Western Digital

BETTER WITH NVMe

Performing at the speed of business

NVMe™ SSDs enable data infrastructure leaders to transition from legacy SATA and SAS solutions to the extreme performance and low latency of NVMe. To get a better appreciation of how these NVMe drives compare to SATA SSDs, we ran tests on Western Digital Ultrastar DC SA210 1.92TB SATA drives and compared them with the 3.84TB **SN640**.

COST & PERFORMANCE

When NVMe™ drives first came out, we knew the performance would be superior, but questioned when they would be cost-comparable to SATA SSDs. Due to their initial cost, NVMe drives were used for enterprise applications that needed to take advantage of their high-performance characteristics.

Now that NVMe SSDs are near cost parity, we see them as a replacement for SATA drives in the data center for mainstream applications as they offer better performance while having lower power requirements.

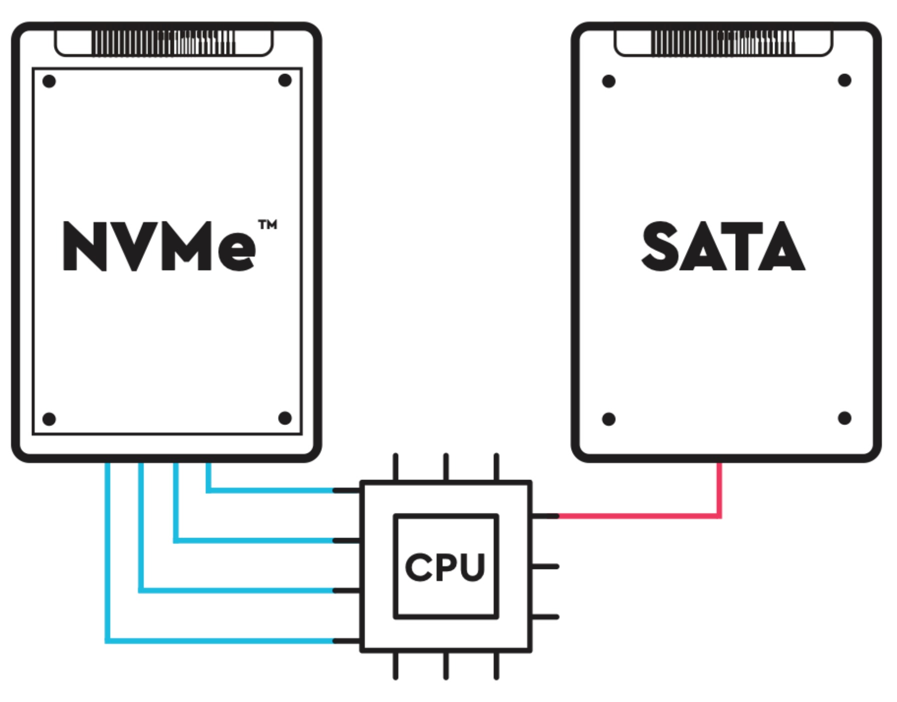
NVMe vs SATA

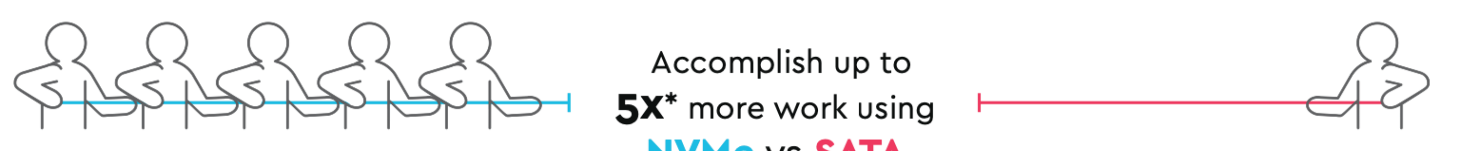
NVMe

A communications protocol optimized specifically to handle high bandwidth transfer speeds with up to 4 lanes per device Supports up to 1000MB/s per lane (PCIe Gen 3.1)

