THE FIBRE CHANNEL ROADMAP

THE PAST, PRESENT AND FUTURE OF FIBRE CHANNEL

FCIA
FIBRE CHANNEL INDUSTRY ASSOCIATION

Thanks to the Ethernet Alliance for sharing graphics from www.ethernetalliance.org/roadmap/
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www.fibrechannel.org/roadmap.html

GENERATIONS OF FIBRE CHANNEL

FIBRE CHANNEL SPEEDMAP

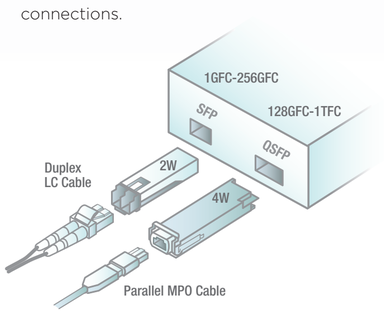
Fibre Channel has a laser-focus on speed and continues to progress at a blistering pace. Fibre Channel is continually evolving to higher speeds to meet the high bandwidth needs of storage applications. When large blocks of data are moved between servers and storage, the performance of the application is directly dependent on how fast the data can fly. The storage industry has come to rely on Fibre Channel to deliver superior performance and reliability for mission-critical applications.

Fibre Channel has traditionally doubled link throughput when the available technology can fit in the SFP form factors. The two lower lines on the graph at the left show the exponential growth in serial speeds of Fibre Channel and Fibre Channel over Ethernet. 8GFC and 10GFCoE require the SFP+ form factor that supports speeds up to 10 Gb/s since the SFP form factor only supported up to 5 Gb/s. 32GFC requires the SFP28 that supports 28Gb/s and 25GbE. The SFP form factor will continue to evolve and support speeds over 100 Gb/s in the next decade.

With Gen6 Fibre Channel, the T11 technical committee has developed the 32GFC SFP28 as well as the 128GFC QSFP28 that aggregates 4 lanes into a single module. Fibre Channel and Ethernet are both adopting these 4X technologies in QSFP form factors to meet the needs of inter-switch links that aggregate bandwidth from multiple sources. The upper two curves on the chart on the left show how the 4X technologies are creating incredibly high speeds needed for core networking. Instead of running 4 SFP-based links, the industry uses parallel optics in the MPO connector to deliver over 100Gb/s of bandwidth in one QSFP port.

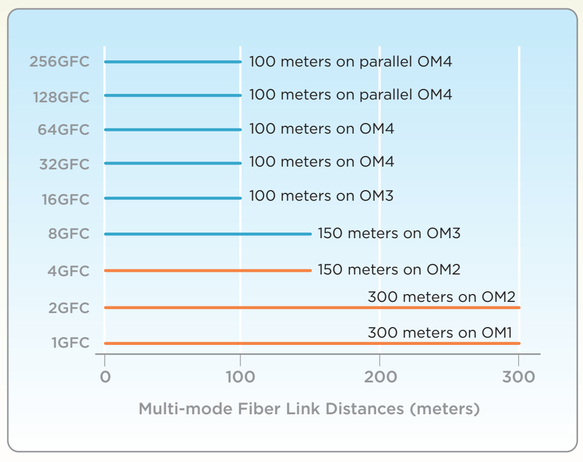
MEDIA AND MODULES

Fibre Channel is focused on storage in the data center and uses the latest fiber optic technologies to deliver massive bandwidth. Every few years, Fibre Channel doubles its data rate to provide exponential growth in speeds. In 2016, Fibre Channel introduces "Gen6 Fibre Channel", which consists of two speeds — 32GFC in the SFP28 form factor, and 128GFC in the QSFP28. 32GFC uses duplex fibers while 128GFC is based on quad lanes that use the MPO connectors. This trend is expected to continue with serial lanes for connectivity to servers and storage and quad lanes for network connections.



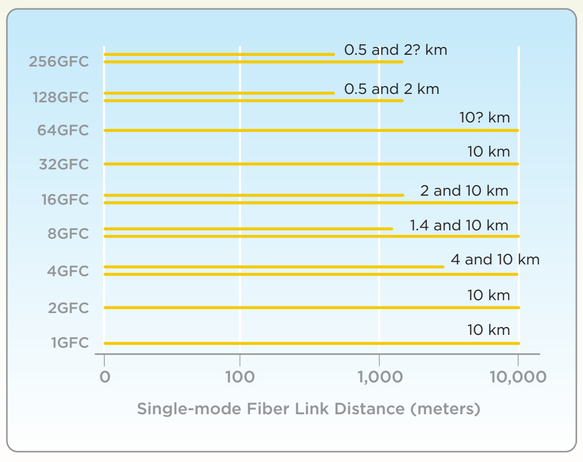
MULTIMODE FIBER LINKS

Over 90% of Fibre Channel links are based on multimode fiber and vertical cavity surface emitting lasers (VCSELs). Fibre Channel has deployed more optical bandwidth than any other protocol and benefits from the reach capabilities and reliability of each generation of Optical Multimode (OM) fiber. Fibre Channel is maintaining multimode link distances of 100 meters to support common architectures in data centers.



