Lab Validation Report

Emulex LPe16000 Series 16GFC HBAs

Extremely High Performance and Low Latency, Designed for Highly Virtualized Environments

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ESG Lab Reports

The goal of ESG Lab reports is to educate IT professionals about data center technology products for companies of all types and sizes. 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.

Introduction

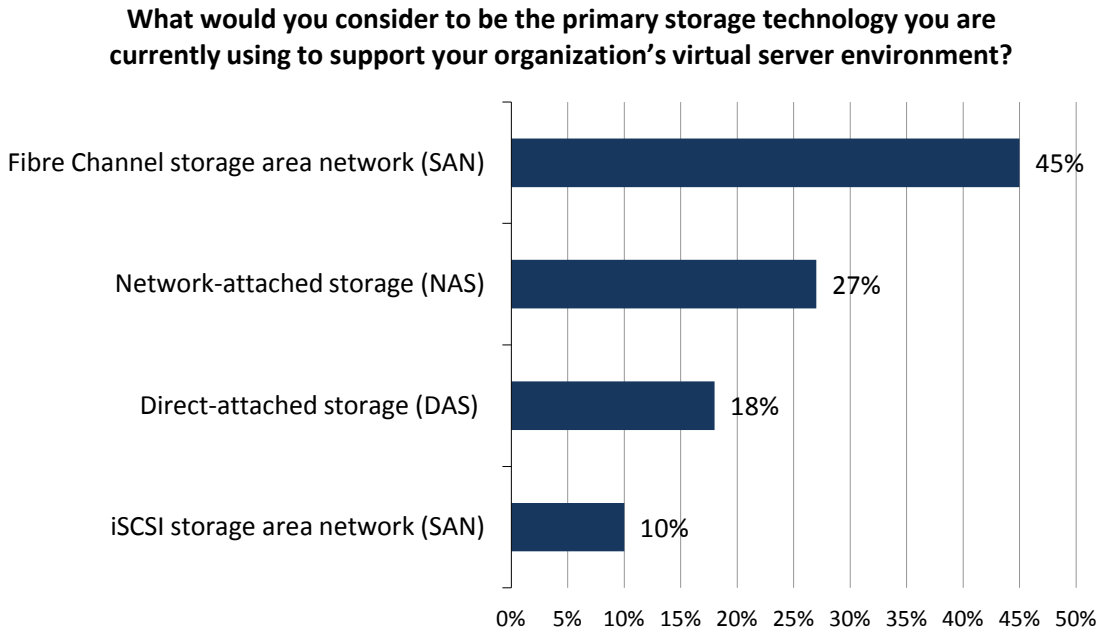
This report documents ESG Lab's hands-on testing of the Emulex LightPulse 16G Fibre Channel (16GFC) Host Bus Adapter (HBA), and explores the HBA's ability to improve virtualization efficiency and increase performance in an 8Gb or 16Gb environment. The report also covers the ease of management and simplicity of deployment of the LPe16000 series.

Background

Virtualized server deployments are rapidly expanding into production environments, and the number of virtual machines (VMs) per host is rapidly increasing. More than 30% of respondents to an ESG research survey[1] expected to be running 25 or more VMs per host in less than two years. With that in mind, it's no surprise that IT organizations are changing the way they support their businesses.

A key component of the new architecture is networked storage, and as a result of increasing VM densities in production environments, demand exists for higher-bandwidth solutions with advanced features such as I/O virtualization. While converged networks have received a lot of media attention, organizations still rely on Fibre Channel. In fact, Fibre Channel is still the primary storage technology used to support virtualized server environments.

Figure 1. Top Storage Technology Supporting Virtualized Environments



Source: Enterprise Strategy Group, 2010.

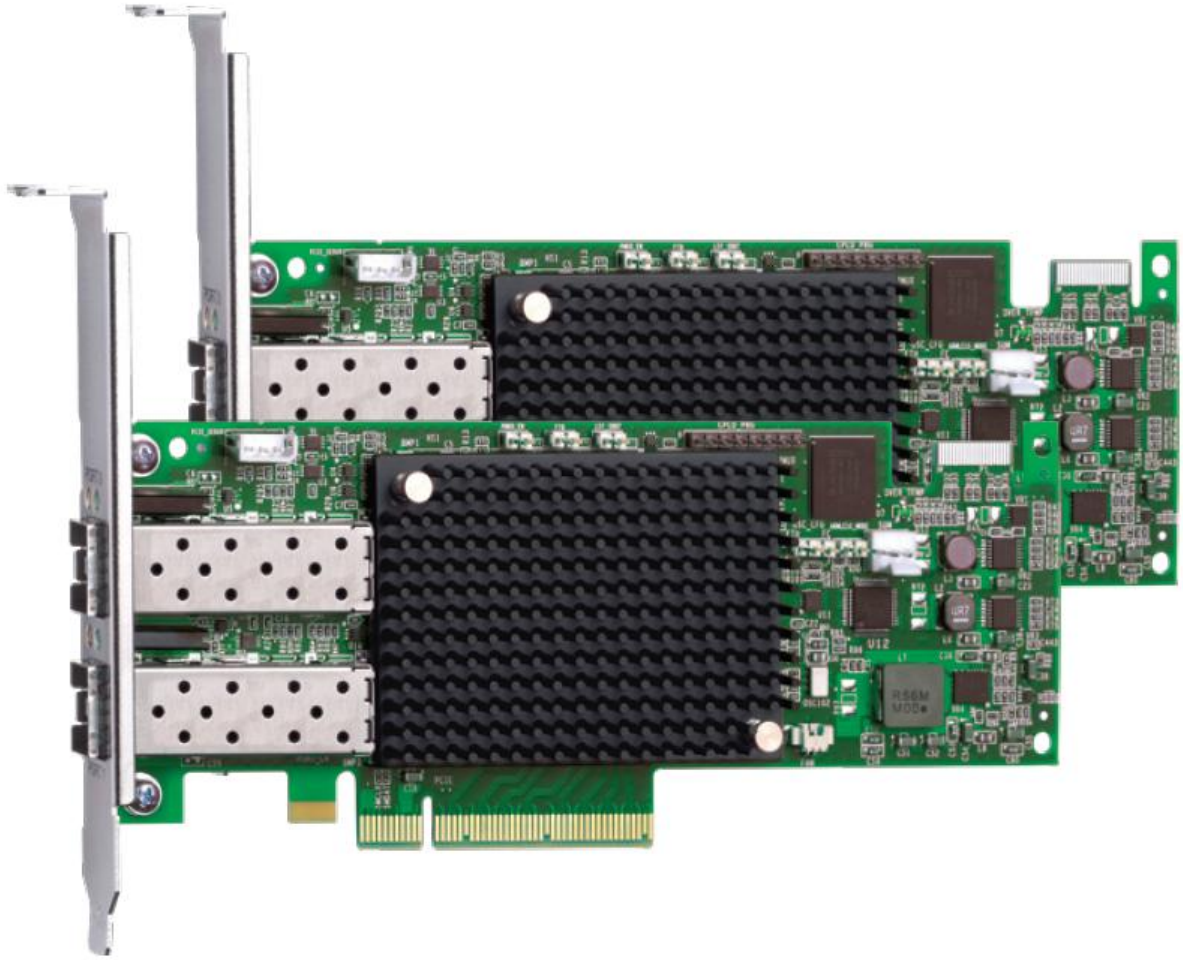
Emulex LPe16000 Series Fibre Channel HBA

