INTRODUCTION
The enormous amount of growth in disk and tape storage is greatly complicating the life of Information Technology (IT) professionals assigned to manage their corporation's information assets. A new concept, called Storage Area Networking (SAN), has emerged to provide an architectural framework for storage-related applications. The SAN concept has encouraged exciting new hardware and software technology to focus on this storage management and capacity problem.

As this new technology emerges, it is important to implement tactical projects that will lead to a strategic, new SAN infrastructure. Obviously, this roadmap will be different for every corporation, depending on their business, size of company, and storage management requirements. This article provides guidance on the applications enhanced by a SAN to add to the IT manager's knowledge and experience toolkit.

NEW FOCUS ON STORAGE
Individuals, and corporations consisting of many people, creatively develop information related to their business every day. Often this is based partly on data the corporation collects about its sales, market, positioning, customers, etc. Then information is exchanged with other people to seek confirmation or even newer ideas, based on many other sources of information. The driving force behind this creative process is to make the corporation more successful in its business.

Recently, this concept has shifted attention to how to manage the flow of information. This management process starts at the source. If the in-
formation is in hard-copy form, the flow is relatively slow. Remember “snail mail”? Today, more and more information is digital, greatly increasing the potential velocity of data movement through an organization. It follows that more timely access to information and better data management can provide a competitive advantage. The “information at your fingertips” slogan epitomizes the concept. (If it was only that simple!)

As corporations rely more and more on this fast-paced digital flow of information, they realize that continuous investments are required to add capacity and streamline the arteries of transport. As the investments in capacity have geometrically expanded — from megabytes to gigabytes to terabytes and beyond — the transport and management infrastructure struggles to keep pace.

WHAT IS A SAN?
Storage Area Networks (SANs) were envisioned to solve these “big” problems surrounding data storage and management. The original computing paradigm has the CPU shuttle data from main memory to longer-term permanent storage over an input/output (I/O) connectivity architecture and communication protocol. The CPU “owns” the storage device, and the I/O path is relatively short to ensure minimum latency of data transfers. This model works well and can be scaled to fit the size of many applications. However, it does not facilitate the exchange or protection of information and can be very limited in environments with large applications or a large number of users.

So the computing model evolved to place multiple “servers” on a network, with storage facilities that could be partitioned and shared by many users. Faster networks and network switching attempted to solve problems of scalability created by expanding the number of users. However, each server still “owned” its storage devices, limiting affordable scalability. In addition, I/O traffic is forced to contend with user application access, resulting in slower overall performance.

The next evolutionary step is the SAN. The concept is simple: enable servers and storage to independently provide their services on the network. Just like an appliance gets its power from the wall plug, a SAN provides a common plug-in connectivity infrastructure for adding processing power or storage capacity. The SAN becomes an independent, high-performance network, dedicated to I/O. (See Exhibit 1.)

The potential benefits of a SAN are appealing:

• independence of server and storage implementation, enabling the selection of the best technology for the application
• the ability to add new storage or server capacity as needed without impacting the existing production
EXHIBIT 1 — Storage Area Networks (SANs)
• increased availability of the information with improved disaster recovery and high availability storage solutions
• improved overall performance of the information flow by implementing new channel I/O technologies that have better bandwidth, aggregate capacity, and processing speeds
• a more streamlined approach to data management tasks that results in a more productive, efficient process with better security and lower cost of ownership

Since IT rarely has the luxury of building a computing and networking infrastructure from scratch, an important but often overlooked aspect of SANs is the need to integrate new technology and methods with existing systems. Integration protects the current investment in hardware and software and better leverages the capital dollars already spent.

Refer to the SAN requirements checklist below for several additional data management issues for SANs that need to be considered.

SAN requirements checklist:

• data management tools
• I/O protocols
• server file systems
• system-level optimization through network operating system, server interconnect, disk arrays, etc.
• record locking, transaction processing for shared applications
• virtualization of data storage
• shared data or shared storage
• device pathing (access to storage devices)
• security
• data protection and availability
• interoperability over the SAN between heterogeneous systems (S/390, multiple UNIX flavors, NT)

SAN ADVANTAGES
The advantages of implementing a SAN become apparent when applying the infrastructure to a series of applications that respond to various corporate requirements. These applications include:

• device sharing
• backup/restore
• disk mirroring
• data migration
• data sharing
• archive/retrieval
GETTING STARTED WITH DEVICE SHARING

Device sharing responds to the economic imperative that because money is scarce, an expensive resource is best utilized when shared by the optimum number of users. (See Exhibit 2.) This concept is as old as the idea behind the A:B switch that enabled a path to a destination to be manually switched from one source to another. However, the concept is complicated by one other important reality: diversity.

