Industry 8Gb / 16Gb Fibre Channel HBA Evaluation

Evaluation report prepared under contract with QLogic

Executive Summary

Explosive growth in the complexity and amount of data of today's datacenter environments is pervasive. We see more users, more devices and increasing numbers of virtual machines per physical server than in the past. Cloud computing, big data, and increased backup and recovery burdens are driving the need for higher storage bandwidth.

Fibre Channel storage area networks (SANs) are a key component of most large datacenter storage environments. Large IT organizations have made huge investments in Fibre Channel storage technology to meet their high availability storage and reliability needs. According to the Fibre Channel Industry Association (FCIA), 2012 is the year of "10-10-10", in which it is expected to see 10 million Fibre Channel ports shipped (adapter and switch ports), $10 billion invested in Fibre Channel technology, and 10 Exabytes (EB) of Fibre Channel storage shipped. The FCIA calculates that more than $100 billion has been invested in Fibre Channel technology over the last two decades. Fibre Channel continues to remain the dominant storage networking architecture for Next Generation enterprise workloads, server virtualization and cloud architectures and is known for its ultra-reliability and mission critical high performance capabilities in enterprise datacenters.

QLogic has released its PCIe 3.0 16Gb Fibre Channel (16GFC) host bus adapter (HBA), known as the QLogic 2600 series Fibre Channel HBA.

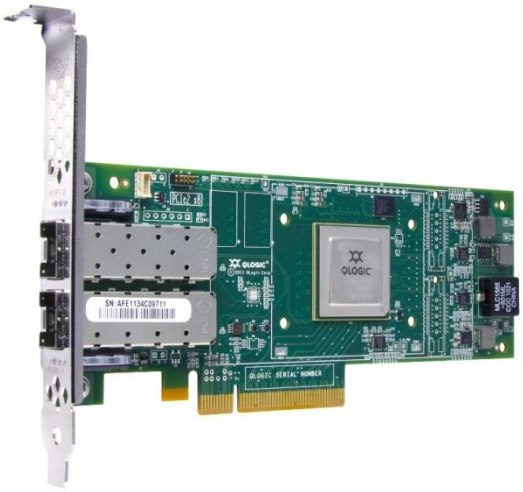
This report analyzed the storage performance, reliability and scalability of QLogic 2600 Series FC HBAs relative to those from Emulex as well as its previous generation adapter.

In our tests, we found:

- QLogic 8Gb and 16Gb Fibre Channel adapters continue to provide a high availability ASIC architecture with complete port-isolation across its dual-port architecture. This architecture demonstrated a deterministic predictable and scalable performance across its dual-port architecture.
- The QLogic 8Gb FC HBA outperformed Emulex 8Gb FC HBA by 17% in business analytics database transactions as measured with TPC-H.
- The QLogic 16Gb delivered three times the transactions, double the bandwidth compared to its 8Gb adapter. In real-life business analytics type environment (TPC-H), QLogic 16Gb completed the same analytical queries in 35% less time.
- The QLogic 16Gb FC HBA outperformed the Emulex 16Gb FC HBA by 16% in TPC-H benchmarks.

QLogic 16Gb Fibre Channel HBA

QLogic 2600 Series FC HBA

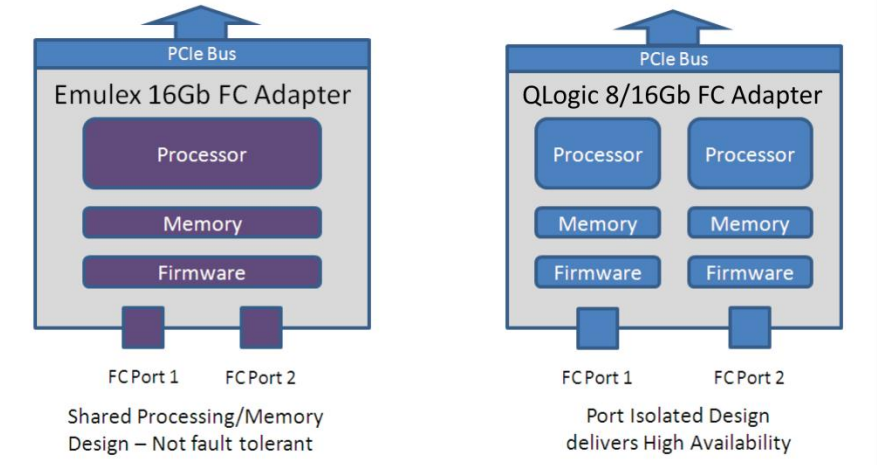


These new QLogic 2600 Series adapters provide several features designed for supporting enterprise I/O workloads:

