Benefits of an End-to-End NVMe over FC Solution with Lenovo ThinkSystem
Positioning Information

Fibre Channel is the most trusted and widely deployed purpose-built network infrastructure for storage. Decades of use supporting mission-critical applications have proven that Fibre Channel has the reliability, scalability, and performance to handle evolving, demanding storage applications.

Lenovo can provide end-to-end Fibre Channel solutions that take advantage of new All Flash Arrays (AFAs) that utilize the latest 32/64Gb Fibre Channel technologies and features including Non-Volatile Memory Express over Fibre Channel (NVMe over FC) available with the Lenovo ThinkSystem DM Series All Flash Storage Arrays, ThinkSystem DB Series FC SAN Switches and Directors from Brocade, and Emulex Host Bus Adapters.

Business problem

Data storage is consistently getting faster, delivering improved economics for data centers of all sizes. Flash memory-based storage is a key technology that has significantly increased the performance of storage systems. Solid state disks (SSDs) are now so fast, that the SCSI I/O interface has become the bottleneck.

Solution

The solution is based on a modern storage network capable of adapting to the requirement of NVMe-based arrays. There are critical capabilities that are a requirement to support next-generation flash that every customer needs to keep in mind:

- First, it has to keep running no matter what. With more data moving faster, any slowdowns or disruptions in the network could be catastrophic.
- Next, you need a network that's designed for flash and ready for NVMe. This means support for low latency, high speed and high bandwidth.
- Then, it needs to scale and be able to adapt to the business. For many enterprises this is petabytes of storage and thousands of servers and storage.
- Finally, it has to be secure to mitigate the risks of breaches. This requires isolation and managed access for peace of mind.

NVMe over Fibre Channel is a solution that is defined by two standards: NVMe-oF and FC-NVMe. NVMe-oF is a specification from the NVM Express organization that is transport agnostic, and FC-NVMe is an INCITS T11 standard. These two standards define how NVMe leverages Fibre Channel. NVMe over Fibre Channel was designed to be backward compatible with the existing Fibre Channel technology, supporting both the traditional SCSI protocol and the new NVMe protocol using the same hardware adapters, Fibre Channel switches, and Enterprise AFAs. There is no need to "rip and replace" the SAN infrastructure with NVMe over Fibre Channel.

An NVMe all-flash array connected to a storage network will help eliminate the bottleneck and deliver more value back to the business. This scalable storage network will deliver reliable flash that performs at the speed of memory.

With this newfound performance:

- Critical applications will accelerate transactions and lead to better user experiences
- Databases will increase the number of queries they support, leading to faster decisions and results
- VM farms will be more efficient with higher VM densities per server, reducing infrastructure costs and simplifying IT
- More types of workloads can be consolidated on hypervisors due to the improved storage performance

Benefits

The benefits of NVMe over FC include the following:

- IOPS: Experience a 2.1x increase in IOPS using a more efficient command by simply moving over to NVMe/FC from the traditional SCSI FCP command set.
- Latency: Achieve 52% lower latency using NVMe over FC. NVMe over FC will have has lower latency than traditional SCSI FCP. Depending on the workload scenario.
- Throughput: Accomplish up to 2.1x throughput improvement over traditional SCSI FCP when using NVMe/FC
- Increased OLTP performance Microsoft SQL Server 2019 for Linux up to up to 2.7x more transactions/minute.
- Increased OLTP performance for Oracle 19c Databases up to 2.6x more transactions/minute and up to 60% better CPU efficiency.

