

Technical Validation

# Dell PowerStore

Future Proofing Data Infrastructure with More Performance, Scalability, and Resiliency

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## Introduction

This report documents ESG’s validation of Dell PowerStoreOS v2.1 with a focus on software-only updates. ESG reviewed how PowerStoreOS v2.1 can help organizations future-proof data infrastructure with software performance improvements, NVMe-TCP, and clustered scale-out, and can help them improve data resiliency with Dynamic Resiliency Engine with dual parity (DRE-DP).

## Background

With today’s continuously increasing quantity of data, organizations are tasked with adapting to and managing this constant influx, including storing, protecting, and analyzing the data. In a recent ESG research study, organizations were asked what the most important capabilities and attributes are when they look to implement technologies to support data initiatives at their organizations. Respondents revealed that reliability (44%) and performance (43%) were their top priorities (see Figure 1).<sup>1</sup>

**Figure 1. Top Five Technology Capabilities/Attributes to Support Data Initiatives**

**When looking to implement technologies to support data initiatives within your organization, what are the most important capabilities/attributes?  
(Percent of respondents, N=338, five responses accepted, top five responses)**



Source: ESG, a division of TechTarget, Inc.

With a goal of cost-effectively improving performance, many organizations are turning to NVMe (nonvolatile memory express) technology. When asked about the benefits their organizations have realized with on-premises NVMe storage technology, almost two-thirds of respondents (62%) noted that it had improved the performance of existing applications and over half (59%) noted the increased performance of storage infrastructure to “future proof” the environment, or support new, more demanding workloads.<sup>2</sup>

<sup>1</sup> Source: ESG Complete Survey Results, [Cloud Analytics Survey](#), November 2021.

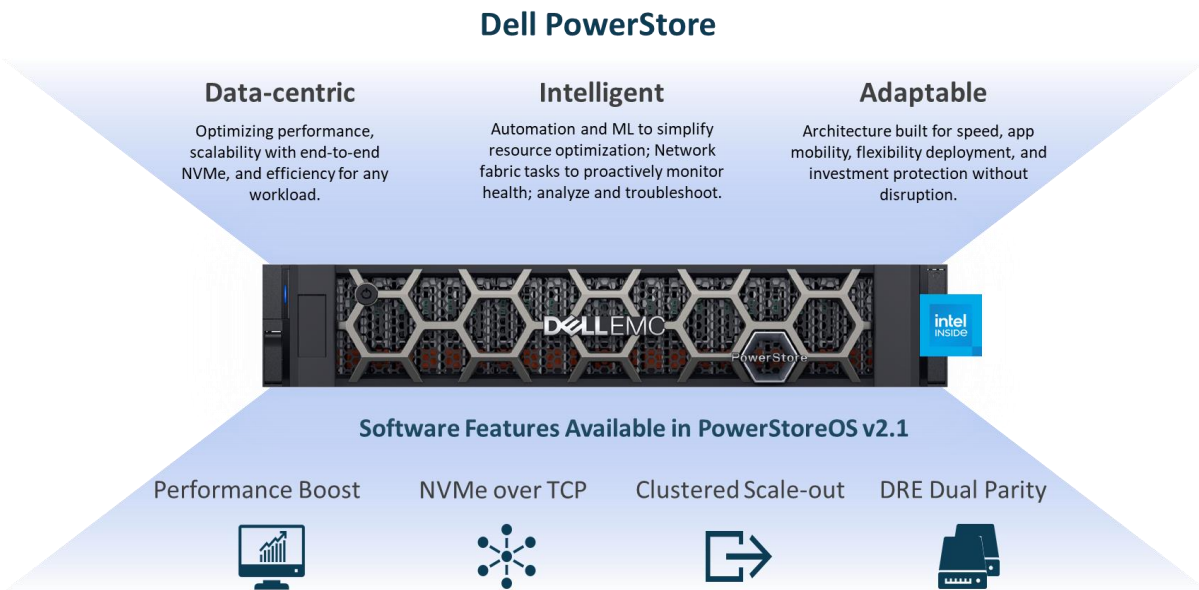
<sup>2</sup> Source: ESG Research Report, [Data Infrastructure Trends](#), November 2021.

## The Solution: Dell PowerStore

Dell Technologies utilizes a combination of the latest hardware (e.g., Intel Xeon Scalable processors, dual-ported Intel Optane Storage Class Memory, end-to-end NVMe technology) and future-proof container-based software to create the PowerStore enterprise storage solution, which is designed to be data-centric, intelligent, and adaptable (see Figure 2).