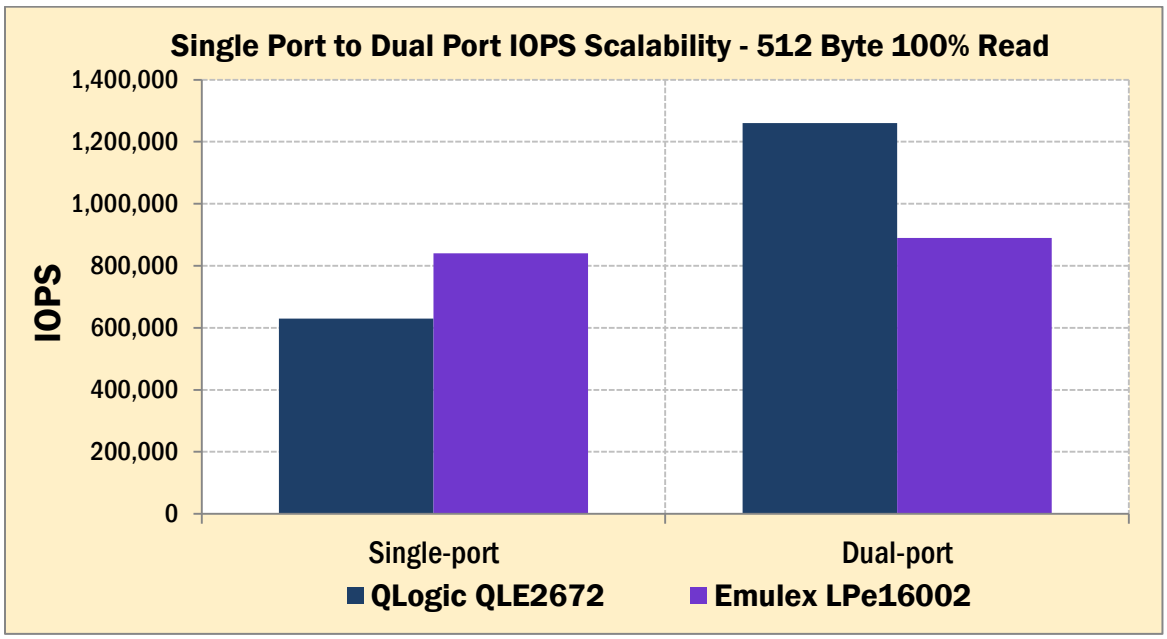
- 16Gbps Fibre Channel per port maximum throughput for high bandwidth storage area network (SAN) traffic
- Over 1.2 million IOPS reduce latency in high transaction intensive applications and virtualized environments
- Reduced hardware, cabling, and management costs by enabling more applications (virtual machines) to run on a single server and Fibre Channel port
- Decreased power and cooling costs by using the fewest PCI Express lanes in PCIe Gen3 environments
- Overlapping protection domains (OPD) to ensure a high level of reliability as data moves to and from the PCI bus and Fibre Channel network
- Complete investment protection for legacy 8Gb and 4Gb Fibre Channel infrastructure
- Future-proof design enables conversion to a 10GbE Converged Network Adapter

HBA Architecture and Design

The different brands of Fibre Channel HBAs tested have a different design for their dual-port adapters. The primary difference is that the QLogic design has separate processor, memory and firmware for each port on the adapter, for both the 8Gb and 16Gb products. With these independent components in the QLogic design, activity such as high I/O loads, resets, recoveries and errors that occur on one port do not impact the other port. Each port on the QLogic HBA is able to achieve full line rate independent of the activity of the other port.



To highlight these architecture differences, Demartek audited the results of tests performed in the QLogic lab with the two competing adapters, connected to DRAM storage targets. A series of IOmeter runs were performed, using first one port then both ports. The QLogic adapter scaled more linearly as the second port was added to the workload.



QLogic's isolated ASIC design architecture provides the following benefits which are table stakes for key enterprise deployments with Fibre Channel SANs.

