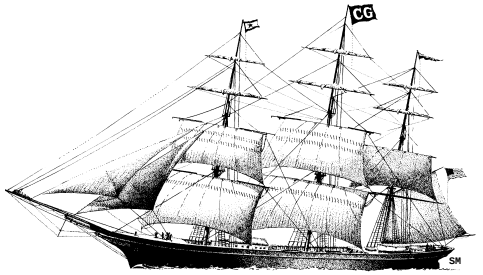
THE CLIPPER GROUP
Explorer™



Navigating Information Technology Horizons℠
Published Since 1993 December 14, 2001

Fibre Channel – The Defending Champion Has Staying Power

Analyst: Michael Fisch

Management Summary

Today, Fibre Channel is the defending heavyweight champion of storage connectivity. In a few short years, it has been adopted by most of the larger enterprises as the best way to connect large-to-massive amounts of storage to a collection of open servers. Even mainframes are using it under the name of FICON. Like any defending champion, Fibre Channel is constantly required to defend this title.

It used to be that defending Fibre Channel was easy. Fibre Channel originated as a replacement for SCSI, the bus technology used for connecting computers to storage devices and other peripherals. Remember those big, thick cables with about a million pins on each end? That was SCSI and it came in many flavors. Then came Fibre Channel with its thin, elegant copper or fiber optic cables. It was superior in all respects – longer cabling distances, faster transfer rates, and practically infinite scalability.

Fibre Channel revolutionized the connection between servers and storage. It enabled the creation of Storage Area Networks (SANs), gave birth to an era of storage consolidation, and offered simplified management. **It simultaneously lowered the total cost of ownership of storage and increased utilization and availability.** It was (and still is) well-conceived and robust!

Today, Fibre Channel has gone from being the challenger to the challenged. On one hand, IP (i.e., TCP/IP over Gigabit Ethernet) is attempting to crash through the walls of the corporate LAN and move into the domain of the Fibre Channel SAN. Why maintain two networks, when one will do? On the other hand, InfiniBand has ambitions beyond replacing the outmoded PCI bus on servers. InfiniBand wants to be the undisputed interconnect for the data center, joining servers to other servers, as well as peripherals like storage. Fibre Channel now finds itself in a defensive position against challengers with a stronger case than the aging SCSI technology. Furthermore, the swells of promotion around IP and InfiniBand are clouding the established virtues of Fibre Channel.

A casual observer might unknowingly assume that Fibre Channel's demise is imminent. It is not. There is going to be a great battle for storage network connectivity, though most large data centers will continue to be dominated by Fibre Channel networks for the foreseeable future. Read on to understand why and to discover why the fight is only in the third round.

IN THIS ISSUE

The Standard Is Fibre Channel

Fibre Channel (FC) was developed in response to the limitations of SCSI[1] technology. As a high-speed parallel bus, SCSI worked well for moving data short distances between servers and dedicated storage arrays. However, direct-attach storage led to disconnected islands of information dispersed throughout many organizations as servers and applications proliferated. It became costly to manage all of these islands and difficult to share, protect, and fully utilize the information they contained. The solution to this problem was centralizing disks into a common pool of storage, and this required a new way to connect to an enterprise's many servers.[2] **Fibre Channel became the new interconnect of choice because it was extremely fast and, unlike SCSI, allowed for extended connections up to 10 km and could be deployed as a highly scalable network.** These Storage Area Networks or SANs enabled tremendous economies of scale in management, higher utilization of storage capacity, and ultimately lower total cost of ownership.

Fibre Channel has become the de facto SAN standard. Virtually all SANs deployed today use Fibre Channel equipment – switches, hubs, host bus adapters, cables, and storage arrays. According to the Fibre Channel Industry Association[3], the installed base of Fibre Channel has been growing at an 85% compound annual growth rate for several years. Fibre Channel switch vendors like Brocade, McData, and QLogic have seen their revenues climb hundreds of percent over the last couple of years. **SANs based on Fibre Channel technology have taken hold in the mainstream storage market. This robust interconnect offers an acceptable answer to most of today's requirements.**

Fibre Channel At A Glance

Fibre Channel is a standard interconnect designed for high bandwidth, robust, low latency data transfer. It has been widely adopted for connecting storage arrays and other peripherals to servers over a common network (SAN). Devices that support Fibre Channel include switches, hubs, host bus adapters, storage arrays, bridges, routers, and tape libraries.

