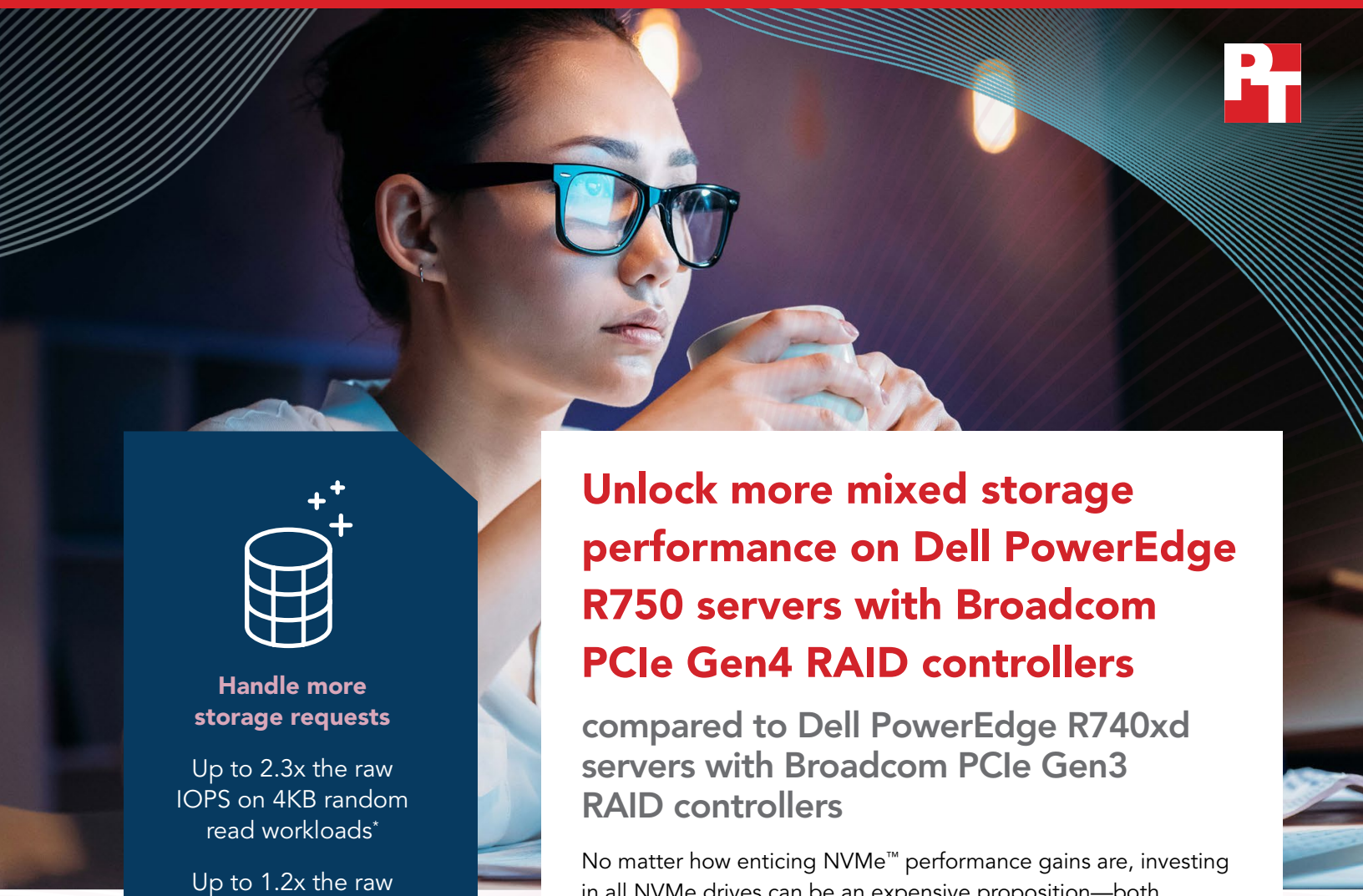


Handle more storage requests

Up to 2.3x the raw IOPS on 4KB random read workloads*

Up to 1.2x the raw IOPS on 4KB random write workloads*

Maintain more concurrent throughput

Up to 2.0x the GiB/s on 1MB sequential read workloads*

Up to 1.3x the GiB/s on 1MB sequential write workloads*

*vs a PowerEdge R740xd server with a Broadcom PCIe Gen3 RAID controller

Unlock more mixed storage performance on Dell PowerEdge R750 servers with Broadcom PCIe Gen4 RAID controllers

compared to Dell PowerEdge R740xd servers with Broadcom PCIe Gen3 RAID controllers

