White Paper

# NetApp AFF A300 Gen 6 Fibre Channel


**Executive Summary**

Faster time to revenue and increased customer satisfaction are top priorities for today's businesses. Improving business responsiveness is key to achieving these goals and IT administrators increasingly choose all-flash arrays to meet these needs. Using NetApp® All Flash FAS (AFF) systems for mission critical applications addresses enterprise storage requirements with high performance, superior flexibility, and best-in-class ONTAP® data management software. The AFF A-Series delivers industry-leading performance and network connectivity with up to 7M IOPS per cluster while delivering sub-millisecond latency. The NetApp AFF A-Series arrays are also the industry's first storage arrays to offer Gen 6 32GFC Fibre Channel (FC) connectivity.


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## Introduction

With the NetApp AFF A-Series arrays solving storage performance issues, the performance bottleneck has shifted to the network. AFF A-Series customers frequently select Fibre Channel to meet their storage networking performance requirements with leading reliability and the ability to scale to thousands of nodes. It is for these reasons that an estimated 80% of all-flash arrays deployed today utilize Fibre Channel fabrics.[1] Some customers with legacy 8Gb FC fabrics are experiencing network bottlenecks that impact performance of their new powerful all-flash arrays. Gen 6 32Gb Fibre Channel switches from Brocade® and Emulex®-branded HBAs by Broadcom® solve network bottlenecks by delivering the bandwidth, IOPs and latency demanded by NetApp all-flash arrays as well as providing a suite of enhanced diagnostics and troubleshooting features designed for the enterprise.

To illustrate how all-flash arrays can benefit from increased network performance, a series of database application tests, virtual machine (VM) boot storm tests and VM migration tests was conducted with a NetApp AFF A300 all-flash array utilizing three different generations of Fibre Channel products from Emulex and Brocade: Gen 6 -32Gb FC, Gen 5 -16Gb FC and Gen 4 -8b GFC.

## Key Findings

- Customers facing increased application data requirements can now meet and exceed SLAs with NetApp flash storage and Gen 6 32Gb FC infrastructure consisting of Emulex Host Bus Adapters (HBAs) and switches from Brocade
- Using a 32Gb FC equipped NetApp AFF A300 storage array along with Emulex LPe32002 HBAs and a Brocade G620 switch accelerated the following applications
  - Oracle Database 12c data warehouse DSS query time was reduced by up to 70% compared to 8Gb FC, and reduced by 47% for 16Gb FC
  - Microsoft Hyper-v virtual machine storage migration time was reduced by up to 72% compared to 8Gb FC, and reduced by 49% compared to 16GFC
  - Citrix boot storm times were reduced by up to 72% compared to 8Gb FC, and reduced by 49% compared to 16Gb FC
- Application response times were accelerated due to the 2x throughput increase of the Gen 6 32Gb FC network versus the previous generations of Fibre Channel
- The NetApp all-flash array fully consumed the available 3,200MB/second throughput of the Gen 6 Fibre Channel network
- Easy-to-upgrade from previous generations of Fibre Channel (8GFC/16GFC) with forward/backward compatibility – using the same connectors, management, and cabling.
- Advanced features developed by Brocade and Emulex accelerate deployment and simplify support

## Solution Details

### NetApp AFF A-Series Storage Arrays

NetApp® All Flash FAS (AFF) systems address enterprise storage requirements with high performance, superior flexibility, and best-in-class data management. Built on ONTAP® data management software, AFF A-Series systems speed up your business without compromising on the efficiency, reliability, or flexibility of your IT operations. The AFF A-Series all-flash systems deliver industry-leading performance, capacity density, scalability, security, and network connectivity in dense form factors. At up to 7M IOPS per cluster with sub-millisecond latency, they are the fastest all-flash arrays built on a true unified scale-out architecture. The AFF A-Series allows customers to complete twice the work at half the latency as compared with the previous generation of AFF A-Series' systems. As the industry's first all-flash arrays to provide 32GFC Fibre Channel connectivity, AFF A-Series systems eliminate the bandwidth bottlenecks that are increasingly moved to network from storage as flash gets faster and faster.

