

The Transition to 10 Gigabit Ethernet Unified Networking: Cisco and Intel Lead the Way

WHAT YOU WILL LEARN

In recent years, growth in Ethernet-based storage has surpassed that of storage-specific fabrics, propelled in large part by the increase in server virtualization. Unified networking over 10 Gigabit Ethernet in the data center offers compelling benefits for the evolving virtualized data center, including a simplified infrastructure, lower equipment and power costs, and greater flexibility. Ethernet is the foundation of cloud computing, and easy and simple access to the SAN will be critical as virtualization deployments continue to grow and new, on-demand data center models emerge.

Intel and Cisco are two companies leading the transition to 10 Gigabit Ethernet unified networking. This document explores the benefits of unified networking and approaches to enabling it and the ways that Intel and Cisco are helping to bring important consolidation technologies to enterprise data center customers.

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SIMPLIFYING THE NETWORK WITH 10 GIGABIT ETHERNET

As IT departments look for ways to reduce costs and improve server efficiency, they are turning increasingly to server virtualization and consolidation. The benefits of virtualization are widely understood: less server hardware to purchase, reduced power and cooling needs, and centralized management. Today's servers are based on powerful new processors, including the Intel® Xeon® processor 5600 and 7500 series, that support more virtual machines per physical host than ever before, helping IT achieve greater consolidation ratios.

- The latest generation of Intel Xeon processors enables IT to consolidate servers at a 15:1 ratio, delivering power savings of up to 90 percent and a 5-month return on investment (ROI).
- New four-socket processors are delivering 20 times the performance of previous-generation processors.
- Nearly 50 percent of the four-socket servers shipped today are being used for virtualization.¹

Unfortunately, the success achieved by many organizations in attaining these benefits has been hindered by past practices for networking virtualized servers. As virtual machine density increases, a physical server's networking needs also increase, adding both cost and complexity. A typical virtualized server contains 8 to 10 Gigabit Ethernet LAN ports and 2 dedicated SAN ports (Figure 1).



Figure 1. Multiple gigabit Ethernet connections in a typical virtualized server.

As the use of server virtualization continues to grow, 10 Gigabit Ethernet unified networking is simplifying server connectivity (Figure 2). Consolidating the traffic of multiple Gigabit Ethernet connections onto a single 10 Gigabit Ethernet adapter significantly reduces cable and infrastructure complexity and overall total cost of ownership (TCO). Enhancements to the Ethernet standard also enable 10 Gigabit Ethernet support for both LAN and SAN traffic, allowing IT to achieve further benefits by converging data and storage infrastructures. As a result of its ubiquity, cost effectiveness, flexibility, and ease of use, Ethernet has emerged as the unified data center fabric.

10 GIGABIT ETHERNET: THE FABRIC OF CLOUD COMPUTING

The growth in server virtualization has helped data center networks evolve from discrete, siloed infrastructures to more flexible fabrics with the scalability and agility necessary to address the needs of new usage models and provide an excellent foundation for enterprise cloud computing.

More than 2.5 billion users will connect to the Internet in the next 5 years² with more than 10 billion devices.³ This usage will require eight times the amount of storage capacity, 16 times the network capacity, and more than 20 times the computing capacity by 2015.⁴ A new infrastructure must emerge to power this growth and



Figure 2. Simplified server connectivity using 10 Gigabit Ethernet.

enable the most efficient use of resources. This infrastructure is cloud computing. The cloud is an evolution of computing that delivers services over the Internet to consumers and enterprises. Services scale—as needed and only when needed—without user intervention. A highly scalable and efficient cloud architecture is needed to provide both the technical attributes and the extreme resource utilization and efficiency that cloud computing promises.

