Fibre Channel over Ethernet

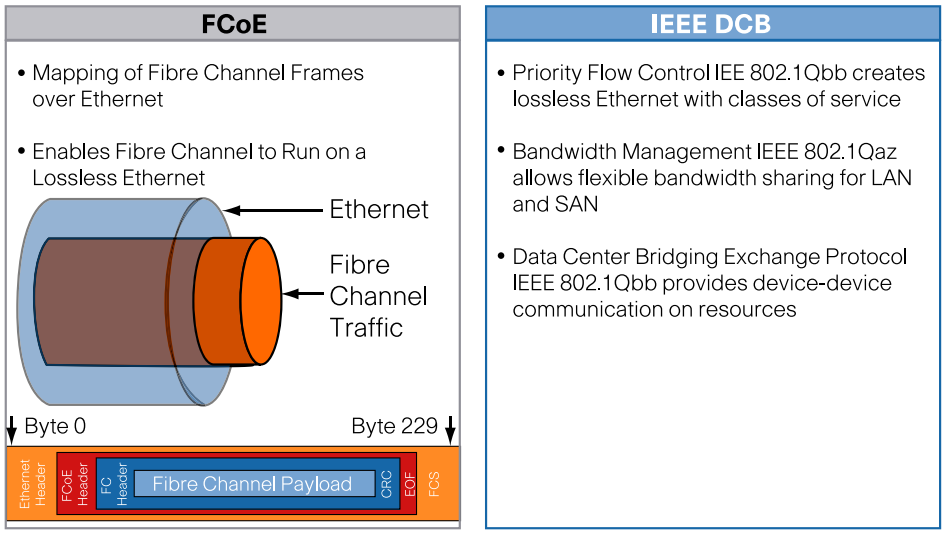
At-A-Glance

What Is Fibre Channel over Ethernet?

Fibre Channel over Ethernet (FCoE) is the next evolution of the Fibre Channel networking and Small Computer System Interface (SCSI) block storage connectivity model. FCoE maps Fibre Channel onto Layer 2 Ethernet, allowing the combination of LAN and SAN traffic onto a link and enabling SAN users to take advantage of the economy of scale, robust vendor community and roadmap of Ethernet. The combination of LAN and SAN traffic on a link is called unified fabric. Unified fabric eliminates adapters, cables and devices, resulting in savings that can extend the life of the data center. FCoE enhances server virtualization initiatives with the availability of standard server I/O, which supports the LAN and all forms of Ethernet-based storage networking, eliminating specialized networks from the data center. FCoE is an industry standard developed by the same standards body that creates and maintains all Fibre Channel standards. FCoE is specified under INCITS as FC-BB-5.

FCoE is complemented by new facilities in Layer 2 Ethernet called Data Center Bridging (DCB). DCB is a collection of IEEE 802.1 standard enhancements that allows the LAN behavior of dropping packets upon congestion to co-exist with the SAN requirement of no loss of frames. Classes of service (CoSs) allow this behavior, and new bandwidth management tools enforce appropriate use of bandwidth among the classes. In this way, LAN scaling and the deterministic needs of SAN I/O are made compatible (Figure 1).

Figure 1. Enabling Technologies for Fibre Channel over Ethernet



Why Is FCoE Evolutionary?

FCoE is evolutionary in that it is compatible with the installed base of Fibre Channel as well as being the next step in capability. FCoE can be implemented in stages non-disruptively on installed SANs. FCoE simply tunnels a full Fibre Channel frame onto Ethernet. With the strategy of frame encapsulation and de-encapsulation, frames are moved, without overhead, between FCoE and Fibre Channel ports to allow connection to installed Fibre Channel. In support of FCoE, all the Fibre Channel network services, nomenclature, behaviors, and network tools remain intact. SAN administrators manage Fibre Channel flows in a manner very similar to that used today.

This sort of evolutionary transition has occurred before. In the mid 1990s, the SCSI protocol implemented over a bus architecture was the standard for block attached storage. However, storage assets coupled with individual servers used capacity inefficiently, so a networking model for storage was created, along with the capability to consolidate storage. Because valuable and robust driver and firmware technology needed to be preserved, not reinvented, the SCSI protocol became the upper-layer protocol of the Fibre Channel networking model. Thus, a new physical infrastructure was created for SCSI with significant investment in creation of a robust networking model. This process is being repeated today but with the difficult work of network model creation done, and the porting of SCSI and Fibre Channel now occurring over proven 10 Gigabit Ethernet.

FCoE Devices

To implement FCoE and unified fabric, at least two devices are required: a lossless Ethernet switch that can forward Fibre Channel frames and a multifunction server adapter that supports the LAN and SAN.