- **Data-centric to optimize every workload.** PowerStore simplifies IT infrastructure by supporting a wide range of traditional and modern workloads with its scale-up, scale-out architecture for block, file, and VMware vVols, and always-on data reduction with a 4:1 data reduction guarantee.
- **Intelligent to simplify tasks and relieve IT.** PowerStore automates storage provisioning and can be deployed within minutes. Integrated with VMware and leading DevOps frameworks, PowerStore automatically discovers new cluster resources and provides intelligent data placement recommendations.
- **Adaptable deployment, app mobility, and consumption.** PowerStore maximizes flexibility and security with a container-based microservices architecture with the PowerStore OS installed on the appliance or in a virtual machine. With VMware vSphere built-in and the ability to run apps directly on the appliance (AppsON), applications can be run directly on the appliance for increased efficiency and mobility.

Figure 2. Dell PowerStore



Source: ESG, a division of TechTarget, Inc.

The balance of this report explores specific software capabilities available in PowerStoreOS:

- **Performance boost:** New software-only performance improvements (new in PowerStoreOS v2.1).
- **NVMe over TCP:** New end-to-end NVMe protocol support leveraging industry-standard Ethernet infrastructure (new in PowerStoreOS v2.1).
- **Clustered Scale-out:** Cluster up to four appliances for more performance and flexibility (introduced in PowerStoreOS v1.0).

- **DRE-DP:** Dynamic Resiliency Engine (DRE) with dual parity for increased resiliency (introduced in PowerStoreOS v2.0).

## ESG Technical Validation

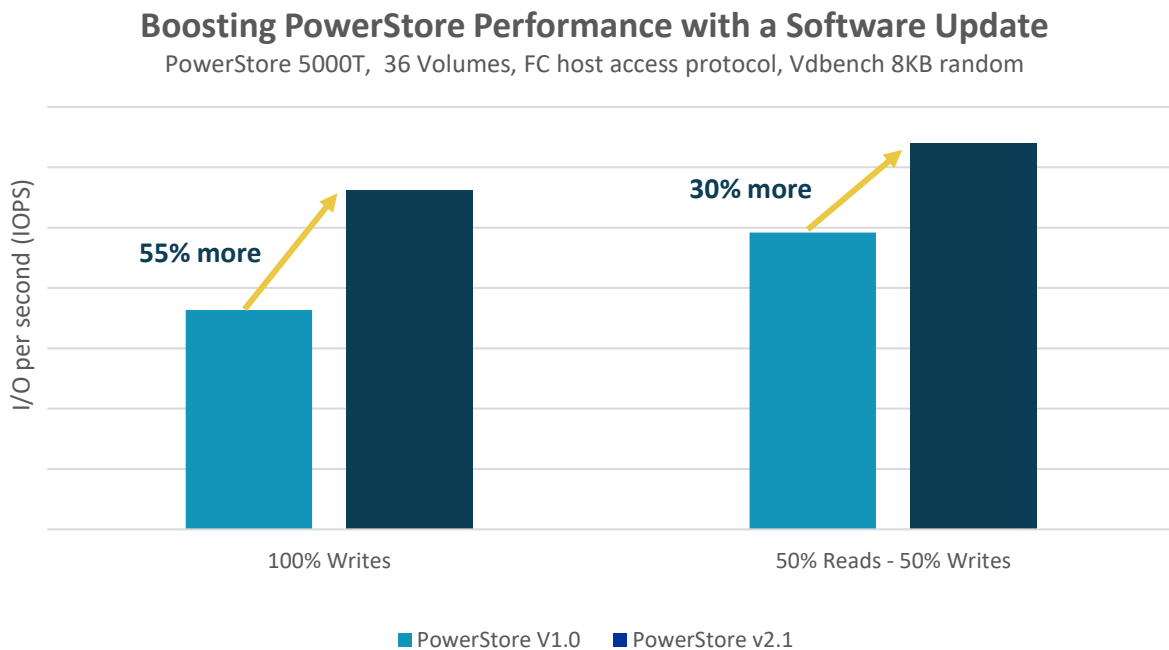
ESG Validation testing of the PowerStore storage platform was conducted at a Dell Technologies facility in Hopkinton, MA. The testing was designed to demonstrate the future-proof value of PowerStoreOS v2.1 software with a focus on the latest performance, scalability, and resiliency improvements.