No matter how enticing NVMe™ performance gains are, investing in all NVMe drives can be an expensive proposition—both economically and operationally. So it comes as no surprise that "IDC estimates that SAS is found in over 70 percent of enterprise storage drives and expects it to reach more than 85 percent of enterprise storage capacity by 2022."[1] Dell PowerEdge™ R750 servers include Broadcom PCIe® Gen4 RAID controllers, which not only deliver twice the bandwidth (throughput) of previous-generation servers with Gen3 technology, but also support SAS, NVMe, and mixed-drive environments.[2]

To explore the advantages of the 15G Dell PowerEdge R750 server in a mixed-storage environment, we compared its input/output operations per second (IOPS) and throughput to those of a 14G Dell PowerEdge R740xd server.

In our 16 SAS and 8 NVMe drive mixed-storage test configuration, the Dell PowerEdge R750 server with a PCIe Gen4 RAID controller handled over 7.5 million more IOPS in our 4KB random read workload and maintained over twice the gibibytes per second (GiB/s) in our 1MB sequential read workload compared to the previous-generation server.

About the Dell PowerEdge R750 server

The Dell PowerEdge R750 is a full-featured, general purpose 2U rack server powered by 3rd Gen Intel® Xeon® Scalable processors. According to Dell, this rack server is purpose-built to optimize application performance and acceleration with PCIe Gen 4.0 compatibility, eight channels of memory per CPU, and up to 24 NVMe drives. It also includes "improved air-cooling features and optional Direct Liquid Cooling to support increasing power and thermal requirements."[3]

How we tested

We compared the server and mixed SAS/NVMe drive storage performance of a Dell PowerEdge R750 server with a Broadcom PCIe Gen4 RAID controller (Dell PERC H755) to that of a Dell PowerEdge R740xd server with a Broadcom PCIe Gen3 RAID controller (Dell PERC H740P). To measure each dual-processor solution's block storage performance in four mixed-drive configurations, we captured Flexible input/output (FIO) benchmark performance metrics, which offer insight into server and storage performance by showing:

- The number of IOPS a solution can handle, indicating whether it can process a high volume of storage requests at once.
- The amount of information (in GiB) a solution can process per second (throughput), indicating how well it can process a high volume of data.

In all of our FIO benchmark tests, we used the maximum number of cores per processor: 56 cores for the Dell PowerEdge R750 and 48 for the PowerEdge R740xd. Our final mixed-drive test included eight NVMe drives—filling all NVMe slots in the backpanes of the servers under test. We tested the two server solutions in these mixed drive configurations:

1. 2 SAS drives + 2 NVMe drives = 4 mixed drives
2. 4 SAS drives + 4 NVMe drives = 8 mixed drives
3. 6 SAS drives + 6 NVMe drives = 12 mixed drives
4. 16 SAS drives + 8 NVMe drives = 24 mixed drives

We first ran the FIO benchmark with small blocks of data (4 KB)—once using a random read workload and again using a random write workload. These are our IOPS results. Then, we repeated the process on large blocks of data (1 MB)—once using a sequential read workload and again using a sequential write workload. These are our GiB/s results.

For detailed system and mixed-drive configuration information, FIO benchmark parameters, and a step-by-step testing methodology, see the science behind the report.

What is the difference between random and sequential workloads?

Our FIO benchmark testing included random and sequential workloads, which use different patterns for data access and storage. For example, a read-heavy random workload pattern might represent a user who browses multiple web pages in an online store before making a purchase. That's because the application may have to pull data from multiple drives. On the other hand, streaming video requires that a server read data sequentially in a single continuous stream. The same rule applies in data storage and retrieval. Running both types of workloads provides insight into how the server solution handles data access, retrieval, and saving.

About Broadcom PCIe Gen4 technology in Dell PowerEdge servers

The Broadcom PCIe Gen4 RAID controller (Dell PERC H755) on the motherboard of the PowerEdge R750 server delivers twice the bandwidth (from 8GT/s to 16GT/s) of PCIe Gen3 RAID controllers.[4]

Comparing server capabilities

Dell Technologies made some big changes with the 15G refresh of its 2U workhorse. The PowerEdge R750 server takes advantage of PCIe Gen4, which doubles the bandwidth available on the PowerEdge R740xd server.[5] While we only compared server and mixed SAS/NVMe drive storage performance, the redesigned PowerEdge R750 chassis with its multi-vector cooling is a major departure from its predecessor. Below, we list some of the most notable 15G performance and storage-related features, including upgraded RAID, PowerEdge RAID controller (PERC), boot-optimized storage subsystem (BOSS), and host bus adapter (HBA) storage controllers.