A comparison of performance between Fibre Channel (FCP) and NVMe over FC is shown in the following figure.
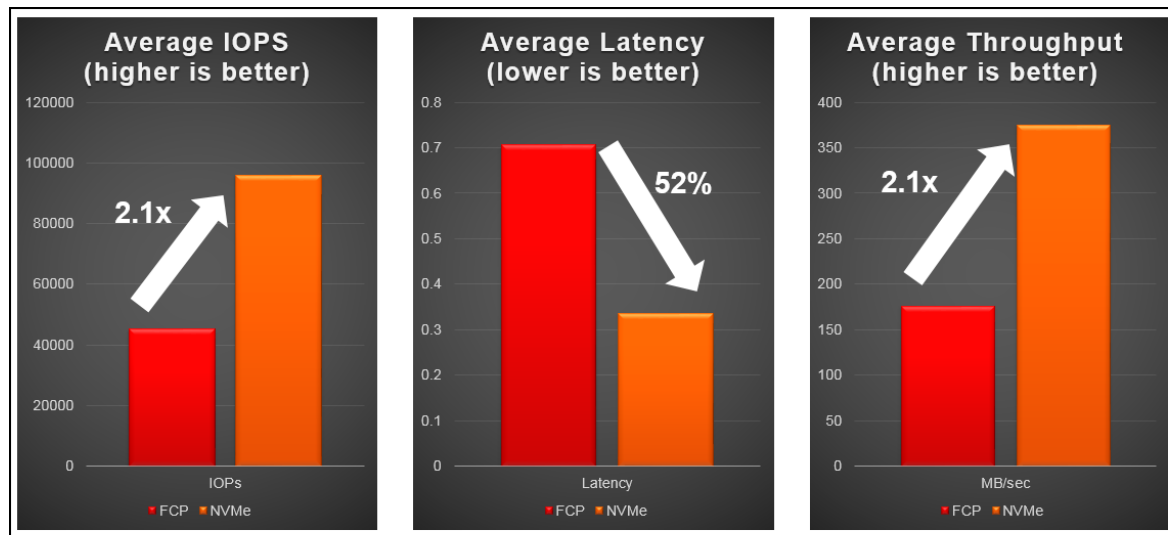

Figure 1. DM7000F Performance

The following figure shows the Increased OLTP performance Microsoft SQL Server 2019 for Linux up to up to 2.7x more transactions/minute.
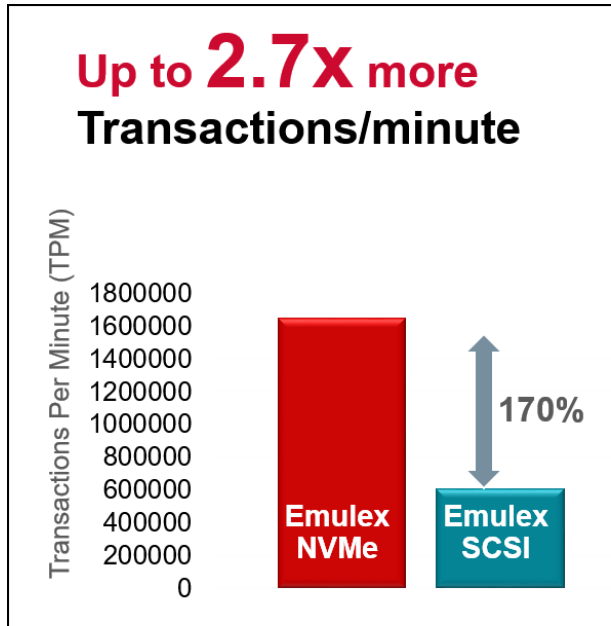
Figure 2. Microsoft SQL Performance (*Emulex ECD Labs tested 9/4/2020, Microsoft SQL 2019 for Linux, RHEL 8.1 NVMe/FC, Lenovo ThinkSystem SR650 with 2x Intel Xeon 8280 Scalable Processors, Emulex LPe35002, Lenovo ThinkSystem DB620S, Lenovo DM7100F, HammerDB TPC-C Transactions per minute. 1:10 mem/dataset ratio, XFS filesystem).