### Improving Performance

PowerStoreOS v2.1 includes a wealth of powerful software-only performance improvements. With a goal of quantifying those improvements, ESG directed performance testing using the industry standard Vdbench<sup>3</sup> workload generator. Vdbench workloads, running on bare metal Linux servers, were tested with PowerStoreOS v1.0 and v2.1 on the same PowerStore 5000T appliance. An 8KB Vdbench random block workload was used for this test, and all of the performance tests that are documented later in this report.<sup>4</sup>

As shown in Figure 3, upgrading to PowerStoreOS v2.1 increased write performance by 55% and mixed read/write improvement by 30%. ESG is confident that the improved write performance will have a positive impact for a typical mix of consolidated applications that are deployed with PowerStore.

**Figure 3. Comparing PowerStoreOS v1.0 and v2.1 Performance**



Source: ESG, a division of TechTarget, Inc.

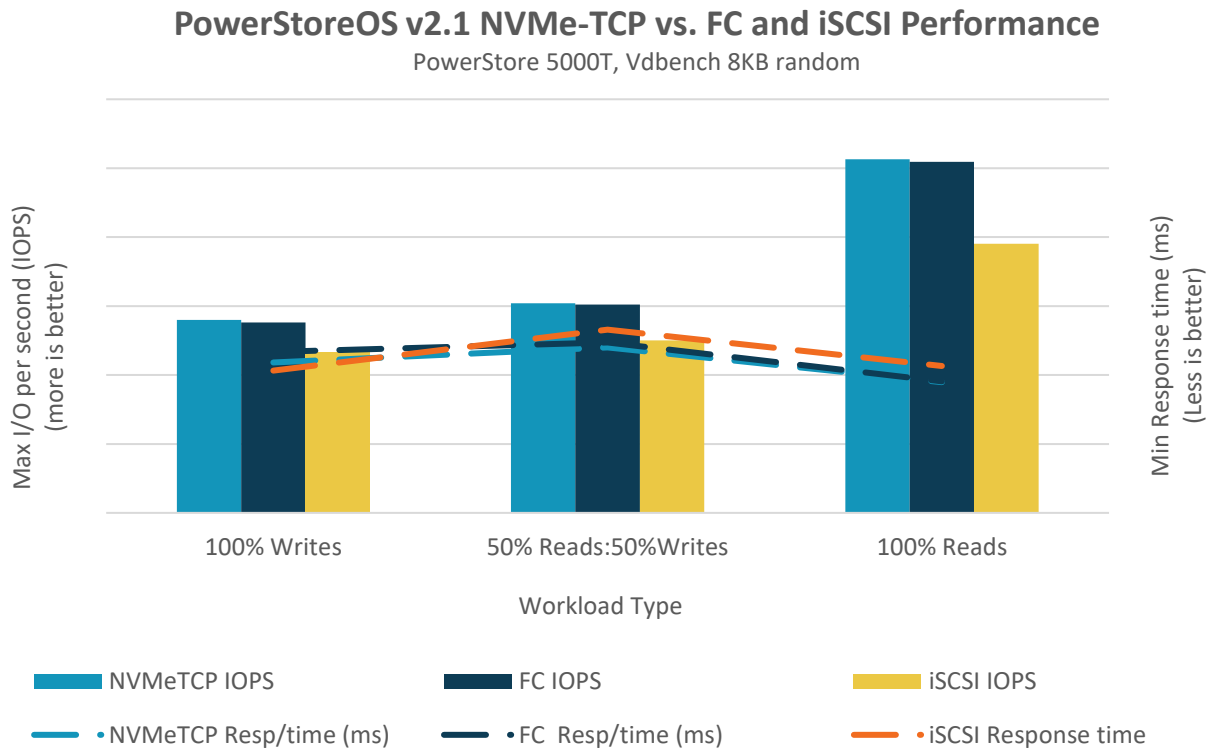
<sup>3</sup> <https://sourceforge.net/projects/vdbench/>.

<sup>4</sup> For more configuration details, please refer to the Appendix.

Next, ESG guided testing that compared the performance of Fibre Channel, iSCSI, and the new NVMe-TCP protocol. Each of the host access protocols was tested with the same PowerStore appliance and server configuration.<sup>5</sup>

As shown in Figure 4, the recently added NVMe-TCP host access protocol that leverages commodity Ethernet switches and adapters sustained nearly the same performance as Fibre Channel (+/- 1%) and performed 16 to 23% better than iSCSI. The dotted lines show how response times for all three protocols were approximately the same (+/- 10%).