- Independent functionality - Reset or error recovery on one port does not impact performance of other port
- Higher reliability – Firmware crash on one port does not crash the other port
- Better Security – Isolation at physical level: Physical Function (PF) for one port cannot access state information (registers, memory info, etc.) of another PF due to physical isolation
- Predictable performance – I/O spikes on one port do not affect the performance of the other

Real World Enterprise Workload Analysis

Demartek deployed 16Gb and 8Gb Fibre Channel host bus adapters (HBA) from QLogic and Emulex in its lab in Colorado in order to test the performance of these adapters in a real-world environment. For these tests, we ran a data warehousing (TPC-H) workload using Microsoft SQL Server in a Microsoft Windows Server 2012 environment.

Workload Overview

This read-intensive database workload consists of a suite of business oriented ad-hoc queries and concurrent data modifications. The queries and the data populating the database have been chosen to have broad industry-wide relevance. This workload illustrates decision support systems and business analytics that examine large volumes of data, execute queries with a high degree of complexity, and give answers to critical business questions.

Workload Database Queries

This workload consists of a series of twenty-two unique queries that exercise different sections of the database. Each query puts a different load on the combined CPU, memory and storage resources. Because each repetition of this workload performs the same work, the time to complete the process will be lower for faster configurations of CPU, memory and storage.

Server Memory Constrained for Testing

For these tests, we constrained the memory available to Microsoft SQL Server so that we could demonstrate the effects of choosing an FC HBA on the workload performance.

Real-world Variable I/O Rates vs. Synthetic Workloads

Synthetic workloads such as IOmeter serve a useful purpose and are designed to primarily exercise the storage system and its interface, with the ability to place a steady workload on the storage system. However, a real database application workload requires varying amounts of CPU, memory and storage throughout the normal course of activity, depending on the particular transactions being processed. As a result, the I/O activity will vary during the progression of the workload. The TCP-H benchmark provides a more accurate and real life determination on how choosing the right FC HBA can significantly improve real world database and database analytical performance.

Performance Results

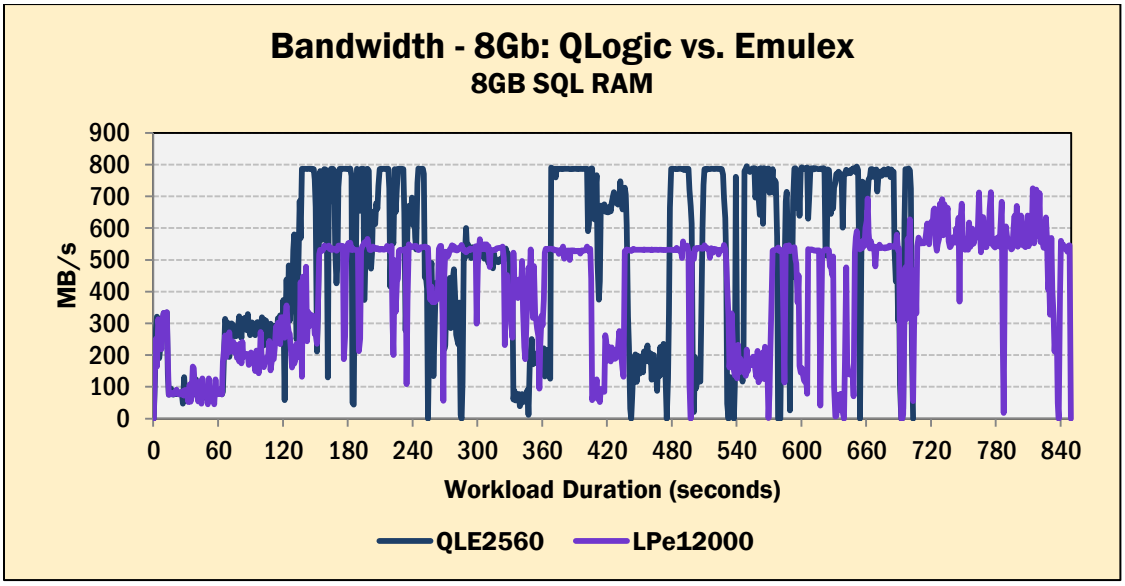
For the TPC-H tests, we focused on the time to complete the workloads and the I/O bandwidth rates that were achieved during the tests. We captured data using the standard Performance Monitor (PerfMon) tool provided in the Windows Server operating system.