Cisco has offered FCoE and unified fabric capability on the Cisco Nexus® 5000 Series Switches since June 2008. The Cisco Nexus 5000 Series consists of lossless, line-rate 10 Gigabit Ethernet switches that optionally support FCoE and unified fabric on every port. To integrate with installed SANs, native Fibre Channel ports are available for connection to Fibre Channel storage, Fibre Channel host bus adapters (HBAs), and Fibre Channel switches. The foundation of the Cisco Nexus 5000 Series as true 10 Gigabit Ethernet LAN switches allows them to be deployed across a data center's access layer for all purposes. Cisco® NX-OS Software supports both the LAN and SAN for a single data center operating environment.

A powerful new feature of FCoE networks is support for Ethernet pass-through switches. An Ethernet pass-through switch forwards Fibre Channel frames as an upper layer protocol. These switches must be lossless, but they require no knowledge of Fibre Channel technology as long as an FCoE-aware switch exists upstream in the I/O flow.

Thus, specialized Fibre Channel networks can begin to match the economics of Layer 2 Ethernet networks. Cisco Nexus 4000 Series Switches are the first such lossless Ethernet switches capable of participating in Fibre Channel and FCoE networks. The Cisco Nexus 4000 Series is a blade server switch compatible with IBM BladeCenter series H and HT.

Converged network adapters (CNAs) support both LAN plus SCSI and Fibre Channel operating system stacks and can place 10 Gigabit Ethernet LAN and FCoE traffic on the network wire. A CNA can function as just a LAN network controller or a network interface card (NIC) but also have the additional capability of FCoE. A 10 Gigabit Ethernet CNA typically replaces multiple adapters per server and generally simplifies server physical I/O requirements. Fibre Channel HBA industry leaders QLogic and Emulex market CNAs, with NIC volume leaders preparing offerings for the future. CNA market participation shows how unified fabric and FCoE together provide more competitive choices to users.

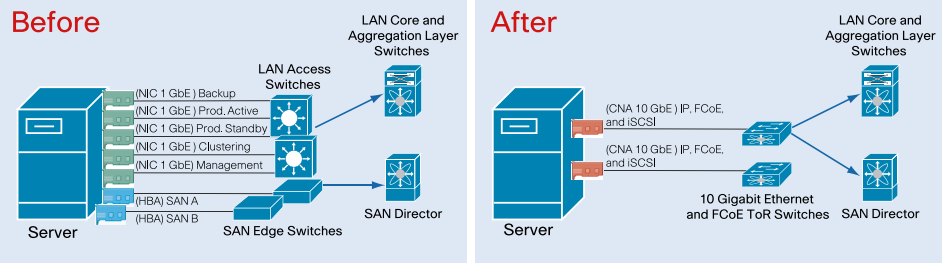
Implementing FCoE

Today the Cisco Nexus 5000 Series enables unified fabric solutions at the server access layer, typically as top-of-rack (ToR) switches. Future availability of distribution and core switches with FCoE line cards and storage devices with FCoE interfaces will allow implementation of FCoE fabrics above the access layer and across the network. However, there are powerful benefits to implementing FCoE at the access layer and scaling horizontally with the deployment of servers. These benefits include:

- Reduction in the number of adapters and network infrastructure devices
- Reduction in the number of cables
  - Allows economical blend of inexpensive copper and longer-link optical technologies
  - Reduces cable installation expenses
  - Significantly reduces the number of long cables
  - Can increase server density if server deployment is impeded by cable bulk or airflow concerns
  - Reduces the possibility of air dams in the data center
  - Reduces cable maintenance and provisioning concerns in the data center
- Reduction in the amount of power used
- Reduction in space used due to switch equipment rack occupancy
- Reduction is server height due to fewer add-in card slot requirements if servers are I/O bound
- Redeployment of power and space savings to provisioning of additional servers, extending the life of the data center

Figure 2 illustrates the benefits of FCoE.

Figure 2. FCoE Eliminates Devices at the Access Layer



Following are typical methods of implementing FCoE and unified fabric:

- For larger networks, fully implement I/O consolidation of the LAN, network-attached storage (NAS), and SAN at the access layer, and scale with server deployment. I/O above the access layer either continues as specialized networks or is further consolidated over Ethernet at a later time when modular switch technology is ready.
- For smaller networks, implement a full unified fabric network with a single Cisco Nexus 5000 Series Switch, and direct attach either native Fibre Channel or FCoE storage devices to the Cisco Nexus 5000 Series Switch.
- Consolidate storage networks only over 10 Gigabit Ethernet. This implementation would include iSCSI and FCoE block attached storage (SAN) as well Common Internet File System (CIFS) and Network File System (NFS) file attached storage (NAS). The LAN is left unconsolidated. FCoE is the last and missing element in a unified storage network strategy. Incorporation of the LAN can optionally occur in a later deployment.
- Implement FCoE-ready technology at the access layer and migrate to unified fabric at a later date. The Cisco Nexus 5000 Series are powerful LAN switches, and when complemented with the Cisco Nexus 2000 Series Fabric Extenders, they represent a full access-layer solution for Gigabit Ethernet and 10 Gigabit Ethernet LANs.

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