

Evaluation Report: HP StoreFabric SN1100E 16Gb Fibre Channel HBA and Brocade 6510 16Gb Fibre Channel Performance

Evaluation report prepared under contract with HP, Emulex, and Brocade

Executive Summary

The computing industry is experiencing increasing demand for storage performance, including greater bandwidth and IOPs along with reduced latency due to demands for increased 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 being continually improved to meet these increased demands.

Enterprises may find themselves constrained by the available bandwidth between the servers and storage, or foresee a constraint as they observe their growing data consumption patterns. HP StoreFabric SN1100E 16Gb Fibre Channel (16GFC) host bus adapter (HBA) addresses these increasing demands on storage performance by providing double the bandwidth of previous generation Fibre Channel HBAs.

Demartek deployed an HP ProLiant DL380 Gen8 Server with the HP StoreFabric SN1100E dual-port 16GFC HBA and connected this server via a 16GFC Brocade 6510 switch to an HP StoreServ Storage 7450 all-flash array with eight 16GFC host ports. We ran a read-intensive, data warehouse workload based on the TPC Benchmark^{TM1} standard to determine whether this type of workload could take advantage of the increased bandwidth and performance that Gen 5 Fibre Channel provides. We repeated the database workload test with a previous-generation 8Gb dual port Fibre Channel HBA, 8GFC switch, and eight 8GFC storage ports and compared the results. As a final point of analysis, we tested the same workload again, replacing portions of the 16GFC infrastructure with 8GFC optics to create a mixed speed environment.

¹ See Test Description and Environment for additional details. The Transaction Processing Performance Council (TPC) defines transaction processing and database benchmarks including the TPC-H benchmark specification but was not involved in this study. Additional information about this standard is available at: www.tpc.org/tpch

Key Findings

We confirmed that, for the database workload used in testing, the 16GFC infrastructure created through the HP StoreFabric SN1100E HBA, Brocade 6510 FC switch, and 16GFC targets on the storage array exceeded the performance of the same workload in an 8Gb Fibre Channel environment. The additional bandwidth available to the database workload enabled the job to complete in significantly less time, with marked reduction in I/O latency. We also confirmed that the 16GFC components provided enhanced performance even in the mixed 16GFC/8GFC configuration.

The HP StoreFabric SN1100E 16GFC HBA with Brocade 6510 end-to-end results include the following:

- ◆ The real database workload was completed up to 28% faster than the 8GFC infrastructure.
- ◆ The peak throughput was 2x compared to the 8GFC.
- ◆ Latency was reduced by an average of 75%.

The HP StoreFabric SN1100E 16GFC HBA and Brocade 6510 with mixed 16GFC and 8GFC components produced the following results:

- ◆ The real database workload was completed in roughly the same amount of time as with the 8GFC infrastructure.
- ◆ Latency was reduced by an average of 50% compared to end-to-end 8GFC.

The Need for More Bandwidth and Lower Latency

Today's datacenters face a variety of challenges brought on by seemingly insatiable demands on server and storage infrastructure. At the same time, new technologies are being introduced that contribute to new hurdles while also offering opportunities to meet these growing challenges.

The following is a summary of factors that Demartek has identified as driving the need for greater storage networking performance as provided by Gen 5 Fibre Channel devices such as HBAs like the HP StoreFabric SN1100E 16GFC HBAs and switching, as provided by the Brocade 6510 FC switch.

8Gb Fibre Channel Saturation

When speaking with end-users about saturation of Fibre Channel links, we're hearing from a growing number of users who indicate that they saturated their 8GFC links and need something faster. The applications that are consistently identified as needing this higher bandwidth are database applications, regardless of the brand of database. These include single database instances running on physical hardware, multiple database instances running on physical hardware and multiple database instances running in virtual machines (VMs). These users are generally looking for something compatible with their existing infrastructure but that provides higher bandwidth to meet their growing demands.