Table 1: Comparing Dell PowerEdge test server capabilities. Source: Principled Technologies.

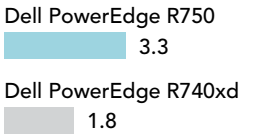
Features	PowerEdge R750[6]	PowerEdge R740xd[7]
Processor	Up to two 3rd Generation Intel Xeon Scalable processors, with up to 40 cores per processor	Up to two 2nd Generation Intel Xeon Scalable processors, with up to 28 cores per processor
Memory	• 32 DDR4 DIMM slots, supports RDIMM (2TB max) / LRDIMM (8TB max), speeds up to 3200 MT/s • Up to 16 Intel Persistent Memory 200 series (BPS) slots, (8TB max) • Supports registered ECC DDR4 DIMMs only	• 24 DDR4 DIMM slots, supports RDIMM / LRDIMM, speeds up to 2666MT/s, 3TB max • Up to 12 NVDIMM, 192GB max • Supports registered ECC DDR4 DIMMs only
Storage controllers	**Internal controllers:** • PERC H745 • HBA355I • PERC S150 (SWRAID) • PERC H345, H755, H755N (HWRAID) • BOSS-S2 (HWRAID) 2 x M.2 SSDs 240 GB or 480 GB • BOSS-S1 (HWRAID) 2 x M.2 SSDs 240 GB or 480 GB **External controllers:** • PERC H840 (RAID) • HBA355e (non-RAID)	**Internal controllers:** • PERC H730P, H740P • PERC S140 (SWRAID) • BOSS (HWRAID) 2 x M.2 SSDs 120GB or 240 GB • HBA330 (non-RAID 12Gbps SAS HBA) **External controllers:** • PERC H840 (RAID) • 12Gbps SAS HBA (non-RAID)
Storage	**Front bays:** • Up to 12 x 3.5-inch SAS/SATA drives (192TB max) • Up to 8 x 2.5-inch NVMe drives (122.88TB max) • Up to 16 x 2.5-inch SAS/SATA/NVMe drives (245.76TB max) **Mid bay:** • Up to 24 x 2.5-inch SAS/SATA/NVMe drives (368.84TB max) **Rear bays:** • Up to 2 x 2.5-inch SAS/SATA/NVMe drives (30.72TB max) • Up to 4 x 2.5-inch SAS/SATA/NVMe drives (61.44TB max)	**Front bays:** • Up to 24 x 2.5-inch SAS/SATA/NVMe drives (153TB max) or up to 12 x 3.5-inch SAS/SATA drives (144TB max) **Mid bay:** • Up to 4 x 2.5-inch SAS/SATA/NVMe drives (25TB max) or up to 4 x 3.5-inch SAS/SATA drives (48TB max) **Rear bays:** • Up to 4 x 2.5-inch SAS/SATA/NVMe drives (25TB max) or up to 2 x 3.5-inch SAS/SATA drives (24TB max)
PCIe	8 x PCIe Gen4 slots (up to 6 x 16) with support for SNAP I/O modules	8 x PCIe Gen3 slots (up to 6 x 16)

Handle more outgoing storage requests
Up to 2.3x the raw IOPS

Random read testing results

Based on the raw IOPS output we saw in random read workload testing, upgrading from 14G Dell PowerEdge R740xd servers to 15G Dell PowerEdge R750 servers could help companies grow their user base or achieve performance gains for I/O-intensive applications.

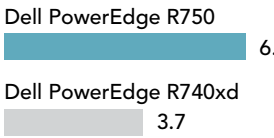
4KB random read FIO results with 2 SAS and 2 NVMe drives
IOPS (millions) | Higher is better



Over **3.3 million IOPS**

Figure 1: 4KB random read FIO benchmark results with 2 SAS and 2 NVMe drives. Higher is better. Source: Principled Technologies.

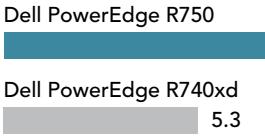
4KB random read FIO results with 4 SAS and 4 NVMe drives
IOPS (millions) | Higher is better



Over **6.5 million IOPS**

Figure 2: 4KB random read FIO benchmark results with 4 SAS and 4 NVMe drives. Higher is better. Source: Principled Technologies.

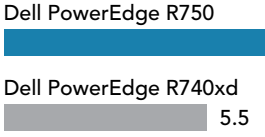
4KB random read FIO results with 6 SAS and 6 NVMe drives
IOPS (millions) | Higher is better



Over **9.8 million IOPS**

Figure 3: 4KB random read FIO benchmark results with 6 SAS and 6 NVMe drives. Higher is better. Source: Principled Technologies.