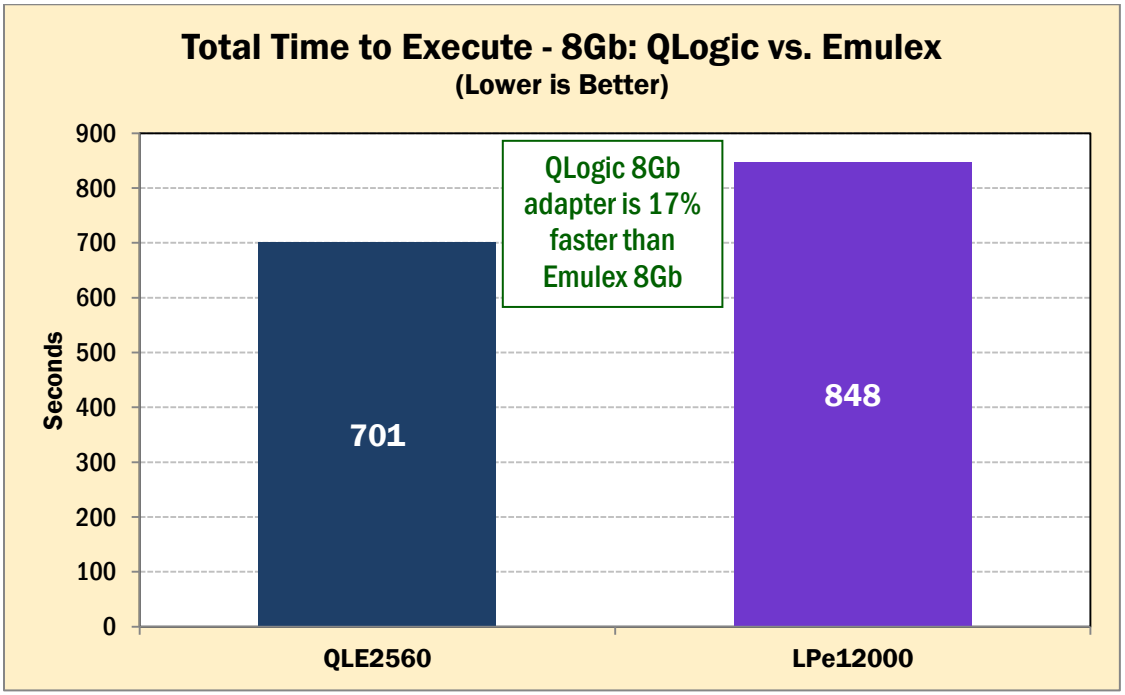
Although 16Gb Fibre Channel technology has been recently introduced, there are large existing investments in 8Gb Fibre Channel infrastructure today. So our analysis included various combinations of performance tests using 8Gb and 16Gb Fibre Channel technology, in order to show the existing environments and what is possible with the newer technology.

The tests conducted in the Demartek lab used a "Romley" server with dual Intel Xeon E5-2600 family processors on a Supermicro motherboard that has all PCIe 3.0 slots. The complete configuration details are provided in the **Appendix**.

QLogic vs. Emulex – 8Gb

We measured the performance of the 8GFC HBAs from both companies. The flat tops of the bandwidth graph indicate that the adapter had reached its maximum performance during those portions of the workload. Specific queries within the workload completed almost 120% faster with the QLogic HBA compared to the Emulex HBA.