Technical strengths include:

- *Fast* 2 Gbps links, roadmap to 10 Gbps
- *Highly scalable* switched fabric
- *Reliable* links with guaranteed delivery
- *Low latency* channel with minimal host CPU impact and high bandwidth utilization
- *Long-distance* connections to 10+ km

Fibre Channel enjoys the position of a well-entrenched, standards-based technology, which is, by its very nature, difficult to displace. Standards like Fibre Channel are usually the result of collaborative efforts among major vendors and therefore have broad industry support. Most vendors make sure their products support them to maximize their usefulness and appeal. Otherwise, they risk becoming a fringe player. The conservative nature of most IT departments inclines them to buy and deploy standard technologies because they are safe. They have been tried and found true. The lifeblood of a corporation – its information – is too important to risk on anything but a sure thing. They allow buyers to avoid vendor lock-in to a proprietary solution, usually along with the accompanying higher prices. There is also a comfort in knowing other IT shops are using the same technology (i.e., "I won't get fired for buying …"). Finally, entrenched standards create barriers to change, e.g., moving to a different technology means replacing existing equipment, re-training IT personnel, and risking technical shortcomings or interoperability issues. **In short, standards are a refuge of stability in the topsy-turvy world of information technology, and the**

[1] Small Computer Systems Interface, used mainly for storage connectivity.

[2] Networked Attached Storage presented an alternative solution. See **The Clipper Group Explorer** dated September 27, 2000, entitled *SAN versus NAS - The Holy War Not Worth Fighting*.

[3] To learn more about Fibre Channel technology, check out www.fibrechannel.com.

market itself works to keep them in place.

SCSI, for example, has been around since 1982 and is still widely used as an interface for hard disk drives. That's longevity! **There is tremendous market momentum surrounding standards that challengers must overcome.** Surmounting such a hurdle typically requires a quantum leap in price/performance.

Meanwhile, Fibre Channel is not standing still. Products are migrating from 1 to 2 gigabits per second (Gbps), and there is a roadmap in place to reach 10 Gbps, all with forward and backward compatibility. Product interoperability issues are being addressed with the SANmark compliance program, as well as vendor collaboration activities with the support of consortiums like Fibre Channel Industry Association and the Storage Networking Industry Association. For example, Brocade, McData, Compaq, EMC, HDS, and IBM are collaborating on the development of mutually-supported, interoperable multi-vendor SAN solutions. Moving forward, we can expect more plug-and-play between Fibre Channel products as well as extensions to the standard in areas such as quality of service[4] and remote direct memory access (RDMA)[5].

IP Storage Incursion

IP[6] storage certainly has its attractions. Proponents say it will unify the SAN and the LAN under a single, ubiquitous, relatively affordable, matured networking technology. It will bring storage into the domain of the corporate LAN and offer economies of scale in deployment and administration. IP has withstood the Darwinian test of time and has evolved advanced features like security, virtual private networking, and quality of service. Its wide deployment ensures economies of scale in production and therefore a low cost per port. And with the advent of Gigabit and eventually 10 Gigabit Ethernet, its wire speeds rival Fibre Channel. These are powerful arguments in favor of IP storage.

Will IP storage offer a large enough improvement in price/performance to dislodge Fibre Channel from the data center? If IP's relative value is significant in both dimensions, or overwhelming in one and on par in the other, it could be a serious contender.

IP has the upper hand on price. Its scale in production gives it a price-per-port advantage. Fibre Channel is coming down the cost curve, though, and will not be uncompetitive in pricing, especially when IP starts challenging it. There is more human expertise available for managing IP than Fibre Channel, and this can contribute to lower overall management costs for IP networks. It should be noted, however, that managing networked storage is different from managing data networks, and special storage expertise is required whether the SAN is based on IP or Fibre Channel. The good news is that better tools for this task are coming available in the category of storage virtualization[7].

On the performance side, IP falls short of Fibre Channel, though one must look "under the hood" to see why. IP proponents say it is fast enough at 1 Gbps, with 10 Gbps on the horizon. Though wire speeds for both IP and PC technologies are converging on 10 Gbps (many of the underlying components come from the same vendors), it isn't worth debating which will get there first. (In the data center, it isn't about being first.) **IP's performance shortcomings for storage networking do not relate to wire speed but to inefficiencies inherent in the protocol that create latency and consume network bandwidth and host server CPU cycles.**

[4] Quality of service allows data traffic on the SAN to be prioritized to ensure appropriate service levels (i.e., order entry transactions are high priority, tape backup traffic is low priority).

[5] RDMA is a technique for bypassing the operating system during data transfer to further reduce latency and lessen impact on the host CPU.

[6] Internet Protocol. As storage, refers to storing and retrieving data using the TCP/IP protocol, typically over gigabit Ethernet networks.

[7] See *Storage Virtualization in 2001: A Space Odyssey* in **The Clipper Group Explorer** dated April 9, 2001 at www.clipper.com.

