Lab Validation Report

EMC Cisco Unified Storage Networking

Enabling Virtual Data Center Infrastructures with Trusted FCoE Solutions

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ESG Lab Reports

The goal of ESG Lab reports is to educate IT professionals about emerging technologies and products in the storage, data management and information security industries. ESG Lab reports are not meant to replace the evaluation process that should be conducted before making purchasing decisions, but rather to provide insight into these emerging technologies. Our objective is to go over some of the more valuable feature/functions of products, show how they can be used to solve real customer problems and identify any areas needing improvement. ESG Lab's expert third-party perspective is based on our own hands-on testing as well as on interviews with customers who use these products in production environments. This ESG Lab report was sponsored by EMC Corporation and Cisco Systems.

Introduction

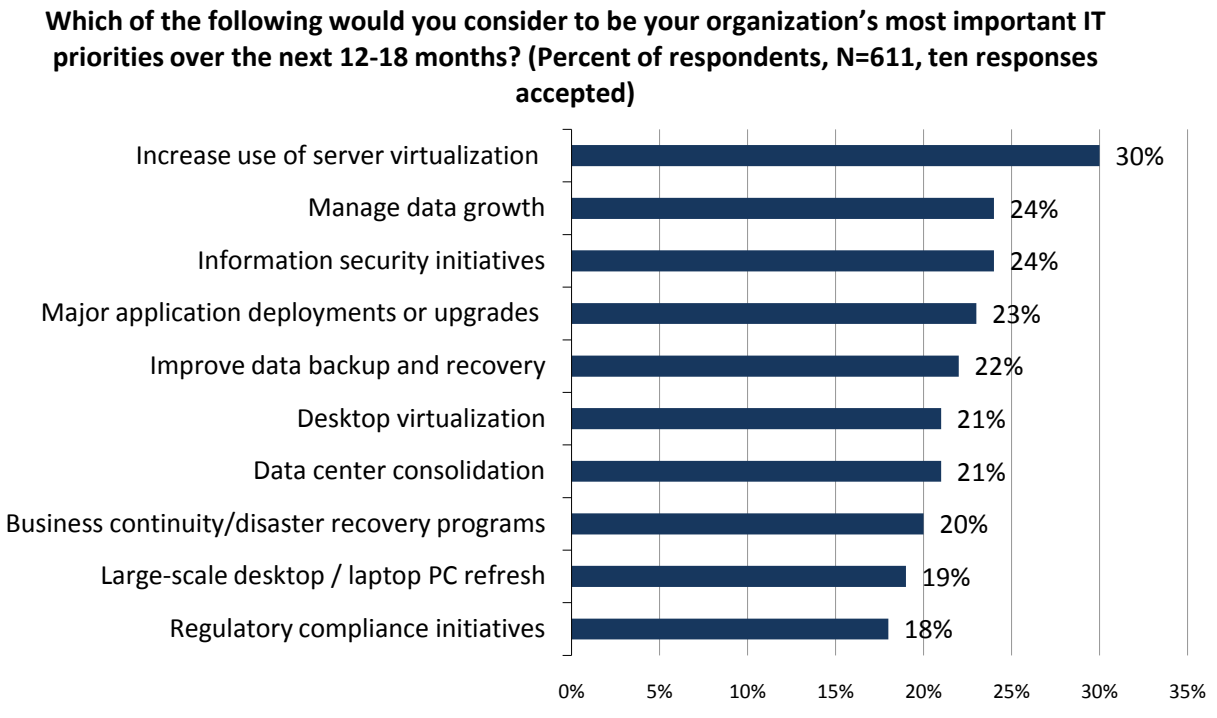
This report presents the results of ESG Lab hands-on testing of EMC Storage and Cisco Unified Fabric solutions focusing on ease of configuration, management, performance, and scalability of Fibre Channel over Ethernet (FCoE) networks.

Background

As businesses increase their reliance on IT to power them, they typically deploy whatever technologies best suit their applications. As a result, data centers often support multiple technologies and network types, with standard Ethernet LANs, Fibre Channel (FC) and iSCSI SANs, separate Ethernet NAS networks, etc. all under management. Multiple networks add complexity as they require unique equipment, particular IT skill sets, and individual management tools, all of which drive up both capital and operational costs. With a goal of reducing cost and complexity in the data center, a growing number of IT organizations have embraced server virtualization and data center consolidation strategies.

The dramatic shift to consolidating workloads with server virtualization has led to reductions in equipment, floor space, power, and cooling costs. However, to take advantage of the advanced mobility features server virtualization offers (such as HA, SRM, DRS, and vMotion) consolidated servers need to be connected not only to the LAN but also to networked storage. In addition, workload consolidation increases demand for network resources and throughput, often hampering performance and creating a chain reaction of bandwidth effects. The interaction of these needs is demonstrated in Figure 1: respondents to a recent ESG survey indicated that server virtualization, managing data growth, and data center consolidation were top IT priorities.[1]

Figure 1. Top IT Priorities



Source: Enterprise Strategy Group, 2011.

Consolidating on fewer networks would seem to be an obvious way to reduce costs and increase efficiency, but the challenge has been to find a way to provide the reliability, low latency, and high performance of FC storage while maintaining the low cost and ease of management of Ethernet. The ultimate goal of network convergence is to

[1] Source: ESG Research Report, *2011 IT Spending Intentions Survey*, January 2011.

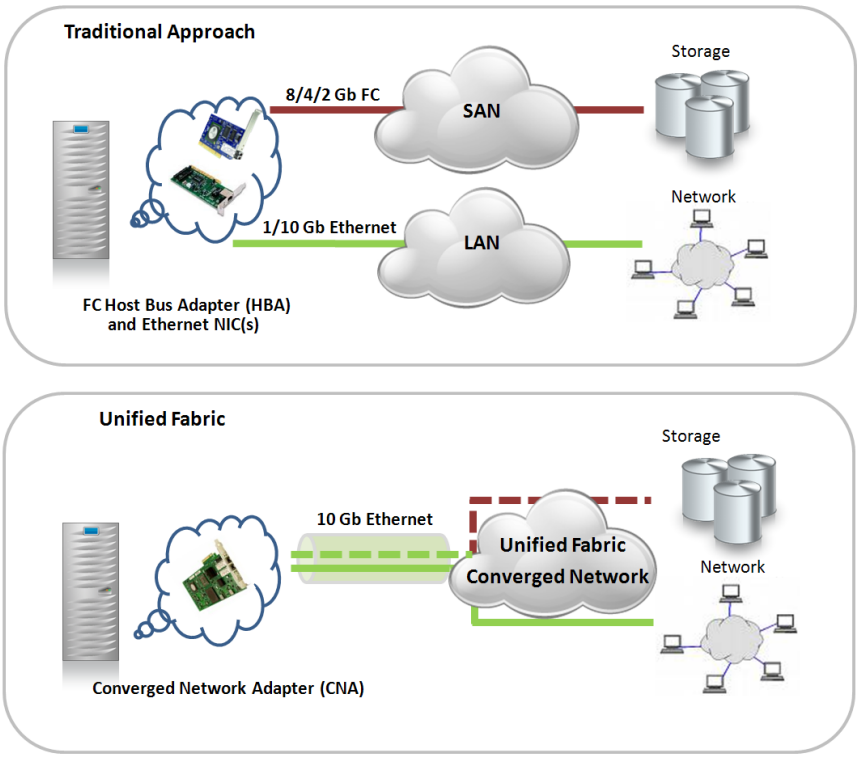
provide the foundation for a truly agile, end-to-end infrastructure while achieving significant reductions in capital equipment and operational expenses.