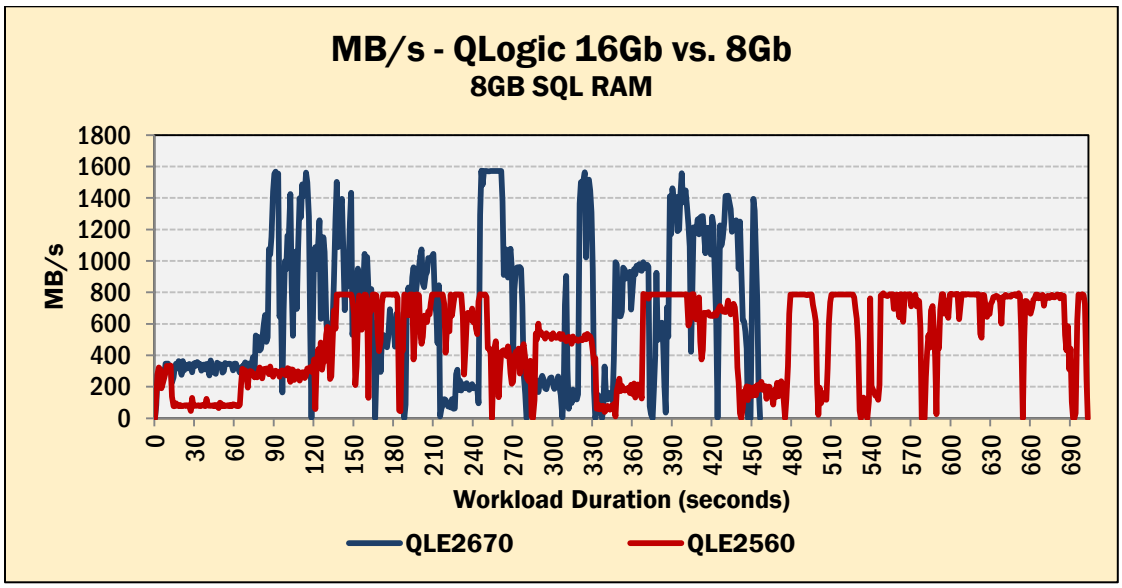


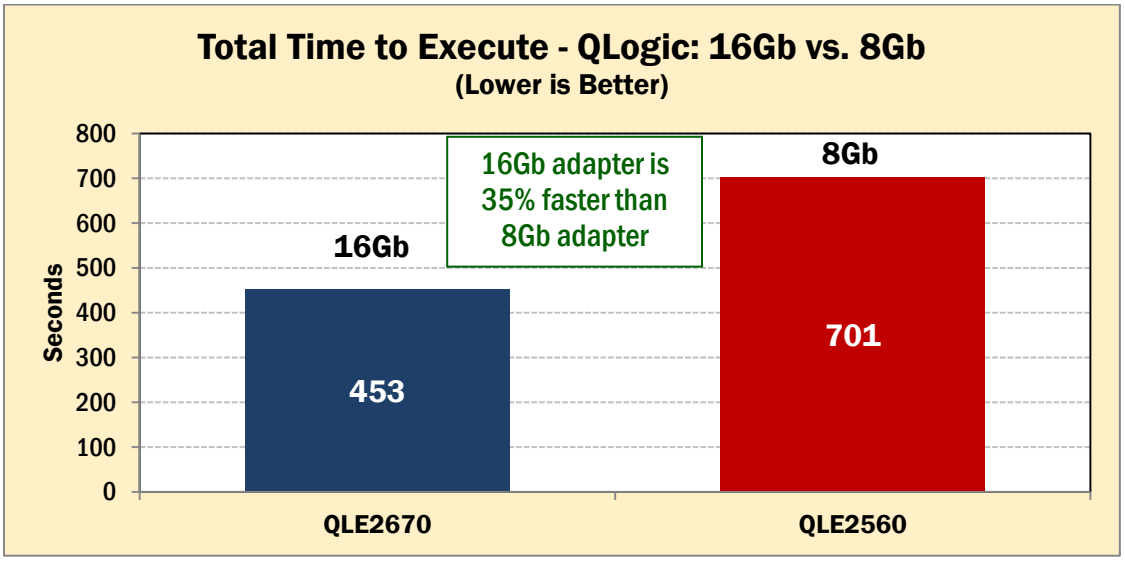


QLogic 16GFC vs 8GFC

One of the key comparisons is the difference in performance between 16GFC and 8GFC. The charts below show the difference that the new QLogic 16GFC HBA makes in improving the performance of the application. The time to complete the workload is noticeably less with the 16GFC HBA.

Note that on the bandwidth chart, "flat tops" on the graph indicate that the adapter was performing at its maximum, but there is the potential for additional performance beyond the capability of the adapter. The 8GFC results show this "flat top" in several places. Specific queries with the workload in the 16Gb environment completed almost 82% faster compared to the 8Gb environment.



