

Technical Review

Lenovo ThinkSystem DM & DE Storage Solutions: Performance and Price-performance

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Abstract

This ESG Technical Review documents our validation of the Lenovo ThinkSystem DM and DE storage solutions with a focus on end-to-end NVMe over Fabric performance and price-performance.

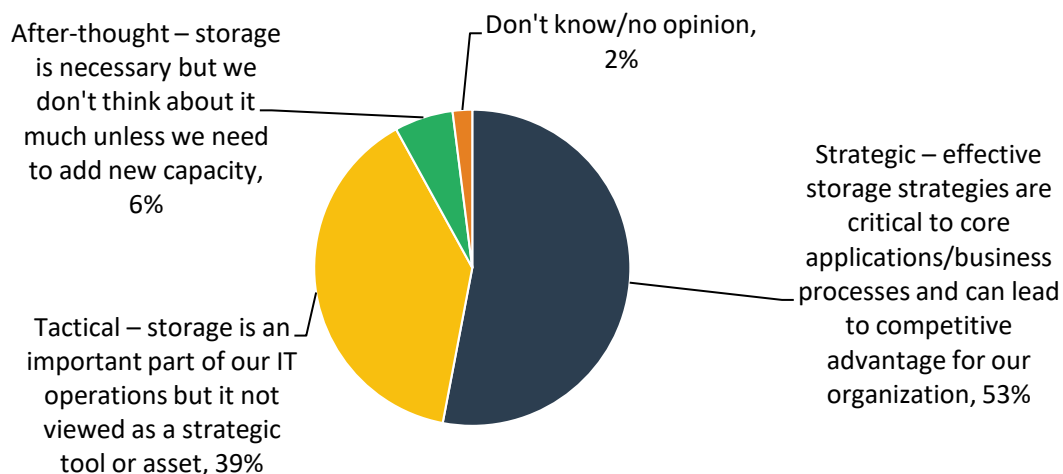
The Challenges

Data and IT services drive most organizations today. IT leaders must be able to support myriad IT needs ranging from virtualized environments to distributed operations to analytics-driven applications. Growing business demands and IT complexity make it challenging for IT to design optimized data centers that deliver the required levels of performance and agility while keeping costs down.

Storage, once considered to be a static, background IT process, today plays a critical role in delivering on business success. The right storage can deliver the optimal mix of performance and cost for different application tiers, particularly with the advent of not only flash storage, but also NVMe over Fabric to maximize flash potential. Important mid-range storage features include data protection and encryption, data reduction technologies that reduce costs, automatic data placement, and simpler monitoring and management. When asked what best describes the role that data storage technology plays in their organization's IT and business operations, 53% of ESG survey respondents agreed that storage was strategic, and that effective storage strategies were critical to their core applications and business processes.¹

Figure 1. Role of Storage in IT and Business Operations

Which of the following best describes the role that data storage technology plays in your organization's IT and business operations? (Percent of respondents, N=356)



Source: Enterprise Strategy Group

¹ Source: ESG Master Survey Results, [General Storage Trends](#), November 2017.