The Emulex LPe16000 series HBA is an enterprise-class PCI Express 2.0 16Gb Fibre Channel HBA with advanced support for server virtualization technology and simplified deployment and management capabilities. The LPe16000 series is compatible with and designed to increase performance in 4Gb and 8Gb networks. As can be seen in Figure 2, the LPe16000 and LPe16002 are short, low-profile PCI Express cards. The small form factor provides for efficient operation with low power requirements and heat dissipation. The Emulex OneCommand Manager application features a cross-platform multiprotocol design that provides centralized management of all Emulex

[1] Source: ESG Research Report, *The Evolution of Server Virtualization*, November 2010. All research references come from this report unless otherwise stated.

HBAs, enabling IT administrators to manage a multi-protocol storage network with one tool for greater simplicity. OneCommand Manager also includes a plug-in for VMware vCenter, enabling management of adapters from within the VMware environment.

Figure 2. Emulex LPe16000 Series 16G Fibre Channel HBAs



Some of the key features of the 16GFC HBA are:

- Support for 16Gb, 8Gb, and 4Gb FC devices.
- A common driver model, which enables a single driver to support all Emulex HBAs on any given OS.
- The eight-way multi-core ASIC engine, which provides massive performance and scalability, supporting up to 8,192 logins and open exchanges for maximum virtual machine density.
- The OneCommand Manager plug-in for VMware vCenter, which enables centralized management of adapters within a VMware environment.
- Two new features that add performance benefits and support server virtualization— vEngine and BlockGuard. Both reduce the host CPU burden, freeing up resources for virtualization, increased performance, and end-to-end data protection.

ESG Lab Validation

ESG Lab performed hands-on evaluation and testing of the Emulex LPe16000 series HBA at Emulex's Lab in Costa Mesa, California. Testing was designed to demonstrate the ease of integration and management while deploying an LPe16000 series HBA into an existing 8Gb Fibre Channel SAN network environment using the OneCommand Manager VMware vCenter plug-in. ESG Lab also explored the performance of the LPe16000 series HBA in both 8Gb and 16Gb Fibre Channel network environments.

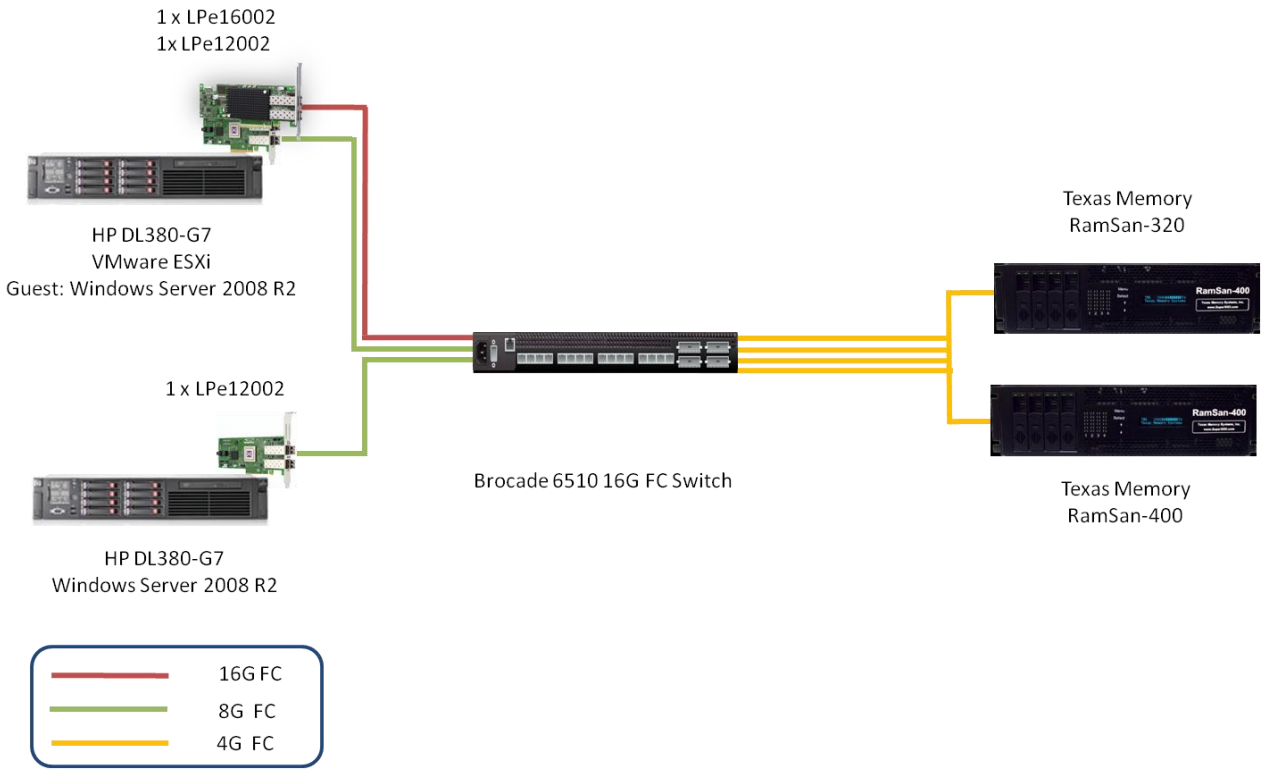
Getting Started

ESG Lab began by testing the ease of deploying the LPe16000 series adapters into an existing Fibre Channel SAN environment.