As a protocol, IP is optimized for connecting together a large number of geographically-dispersed computers over a patchwork network of varying bandwidths (i.e., the Internet). This is what makes the wonders of the World Wide Web possible. IP breaks up data into packets, wraps them in addressing information and meta data (i.e., information about the data), and sends them. Compared to Fibre Channel, IP requires much more data processing (i.e., protocol overhead) that consumes precious CPU cycles on the server and detracts from application performance. This becomes especially burdensome at gigabit speeds required for storage networking, though special host bus adapters that offload this work onto additional specialized processors are arriving in the marketplace. The processing of overhead also slows the transmission process, and the overhead itself consumes bandwidth on the network and lowers actual data transfer rates well below wire speeds. If other servers are sending information simultaneously or if there is too much network traffic (i.e., congestion), errors can occur and packets must be re-sent. Unlike Fibre Channel, delivery at link level is not guaranteed. The packet loss creates further latency, due to the recovery process. Transaction latency across IP switches (more specifically, Gigabit Ethernet switches) can be *several orders of magnitude* greater than Fibre Channel. This is akin to how long one must stop at a tollbooth on the freeway – the longer the stop, the more it slows network performance. **For demanding applications that require fast, robust access to storage, the latency and resource consumption issues associated with IP make it less attractive than Fibre Channel.**

A number of vendors are working on these problems by trying to accelerate the processing or to circumvent some of the protocol stacks, so the race continues. However, these special technologies will add cost to IP storage solutions, forcing a trade-off with IP's main advantage – price.

On balance, IP's better pricing and less robust performance do not constitute an overwhelming value proposition – not one that will necessarily dislodge a de facto standard like Fibre Channel. Yet some still say the benefits of having a less expensive, unified network overwhelm any performance deficiencies in IP. Using this argument, one could also expect enterprises to use only one type of operating system and one type of server hardware to meet all their IT needs. After all, this would be the most efficient approach. But this is not the case in practice. This may work for many smaller enterprises, but diversity is universal at larger enterprises. Most enterprises deploy everything from workstations to mid-range and high-end servers and even mainframes, depending on the requirements of the application and the enterprise. It is also common to see both Windows NT/2000 and Unix/Linux operating systems in use. Though it would be simpler to pick just one or the other, many organizations value diversity because each has its respective strengths – Unix for its robustness and scalability and Windows NT/2000 for lower cost and ease of use. (Linux, a lower cost Unix derivative, fits somewhere in between.) And let's not forget mainframes, which still offer the highest value, although at a correspondingly higher cost. **Therefore, the "one-size-fits-all" argument for a converged SAN and LAN based on IP does not necessarily fit with the reality of how IT infrastructure is chosen and deployed at most larger enterprises. Application requirements are the key driver of infrastructure decisions.**

Nevertheless, IP will have a significant place in storage networking, but it will not displace Fibre Channel in the data center for the foreseeable future. The advantages of IP storage lend it to customer segments and applications that are more price sensitive and do not require maximum performance. Initial applications for IP storage may include long-distance data transfer for remote mirroring, content distribution, or consolidated tape backup. It could also connect servers in remote buildings or branch offices to the corporate data center.

Furthermore, small- and medium-size enterprises (SMEs) that lack the resources to develop both IP and Fibre Channel expertise and infrastructure may opt for an IP-based storage. The new iSCSI protocol may facilitate the adoption of IP storage by providing block-level access over IP networks[8]. But IP will not be the only contender to Fibre Channel.

InfiniBand Ambitions

InfiniBand also holds promise as a transport for storage networking. This up-and-coming interconnect is designed to replace the aging PCI bus on servers. It offers a scalable, switched-fabric architecture that extends outside of the server to connect devices in the data center. InfiniBand will be fast and reliable and will offer built-in features for service level management and network partitioning. **Put simply, this high performance interconnect is designed for demanding data center applications.**

Furthermore, InfiniBand's widespread support among server vendors will ensure its presence in data centers. InfiniBand promises to revolutionize server architectures by enhancing scalability, flexibility, compactness, and total cost of ownership. As a result, all of the major industry players like Intel, Compaq, Dell, HP, Compaq, IBM, Microsoft and Sun are embracing it. Within two years, the majority of servers shipped are expected to support InfiniBand (significant shipments are expected to begin in the second half of 2002). **This momentum in the server market will be InfiniBand's Trojan horse into the data center, and its ardent proponents would like to see it become the standard high performance interconnect there.**

The same test we applied to IP can be applied to InfiniBand. The central question is: ***Does InfiniBand offer a large enough improvement in price/performance to dislodge Fibre Channel from its leading position in storage networking?***

