Network Storage Trend and Markets

1. Storage Traditions, Trends, and Growth

Traditional approaches to storage and storage management emphasize the need to control expense and restrict access. Using traditional storage management principles, the amount of information stored is significantly limited, even to the point of reducing a data field to two digits. At the same time, information access is often restricted to a single server. Recent advances in recording technology now make it possible to store vast quantities of data at relatively low cost. New applications and new business models brought on by the network era are increasing to demands on corporations to share information both internally and with their partners and customers. The challenge for companies is no longer the cost of the storing data, but finding ways to cost effectively manage vast storage resources and provide access to data so that it cab be turned into valuable information.

Even as the amount of storage continues to grow, skilled storage managers remain in short supply. This combination of growing data, the need for information access, and the lack of management resources has driven the demand for a new class of storage solutions called Storage Area Networks (SAN). These solutions promise support for the broadest range of server platforms, operating systems and applications, with virtually limitless scale in terms of capacity, connectivity, performance, and availability.

International Data Corporation (IDC) predicts that disk storage system pricing as measured in price per megabyte will continue to decline almost 40 percent compound per year through 2003. Among other factors, continued doubling of recording density of new hard disk drives every twelve to eighteen months make this possible. These price declines allow companies to meet the storage demands of a much boarder range of business tools, including enterprise resource planning, sales force automation, data warehouses, and data marts. At the same time declining storage prices have accelerated the digitization of information that was previously in only analog or written form, including publishing and the output from a broad range of audio and video applications. The net result of these changes is that the amount of new storage capacity shipped increases approximately ninety percent per year. Now that all of this information is available in digital for, everyone wants access to it.

Few would dispute the value of being well connected, and yet for years, corporations tightly controlled both the quantity of and access to stored information. The Internet, however, has increased companies' awareness of the value of networking and the risks associated with protectionist attitudes towards information access. At the same time, the Internet and its associated e-business model have brought with them the challenges of unpredictability. The Internet puts the decision of when and where business transactions occur into the hands of the customers. In an Internet world, the store is always open and the number of potential customers is limited by factors almost completely out of control of the business owner. The Internet has also become an increasingly important delivery mechanism for customer service, largely replacing the telephone for a growing segment of customers. In addition, the Internet eliminates many of the barriers that prevented customers from switching from one supplier to another. Geographic proximity offers little or no advantage and competitors are simple to locate. Thus, application availability takes on a new level of importance by becoming a point of differentiation between competitors.

Massive increases in connectivity stand as one of the most significant changes to occur in corporate information systems. Increasingly, legacy accounting systems are linked with sales order processing, inventory systems, and billing systems to improve efficiency and enable the support of dramatic increases in transaction volume. This has resulted in a substantial increase in the need to move and share data between systems. More important, however, is the increased integration and connectivity between corporations and their community of suppliers and customers. Historically, companies strove to manage risk by restricting access to systems and protecting valuable information. Companies now recognize that there exists an even greater risk in failing to provide the broader community with access to system and information. In an Internet world, infrastructures that previously took years to build must be built over night. And for companies that are adding an Internet, e-commerce strategy to a legacy delivery model, the challenges are even greater. These companies must tightly integrate Internet systems with legacy systems or risk damaging the existing brand.

2. Fibre Channel Standards

The information explosion and the need for high-performance communications for server-to-storage and server-to-server networking have been the focus of much attention during the 90s. Performance improvements in storage, processors, and workstations, along with the move to distributed architectures such as client/server, have spawned increasingly data-intensive and high-speed networking applications. The interconnect between these systems and their input/output devices demands a new level of performance in reliability, speed, and distance. Fibre Channel, a highly-reliable, gigabit interconnect technology allows concurrent communications among workstations, mainframes, servers, data storage systems, and other peripherals using SCSI and IP protocols. It provides interconnect systems for multiple topologies that can scale to a total system bandwidth on the order of a terabit per second. Fibre Channel delivers a new level of reliability and throughput. Switches, hubs, storage systems, storage devices, and adapters are among the products that are on the market today, providing the ability to implement a total system solution.