With its reduced hardware requirements, fewer points of management, and broad ecosystem support, 10 Gigabit Ethernet delivers the flexible, simplified network infrastructure needed to support cloud computing. The following characteristics make 10 Gigabit Ethernet the ideal fabric for cloud infrastructure:

- **Ubiquity.** Ethernet connectivity ships standard on nearly every server today, and Ethernet infrastructure is a universal data center component. When 10 Gigabit Ethernet LAN-on-motherboard (LOM) connections are integrated into the next generation of servers, unified LAN and SAN connectivity will be a feature available by default.
- **Advanced virtualization support.** Advanced server virtualization enables dynamic resource allocation and is required for any cloud computing infrastructure. Technologies from companies such as Intel, Cisco, VMware, and Microsoft are delivering line-rate 10 Gigabit Ethernet throughput and support for platform virtualization enhancements.
- **Unified networking.** A 10 Gigabit Ethernet unified fabric simplifies the network infrastructure by consolidating LAN and SAN traffic. Recent Ethernet enhancements help ensure quality of service (QoS) for critical traffic.

THE PROMISE OF ETHERNET STORAGE

New usage models and the dramatic growth of data in their organizations have forced IT administrators to confront complicated technical and business challenges. Today, most IT departments deploy separate LAN and storage networks, with storage often divided between network-attached storage (NAS) for file-based applications, and SAN (Fibre Channel and Small Computer System Interface over IP [iSCSI]) for block-based applications. The goal of unified networking is to allow a single-network infrastructure, based on 10 Gigabit Ethernet, to carry all these disparate traffic types.

Ethernet has served as a unified data center fabric for years, supporting LAN, NAS (Network File System [NFS] and Common Internet File System [CIFS]), and iSCSI SAN traffic. With recent Ethernet enhancements and the ratification of the Fibre Channel over Ethernet (FCoE) specification, Ethernet adapters based on IEEE Data Center Bridging (DCB) can now help connect servers to Fibre Channel SANs. Extending Ethernet's ubiquity and

wide familiarity to Fibre Channel SAN traffic will help accelerate the move to 10 Gigabit Ethernet-based I/O consolidation in virtualized data centers, reduce costs, and enable simplification and agility.

Given its flexibility and long history, it is not surprising that Ethernet storage is the fastest growing segment of the storage systems market. The industry research firm IDC⁵ estimates that the worldwide Ethernet-based storage systems (NAS and iSCSI SAN) market had a compound annual growth rate (CAGR) of approximately 23 percent between 2005 and 2009 (Figure 3). iSCSI storage shipments experienced the highest growth rate (70 percent) from 2005 to 2009, as a result mainly of broad iSCSI adoption in Microsoft Windows, virtual server, and blade server environments.

Industry analysts project continued gains in the Ethernet storage market share due to increasing deployment of Ethernet-only data centers (which use a unified 10 Gigabit Ethernet infrastructure for all data and storage traffic), the emergence of cloud computing, and the increasing deployment of FCoE solutions.

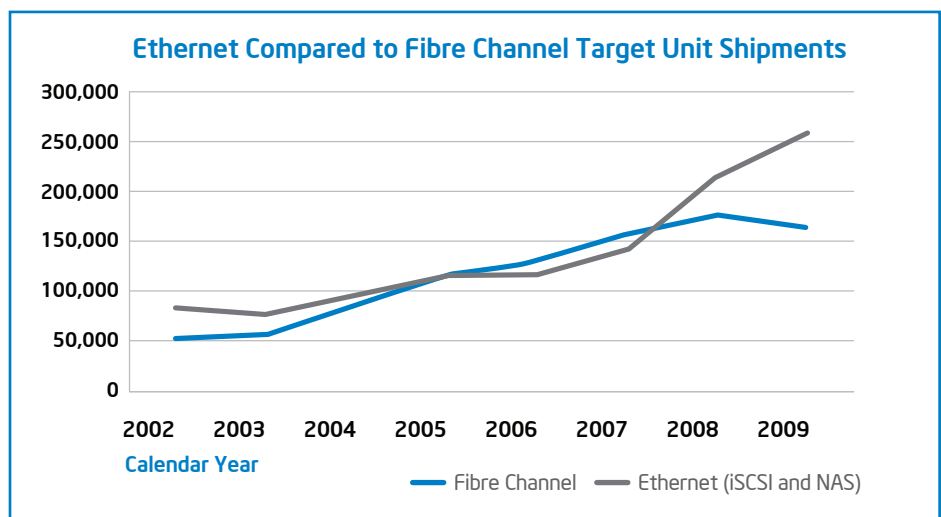


Figure 3. Actual unit shipments for Ethernet and Fibre Channel storage (IDC, 2009).