ESG Lab Testing

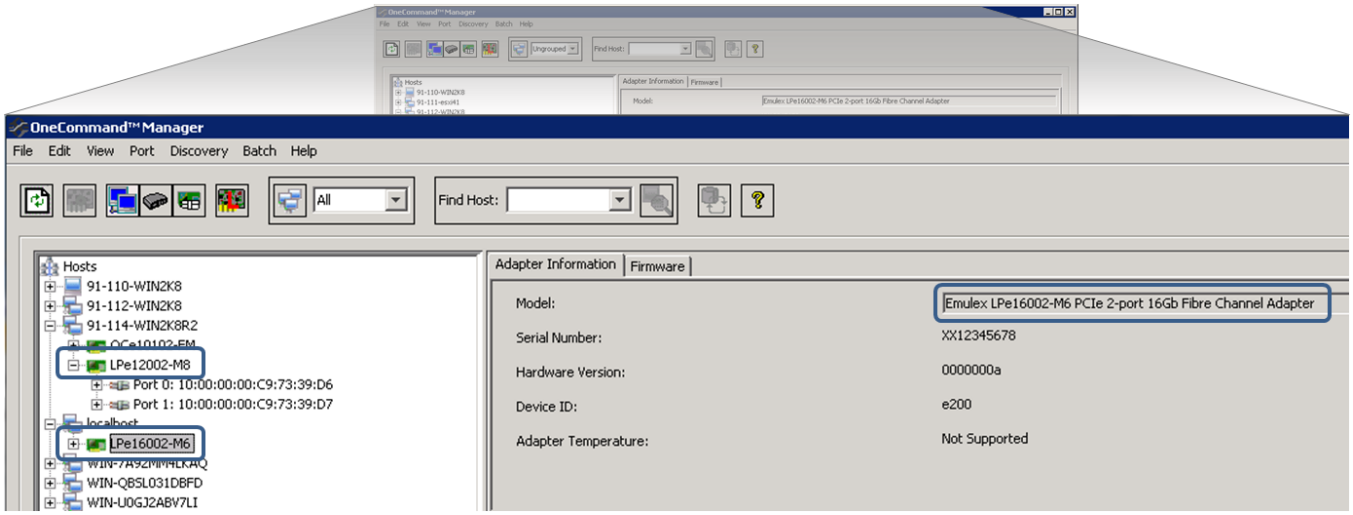
The ESG Lab test bed consisted of one HP DL380-G7 server running VMware ESXi 5.0 with a number of virtual machines running Windows Server 2008 R2. The DL380 had one Emulex LPe1250 8GFC HBA and one Emulex LPe16002 16GFC HBA installed. A Brocade 6510 24-port 16Gb Fibre Channel switch was used to attach to two Texas Memory Systems RamSan storage systems, as shown in Figure 3. Each RamSan system had four 4Gb FC ports attached to the SAN to provide sufficient bandwidth for the performance tests.

Figure 3. The ESG Lab Test Bed



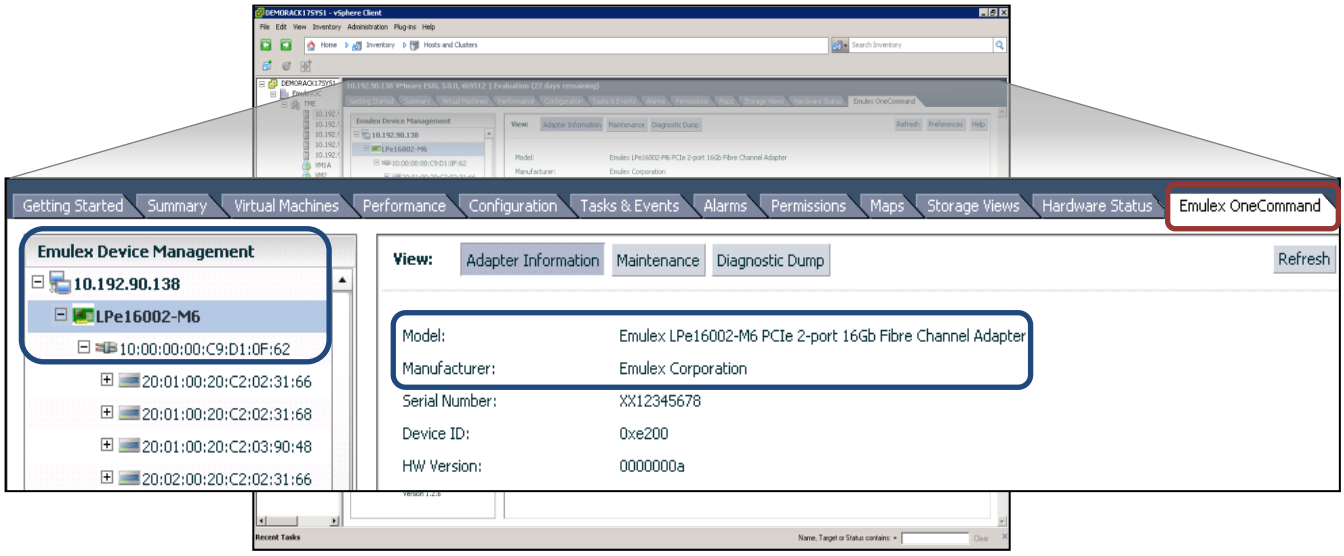
ESG Lab installed the Emulex driver and confirmed that both the Emulex 8GFC HBA and the 16GFC HBA were recognized by Windows. Figure 4 shows the Emulex HBAs used for these tests in the Emulex OneCommand Manager application.

Figure 4. Emulex One Command Manager Adapter Information



Using Emulex OneCommand Manager, ESG Lab was able to discover and view all HBAs within the test environment. Next, ESG Lab launched the vCenter management console and confirmed that all HBAs visible to the OneCommand manager console were also visible under the Emulex OneCommand tab, as shown in Figure 5.

Figure 5. Emulex One Command Manager VMware vCenter Plug-In



Why This Matters

Virtualized server deployments are rapidly expanding into production environments, and the number of virtual machines (VMs) per host is rapidly increasing. More servers per host equals more complexity when deploying and managing these systems, which translates to increased costs for IT staff to implement and maintain growing virtual environments. Emulex OneCommand Manager software and the vCenter plug-in are both designed to increase the efficiency of deployment and management in complex, virtualized, enterprise environments.

ESG Lab was able to verify the ease and simplicity of deploying Emulex LPe16000 series HBAs into an existing networked storage environment. The LPe16002 used the same driver as the existing 8GFC HBAs, which simplified installation and decreased the amount of time required to complete installation tasks. Backward compatibility with 8Gb and 4Gb SAN environments and the vCenter plug-in enabled ESG Lab to quickly and easily bring a system with a new LPe16002 HBA online.