SATA

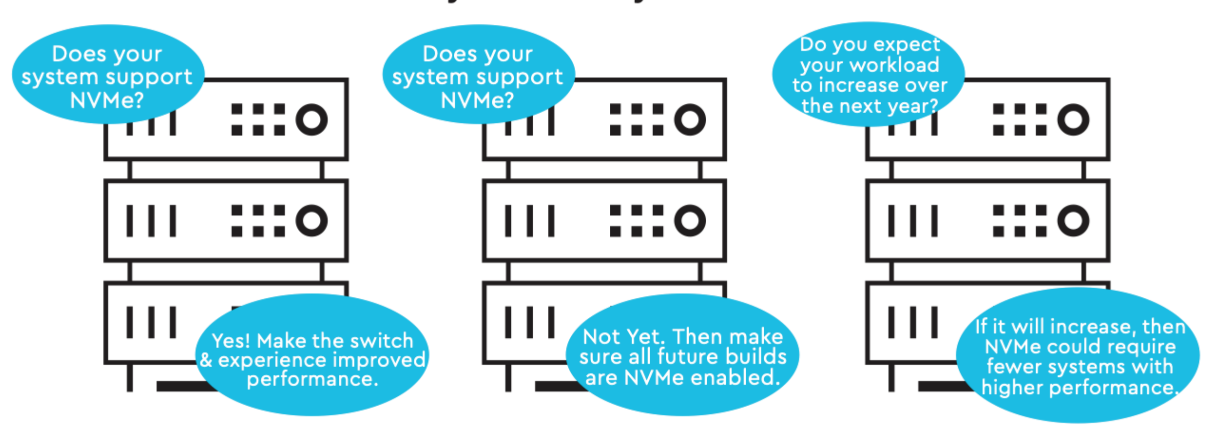
A communications protocol optimized for spinning magnetic disk. Supports up to 600MB/s transfer rate (SATA 6Gb/s)



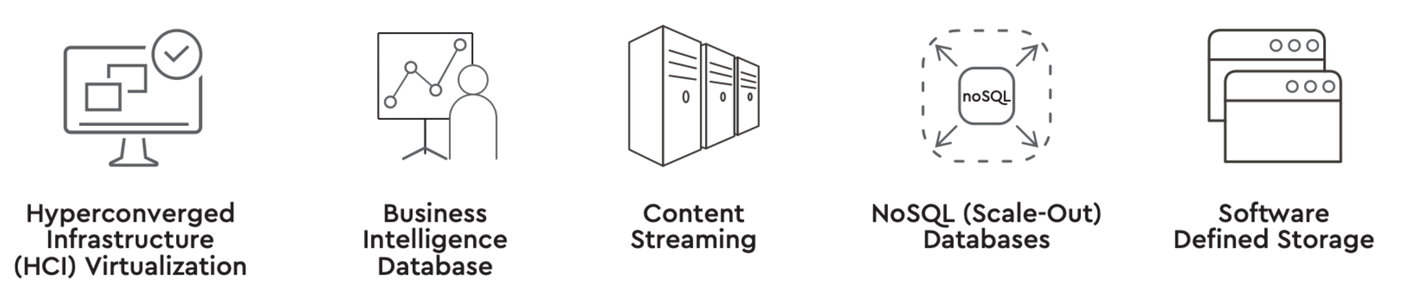


Accomplish up to **5X*** more work using **NVMe** vs **SATA**

Is Your System Ready for the Future?



Applications for NVMe SSDs

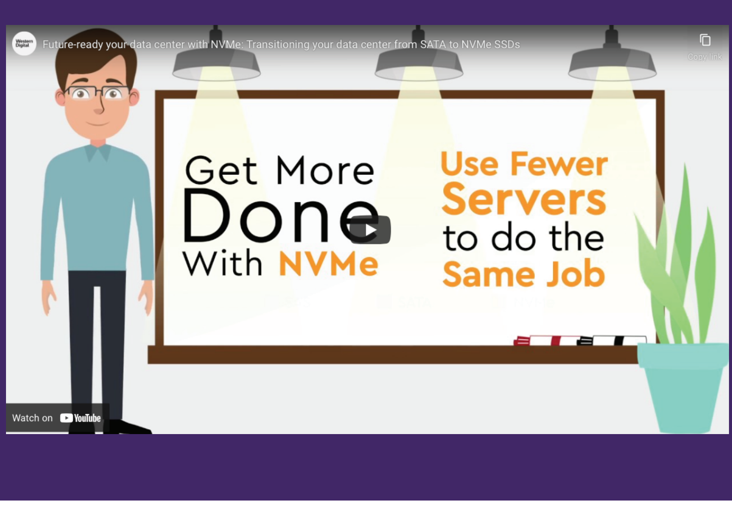


A Trusted Brand with Applications for NVMe SSDs

Drawing upon this rich history, Western Digital has developed a swath of products to meet the specific requirements of both commercial and enterprise users alike and has used different brands to meet the needs of different markets with unique product offerings. For instance, the SanDisk brand is focused on mobile storage products, and the G-Technology® brand is focused on drives and storage systems designed for creative professionals.

For enterprise and data center customers, Western Digital has a line of Ultrastar drives. They prefix their drives with a two-character code to indicate the type of device: HC are HDD devices, SS are SAS drives, SN are NVMe drives, SA are SA SATA drives, and ME are memory extension drives.

The drive that we will be looking at in this article is the Western Digital Ultrastar DC SN640 NVMe SSD. These drives are for mainstream designs, which is the drive that Western Digital markets as a transitional drive to get enterprise customers away from last-gen SATA/SAS Flash storage technologies and into current NVMe Flash storage.



