Dell EMC™ PowerEdge™ studies

Accelerate I/O with NVMe drives on the new Dell EMC PowerEdge R650 server

A new controller that supports NVMe RAID allowed the server to deliver up to 15 times the input/output operations per second (IOPS) of a previous-generation server

Upgrading to new servers is a good way for organizations to get performance improvements that meet growing operational demands. The latest-generation Dell EMC PowerEdge R650 can boost IOPS performance with a new redundant array of independent disks (RAID) controller that can use speedy NVMe™ PCIe® Gen4 storage.

We tested a new Dell EMC PowerEdge R650 server with NVMe PCIe Gen4 SSDs and powered by pre-production 3rd Gen Intel® Xeon® Scalable processors with 32 cores and found that, as anticipated, it delivered more IOPS than a previous-generation Dell EMC PowerEdge R640 server. The IOPS increase is due partially to the new, unique Dell PERC H755N Front RAID controller, which allows the server to access high-performance NVMe storage with a redundant hardware architecture. Until now, the only way to provide data protection for NVMe RAID was to use software RAID.

We also found that the PowerEdge R650 with NVMe SSDs transferred more data per second from the CPUs to the disks than the previous-generation server. Processing more IOPS and providing greater disk bandwidth, due to the combination of a new RAID controller and support for NVMe PCIe Gen4 storage, could allow your organization to support more users and greater application usage.

Upgrade servers and storage to process more user requests

Up to 15X
the raw IOPS*

Transfer more data from the CPUs to storage at once

Up to 15X
more MB/s*

* than Dell EMC PowerEdge R640 with SAS/SATA SSDs

How we tested

We used a tool called Flexible input/output tester (FIO) to create the input/output (I/O) workloads that we used in testing. FIO "spawns a number of threads or processes doing a particular type of I/O action as specified by the user."[1] With the tool, we ran five workloads at varied thread counts and queue depths on RAID 10, RAID 6, and RAID 5 levels of the Dell EMC PowerEdge R650 server with the Dell PERC H755N Front RAID controller and NVMe drives and the Dell EMC PowerEdge R640 server with a PERC H730P Mini controller and SATA and SAS drives. Table 1 shows our workloads and their parameters.

Read-heavy workloads (such as those that featured either 100 or 70 percent of queries) indicate how quickly the servers can retrieve information from their disks. Write-heavy workloads show how quickly the servers can commit or save data to the disks. Seeing how each server performed with these different data-intensive workloads helps us understand how they could handle workloads of different block sizes.

"Random" and "sequential" in the workload descriptions refer to the access patterns for reading or writing data. An example of random reading is a user clicking different web links at random, which requires the server to pull data from multiple disks. In contrast, streaming video requires a server to read data in a single continuous stream, which is also known as sequential reading. Running both types of access patterns can offer insight into how servers might handle routine tasks that access, retrieve, or save data.

Table 1: The workloads and parameters we used in testing of the two servers.

	Threads	Queue depth
RAID 10 testing		
4KB random read	32	32
4KB random write	64	64
8KB random 70/30 read/write	16	32
8KB random 50/50 read/write	8	32
64KB sequential 100% write	1	256
RAID 6 and RAID 5 testing		
4KB random read	32	32
4KB random write	32	32
8KB random 70/30 read/write	8	32
8KB random 100% read	8	32
64KB sequential 100% read	1	256

About the Dell EMC PowerEdge R650 server

According to Dell, the Dell EMC PowerEdge R650 is an enterprise server that aims to optimize application performance and data center density. Offering new features such as support for PCIe Gen4, NVMe HWRAID, expanded memory capacity, Hot Plug BOSS controllers, and the latest generation of Intel Xeon Scalable processors, this server has the potential to increase performance as well as reliability.

How upgrading servers and storage can help you

IOPS performance

Upgrading your servers can bring a wealth of improvements to your organization. Chief among them is the potential for significant performance boosts for your I/O-intensive applications and workloads. Although IOPS is not an explicit measure of a single kind of performance, it does indicate the level of user requests that the server can handle. Based on the IOPS output we saw in our testing, upgrading from previous-generation Dell EMC PowerEdge R640 servers to the latest-generation Dell EMC PowerEdge R650 servers could help your organization expand its user base or deliver performance gains for I/O-intensive applications. In all three RAID configurations we tested, the PowerEdge R650 with NVMe SSDs delivered more IOPS than the previous generation server. Figure 1 shows how many average IOPS each solution handled during RAID 10 configuration testing.

Figure 1: The amount of IOPS each solution in a RAID 10 configuration handled during FIO testing. Higher is better. Source: Principled Technologies.

About the metrics we used to measure server and storage performance

Our FIO testing offers insight into server performance by showing:

- The number of IOPS a solution can handle, indicating whether it can process a high volume of user requests
- The speed at which a solution can respond (latency), potentially helping users and applications avoid long wait times
- The amount of information (in MB in our tests) a solution can process per second (bandwidth), indicating how well it can process a high volume of data

Figure 2 shows the average IOPS each solution handled during the RAID 6 and RAID 5 configuration testing.

Figure 2: The amount of IOPS each solution in RAID 6 and RAID 5 configurations handled during FIO testing. Higher is better. Source: Principled Technologies.