SSD Technology

Solid State Disk (SSD) technology is strong driver of bandwidth growth. Enterprises that deploy any form of SSD technology have 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 have concluded that faster storage networking technology such as Gen 5 Fibre Channel—including the HP StoreFabric SN1100E 16GFC HBA and Brocade 6510 switch—is well-suited to SSD technology.

Standard Deployment of PCIe 3.x in Servers

Current and recent generation servers include PCIe 3.x technology, which doubles the maximum possible I/O rates to 1 GBps (gigabyte per second) per lane from the previous PCIe generation. PCIe 3.x also doubles the maximum number of lanes available up,

allowing up to 40 PCIe lanes per processor as compared to the previous generation. As a result, the total I/O bandwidth available in one of these servers is approximately quadruple that of the earlier generations of PCIe 2.x servers.

Bandwidth Growth Summary

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 SAN interface for the foreseeable future.

When using storage-intensive applications like backup/restore, database transactions, virtualization, and rich media, there is clearly a need for higher storage networking bandwidth and performance. The improved I/O performance of Gen 5 Fibre Channel enables faster storage and retrieval of data. For those enterprises that don't believe they need this higher performance yet, now is the time to start planning for these eventualities, making HP StoreFabric SN1100E 16GFC HBAs a solid choice for host-side upgrades and Brocade 6510 switches a worthy consideration for the FC backbone of the data center.

HP StoreFabric SN1100E Series

Technology advances, including the HP StoreFabric SN1100E series of 16Gb Fibre Channel HBAs, can help address growing constraints on current server and storage infrastructure.



Whether the environment includes mission-critical standalone database workloads or increasing numbers of VMs running on a single server, HP StoreFabric SN1100E 16Gb HBAs enable higher workloads and more applications and VMs to run on a single server and port, resulting in reduced cabling and higher return on IT investment.

The HP StoreFabric SN1100E series of Fibre Channel adapters provide several features designed for supporting growing enterprise I/O workloads:

- ◆ Twice the performance of 8Gb Fibre Channel adapters
- ◆ Backward compatibility with 4 Gb and 8Gb Fibre Channel infrastructure
- ◆ Support for Microsoft Windows Server 2008, 2012, and 2012 R2 (with and without Hyper-V), VMware ESX and ESXi Server, Red Hat Linux and SUSE Linux Enterprise Server (SLES)
- ◆ In-box drivers for Windows Server 2012 R2 and VMware vSphere 5.5
- ◆ NPIV support standard
- ◆ An HP-branded solution which has undergone extensive HP interoperability testing for connecting HP ProLiant servers in storage and networking environments

Brocade 6510 16Gb Fibre Channel Switch

16 Gb switching has been available for several years now, with the Brocade 6510 a well-known, stable device. This switch continues to be a reliable backbone for Gen 5 Fibre Channel deployments.



The Brocade 6510 Fibre Channel switch offers a number of features to support modern and legacy infrastructure including the following:

- ◆ 24, 36 or 48 port configurations in a 1U package
- ◆ Compatibility with 2, 4, 8, 10, and 16 Gbps speeds
- ◆ Simple deployment with the Brocade EZSwitchSetup wizard
- ◆ Easy centralized management with Brocade Network Advisor
- ◆ Non-disruptive monitoring of every port
- ◆ Low power consumption (110 Watts for a fully populated 48 port switch)