**Figure 4. Scaling Out with PowerStoreOS v2.1**



Source: ESG, a division of TechTarget, Inc.

<sup>5</sup> For more configuration details, please refer to the Appendix.

## Why This Matters

Because poor storage performance can negatively impact sales, productivity, competitiveness, and customer satisfaction, it is imperative that organizations keep their data infrastructures performing to the best of their ability while avoiding the cost of adding more storage hardware. To address these challenges, many organizations are turning to NVMe technology. In a recent ESG study, 70% of respondents revealed that they were already, or were planning to, deploy NVMe over Fabric in the next 12 months, and another 24% showed interest in deploying NVMe over Fabric at some point.<sup>6</sup>

ESG has validated that Dell Technologies has improved the performance of the PowerStore NVMe-based storage system with software-only performance improvements in PowerStoreOS v2.1 (up to 55% faster than version 1.0) and recently added NVMe-TCP fabric support (nearly the same as FC and up to 23% faster than iSCSI). Based on these results, ESG notes that organizations can optimize existing iSCSI infrastructures with NVMe-TCP support without the added cost, compared to implementing other protocols such as FC.

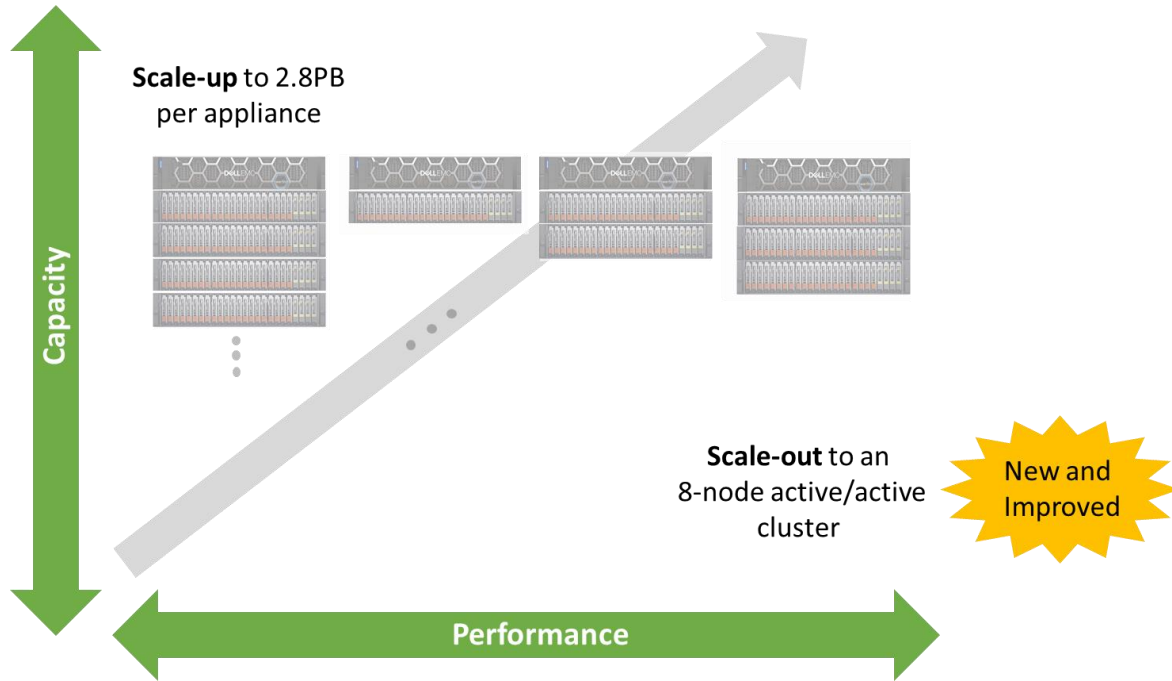
## Scale-out Performance

PowerStore enables organizations to independently scale storage capacity *and processing power* to meet the growing needs of the business. As shown in Figure 5, a single PowerStore appliance can scale up to 2.8PB of effective capacity by adding storage devices and enclosures. Scale-out support, available on PowerStore T models since the first PowerStore v1.0 release and on PowerStore X models beginning with v2.0, uses clustering technology to increase the performance of a PowerStore solution with support for up to four appliances (eight active/active nodes) per cluster.

A PowerStore scale-out cluster can be configured during initial configuration or later by adding appliances to an existing PowerStore solution. Each appliance that is added to a PowerStore cluster provides additional processing power, memory, and bandwidth for improved performance and scalability. Note that different PowerStore appliance models, with the same or different drive types and capacities, can be configured in the same cluster.