The Fibre Channel standards group realized that channels and networks should be able to share the same fiber. (Note that "fiber" is used as a generic term which can indicate either an optical or a copper cable.) IT systems frequently support two or more interfaces, and sharing a port and media makes sense. This reduces hardware costs and the size of the system, since fewer parts are needed. Fibre Channel, a family of ANSI standards, is a common, efficient transport system supporting multiple protocols or raw data using native Fibre Channel guaranteed delivery services. Profiles define interoperable standards for using Fibre Channel for different protocols or applications.

The ambitious requirements given the standards group:

- Performance from 266 megabits/second to over four gigabits/second
- Support for distances up to 10 km
- Small connectors
- High-bandwidth utilization with distance insensitivity
- Greater connectivity than existing multidrop channels
- Broad availability (i.e., standard components)
- Support for multiple cost/performance levels, from small systems to supercomputers
- Ability to carry multiple existing interface command sets, including Internet Protocol (IP), SCSI, IPI, HIPPI-FP, and audio/video.

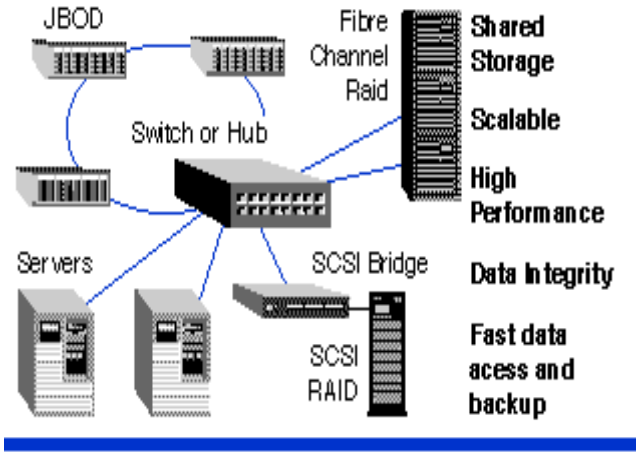
Fibre Channel, a channel/network standard, contains network features that provide the required connectivity, distance, and protocol multiplexing. It also supports traditional channel features for simplicity, repeatable performance, and guaranteed delivery. Fibre Channel also works as a generic transport mechanism. Fibre Channel architecture represents a true channel/network integration with an active, intelligent interconnection among devices. All a Fibre Channel port has to do is to manage a simple point-to-point connection. The transmission is isolated from the control protocol, so point-to-point links, arbitrated loops, and switched topologies are used to meet the specific needs of an application. The fabric is self-managing. Nodes do not need station management, which greatly simplifies implementation.

Fibre Channel is the next storage interface. Fibre Channel has been adopted by the major computer systems and storage manufacturers as the next technology for enterprise storage. It eliminates distance, bandwidth, scalability, and reliability issues of SCSI. Fibre Channel is being provided as a standard disk interface. Industry leading RAID manufacturers are shipping Fibre Channel systems. Soon, RAID providers will not be regarded as viable vendors unless they offer Fibre Channel.

The network behind the servers linking one or more servers to one or more storage systems. Each storage system could be RAID, tape backup, tape library, CD-ROM library, or JBOD (Just a Bunch of Disks). Fibre Channel networks are robust and resilient with these features:

- Shared storage among systems
- Scalable network

- High performance
- Robust data integrity and reliability
- Fast data access and backup



SAN is the Network behind Servers

In a Fibre Channel network, legacy storage systems are interfaced using a Fibre Channel to SCSI bridge. IP is used for server to server and client/server communications. Storage networks operate with both SCSI and networking (IP) protocols. Servers and workstations use the Fibre Channel network for shared access to the same storage device or system. Legacy SCSI systems are interfaced using a Fibre Channel to SCSI bridge. Fibre Channel products have defined a new standard of performance, delivering a sustained bandwidth of over 97 MB/second for large file transfers and tens of thousands I/Os per second for business-critical database applications on a Gigabit link. This new capability for open systems storage is the reason Fibre Channel is the connectivity standard for storage access.