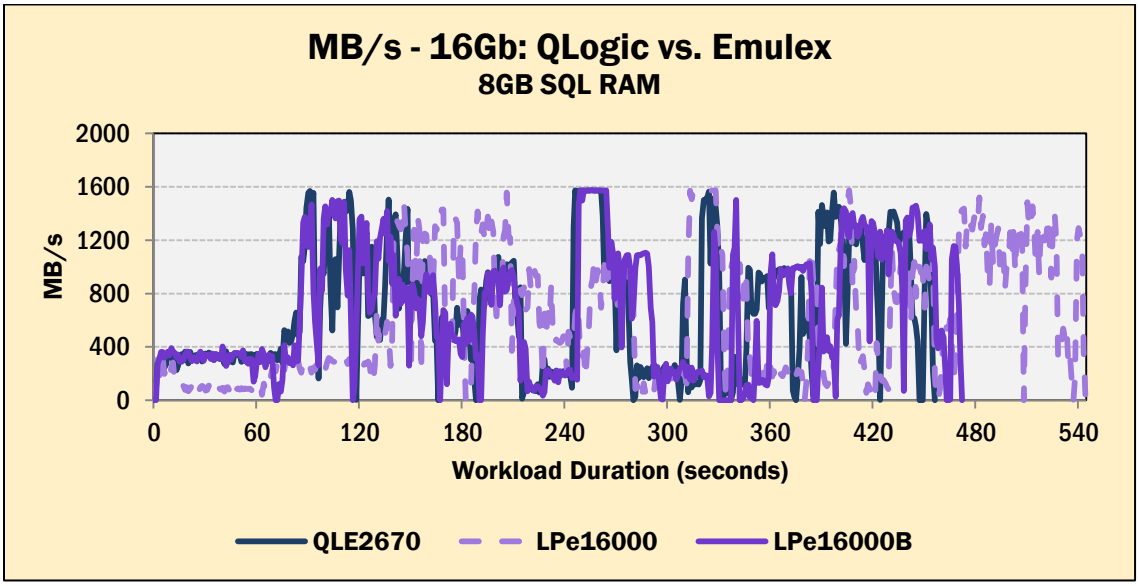


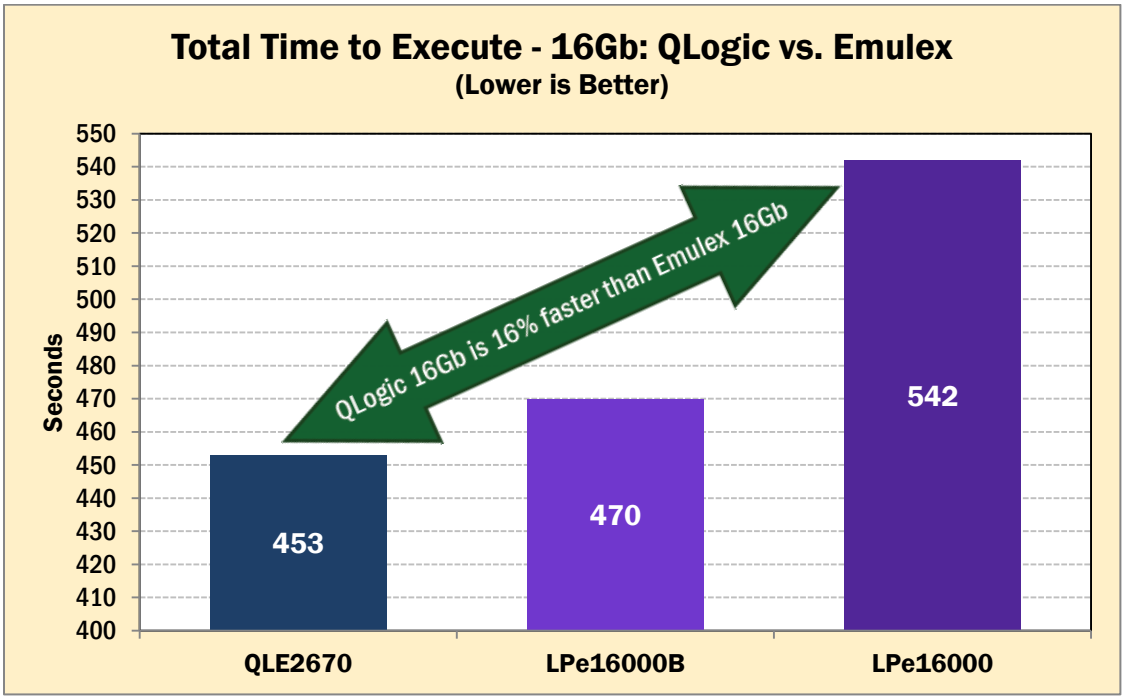
16Gb Fibre Channel provides additional bandwidth that can be used by mission-critical database applications to improve performance over 8Gb Fibre Channel, as shown above. It also provides support for other I/O intensive applications such as support for increased numbers of virtual machines running on physical servers, cloud applications and more.

