

LAB VALIDATION REPORT

Emulex Converged Network Adapter Intelligently Connecting Storage, Servers and Networks

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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 Emulex.

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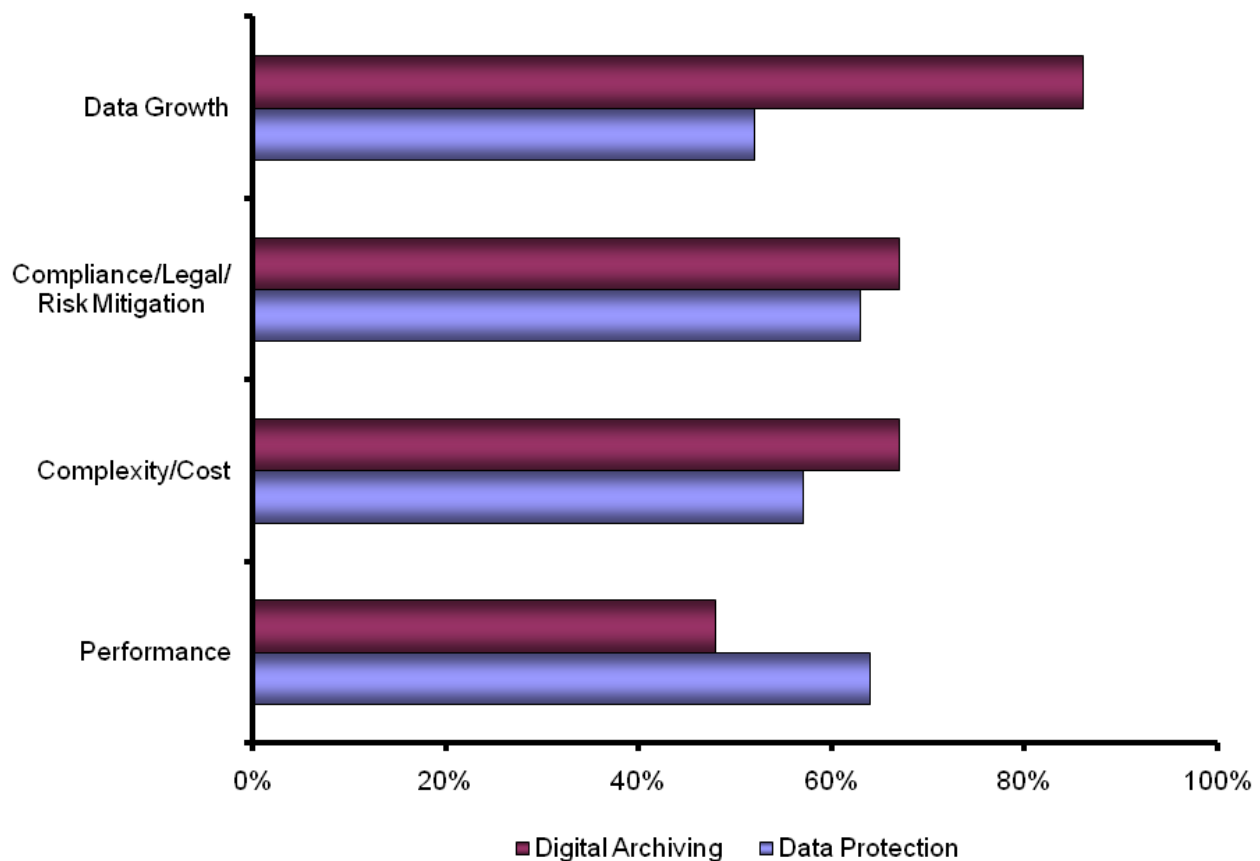
Introduction

Fibre Channel over Ethernet (FCoE) is an emerging standard that maps Fibre Channel storage traffic over an Enhanced 10 Gigabit Ethernet network. This report documents ESG Lab hands-on testing and customer feedback of Emulex LightPulse LP21000 Converged Network Adapters (CNAs) connecting servers within an FCoE-enabled data center environment that leverages familiar tools and processes.

Background

IT managers are struggling to feed the voracious storage appetites of all sorts of applications. From the high availability and performance needs of mission critical e-mail and database applications to the capacity and throughput-intensive needs of archive and backup applications, IT managers are faced with a number of challenges. As shown in Figure 1, ESG research¹ indicates that data growth, risk mitigation, complexity, cost and performance are top concerns. Fibre Channel (FC) technology has become the gold standard for addressing these enterprise-class storage challenges over the past decade.

FIGURE 1. ENTERPRISE IT CHALLENGES



The increased utilization and enhanced reliability of a centrally managed FC storage network has driven a massive wave of storage consolidation in recent years. Driven by a similar set of challenges associated with the cost and complexity of servers, a growing number of organizations are using server virtualization technology to

¹ Sources: ESG Research Report: *Digital Archiving: End-User Survey & Market Forecast 2006-2010*, January 2006
ESG Research Report: *2007 Data Protection Survey*, November 2007

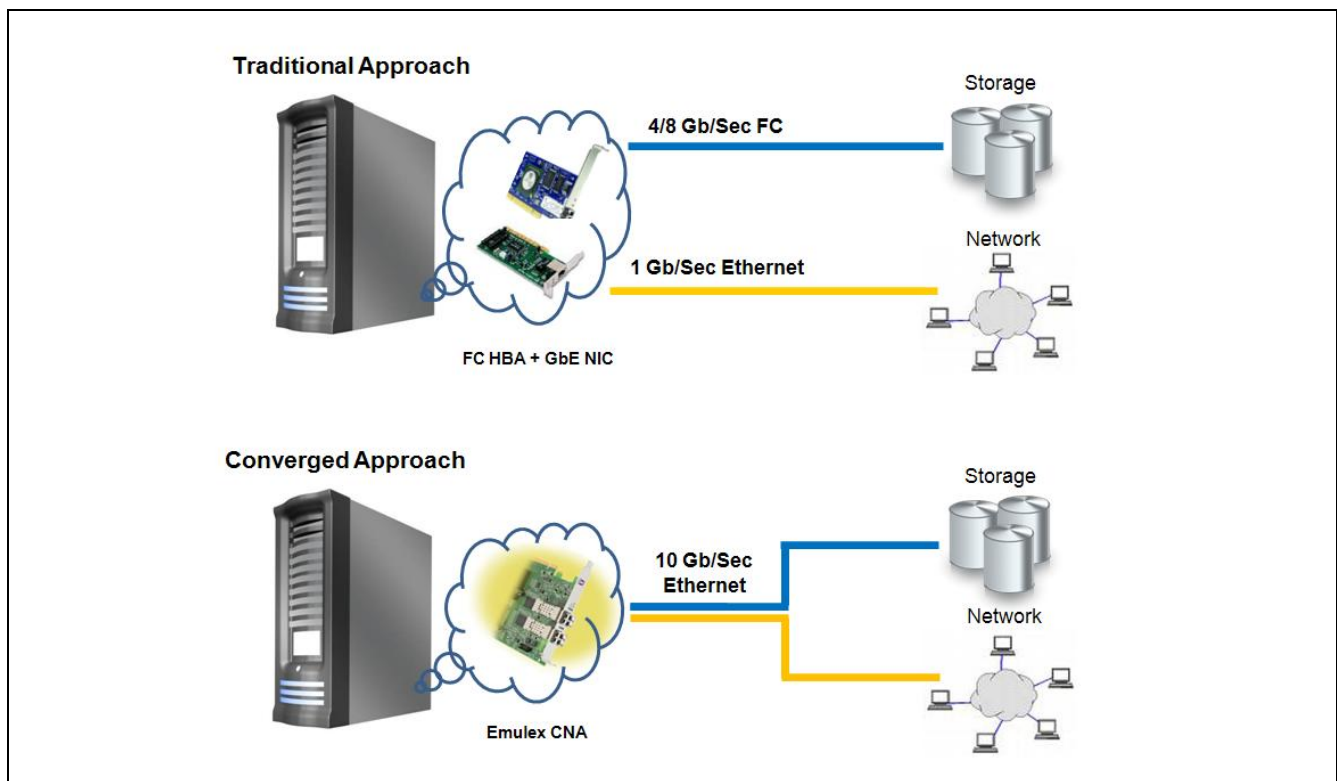
consolidate servers in the data center. As these trends continue, a new wave of consolidation, which supports traditional Ethernet-based network traffic and FC-based storage traffic, has begun to take form.