The fact is that corporate enterprise systems are diverse, comprised of mainframes, midrange systems, and popular open systems such as Windows NT and UNIX. Each kind of server has its own kind of storage systems, creating in effect islands of information. These islands are becoming more and more densely populated, growing rapidly (as much as 50 percent a year). By sheer weight, all have become critical, whether or not they were originally designed for mission-critical applications. The cost of growing these diverse storage resources and maintaining them with the same or shrinking IT staffs is a major problem.

SANs solve those problems. The SAN acts like a high-speed subnet that establishes a direct connection between storage resources and servers. (See Exhibit 3.) It presents a new infrastructure that liberates the storage devices, so they do not attach to particular server buses. Rather, they attach directly to the network SAN. This in essence externalizes storage resources and functionally distributes them to the organization. Storage resources, such as tape and disk libraries, can be centralized and servers can be clustered, which makes for easier access and less-expensive administration.

Specialized networking devices interface servers and storage devices to the network. These are high-speed directors, multiplexers, and gateways that possess a high order of connectivity, performance, and manageability. Just as a LAN might use technologies such as Ethernet, Token Ring, or FDDI, a SAN can employ a wide range of local area and wide area technologies, including SCSI, ESCON, SSA, Fibre Channel, T3/E3, and SONET. All of this makes SANs suitable for corporate enterprise systems, which in addition to being diverse are spread all over the place.

Device sharing using SANs can be implemented with a slightly more automatic method than the A:B switch mentioned previously. However, the potential SAN value is greatly expanded through new software that automatically handles reserve/release protocol commands from multiple servers to the same devices.

BACKUP/RESTORE APPLICATION REQUIRES INCREASED COMPLEXITY

Once access to a shared device like a tape library is available, the first application to ensure data security is to put the data on tape via a backup application. In the event of a human-caused problem such as deleting a file, a data integrity problem like the fallout from data corruption, or a
EXHIBIT 2 — Shared Storage Requirements

**Business Drivers**
- Overall cost of storage
- Manageability
- Recoverability
- Consistency of backups

**Issues**
- Different storage strategy for each platform
- Redundant storage resources
- Decentralized management
- Virtual storage management software
Data is accessible to any system type: locally and remotely off-site.

EXHIBIT 3 — SAN: The Real Benefits
physical device problem disrupting access to the data, a copy can be re-
stored from tape. Tape is also useful to restore files from a particular
point in time, such as end-of-quarter sales figures.

A common problem in many corporate enterprise systems is varying
degrees of discipline exercised in controlling and maintaining systems.
Many LANs evolved from non-mission-critical applications, such as word
processing, presentation development, and other personal productivity ac-
tivities commonly resident on PC-based systems. Early on, these systems
were indeed “personal systems” — outside the control of corporate IT
staff. Individual users determined the level of discipline involved in main-
tenance and security. Activities like backup and restore, which were basic
and integral to the maintenance strategies for mainframe-based systems
and servers, were for the most part nonexistent on PC-based systems.

As PCs became common office tools, they evolved into LANs. Their
importance and the importance of the information they generated and
maintained increased. Now, many of the same backup disciplines of
mainframe-based systems are needed for these “rogue” systems as well.

Faced with increasing responsibilities and shrinking resources, IT
staffs can look to SANs to extend backup resources where needed in the
corporate enterprise system. A shared backup resource in a SAN maxi-
mizes the use of tape and disk backup resources and provides consisten-
cy in the backup process.

MOVING ON TO DISK MIRRORING

Daily backups alone are not enough when companies are vulnerable to
a substantial business impact from data lost between backups, or when
non-stop data accessibility is required. In those cases, disk mirroring is
often employed.

Disk mirroring is a method of duplicating data on separate disks in re-
altine to preserve the data’s accuracy and make it available continuously,
even in the face of disaster. Each time data is written to a primary disk,
the data is duplicated — or mirrored — to a second disk. In the event
that the primary disk goes down, the system can switch to the secondary
disk in a matter of minutes.

Disk mirroring can be an important part of an overall disaster recovery
strategy, along with backup/restore and archive/retrieval. It also can be
part of a strategy to incorporate subsidiary functions, such as system de-
velopment, testing, or maintenance, into a company’s processing scheme
without impacting mainline business operations. (See Exhibit 4.)

In any case, disk mirroring is employed by companies that simply cannot
afford downtime for any reason, whether it is disaster related or not.
These companies must have continuous operation, seven days a week,
24 hours a day. The application requires duplicate storage resources, mir-
roring software, interconnect facilities, and for many solutions additional
EXHIBIT 4 — Typical Remote Disk Mirroring Network
processor resources. This added expense requires careful consideration before and during implementation.