The following figure shows the Increased OLTP performance for Oracle 19c Databases up to 2.6x more transactions/minute and up to 60% better CPU efficiency.
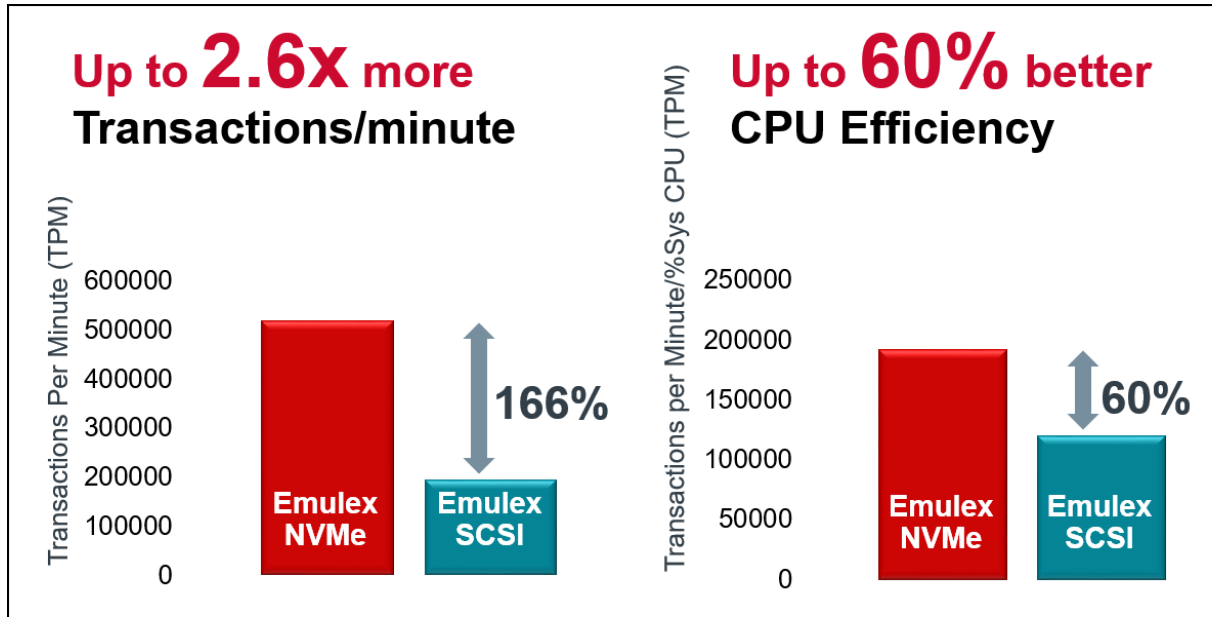

Figure 3. Oracle Performance (*Emulex ECD Labs tested 8/24/2020, Oracle 19c, RHEL 8.1 NVMe/FC, Lenovo ThinkSystem SR650 with 2x Intel Xeon 8280 Scalable Processors, Emulex LPe35002, Lenovo ThinkSystem DB620S, Lenovo DM7100F, HammerDB TPC-C Transactions per minute. 1:10 mem/dataset ratio, 8k XFS, Direct/Async IO).

Deployment Scenarios

NVMe over Fibre Channel can enhance existing SAN workloads. Enterprise applications such as Oracle, SAP, Microsoft SQL Server and others can immediately take advantage of NVMe/FC performance benefits.

NVMe over Fibre Channel can also enable new SAN workload scenarios as well. Big data analytics, Internet of Things (IoT) and AI/deep learning will all benefit from the faster performance and lower latency of NVMe over FC.

Lenovo Solution Components

The Lenovo components in the NVMe over FC solution are as follows.