Data Transportation Technology Comparison			
	Fibre Channel	**Gigabit Ethernet**	**ATM**
Technology application	Storage, network, video, clusters	Network	Network, video
Topologies	point-to-point loop hub, switched	Point-to-point hub, switched	Switched
Baud rate	1.06 Gbps	1.25 Gbps	622 Mbps
Scalability to higher data rates	2.12 Gbps, 4.24 Gbps	Not defined	1.24 Gbps
Guaranteed delivery	Yes	No	No
Congestion data loss	None	Yes	Yes
Frame size	Variable, 0-2KB	Variable, 0-1.5KB	Fixed, 53B
Flow control	Credit Based	Rate Based	Rate Based
Physical media	Copper and Fiber	Copper and Fiber	Copper and Fiber
Protocols supported	Network, SCSI, Video	Network	Network, video

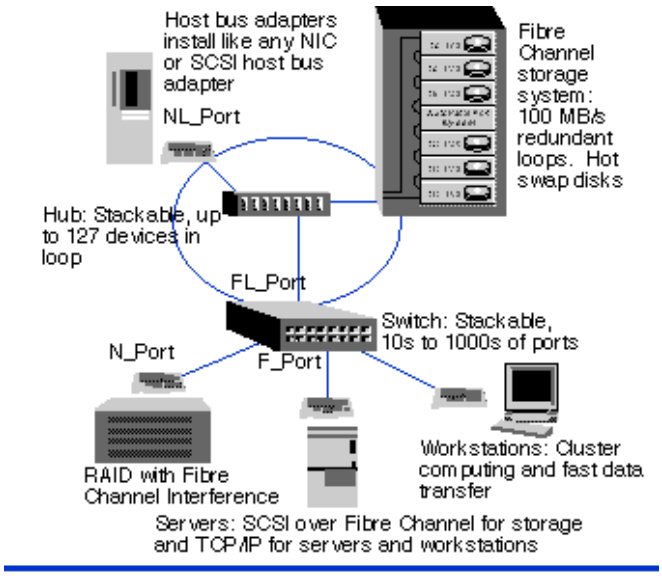
Fibre Channel is a product of the computer industry. Fibre Channel was specifically designed to remove the barriers of performance existing in legacy LANs and channels. In addition to providing scalable gigabit

technology, the architects provided flow control, self-management, and ultra-reliability. Gigabit Ethernet is designed to enable a common frame from the desktop to the backbone. However, Fibre Channel is designed to be a transport service independent of protocol. Fibre Channel's ability to use a single technology for storage, networks, audio/video, or to move raw data is superior to the common frame feature. ATM was designed at a wide area network with the ability to provide quality of service for fractional bandwidth service. The feature of fractional bandwidth with assured Quality of Service is attractive for some applications. For the more demanding applications, Class 4 Fibre Channel provides guaranteed delivery and gigabit bandwidth as well as fractional bandwidth quality of service. Fibre Channel's use in both networks and storage provides a price savings due to economies of scale associated with larger volumes. Users can expect their most cost-effective, highest-performance solutions to be built using Fibre Channel.
As shown in Table above, Fibre Channel is the best technology for applications that require high-bandwidth, reliable solutions that scale from small to very large.

Fibre Channel is the solution for IT professionals who need reliable, cost-effective information storage and delivery at blazing speeds. With development started in 1988 and ANSI standard approval in 1994, Fibre Channel is the mature, safe solution for gigabit communications. Today's data explosion presents unprecedented challenges incorporating data warehousing, imaging, integrated audio/video, networked storage, real-time computing, collaborative projects and CAD/CAE. Fibre Channel is simply the easiest, most reliable solution for information storage and retrieval.
Fibre Channel, a powerful ANSI standard, economically and practically meets the challenge with these advantages:

- **Price Performance Leadership -** Fibre Channel delivers cost-effective solutions for storage and networks.
- **Solutions Leadership -** Fibre Channel provides versatile connectivity with scalable performance.
- **Reliable -** Fibre Channel, a most reliable form of communications, sustains an enterprise with assured information delivery.
- **Gigabit Bandwidth Now -** Gigabit solutions are in place today! On the horizon is two gigabit-per-second data delivery.
- **Multiple Topologies -** Dedicated point-to-point, shared loops, and scaled switched topologies meet application requirements.
- **Multiple Protocols -** Fibre Channel delivers data. SCSI, TCP/IP, video, or raw data can all take advantage of high-performance, reliable Fibre Channel technology.
- **Scalable -** From single point-to-point gigabit links to integrated enterprises with hundreds of servers, Fibre Channel delivers unmatched performance.
- **Congestion Free -** Fibre Channel's credit-based flow control delivers data as fast as the destination buffer is able to receive it.
- **High Efficiency -** Real price performance is directly correlated to the efficiency of the technology. Fibre Channel has very little transmission overhead. Most important, the Fibre Channel protocol, is specifically designed for highly efficient operation using hardware.

