Emulex LPe16000B 16Gb Fibre Channel HBA Evaluation

Evaluation report prepared under contract with Emulex

Executive Summary

The computing industry is experiencing an increasing demand for storage performance and bandwidth due to increases in virtual machine density, increasing demands for application performance and continual data growth. Fibre Channel storage area networks (SANs) carry the bulk of storage traffic in the enterprise data center and are beginning to feel the stresses of these increased demands.

In many cases, enterprises are currently constrained by the available bandwidth between the servers and storage, or foresee a constraint as they observe their growing data consumption patterns.

Emulex has released its second-generation 16Gb Fibre Channel (16GFC) host bus adapter (HBA), known as the LPe16000B, to address these increasing demands on storage performance.

Demartek audited the results of some tests recently completed using the Emulex LPe16000B 16GFC HBA. This data shows that the new LPe16000B performance is the fastest Fibre Channel HBA in the market. The LPe16000B uses a new on-board controller that delivers 1.2 million IOPS at 512 bytes, 1K byte and 2K byte block sizes for reads, writes and a read/write mix and all with extremely fast response times.

The LPe16000B series HBAs are an outstanding solution for growing performance needs.

The Need for More Bandwidth

Today's data centers face a variety of challenges brought by seemingly insatiable demands on server and storage infrastructure. At the same time, new technologies are being introduced that offer both challenges and possible solutions to meet these growing challenges.

VM Density and vSphere 5.1

When Demartek presents to users about next-generation storage networking technologies at various industry events, we usually ask the audience of primarily technical users and first-line managers a few questions about their environments. For approximately the past year, when we asked for the specific number of guest virtual machines our audience had running on a single physical server, we commonly heard responses of 16, 20 or 25 guest virtual machines per physical server. These numbers are higher than in previous years. While this should be considered non-scientific, anecdotal data, it does provide a general sense of the direction that many end-users are taking with respect to VM density.

With the recent release of VMware vSphere 5.1, 64 virtual CPUs (vCPU) are now supported, doubling from the previous version. VMware vSphere also supports 16Gb Fibre Channel links. These improvements enable a higher workload to be placed on servers, and provide for the I/O bandwidth to support these increased workloads.

Windows Server 2012 and Hyper-V

Windows Server 2012 with Hyper-V was recently released, and it also addresses growing demands on computing infrastructure. Windows Server 2012 Hyper-V supports 320 logical processors and 4 TB of physical memory. It supports 64 virtual processors, along with 1 TB of memory per virtual machine. This enables virtualization environments not previously possible. When coupled with today's newer server hardware environments and new technologies such as 16GFC, much heavier workloads can be supported.

A new feature for Windows Server 2012 Hyper-V is the support for virtual Fibre Channel, also known as Synthetic FC. This allows guest virtual machines to connect directly to Fibre Channel storage LUNs, allowing guests to take advantage of existing Fibre Channel infrastructure. This includes the ability for guest operating systems to be clustered over Fibre Channel. In order to take advantage of this feature, newer FC HBAs that support virtual Fibre Channel are required. The Emulex LPe16000B 16GFC HBA supports this feature and provides up to four virtual Fibre Channel ports per VM. Also required for virtual Fibre Channel is NPIV in the switch and HBA, which the LPe16000B FC HBA supports. Hyper-V in Windows Server 2012 supports the use of multi-path I/O (MPIO) and virtual SANs, both of which are also supported by the Emulex 16GFC HBA.

8Gb Fibre Channel and Application Performance

During this calendar year, when we asked the end-users in our audiences about saturation of Fibre Channel links, we consistently heard from a small percentage of users who indicated that they had saturated their 8Gb Fibre Channel links and needed something faster. The applications consistently identified as needing this higher bandwidth are database applications, regardless of the

brand of database. These users are generally looking for something compatible with their existing infrastructure but that provides higher bandwidth.

Applications across the board are experiencing growth in the total amount of data used by these applications and the increasing desire for faster access to this data.

SSD

Solid State Disk (SSD) technology is another driver of bandwidth growth. Although relatively early in the deployment cycles, we have found that those who deploy any form of SSD technology in the enterprise experienced significant storage performance improvements. Many of these SSD deployments are in SAN environments, which drive up storage networking bandwidth consumption. Based on comments from users and many of the tests we have performed in our own lab, we concluded that SSD technology and faster storage networking technology such as 16GFC are well suited for each other.