Test Description and Environment

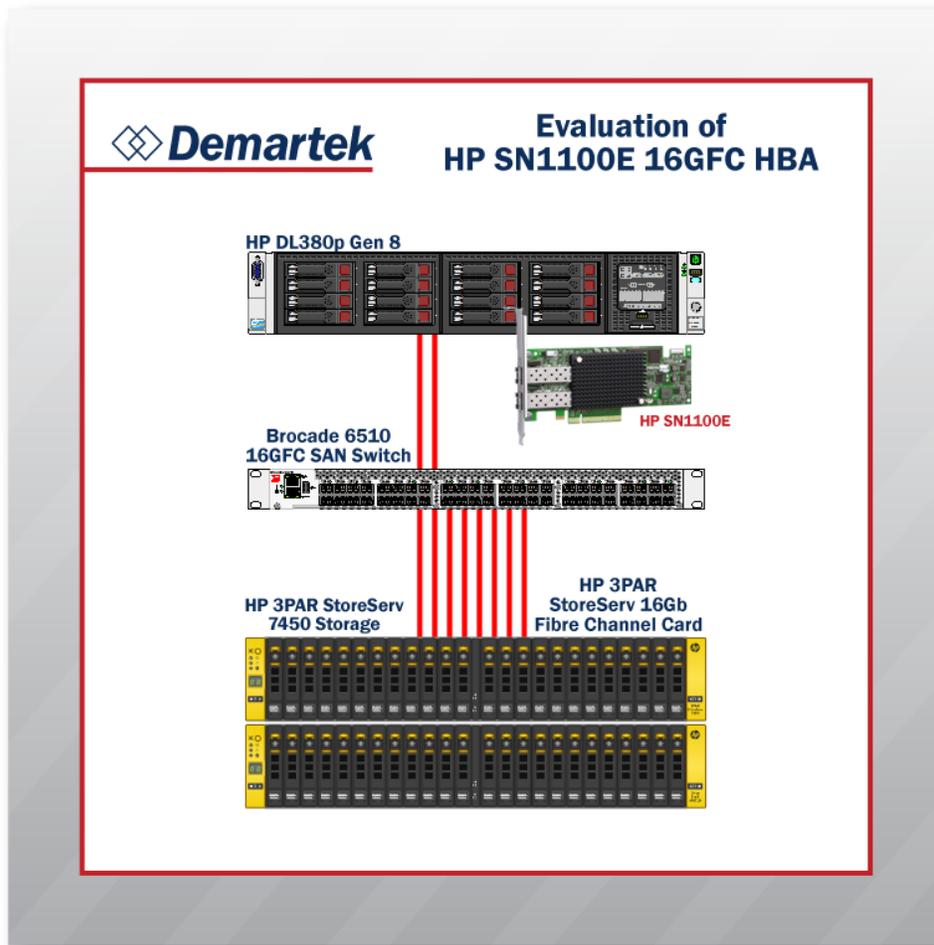
Demartek ran a read-intensive data warehouse workload with the configuration shown below. For these tests, we ran a database application modelled on the TPC Benchmark™ H (TPC-H), which was used to generate a real-world workload, but not for the purpose of publishing official benchmark results. TPC-H is an industry-standard, decision-support benchmark that simulates business intelligence database environments similar to those used to provide businesses with critical operational data.

Database memory was constrained to 16GB to minimize caching any data in server RAM. This creates a very IO intensive workload that is quite dependent on the available bandwidth.

This test was run with the Gen 5 (16GFC) HP StoreFabric SN1100E Fibre Channel HBA running at 16Gb/sec. The test was repeated with the 8Gb HP StoreFabric 82E Fibre Channel HBA.

The test configuration was connected to an HP 3PAR StoreServ Storage 7450 all-flash array. For the 16GFC testing, the array was provisioned with eight 16GFC target ports. These were replaced with eight 8GFC targets for the 8Gb scenarios.

A Brocade 6510 16GFC switch (OEM'ed by HP as the HP StoreFabric SN6000B) supported the 16Gb testing, while a Brocade 300e 8Gb switch supported the 8Gb testing. For the mixed-speed environment, we replaced the 16Gb optics in the HBA and switch with 8Gb optics.