Corporate information is a key competitive factor, and Fibre Channel enhances IT departments' ability to access and protect it more efficiently. In fact, multiple terabytes of Fibre Channel interfaced storage are installed every day! Fibre Channel works equally well for storage, networks, video, data acquisition, and many other applications. Fibre Channel is ideal for reliable, high-speed transport of digital audio/video. Aerospace developers are using Fibre Channel for ultra-reliable, real-time networking. Fibre Channel is a fast, reliable data transport system that scales to meet the requirements of any enterprise. Today, installations range from small post-production systems on Fibre Channel loop to very large CAD systems linking thousands of users into a switched, Fibre Channel network.



Fibre Channel Networks are built from familiar Elements

Fibre Channel systems are assembled from adapters, hubs, storage, and switches. Host bus adapters are installed into hosts like any other SCSI host bus adapter. Hubs link individual elements together to form a shared bandwidth loop. Disk systems integrate a loop into the backplane. A port bypass circuit provides the ability to hot swap Fibre Channel disks and Fibre Channel links to a hub. Fibre Channel switches provide scalable systems of almost any size. IT systems today require an order of magnitude improvement in performance. High-performance, gigabit Fibre Channel meets this requirement. Fibre Channel is the most reliable, scalable, gigabit communications technology today. It was designed by the computer industry for high-performance communications, and no other technology matches its total system solution.

3. 2000 U.S. Medium Business Market: Internet, e-Business and Telephony

There is a tremendous opportunity in today's U.S. medium business market for information technology (IT) products and services, largely driven by the need for computing upgrades, enterprise-wide extension, e-commerce infrastructure development, and IP-enabled solutions. The Internet, intranet, and telephony markets continue to see colossal growth as new ideas and technologies change the way companies conduct their business. AMI-Partners estimates total 1999 IT and telecom/datacom spending among U.S. medium businesses was $68.6 billion, with the IT-only portion accounting for approximately $378, 000 per medium business per year! In the coming year, AMI-Partners estimates that the total IT budget including telecom/datacom will be approximately $85.8 billion.

Presented is a detailed look at the latest research from AMI-Partners as it pertains to the Internet, Web sites, e-commerce, intranets, e-attitudes, and telephony. Key highlights are as follows:

- Per AMI-Partners' estimates, the medium business market consists of approximately 157,000 companies with 100-999 employees. Of this group, 93% may be classified as *core* medium businesses, or those with 100-499 employees. The remainder may be classified as *expanded* medium businesses, having between 500-999 employees.

- AMI-Partners estimates that the total U.S. medium business workforce has 37.4 million employees, 78% of them working for core medium businesses. The U.S. medium business workforce accounts for 27% of the entire U.S. workforce (140 million employees).

- In today's rapidly evolving technological environment, U.S. medium businesses are striving to stay ahead of the curve with routine IT staff training and skills enhancement as they realize the vital importance technology has on the competitive survival of the corporation.

- In reviewing U.S. medium businesses perspectives (e-attitudes) on e-commerce, we find about half of all U.S. medium businesses believe that e-business is critical to the future success of their company.

- U.S. medium businesses continue to work feverishly to implement e-commerce capabilities. Over 50% of U.S. medium businesses believe that being e-commerce enabled is critical to the success of their companies. There is tremendous room for growth in this sector as only about 15% (approximately 23,000) of all U.S. medium businesses are e-commerce enabled.

- Total spending on Internet access and Web-site maintenance is estimated at $1.7 billion, with access accounting for 64%. AMI-Partners continues to believe this proportion will shift in favor of Web-site maintenance as U.S. medium businesses transform their sites into interactive e-commerce platforms.