New Servers

In the first half of 2012, the major server vendors introduced their latest generation of servers that support the newest Intel® Xeon® E5-2600 and Intel® Xeon® E5-4600 processors ("Romley") and PCI Express (PCIe) 3.0. These servers provide not only higher numbers of cores and performance improvements in processor power but also provide significant increases in I/O throughput. PCIe 3.0 doubles the maximum possible I/O rates and processors that support PCIe 3.0 support approximately double the number of PCIe lanes available to each processor. As a result, the total I/O bandwidth available in one of these new servers is approximately quadruple that of the previous generation of servers.

Bandwidth Growth Summary

With growing VM density, database performance requirements and new server and storage technologies, there is clearly a need for higher storage networking bandwidth and performance. For those enterprises that don't need this higher performance yet, now is the time to start planning for these eventualities.

When we discuss storage networks with enterprise users, we find that Fibre Channel is still the dominant storage interface in large-scale data centers, and is expected to remain dominant as a storage area network (SAN) interface for the foreseeable future.

Emulex LPe16000B Series

Technology advances including the second generation Emulex LPe16000B series of 16GFC HBAs can help address these growing constraints on current server and storage infrastructure.

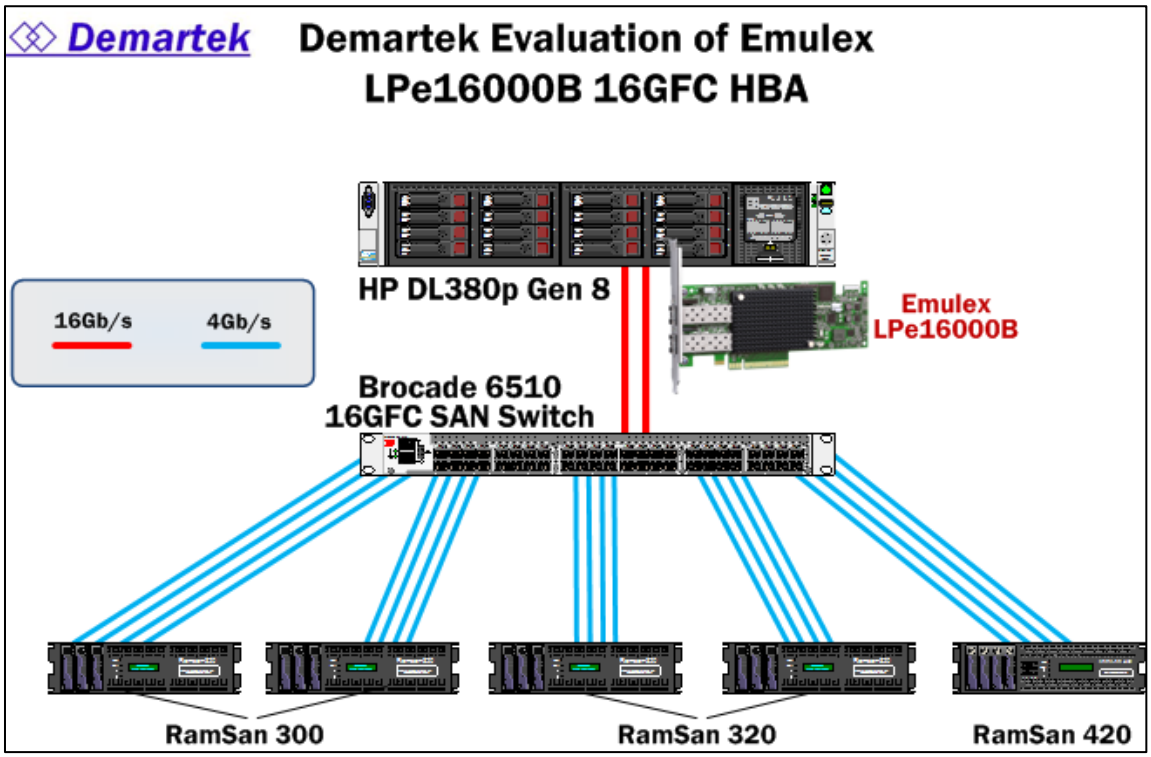
These new Emulex LPe16000B series adapters provide several features designed for supporting enterprise I/O workloads:

- 1.2 million IOPS per port
- 3200 MBPS bi-directional per port of bandwidth
- Support for PCIe 3.0
- Backward compatible with 4GFC and 8GFC
- BlockGuard data integrity with support for T10 Protection Information (T10-PI) offload enabling end-to-end data integrity with no performance penalty
- vScale performance and scalability with a multi-core ASIC supporting 255 Virtual Functions, 1024 MSi-X and 8192 logins/open exchanges
- N_Port ID Virtualization (NPIV) support standard

Test Description and Environment

Emulex asked Demartek to audit the results of benchmark testing with their second generation 16GFC HBA, the LPe16000B series adapters. IOmeter was used to drive workloads in a 16GFC SAN to a collection of DRAM storage targets provided by Texas Memory Systems.