Server

- ◆ HP ProLiant DL380p Gen8 Server
- ◆ 2x Intel® Xeon® E5-2630, 2.3GHz, 16 total cores, 32 logical processors
- ◆ 16GB RAM
- ◆ Boot drive: HP 600GB 10K RPM SAS HDD
- ◆ Microsoft Windows Server 2012 R2

Fibre Channel HBA

- ◆ HP StoreFabric SN1100E 16Gb FC HBA (OEM'ed Emulex LPe16002)
- ◆ HP StoreFabric 82E 8Gb FC HBA (OEM'ed Emulex LPe12002)

Fibre Channel Switch

- ◆ Brocade 6510 16Gb FC SAN Switch, OEM by HP as the HP StoreFabric SN6000B 16Gb SAN Switch
- ◆ Brocade 300e 8Gb FC SAN Switch, OEM by HP as the HP 8/24 8Gb SAN Switch

Storage Array

- ◆ HP 3PAR StoreServ 7450 Storage
- ◆ 48x 400GB 6Gb SAS SSD
 - ◇ RAID5 configuration for database volumes
 - ◇ RAID10 configuration for log volumes
- ◆ 8x 16GFC target ports
- ◆ 8x 8GFC target ports

Note: HP 3PAR StoreServ 7000 Storage and HP 3PAR StoreServ 10000 Storage arrays use Emulex quad-port 8GFC HBAs and dual port 16GFC HBAs configured in target mode.

Data Warehouse Workload and Performance Results

Database Workload

The read-intensive database workload used consisted of a suite of business-oriented, ad-hoc queries. The queries and the data populating the database were chosen to have broad, industry-wide relevance.

This particular workload consisted of 22 different queries, each exercising a different area of the database. This benchmark simulates decision support systems that examine large volumes of data, execute queries with a high degree of complexity, and give answers to critical business questions. These queries are similar in nature to one a real business would run against its own business operation databases gather business intelligence data.

The workload ran the same queries in the same order for each run, with a lower elapsed time for each query indicating a faster system. The full workload is run in two parts. The first part consists of a single virtual user executing all the queries in a defined order, followed by second execution of the same queries in differing, but predefined, orders by six virtual users simultaneously.

Real vs. Synthetic Workloads

The workload employed in this test used a real database (Microsoft SQL Server) with database tables, indexes, etc., performing actual database transactions. When using real database workloads, I/O rate will vary as the workload progresses because the database performs operations that consume varying amounts of CPU and memory resources in addition to I/O resources. These results more closely resemble a real customer environment.

This is unlike benchmarks that use synthetic workloads that perform the same I/O operations repeatedly, resulting in relatively steady I/O rates which, although potentially faster, do not resemble real customer environments.

Hardware and Software Specifications

The specifications for the software used for this test are listed below. The RAM allocated to the database application was limited to 16GB in order to force the I/O through the Fibre Channel HBAs and out to the storage system with minimal host memory caching.

Database

- ◆ Microsoft SQL Server 2012
- ◆ HammerDB 2.16 Open Source TPC benchmarking tool
- ◆ RAM allocated to SQL Server: 16Gb
- ◆ Database size: 300 GB
- ◆ Total size of all database files: 600 GB

The server was rebooted between runs to clear any host memory caching.

Bandwidth Results

For this set of tests, Demartek used a dual-port host connection to the SAN. Two runs were performed with this workload. One run used a single database user, and the other run used six (6) database users executing the same queries in differing, but predefined, orders for each user. These two portions of the workload were run back to back, reported with only a five second gap between them.