Lenovo ThinkSystem DM and DE Series

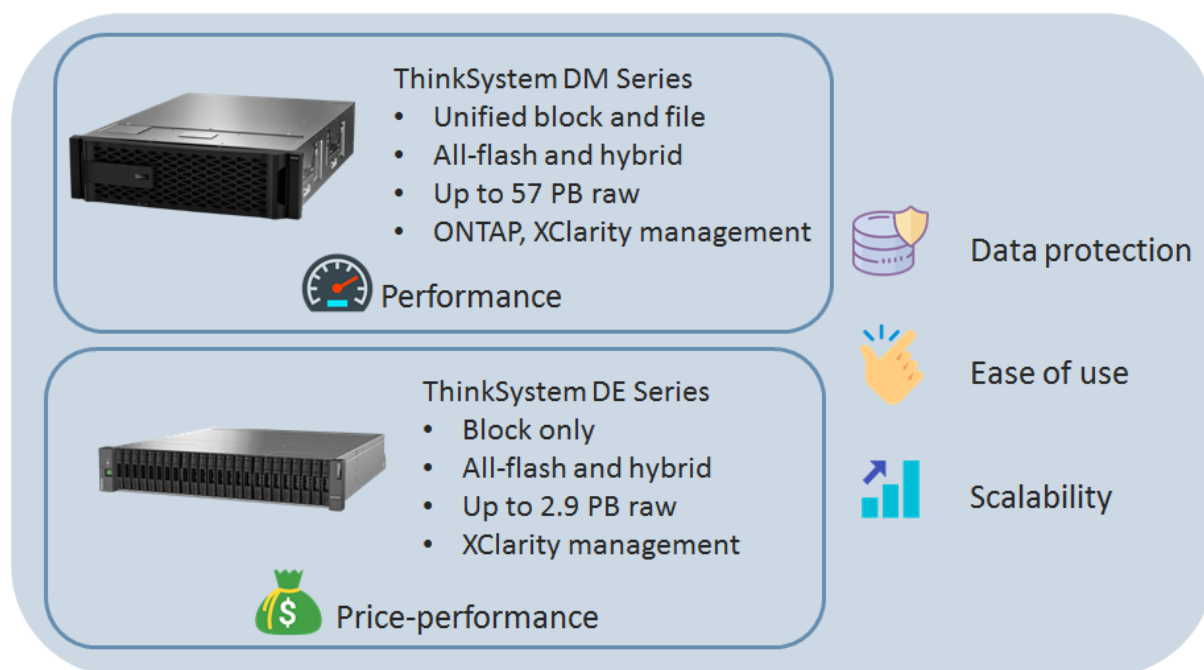
The Lenovo ThinkSystem DM and DE series are the first products delivered based on the strategic partnership and collaborative development between Lenovo and NetApp. The DM Series offers unified all-flash and hybrid storage arrays, while the DE Series provides block-only all-flash and hybrid storage. These arrays were designed for SMB to enterprise organizations seeking high performance and simple management. Lenovo validates its solutions end to end to ensure that storage, servers, and networking components function properly together.

The ThinkSystem DM Series is a cost-effective, unified block and file storage solution. NetApp ONTAP provides this unified capability that enables organizations to reduce their hardware requirements by deploying both SAN and NAS workloads in a single system. Cloud connectivity is an optional feature which can increase ROI by offloading cold storage to lower-cost cloud storage, reducing the need for physical disk capacity and eliminating wasted storage space. The inline data reduction technologies built into DM Series systems provide up to 7X space savings; this can reduce the overall storage footprint, saving money on SSDs as well as on power, cooling, and floor space. Easy to scale, DM Series arrays enable organizations to grow and adapt with the business; they offer the flexibility to scale up to support higher performance, or to scale out for higher capacity, as well as supporting a mix of controllers, SSD sizes, and next-generation technologies for investment protection.

In today's competitive landscape, business success often depends on ensuring continuous access to critical data, and the ThinkSystem DM Series delivers six nines of availability, eliminating unexpected downtime. These arrays offer backup and recovery based on storage snapshots using ONTAP SnapCenter; in addition, built-in replication technologies include asynchronous SnapMirror and synchronous Metrocluster for storage-based disaster recovery.

The ThinkSystem DE Series provides scalable block storage (Fibre Channel and iSCSI) and was designed for small- to medium-sized organizations to optimize price-performance. Three hybrid models offer up to 345 TB of raw capacity, while two all-flash models offer 2.9 PB of raw capacity. DE Series arrays are easy to scale and include snapshots, mirroring, and encryption for data protection; non-disruptive management maximizes system uptime. XClarity provides simple monitoring and management across Lenovo servers, storage, and networks.

Figure 2. Lenovo ThinkSystem Storage Solutions



Source: Enterprise Strategy Group

ESG Tested

ESG validated Lenovo testing to evaluate the performance improvements provided by end-to-end NVMe over Fabric on the DM Series. For the DE Series midrange array, we validated price/performance testing that was done using the SPC-1 benchmark.