4KB random read FIO results with 16 SAS and 8 NVMe drives
IOPS (millions) | Higher is better



Over **13.2 million IOPS**

Figure 4: 4KB random read FIO benchmark results with 16 SAS and 8 NVMe drives. Higher is better. Source: Principled Technologies.

4KB random write FIO results with 2 SAS and 2 NVMe drives
IOPS (millions) | Higher is better

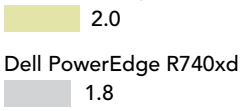


Figure 5: 4KB random write FIO benchmark results with 2 SAS and 2 NVMe drives. Higher is better. Source: Principled Technologies.

Over **2 million IOPS**

4KB random write FIO results with 4 SAS and 4 NVMe drives
IOPS (millions) | Higher is better

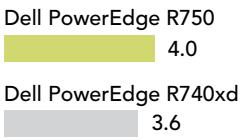


Figure 6: 4KB random write FIO benchmark results with 4 SAS and 4 NVMe drives. Higher is better. Source: Principled Technologies.

Over **4 million IOPS**

4KB random write FIO results with 6 SAS and 6 NVMe drives
IOPS (millions) | Higher is better

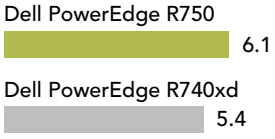


Figure 7: 4KB random write FIO benchmark results with 6 SAS and 6 NVMe drives. Higher is better. Source: Principled Technologies.

Over **6 million IOPS**

4KB random write FIO results with 16 SAS and 8 NVMe drives
IOPS (millions) | Higher is better

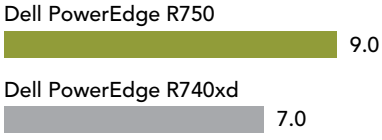


Figure 8: 4KB random write FIO benchmark results with 16 SAS and 8 NVMe drives. Higher is better. Source: Principled Technologies.

Over **9 million IOPS**

Handle more incoming storage requests
Up to 1.2x the raw IOPS

Random write testing results

In our random write workload-based FIO benchmark testing, we found that the more SAS drives we used in the mixed SAS/NVMe configuration, the bigger the performance differences were between the PowerEdge R750 and the PowerEdge R740xd. We credit this IOPS jump, in part, to the next-gen Broadcom RAID controller.

Maintain more outgoing concurrent throughput
Up to 2.0x the GiB/s

Why concurrent throughput matters

Upgrading to server solutions with high throughput and IOPS could have a direct impact on a company's profit margin. According to Data Center Knowledge, "Throughput is the result of IOPS, and the block size for each I/O being sent or received. Since a 256KB block has 64 times the amount of data as a 4K block, size impacts throughput. In addition, the size and quantity of blocks impacts bandwidth on the fabric and the amount of processing required on the servers, network and storage environments."[8] All of these items have a big impact on application performance.

Sequential read testing results

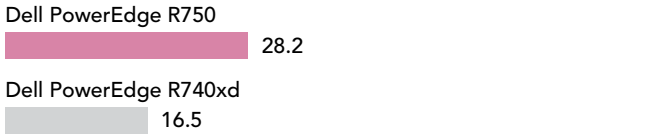
Based on the higher volume of outgoing large blocks of data (1 MB) we saw in the sequential read workload testing, upgrading to the 15G Dell PowerEdge R750 server could benefit applications that stream video, allow end users to import large amounts of data in less time, and enable staff to access large files more quickly.

1MB sequential read FIO results with 2 SAS and 2 NVMe drives
Throughput (GiB/s) | Higher is better

Achieve 14.1 GiB/s

Figure 9: 1MB sequential read FIO benchmark results with 2 SAS and 2 NVMe drives. Higher is better. Source: Principled Technologies.

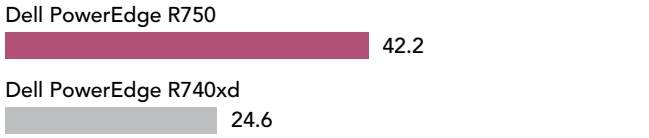
1MB sequential read FIO results with 4 SAS and 4 NVMe drives
Throughput (GiB/s) | Higher is better



Achieve 28.2 GiB/s

Figure 10: 1MB sequential read FIO benchmark results with 4 SAS and 4 NVMe drives. Higher is better. Source: Principled Technologies.