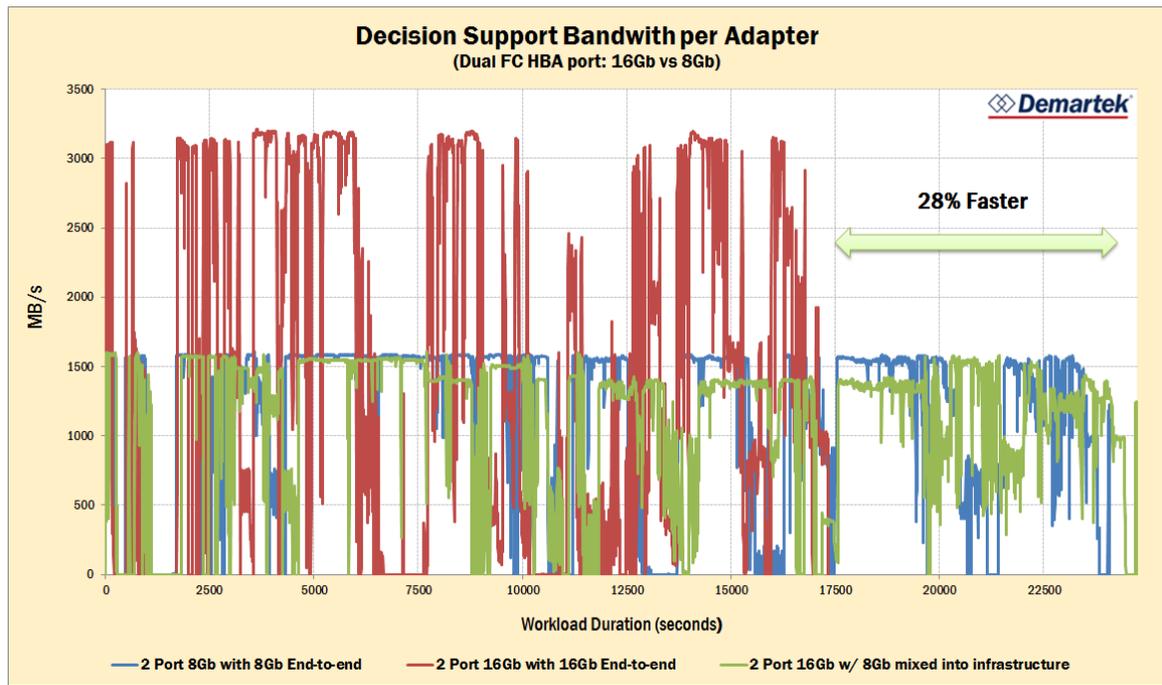
This data warehouse workload was able to achieve full line-rate bandwidth with the 8GFC adapter for most of the queries. Line and near line-rate was also achieved with the HP StoreFabric SN1100E 16Gb FC HBA adapter without changing the workload configuration.

In the graph below, I/O showing a “flat top” using either adapter indicates that more performance is available, but the adapter is limiting the bandwidth; we’ve reached the “line-rate” of the infrastructure. This is quite evident with the 8Gb HBA and when 8Gb components were mixed into the 16Gb environment.

When running this test with the HP StoreFabric SN1100E 16Gb FC HBA on a full 16Gb end-to-end infrastructure, including the Brocade 6510 switch and 16Gb storage targets, the time to complete the run was 72% of the time required by the 8Gb adapter, or 28% faster. This reduced the time required for the full workload by nearly two hours.

For many database workloads, time to complete the work is critical because this improvement compounds with more users and more transactions. The improvements in bandwidth demonstrated by this testing were achieved without increasing the demand on the server. In other words, the exact same workload was executed, but significant performance improvements were realized by transitioning from 8Gb FC to 16Gb FC.