Western Digital Ultrastar DC SN640 NVMe SSD specifications:

- Form factor: 2 2.5", 7mm
- Capacity: 800GB to 7,680GB
- NAND: Western Digital BiCS4 3D TLC NAND
- Interface: PCIe Gen3 x4 (Compliant to NVMe 1.3c)
- Performance: (TCG Ruby model)
  - Sequential Read Performance (Up to): 3340 MB/s
  - Sequential Write Performance (Up to): 2190 MB/s
  - Random 4KiB Read (Up to): 515K IOPS
  - Random 4KiB Write (Up to): 161K IOPS
  - Random 70/30 Read/Write, 4KiB (Up to):
  - 305K IOPS
  - Read Latency (down to): 78 us
- Endurance and Reliability:
  - DW/D: 0.8 (read-intensive), 2 (mixed-use)
  - Uncorrectable Bit Error Rate (UBER): 1 in 10 to the 17th
  - MTBF: 2 M hours
  - Power Loss Protection (PLP) and end-to-end data path protection
- Features
  - 128 NVMe Namespace Support
  - Variable Sector Size Support
  - NVMe-MI 1.1 (TCG Ruby model)
  - Secure Erase, Instant Secure Erase, and
  - TCG Ruby
- Environment:
  - Operating Power State (max): 12W
  - Idle Power State (typical): < 5W
  - Operating Temperature: 0 to 70 °C ambient temperature with suggested airflow
  - Non-Operating Temperature: -40° to 85° C
- 5-year limited warranty

TEST DATA

To measure the performance of the Western Digital Ultrastar DC SN640 NVMe SSDs, we used an industry-standard Dell EMC PowerEdge R740xd server equipped with an NVMe-compatible backplane. This server configuration offered 12 NVMe bays, from which we used 8 slots.

Test Environment:

- 8x Western Digital Ultrastar DC SN640 NVMe SSDs
- 8x Western Digital Ultrastar SA210 SATA SSDs
- Dell EMC PowerEdge R740xd server with 12x NVMe slots (8 used)
  - CPU 2 x Intel® Scalable Platinum 8280
  - DRAM 12 x 32GB DDR4-2933MHz

For these tests, we use a CentOS 7 environment with VDBench installed for the synthetic section and VMware ESXi™ 6.7u3 for our SQL Server and MySQL™ Sysbench VMs.

We ran tests on Western Digital Ultrastar DC SA210 1.92TB SATA drives and compared them with the 3.84TB SN640.

The chart below shows that in every category the Western Digital SN640 trounced the SATA drive by a wide margin. This ranged from a 46% improvement in our Sysbench average latency to an outstanding 875% improvement during our 4K 70/30 random IOPS testing.

Western Digital NVMe vs SATA

	SA210 SATA	SN640 NVMe	% Better
4K Random Read IOPS	505,911	4,002,208	691%
4K Random Write IOPS	200,926	795,667	296%
4K 70/30 Random IOPS	254,588	2,482,619	875%
64K Sequential Read MB/s	4,268	22,624	430%
64K Sequential Write MB/s	2,026	5,744	184%
Sysbench TPS	10,726	19,965	86%
Sysbench Average Latency	23.87	12.92	46%
Sysbench 99th Latency	65.38	25.20	61%

StorageReview

CONCLUSION

Our testing on the Ultrastar DC SN640 confirmed that Western Digital—using its latest in-house controller, 96L flash, and firmware—has delivered a mainstream NVMe SSD which balances performance and power for a cost-effective solution to displace SATA once and for all. NVMe drives quickly achieved parity in cost per IOPS and we predicted that there would be an inflection point where they would be cost-competitive on a capacity basis in the future, and we are now at that point. In a casual price comparison, we found that there was only a slight uplift in the price of the SN640 over SATA/SAS SSDs on a per GB basis. When viewed through the performance lens as illustrated above, there's simply no reason to be using SATA SSDs for data storage.

Western Digital has long been an innovator in, and at the forefront of, storage technology – and this achievement extends to flash drives. Western Digital's relentless innovation can be seen in their SN640 line of drives where they were able to use their technical prowess to not only extract superior performance from the device but to do so at a very attractive price point.

The Ultrastar SN640 serves as a great gateway drive to get users off prior-generation storage and onto NVMe-based flash. The data clearly shows that NVMe is the path forward when it comes to providing responsive performance to the diverse set of workloads in the data center.

Not only will NVMe drives increase the performance of current workloads, such as databases and virtualized workloads, but they position the data center for the more demanding next-gen workloads that are starting to appear, such as machine learning (ML) and artificial intelligence (AI), which require storage solutions with ultra-low latency and ultra-high bandwidth.

Learn More About the Test

Western Digital

This report is sponsored by Western Digital. All views and opinions expressed in this report are based on our unbiased view of the product(s) under consideration.

*Theoretically, 4-lane NVMe interface delivers up to 7x better performance than SATA based on 1000MB/s per lane NVMe and 600MB/s SATA . Practically speaking, current NVMe SSDs have the capability of delivering up to 3-5X better sequential performance, depending on whether the workload is write or read.