<sup>6</sup> Source: ESG Research Report, [Data Infrastructure Trends](#), November 2021.

Figure 5. Scaling Up and Out with PowerStore



Source: ESG, a division of TechTarget, Inc.

### ESG Testing

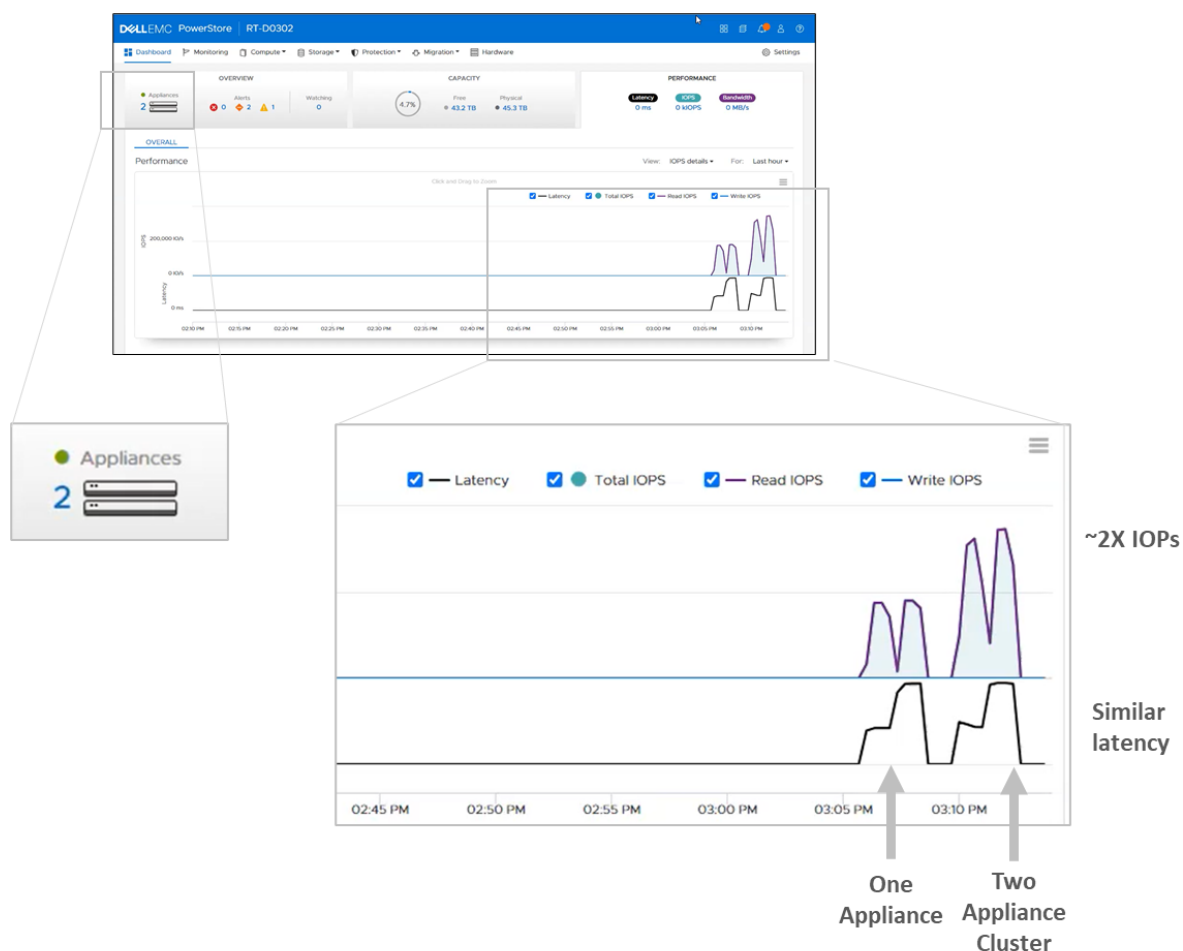
ESG observed a configured PowerStore appliance being expanded into a two-node cluster. Less than 10 minutes and a dozen mouse clicks with an intuitive wizard-driven process, a two-node cluster had been created.<sup>7</sup>

Next, a pair of identically configured PowerStore model 500T appliances was used to compare the performance of a single appliance to a two-appliance cluster. The Vdbench utility was used to measure the maximum I/O performance for a 100% read workload with two levels of increasing I/O activity (8 threads, 16 threads).