Ethernet Enhancements for Storage

IEEE DCB for Lossless Ethernet

To strengthen 10 Gigabit Ethernet as a unified data center fabric, the IEEE has standardized Ethernet enhancements to support storage traffic, including FCoE and iSCSI. These extensions, known collectively as Data Center Bridging, or DCB, enable better traffic prioritization over a single interface and an advanced means for shaping traffic on the network to decrease congestion. In other words, DCB delivers a lossless Ethernet fabric for storage traffic.

FCoE: Enabling End-to-End Unified I/O

FCoE is a logical extension of Ethernet that uses Fibre Channel's network, service, and protocol layers to carry data packets over Ethernet's physical and data link layers. Fibre Channel's unique network-centered management model has proven administrative capacity to scale to thousands of end nodes in a data center. The use of Fibre Channel's higher layers smooths the transition to FCoE because existing SAN-based applications do not need to change to benefit from the performance and cost benefits of FCoE. The provisioning responsibilities, now split between the server and storage administrators, can be maintained in the transition from Fibre Channel SANs to Ethernet-based FCoE-powered SANs. In addition, Ethernet links for FCoE traffic can be used in conjunction with native Fibre Channel links for the same traffic flow. This capability enables existing Fibre Channel SANs to be extended with new servers or storage using converged LAN and FCoE SAN links as needs change.

Many enterprises have extensive Fibre Channel installations, and the availability of software-based FCoE initiators makes the Fibre Channel SAN easily accessible for any server with a 10 Gigabit Ethernet port. By allowing Fibre Channel technology to use DCB-capable Ethernet, FCoE eliminates the need for dedicated Fibre Channel host bus adapters (HBAs), reducing cabling and switch-port requirements, while coexisting with existing Fibre Channel infrastructures. The result is a simplified data center infrastructure, lower equipment and power costs, and universal SAN connectivity across the data center over the trusted Ethernet fabric.

INTRODUCING THE OPEN FCOE ARCHITECTURE

The Open FCoE approach consists of standard 10 Gigabit Ethernet adapters and native OS-based FCoE initiators, which together provide a robust, scalable, and high-performance server connectivity option without expensive, proprietary hardware. As shown in Figure 4, Open FCoE implements the complete Fibre Channel protocol in the OS kernel. It provides libraries for different system-level implementations, allowing vendors to implement dataplane functions of the FCoE stack in hardware to deliver optimum performance.

Open FCoE: Momentum in the Linux Community

The Linux* community accepted the Open-FCoE project in November 2007 with the goal of accelerating development of a native FCoE initiator in the Linux kernel. The industry responded enthusiastically, and today there are more than 190 active participants in the community who are contributing code, providing review comments, and testing the Open FCoE stack. To date,

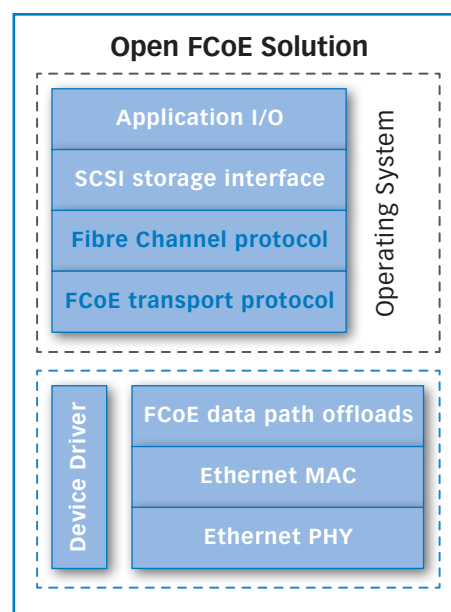


Figure 4. Overview of the Open FCoE initiator solution.

the Open FCoE source web site (www.open-fcoe.org) has received more than 20,000 hits. Open industry standards and open source technology play significant roles in the modern data center, reducing R&D investment and enabling access to a multivendor supply chain that is designed for heterogeneous interoperability, ultimately resulting in greater choice and lower equipment costs.