Table 1. Servers

ThinkSystem Server	Machine types	Host Bus Adapter (Check specific Server for which adapters are supported)	Host Operating System
SR630	7X01, 7X02	4XC7A77485 - ThinkSystem Emulex LPe36002 64Gb 2-port PCIe Fibre Channel Adapter 4XC7A08251 / 4XC7A76525 - ThinkSystem Emulex LPe35002 32Gb 2-port PCIe Fibre Channel Adapter (12.6.x.x or later) 4XC7A08250 / 4XC7A76498 - ThinkSystem Emulex LPe35000 32Gb 1-port PCIe Fibre Channel Adapter (12.6.x.x or later) 7ZT7A00519 – Emulex LPe32002-M2-L PCIe 32Gb 2-Port SFP+ Fibre Channel Adapter (12.6.x.x or later) 7ZT7A00517 - Emulex LPe32000-M2-L PCIe 32Gb 1-Port SFP+ Fibre Channel Adapter (12.6.x.x or later) 01CV840 – Emulex LPe31002-M6-L PCIe 16Gb 2-Port SFP+ Fibre Channel Adapter (12.6.x.x or later) 01CV830 - Emulex LPe31000-M6-L PCIe 16Gb 1-Port SFP+ Fibre Channel Adapter (12.6.x.x or later)	RHEL 8.0 and later RHEL 7.7 and later SLES 15 and later SLES 12 SP4 and later Windows Server 2016 and later Windows Server 2019 and later ESXI 7.0 and later
SR630 V2	7Z70, 7Z71		
SR635	7Y98, 7Y99		
SR645	7D2Y, 7D2X		
SR650	7X05, 7X06		
SR650 V2	7Z72, 7Z73		
SR655	7Y00, 7Z01		
SR665	7D2W, 7D2V		
SR850	7X18, 7X19		
SR850P	7D2F, 2D2G		
SR850 V2	7D31, 7D32, 7D33		
SR860	7X69, 7X70		
SR860 V2	7Z59, 7Z60		
SR950	7X11, 7X12, 7X13		
SD530	7X21		

Table 2. Networking

Model	Software
Lenovo ThinkSystem DB610S FC SAN Switch	Fabric OS 8.1.0b and later
Lenovo ThinkSystem DB620S FC SAN Switch	Fabric OS 8.1.0b and later
Lenovo ThinkSystem DB630S FC SAN Switch	Fabric OS 8.1.0b and later
Lenovo ThinkSystem DB720S FC SAN Switch	Fabric OS 9.0 and later
Lenovo ThinkSystem DB730S FC SAN Switch	Fabric OS 9.1.0b and later
Lenovo ThinkSystem DB400D 4-slot FC SAN Director	Fabric OS 8.1.0b and later
Lenovo ThinkSystem DB800D 8-slot FC SAN Director	Fabric OS 8.1.0b and later

Table 3. Storage Array

Description	Part Number	Adapter	Software
Lenovo ThinkSystem DM5100F	7D3KCTO1WW	Lenovo ThinkSystem DM Series HIC, 16/32Gb FC,4-ports (4C57A67133)	ONTAP 9.8 and later
Lenovo ThinkSystem DM7000F Unified Flash Storage Array	7Y40CTO1WW	Emulex 32Gb Host Bus Adapter (Option PN: 4XC7A14396)	ONTAP 9.4 and later
Lenovo ThinkSystem DM7100F Unified All Flash Storage Array	7D25CTO1WW	Lenovo ThinkSystem DM Series 32Gb 4 port Fibre Channel Card (4XC7A38326)	ONTAP 9.8 and later

The following figure shows an example of the components.

Lenovo ThinkSystem Server with FC HBA

Requirements:
• Lenovo ThinkSystem Server (Supporting multiple OSes)
FC SFP+ Adapters, choice of:
• Emulex LPe36002-M2-L PCIe 64-Gb 2-Port
• Emulex LPe35000-M2-L PCIe 32-Gb 1-Port
• Emulex LPe35002-M2-L PCIe 32-Gb 2-Port
• Emulex 16-Gb Gen6 FC Single-port HBA
• Emulex 16 Gb Gen6 FC Dual-port HBA

ThinkSystem FC SAN Switch or Director

Choice of Switches:
• ThinkSystem DB610S
• ThinkSystem DB620S
• ThinkSystem DB630S
• ThinkSystem DB720S
• ThinkSystem DB730S