Fibre Channel over Ethernet

FCoE allows Fibre Channel traffic to move natively over Ethernet; storage and LAN traffic converge on a single platform, leveraging familiar management tools, security models, and processes. The FCoE standard has been tested and certified (ANSI T11) and is supported by most major vendors. Rather than adding yet another network protocol, merging FC with 10GbE offers a way to gracefully migrate from existing FC to Ethernet over time, protecting current networking investments. Consolidating FC and Ethernet on converged network adapters (CNAs) eliminates the need for separate network interface cards (NICS) and FC host bus adapters (HBAs), reducing the cost of devices.

As shown in Figure 2, the traditional multi-fabric network requires separate networks and management for storage and LAN traffic, as well as separate HBAs and NICs. In the unified fabric or converged network, storage and LAN traffic converge into a single network traveling over 10 GbE and hosts are connected with a single CNA.

Figure 2. Converging to a Unified Fabric with FCoE



The enhanced Ethernet standard (a.k.a., data center bridging, or converged enhanced Ethernet) was defined to enable the unified fabric shown. One of the key features of enhanced Ethernet is its ability to differentiate between and prioritize traffic sharing a common physical layer (a.k.a., quality of service, or QoS). The enhanced Ethernet standard also supports link-level flow control and end-to-end congestion management to meet the lossless performance requirements of mission critical applications currently relying on FC for networked storage connectivity. The FCoE standard picks up everything from the FC standard—except for the cabling and the physical interface—and places it within an enhanced Ethernet network.

EMC Storage with Cisco Unified Fabric: Enabling Virtual Data Center Infrastructures

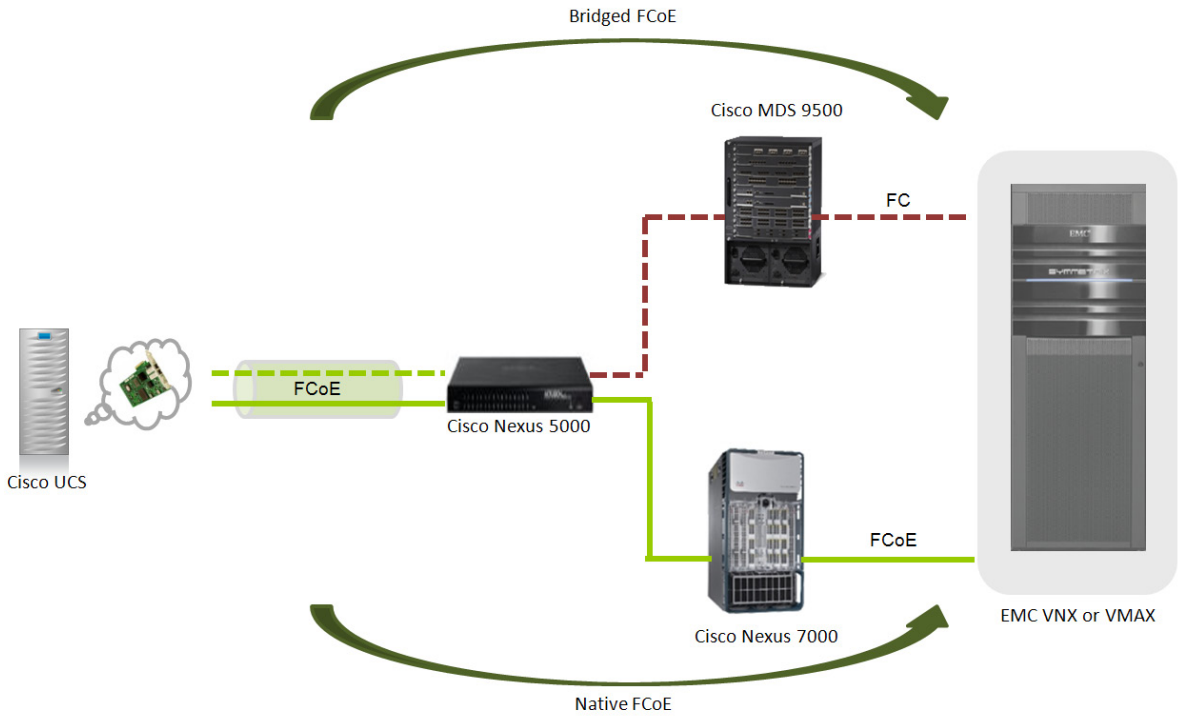
A converged network that consolidates storage and LAN traffic can help increase efficiency, reduce costs, and speed the journey to the cloud. Long-term partners EMC and Cisco offer converged network solutions, product bundles,

EMC E-Lab Tested and Cisco Validated designs, and consulting and support services to help customers plan, deploy, and manage their converging infrastructures.

- On the networking side, the Cisco Unified Fabric unifies storage and data networking for seamless, converged, scalable, and intelligent networks that reduce total cost of ownership. Nexus and MDS series switches and directors provide native and bridged FCoE support. Additional offerings include Cisco Unified Network Services and the Cisco Unified Computing System (UCS), a pre-integrated compute, network, storage, and vitalization platform.
- On the storage side, EMC VNX arrays are affordable, easy-to-use, mid-tier solutions that provide high efficiency storage for multi-protocol SANs. The EMC Symmetrix VMAX platform supports large enterprise environments with unmatched scalability, high availability, and scale-out performance levels for the most demanding virtual data center needs. EMC VNX and VMAX storage systems are qualified and supported in Cisco enabled bridged FCoE configurations. The VNX supports native FCoE with 10 Gb Ethernet IO modules that can be added non-disruptively. Native FCoE support for the VMAX is planned, but not yet generally available as of this writing.

Figure 3 is a summary of the end-to-end family of unified fabric solutions from EMC and Cisco. A variety of servers and CNA adapters are supported including the Cisco UCS server shown toward the left. Cisco Unified Fabric solutions shown in the middle are attached to an EMC VNX or VMAX disk array on the right. In the bridged configuration shown at the top, FCoE traffic flows through the CNA adapter within the Cisco UCS server and arrives as native Fiber Channel traffic at the disk array. The native FCoE path shown at the bottom uses an end-to-end FCoE path to transport storage traffic over an enhanced 10 Gb Ethernet network.

Figure 3. EMC/Cisco Converged Unified Fabric with FCoE



New line cards for the Cisco Nexus 7000 data center switch and MDS 9500 storage director switch as well as native FCoE support for the EMC VNX have been recently released. Previously, the MDS9500 could only talk to back-end storage arrays using Fibre Channel, now it can use FCoE as well. That means a switch like the Nexus 5000, which could already receive FCoE, can now pass FCoE messages to and through the Nexus 7000 and MDS 9500 to destination storage arrays.