InfiniBand and Fibre Channel have comparable performance characteristics. Both are high-speed, low-latency, scalable, switched-fabric transports. Both are capable of RDMA for data transfer with extremely low latency and low host CPU utilization[9]. Both offer CRC error detection[10] and link fail-over for high availability and reliability. Both establish connections at the link level and guarantee delivery. Both offer fabric partitioning, also called zoning. Both support serial copper and fiber optic connections. InfiniBand links are 2.5 Gbps, and Fibre Channel is 2 Gbps, with plans to reach 10 Gbps. InfiniBand will eventually have the capability to combine links in 4x and 12x bundles for super high bandwidth. Fibre Channel can effectively scale in a similar way through multiple connections from a host server into the fabric. InfiniBand has advantages in quality of service and in-band management. These are nice features but not distinctions that involve a fundamental shift in value. **Stacked side by side, Fibre Channel and InfiniBand are in the same league of performance.**

In pricing, InfiniBand may be at a disadvantage to Fibre Channel in the short and mid term. InfiniBand is a brand new technology. Products supporting it are only beginning to arrive on the market, and there likely will not be shipments of significant volume until the second half of 2002. Meanwhile, Fibre Channel continues to travel down the cost curve as the explosion in SAN deployment continues. As a result, InfiniBand does not yet have economies of scale in production that Fibre Channel enjoys. **This does not mean InfiniBand cannot be priced competitively out of the chute, but Fibre Channel will have the cost advantage, as well as market mindshare, if a price war ensues.** In the long run, InfiniBand's eventual broad deployment in the server market will give it the scale it needs for cost parity.

[8] See *IBM's iSCSI Leadership Initiative – How To Grow A Market In A Maelstrom* in **The Clipper Group Navigator** dated August 8, 2001 at www.clipper.com.

[9] The approval of Fibre Channel's FC-VI standard is imminent.

[10] Cyclic Redundancy Check is an error-checking technique that helps ensure the integrity of data during transport.

When InfiniBand is ready for prime time, its price/performance ratio will be strong but not necessarily strong enough to displace Fibre Channel. **The necessary quantum leap is not there.** We expect the two technologies will coexist in the data center. Fibre Channel will continue as the main storage interconnect and InfiniBand will dominate other areas like server clustering. Occasionally, they will make incursions into the other's territory, but overall their respective roles will be clear.

Conclusion

IP storage and InfiniBand are preparing to mount an offensive against Fibre Channel's dominance in storage networking. Both bring good reasons to the table why they should own that territory. And indeed, we expect both will find a place there. **However, a careful analysis of the two challengers' value propositions shows that neither will gather enough momentum to topple Fibre Channel's dominance in data center SANs for the foreseeable future.** It takes more than a few good reasons to overturn the market momentum of an entrenched standard, and Fibre Channel still has plenty of punch.

So don't be confused by the hype and promotion. **Fibre Channel is not about to fade away. On the contrary, it is the only proven, high-performance transport for storage networking available today.** And there is every reason to believe Fibre Channel will remain the de facto standard for data center SANs for a long time to come.

About The Clipper Group, Inc.

The Clipper Group, Inc., is an independent consulting firm specializing in acquisition decisions and strategic advice regarding complex, enterprise-class information technologies. Our team of industry professionals averages more than 25 years of real-world experience. A team of staff consultants augments our capabilities, with significant experience across a broad spectrum of applications and environments.

- ***The Clipper Group can be reached at (781) 235-0085 and found on the web at www.clipper.com.***

About the Author

***Michael Fisch* is a Contributing Analyst with the Clipper Group.** He brings over six years of experience in marketing and engineering at computer hardware and software manufacturers. Mr. Fisch worked at EMC Corporation as a marketing program manager focused on service providers and as a market analyst. Prior to that, he worked in international channel development, manufacturing, and technical support at Extended Systems, Inc. Mr. Fisch earned an MBA from Babson College and a Bachelor's degree in electrical engineering from the University of Idaho.

- ***Reach Michael Fisch via e-mail at MFisch@clipper.com or at (781) 235-0085 Ext. 36.***

Regarding Trademarks and Service Marks

The Clipper Group Navigator, **The Clipper Group Explorer**, **The Clipper Group Observer**, and **The Clipper Group** Captain's Log are trademarks of The Clipper Group, Inc., and the clipper ship drawings, *"Navigating Information Technology Horizons"*, and "teraproductivity" are service marks of The Clipper Group, Inc. The Clipper Group, Inc., reserves all rights regarding its trademarks and service marks. All other trademarks, etc., belong to their respective owners.

Disclosure

Officers and/or employees of The Clipper Group may own as individuals, directly or indirectly, shares in one or more companies discussed in this bulletin. Company policy prohibits any officer or employee from holding more than one percent of the outstanding shares of any company covered by The Clipper Group. The Clipper Group, Inc., has no such equity holdings.

Regarding the Information in this Issue

The Clipper Group believes the information included in this report to be accurate. Data has been received from a variety of sources, which we believe to be reliable, including manufacturers, distributors, or users of the products discussed herein. The Clipper Group, Inc., cannot be held responsible for any consequential damages resulting from the application of information or opinions contained in this report.