IOPS - RAID 6 *Higher is better*

4KB random read

Dell EMC PowerEdge R650
3,541,000

Dell EMC PowerEdge R640
515,000

4KB random write

Dell EMC PowerEdge R650
198,000

Dell EMC PowerEdge R640
12,600

8KB random 70/30 read/write

Dell EMC PowerEdge R650
407,000

Dell EMC PowerEdge R640
47,300

8KB random 100% read

Dell EMC PowerEdge R650
1,793,000

Dell EMC PowerEdge R640
398,000

64KB sequential 100% read

Dell EMC PowerEdge R650
226,000

Dell EMC PowerEdge R640
65,600

IOPS - RAID 5 *Higher is better*

4KB random read

Dell EMC PowerEdge R650
3,541,000

Dell EMC PowerEdge R640
514,000

4KB random write

Dell EMC PowerEdge R650
186,000

Dell EMC PowerEdge R640
27,100

8KB random 70/30 read/write

Dell EMC PowerEdge R650
499,000

Dell EMC PowerEdge R640
88,400

8KB random 100% read

Dell EMC PowerEdge R650
1,793,000

Dell EMC PowerEdge R640
398,000

64KB sequential 100% read

Dell EMC PowerEdge R650
226,000

Dell EMC PowerEdge R640
65,500

Disk bandwidth

Performance isn't just about a single number—combining multiple measures of different aspects of performance helps tell a more complete story. IOPS indicate how many storage operations a system can perform, while disk bandwidth demonstrates the volume of data a system can read or write. A server with high disk bandwidth can process more data for large data requests such as streaming video or big data applications. At all three RAID levels, the latest-generation Dell EMC PowerEdge R650 server with NVMe storage transferred more MB per second from its pre-production 3rd Gen Intel Xeon Scalable processors to its NVMe disks than the previous-generation Dell EMC PowerEdge R640 server could from its processors to its SATA and SAS storage. Figure 3 shows the disk bandwidth that each of the two servers supported running one workload at each RAID level. For all our disk bandwidth results from testing, see the science behind this report.

Figure 3: The amount of bandwidth in MB per second each solution delivered while running three workloads, each at a different RAID level. Higher is better. Source: Principled Technologies.

Disk bandwidth *Higher is better*

RAID 10

4KB random write

Dell EMC PowerEdge R650
3,757 MB/s

Dell EMC PowerEdge R640
477 MB/s

RAID 6

4KB random write

Dell EMC PowerEdge R650
811 MB/s

Dell EMC PowerEdge R640
52 MB/s

RAID 5

4KB random read

Dell EMC PowerEdge R650
14,500 MB/s

Dell EMC PowerEdge R640
2,107 MB/s

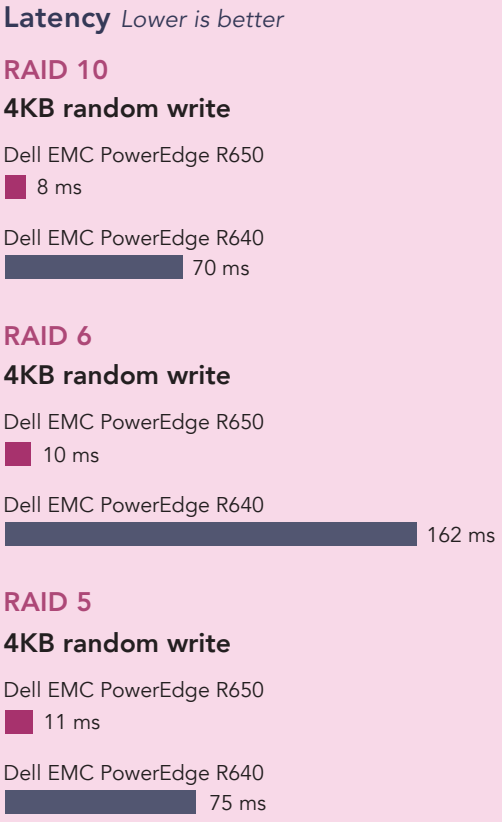
About the new Dell PERC H755N Front RAID controller in Dell EMC PowerEdge R650 servers

RAID controllers combine the physical disks of a server into logical units and manage them. They apply RAID levels that allow storage to offer data redundancy, workload performance enhancements, or both. The new Dell PERC H755N Front RAID controller in Dell EMC PowerEdge R650 servers can allow the servers to access high-performance NVMe PCIe Gen4 storage with a redundant hardware architecture where previous Dell server generations relied on software-defined RAID solutions to do so.

Latency

Latency is another system metric that contributes to the larger performance story. For storage, latency indicates how quickly the system can respond to a request for an I/O operation. Longer latency can impact application responsiveness and could contribute to a negative user experience. In addition to greater disk bandwidth, the Dell EMC PowerEdge R650 server delivered lower latency at each of the three RAID levels than the Dell EMC PowerEdge R640. Figure 4 shows the latency that each server delivered while running one workload at each RAID level. For all our latency results from testing, see the science behind this report.

Figure 4: The latency in milliseconds that each solution delivered while running three workloads, each at a different RAID level. Lower is better. Source: Principled Technologies.



Conclusion

When your organization's future is on the line, you'll want to be able to support all your users and deliver quality application experiences. Choosing to upgrade the servers in your data center could unlock performance improvements from faster server components and new technologies. We found that a latest-generation Dell EMC PowerEdge R650 server with a new Dell PERC H755N Front RAID controller and NVMe PCIe Gen4 SSDs delivered up to 15 times the IOPS of a previous-generation Dell EMC PowerEdge R640 server. In addition, the latest-generation server transferred up to 15 times the data per second from the CPUs to the storage that the previous generation server could handle and reduced latency by up to 93 percent. For organizations that wish to support more application usage or improve server performance, upgrading to the latest-generation Dell EMC PowerEdge R650 could help.

1 Axboe, Jens, "1. fio - Flexible I/O tester rev. 3.25," accessed March 12, 2021, https://fio.readthedocs.io/en/latest/fio_doc.html.

Read the science behind this report at http://facts.pt/jkgws2s ▶

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