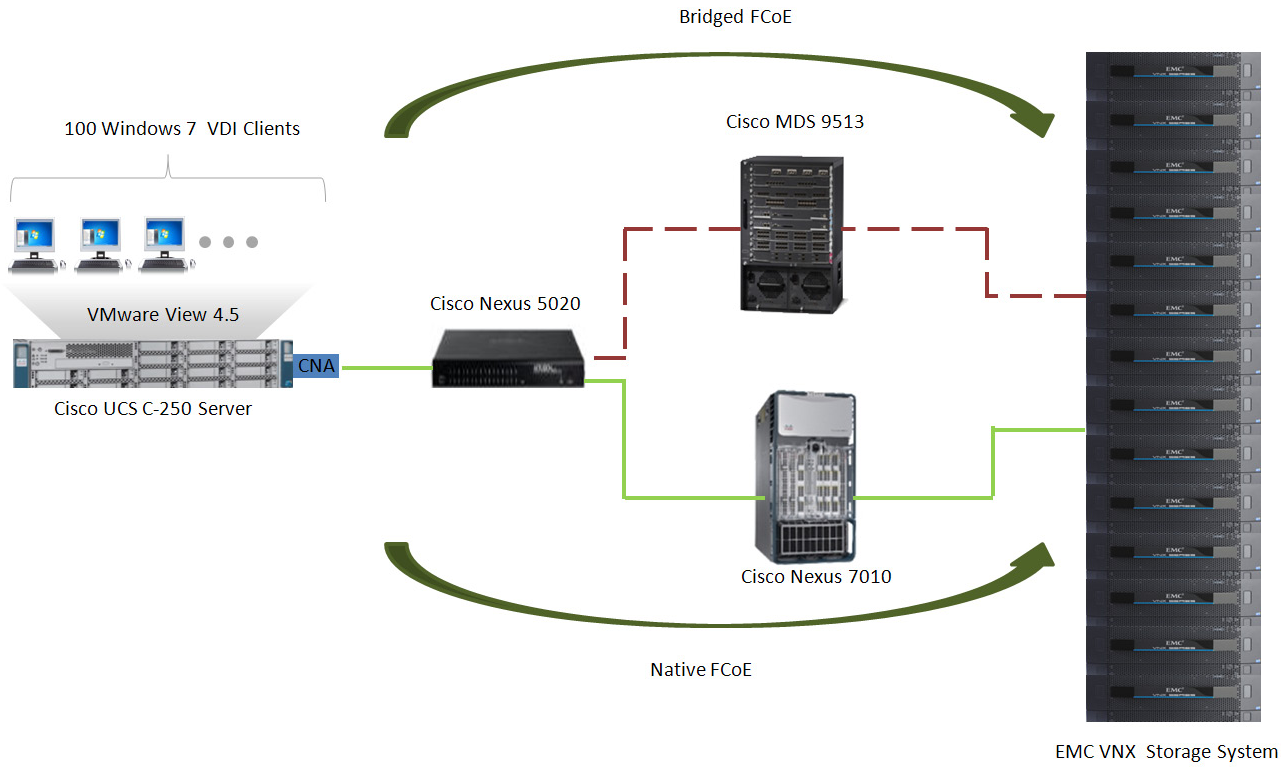
ESG Lab Validation

ESG Lab performed hands-on testing of an EMC and Cisco Unified Storage Networking solution at an EMC facility in Hopkinton, Massachusetts. An end-to-end Cisco and EMC solution was tested with Cisco UCS servers and switches configured for bridged and native FCoE connectivity to an EMC VNX disk array. The performance of a virtual desktop infrastructure (VDI) workload running over bridged and native FCoE storage connections was examined. This report also includes an overview of bridged FCoE testing with an EMC VMAX disk array that was documented in a previously published ESG Lab Validation report.

Getting Started

As shown in Figure 4, a Cisco USC C-250 server with a pair of converged network adapters was configured to use storage within an EMC VNX array. VMware View 4.5 was installed on the Cisco server to create a VDI workload with 100 Windows 7 clients performing typical desktop operations. The EMC VNX storage array was configured to present LUNs from both its FC and FCoE ports. A bridged FCoE connection was created with a Cisco Nexus 5020 at the edge of the storage network and a Cisco MDS 9513 in the core. A native FCoE connection tied a Cisco Nexus 5020 at the edge to a Cisco Nexus 7010 at the core.

Figure 4. Bridged and Native FCoE Unified Fabric Testing with EMC VNX Storage (2011)

