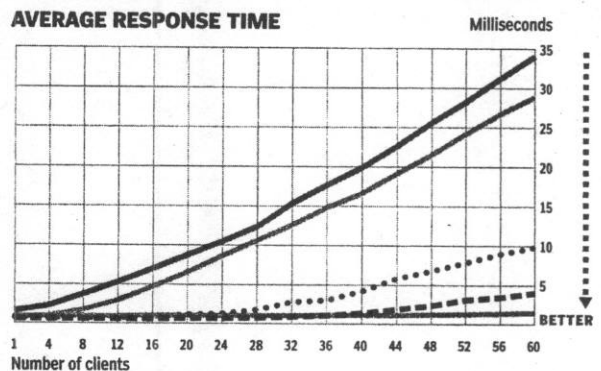
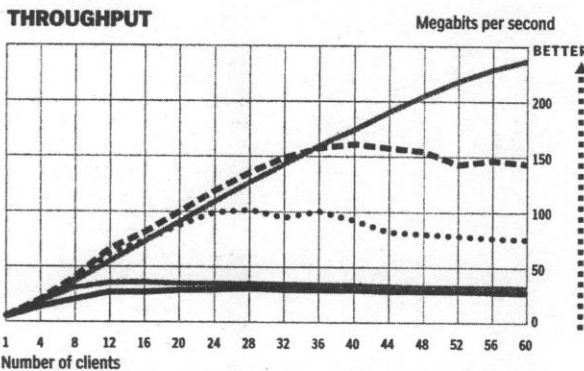
mance against that of the Compaq TaskSmart N2400 (a midrange NAS device).

The workgroup NAS market is driven by price and ease of implementation, not speed, and our benchmark tests bore out the fact that performance is not ready to be a selling point. As we scaled up the number of clients, the Dell server's throughput was roughly three times that of the InstaGate and the Snap Server.

The TaskSmart N2400 ran neck and neck with our beefed-up PowerEdge up to 36 clients. After that point, the TaskSmart N2400 flexed its muscles and pulled away. To see how far the TaskSmart N2400 could go, we added 60 more clients to our original 60-client test-bed. It easily handled 80 clients, and the average response time and throughput were still reasonable at 120 clients.—Analysis written by Matthew D. Sarrel

WORKGROUP SOLUTIONS:
 ●●● (single processor) **Dell PowerEdge 2450**
 — (single processor) **eSoft InstaGate EX**
 — (dual processors) **Quantum Snap Server 4100**

MIDRANGE SOLUTIONS:
 — (single processor) **Compaq TaskSmart N2400**
 — (dual processors) **Dell PowerEdge 2450**
TESTED FOR COMPARISON



The Compaq TaskSmart N2400 NAS device showed no signs of letting up at 60 clients. Performance on the eSoft and Quantum workgroup solutions began to decrease by the time they reached simultaneous clients.

Response time is the period the client spends waiting for the server to acknowledge a request. The workgroup solutions had slower response times than the midrange solutions.



Midrange NAS

It took a disaster for Darrell Starnes to upgrade his company's storage. Starnes is the director of systems infrastructure at the Houston-based e-tailer Ashford.com.

The upscale online retailer produces its own high-end photographs for its Web catalog and stores all of the images in a database. During a redesign of the site last summer, so many JPEG images were created that Starnes was adding a new disk drive to his Compaq servers every few weeks. Around the same time, the company was hit by the I Love You virus, which wiped out all of the catalog's most recent photographs and image files.

"We decided we needed network-attached storage so we could grow our network, but also so we could constantly back up our database and do a restore very quickly if we had to," Starnes says. He evaluated Compaq, EMC, and Network Appliance products. But during discussions with Compaq, he mentioned that he really wanted to reuse his old hard drives in a new network-attached configuration. Compaq was beginning beta testing of the new Compaq TaskSmart N2400, and Starnes was invited to participate.

He was able to combine his two servers—one that stored his site's images and one for more general use, which included the appliance and an additional 500GB, giving him a total capacity of 1 terabyte. All told, this solution cost \$40,000. Starnes says reusing all of the storage he already had saved him over \$70,000.