### Brocade G620 Switch

The Brocade G620 Gen 6 Fibre Channel switches shatter application performance barriers with up to 100 million IOPS and 32/128 Gb FC performance to meet the demands of flash-based storage workloads. Pay-as-you-grow scalability enables organizations to scale from 24 to 64 ports to support evolving storage environments. IO Insight, the industry's first integrated network sensors, provides proactive, non-intrusive, real-time monitoring and alerting of storage IO health and performance to help organizations achieve greater control and insight to quickly identify the root cause of problems at the storage or VM tier. VM Insight seamlessly monitors VM performance throughout a storage fabric with standards-based, end-to-end VM tagging. Administrators can quickly determine the source of VM/application performance anomalies, as well as provision and fine-tune the infrastructure based on VM/application requirements to meet service-level objectives. The NVMe over Fibre Channel-ready feature supports NVMe over Fibre Channel (FC-NVMe) and Fibre Channel over SCSI protocols concurrently, allowing organizations to seamlessly integrate Brocade Gen 6 Fibre Channel networks with the next generation of low-latency flash storage, without a disruptive rip and replace.

### Emulex LPe32002

Emulex Fibre Channel HBAs by Broadcom are designed to address the demanding performance, reliability, and management requirements of modern networked storage systems that utilize high performance and low latency solid state storage drives. The latest Emulex LPe32002 FC HBAs with Dynamic Multi-core Architecture deliver an industry-leading 1.6Million IOPS to any port that needs it, providing performance when and where it's needed. LPe32000-series provides 3,200MB/s throughput, low latency, and enhanced manageability along with the highest reliability in the industry (10 million hours MTBF) to ensure maximum up-time. The secure firmware update feature protects and ensures the authenticity of device firmware. Emulex Gen 6 HBAs are NVMe over Fibre Channel-enabled, delivering up to 55% lower latency than SCSI over Fibre Channel, and support both NVMe over Fabrics and SCSI protocols concurrently for investment protection.

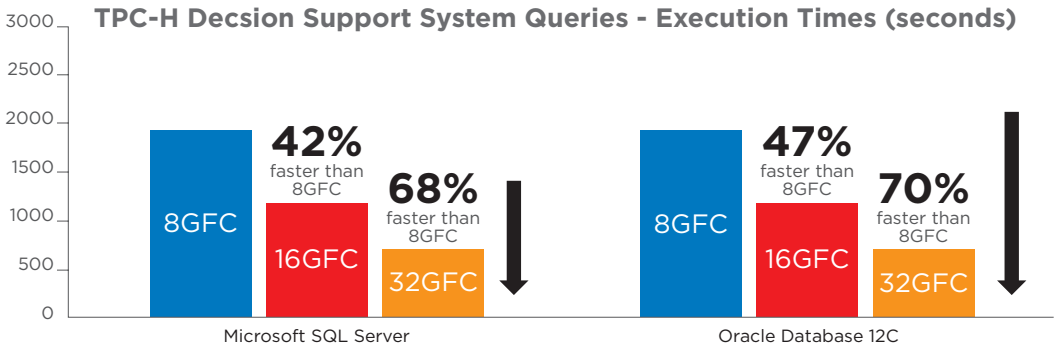
## Test Results

### Database Applications

Decision support systems (DSS) analyze large volumes of data and execute complex queries to provide answers to business questions that often have a significant impact to revenue. Examples include sales figures over time, projected revenue figures, and the modelling of consequences of different promotional options, seasonal factors and various other business decisions. TPC-H-like tests simulate queries that are commonly used in the industry to provide performance metrics. The TPC-like tests used in this report consisted of 22 ad-hoc queries to a database. The query execution time was then measured.

Figure 1 demonstrates a performance improvement of over 3 times faster Microsoft SQL Server and Oracle Database DSS queries times. The time to complete the 22 queries is shown for each of the three Generations of Fibre Channel speeds (8Gb FC, 16Gb FC and 32Gb FC). Using the 8Gb FC Emulex LPe12002 HBA and Brocade G610 switch completion time as a baseline, the Emulex 32Gb FC LPe32000 HBA and Brocade G620 switch achieved up to 70% reduction in the time to complete the workload, from approximately 40 minutes to approximately 12 minutes for the Oracle database workload. The Microsoft SQL Server query time was reduced by 68% compared to 8Gb FC and 42% compared to 16Gb FC.