The screenshot shown in Figure 6 was captured after the second set of tests was run on the two-appliance/four-node cluster. The performance graphs towards the bottom right show how the performance of the two-appliance cluster delivered twice the IOPS with similar latency compared to one appliance.

<sup>7</sup> Excluding the wait time for a reboot and the background cluster addition process to finish.

Figure 6. Scaling Out from a Single Appliance to a Two-Appliance Cluster



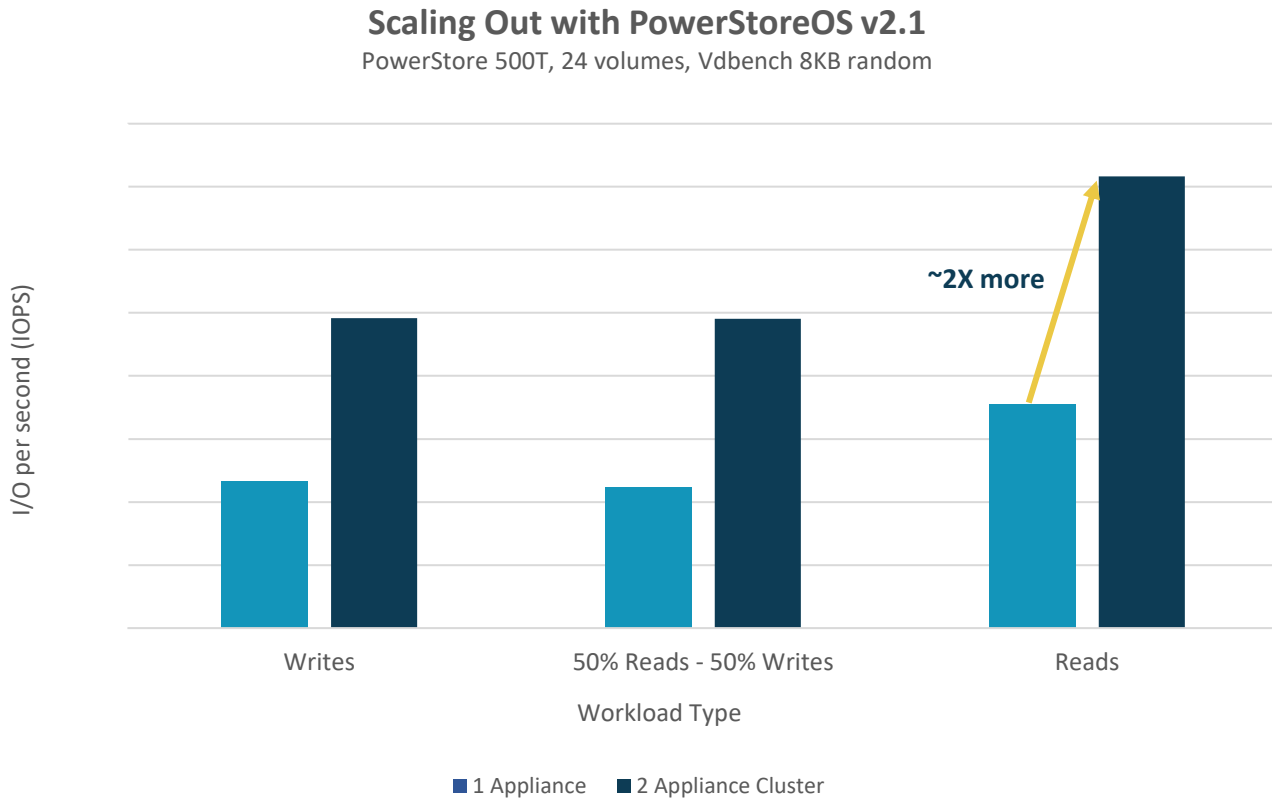
Next, ESG directed a set of Vdbench tests for three I/O workloads (100% reads, 100% writes, 50% read/50% write) with a goal of quantifying PowerStore scale-out performance benefits as I/O activity increased to peak levels of I/O activity (32 threads).<sup>8</sup>

The results of the peak I/O activity performance tests are shown in Figure 7. Like the previous test at lower levels of activity, a two-appliance cluster sustained approximately twice the number of I/Os per second as a single appliance (between 2.01 and 2.12 times more). ESG noted that the I/O response times for this test were approximately twice as fast for the two-appliance cluster compared to the previous test with lower levels of I/O activity and host queuing. This was due to the increased processing power of the two-node cluster.

