Server	Company	Price	No. of E'net segments supported	Max diskless workstations/ E'net segment	Types of storage	Storage Model	Max disk
Array Disk Subsystem	Array Technology (subsystem only)	$40,000 - $100,000	N/A	N/A	5.25-inch SCSI Winchester	RAID-5	1
NS 5000	Auspex Systems	$115,000 - $262,000	1-8	30	5.25-in SCSI Winchester. 8 mm, .5-in, .25-in tape	RAID-5	19 Gb
Epoch-1	Epoch Systems	$95,000 - $450,000	1 -2	30	1200 Mb optical 5.25-in SCSI Winchester 8 mm tape	Hierarch -ical	982 Gb
Omni300 avail 12/89	Omni Solutions	$16k-$25k	1-4	30	All SCSI, ESDI SMD. All existing tapes	Standard and RAID	≤8 drive
Omni600 avail 2/90		$20k-$35k	2-4	30			≤16 drv
Omni1000 avail 6/90		$40k-$100k	2-12	30	Unknown	RAID	≤64 drv
Workgroup	Solbourne Computer	$33k-$108k	1	10	5.25-in SCSI Winchester 8 mm, .5-in, .25-in tape	Standard	2.6 Gb
Department Server		$42k-$147k	1-2				
Network Server		$54k-$333k		30	8-in SMD & above tape		13.3 Gb
Concept 51	Storage Concepts (Subsystem only)	$22,000- $520,000	N/A	N/A	5.25-in ESDI Winchester	RAID-3	56 Gb
Sun-3/470	Sun Microsystems	≥$58,900	1	10	8-in SMD, 9-in ESMD, 5.25-in SCSI Winchester. 8 mm, .5-in, .25-in tape	Standard	5.3
Sun-3/480		≥$66,900	2	15			14.4 Gb
Sparcserver 330		≥$28,900	1	5			1.3 Gb
Sparcserver 370		≥$61,900	2	20			5.5 Gb
Sparcserver 390		≥$71,900	2	30	8-in IPI Winchester 8 mm, .5-in, .25-in tape		32 Gb

Above, a quick comparison of industry server

1993 sales expected to top $5 billion...

The NFS server market is exploding

by Brad Harrison

As a class of storage devices, the new crop of NFS servers being introduced by a number of start-up companies is finding its initial market acceptance in the Sun environment, but will soon be implemented across the industry.

Built to satisfy the workstation's seemingly insatiable appetite for disk space and short data-access times, these servers represent architectural breakthroughs and, as a bonus, are proving a close fit with corporate data-management plans.

NFS servers are supplying a market that Dataquest, a Silicon Valley market research firm, estimates will be worth nearly $5 billion per year by 1993 (see Figure 1 on page 18). Aiming to share this immense pie with Sun, DEC and Hewlett-Packard/Apollo, a handful of newcomers has enlisted some of the strongest and best-known technical and management talent in the industry, including many people from Sun.

The start-up companies are building servers that aren't simply repackaged computers with a lot of storage — which is how they characterize the standard server product from the big companies — but a full new breed of product, featuring features designed explicitly to deal with management of programs and data.

Continued on page 1

NFS...

Continued from page 16

Third-party triumph

According to some industry sources, the start-up companies are destined to do better, at least in the short term, than the big companies, perhaps setting the stage for the next huge entrepreneurial computer success story.

"Sun doesn't currently have the people who can design a product to compete with the Auspex server," said Phil Devin, a senior analyst at Dataquest who specializes in data storage technology.

The Auspex NFS server, introduced in October by Auspex Systems of Santa Clara, Calif., is the highest-performance product to date, supporting up to 10 times the number of diskless workstations as a conventional server.

In addition, it appears that Sun is planning to step aside for at least one third-party company. "They're allowing us to coexist," said Jay Woodruff, marketing communications manager at Epoch Systems, a Marlboro, Mass., start-up company that introduced an innovative hierarchical-storage NFS-server system late last year. "We're not expecting a direct challenge from Sun."

It is also interesting to note that Dr. Ron Cornell, former vice president of storage systems development at Sun, left the company to pursue his own direction in the Sun market. His company, Omni Solutions of Mountain View, Calif., will introduce its first product this month, the Omni300. The product, engineered by some of the same talent that brought us a variety of Sun hardware and software, fits into existing Sun servers to increase performance by a factor of 3 to 10.