Ease of Management

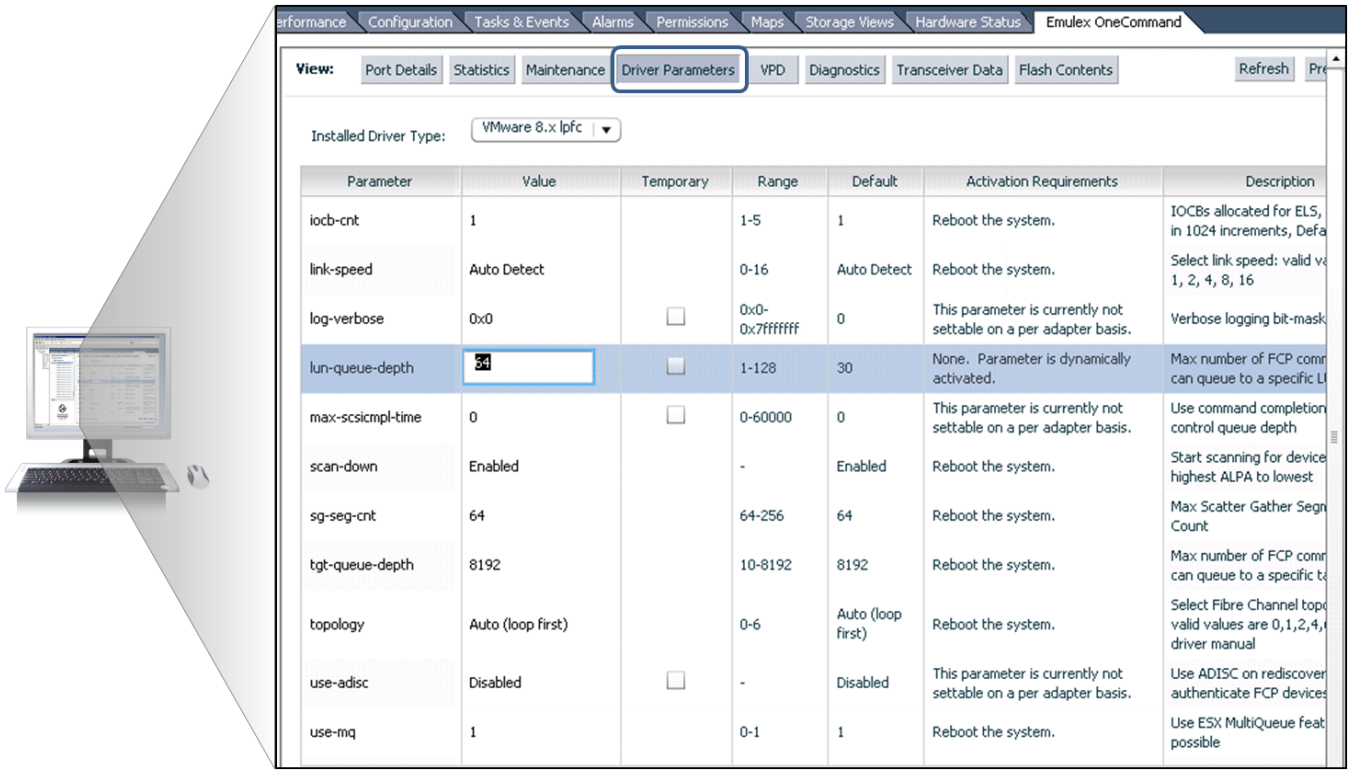
Emulex OneCommand Manager enables centralized administration of all Emulex HBAs within local or remote systems in a multiprotocol, heterogeneous environment. OneCommand Manager provides detailed insight into the adapter for configuration, diagnostics, monitoring, and statistics to help optimize SAN network performance from the host, through the network fabric, to the storage. OneCommand includes key management capabilities such as:

- The ability to push multiple HBA firmware upgrades to multiple servers without downtime.
- The ability to apply configuration updates for drivers and adapters across many hosts.
- The ability to change adapter World Wide Names (WWNs) without impact to the SAN or storage.
- Online adapter and Fibre Channel network diagnostics.
- A full-featured VMware vCenter plug-in for centralized management of all Emulex adapters through the vCenter console.

ESG Lab Testing

ESG Lab tested the Emulex LPe16000 series HBA's ease of management using the Emulex OneCommand VMware vCenter plug-in. ESG Lab launched the vCenter management console, clicked the Emulex OneCommand tab, and opened the Driver Parameters tab for the LPe16002 HBA being tested, as shown in Figure 6.

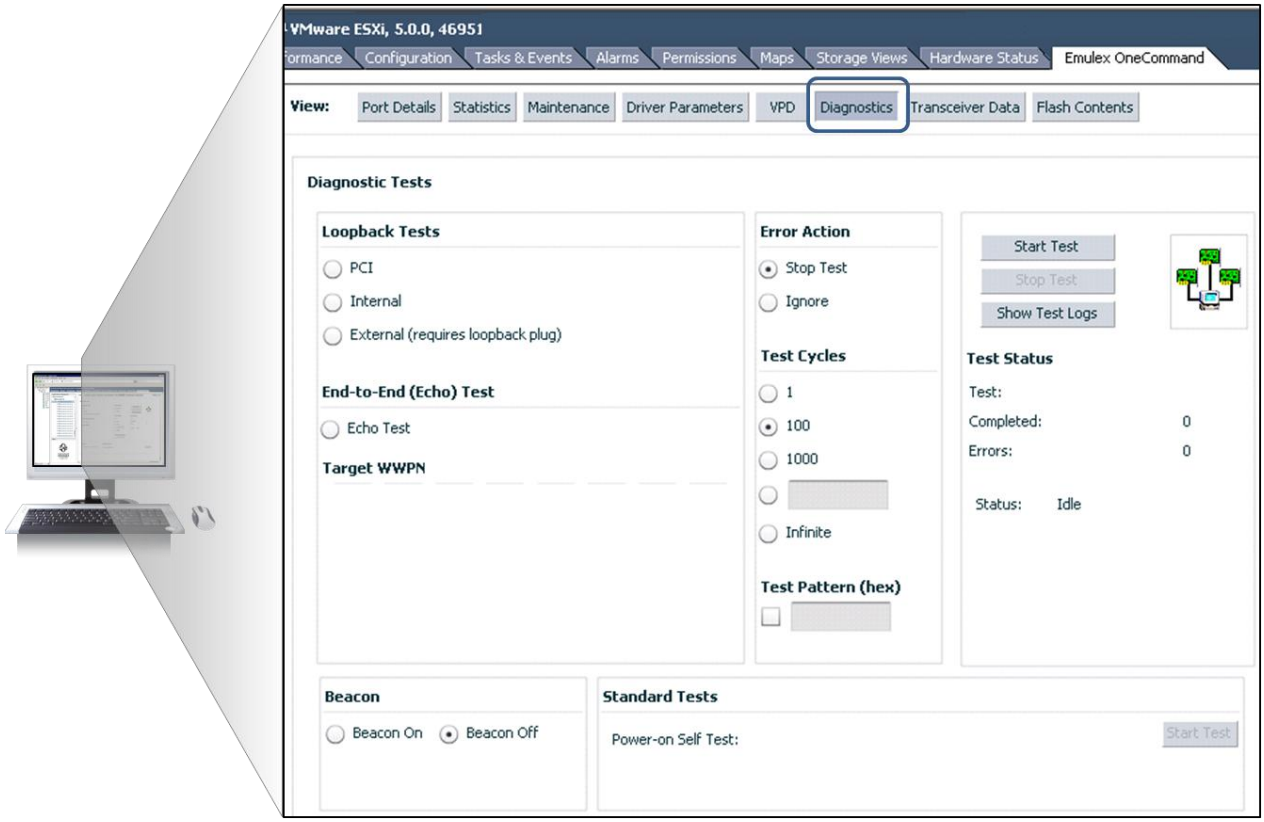
Figure 6. Setting Driver Parameters



Exploring the Driver Parameters tab, ESG Lab found the information as detailed and complete as that found in the standalone Emulex OneCommand application. The layout of the columns and context-sensitive details help make the plug-in intuitive, easy to use, and powerful, particularly because it includes useful information about each parameter, such as the default value, activation requirements, and a description of the parameter.