<sup>8</sup> More details on the test configuration and methodology can be found in the Appendix



Figure 7. Scaling Out with PowerStoreOS v2.1



Source: ESG, a division of TechTarget, Inc.

Based on a review of the new scale-out architecture of PowerStore and the results shown above, ESG is confident that adding similarly configured PowerStore appliances to a cluster will deliver near-linear performance scalability up to the currently supported limit of four appliances/eight nodes per cluster.



### Why This Matters

Data is growing quickly, but the speed and quantity of that data growth are not always predictable. Therefore, organizations may not know exactly how much storage capacity or performance they will need at a given time. For this reason, organizations are looking for a storage solution that can scale to meet the evolving needs of the business. When asked to prioritize the factors that most influence their new data center infrastructure purchases, 57% of respondents to a recent ESG survey considered scalability as an important or critical consideration.<sup>9</sup>

ESG validated that with clustered scale-support in Dell PowerStoreOS v2.1, organizations can scale their data infrastructure to meet the needs of the business. Scale-out testing that compared the performance of a single PowerStore 500T appliance with a two-appliance cluster proved that IOPS doubled while a similar response time was maintained. This allows organizations to meet the application performance needs of the business while avoiding the complexity and costs associated with managing over-provisioned storage silos. ESG also noted that organizations have the option to scale up capacity without having to add performance capability.

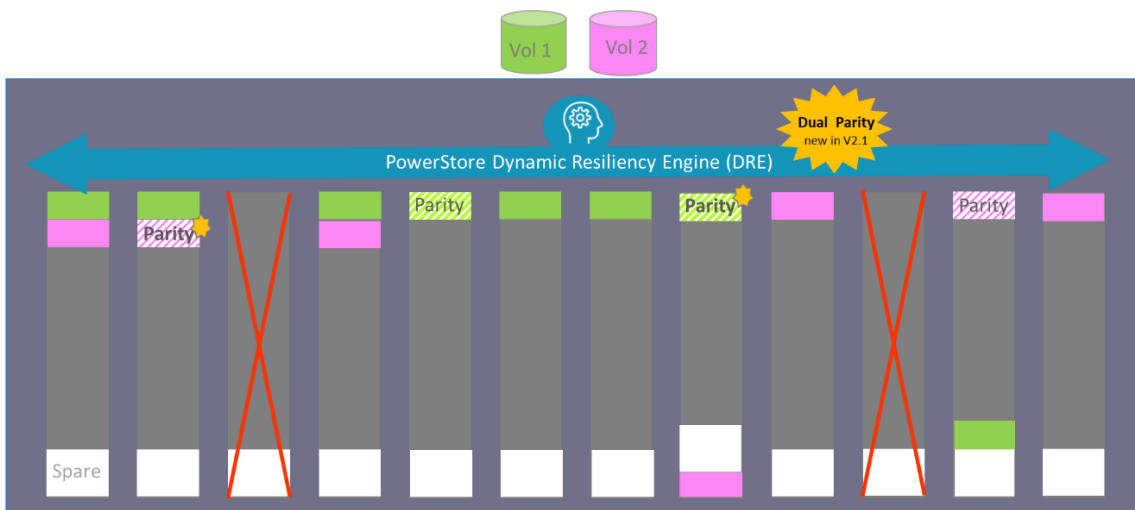
<sup>9</sup> Source: ESG Survey Results, [2021 Data Infrastructure Trends](#), September 2021.

### A Smarter Way to Protect Your Data

The PowerStore Dynamic Resiliency Engine (DRE) is an intelligent software-based approach to drive failure redundancy that was designed with a goal of being more distributed, automated, and efficient than traditional RAID (Redundant Array of Independent Drives). Dual parity support was introduced in PowerStoreOS v2.0 with a goal of increasing the resiliency of business-critical applications.

Compared to traditional RAID algorithms that consume a whole drive for parity and sparing, parity and spare capacity are intelligently distributed within a DRE resiliency group as data is written. In this example (see Figure 8), the data and parity for a write to volume one (shown in green) is distributed across multiple drives in a resiliency group. Using dual parity option that was introduced in PowerStoreOS v2.0, the PowerStore appliance can support two simultaneous drive failures within the same resiliency group (shown by red Xs).

**Figure 8. PowerStore DRE-DP Support**



Source: ESG, a division of TechTarget, Inc.

The differences between traditional RAID and PowerStore DRE are summarized in Table 1.