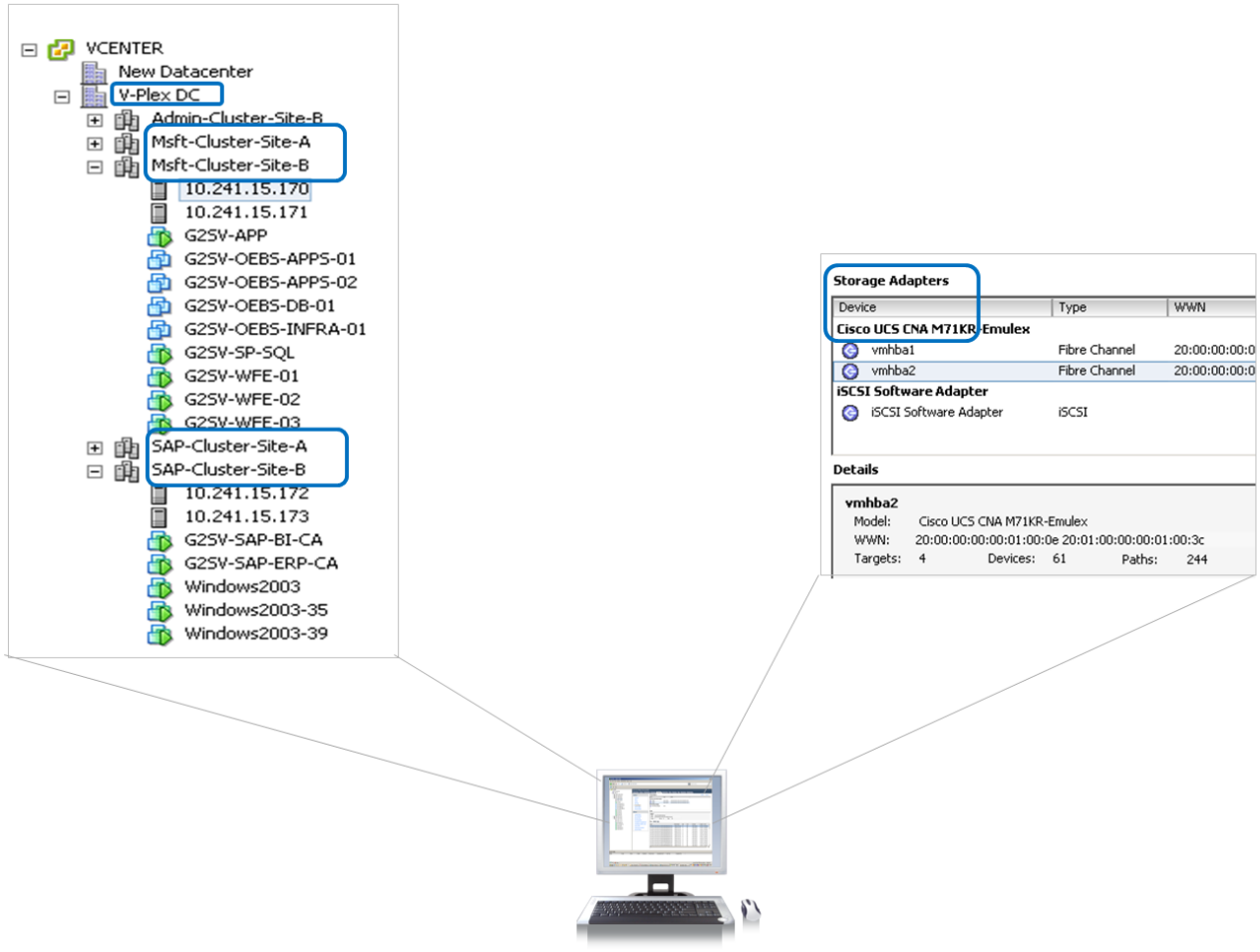


A bridged FCoE topology was tested by ESG Lab during a validation of the EMC VPLEX in 2010.[2] Converged Network Adapters (CNAs) installed in Cisco UCS servers were used to reduce the number of wires and network connections between the server and an EMC VMAX disk array. In this example, two Ethernet user network connections, two FC storage area network connections, and an Ethernet Management network connection were consolidated onto an enhanced 10 Gb Ethernet network with a Cisco MDS 5020, providing a bridge between FCoE traffic on the server

[2] http://www.enterprisestrategygroup.com/2010/05/emc-vplex-metro-and-vmware-esx-enabling-100-km-vmotion-with-new-distributed-storage-federation/

and FC traffic on the storage array. Figure 5 shows how Microsoft and SAP clusters were deployed on FCoE attached Cisco UCS servers in two data centers located 100 kilometers apart.

Figure 5. Bridged FCoE Unified Fabric Testing with EMC VPLEX with VMAX Storage(2010)



Why This Matters

A growing number of IT managers are consolidating servers and storage to reduce power, cooling, and management costs. As a matter of fact, 66% of respondents to a global ESG survey indicate that a formal IT initiative or program is underway with a goal of reducing power and cooling in the data center.[3] With these challenges in mind, storage networking and server virtualization have enabled the first wave of consolidation and savings. End-to-end FCoE solutions from Cisco and EMC are fueling the next wave of consolidation through decreased complexity, increased efficiency, improved utilization, and less power, space, and cooling required in the data center.

Organizations have been spending huge sums of money to consolidate data centers, servers, and storage. Now is the time to begin consolidating the data center network. Technology exists to drive data center network consolidation to the next level: FCoE helps converge traditional networks and storage networks onto a single fabric using industry standard enhanced Ethernet technology.

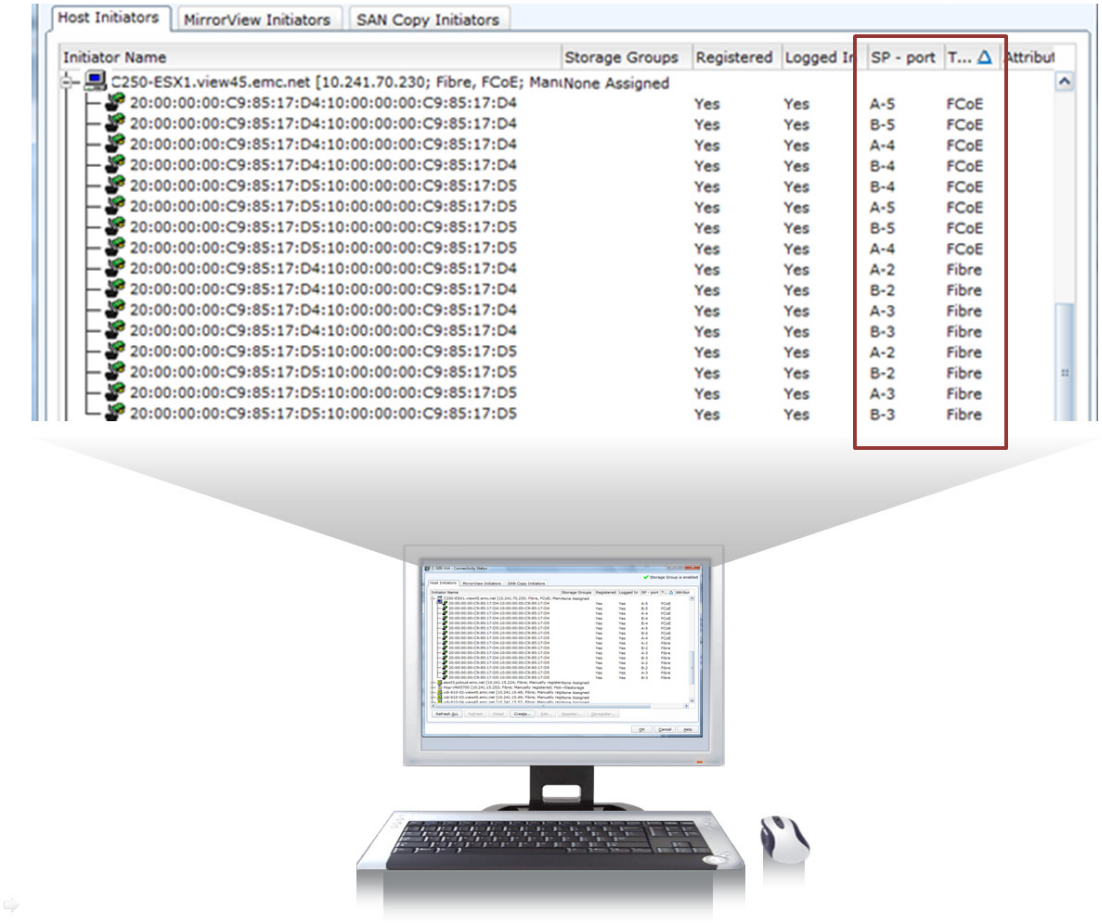
[3] Source: ESG Research Report, *Global Green IT Priorities: Beyond Data Center Power and Cooling*, November 2008.

Intuitively Manageable FCoE

The FCoE specification was defined with ease of integration into existing FC networks in mind. Bridged FCoE support can be used to add new servers to a converged 10 Gb Ethernet fabric while existing investments in FC switches and storage systems are preserved. Native FCoE connections to disk systems can be used to consolidated storage network traffic onto an end-to-end 10 Gb Ethernet infrastructure. Bandwidth allocation and management with priority groups is designed to ensure applications have the bandwidth they require, regardless of protocol.