The configuration is shown in the diagram below. The host server, an HP DL380p Gen8 with Intel® Xeon® E5-2690 (2.9GHz/8-core) processors, used the second-generation, dual-port Emulex LPe16002B 16GFC HBA connected to a 16Gb Fibre Channel switch. Five Texas Memory Systems RamSan DRAM storage targets were also connected to this FC switch. The five RamSan targets each had 4GFC host interfaces, so multiple interfaces from each target were connected to insure that the back-end storage infrastructure was able to keep pace with the host server.



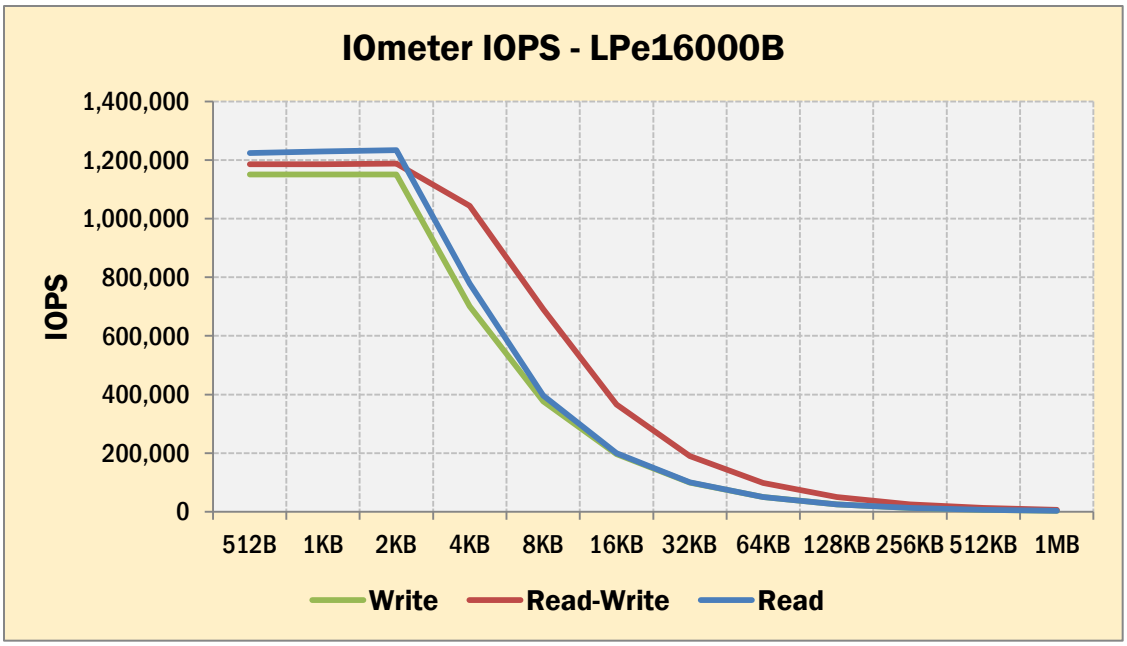
A series of IOmeter tests were run focusing on 100% read, 100% write and 50% read/50% write operations. These tests show traffic flowing in one direction at a time and traffic flowing in both directions simultaneously between the server and storage targets. The IOmeter configuration used was:

- Workers: 20 (one for each LUN on the storage targets)
- Queue Depth: 30
- Block sizes: 512 byte through 1 MB

IOmeter is an open-source I/O workload generator that can be used to measure server and storage performance.