In addition, the deployment of 16Gb Fibre Channel provides the opportunity to reduce the number of cables required within server racks. It can also play a role in consolidating the total number of Fibre Channel switch ports required in a Storage Area Network (SAN), because of the increased bandwidth available.

QLogic vs. Emulex – 16Gb

Emulex recently announced a new version (model "B") of their 16GFC HBA in the channel. (As of this writing, the major server OEM vendors currently ship the previous generation Emulex 16Gb adapter.) This new adapter supports PCIe 3.0 and has improved performance over their first 16GFC HBA. Both are included in these results, along with the QLogic adapter results. Specific queries within the workload completed almost 133% faster with the QLogic adapter compared to the Emulex LPe16000 adapter.





Summary and Conclusion

16Gb Fibre Channel infrastructure removes bottlenecks by providing a "bigger pipe" for environments with growing performance requirements such as virtualization servers, database applications and SSDs.

Our test results show that the QLogic adapters outperformed the Emulex adapters in these tests, in terms of bandwidth and time to complete the database workload, and provide secure, predictable and scalable dual-port architecture.

The QLogic 16Gb dual port adapter scales linearly and delivers twice the performance compared to its own single port adapter, whereas Emulex shared architecture does not enable its dual port to provide any further scalability compared to its own single port adapter.

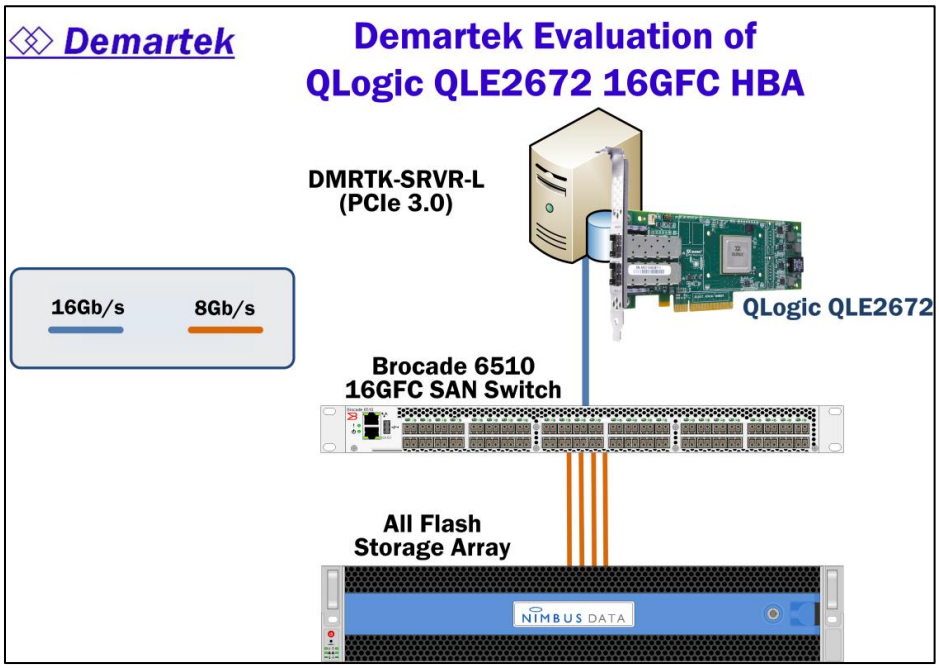
In our testing we found that for this TPC-H workload:

- Moving from QLogic 8Gb to QLogic 16Gb improves TPC-H performance by up to 82% for some queries and overall TPC-H full run by 35%.
- QLogic 8Gb outperforms Emulex 8Gb by up to 120% for some queries, with overall TPC-H full run completing 17% faster.
- QLogic 16Gb outperforms Emulex 16Gb in TPC-H queries by up to 133%, with overall TPC-H full run completing 16% faster.