Migrating to the new appliance was simple. Starnes copied all of the data live using a Microsoft tool called Robocopy. As the last step, he had to take the servers down for less than an hour to finish the installation. Since he was already running Windows NT, he was able to transfer all of his company's data and security information including permissions.

Starnes feels prepared, thanks to the ease with which he can take snapshots of his data throughout the day and immediately roll the servers back. "If a virus ever hits us again we can be back to where we were in about five seconds," Starnes says.

The NAS solutions we're calling midrange offer better scalability and reliability and provide similar benefits as the lower classes of NAS, such as convenient, dedicated storage and easy installation and administration. These NAS units take a significant upward leap in cost (up to \$20,000 and above) when compared with server appliances (\$1,500 to \$2,500) or workgroup-level NAS (\$3,000 to \$10,000). Players in the midrange include the Compaq TaskSmart N2400 (which we reviewed), Network Appliance's lower-end models, and the Procom NetForce offerings.

COMPAQ TASKSMART N2400

The computer giant has brought its server expertise to bear with the Compaq TaskSmart N2400 (\$34,711 direct). This device is essentially a Compaq server running a version of Microsoft Windows 2000 optimized for file sharing and modified to ease

administration. We got our test unit up and running in about 30 minutes.

The system consists of a ProLiant server unit outfitted with dual 733-MHz Pentium III processors and 1GB of ECC SDRAM, paired with a StorageWorks disk enclosure. Both hardware components are available separately from Compaq. The server itself may contain up to four hot-swappable 18.2GB Ultra3 SCSI disks, for a total of 72GB of raw storage capacity. These components are rack-mountable, and the server and enclosure together stand at 6U (unit). The configuration we tested had a single disk enclosure fully populated with 14 disks, for a raw capacity of 252GB. The maximum capacity of the system, configured with four disk enclosures fully populated with 36.4GB disks, is 2TB. The disks connect back to the server via a four-channel Compaq SmartArray 4200 disk controller.

Beyond using RAID in the disk subsystem to provide data reliability, the server itself is well outfitted for high availability. The OS is run from two additional hot-swappable, mirrored 18.2GB drives in the server unit, each with its own fan and power supply. The 4-port NIC, when configured for network teaming, provides fault tolerance and load balancing. The TaskSmart N2400 proved highly scalable and easily outpaced a comparable Dell file server on the benchmark tests. (Compaq Computer Corp., Houston; 800-345-1518; www.compaq.com.)—KJB and RI

How they stack up

ESOPT INSTAGATE EX

Price: 25 users, \$799 direct; 250 users, \$2,199.

Storage capacity: 10.2GB (single ATA drive).

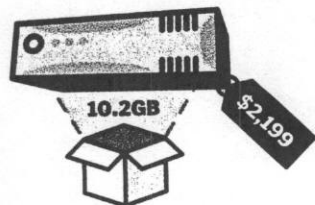
RAID levels supported: None.

Network connection: Dual Ethernet (auto-sensing 10/100-Mbps), 2 DB-9 RS-232 serial ports.

Network protocols: TCP/IP.

Application protocols: AFP, HTTP, LDAP, SMB.

Dimensions: 3.5 x 12.2 x 11.8 inches, 10.8 lbs.



QUANTUM SNAP SERVER 4100

Price: 120GB, \$2,999 list; 240GB, \$4,499.

Storage capacity: 240GB.

Hard drives: 4 30GB or 60GB 7,200-rpm SCSI drives.

RAID levels supported: RAID 0, RAID 1, RAID 5.

Network connection: Auto-sensing 10/100-Mbps.

Network protocols: AppleTalk, IPX, NetBEUI, TCP/IP.

Application protocols: AFP, HTTP, NCP, NFS, SMB.

Dimensions: 1U; 1.8 x 17 x 17 inches, 19.6 lbs.



COMPAQ TASKSMART N2400

Price: 252GB (tested configuration), \$34,711 direct; 2TB, \$125,000.

Storage capacity: 72GB to 2TB of raw storage.

Hard drives: 18.2GB or 36.4GB Wide Ultra3 SCSI 10,000-rpm drive.