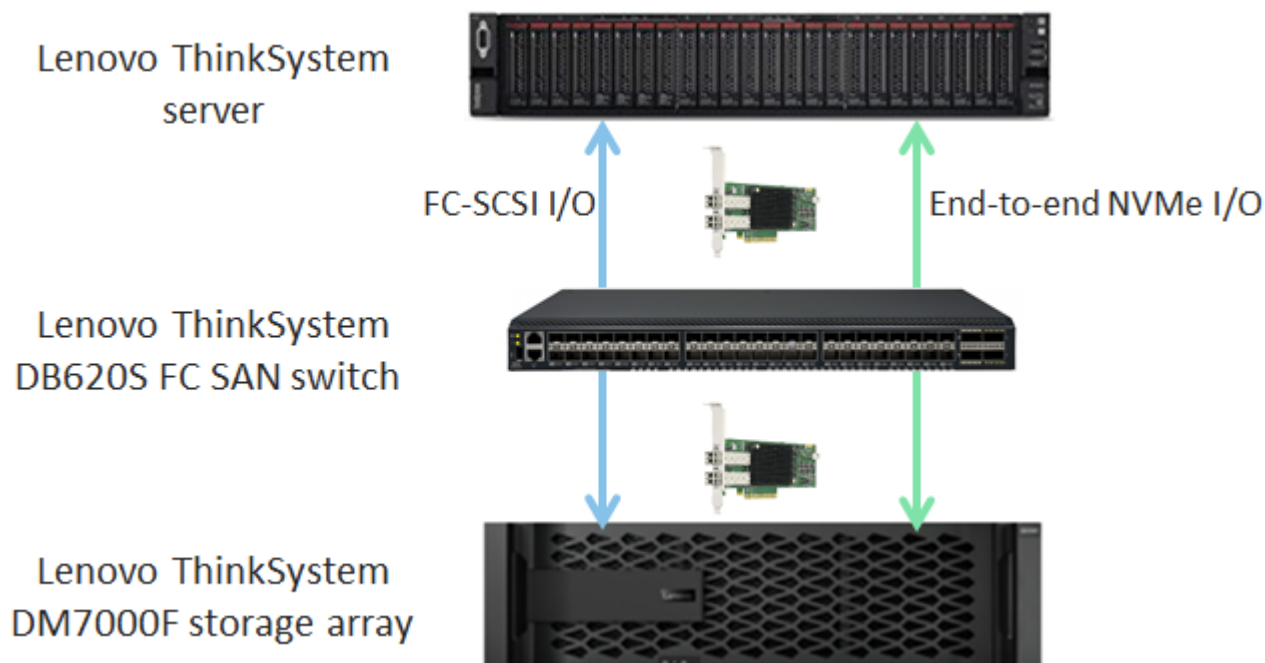
Lenovo ThinkSystem DM Series: Higher Performance with End-to-end NVMe over Fabric

The performance improvements that SSDs bring over HDDs has been well established. However, innovations in SSD technology have resulted in performance levels that can overwhelm traditional SCSI I/O interfaces, creating a bottleneck. The NVMe over Fabric protocol was designed for memory-based flash to reduce data access latency, and IT organizations are noticing the benefits. In ESG research, 79% of storage decision makers familiar with NVMe technology expect NVMe-based flash to eventually replace SAS- or SATA-connected flash.²

Speed of data access can be further improved by enabling NVMe throughout the data path. Lenovo tested this end-to-end solution to demonstrate its performance improvement over FC-SCSI paths. It should be noted that the testing was not designed to push high IOPS or throughput, but to focus specifically on the impact of end-to-end NVMe over Fabric.

ESG validated Lenovo testing that used the Vdbench storage performance test harness.³ The I/O profile was 4kb block size, 100% random, 70% reads/30% writes, to emulate a typical OLTP workload. The test bed used dual-port HBAs on a single server and DM7000F storage array. For comparison, one port was zoned for NVMe over Fabric and wrote to a single NVMe namespace volume on the array; the other port was zoned for FC-SCSI and wrote to a FC-SCSI LUN on the array. This ensured identical test conditions, to focus the comparison on the data path (Figure 3).