It seems likely that Sun will soon be incorporating Omni products into its server line. However, analysts and marketing personnel are expecting a Sun announcement within the next two months that will be a strong indication of both the server technology and marketing direction the company will take over the next few years.

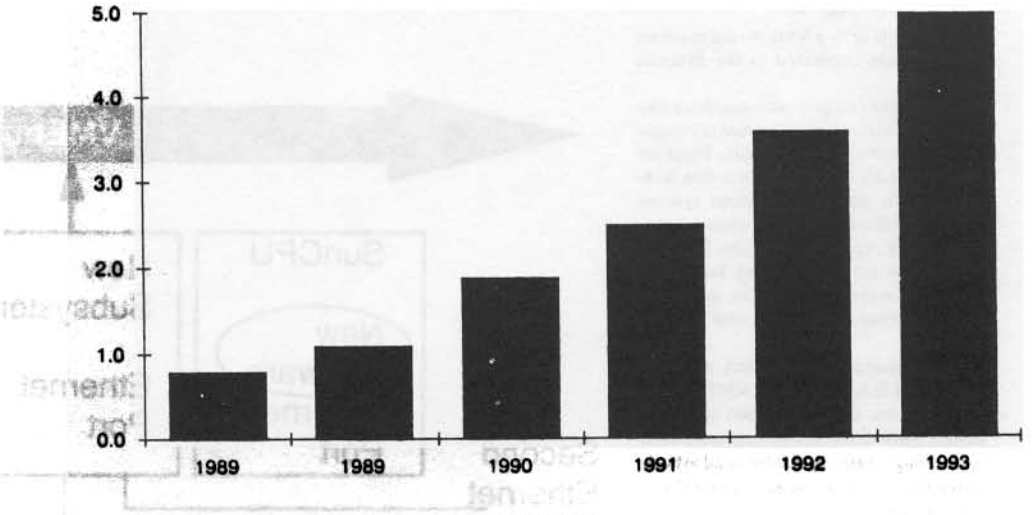

Figure 1

More than just servers

The rapid growth expected in the server market is due as much to the need for high-capacity, high- performance network data storage and retrieval as it is to management's keen interest in the products.

"Servers are going to provide the glue that unites the end-user and corporate computing environments," said Kathleen Hurley, a data systems analyst at Dataquest. "They will for the first time permit the true sharing of resources between both levels and allow upper management the tight control it's been looking for."

The trend puts Sun and Sun customers in an important position. Sun installations have developed large, distributed databases of shared programs and data that server manufacturers want to centralize and that corporate computer personnel want to connect to. Add to this the fact that de facto standard NFS is being adopted industry wide, and it becomes clear that Sun "islands" will not only provide much of the centralized data and storage, but the means of sharing it as well.

The Dataquest projections are for the technical workstation market only, but substantial growth is expected for servers in all areas of the industry.

NetFrame Systems of Sunnyvale, Calif., is the best- known start-up company initially aiming to sell its high- performance servers to financial and other departments where the PC reigns supreme.

But NetFrame intends to work its way into the NFS market as well. "We'll be nouncing support for NFS in the late sp of next year, based on Novell's NetW '386 product," said Tom Glassanos, dire of marketing at the company.

Storage galore

The rapid proliferation of NFS ser will prove a real boon to storage manufac ers in general, but it appears that manu turers of 5.25-inch SCSI and ESDI W chester disk drives — such as Seagate primis and Maxtor-stand — to gain the n These companies are setting the pace fo low-cost, mass-produced disk units tha being assembled into large disk arrays t commodate the large storage requirem of the servers.

"Some of the storage [on these ser will be provided by optical disks and 8- parallel-transfer drives," said Dataqu Devin. "But by far the most will be RA

RAID (redundant array of inexpe disks) architectures stem from recent done at the University of California- Ber that has focused on connecting many s disks into large, high-performance, h reliable disk farms that can take adva of the rapidly dropping costs of 5.25 Winchesters.

RAID takes the concept of an arr disks to its logical extreme, building in array a means to provide fault-toleranc huge capacities while virtually elimin downtime.

Auspex has built RAID into its disk and other manufacturers, such as Technology of Boulder, Colo., and St Concepts of Costa Mesa, Calif. designed VME-compatible subsystem are based on RAID models. (For a con discussion of RAID, see Erle Mote Control" columns in the October an vember issues of *The Sun Observer*.)

Three flavors

According to Devin, NFS servers divided into three categories.