Next ESG Lab selected the Diagnostics tab, as shown in Figure 7. Online diagnostics enable administrators to troubleshoot both adapter and Fibre Channel SAN issues online and avoid unnecessary downtime or inappropriate hardware removal during the troubleshooting process.

Figure 7. Emulex OneCommand Diagnostics Tab

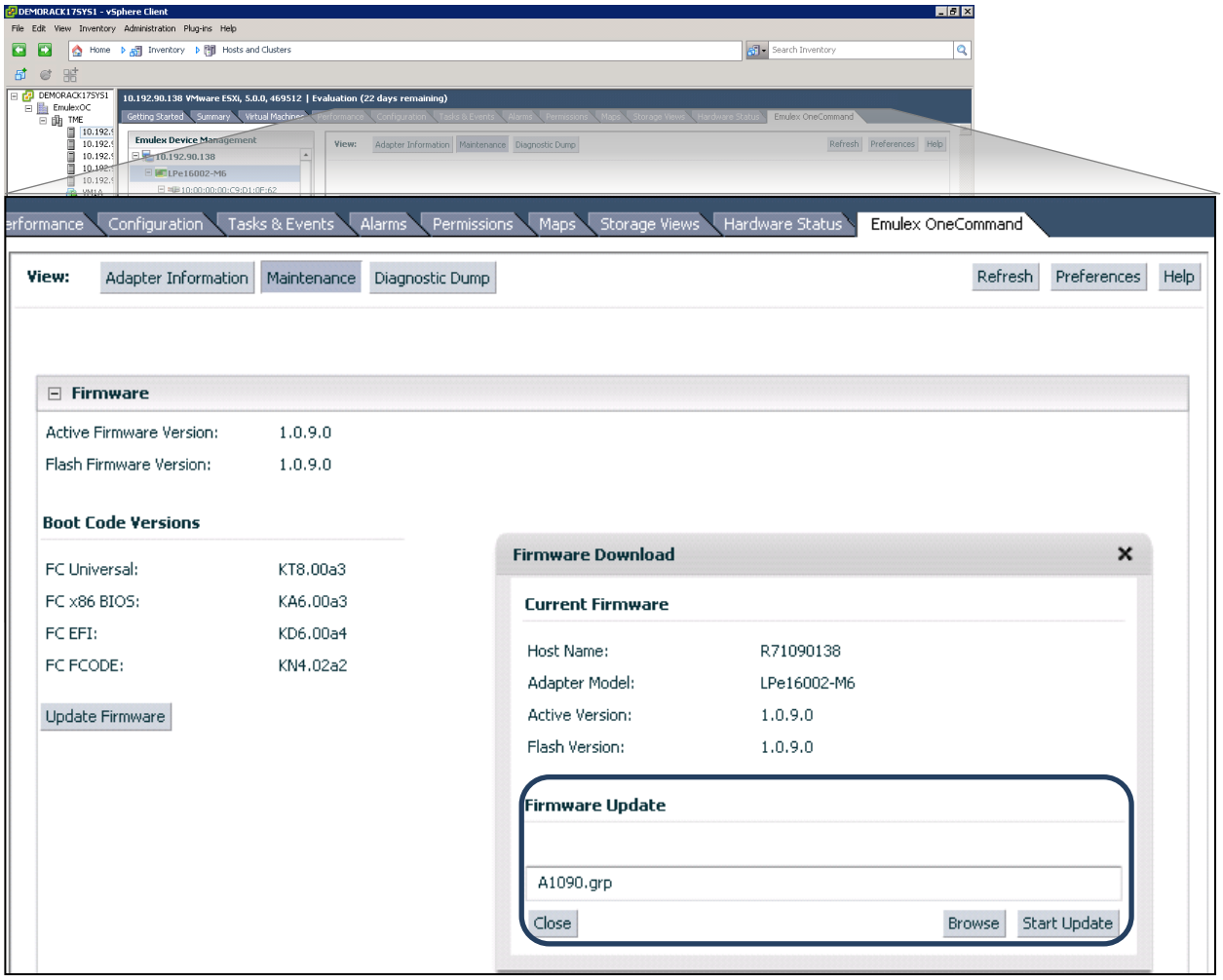


Finally, ESG Lab performed a firmware update on an LPe16002 HBA from the vCenter Console. ESG Lab selected Host View from the OneCommand tab and selected the HBA to be updated. Under Maintenance, ESG Lab clicked Firmware Update, then browsed to the firmware update file.

After selecting the file, ESG Lab simply clicked Start Update, as shown in Figure 8, and the firmware update began.

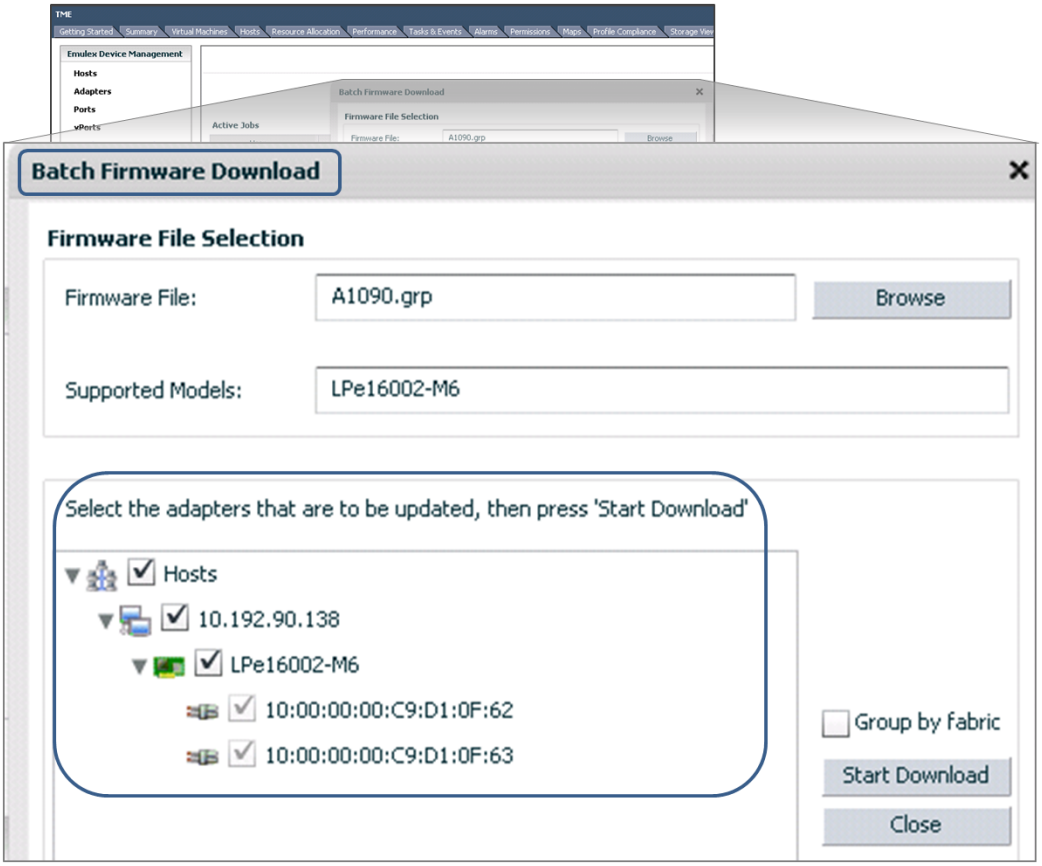
It's important to note that the firmware update executed with the server online, without disruption, and was activated on the HBA without a server reboot.