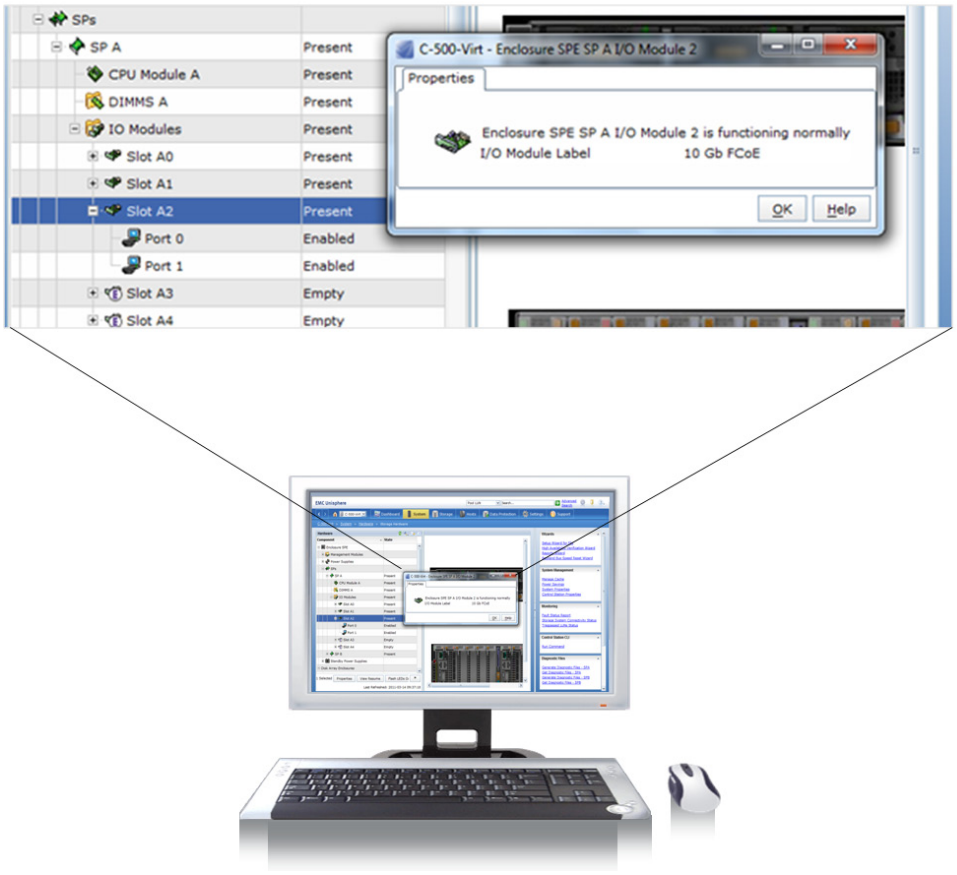
ESG Lab examined the configuration of the FCoE storage network to confirm that managing an FCoE network looks and feels very similar to a traditional Fibre Channel network. The EMC Unisphere screen shot shown in Figure 6 shows how host interfaces within the EMC VNX disk array were configured for native (FCoE) and bridged (Fibre) connectivity.

Figure 6. Native and Bridged EMC VNX Connectivity



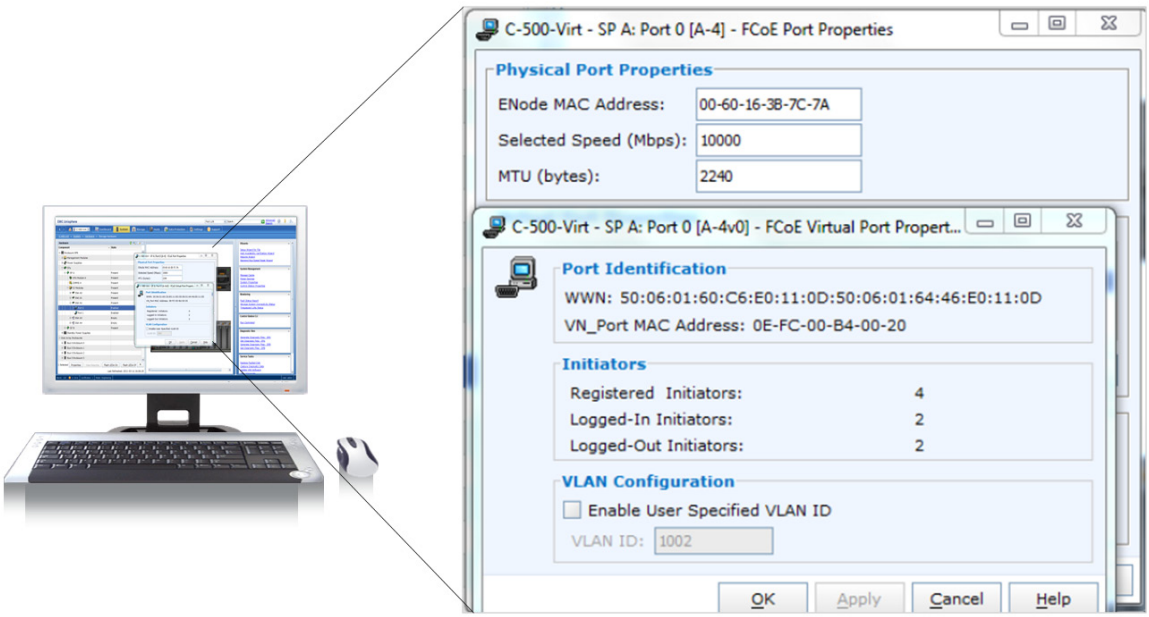
EMC VNX storage includes support for hot-swappable power, bus, and host interfaces. Hot-swap 10 Gb host interfaces, which can be used to ease the transition to native FCoE, are also supported. Figure 7 shows the configuration for one of the 10 Gb FCoE modules used during ESG Lab testing. Two modules were installed to create a total of four native FCoE connections between the UCS server and the storage area network.

Figure 7. EMC VNX with a Hot-swap 10 Gb FCoE Module for Native FCoE Connectivity



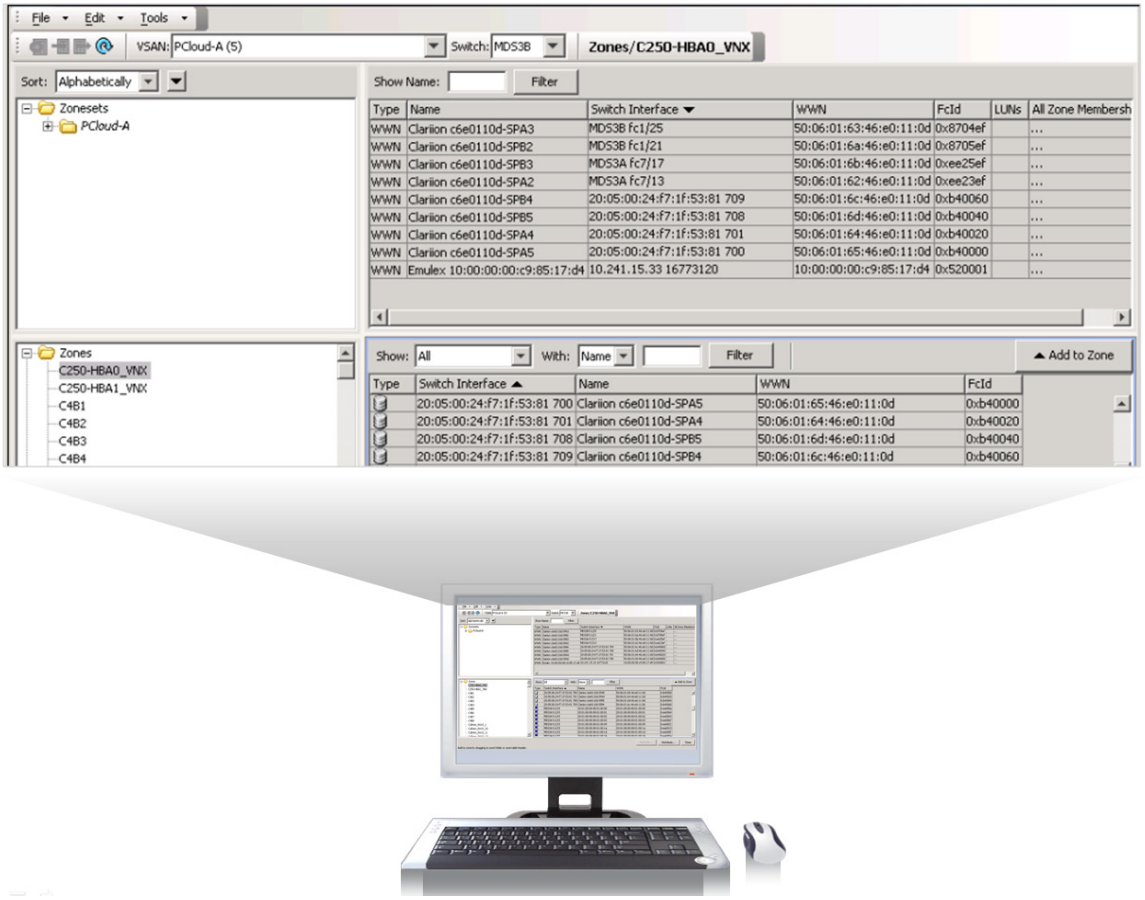
The Unisphere screen shot in Figure 8 shows how physical Ethernet addresses were mapped to logical Fibre Channel addresses during native FCoE testing.