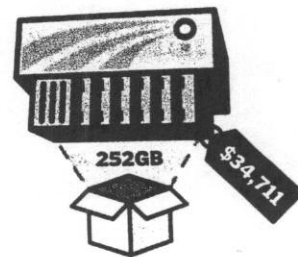
RAID levels supported: RAID 0, RAID 1, RAID 5.

Network connection: 4-port auto-sensing 10/100-Mbps.

Network protocols: AppleTalk, IPX/SPX, TCP/IP.

Application protocols: CIFS, FTP, HTTP, NFS.

Dimensions: 6U; 5.2 x 17.6 x 19.9 inches, 89 lbs.



Enterprise Storage

Digital music is a hard drive hog. So it should come as no surprise that the reason Mike Streb, senior director of technology architecture at record label Warner Elektra Atlantic (WEA), needed to upgrade his company's storage is because there was simply too much music being saved to disk.

WEA is currently digitizing its entire music catalog and storing it for future electronic sales. Although the company's previous storage option—a combination of the Sun Microsystems StorEdge A5000 and A3500 direct-attached storage arrays—was meeting the company's current needs, Streb knew that the digitized music would eventually fill several terabytes of space.

"We're trying to get all our music available for sale, and we knew it was going to take multiple servers and applications to do this," says Streb. "We also wanted something that would let us back up our data quickly and easily."

Last fall, Streb decided to implement 6 EMC Clariion FC4500 storage systems. Since then he has added 6 more FC4500s, bringing the total to 12 systems with a combined capacity of 25TB. Initially, adding the \$2 million system took about three days of working with EMC engineers.

INSIDE HEAVYWEIGHT NAS STORAGE

EMC defines the Clariion line as "midrange" information storage, but for the purposes of this story we're placing it at the higher end of the spectrum. EMC's modesty, however, is an indication of the scale such products can reach in terms of both storage capacity and price.

At this storage-device level, it's critical that systems be very scalable, as well as highly available and redundant. Also, these devices must offer high-end server performance, flexible management, and the ability to interface with heterogeneous network platforms.

EMC CLARIION FC 4500 AND FC/IP 4700

We reviewed the EMC Clariion FC4500 (tested configuration, \$93,400 direct), a fully self-contained rack unit providing Fibre Channel-based disk storage. The solution comes in two rack sizes: a full 39U locking cabinet and a 20U desksize cabinet chassis. We reviewed the 39U rack solution, which came configured with 30 18GB, 10,000-rpm Quantum hot-swappable hard drives. Its chassis supports a total of ten disk enclosures, each capable of housing as many as ten hard drives that provide as much as 7.3TB of storage capacity in the chassis.

EMC released its fifth generation of the Clariion line (the 4700 series) in January. The company refers to the IP4700/FC4700 as "the industry's first multi-personality SAN/NAS storage solution." Because of the system's "chameleon-like" architecture, customers can deploy the same Clariion 4700 system in a NAS configuration (IP4700) or as a SAN component (FC4700). The NAS implementation can be accomplished by swapping out the storage processors and adding a gigabit Ethernet interface card.

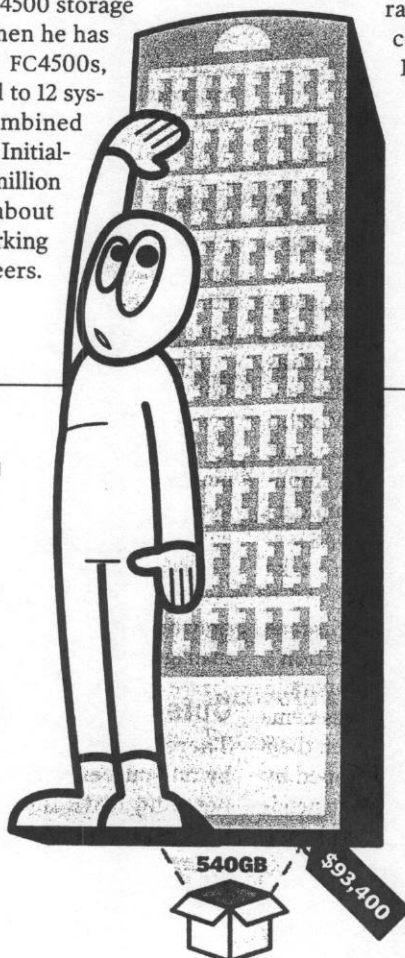
In other ways, the 4700 remains very similar to its predecessors, although it offers new high-performance multi-CPU storage processors, 2GB of high-speed cache memory, four front-end and four back-end Fibre Channel connections, and redundant paths from each storage processor.