Figure 8. Emulex Firmware Update



Firmware updates can be performed across multiple Emulex HBAs using the Batch Firmware Download function shown in Figure 9. The process to update multiple HBAs is very similar to updating a single adapter. Batch updates can be grouped by fabric to ensure that all adapters in the same fabric are updated to the same firmware at the same time.

Figure 9. Batch Firmware Update



Why This Matters

Because server virtualization touches the entire technology stack, all parts have to work in concert for the effective delivery of IT services. ESG research found that IT managers across all functional technology areas point to the need for tighter integration among components as a requirement to enable more widespread server virtualization usage in their organizations. Making server virtualization work well demands cross-functional visibility, tools, and cooperation.

ESG Lab confirmed the OneCommand Manager application's capabilities were fully represented in the VMware vCenter plug-in, enabling single-pane management for virtual systems from the HBA, through the SAN fabric, to the storage. ESG Lab was impressed by the depth and breadth of integration with vCenter, allowing seamless "no downtime" firmware upgrades to single or multiple Emulex HBAs through the plug-in. ESG Lab believes IT administrators will find the ease of management and depth of features offered by the Emulex OneCommand vCenter plug-in will enable them to keep pace with the growing demands of virtualization in their environments.

Performance

In a modern virtualized data center, with potentially dozens of virtual machines per physical server, performance becomes a critical factor. The Emulex LPe16000 series HBAs were designed with high-performance goals in mind to provide sufficient performance for highly scalable servers with 10 (or even 12) core processors and solid-state disk (SSD) to support critical tier-1 applications.

ESG Lab Testing

ESG Lab tested the performance capabilities of the Emulex LPe16000 series HBAs in both pure 16Gb SAN environments and existing 8Gb storage networks, comparing the results to previous-generation Emulex 8GFC HBAs.

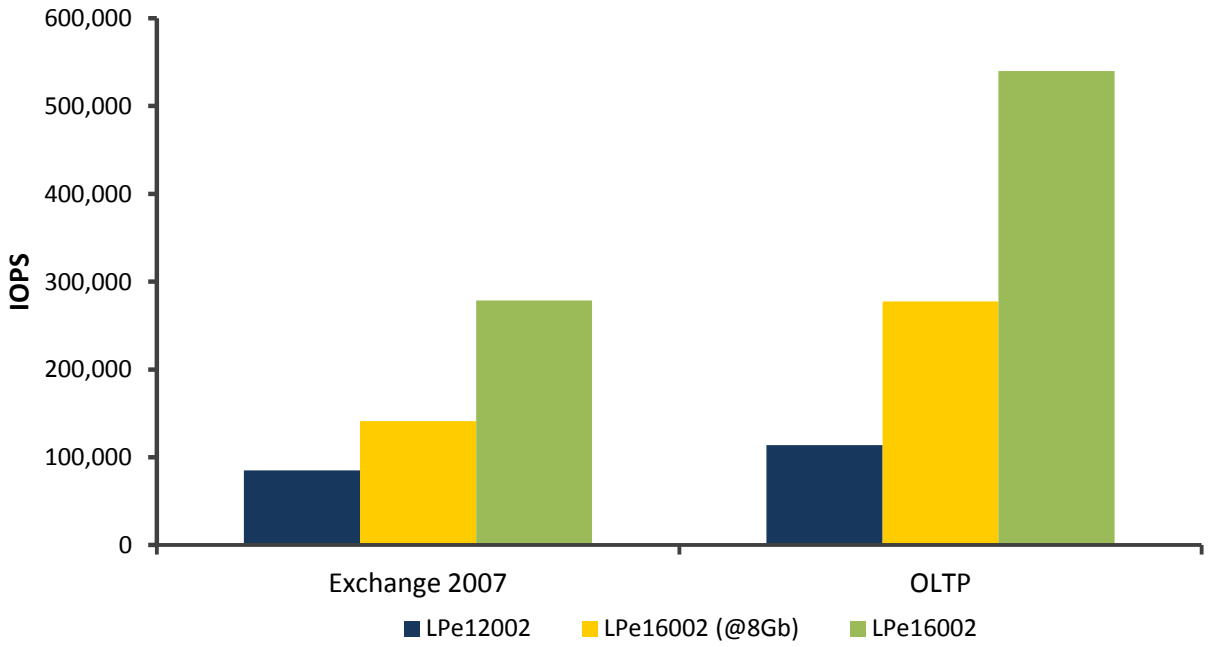
ESG Lab used three different configurations in the test bed shown in Figure 3 to execute performance testing. Virtual machines were configured with:

- A single port of an LPe12002 8GFC HBA connected to a solid-state storage system.
- A single port of an LPe16002 16GFC HBA connected to the same storage array through a single 8Gb connection.
- An LPe16002 HBA connected to the same solid-state storage system through a 16GFC connection.

The Iometer utility was used to generate simulated application workloads including OLTP (online transaction processing) workloads using small block random I/O, a Microsoft Exchange 2007-like workload, and a streaming media simulation using large block sequential I/O.

First, ESG Lab ran the transactional workload and Exchange simulation for all three configurations and documented the IOPS achieved, as shown in Figure 10.