The Open FCoE approach offers a number of advantages in accessibility and ease of use:

- **Accessibility.** The Open FCoE approach makes Fibre Channel SAN access available to any server with a DCB-capable 10 Gigabit Ethernet adapter installed. IT departments can standardize on these adapters to simplify server connectivity across multiple use cases. With FCoE support integrated into the OS, Fibre Channel SAN access will become readily available across these converged networks and even more accessible when 10 Gigabit Ethernet LOM technology becomes pervasive.

- **Ease of use.** Because the Open FCoE approach uses standard DCB-capable 10 Gigabit Ethernet adapters that comply with broad, well-known Ethernet standards, IT can use existing knowledge to configure and manage these adapters for FCoE deployments. In fact, IT can standardize on a single product or product family for all LAN and SAN connectivity. FCoE initiator integration into the OS also means common OS-based tool support across a product family, or even the use of adapters from multiple vendors, as they become available.

Native Initiator Success: iSCSI

iSCSI provides an excellent example of the success of native storage initiators integrated into the OS. Today, all major OSs include native iSCSI support, delivering the same benefits as already discussed. Native iSCSI initiators have continued to mature and now support advanced adapter features and platform advancements that help deliver excellent performance. In fact, Intel recently demonstrated a standard Intel® Ethernet 10 Gigabit Server Adapter supporting 1.25 million I/O operations per second (IOPS) using the native iSCSI initiator in Microsoft Windows Server* 2008 Release 2.⁶

IT departments standardizing on Intel® Ethernet Server Adapters for iSCSI connectivity can use a single initiator, TCP/IP stack, and set of management tools and IT policies. Easier server provisioning, lower likelihood of human error, and simpler management help enable lower capital and operational expenditures. This standardization also allows IT to gain the benefits of simplified management and integrated tools. Intel expects the same benefits for Open FCoE-based solutions.

INTEL AND CISCO: LEADING THE WAY TO A UNIFIED FABRIC

As established leaders in Ethernet, Intel and Cisco are uniquely positioned to lead the industry transition to a unified 10 Gigabit Ethernet fabric. Together these companies led the DCB standards effort, and they were the first companies to include DCB and FCoE support in their products: Cisco in switches, and Intel in server adapters. Unified fabric support is a critical feature in products from each company, and these solutions enable infrastructure simplification, offer industry-leading virtualization support, and lay the foundation for dynamic, on-demand cloud computing models.

Intel® Ethernet Unified Networking

Ethernet is the foundation of unified networking, and Intel has 30 years of experience delivering high-quality Ethernet products. Intel is the volume leader in Ethernet adapter shipments and has led the industry through speed transitions and enhancements to the Ethernet standard.

Broad Support Commitment

Intel® Ethernet products have the broadest OS support in the industry, and Intel's long-term product plans align future products with new server platform capabilities and upcoming data center trends, including cloud computing. Intel is expanding the capabilities of its trusted Ethernet product line to incorporate FCoE for true unified networking. Qualification by leading storage vendors means that customers can be confident that servers with the Intel Ethernet Server Adapter X520 installed will interoperate with their storage systems.

Cost-Effective Efficiency

Standardizing on Intel Ethernet 10 Gigabit Server Adapters uses Ethernet economics for cost-effective, broad-based unified networking deployment. A single Intel Ethernet Server Adapter X520 supports FCoE, iSCSI, NAS, and LAN traffic for true unified networking without the need for expensive upgrades.

In terms of performance, the Intel Ethernet Server Adapter X520 combines high throughput, intelligent hardware-based offloads with native OS initiators, and stable hardware, while leaving processor cycles available for application processing. These adapters offload the main data paths to improve FCoE throughput. The net result is excellent FCoE performance for real-world workloads.

In real-world implementations, SAN performance is determined by a number of factors, including application threading and storage target processor and disk speeds. At typical IOPS levels, processor utilization is typically quite low, in part because of recent increases in processor performance.