The most current version of this report is available at http://www.demartek.com/Demartek_QLogic_2600_FC_HBA_2012-12.html on the Demartek website.

Appendix – Test Environments and Configurations

Demartek Lab Configuration



Hardware Specifications

Server (DMRTK-SRVR-L):

- Supermicro X9DR3-LN4+
- BIOS Version/Date: American Megatrends Inc. 1.1, 6/7/2012
- SMBIOS Version: 2.7
- PCIe 3.0 slots (4 x16, 1 x8, 1 x4)
- 2x Intel Xeon E5-2690, 2.9 GHz, 16 total cores, 32 total threads (logical processors)
- 32 GB RAM
- Internal boot SSD

Switch

- Brocade 6510 16GFC Switch (48 ports)

Storage

- Nimbus Data S-Class all flash array, 4x 8GFC host ports
- 24x 100GB SSD drives, 2.4 TB raw capacity

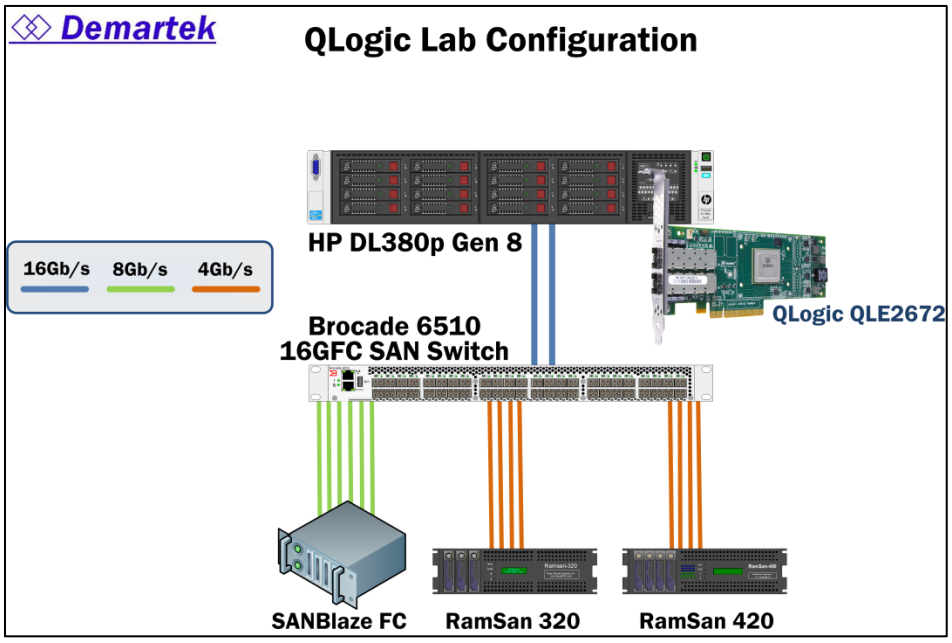
Host Bus Adapters (HBAs)

- Emulex LPe12002 8GFC HBA (dual port)
- Emulex LPe16002 16GFC HBA (dual port)
- Emulex LPe16002B 16GFC HBA (dual port)
- QLogic QLE2562 8GFC HBA (dual port)
- QLogic QLE2672 16GFC HBA (dual port)

Some of the tests were conducted with both HBA ports active and some were conducted with a single HBA port active.

QLogic provided all the 16Gb FC HBAs used for these tests, and the latest available GA code was used for all adapters tested.

QLogic Lab Configuration



Hardware Specifications

Server:

- HP DL380 Gen8
- BIOS Version/Date: HP P70 02/25/2012
- PCIe 3.0 slots (1 x8)
- 2x Intel Xeon E5-2690, 2.9 GHz, 16 total cores, 32 total threads (logical processors)
- 64 GB RAM

Switch

- Brocade 6510 16GFC Switch (48 ports)

Storage

- RAMSAN 325, 4x 4GFC host ports
- RAMSAN 420, 4x 4GFC host ports
- SANBlaze FC, 6x 8GFC host ports

Host Bus Adapters (HBAs)

- Emulex LPe16002 16GFC HBA (dual port)
- QLogic QLE2672 16GFC HBA (dual port)