First, there are the high- performanc tems such as the NS 5000 from A These tend to be based on large ma disk arrays, and either connect directly

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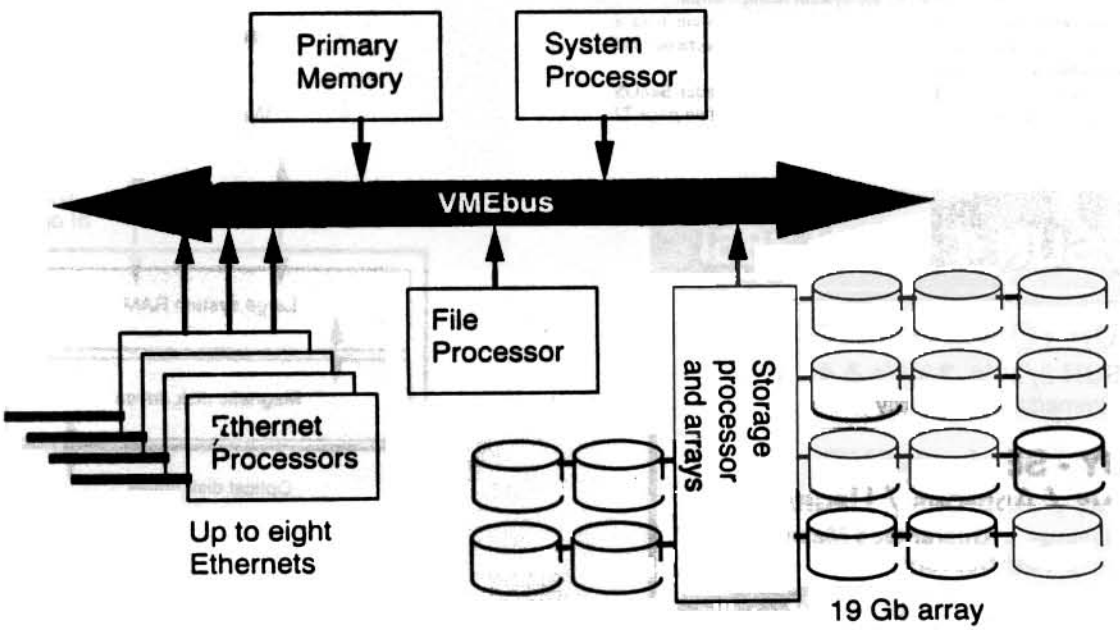

Figure 2

NFS...

Continued from page 18

Ethernet cable or to a VME-based machine that is in turn connected to the Ethernet cable.

The second category includes those like Epoch's, and feature reduced cost per megabyte and extremely high capacity. These are at least partially based on optical disk technology, with the more advanced systems using hierarchical storage techniques.

Some are capable of the same high performance as the first category but cannot support as many clients at the same sustained Ethernet data transfer and response rates.

These systems also connect either directly to the Ethernet or via a VME connection. Both the first and second categories include substantial data management functions, though these capabilities tend to be the hallmark of the high-capacity archival storage systems.

The third category is by far the largest but probably will prove to be the shortest-lived. This is where we find the standard servers produced by Sun, HP, DEC and Solbourne Computer of Longmont, Colo.

These servers tend to be based on the same technology as the company's computers themselves, and aren't necessarily optimized in any way for server performance or system-management functions.

They often perform as compute or printer servers as well. For example, Solbourne servers are now offering up to 65 MIPS additional LAN processing power plus substantial disk space. New products from Omni Solutions, however, promise to breathe new life into these systems.

See the accompanying table for a summary of the NFS-based servers. The remainder of this article provides a technical description of representative products in each of the three categories.

Closing the gap

Claiming that the chief problem to be solved by today's server technology is that of increasing server performance at the same rapid rate as processor performance (as reflected in MIPS ratings), Auspex Systems' NS 5000 features a hardware and software architecture designed to maximize the routing of data from the disk array to a large number of clients (Figure 2 on page 18). Auspex recommends use of its server at sites with at least 25 workstations.

Auspex has partitioned operating system and data communications functions into several separate components and has assigned these functions to separate, dedicated processors.

As a result, excess operating-system and communications overhead that normally occurs in server operations is reduced or eliminated, speeding operations that range from data transfers and Ethernet communications to file-system manipulation.

In addition, the Auspex system uses a large system memory as a data cache on read operations.