Ease of Use

By using the native storage initiators integrated into the OS, the Intel Ethernet Server Adapter X520 makes it easy to connect any server to the SAN. Standardizing on the Intel Ethernet Server Adapter X520 product line delivers a number of benefits to enterprise IT:

- Trusted OS-based initiators
- Same interface to configure an adapter for LAN or SAN traffic (Figure 5)
- Plug and Play with existing management tools
- No proprietary software to install

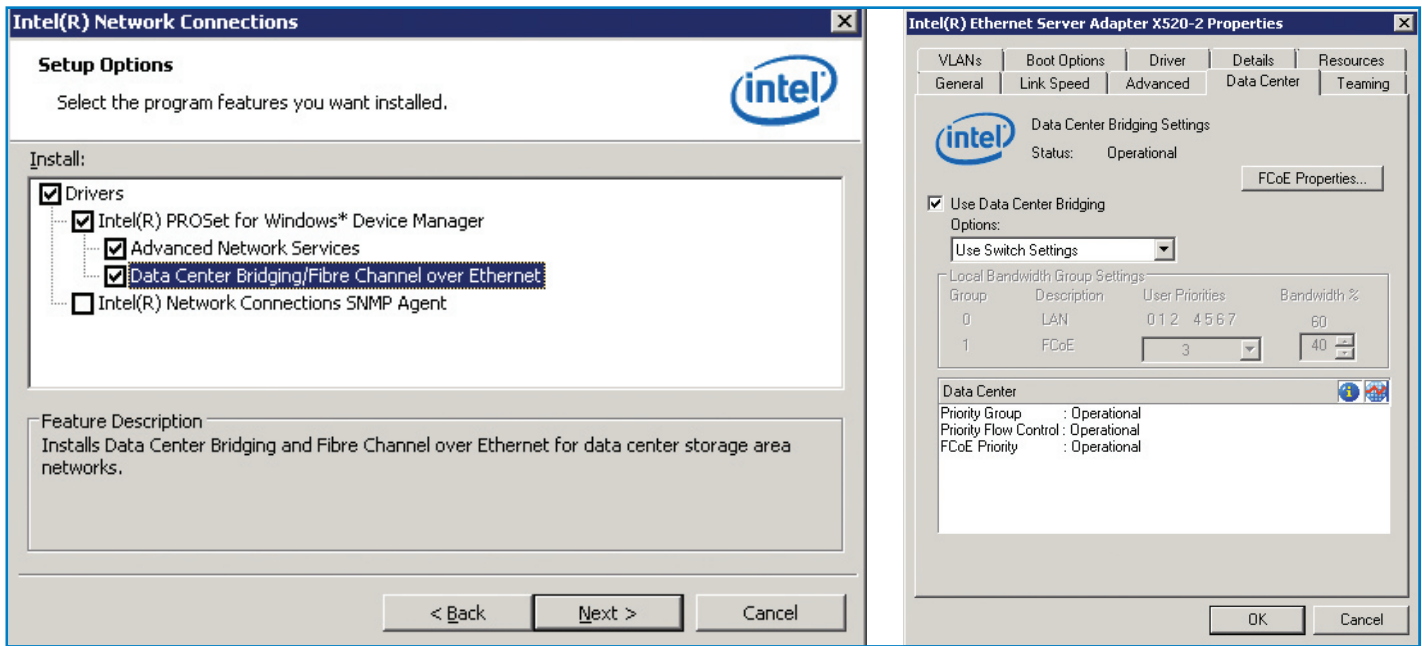


Figure 5. IT administrators use the same interface for configuring LAN and Fibre Channel SAN traffic.

Cisco Unified Fabric

Cisco Unified Fabric provides a key building block for both traditional and virtualized data centers that helps unify storage and data networking to deliver seamless convergence and scalability with reduced total cost of ownership and faster return on investment. It provides the flexibility of high-performance, highly available networks to serve diverse data centers needs including the lossless requirements to carry storage traffic (FC, FCoE, iSCSI, NAS) over Ethernet. Offering the best of both LAN and SAN worlds, Cisco Unified Fabric enables storage network users to take advantage of the economy of scale, robust vendor community and aggressive roadmap of Ethernet while providing high-performance, lossless characteristics of a Fibre Channel storage network.