Figure 8. Familiar Addressing (Ethernet MAC and Fibre Channel WWN)



The Cisco Data Center Network Manager shown in Figure 9 was used to examine how bridged and native Fibre Channel connections were zoned. ESG Lab noted that the security and isolation provided with traditional FC zoning and access control is preserved when configuring an EMC Cisco Unified fabric. ESG Lab is confident that SAN administrators who are familiar with FC zoning and access control will find that managing an FCoE SAN looks and feels very similar to traditional FC SAN.

Figure 9. Familiar SAN Management (Cisco Data Center Network Manager)



Why This Matters

Data center consolidation efforts are designed to increase efficiency not only by reducing the number of devices, but also by simplifying management. Data center virtualization and convergence is beginning to blur the lines separating the roles of server, network, and storage administrators, making management automation that much more important. Technology may offer savings on equipment, power, and cooling, but if it increases management costs, those savings can be negated. In addition, organizations have invested in IT skills and training for their FC deployments; there is inherent risk and cost in having to retool and retrain.

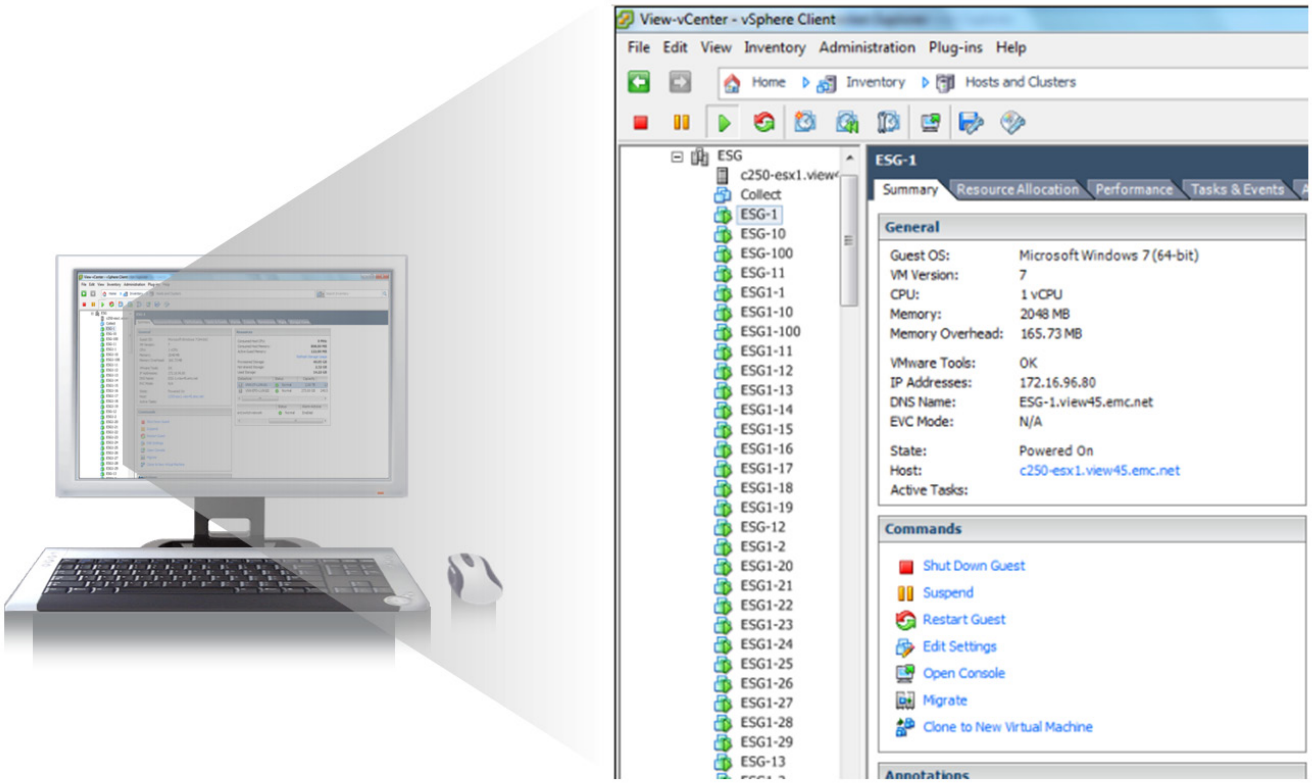
ESG Lab has verified that FCoE does not interfere with existing tools, processes, or applications, protecting customer investments. In addition, the management tools provided are simple and effective, and enable automation of basic and advanced functionality.

Hosting Virtual Desktops with Bridged and Native FCoE

The native and bridged FCoE infrastructure was exercised using a 100-user virtual desktop infrastructure (VDI) workload. The Login Virtual Session Indexer (VSI) test tool used to generate the VDI workload[4] was configured to simulate a medium workload for 100 virtual desktop users conducting typical tasks such as creating, opening, and editing Microsoft Office applications. The server and storage configuration was tested with a goal of comparing the performance of native and bridged FCoE networks.

The configuration of the 100 virtual desktops exercised during ESG Lab testing is shown in Figure 10. Note that each of the Windows 7 virtual desktops was configured with one virtual CPU and 2 GB of RAM.

Figure 10. 100 VDI Clients (VMware View-vCenter)



The EMC VNX disk array was configured with a combination of SAS and enterprise flash drives (EFDs) during VDI testing. Operating system and desktop data was stored on a FAST VP pool which tiered data automatically between 96 SAS drives (300 GB) and four near-line SAS drives (2 TB). The desktop data pool was configured as a virtually provisioned pool (a.k.a., thin provisioned) which cost effectively delivered capacity on demand. Performance sensitive VDI replica data was stored on a pool of four high speed EFD drives not configured for virtual provisioning (a.k.a., thick provisioned).

The VSI tool was used to measure the average transaction time for each virtual desktop user as they executed typical tasks. Testing was performed with a goal of staying below a generally accepted average end-user response limit of three seconds.