What sets the EMC product apart from others is the high level of service and support offered, along with the strong heterogeneous networking capabilities of the Clariion management software suite. EMC's standard two-year warranty provides for mission-critical support, including a guarantee of 2-hour turn-around time.

EMC could improve its offering by integrating a backup solution; currently the company suggests several third-party applications, such as Legato NetWorker and Veritas NetBackup, as well as several tape libraries and tape drives compatible with the Clariion arrays, though EMC makes no specific recommendations.

A comprehensive management framework called Navisphere Manager allows a customer to monitor and configure the Clariion system. We highly recommend that companies take advantage of the installation and planning assistance that EMC provides rather than attempt to do the task on their own.

CLARAlert software monitors the system and immediately contacts the EMC data center if a hardware problem presents itself. When specific error thresholds are surpassed, CLARAlert initiates contact with the EMC monitoring center. Once a problem call has been logged, EMC technicians also have the option to dial in to the FC4500 to perform troubleshooting tasks remotely. (EMC Corp., Hopkinton, MA; 508-435-1000; www.emc.com.)—KJB and RS



EMC CLARIION FC4500

Price: With 30 18GB hard drives (tested configuration), \$93,400 direct; with 100 18GB drives, \$250,000.

Storage capacity: Up to 7.3TB.

Hard drives: Up to 100 18GB, 36GB, or 73GB; 10,000 or 15,000 rpm.

RAID levels supported: RAID 0, RAID 1, RAID 1/0, RAID 3, RAID 5.

Front-end (host) connectivity: Two storage processors, each with two GBIC

connections into one 100-Mbps Fibre Channel arbitrated loop; two optical GBICs supplied per storage processor.

Back-end (disk) connectivity: One 100-Mbps logical Fibre Channel arbitrated loop connection per storage processor.

Management software: CLARAlert (remote-monitoring software), EMC Access Logix, Navisphere Manager.

Dimensions: 39U; 75.3 x 25.5 x 34.2 inches; 296 lbs. (empty cabinet). Also comes in a desksize 20U chassis.

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Storage Area Networks

Using a computer to edit videos seems to make anything possible for a talented film director. Consider the computer-generated effects in such recent movies as *Toy Story* and *Forrest Gump*. But non-linear video-editing workstations must access and process enormous files at very high data throughput rates—rates that will quickly bog down a server, even one using a NAS device. That's why the video market was one of the original adopters of storage area networks (SANs).

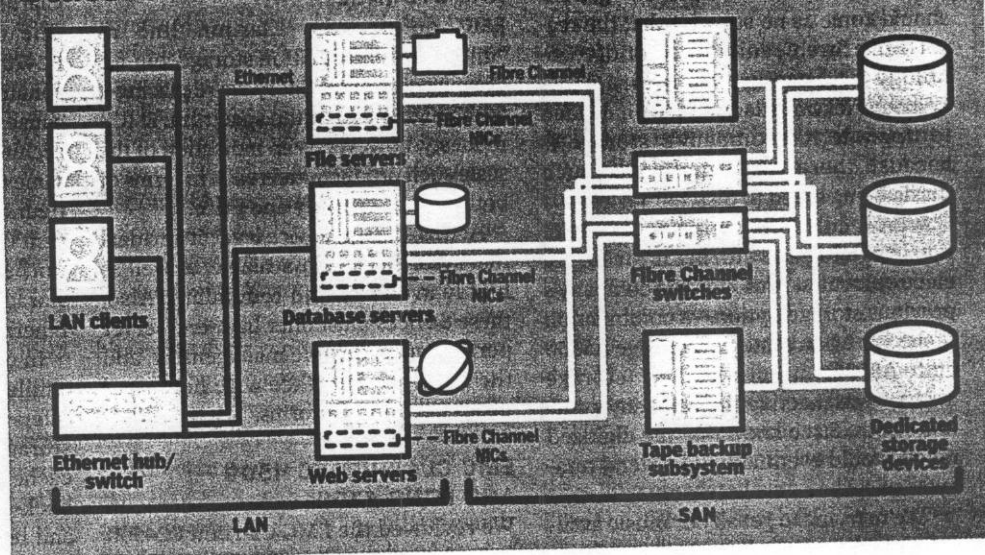
A SAN is a dedicated network of storage-related devices such as hard drives, RAID arrays, and tape backups. SANs are often considered the next step in storage after NAS, although the two are not mutually exclusive. SANs may even include NAS devices.