Figure 3. Lenovo End-to-end NVMe over Fabric Testing



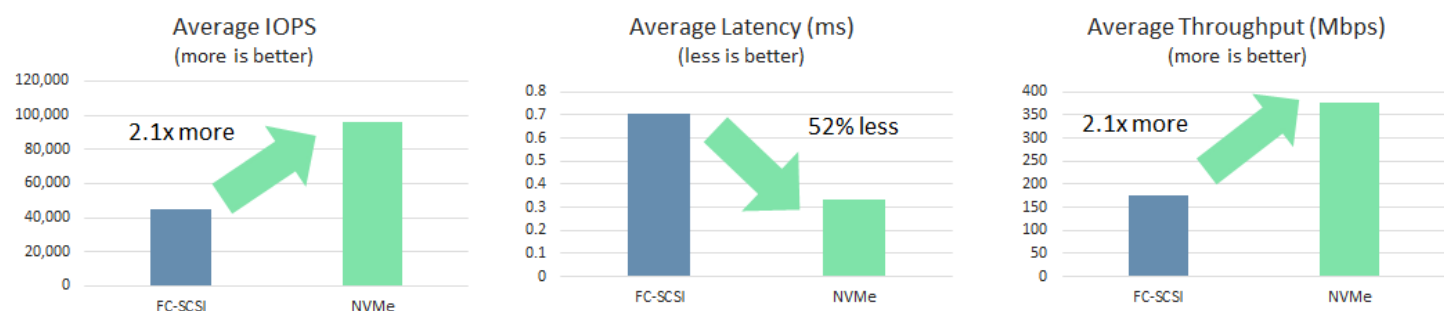
Source: Enterprise Strategy Group

² Source: ESG Master Survey Results, [General Storage Trends](#), November 2017.

³ The testbed was a Lenovo SR650 server, configured with an Emulex 32Gb dual-port HBA, running SUSE Linux 12 SP3 with the kernel updated to support NVMe. A Lenovo DB620S 32Gb Fibre Channel SAN switch was running Brocade FOS 8.2.0a. The storage was a Lenovo DM7000F with the Emulex 32Gb dual-port HBA and running ONTAP 9.4 SP1.

Figure 4 shows results of this testing, demonstrating that the end-to-end NVMe over Fabric path delivered more than twice the I/O per second (IOPS) and throughput, as well as 52% lower latency.

Figure 4. Lenovo ThinkSystem DM7000F Performance



Source: Enterprise Strategy Group

With this increase in performance, organizations can achieve benefits such as:

- Accelerated business-critical transactions.
- Faster database queries for faster, more accurate results.
- Higher workload/VM consolidation for greater efficiency and lower costs.

Lenovo ThinkSystem DE Series: Industry-best Price/Performance

Organizations with tight budget constraints, particularly in the mid-range, need to find solutions that optimize price-performance. ESG reviewed the most recently published results of the SPC-1 version 3⁴ benchmark demonstrating the price-performance of the ThinkSystem DE6000H. This industry-standard benchmark suite demonstrates application-level price-performance and is maintained by the Storage Performance Council; the benchmark uses a full operating system and application stack to emulate real-world conditions. The testing generates a single workload that emulates typical transaction-oriented functions that real-world databases (such as OLTP, database operations, and mail server implementations) execute. This involves primarily random read and write I/O typical of database queries and updates. The price-performance measurement provides a relative indication of the cost of handling storage demands in these application environments.