Cisco Nexus 5000 Series Switches

The Cisco Nexus 5000 Series Switches, including the new Cisco Nexus 5500 platform was the first open-standards-based access-layer switch to support I/O consolidation at the rack level through FCoE. More information can be found by visiting <http://www.cisco.com/go/nexus5000>.

Rich Feature Sets

The rich feature sets of the Cisco Nexus 5000 Series Switches make them well suited for data center access-layer applications. They help protect the investment in data center racks with standards-based 10 Gigabit Ethernet and FCoE features and virtual machine awareness features that allow IT departments to consolidate networks based on their own requirements and timing. The combination of higher

port density, lossless Ethernet, wire-speed performance, and very low latency makes the Nexus 5000 switch series well suited for meeting the growing demand for 10 Gigabit Ethernet that can support a common Ethernet-based fabric in enterprise and service provider data centers, protecting enterprises' investments.

Investment Protection

The Cisco Nexus 5000 Series supports consolidated I/O using FCoE on downlinks to servers. FCoE is Fibre Channel and, as such, has familiar methods of configuration, operation, and management. On the uplinks to the network, customers can choose among FCoE direct attachment to storage systems, native Fibre Channel direct attachment to storage systems, FCoE connection to FCoE-capable switches and

native Fibre Channel connection to existing SANs. Fibre Channel and FCoE can exist simultaneously in the Fibre Channel network, providing the most flexibility and allowing customers to continue to use their existing administration and management tools.

FCoE is a compelling technology for enabling unified I/O in the data center and will continue to gain traction in the marketplace. Cisco is committed to

developing, supporting, and promoting the FCoE technologies required to facilitate this transition in a smooth, evolutionary way. Data center administrators can now begin consolidating infrastructure to achieve economic benefits. IT departments can take advantage of what Cisco FCoE storage networking can offer today and be prepared to gain additional benefits from operational efficiencies and performance enhancements.

CONCLUSION

10 Gigabit Ethernet's simplicity, flexibility, and familiarity make it the ideal fabric for a unified data center network fabric and lay the groundwork for new models, including cloud computing, that will deliver more intelligent, responsive data centers and greater business agility. Through their product and industry leadership, Intel and Cisco are helping IT departments transition to 10 Gigabit Ethernet and build next-generation data center infrastructures.

FOR MORE INFORMATION

www.intel.com/go/unifiednetworking

www.cisco.com/go/fcoe

¹ Source: Intel estimates as of January 2010. Performance comparison using SPECjbb*2005 business operations per second (bops). Results have been estimated based on internal Intel analysis and are provided for informational purposes only. Any difference in system hardware or software design or configuration may affect actual performance.

² IDC, "Server Workloads Forecast," 2009.

³ IDC, "The Internet Reaches Late Adolescence," December 2009.

⁴ 8x network: 800 terabytes per second of IP traffic estimated on internal Intel analysis "Network Supply/Demand 2010-2020" forecast; 16x storage: 60 exabytes of data stored from Barclays Capital "Storage Bits" September 2009, extrapolation by Intel for 2015; 20x compute: Intel internal long-range planning forecast, extrapolated to 1 billion virtual servers using one virtual machine per core.

⁵ IDC WW Storage Systems Tracker, December 2009.

⁶ Test configuration: Iometer v. 2006.7.27, number of managers = 1, number of workers / manager = 30 (total number of workers) = 30, number of logical unit numbers (LUNs) = 30, number of outstanding I/O operations = 50, I/O size = 512 bytes. 10 iSCSI targets with 3 LUNs per target. Target is StarWind Enterprise configured with RAM disk.

SUT: Supermicro 6026T-NTR+, Intel® Xeon® processor W 5680 (12 M cache, 3.33 GHz, 6.40 GT/s Intel® QuickPath Technology), 24 GB DDR3, Microsoft Windows Server* 2008 R2 x64.
Network configuration: Cisco Nexus® 5020 Switch, Intel® 82599EB 10 Gigabit Ethernet Controller connected at 10 Gbps.

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