The Auspex system runs under SunOS

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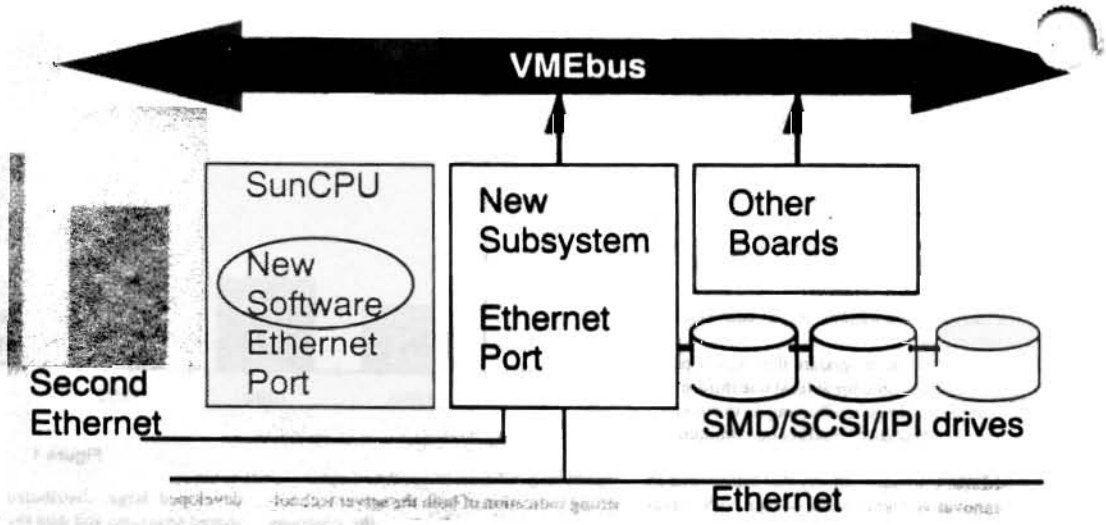

Figure 3

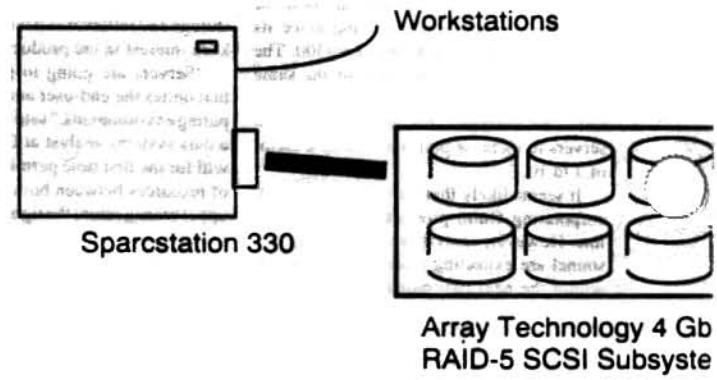

Figure 4

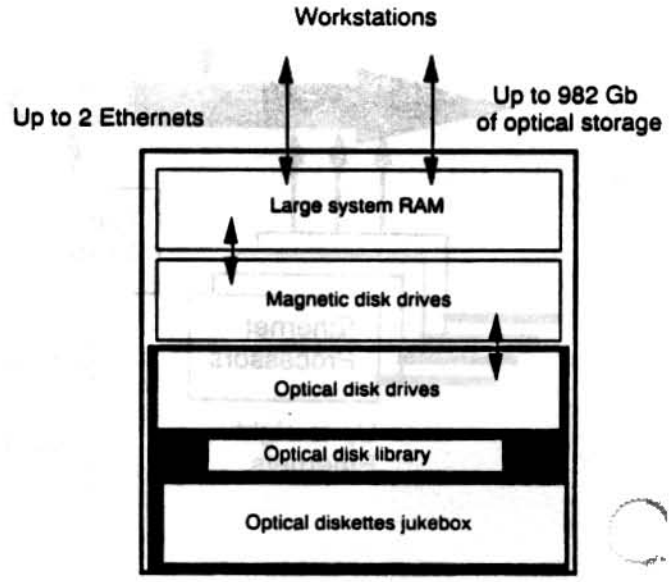

Figure 5

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NFS...

Continued from page 20

and features an enhanced VME backplane capable of transferring data at a maximum rate of 55 Mb per second. The storage processor controls up to ten parallel, synchronous 5-Mb-per-second SCSI channels simultaneously. Auspex was founded by Larry Boucher, author of the original SCSI specification.

The Auspex disk array is organized in racks of five 760-Mb 5.25-inch Winchesters on a single SCSI bus. Data is read and written in parallel.