SANs are a natural host for just such a storage application, making the storage resources accessible anywhere in the enterprise system and allowing efficient use of this expensive facility.

The power of the SAN can be leveraged with disk mirroring systems beyond duplicating data for disaster recovery. Increasingly, additional software provides capabilities for moving data between disk volumes as a method of data migration, file transfer, data sharing, or data warehousing. Because the SAN can be a local, campus, or remote topology, disk mirroring now becomes a very efficient method for exchanging information across the enterprise.

ANOTHER STEP — DATA MIGRATION
Another storage application that suits SANs is data migration. Data migration accompanies business change, and business change is about the only sure thing left today — besides death and taxes. Businesses alternately expand and contract due to mergers and downsizing. That, along with continual development of new technology, requires data to be migrated to new disk technology or to new locations due to data center moves and consolidations. Easy access to storage resources from remote and local sources, permanently or temporarily, is an important asset to IT managers; so is the ability to move large volumes of data quickly and safely. SANs allow all of that — quickly, easily, and safely — among diverse systems and through many types of interconnections.

ULTIMATE STORAGE APPLICATION — DATA SHARING
Once storage devices can be shared and data can be moved quickly and safely between servers and storage facilities, the way is paved for data sharing. Data sharing is the ultimate storage application. It enables enterprise-wide data collection and dissemination on a real-time basis. Access to legacy applications can be extended to open systems. Intellectual property can be collected, organized, and accessed corporate-wide.

Mainframes, which are good at collecting raw data from the sources or points of transactions, collect the data transaction by transaction in real-time. The data moves through interlinking facilities, becoming deposited in databases in open systems for access and analysis. This systematic collection, extraction, and transformation process is called data warehousing. It is an emerging and widely acclaimed method of giving companies exactly the kind of relevant up-to-date information they need to run their businesses intelligently and competitively in constantly changing market-driven environments. (See Exhibit 5.)

SANs have exceptional capabilities to store data efficiently, interface dissimilar resources over a variety of communication links, and move
EXHIBIT 5 — Building a Data Warehouse Network with a SAN
large volumes of data quickly and safely between servers and storage devices. They quite simply enable effective data sharing.

Data sharing can mean either multiple applications reading and writing to the same data fields, or it can mean sending a copy of the data from the source location to another location.

Data copy services, also known as file transfer, has existed with the first creation of a file. If one wanted to share the information with someone else, one either copied the file to a disk or tape and sent the physical media, or invoked a file transfer protocol and program to send an electronic copy. Today’s programs are now specialized to utilize the I/O transport protocols for much faster transport.

True data sharing of the same data fields by multiple applications and heterogeneous environments is still mostly in the experimental development stage. The enterprise data management disciplines need to evolve significantly to enable true SAN interaction. Today’s operating systems still expect direct ownership of the storage devices and do not have a referee to sort out allocation requests from operating systems competing for the same storage. The Storage Networking Industry Association (SNIA) was organized to promote development of SAN industry standards and has committees working on these data management issues.

ARCHIVE/RETRIEVAL

Finally, data sometimes needs a final resting place. Archived data is recorded on the least costly, highest capacity storage medium because the data is rarely accessed after the first month or so. Archiving data digitally offers the potential for streamlining operations, lowering costs, and improving the preservation of the stored information.

However, there is a major problem developing in many organizations as they grapple with an efficient method for archiving digital data. Selecting storage media that will stand the test of time is a major problem as tape formats and readers typically become obsolete within three to five years. For example, in the music industry, there are not too many eight-track audio tape players still around and record turntables are becoming scarce. The fast-paced tape industry has the same problem as converter machines become difficult to find. The SAN may enable more data to be stored on low-cost disk systems, avoiding some of the tape media incompatibilities.

SUMMARY

If information is the key element of the current age, then Storage Area Networks, or SANs, are the key infrastructures. The explosive proliferation of information necessitates new and creative ways of handling that information and making it accessible.

SANs meet that challenge:
SANs provide efficient and cost-effective storage for huge and growing volumes of data.
SANs bridge the islands of information created by diverse systems.
SANs smooth the flow of information through diverse communications facilities.
SANs provide an effective nonobtrusive structure for handling those storage applications so necessary for safe and secure operation of corporatewide enterprise systems.

Implementing a SAN starts with the basic need of sharing storage devices with multiple servers for more cost-effective storage. Each subsequent application can be viewed as another tactical project that leads to the strategic implementation of a Storage Area Network infrastructure.

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