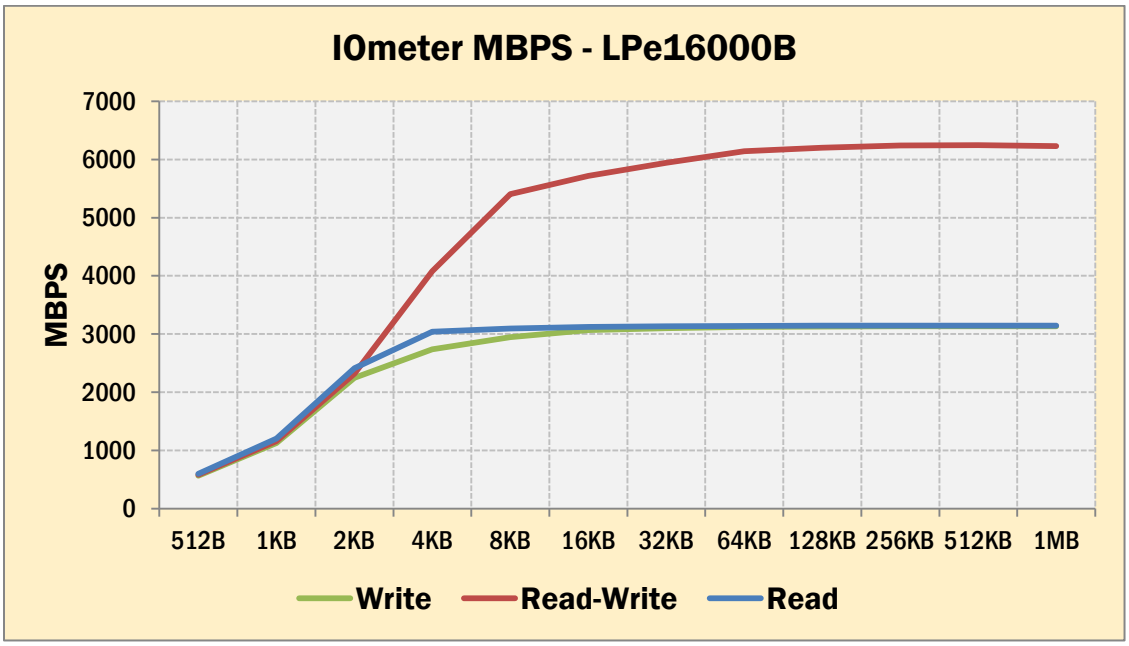
IOmeter IOPS

I/O operations per second (IOPS) is a measure of the number of transactions that can be completed per second. The LPe16000B series 16GFC HBA sustained well over one million IOPS at the smaller block sizes, and achieved more than one million IOPS in read-write mode at 4KB – a common block size for some database applications and file systems.



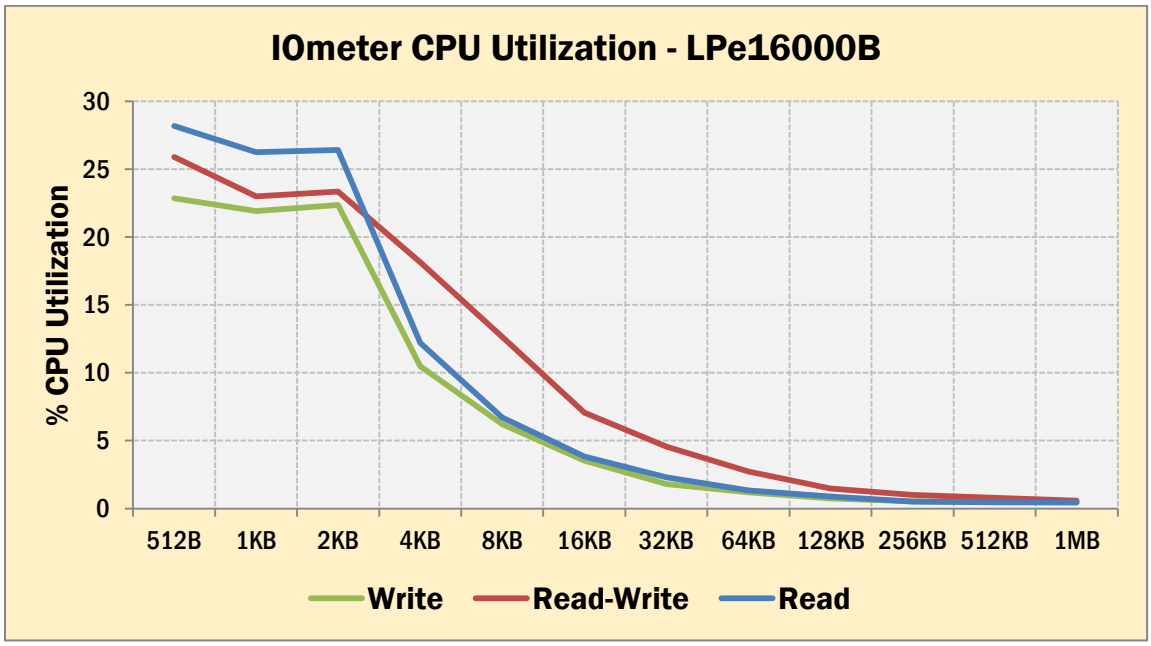
IOmeter MBPS

Megabytes per second (MBPS) is a measure of the bandwidth used during the tests. In read-write mode traffic was flowing in both directions simultaneously, so the bandwidth achieved was approximately double at the larger block sizes.