[4] http://www.loginconsultants.com/index.php?option=com_content&task=view&id=231&Itemid=279

The average end-user transaction time reported by the VSI utility for the native and bridged FCoE configuration is shown in Figure 11.

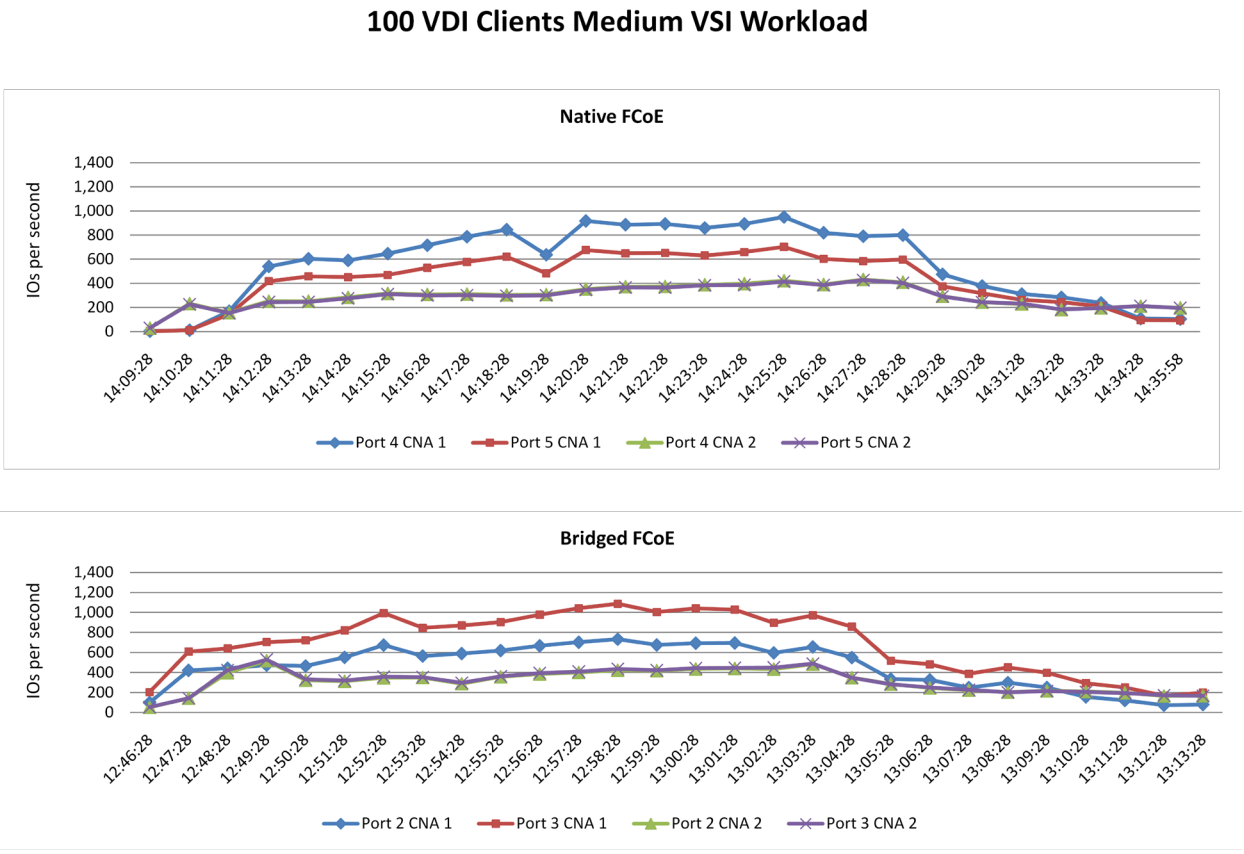
Figure 11. VDI Client Performance Analysis (Response Time)

What the Numbers Mean

- Response time increased as the number of concurrent virtual desktop users increased from 10 to 100.
- The VSI maximum response time limit was not reached and end-user response times were below the generally accepted limit of three seconds (3,000 milliseconds).
- The native FCoE configuration performed slightly better with lower average response times (~15%). That said, ESG Lab is confident that end-users would not be able to tell the difference between the performance of the native configuration and that of bridged FCoE.

Performance at the storage system level was monitored using EMC Unisphere. Performance, in IOs per second, over the duration of the 100 VDI workload test is shown in Figure 12. While performance of the native and bridged FCOE configurations was very similar, the bridged FCoE configuration generated slightly more IOs per second (8.6%) over the duration of the VDI test. The average performance for the native FCoE was 429.1 IO/sec compared to 469.5 IO/sec for the bridged FCoE configuration. Like the sub-second differences in VSI response time, ESG Lab is confident that end-users would not be able to perceive this minor difference in performance.

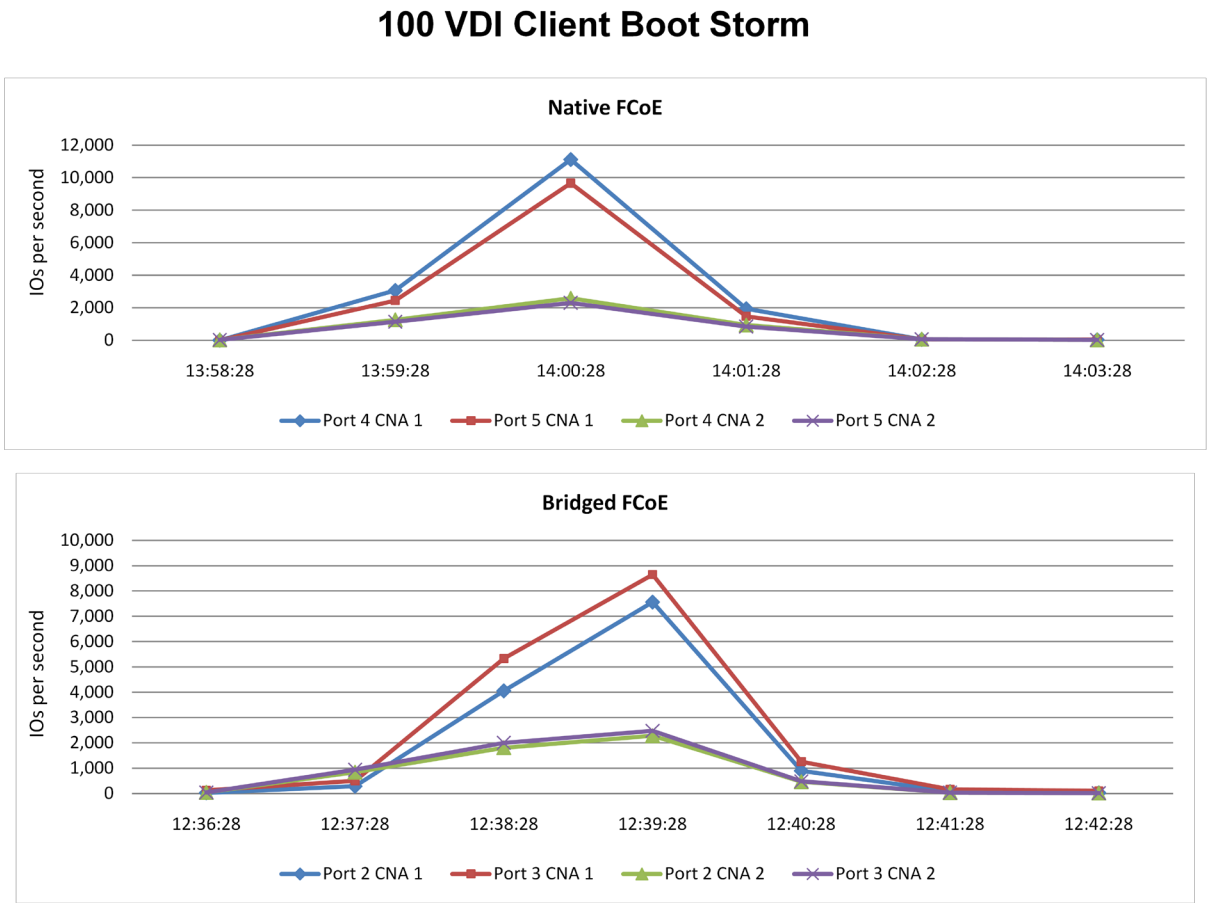
Figure 12. VDI Client Performance Analysis (IOs per second)