The first 10 drives configured in a system each get their own SCSI channel; additional drives are then daisy-chained to the existing drives. Because of drive packaging limitations in the existing chassis, fully loaded systems aren't yet available.

RAID level 5 capabilities have been built into the hardware but aren't currently in use. Auspex is one of the first original-equipment manufacturers to use HP's latest 5.25-inch 150,000-hour/five-year-warranty SCSI Winchesters, which gives an average Auspex system a two-year MTBF rating. With this kind of reliability, the RAID capabilities will not need to be fully implemented in the NS 5000 until next year, when the software to do so becomes available.

Existing systems in the field will simply need to install the software, because RAID-5 hardware capability is sold with the system.

With RAID, recovery is automatic in the event of a drive failure and no data is lost. The system continues to operate at the same performance level after the disk has been reconstructed, using a spare already installed in the system. Data reconstruction and recovery are completely transparent, though system performance may be temporarily degraded.

Auspex claims its system is capable of 1000 NFS 8-Kb read-data packets per second over a maximum of eight Ethernet segments, theoretically saturating the maximum 10-Mega-per-second Ethernet transfer rate on each cable. Write operations are subject to the NFS requirement that they occur to nonvolatile storage before an acknowledge is sent to the client, so they require about twice as much time as a read. This kind of performance will supplant existing servers on the network, and Auspex recommends allocating existing servers to new functions like mail and computational services.

The Auspex assumption seems to be that system managers in the workstation environment are in desperate need of an easily managed, centralized storage solution, plus server performance great enough that the workstations can be diskless.

The NS 5000 can, at least on paper, support some 240 diskless workstations under any application mix without any noticeable performance loss.

System management features include the configuration of many workstations into an integrated whole, and the elimination of routers and bridges.

In addition, since several servers are now reduced to one, backup may occur to a single server, and redundant copies of shared applications, libraries and data are reduced to single copy.

The ability to use diskless or dataless workstations across the network further ensures tight control over programs and data by departmental and corporate management

Fitting in

Though Omni Solutions is developing product — the Omni1000 — that will include its own native high-speed bus and should in fact exhibit performance characteristics very similar to the Auspex product the company's first two products are designed to enhance existing Sun and Solbourne servers.

With these products, the Omni philosophy is to substantially increase server performance while utilizing existing server hardware.

In this way, the customer's investment in existing storage peripherals is maximized and existing servers needn't be reassigned to new tasks.

As shown in Figure 3 on page 20, several new VME boards and new software are installed in an existing machine. The boards distribute file system and Ethernet communications functions in the same manner as the Auspex system; the only obviously difference is that the existing VME in a Sun Solbourne machine is slower than the enhanced Auspex bus.

The Omni300, the low end of the product line and the company's first available product, supports up to eight drives, whether they implement an SCSI, IPI or SMD interface. One to four Ethernets are supported.

The Omni600 provides six to 10 times existing server performance, compared to about 3 times the performance with the Omni3 and supports up to 16 drives using any of three interfaces or a combination of them.

Kent Winton, director of marketing for Omni, indicated that RAID configurations as well are very much a part of the company's plans. "Our goal was to provide a generic interface to the disk storage to offer a variety of levels of increased performance," he said. "RAID will integrate nicely into the system."

Though it's too soon to evaluate Omni Solutions' products, it's clear that its first two products will be winners. The idea is solid, and the engineering talent comes from Sun itself.

As for the Omni1000 product, which

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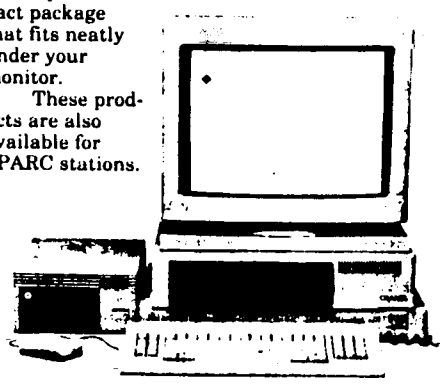

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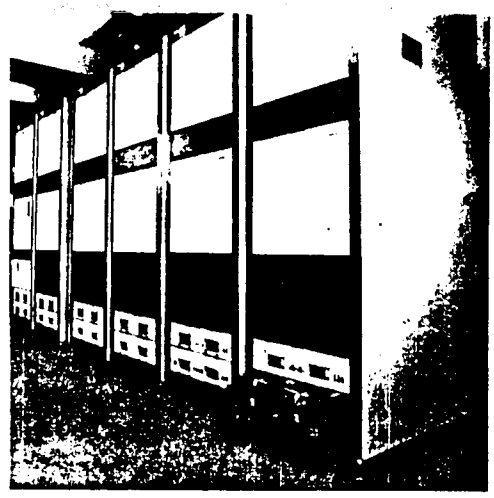

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being positioned directly against the NS 5000, it should be an interesting face-off. Auspex storage talent is matched by Omni's Sun experience.