Figure 1.



### VM Boot Storms

Virtual Desktop Infrastructure (VDI) relies heavily on centralized storage performance to provide adequate I/O to meet end-user demand. One of the biggest challenges for storage in VDI environments is managing periods of peak usage where I/O demands are at their highest. Boot storms occur when large numbers of users start up applications at the same time, such as the beginning of the business day, which causes I/O to spike. Boot storms impact end user VDI experience, and the longer they take, the more they impact productivity, making the selection of storage components critical. To test the performance of the NetApp A300 array under boot storm conditions, Broadcom measured VM boot times connected to three different fabrics - 8Gb FC, 16Gb FC and 32Gb FC. Figure 2 validated performance improvements of over 3.5 x faster VM boot times. Testing showed that compared to an 8Gb FC fabric, the 32Gb FC fabric reduced boot storm time by 73% for Hyper-v from approximately 7 minutes to under 2 minutes. The Citrix boot storm time was reduced from approximately 13 minutes to less than 4 minutes. The VMware boot storm time was reduced from approximately 6 minutes to 2 minutes.

### Virtual Machine Storage Migration

Virtual Machine Storage Migration moves the virtual disk files of a running VM from one data store to another, with minimal disruption for the VM or user. Data stores can be on different storage area networks (SANs) or on the local storage of a server. Storage Migration is used when:

- The SAN has reached capacity
- For load balancing reasons
- To replace a SAN or to take a SAN down for maintenance
- Move virtual disks from local server storage to a SAN

Figure 3 demonstrates a performance improvement of over 3 times faster VM Migration completion times. To test Virtual Machine storage migration, 15 Virtual Machines each with 43GB size were migrated from data store 1 (source) to data store 2 (destination). The time from Read throughput on data store 1 to Write throughput on data store 2 was measured through to the completion of the storage migration. The same test was performed for Microsoft Hyper-v VM Migration, and Citrix XenMotion. The Emulex 32Gb FC LPe32000 HBA and Brocade G620 switch achieved up to a 72% reduction in the time to complete the storage migration, from over 15 minutes to less than 5 minutes for Hyper-v. The Citrix XenMotion time was reduced from approximately 27 minutes to less than 11 minutes.

Figure 2.

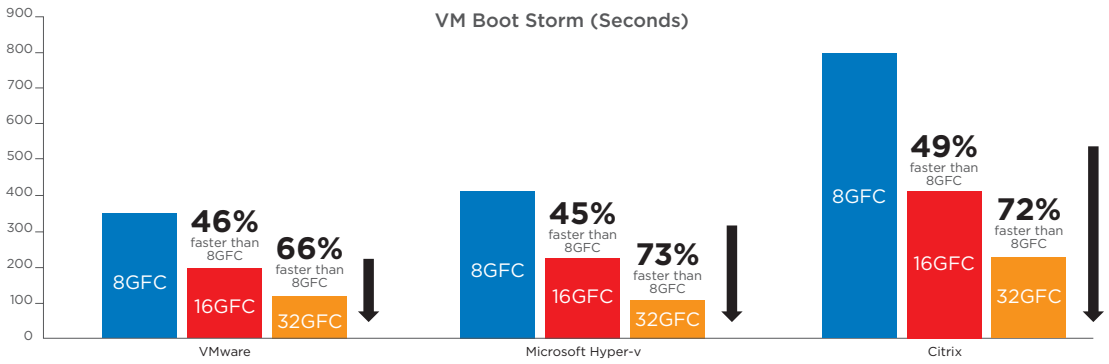
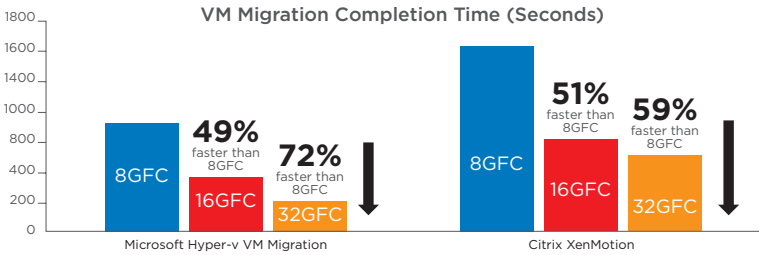



Figure 3.