Fibre Channel over Ethernet

FCoE is an emerging standard that maps FC storage traffic over an Ethernet network with the goal of converging storage and networking traffic onto a single platform while leveraging familiar management tools, security models and processes. Finalized FCoE and related Ethernet standards are expected from the INCITS and IEEE standards committees respectively in late 2008 or early 2009. Switches and server-based adapters supporting the latest version of the specification became available in 2008 and are being evaluated by a growing number of organizations interested in the potential benefits of FCoE technology.

FCoE has the potential to reduce data center complexity—and make the world a little greener—by reducing the number of cards, cabling and network devices in the data center. This will save money and reduce power and cooling requirements. By combining FC and Ethernet onto a single card as shown in Figure 2, a Converged Network Adapter, or CNA, replaces the need for separate network interface cards (NICs) and FC host bus adapters (HBAs). Leveraging the maturity of existing driver stacks; the security of Fibre Channel zoning and access control models; and the familiarity of existing firmware and driver management tools, FCoE provides an elegant way to migrate FC traffic to an Ethernet network while protecting existing investments and skill sets.

FIGURE 2. CONVERGING WITH FCOE



Emulex LightPulse LP21000 CNA

The Emulex LightPulse LP21000 family of converged network adapters provides LAN and SAN connectivity over 10 Gb/sec Ethernet using FCoE and Enhanced Ethernet functionality. With a PCI Express connection for server-side communication and one or two ports of 10 Gb/sec Ethernet connectivity for network and storage connectivity, LP21000 CNAs leverage eight generations of field-proven FC HBA technology. Emulex FCoE CNAs and FC HBAs share a common Fibre Channel driver stack. Both can be managed with the field-proven Emulex HBAnyware application. Both support N-Port ID Virtualization (NPIV), which provides virtualized addressing and zoning for enhanced security in server virtualization environments. Leveraging a proven heritage and a common tool set, Emulex CNAs are designed to enable consolidation, energy conservation and savings.

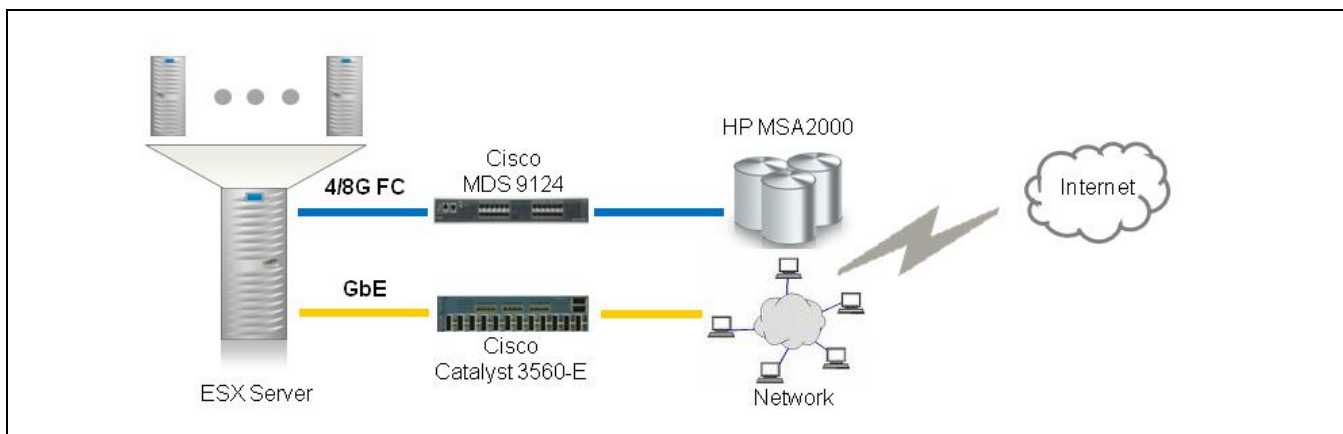
ESG Lab Validation

ESG Lab performed hands-on testing of the Emulex LP21000 CNA at Emulex's facility in Costa Mesa, California. ESG tested the CNA's ability to provide transparent network and storage connectivity for industry standard physical and virtual servers. ESG Lab also looked at the management capabilities of the HBAnyware application.