As Dataquest's Devin pointed out, "In the high-end server market you've got to have the best in the business to make it."

It's RAID!

Other high-performance systems are becoming available from VARs who are integrating RAID- based subsystems directly into VME-based products.

For example, RAID-3 and RAID-5 subsystems are available from Array Technology and Storage Concepts, respectively, that can be plugged into VME-bus-based workstations from, for example, Sun or MIPS Computer of Sunnyvale, Calif. (see Figure 4 on page 20).

Most RAID subsystems are presently restricted to high-performance graphics applications like imaging and simulation where high throughput directly on the system bus is mandatory.

It's just recently — with the Auspex product — that we're beginning to see large-array performance being tapped for data server applications. But companies like Maximum Strategy, with its Strategy 2 disk-array controller, are now reporting sales of RAID components to integrators interested in constructing high-performance servers. The Strategy 2 product is based on RAID- 3 and is capable of burst data rates as high as 40 Mb per second.

Industry observers predict substantial activity involving standards-based "mix-and-match" server systems like these, resulting in relatively low- cost, high-performance solutions to the large data requirements on LANs of technical workstations, as well as X-Windows-based general purpose configurations.

But the big problem here, at least for the time being, is that the RAID subsystems far outperform the hardware's ability to serve the data. And even if the hardware throughput problem is resolved, the bottleneck then becomes the overhead introduced by the operating-system and data-communications software normally bundled with VME systems.

Storage unlimited

Equally as important as the high-performance solutions are the low cost-per-megabyte products that in many cases feature a wider variety of capabilities than the higher-performance competition. Performance of these systems isn't necessarily worse than the high-performance systems, but they support fewer clients.

They aren't designed from the ground up to handle a huge number of workstations at the highest possible data-transfer and packet-processing rates. There are other considerations at work here.

Customers have a range of requirements, as indicated by NetFrame's Glassanos: "As often as we hear the word 'performance,' we hear 'capacity,' 'ease of implementation,' 'ease of maintenance,' 'low cost,' and 'consolidation.'"

Claiming that the chief crisis confronting today's workstation computing environment is a lack of online storage and inadequate methods of archiving data, Epoch Systems announced the Epoch-1 Infinite Storage server in November 1988 (see Figure 5 on page 20).

Based on the concept of hierarchical storage and designed by some of the best-known people in the business (most notably a group — including the president — that came from Data General and were featured in Tracy Kidder's best-selling novel, Soul of a New Machine), this product features several innovative hardware and software designs that are bound to be duplicated by others.

Hierarchical storage is a concept in which files are stored in a mixed-media system on the media most appropriate to their frequency of use.

Under software control, very active files are, for example, stored in a large RAM, while less-frequently accessed files are stored on magnetic disk. Little-used files are archived to optical disk.

The Epoch-1 uses a jukebox system to handle multiple online optical platters, resulting in a system that costs less than one-fifth per megabyte than the competition.

This concept is especially wellsuited to the technical workstation environment because the files tend to be large and often infrequently accessed.

At the same time, performance is excellent because data resides on media with access times appropriate to its use. Epoch also splits server tasks between dual Motorola 68000-based processors in a method similar to that of Auspex and Omni Solutions: one is used as a file processor and one as an I/O processor.

The Epoch system emphasizes system and network management software. In addition to the hierarchical file management software, the system includes a file compaction facility, a storage quota mech[illegible] and a retrieval mechanism that provide[illegible] efficient access to logically related file[illegible] have been physically stored on a number of optical disks.

The Epoch system integrates easily into existing LANs to provide a centralized server facility. It provides satisfactory speed for diskless workstations, but really shines on LANs consisting of dataless workstations that use local disks for paging and swapping operations, and usually storage of key applications as well.