ESG Lab measured performance during a boot storm as 100 virtual desktop users tried to log in at the same time. This simulates the type of activity that can occur in an organization as users arrive at work in the morning or return from lunch. A VDI boot storm is a very resource-intensive operation that places a lot of stress on the virtualized infrastructure. If the virtualized infrastructure gets bogged down during a boot storm, end-users tend to get frustrated and productivity is lost. EMC EFD devices were configured for replica data during ESG Lab testing with a goal of maximizing performance during peak periods of activity—including a boot storm.

As shown in Figure 13, the native FCoE configuration generated slightly more IOs per second than the bridged FCoE configuration during the boot storm test. This translates to slightly faster boot times for the native FCoE VDI clients.

Figure 13. VDI Boot Storm Performance Analysis (IOs per second)



ESG Lab confirmed that the performance of an EMC VNX storage array within a Cisco Unified Fabric scales almost identically with a 100-client VDI environment in native and bridged FCoE configurations.

Why This Matters

Converged networking with FCoE takes advantage of the management simplicity and cost of Ethernet without giving up the performance and reliability of Fibre Channel. As virtual data centers proliferate and workload consolidation expands, networks are stressed and performance can suffer. IT must continue to deliver on performance SLAs, particularly as virtual environments scale, while leveraging current investments. FCoE offers a way to make that transition and maintain the high performance required.

ESG Lab has verified that the EMC and Cisco solution using bridged and native FCoE delivers high performance across the network for both standard and heavy workloads. The ability to ensure application performance after FCoE implementation is critical to data center network consolidation.

ESG Lab Validation Highlights

- ☑ Native and bridged FCoE was tested with EMC VNX storage and a Cisco UCS server connected to a Cisco Unified Fabric.
- ☑ EMC Unisphere and Cisco Data Center Network Manager graphical user interfaces were used to confirm that managing an FCoE network is intuitive and retains the look and feel of a traditional Fibre Channel network. The command line and graphical tools used to manage zoning and access control work the same as traditional FC.
- ☑ End-to-end bridged and native FCoE connectivity was exercised with a performance tool that emulated 100 typical VDI sessions.
- ☑ Performance scaled well for both the bridged and native FCoE configurations, with both solutions yielding end-user desktop response times under the generally accepted limit of three seconds.

Issues to Consider

- ☑ While the T11 committee has published the FCoE standard, the data center bridging (DCB) standards (also known as enhanced Ethernet) are in the final stages of publication. Having said that, most of the major systems and networking vendors are developing products in accordance with the emerging standard. Forward thinking IT managers with existing investments in FC fabrics would be wise to begin investigating this technology sooner rather than later.
- ☑ Upgrades from traditional FC to FCoE require careful planning—upgrades of SAN and network switches as well as host adapters may be required. The good news is that FCoE, deployed in its most likely scenario—when adding new servers—is quite easy to accomplish.
- ☑ The VDI performance tests documented in this report compared native FCoE running over 10 Gb Ethernet to a bridged FCoE configuration which ran over 4 Gb FC due to a lack of the latest 8 Gb FC equipment during ESG Lab testing. While this provided a bandwidth advantage for the native FCoE tests, ESG Lab believes that similar results would be achieved with 8 Gb FC technology due to the intensive and generally small IO pattern of VDI workloads.
- ☑ Native FCoE support for EMC VMAX storage systems was planned, but not yet generally available as of this writing.
- ☑ While administration and troubleshooting should be easier with a single network infrastructure for both FC and Ethernet connectivity as well as fewer cards and cables, there are potential conflicts of IT culture: joining the FC and Ethernet networking teams together. In other words, technology is only one of the issues to consider when migrating from FC to FCoE. The impact on people and processes must also be considered.

The Bigger Truth

Operating and managing multiple networks adds cost and complexity. At the same time, with workload consolidation based on server or desktop virtualization, contention for network throughput and performance escalates. FCoE presents an opportunity to converge storage and network traffic onto a unified network to not only provide the ability to gracefully migrate from FC to Ethernet, but also to reduce costs, decrease complexity, and simplify management. Other opportunities for converged networking are large consolidation projects, projects designed around power constraints, new data center deployments, and projects focused aggressively on cost-cutting.

The first wave of consolidation using server virtualization and networked storage created greater efficiency and reduced costs. Network convergence will usher in the next wave of consolidation to simplify data center operations, particularly as 10 GbE is fully established and the Ethernet roadmap moves swiftly to 40 GbE and then 100 GbE.

EMC Storage and Cisco Unified Fabric create a flexible and easy-to-manage platform that enables IT professionals to consolidate their network infrastructure. This converged network storage infrastructure combines the agility and performance of traditional data center environments with the flexibility to support expanding server virtualization and cloud computing deployments. While much of the joint EMC/Cisco spotlight recently has been on the VCE coalition and large Vblock implementations, the relationship between these two highly respected organizations is long and deep. Together, they can provide a converged network and storage environment offering high performance and scalability for the medium-sized organization to the large enterprise. These industry giants are considered trusted partners by organizations across the world; with their industry-leading products and support, they minimize risk for organizations as they transition their networks.

ESG Lab tested EMC VNX storage arrays with Cisco Nexus and MDS series switches connected to a Cisco UCS server running VMware View virtual desktop infrastructure. Both native and bridged FCoE connections were tested. Managing the unified network with tools that are familiar to FC storage administrators was intuitive. The converged network delivered high-performance for both bridged and native FCoE connectivity in standard VDI workload and boot storm tests.

ESG has confirmed that the EMC and Cisco end-to-end FCoE solution operates properly, scales effectively, and offers high performance. The joint solution is easy to deploy and supports multiple protocols for optimal choice—FC, iSCSI, FCoE, and NAS. This agile and efficient architecture provides any-to-any connectivity backed by industry leaders. Customers should be reassured that with this solution, they can leverage current FC investments as they begin the transition to a more cost-effective, Ethernet-based data center.

Appendix

Table 1. ESG Lab Test Bed

Hardware	
Server	Cisco UCS C-250
Storage	EMC VNX
Unified Fabric	Cisco Nexus 5020, Cisco Nexus 7010, Cisco MDS 9513
Software	
VDI	VMware View version 4.5
VDI workload	Login VSI version 2.0
Desktop OS	Microsoft Windows 7

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