Converging Networks

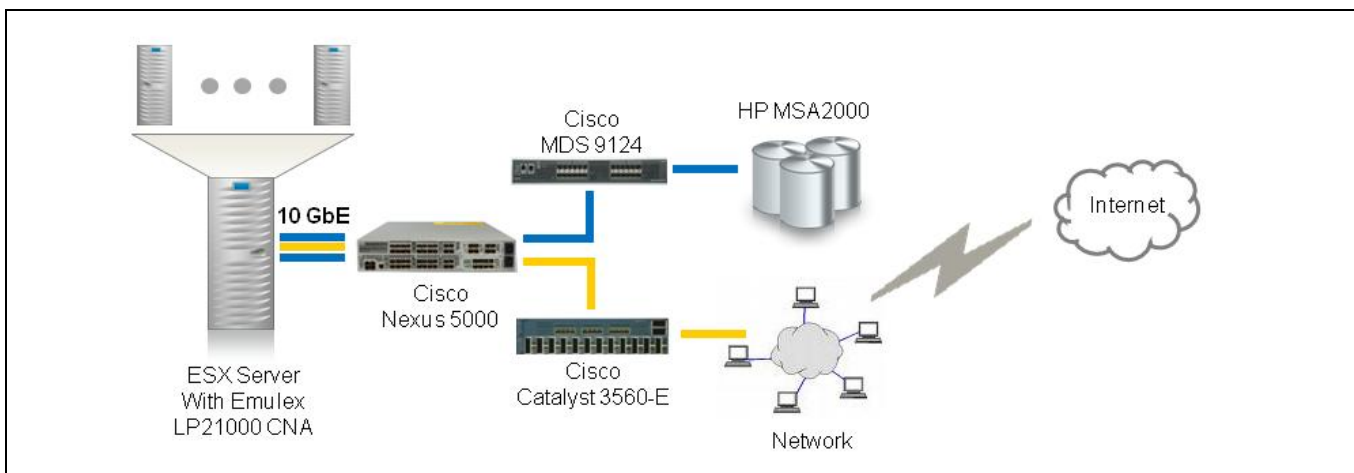
The ESG Lab test bed consisted of four physical servers running VMware ESX with virtual machines running Microsoft Windows 2003 as a guest operating system.² Three servers were configured to represent servers in a traditional data center setup as seen in Figure 3. Each server had either a 4 or 8 Gb/sec FC HBA attached to a Cisco MDS 9124 FC switch as well as a 1 Gb/sec Ethernet NIC attached to a Cisco Catalyst 3560 Gigabit Ethernet switch.

FIGURE 3. THE ESG LAB TEST: TRADITIONAL FC AND ETHERNET CONNECTIVITY (BEFORE FCOE)



One VMware ESX server was configured as seen in Figure 4 with a single LP21000 CNA attached to a Cisco Nexus 5000 FCoE enabled switch for converged network and storage connectivity.

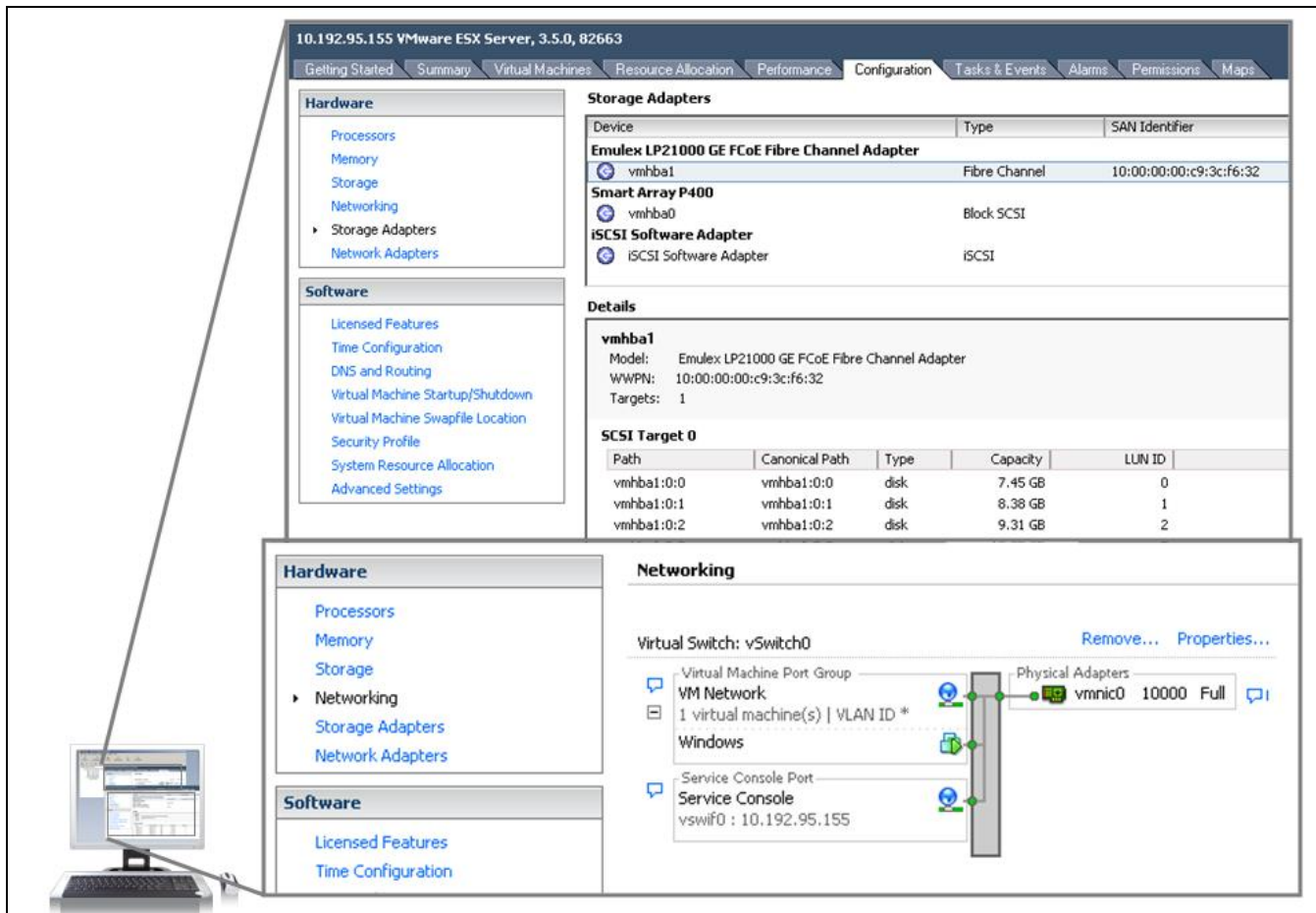
FIGURE 4. THE ESG LAB TEST BED: CONVERGED CONNECTIVITY (AFTER FCOE)



² Complete configuration details can be found in the Appendix.

ESG Lab first examined the VMware configurations for storage adapters and networking. The LP21000 CNA was listed as both a FCoE Fibre Channel adapter and as a 10 Gb/sec Ethernet NIC. For both the ESX hypervisor and the underlying Windows Guest OS, configuration of both Fibre Channel storage and Ethernet networking was exactly the same as with traditional Fibre Channel adapters and Ethernet NICs.