Continued on page 34

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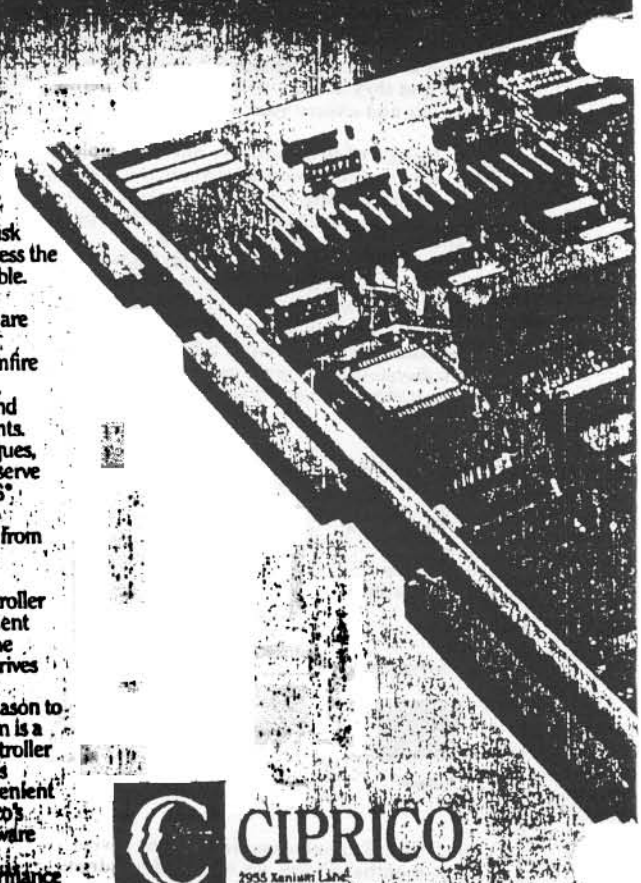

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NFS...

Continued from page 23

The data is easy to manage and access, and backup to tape can occur while the unit is in the process of servicing client requests.

Plug and play

Other methods also exist to bring optical storage online for NFS-based networks. For example, Alphatronix of Durham, NC, offers an erasable 5.25-inch optical system that plugs into any Sun SCSI port to provide up to 1.2 Gb of online storage. The product is called Inspire, and the company provides special software utilities to handle the removable optical media, without requiring any change to the existing SunOS magnetic device driver.

VARs can integrate a product like Inspire into any dedicated VME-based server by using a VME-to- SCSI adapter. In addition, products like Legato Systems' (of Palo Alto, Calif.) PrestoServe can improve performance by providing a "fix" that allows NFS servers to process write requests in about half the time normally required.

PrestoServe plugs into any VME-based system and fields data on write operations. It temporarily writes this data to a battery-backed SRAM and sends an acknowledge to the client, then writes the data to disk.

Normally, under the NFS protocol, the server would have to wait for the information to be written out to disk before the acknowledge could be sent, slowing server response. Sun built this feature into the NFS protocol to provide for system crashes: Any client that receives a write acknowledge knows for sure that the write has in fact occurred. Legato, founded, like Omni Solutions, by former Sun employees, has reported performance increases of 2-3 times with PrestoServe. Legato's biggest market is Sun's server market, but the company is engaged in shared- technology negotiations with other NFS server companies as well.

Tried and true

By far the largest NFS server market is the market that consists of servers built into a company's standard computer line. These include all of Sun's servers, as well as DECstation servers from DEC and the workgroup/departmental/network serv lines from Solbourne.

In product literature, Auspex refers t these servers as "retrofitted workstations Epoch literature attacks them by pointir out that that they are simply general-purpo systems reconfigured without keyboards displays and packaged with multiple disk Furthermore, says Epoch, they aren't op mized for file-server functions and have special I/O handling capabilities. "They a inadequate for a long-term, strategic sol tion to the need for storage access and d management," summarizes one brochu Omni Solutions' products may go a lo way toward remedying these problems, b the criticisms still hold.

The installed base of servers consi almost exclusively of these machines, adequate though they may be. For sm networks of workstations, they probal remain the most cost-effective method serving from a common block of stora "The new servers won't do you much g if you don't have many workstations," s Dick Bush, of Auspex. "The standard se ers still fit in well in smaller installation

Asked if he expects to compete aga Epoch in the larger installations, Bush plied: "We'll probably co-exist. As a ma of fact, I think we already do."

The trend is clearly toward large, d cated servers and greater server perfo ance. Soon, companies and users will be the move to FDDI. Companies like Sun, and DEC have already made announcem based on FDDI, and are promising cust ers easy migration paths to it. The probl of data distribution and management ar fact just now really making themse known. An innovative third party is lea the way in effectively dealing with them. we can expect the giants to react strongl soon as they witness their server mar eroding. Sun's announcement, expe within eight weeks, will certainly be ind tive of its direction in this important ma that Sun itself — more than any other c pany — has helped to create.