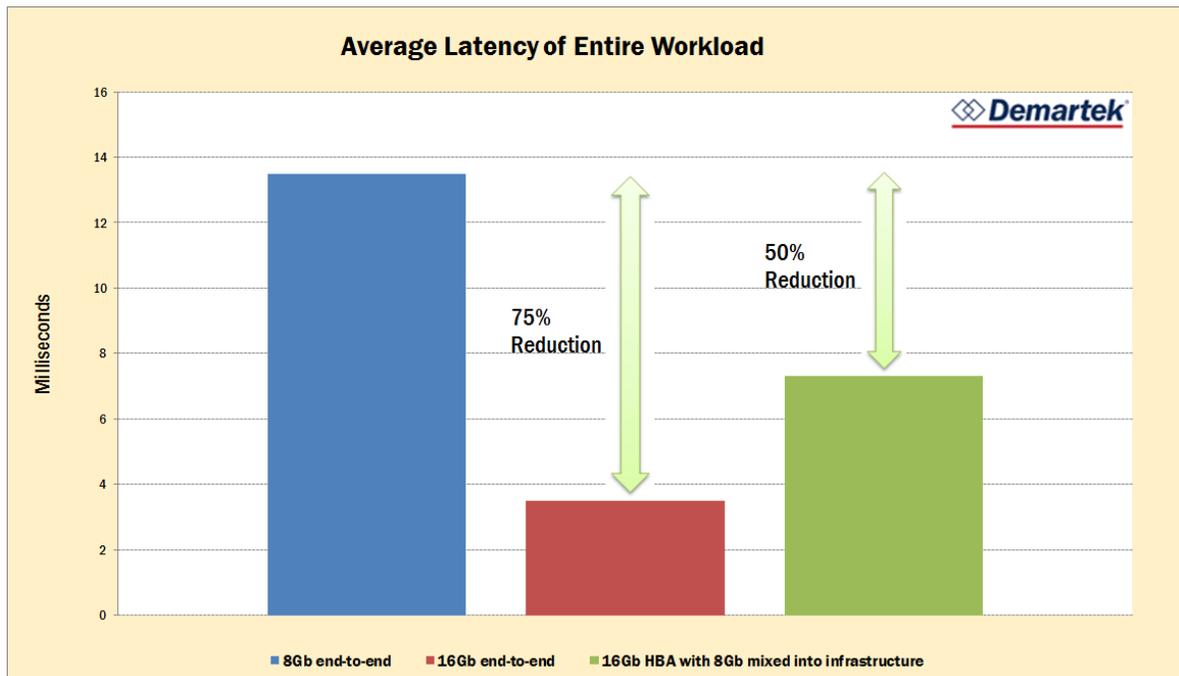
This upgrade increases return-on-investment of both the server infrastructure and storage by enabling not only more work on the same compute resources, but accomplishing it in less time. In large environments, these time reductions can lead to many hours saved on workload processing, delivering results sooner, freeing valuable compute resources for additional work, or both.



Latency Results

The HP StoreFabric SN1100E 16Gb FC HBA and Brocade 6510, functioning in a fully 16GFC environment, provided on average more than 75% reduction in latency for this workload compared to the 8Gb adapter and switch. Interestingly, when 8Gb components were mixed into the environment, overall latency was still reduced by 50% from the end-to-end 8Gb results.

Latency improvements translate into a quicker execution and return of IO requests. In some workloads, such as intense OLTP processing where subsequent processing is highly dependent on previous queries results (for instance stock trading or similar real-time data acquisition) or high-traffic webservers, low latency can be more important to the workload performance than high-bandwidth.



Summary and Conclusion

With the deployment of HP StoreFabric SN1100E 16Gb PCIe 3.0 Fibre Channel HBAs and Brocade 6510 FC switches in the Fibre Channel fabric, enterprises with growing performance requirements due to virtualized servers, database applications, SSDs, flash caching, and other factors have an excellent choice in Gen 5 Fibre Channel technology.

The result of database workload testing with these Gen 5 components was the achievement of higher performance than the same server and storage configuration using the same workload in an all 8GFC environment. The workload saw a doubling of available bandwidth, completing up to 28% faster with an average reduction in latency of more than 75%. By taking advantage of a full end-to-end 16Gb environment, with HP 16Gb adapters as both initiators and targets, communicating through the Brocade 6510 16Gb switch, maximized performance results are realized.

However, all is not lost for the cost-conscious enterprise that may not be able fully deploy 16Gb FC across their infrastructure. Even in an environment with mixed 16GFC and 8GFC technology, workloads still benefitted from significantly reduced latency, up to 50% on average, by the presence of the HP SN1100E 16Gb FC HBA.

Gen 5 Fibre Channel provides the performance horsepower for both new environments and existing environments that demand higher performance than are available today with older technologies. For existing environments with 4Gb or 8Gb FC infrastructure, installing HP StoreFabric SN1100E HBAs switching provides a simple plug-and-play performance upgrade. The addition of 16 Gb switching and targets, at the same time or later, improves results even more.

The original version of this document is available at:

http://www.demartek.com/Demartek_HP_StoreFabric_SN1100E_Brocade_6510_16Gb_Fibre_Channel_Evaluation_2014-11.html

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