## Test Environment

### Storage

All-flash Array

- NetApp AFF A300 with 8 x 32Gb FC target ports

### Switches and HBAs

Test 1

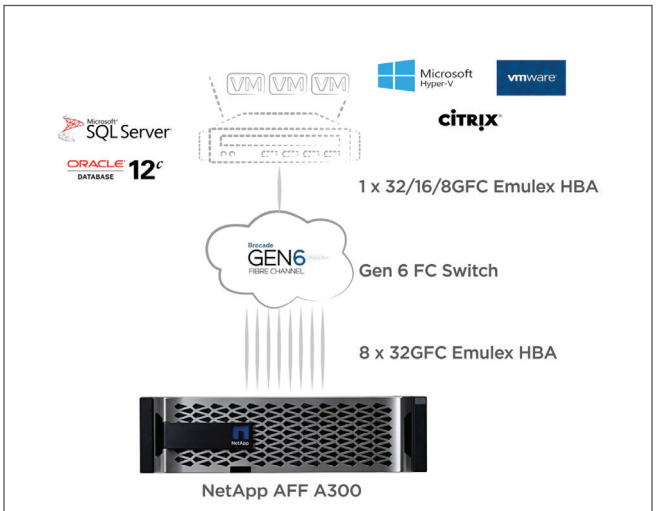
- Brocade G620 32Gb FC switch
- Emulex Gen 6 LPe32002-M2 HBA (32Gb FC)

Test 2

- Brocade G620 switch, auto-negotiated to 16Gb FC
- Emulex Gen 5 LPe16002B-M6 HBA (16Gb FC)

Test 3

- Brocade G620 switch, auto-negotiated to 8Gb FC
- Emulex Gen 4 LPe12002-M8 (8GFC) HBA

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| **Servers** | 96 processor cores, 256GB RAM, E7-8890v4 processors |
| | Microsoft SQL Server 2016, Oracle Database 12c, Oracle 12c GRID, Hammer DB, Red Hat 6.8, Ubuntu, Windows Server 2016 with Hyper-V, Citrix XenServer 7.0, VMware ESXi 6.0 |
| **Fibre Channel HBAs** | Emulex LPe12002-M8 8Gb FC HBA, Emulex LPe16002B-M6 16Gb FC HBA, Emulex LPe32002-M2 32Gb FC HBA |
| **Switches** | Brocade G620 32Gb FC switch- Auto-negotiated to 32Gb FC, 16Gb FC and 8Gb FC |
| **Storage Systems** | NetApp AFF A300 all-flash array- 8 x 32Gb FC target ports |

## Summary

This solution brief documents Broadcom's testing of Gen 6 Fibre Channel networks with a NetApp AFF A300 all-flash array. The testing concluded that the Gen 6 Fibre Channel fabric improved database application performance, VM boot storm performance and VM storage migration when compared to 8GFC or 16GFC networks. This increased performance provides multiple benefits for server, storage and network administrators.

- Due to the 2x throughput increase of the Gen 6 Fibre Channel network, application workload completion times were reduced by up to:
  - 70% for decision support system (DSS) queries, and by 47% compared to 16GFC
  - 72% for virtual machine storage migration, and by 49% compared to 16GFC
  - 73% for VM boot storm, and by 45% compared to 16GFC
- The NetApp all-flash array with 32Gb FC ports was able to fully utilize the available 3,200 MB/s throughput of the Gen 6 Fibre Channel network
- Easy-to-upgrade from previous generations of Fibre Channel (8Gb FC/16Gb FC) with forward/backward compatibility – using the same connectors, management, and cabling
- Advanced features developed by Brocade and Broadcom accelerate deployment and simplify support

As NetApp arrays deployed for data-intensive, performance sensitive applications rapidly grows, it will be critically important to have sufficient network resources to avoid I/O bottlenecks, and enable best performance and ROI on all-flash arrays.

## Footnotes

1 - Silwa, S. (2015) Fibre Channel is most popular networking choice with flash-based storage. http://searchstorage.techtarget.com/news/2240239204/Fibre-Channel-is-most-popular-networking-choice-with-flash-based-storage

Refer to the Interoperability Matrix Tool (IMT) on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.



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