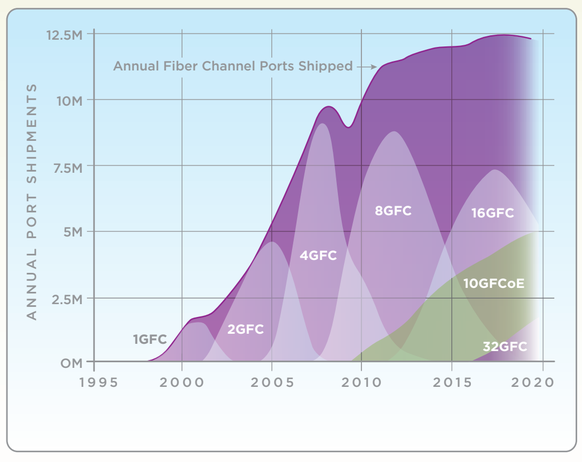
SINGLE-MODE FIBER LINKS

For distances over 100 meters which are usually outside of rooms or between data centers, Fibre Channel uses single-mode links. Distances of 10km or longer have always been supported for every speed except 128GFC and vendors often surpass the standard to support even longer metro-distances. Fibre Channel has proven solutions for mapping Fibre Channel over intercontinental distances for disk mirroring and data synchronization.



FIBRE CHANNEL SHIPMENTS

According to the research firm Dell'Oro, Fibre Channel port shipments will to continue to grow and reach over 12 million ports in 2016 for the first time. Throughout their 5-year forecast to 2019, Dell'Oro expects the industry to continue shipping over 12 million ports per year. Despite predictions and forecasts, Fibre Channel continues to grow with each shipment and delivers the scalability, speed and reliability on which thousands of companies depend.

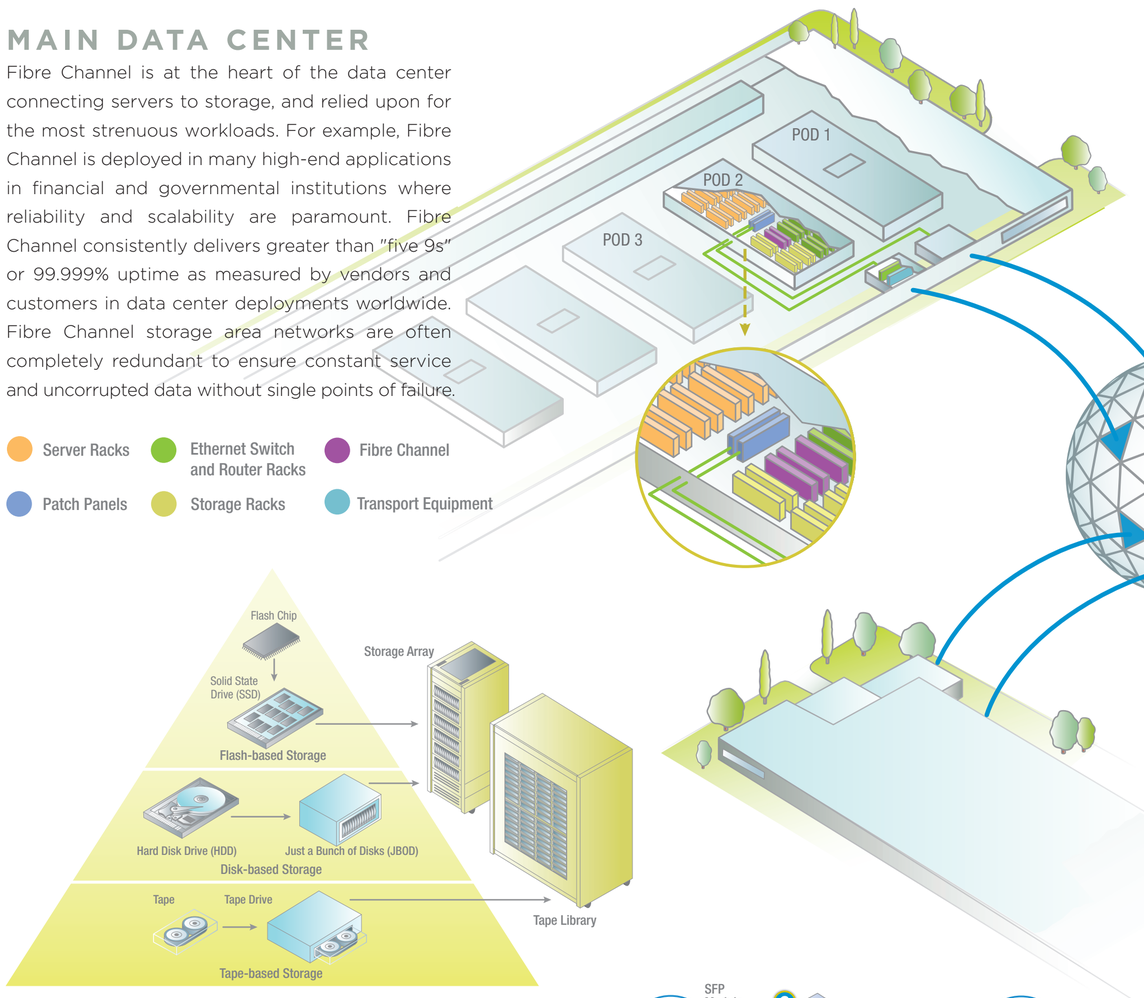


Find out more about the Fibre Channel Roadmap at www.fibrechannel.org/roadmap.html