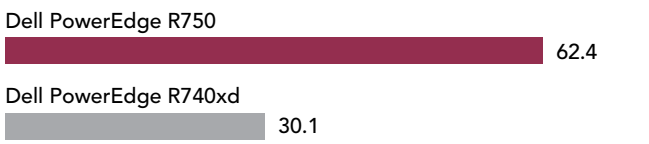
1MB sequential read FIO results with 6 SAS and 6 NVMe drives
Throughput (GiB/s) | Higher is better



Achieve 42.2 GiB/s

Figure 11: 1MB sequential read FIO benchmark results with 6 SAS and 6 NVMe drives. Higher is better. Source: Principled Technologies.

1MB sequential read FIO results with 16 SAS and 8 NVMe drives
Throughput (GiB/s) | Higher is better



Achieve 62.4 GiB/s

Figure 12: 1MB sequential read FIO benchmark results with 16 SAS and 8 NVMe drives. Higher is better. Source: Principled Technologies.

Maintain more incoming concurrent throughput
Up to 1.3x the GiB/s

1MB sequential write FIO results with 2 SAS and 2 NVMe drives
Throughput (GiB/s) | Higher is better

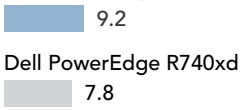


Figure 13: 1MB sequential read FIO benchmark results with 2 SAS and 2 NVMe drives. Higher is better. Source: Principled Technologies.

Achieve 9.2 GiB/s

1MB sequential write FIO results with 4 SAS and 4 NVMe drives
Throughput (GiB/s) | Higher is better

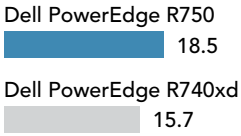


Figure 14: 1MB sequential read FIO benchmark results with 4 SAS and 4 NVMe drives. Higher is better. Source: Principled Technologies.

Achieve 18.5 GiB/s

1MB sequential write FIO results with 6 SAS and 6 NVMe drives
Throughput (GiB/s) | Higher is better

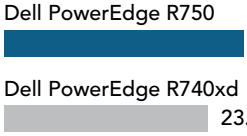


Figure 15: 1MB sequential read FIO benchmark results with 6 SAS and 6 NVMe drives. Higher is better. Source: Principled Technologies.

Achieve 27.8 GiB/s

1MB sequential write FIO results with 16 SAS and 8 NVMe drives
Throughput (GiB/s) | Higher is better

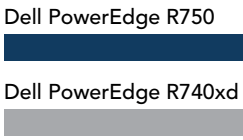


Figure 16: 1MB sequential read FIO benchmark results with 16 SAS and 8 NVMe drives. Higher is better. Source: Principled Technologies.

Achieve 42.5 GiB/s

Sequential write testing results

In this FIO benchmark comparison, the higher volume of incoming large blocks of data processed by the Dell PowerEdge R750 server could speed applications that render video, allow end users to export large amounts of data in less time, and enable staff to copy information from one file to another more quickly.

Hands-on testing, real-world benefits

In today's digital era, big data—which includes unstructured media, imaging, audio, sensor, and text data—has dramatically increased the need for efficient storage and computing capabilities. 15G Dell PowerEdge servers with PCIe Gen4 capabilities have the potential to help companies deal with evolving demands.

Real-world example #1: With worldwide retail commerce sales estimated "to grow by 50 percent over the next four years, reaching about 7.4 trillion dollars by 2025,"[9] the higher IOPS processing capabilities we found in the Dell PowerEdge R750 server with a Broadcom PCIe Gen4 RAID controller can enable retail data centers to handle more orders at once. This could, in turn, reduce the number of discarded shopping carts and increase the number of successful sales.

Real-world example #2: The insurance market's need to constantly improve the customer experience is driving innovation and changing the way companies do business. PwC reports that 63 percent of insurance company CEOs think the internet of things (IoT) is important in their business strategy.[10] The PCIe Gen4 capabilities (doubled bandwidth per lane) in the Dell PowerEdge R750 server can enable companies to handle more or heavier traffic from connected devices already in place.

Conclusion

Upgrading to or investing in the latest generation of servers can help you better deal with evolving demands, grow your business, and keep customers happy. We found that a 15G Dell PowerEdge R750 server with a Broadcom PCIe Gen4 RAID controller processed significantly more storage requests and sustained more concurrent throughput in four mixed SAS/NVMe drive configurations than a 14G Dell PowerEdge R740xd server with a Broadcom PCIe Gen3 RAID controller.

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Read the science behind this report at https://facts.pt/XG5ijq6 ▶

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