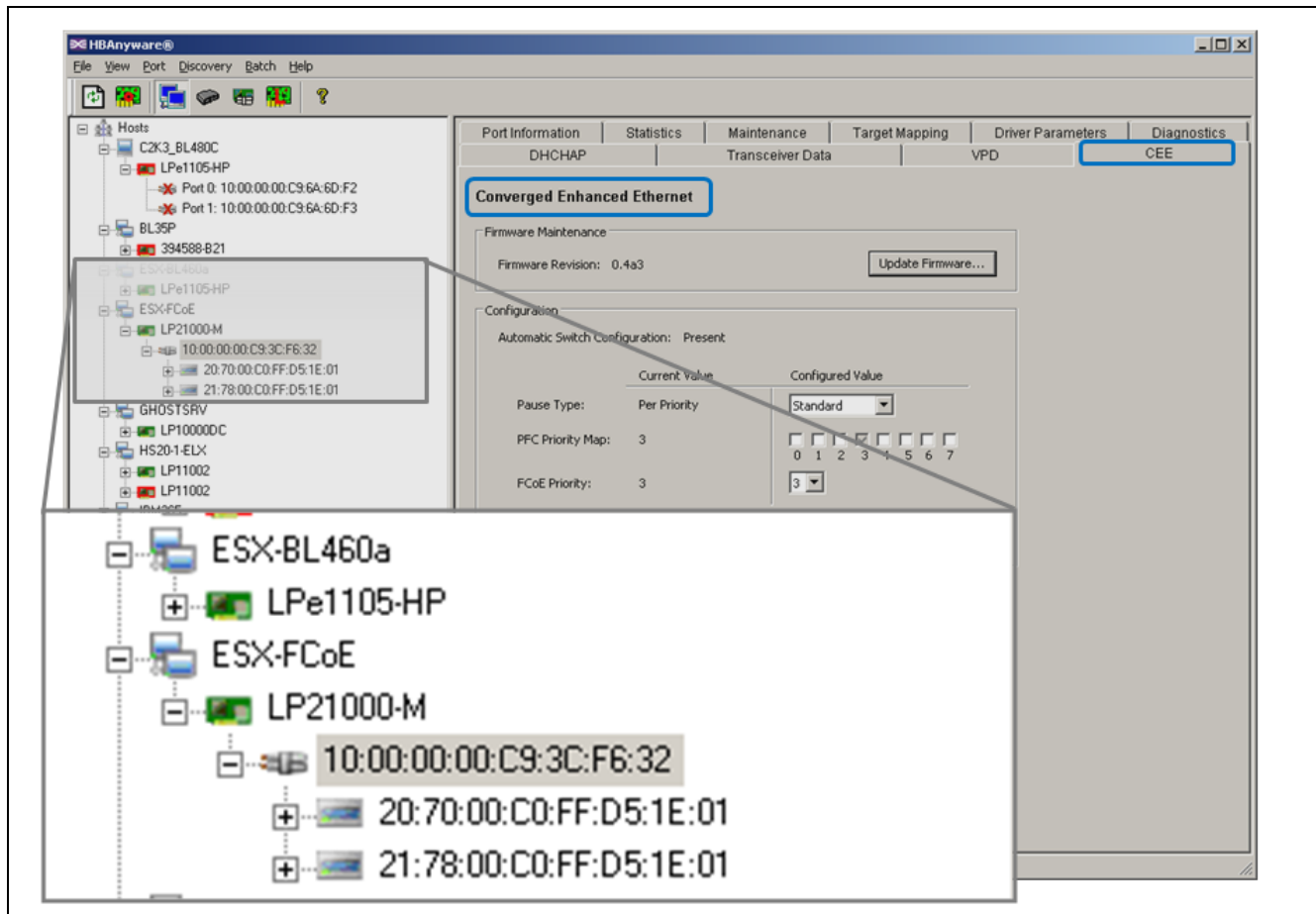
FIGURE 5. NETWORKING AND STORAGE WITH VMWARE



ESG Lab next examined the Emulex HBAnyware centralized management application, which Emulex has recently updated to include management support for its CNAs. The HBAnyware application provided by Emulex is a management platform designed for administration of FC HBAs and FCoE CNAs. It provides control of Emulex adapters within a centralized framework combining remote management options with secure access control across multiple platforms.

HBAnyware leverages Emulex's architectural capabilities including firmware and boot-code upgradeability and driver-compatibility across multiple product generations. Standards-based integration capabilities enable HBAnyware to integrate with enterprise server and storage management solutions.

FIGURE 6. THE LP21000 CNA MANAGED BY HBANYWARE



The HBAnyware management application shows Emulex HBAs and CNAs in a browse-able device tree on the left with configuration tabs arranged on the right. As seen in Figure 6, the LP21000 CNA was viewed side by side with Fibre Channel HBAs. The LP21000 CNA had one additional configuration tab, labeled Converged Enhanced Ethernet, or CEE, which allows administrators to update firmware of the FCoE / Enhanced Ethernet component of the adapter and set lossless Ethernet parameters and traffic prioritization for FCoE traffic.

ESG Lab also confirmed through HBAnyware that the LP21000 CNA uses the same lpfc Fibre Channel driver as the rest of the Emulex HBA family.