Figure 10. Emulex HBA Performance with Exchange and OLTP Workloads

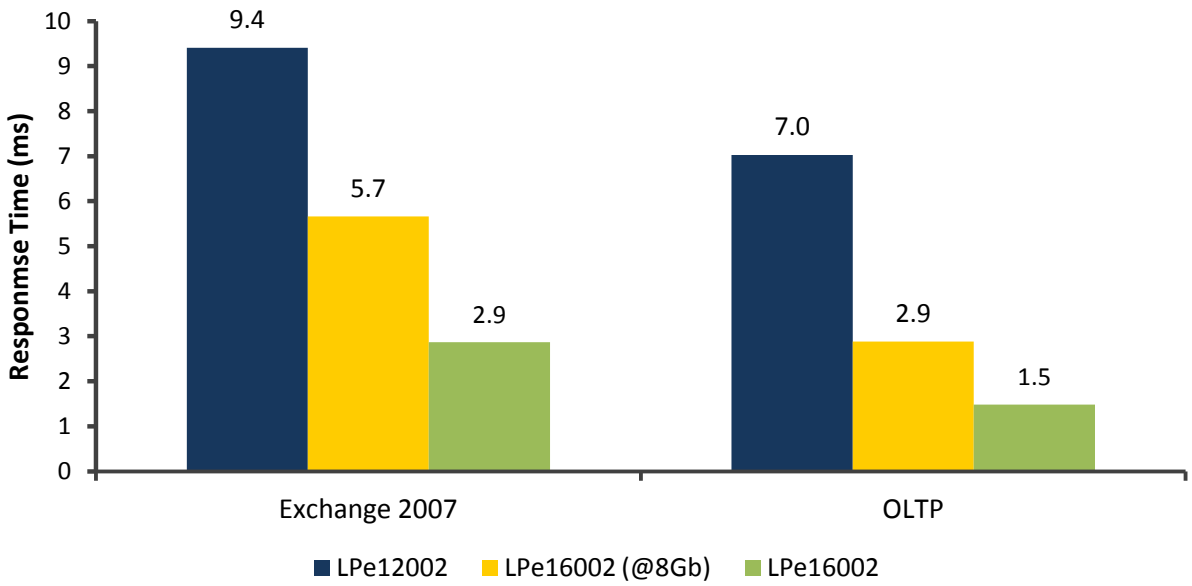


The LPe16002 HBA in a 16Gb SAN delivered more than five times the transactional I/O versus the LPe12002 in an 8Gb SAN environment. In fact, the LPe16002 did something even more impressive. It delivered nearly double the IOPS of the LPe12002 when testing in the same 8Gb SAN against exactly the same storage.

IOPS only tells part of the story. Within the same transactional workload performance test, ESG Lab also measured the response time of each test bed configuration running these workloads. The average response times in milliseconds for each configuration are shown in Figure 11.

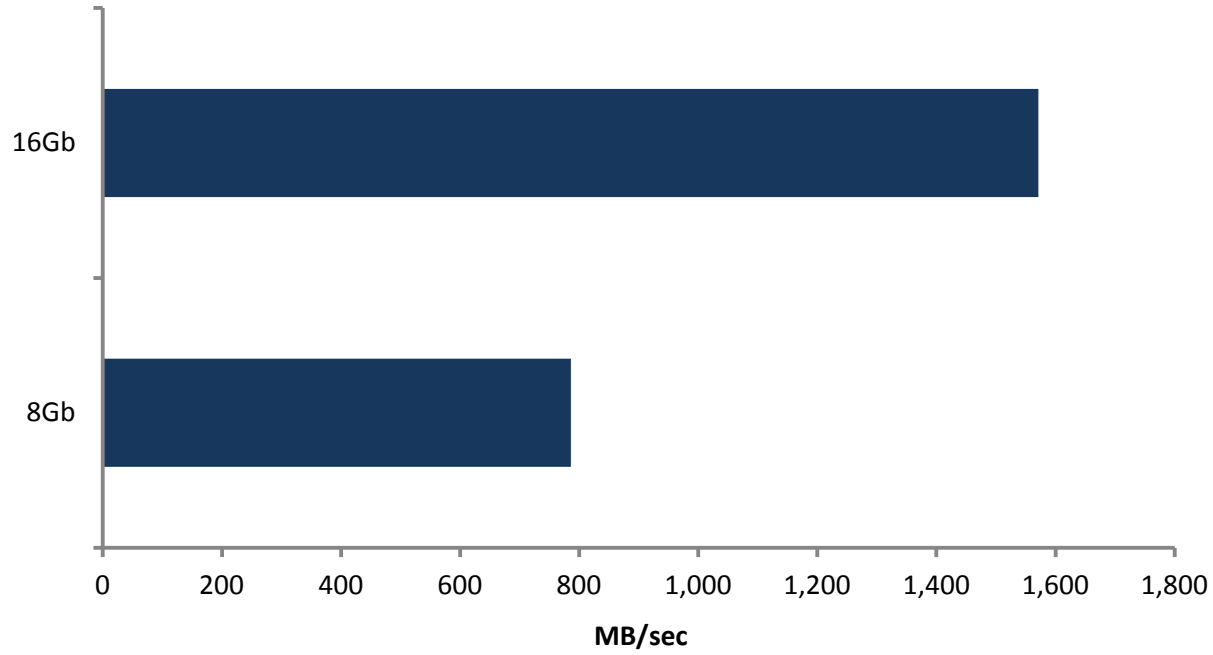
As seen here, the LPe16002 performed with about half the response time of the LPe12002 in an 8Gb SAN, and the latency halved again when the LPe16002 was tested in a 16Gb SAN. Keep in mind that these response times directly correlate to the transactional I/O results in Figure 10, and the lowest response time of 1.5 ms was recorded while the LPe16002 was delivering more than 500,000 IOPS.

Figure 11. Emulex HBA Latency with Exchange and OLTP Workloads



Virtualized server environments present a diverse variety of workloads, including large block sequential I/O for applications such as backup and media streaming. ESG Lab tested throughput for both the LPe16002 and the LPe12002. ESG Lab used Iometer to generate a large block (one megabyte) 100% sequential read workload to produce as much throughput on the wire as possible.

Figure 12. Emulex HBA Throughput with a Streaming Media Workload



ESG Lab performed the maximum throughput tests in both HBAs' native environments—running the LPe12002 HBA in an 8Gb SAN environment and the LPe16000 in a 16Gb SAN environment. As seen in Figure 12, ESG Lab found that the LPe16002 HBA was able to completely fill the 16Gb SAN pipe, achieving achieve twice the throughput of its 8GFC predecessor.

ESG Lab documented the results of the performance tests. Table 1 shows the IOPS, throughput, and response times captured during testing.