Lenovo Storage

Requirements:
• ThinkSystem DM7000
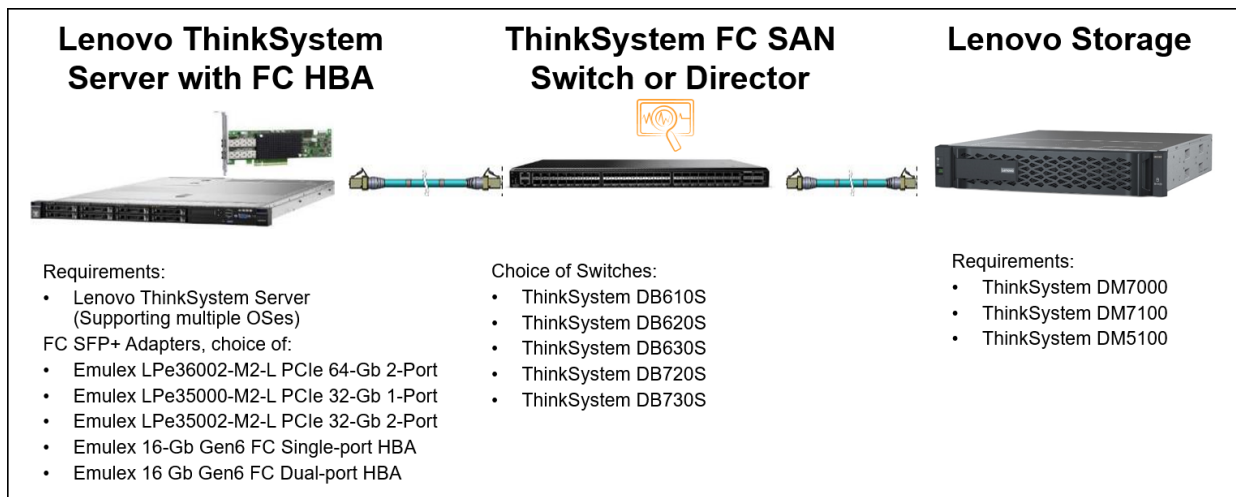• ThinkSystem DM7100
• ThinkSystem DM5100

Figure 4. Lenovo End to End NVMe over FC

Additional Information

For more information, see these web resources:

- Video on the Lenovo ThinkSystem End-to-End NVMe over Fibre Channel Solution
  https://youtu.be/fwxWGAhXXmY

- Infographic on the Lenovo ThinkSystem End-to-End NVMe over Fibre Channel Solution
  https://static.lenovo.com/ww/docs/lenovo-thinksystem-dm-series-nvme-infographic.pdf

- ThinkSystem DM Series Unified Storage product web page
  https://www.lenovo.com/us/en/c/data-center/storage/unified-storage

- Lenovo Storage Interoperability Links
  https://lenovopress.com/lp0584-lenovo-storage-interoperability-links

- Lenovo ThinkSystem DM5100F Unified and DM5100F SAN Flash Storage Array product guide
  https://lenovopress.com/lp1365-thinksystem-dm5100f-unified-flash-storage-array

- Lenovo ThinkSystem DM7000F Unified Flash Storage Array product guide
  https://lenovopress.com/lp0912-lenovo-thinksystem-dm7000f-unified-flash-storage-array

- Lenovo ThinkSystem DM7100F Unified All Flash Storage Array product guide
  https://lenovopress.com/lp1271-thinksystem-dm7100f-unified-all-flash-storage-array

- ThinkSystem DM Series All-Flash Array datasheet
  https://lenovopress.com/ds0047-lenovo-dm-series-all-flash-array

- Emulex Single and Dual Port 32Gb Fibre Channel Adapters product guide
  https://lenovopress.com/lp0692-emulex-32gb-fibre-channel-adapters-for-thinksystem

- ThinkSystem SAN Switches product guides
  https://lenovopress.com/storage/switches/rack

- Emulex NVMe over Fibre Channel User's Guide
  https://docs.broadcom.com/docs/12380302

Related product families

Product families related to this document are the following:

- DM Series Storage
- External Storage
- Lenovo SAN Storage

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