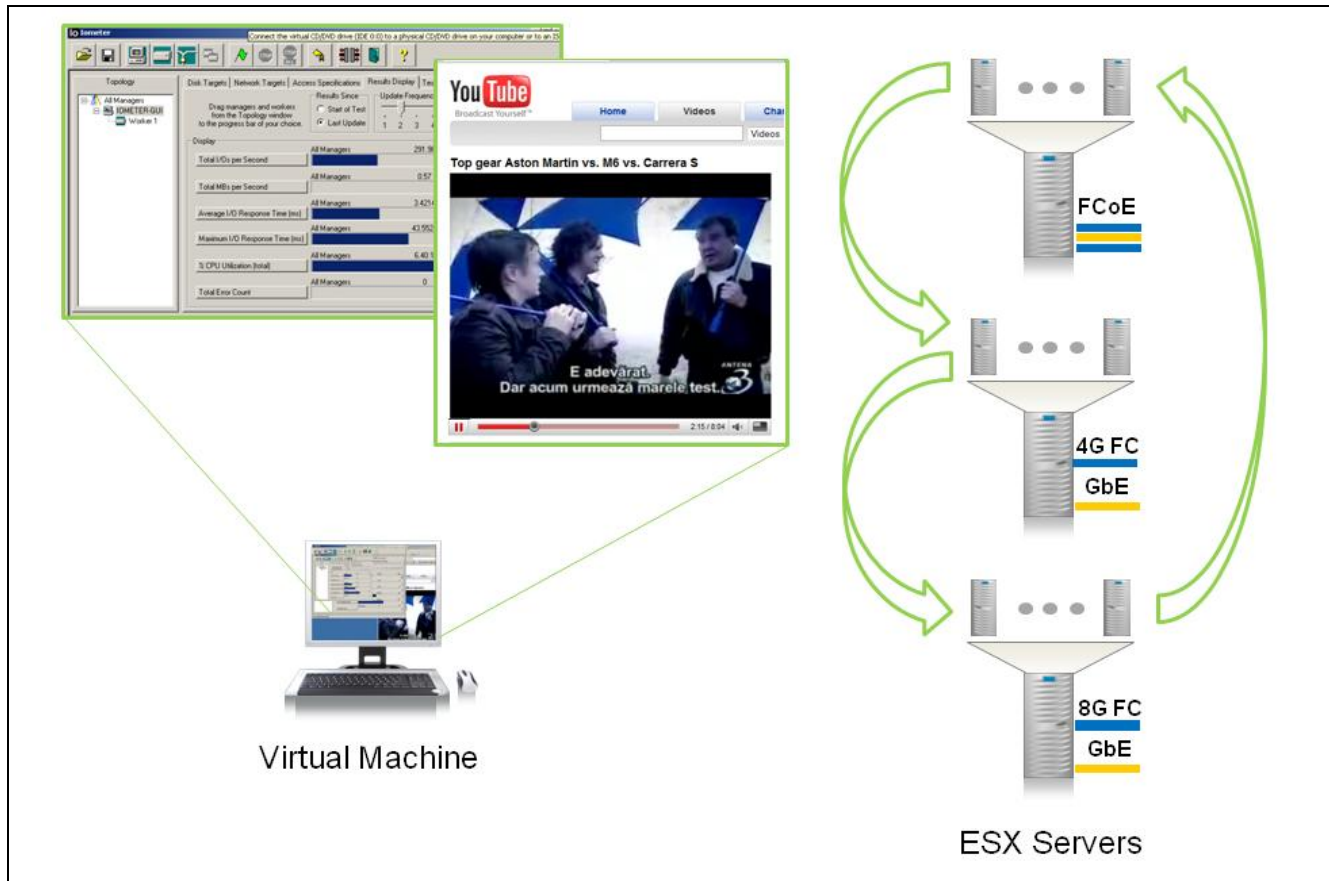
Why This Matters

Organizations of all sizes are struggling with the growth of online storage capacity. Storage administrators are challenged with consolidating servers and storage to reduce power, cooling and management costs. Storage area networks enable consolidation and cost savings, but attaching second tier applications and servers to the SAN has traditionally been prohibitively expensive SAN port costs for applications with non-mission critical storage requirements. ESG Lab has confirmed that FCoE is a viable and cost-effective method for extending a Fibre Channel SAN using Ethernet. The Emulex LP21000 drops into an existing data center environment using the same drivers, tools and techniques as existing FC HBAs and provides transparent IP network connectivity.

ESG Lab Testing

To validate the interoperability and compatibility of the LP21000 CNA in an enterprise Fibre Channel SAN environment, ESG Lab used VMware VMotion to move an active virtual machine between multiple dissimilar hardware platforms across a Fibre Channel fabric. As seen in Figure 7, the virtual machine was performing disk I/O and playing a video stream from the Internet as it was being moved between ESX servers.

FIGURE 7. MOVING A VIRTUAL MACHINE WITH FC AND IP TRAFFIC.

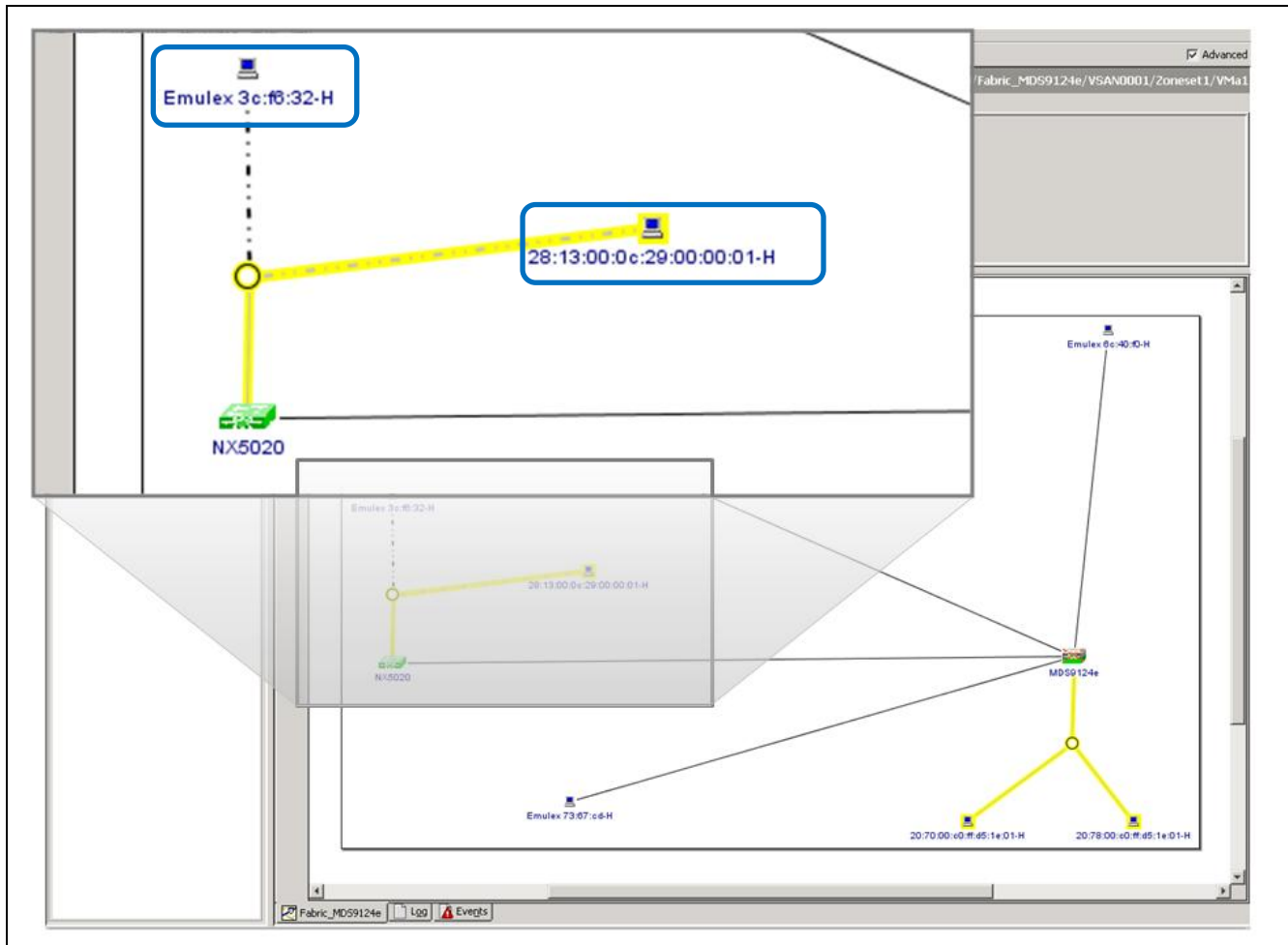


The hypervisor supporting a virtual machine was equipped with an Emulex LP21000 CNA and configured for both SAN (FC) and IP (Ethernet) access. The Fibre Channel and TCP/IP connections were configured in exactly the same manner as with traditional HBAs and NICs, including associating a virtual WWN to the virtual machine.