Table 1. Emulex 8GFC and 16GFC HBA Performance Results

HBA	Workload	SAN	IOPS	Throughput (MB/sec)	Response Time (Milliseconds)
LPe12002	Streaming Media	8GFC		786	
LPe12002	OLTP	8GFC	113,799		7.0
LPe12002	Exchange 2007	8GFC	85,064		9.4
LPe12002	Fastest Response Time	8GFC			.05
LPe16002 (@8Gb)	OLTP	8GFC	277,661		2.9
LPe16002 (@8Gb)	Exchange 2007	8GFC	141,279		5.7
LPe16002 (@8Gb)	Fastest Response Time	8GFC			.03
LPe16002	Streaming Media	16GFC		1571	
LPe16002	OLTP	16GFC	540,010		1.5
LPe16002	Exchange 2007	16GFC	278,669		2.9
LPe16002	Fastest Response Time	16GFC			.03

What the Numbers Mean

- The LPe16002 proved to be a very efficient I/O engine, delivering five times the IOPS of the 8GFC LPe12002 HBA when running in a 16Gb SAN, and nearly doubling the performance of the LPe12002 when running in the same 8Gb SAN.
- Running latency-sensitive transactional application workloads, the Emulex LPe16002 was also able to cut response times in half in an 8Gb environment and in half again when running in a 16Gb SAN.
- The minimum latency of the LPe16002 was measured at only .03 milliseconds, just a bit more than half of the best result from the LPe12002.

Why This Matters

According to ESG research, Fibre Channel is still the primary storage technology used to support virtualized server environments. When asked to name the factors preventing organizations from using server virtualization more pervasively, two of the top-three responses were lack of budget and performance concerns. A Fibre Channel HBA that could enhance performance while reducing latency without having to rip and replace existing SANs would be a compelling proposition.

The Emulex LPe16000 series HBA represents more than just a cost-effective upgrade in performance. The Emulex LPe16000 series HBA embodies technology advances that deliver improved capabilities for highly virtualized environments (such as the ability to support 255 NPIV virtual HBAs per card, maintain data integrity from server to storage, and integrate directly with VMware vCenter). As a result, support for greater VM densities and critical tier-one applications become viable propositions.

ESG Lab verified the LPe16002's impressive performance running challenging transactional application workloads while reducing latency. ESG Lab confirmed that the LPe16002 can cost-effectively improve performance in existing 8GFC SAN environments today and protect organizations' investments as they move to 16GFC SAN infrastructure in the future.

ESG Lab Validation Highlights

- ☑ ESG Lab was able to deploy and manage an LPe16002 HBA into an existing SAN environment side by side with multiple generations of Emulex HBAs using Emulex OneCommand Manager for a single consistent point of management.
- ☑ ESG Lab confirmed that Emulex has developed a robust and very full-featured vCenter plug-in that provides all the functionality of OneCommand Manager, including the distribution of mass firmware updates directly from the vCenter console.
- ☑ The LPe16000 series of HBAs run the same drivers as previous-generation Emulex adapters, simplifying management and maintenance.
- ☑ The performance of the LPe16002 HBA tested by ESG Lab was particularly impressive, driving more than five times the OLTP IOPS of its 8GFC predecessor. Even more impressive was the fact that this increase in performance came with a 50% decrease in latency.

Issues to Consider

- ☑ The driver tested by ESG Lab for this report did not yet have the ability to perform Quality of Service (QoS). As virtual server density increases along with the variety of applications and workloads that are being virtualized, QoS will become a more critical function. In conversation with ESG, Emulex confirmed that QoS capability will be delivered in a future release.[2]
- ☑ In order to take full advantage of the massive throughput provided by the LPe16000 series, users should take care to size their server PCI bandwidth accordingly. A single LPe16002 dual-port HBA can drive nearly 4 GB per second, which will fully consume eight lanes on a PCI Express 2.0 bus.

[2] This is a forward-looking statement and is not meant to be an indication of a commitment to a specific roadmap timeframe.

The Bigger Truth

Respondents to a recent ESG survey indicated that increasing the use of server virtualization was their number one IT priority over the last two years and will continue to be the top priority for the next 12 to 18 months. While server virtualization penetration continues to gain momentum, IT organizations still have numerous hurdles to overcome in order to deploy it more widely and move closer to a 100% virtualized data center.

For example, with 8Gb Fibre Channel technology firmly entrenched as the de facto standard for existing enterprise SAN environments supporting mission-critical production applications, it makes sense that organizations will continue to leverage the technology. Given the need for high performance, low latency, and proven reliability, combined with the price parity between 8GFC and 16GFC switches, 16GFC Fibre Channel should be widely adopted in enterprise data centers.

As virtualized server environments continue to mature and VM densities increase to 25 or more per physical server, it will be critically important to have sufficient network resources and to avoid I/O bottlenecks. 16Gb Fibre Channel solutions need to be virtualization-aware and deliver higher levels of performance. With new server technologies like multi-core processors and the more powerful Intel Romley platform on one end, and solid-state disks raising the ante for performance on the other, it will be imperative for the network to keep pace. In fact, if 16Gb Fibre Channel can demonstrate significantly superior performance (more than just a bandwidth bump), then it could accelerate the transition.

ESG Lab hands-on testing has confirmed that the Emulex LPe16000 series of host bus adapters can be used to meet the performance and scalability requirements of highly virtualized tier-1 application workloads. Remarkably low I/O response times and excellent performance scalability were demonstrated during ESG Lab testing of the LPe16000 series, on both 8Gb and 16Gb SANs. Management was simple and straightforward, whether using the standalone Emulex OneCommand Manager tool or the full-featured vCenter plug-in.

With this release, Emulex has gone beyond just bolting on more bandwidth. It has recognized the need to reduce latency and increase IOPS to better support highly virtualized and cloud environments. It accomplished this leveraging its XE201 controller technology, which produces improved performance in both 16Gb and 8Gb environments. Because these adapters were designed to take advantage of the latest I/O virtualization techniques and scale rapidly, organizations that are committed to Fibre Channel SANs should be able to quickly and easily realize the value in the Emulex LPe16000 series.

Appendix

Table 2. ESG Lab Test Bed

Hardware	
Server	HP DL380 G7 with twelve 2.4 GHz Intel Xeon E7540 CPU cores and 64 GB of RAM
Storage	Texas Memory Systems RamSan 320—64 GB usable capacity, 20 microseconds latency Texas Memory Systems RamSan 400—128 GB usable capacity, 15 microseconds latency
HBAs	1 Emulex LPe1250 single-port 8GFC HBA 1 Emulex LPe16002 dual-port 16GFC HBA
SAN	Brocade 6510 24-port 16GFC Fibre Channel Switch
Software	
Hypervisor	VMware ESXi 5.0
Workload Generator	Iometer 2008.06.28
Guest OS	Windows Server 2008 R2, Data Center Edition (64-bit), SP1, version 6.1.7601
Iometer Workload Profiles	
OLTP	100% 4 KB I/O, 67% Read, 100% Random—40 outstanding I/O, 24 workers
Exchange 2007	90% 8 KB I/O, 73% Read, 100% Random—40 outstanding I/O, 24 workers 7% 8 KB I/O, 100% Read, 100% Sequential 3% 8 KB I/O, 100% Write, 100% Sequential
Video On Demand	100% 512 KB I/O, 100% Read, 100% Sequential—1 outstanding I/O, 1 worker
Response Time	100% 512 Byte I/O, 100% Read, 100% Sequential—1 outstanding I/O, 1 worker

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