- Enterprise extension is a critical area driving today's U.S. medium businesses' IT investments, as they look to create the coveted electronic linkages (e-links) with business partners and branch offices. Telephony technologies will forever play a pivotal role in the successful implementation and effectiveness on these e-links.

- Of the over 61,000 core medium businesses expecting to increase their datacom spending in the next 12 months, one in six expect to increase their spending by up to 10%, and another one in ten by over 10%.

- Based on proprietary surveys of small and medium businesses in the United States, Europe, and the Asia/Pacific region, AMI-Partners' comprehensive data in the Internet, IT< e-business, and communications investment and usage is presented in a highly actionable, graphical format with go-to-market insights and analysis.

4. Storage Industry History and Projections

The requirements for the network storage have grown rapidly, as demand for on-line data storage continues to be enhanced by new software and applications. The network storage can be cataloged as three groups: Direct Attached Storage (DAS), Network Attached Storage (NAS) and Storage Area Network (SAN).

DAS includes the single disk drive which is attached to the disk drive bus (e.g., EIDE, SCSI, etc.) internally or externally; or the disk drive array (e.g., RAID, JBOD, etc.) which is attached to the interface port (e.g., SCSI, Fibre Channel, etc.).

NAS appliance is a storage system which is attached to the Local Area Network (LAN) via network fabric (Ethernet), it has its own network identity (IP address). The NAS appliance contains a number of storage devices that are internally controlled by hardware and software. The hardware includes a general-purpose processor, an I/O engine, a Network Interface, and the disk control interface port.. The processor runs software that emulates the file system of clients accessing the NAS appliance.

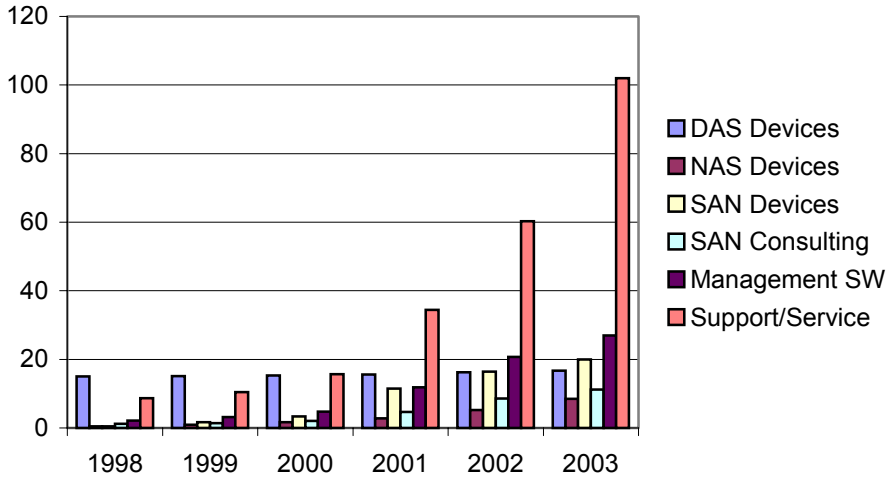
SAN is a dedicated network consisting of diverse storage devices, fast network fabric, fabric channel Switch/Router/Hub which currently employ the Fibre Channel (FC) 1Gbps protocol. (FC 10Gbps standard will be deployed around Q2, 2001). A Storage Area Network (SAN) may incorporate many different types of storage devices (e.g., JBOD, RAID, Tape, etc.), and the capacity of total storage is unlimited.

Table and Figure below show the network storage market growth in those three categories. ($B). It indicates that the total network storage market will be reached $47 billion in year 2003.

Table 2. Network Storage Market Worldwide ($B) Source: IDC (1999)

	1998	1999	2000	2001	2002	2003
DAS Devices	15	15.1	15.3	15.6	16.2	16.7
NAS Devices	0.5	0.9	1.7	2.8	5.2	8.5
SAN Devices	0.5	1.7	3.4	11.5	16.4	20
SAN Consulting	1.2	1.4	2.0	4.6	8.6	11.2

Management SW	2.1	3.2	4.7	11.8	20.7	27.0
Support/Service	8.7	10.4	15.7	34.5	60.3	102
Total	28.0	32.7	42.8	80.8	127.3	185.4



Network Storage Market Worldwide