From the console of the Virtual Machine, the industry standard IOMETER workload generation utility was used to generate traffic to the SAN volumes accessed via FCoE. Simultaneously, a video on YouTube was selected and played. At this point, both the FC and IP data streams were flowing through the LP21000 CNA.

The virtual machine, as shown in Figure 8, was attached to the SAN through the physical FCoE adapter using a virtual World Wide Name (WWN).

FIGURE 8. VIRTUAL MACHINE, PRE-VMOTION

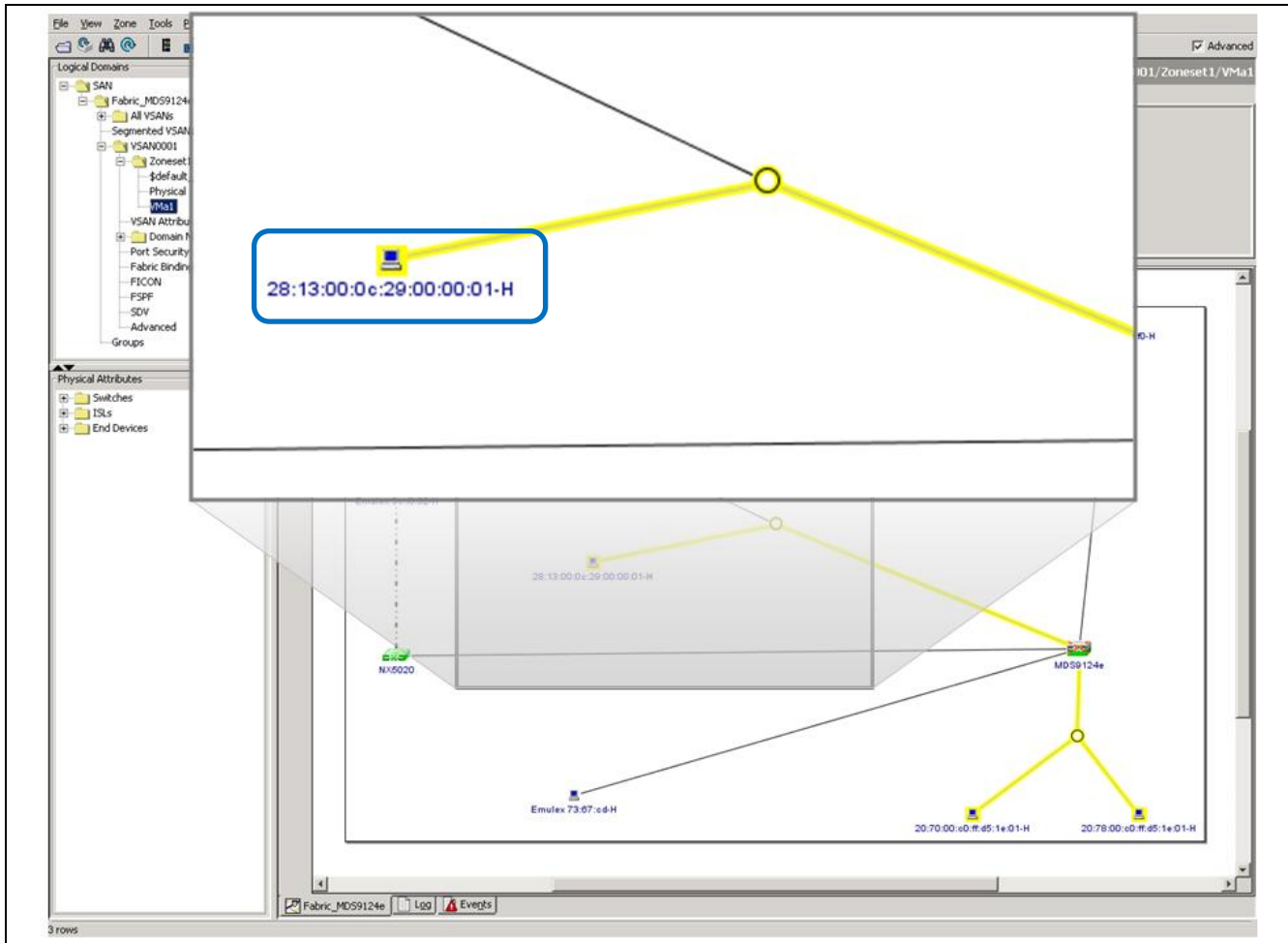


After starting the IOMETER test and the YouTube video stream, ESG Lab began a migration of the virtual machine from one server to another using the VMware VMotion utility. The virtual machine was migrated to a second ESX Server with a Emulex LP11000 4 Gb/sec FC HBA and a separate Gigabit Ethernet NIC installed.

Within a few seconds, the virtual machine had moved to the second ESX server. Both the video and IOMETER continued to function without error and with only the briefest pause. ESG Lab then used VMotion to move the virtual machine to a third server, which had an 8 Gb/sec Emulex FC HBA installed. Again, the move completed quickly with no interruption and only a brief pause in activity.

As seen in Figure 9, the virtual machine has moved to a different physical server, but the WWN remains the same. This is possible because the FCoE CNA (like all Emulex FC HBAs) utilizes N_Port ID Virtualization or NPIV, a Fibre Channel facility that allows multiple virtual Fibre Channel initiators ports to occupy an individual worldwide port name and appear as a single physical port.

FIGURE 9. VIRTUAL MACHINE, AFTER THE MOVE



Finally, ESG Lab moved the virtual machine back to the server with the LP21000 CNA. The entire process took about five minutes, start to finish.