❖

Editors note — The following compa were mentioned in the above news stor

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Epoch Systems, Marlborough, MA
(617) 481-3717
Legato Systems, Palo Alto, CA.
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Storage Concepts, Costa Mesa, C
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Imprimis (Seagate), Minnetonka, M
(612) 853-8100
Maxtor, San Jose, CA.
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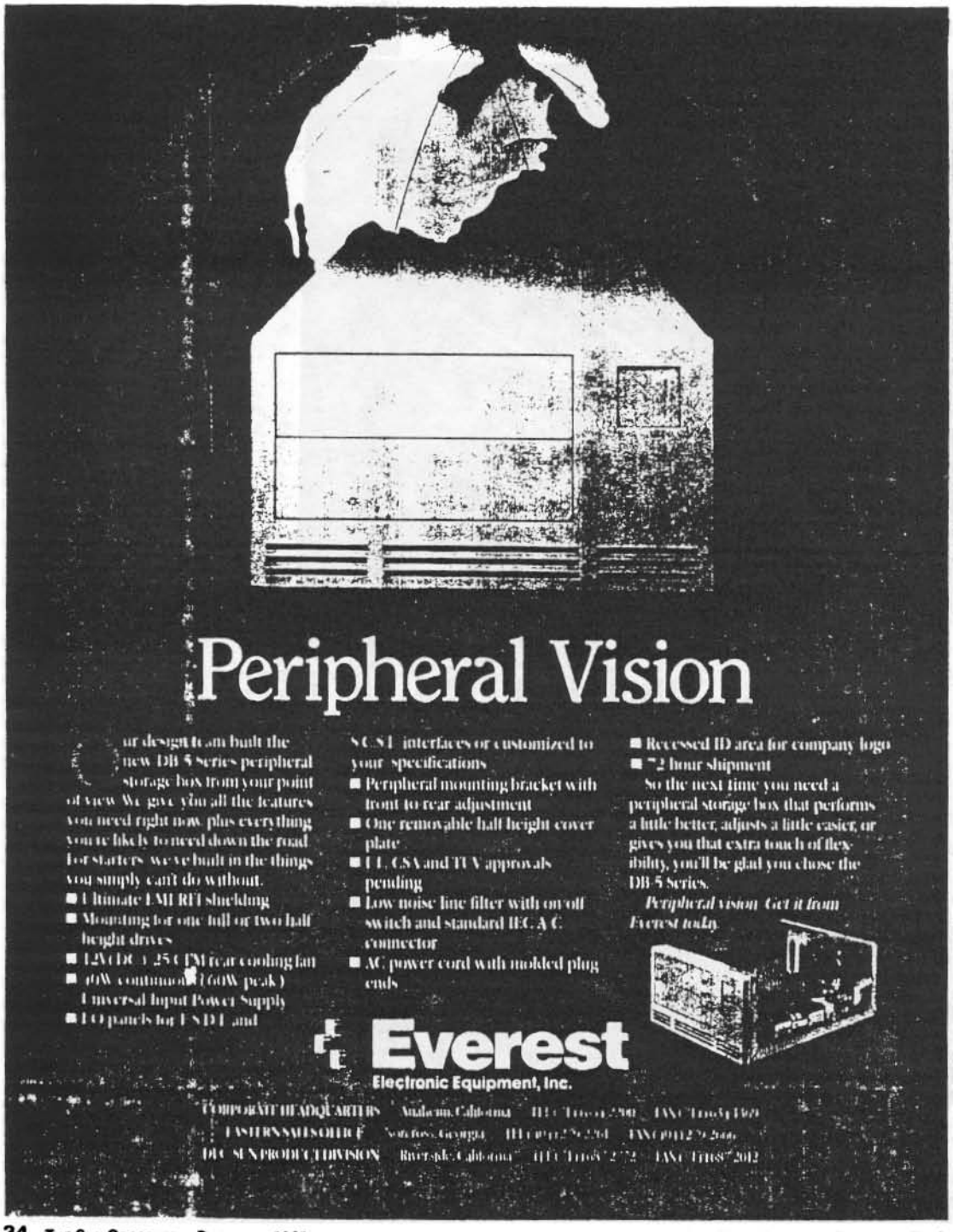

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