The most common distinction between a SAN and NAS is that a SAN offers block-level access to data, whereas NAS offers file-level access. Devices on a SAN write directly to the network's storage resources as if they were internal drives.

NAS and SAN connections also differ in that NAS devices are typically connected to an Ethernet network, whereas SANs usually use Fibre Channel connections in a hub-based or switched network. Fibre Channel provides 1-gigabit-per-second (1-Gbps) throughput, or even 2 Gbps with the latest version. Although gigabit Ethernet theoretically has a similar throughput, very few servers can actually achieve this throughput rate because of inefficiencies in the network protocol stacks and Ethernet's reliance on Carrier Sense Multiple Access/Collision Detection (CSMA/CD). Fibre Channel does not have these limitations, because it treats servers more like hard disks than like separate network-connected devices.

SANs often manage anywhere from hundreds of gigabytes to terabytes of data, and they permit effective utilization of servers' hard drive space. In the old storage architectures, hundreds of gigabytes of storage were spread across dozens of servers. A few servers would run out of space, while others ran at far below their capacities. SANs, however, have the ability to allocate storage to different servers on an as-needed basis, and

State-of-the-Art Redundant, Highly Available SAN



they can even move allocated storage that isn't in use to another server that's running low on available storage space.

SANs also allow LAN-free, serverless backup. In professional video editing, rendering software might take several days to process very large files, and backups can't interrupt the file editing process. A SAN allows data to be archived directly from the storage device to the backup system in real time, as the processing is under way, without affecting network traffic or requiring files to be closed. This would not be possible with server-based storage.

One downside of the current generation of SANs is that they're typically homogeneous, requiring that all the pieces come from a single vendor such as Compaq, Dell, EMC, or IBM. But this limitation is beginning to change. Vixel, a manufacturer of Fibre Channel hubs and switches, worked with Network Appliance to create a multivendor backup/data protection certification so that NAS systems can use SAN technology to take advantage of serverless backups.

At the recent opening of the Storage Networking Industry Association's (SNIA's) Technology Center in Colorado Springs, Colorado, four companies demonstrated interoperability between their devices, using standards developed by the SNIA. The standards, which are pending approval from all the participating manufacturers, should be finished by June. This will go a long way toward making Fibre Channel SANs as easy to set up and configure as Ethernet networks.

Some manufacturers are beginning to blur the lines between NAS and SAN. Procom Technology has released the NetForce 3100HA, a scalable, high-availability NAS device with an initial capacity of more than 4TB. The NetForce 3100HA supports up to 60 36GB or 73GB hot-swappable drives, and it features redundant cooling fans and RAID controllers, as well as a 10/100/1000 Ethernet connection. The device supports Windows, NFS, and the Network Data Management protocol for LAN-free backups. The EMC Clariion FC4700 is a Fibre Channel version of the company's otherwise identical Ethernet-based IP4700, and either device can be converted into the other.