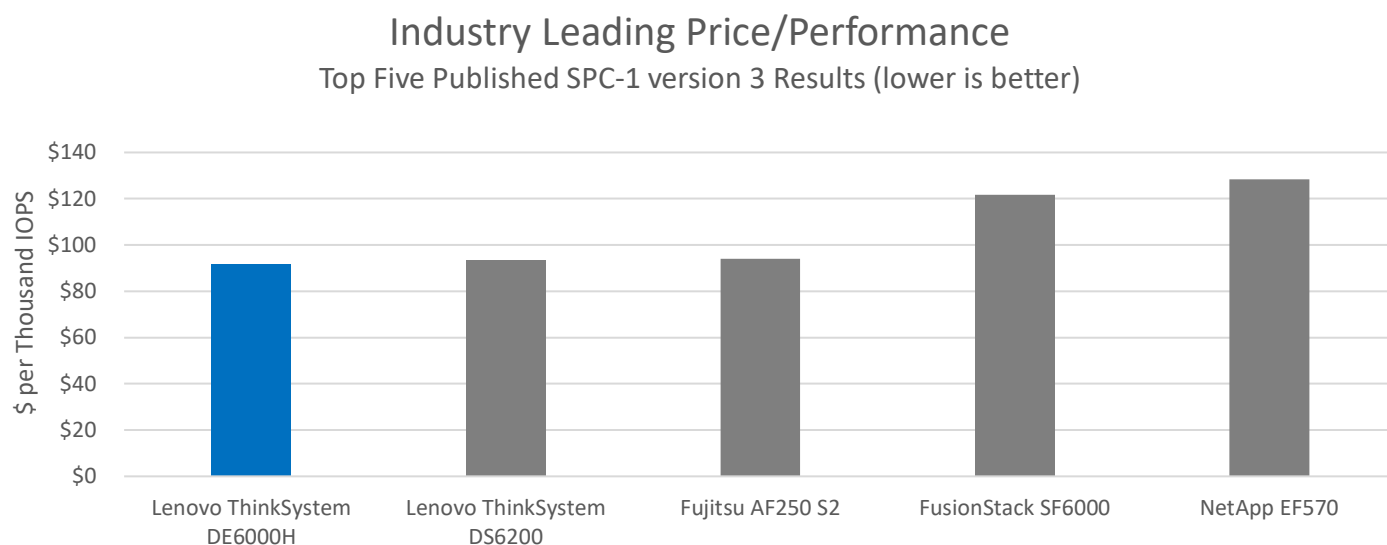
Figure 5 shows the current top five SPC-1 v3 price-performance results.⁵ The ThinkSystem DE6000H results just published show industry-best price performance of \$91.76/KIOPS.⁶ It displaces from the top spot another Lenovo ThinkSystem, the DS6200, which is second with \$93.29/KIOPS. In addition, while not on this top-five chart, a third Lenovo array (DS4200) comes in sixth place. ESG sees this as a clear indication that Lenovo's commitment to customers includes delivering the best price-performance in the industry on an ongoing basis, a benefit that supports both operational and financial objectives.

⁴ It should be noted that the SPC-1 benchmark evolves along with the storage industry, making results of version 1 of the benchmark not comparable with version 3. Version 3 includes the core capabilities of version 1, but includes support for data deduplication and compression, along with refining workload attributes in line with modern workloads. For more information, visit <https://spcresults.org/specifications>.

⁵ <http://spcresults.org/benchmarks/results/top10/price/spc1/3>

⁶ The test bed included 2 x Lenovo ThinkSystem SR630 servers running Windows Server 2012 R2; 2 x Lenovo 430-8e 12Gb SAS HBA; a dual-controller ThinkSystem DE6000H array populated with 24 x 800GB SSDs configured with RAID 10 data protection; and 4 x 12Gb SAS cables connecting the array to the hosts.

Figure 5. SPC-1 Version 3 Price/Performance



Source: Enterprise Strategy Group

Table 1 provides detailed benchmark results. ESG noted that Lenovo has delivered the top two all-flash arrays in terms of price-performance for organizations with different performance demands and budget requirements. The ThinkSystem DE6000H delivers 460K IOPS with a price of just more than \$42K, while the DS6200 delivers 180K IOPS and a price of almost \$17K. This indicates a commitment to optimizing price-performance for a variety of needs.