Why This Matters

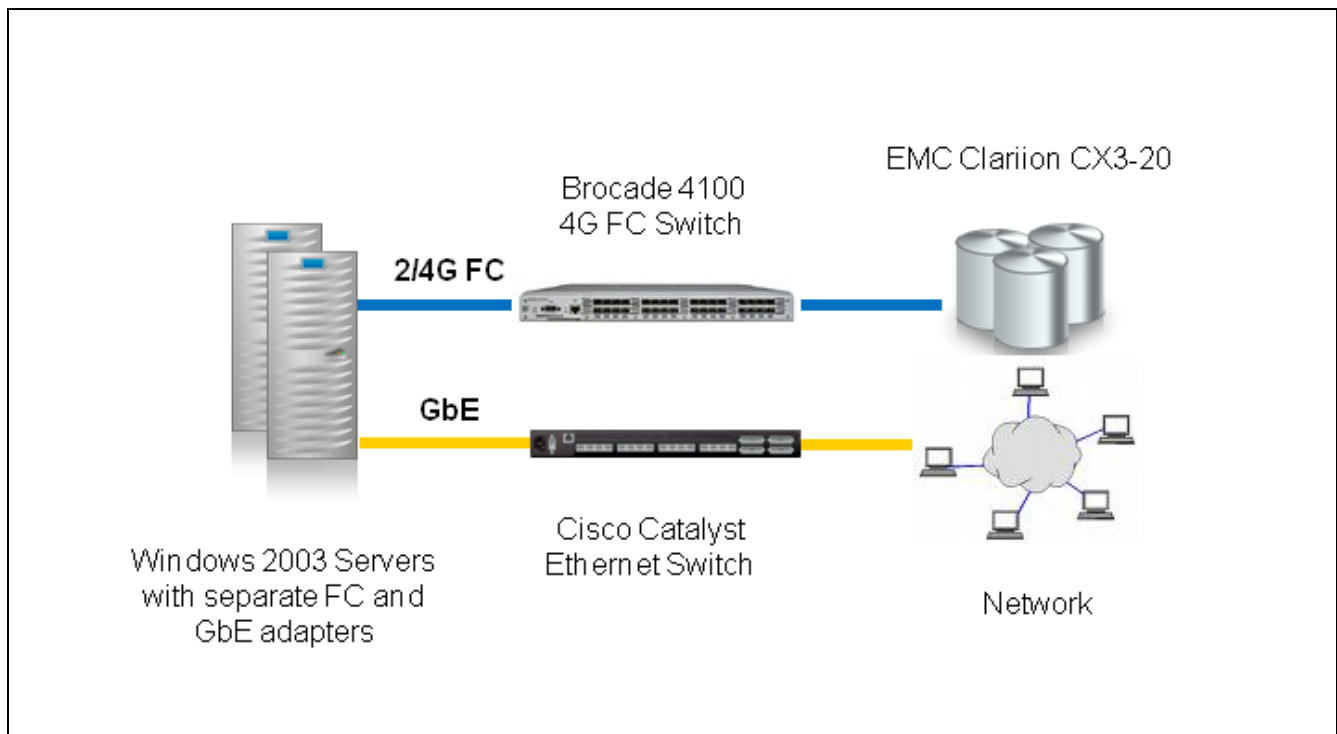
Server and storage consolidation presents challenges in large data centers when High Availability services must be provided to servers and storage with diverse, sometimes incompatible technologies. Consolidating networks, servers and storage arrays using FCoE can potentially increase utilization and availability, while reducing the amount of equipment that needs to be purchased, managed, powered and cooled. ESG Lab validated that the Emulex LP21000 CNA supports the same software, drivers and advanced features as its FC cousins, providing investment protection and enabling seamless migration to a highly available, converged network with fewer ports, cards and cables. This translates directly to lower capital and operational costs to the business.

Fibre Channel over Ethernet in Action

ESG Lab spoke with a customer who was evaluating FCoE technology and had tested the Emulex LP21000 CNA in their own environment. This customer is a manufacturer of IT components and products with a sizeable IT infrastructure. The IT manager is interested in FCoE technology as a cost-effective means to provide unified storage and network connectivity in support of server virtualization and SAN extension initiatives.

This end-user created a test bed for their proof of concept using four x86 servers with identical processors and RAM installed. Two were configured with Emulex LightPulse Fibre Channel HBAs and Ethernet adapters as illustrated in Figure 10 to emulate the standard data center configuration currently in use.

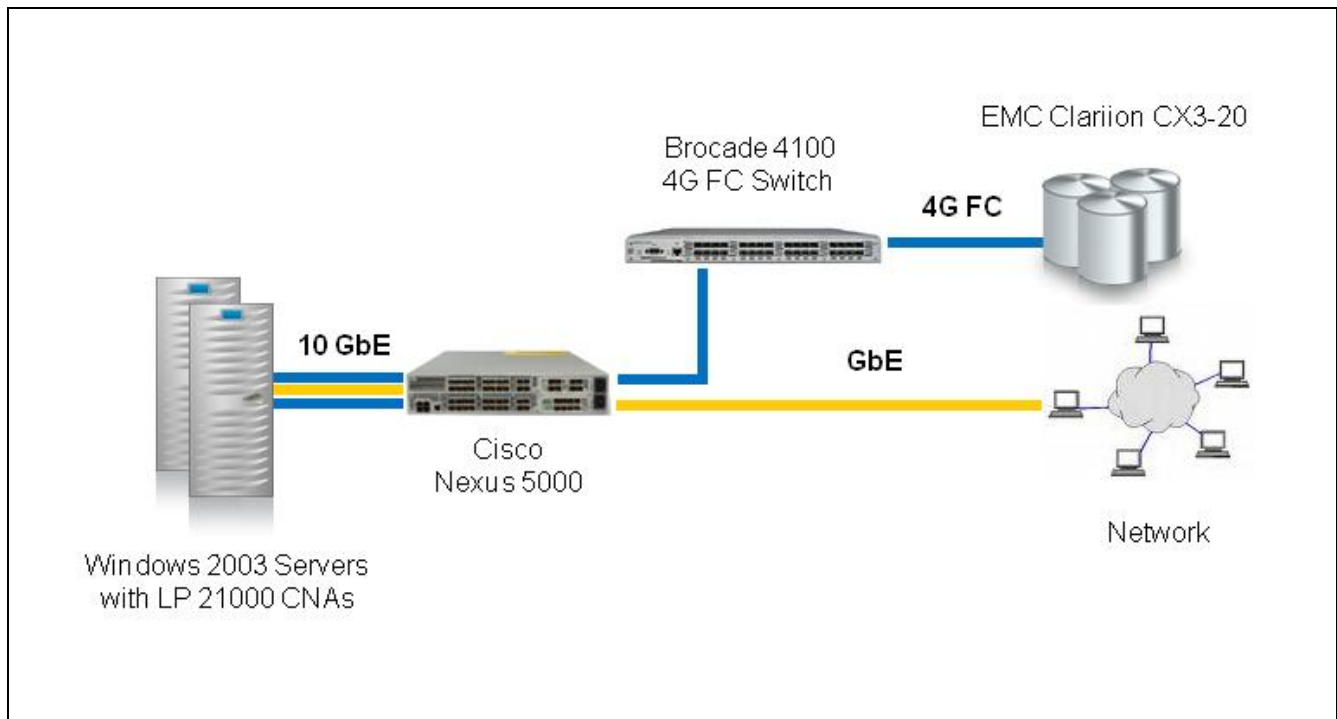
FIGURE 10. TRADITIONALLY CONFIGURED SERVERS



The servers were connected to EMC CLARiiON storage through a Brocade SilkWorm 4100 switch. Network connectivity was provided by Cisco Catalyst switches. This closely modeled the production environment and was used by the customer as a baseline to compare ease of configuration, management and performance with the LP21000 CNA.