IOmeter CPU Utilization

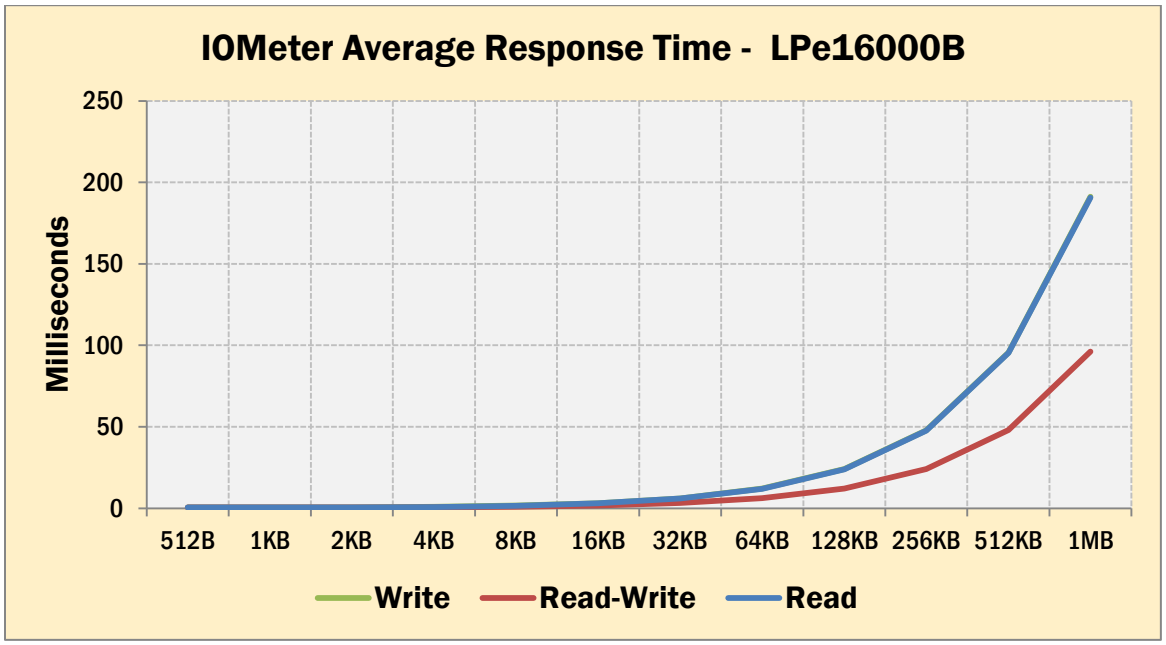
CPU utilization is a measure of the load on the CPU to perform the tests. As the block sizes increase, the amount of work for each I/O decreases. With the very high I/O rates at the smaller block sizes, the CPU utilization is moderate.



IOmeter Average Response Time

Average response time is the time taken to complete a transaction. As expected, the average response time increases as the block sizes increases.

The read and write response times were nearly identical, so the blue line completely covers the green line.



Summary and Conclusion

With the availability of 16Gb Fibre Channel infrastructure including the second generation Emulex LPe16000B 16Gb PCIe 3.0 Fibre Channel HBA, environments with growing performance requirements such as virtualization servers, database applications, SSDs, flash caching and more have an excellent choice in FC HBA.

Test results for the Emulex LPe16000B series HBA show outstanding performance in terms of IOPS, bandwidth and latency. Achieving over 1.2 million IOPS at multiple block sizes and extremely fast response times is a significant achievement.

The latest version of Fibre Channel, 16Gb, provides the performance horsepower for new environments and existing environments that demand higher performance than are available today with older technologies. The Emulex 16GFC HBAs also provide new features such as T10 PI offload for end-to-end protection against silent data corruption.

The most current version of this report is available at http://www.demartek.com/Demartek_Emulex_LPe16000B_Evaluation_2012-10.html.