The migration of such SAN features as storage management and serverless backups to NAS is promising for the future of NAS. And as interoperability and multiple-operating-system support issues are tackled, SANs may begin to approach the ease of installation offered by NAS devices. The two technologies will likely continue to coexist happily, which can only be good news for storage-weary IT managers.—Logan G. Harbaugh

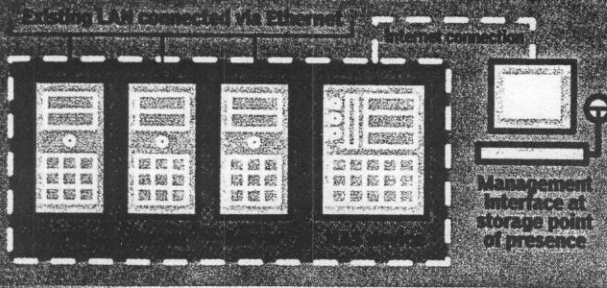
Outsourced Network Storage

There is a persistent theme put forth by outsourcers: Focus on what you do best and leave the rest to us. Lately, this mantra has been adopted by a new group of companies that call themselves *storage service providers* (SSPs). Unlike many other types of technology outsourcing firms, though, SSPs tend to set

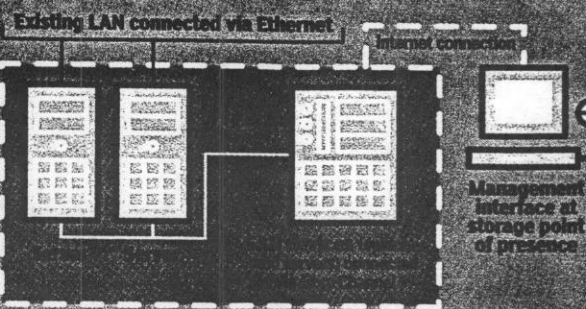


Outsourced Storage: A Range of Scenarios

NAS device maintained at the customer site and managed elsewhere



SAN Implementation maintained at the customer site and managed elsewhere



Off-site SAN Implementation



up shop at your site, not theirs.

The products we reviewed offer an array of solutions for storage needs, but not every organization has the resources—time, capital, and personnel—required to implement them.

Storage outsourcing is a relatively new concept, but big-name companies are already vying for customers. Compaq, EDS, IBM, and StorageNetworks all offer on-site and in some cases off-site managed storage services. SSPs use the same hardware and software a business would buy to create its own storage solution, but they also handle the installation, ongoing maintenance, and management of the storage servers. Pricing varies, based on the performance and reliability required.

One of the most attractive features of outsourced storage is its scalability. Companies that handle their own storage must constantly reassess their storage needs: Buy too little and you're likely to run into a crunch; buy too much and you've wasted money on empty disks. With outsourced storage, you pay for the gigabytes you use.

SSPs install the equipment, lease the communications links, do the maintenance, and perform all the administrative/management tasks. SSPs typically

offer complete turnkey services including design, deployment, and migration of your existing files, as well as several types of service-level agreements (SLAs) that guarantee performance and availability.

The storage servers may be located on the customer's premises, or they may be off-site in a secure facility in which they are co-located with equipment owned by major Internet or telecommunications service providers. The servers are connected back to the customer via a leased connection, usually a dedicated fiberoptic cable. Off-site storage provides physical security, fire protection, redundant communications links, and an emergency backup power supply.

One company that's using outsourced storage is Upromise, an Internet startup based in Brookline, Massachusetts, that helps parents fund their children's college costs. The 140-employee company wanted to minimize its overhead, and outsourcing its network storage seemed to be one way to achieve that goal.

"We outsource what makes sense, and retain the parts we need," says Rich O'Neal, Upromise's technical operations manager.

Upromise recently signed up with StorageNetworks, and O'Neal says that

the installation was painless and the system has worked flawlessly. He is confident that by outsourcing to StorageNetworks, Upromise will be able to keep up with any increase in storage needs. "We liked that we could increase capacity on short notice," he says.

Like other SSPs, StorageNetworks offers several levels of outsourced storage. The DataPACS service uses Fibre Channel-linked SANs that connect to one or more of a company's file or application servers. For those who don't need the performance offered by DataPACS, StorageNetworks offers a similar service called NetPACS, which uses NAS servers that connect to the company's servers via an IP network.

On a much smaller scale, several companies, including Driveway Corp. and Xdrive Technologies, offer Internet-based services that store files on their servers. Customers can access this data by using a Web browser or a small piece of software that maps the Internet drive to a logical drive on a user's PC. Access speed depends on the speed of the customer's Internet connection, but these services are inexpensive or even free for personal use. (For details on free Internet-based storage services, see "Internet Hard Drives" in our issue of April 18, 2000.)—Les Freed ■