Figure 11 shows the FCoE configuration dropped into the test bed. A Cisco Nexus 5000 series switch was used to connect the server to the same SAN and LAN networks as the traditional servers. The IT manager in charge of the evaluation commented that the installation was very simple as the LP21000 “looked just like any HBA” in their environment and was installed using the same driver package used for standard Fibre HBAs. Even more telling was the statement: “In fact, I didn’t even have to read the manual.”

FIGURE 11. CONVERGED NETWORK TEST BED WITH FCOE



IOMeter was used to evaluate the performance of the LP21000. Several workloads producing I/O, which would be found in common applications such as database, e-mail, file services, streaming video and backup were run on both the FCoE and 4 Gb/sec FC connected servers against identically provisioned LUNs on EMC CLARiiON storage. According to this customer, the LP21000 showed 'negligible latency' and performed 'extremely well' keeping pace with the 4 Gb/sec HBA and outperforming the 2 Gb/sec HBA.

The bottom line for this IT manager was that FCoE as supported by the LP21000 was easy to deploy and seamlessly integrated into his environment. "FCoE is definitely worth a look for anyone with an existing FC fabric looking to extend their SAN."

ESG Lab Validation Highlights

- ☑ The Emulex LP21000 CNA was recognized by both VMware and Windows as a Fibre Channel HBA and a 10 Gb/sec Ethernet NIC, without any special software or configuration required.
- ☑ The CNA used the same lpfc drivers as all standard Emulex FC HBAs.
- ☑ The management experience administering the CNA is essentially identical to any Emulex FC HBA.
- ☑ The CNA was able to participate in a Fibre Channel fabric with both 4 Gb/sec and 8 Gb/sec FC HBAs and share the same storage array without any compatibility or interoperability issues.
- ☑ A Windows virtual machine was able to transfer between the ESX server running the CNA and two other ESX servers running traditional FC HBAs and Gigabit Ethernet NICs while both FC and IP I/O ran without interruption.

Issues to Consider

- ☑ While ESG Lab found the LP21000 CNA to be transparently compatible with existing FC SAN environments, a FC to Ethernet switch is required to bridge the two networks and allow the Ethernet based LP21000 to communicate with devices on the FC SAN. Currently there is only one switch certified for connectivity, the Cisco Nexus 5000 series. As with all emerging technologies, ESG expects additional vendors to provide connectivity as the market matures, but if you are in the market today, you have only one choice.
- ☑ The Converged Enhanced Ethernet standards required for reliable FCoE connectivity are still being ratified. ESG does not expect production ready systems to hit the market for about 12 months. Having said that, forward thinking IT managers with existing investment in FC fabrics would be wise to begin investigating this technology sooner rather than later.

ESG Lab's View

Years ago, ESG had a conversation with Bob Metcalfe, the Father of Ethernet and founder of 3Com, about the use of InfiniBand as an alternative to Ethernet for networking and Fibre Channel for storage. After listening patiently as we extolled the virtues of InfiniBand technology, Bob said, "I don't know what comes after Ethernet, but it will be called Ethernet." While it's still early to make a call, it's hard to bet against Bob's vision. The Enhanced Ethernet and FCoE standards efforts are proceeding at break-neck speed with a goal of using Ethernet to unify all of the network traffic in the data center.

Consolidation is a recurring theme in the IT industry. Consolidating server, storage and networking infrastructure has clear and obvious benefits. Less equipment to purchase reduces capital equipment and maintenance costs. Less equipment to install and manage reduces operational costs. Less power reduces recurring costs and cooling requirements. Less cabling reduces cost and complexity. Put simply, if it's not too painful to get there from here, less is better than more.

Leveraging familiar tools and processes, FCoE and Enhanced Ethernet provide a smooth upgrade path for the migration of storage traffic from an isolated FC storage network to a converged Ethernet fabric. It is ESG Lab's opinion that FCoE is a compelling technology and potentially a better fit than iSCSI for organizations with significant investment in Fibre Channel. It enables companies to retain existing FC infrastructure, keeps existing FC management tools in place, provides the same level of performance guarantees and has the potential of reducing costs. This final consideration of cost is a significant variable in the FCoE adoption equation. Given the present economy and the pressure that IT is under to reduce costs, compelling FCoE pricing could be used to accelerate adoption faster than any marketing pitch or certification.

A recent ESG research survey indicates that 15% of companies with 100 to 999 employees and more than 100 servers report that FCoE is the most important storage-related initiative for their organization over the next 24 months.³ For a standard that has yet to be ratified, these are impressive numbers. ESG expects that interest is higher for larger organizations with more complex SAN environments. Given the recent product announcements from vendors like Emulex and Cisco, ESG expects that interest in FCoE adoption will swell throughout 2008 and into 2009.

ESG Lab has seen FCoE in action with Emulex LP21000 CNAs providing converged server connectivity to a LAN and a SAN. Running alongside Emulex HBAs and managed from the familiar Emulex HBAnyware management application, Emulex CNAs worked with field-proven drivers and tools. Testing in a virtual server environment proved that NPIV support securely isolates virtual servers for enhanced security—exactly the same as it does in an Emulex-enabled FC environment. ESG spoke with a customer who summed it up well as he described his experience with an Emulex CNA, "It looked just like any HBA. In fact, I didn't even have to read the manual." Like this customer who has relied on Emulex for years, ESG believes that organizations considering the benefits of FCoE convergence would be wise to schedule an evaluation of the Emulex LightPulse LP21000 family of converged network adapters.

³ Source: ESG Research Report, *2008 Medium-Sized Business Survey*, May 2007

Appendix

Table 1. TEST CONFIGURATION

Hardware	Software/Firmware
2 - HP C-3000 Blade Server Emulex LPe1105 4 Gb/sec FC HBA	VMware ESX 3.5 Server
HP ML370 G5 Blade Server Emulex LP21000 FCoE CNA	VMware ESX 3.5 Server
HP DL140 Emulex LPe12000 8 Gb/sec FC HBA	VMware ESX 3.5 Server
HP MSA2000 FC Storage Array	
Cisco Nexus 5020	
Cisco MDS 9124	
Cisco Catalyst 3560-E	
	HBAnyware Version 4.0



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