STORAGE AREA NETWORKS

MAIN DATA CENTER

Fibre Channel is at the heart of the data center connecting servers to storage, and relied upon for the most strenuous workloads. For example, Fibre Channel is deployed in many high-end applications in financial and governmental institutions where reliability and scalability are paramount. Fibre Channel consistently delivers greater than "five 9s" or 99.999% uptime as measured by vendors and customers in data center deployments worldwide. Fibre Channel storage area networks are often completely redundant to ensure constant service and uncorrupted data without single points of failure.



DISASTER RECOVERY SITE

This disaster recovery site mirrors data via Fibre Channel to multiple sites and archives data in tape libraries and virtual tape libraries. In the case of a remote site failure, the disaster recovery site goes live and secondary servers are activated to become primary servers. Fibre Channel uses Fibre Channel Internet Protocol (FCIP) and transport (DWDM or long haul) networks to connect multiple data centers around the world to keep data synchronized and highly available. Solutions based on Fibre Channel have proven their effectiveness in ensuring highly reliable data transfers at gigabit/second speeds.

MAINFRAMES

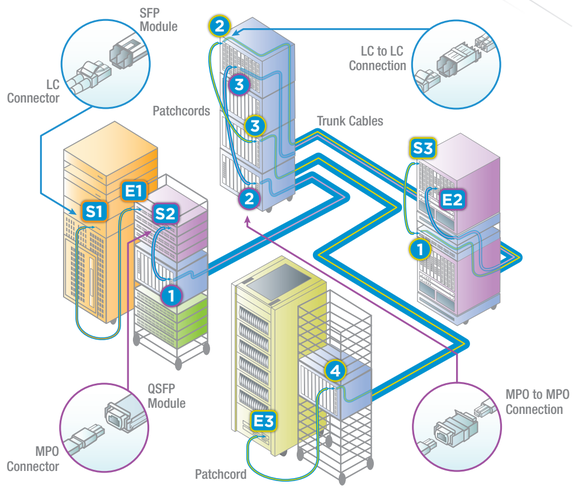
Mainframes are still at the heart of most financial transactions because of their proven reliability and scalability. Often considered a different data center within a data center, mainframes have reliability requirements over "five-9s" and FICON (Fibre Channel used in mainframes) connects to storage, tape libraries and printers reliably and securely.

STORAGE HIERARCHY

The venerable storage triangle shows how flash has traditionally been used for the highest performing applications while hard disk drives are used for mainstream storage and tape for archiving. The rapid growth in capacity and reduction in cost of NAND Flash technology could turn the storage triangle upside down by enabling flash-based archival storage products. Delivering higher throughput, lower latency and low power, the flash based storage should enable >10TB SSDs in 2016 and drive the need for high speed Fibre Channel.

CABLING SYSTEMS

The diagram on the right shows three typical links between servers and storage. Link 1 from a server to an edge switch has no fiber optic connections and is a simple point-to-point link. Link 2 is a 128GFC Inter-Switch Link (ISL) from a QSFP28 to a QSFP28 that is connected with MPO connectors. Link 3 connects switches to storage via two trunk cables and has 4 LC connections with up to 1.5dB of connector loss to support 100 meters.



Link	Start	End	Connections	# of Fibers
1	Server (S1)	Edge Switch (E1)	0	2
2	Edge Switch (S2)	Core Switch (E2)	3	12
3	Core Switch (S3)	Storage Array (E3)	4	2

SERVER CONNECTIONS

Servers are connected to Fibre Channel networks with host bus adapters (HBAs) or converged network adapters (CNAs). HBAs adapt Peripheral Component Interconnect (PCI) connections to Fibre Channel ports. CNAs support Fibre Channel over Ethernet (FCoE) and have Ethernet ports that typically connect to edge switches that connect the Fibre Channel traffic to the core of the SAN. HBAs and CNAs often have multiple ports that are connected to dual fabrics to ensure high availability.

DISK MIRRORING

To ensure that every transaction is reliably processed, disk arrays are mirrored between data centers. Often spanning thousands of miles, primary disk arrays are mirrored so that the secondary disk array contains the exact same information upon failure of the primary.

DUAL FABRICS

To ensure application uptime and highly reliable access to data, Fibre Channel fabrics are usually configured with an "air gap" between redundant fabrics. The air gap means that fabric "A" can completely fail and the backup fabric "B" will become the primary so that servers don't lose access to their valuable data.

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