Table 1. SPC-1 Version 3 Detailed Results

SPC-1 Toolkit Version 3.0.2	Lenovo DE6000H	Lenovo DS6200	Fujitsu AF250	FusionStack SF6000	NetApp EF570
SPC-1 IOPS	460,011	180,006	360,070	801,083	500,022
SPC-1 price-performance (\$/KIOP)	\$91.76	\$93.29	\$94.02	\$121.73	\$128.42
SPC-1 IOPS response time (ms)	0.411	0.518	0.673	0.296	0.437
SPC-1 overall response time (ms)	0.252	0.344	0.361	0.208	0.260
SPC-1 ASU capacity (GB)	9,448	2,267	3,435	11,520	9,006
SPC-1 ASU price (\$/GB)	\$4.47	\$7.41	\$9.86	\$8.47	\$7.13
SPC-1 total system price (\$US)	\$42,207.87	\$16,791.99	\$33,851.38	\$97,509.95	\$64,212.58
Physical storage capacity (GB)	19,200	4,800	9,600	32,006	19,203
SPC-1 submission ID	A32008	A32006	A32003	A31008	A31009

Source: Enterprise Strategy Group



Why This Matters

High performance is essential for many of today's business applications, as organizations strive to be more agile. Flash storage can deliver high performance, but can be expensive; however, it can also provide economic benefits. ESG research respondents who use flash storage cited as benefits not only improved application performance, but also improved TCO, reduced operational expenses, reduced power consumption, and reduced or deferred hardware capital expenses.⁷

ESG validated the high performance and low latency of Lenovo's ThinkSystem DM series arrays, which leverage NVMe over Fabric protocol. In testing designed to compare NVMe over Fabric vs. traditional data paths, the Lenovo DM7000F delivered more than twice the IOPS and throughput of a FC-SCSI path, in addition to 52% lower latency. These results demonstrate the DM Series' ability to deliver the fast application performance, database speed, and workload consolidation that today's organizations demand to respond to changing business requirements. ESG also confirmed that the ThinkSystem DE6000H configured as an all-flash array delivered an industry-leading price-performance of \$91.76 per thousand SPC-1v3 IOPS, demonstrating an ongoing commitment to cost-efficient performance.

The Bigger Truth

Many organizations are fully engaged in digital transformation to optimize business opportunities and reduce threats. These objectives drive new approaches to IT infrastructure designed to deliver results faster and easier. NVMe over Fabric is a good example; by reducing the storage bottleneck, NVMe over Fabric can deliver the speed and agility organizations need for business-critical cloud and on-premises applications such as streaming, big data, OLTP, and high-performance computing, while enabling increased VM density to lower TCO.

Lenovo may be somewhat new to data center solutions, but it has made a solid market impact with some robust and scalable solutions. Its commitment to the data center was demonstrated with its 2014 purchase of IBM's x86 systems business, giving it access to the top echelons of the enterprise data center business. The recent strategic partnership between Lenovo and NetApp, a long-time storage heavyweight, should provide both organizations with a more complete product suite in order to compete more effectively in the mid-range/high-end data center storage market. Lenovo's supply chain expertise and purchasing power are core strategic advantages that have fueled its history of reducing costs; NetApp has long been a major player in the enterprise storage market. Together, they can bring validated hybrid and all-flash solutions to enterprise and mid-market organizations. The ThinkSystem DM and DE series, the first fruits of the partnership, deliver adaptable and dynamic data center storage that can reduce cost and complexity while generating high performance.

ESG validated the high performance of the ThinkSystem DM series, demonstrating twice the IOPS and throughput and 52% lower latency with end-to-end NVMe over Fabric compared with a traditional data path. We also validated the industry-leading price/performance of the ThinkSystem DE6000H based on the most recent SPC-1 submission.

This is a new partnership between Lenovo and NetApp, and it is too early to declare it a success. That will depend on execution and strategic focus. But ESG sees both organizations as fully able to make a strong showing with the current products and with future innovations.

⁷Source: ESG Master Survey Results, [General Storage Trends](#), November 2017.

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