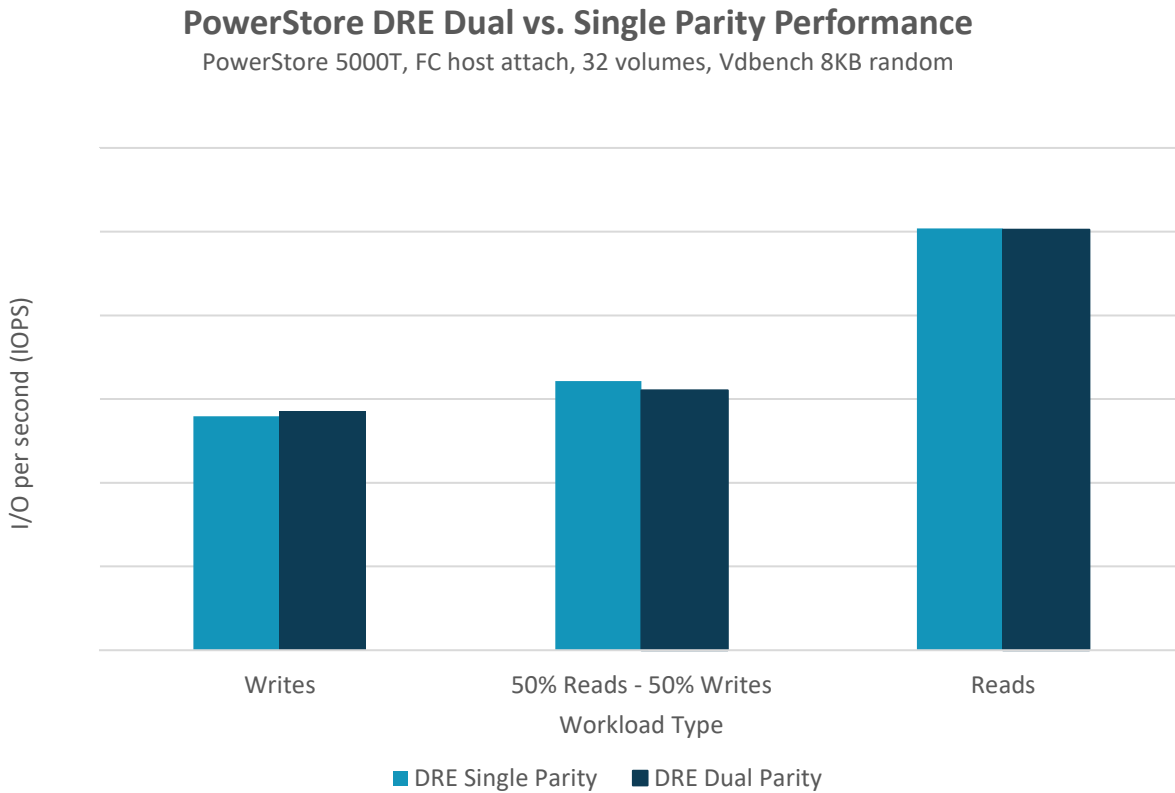
**Table 1. Comparing Traditional RAID and PowerStore DRE**

	Traditional RAID	PowerStore DRE
Mixed capacity drive support	Not within a RAID group	Yes
Data and parity distribution	Fixed algorithm within a RAID group	Intelligent distribution within a resiliency group
Data and parity capacity overhead	Whole drive(s)	Only consumed capacity
Management complexity	More	Less
Rebuild horsepower	Only drives in a RAID group	All drives in a resiliency group
Rebuild times	Slower	Faster
Rebuild performance impact	More	Less
Two drive failure protection	RAID-6	<b>Dual Parity (new in 2.0)</b>

ESG directed a series of tests that compared the performance of DRE dual and single parity, using the Vdbench utility. The same PowerStore 5000T appliance with 21 NVMe solid-state drives was used for both tests. As shown in Figure 9, the

performance of dual parity was nearly identical to that of single parity (+/- 4%). ESG noted during this series of tests that the PowerStore management console showed the same amount of usable capacity for single and dual parity.<sup>10</sup>

**Figure 9. PowerStore DRE Dual versus Single Parity Performance**



Source: ESG, a division of TechTarget, Inc.



### Why This Matters

Organizations have a low tolerance for downtime since it negatively affects many aspects of the business. An ESG research survey indicated that organizations most frequently reported a loss of employee productivity (46%) and diversion of IT resources from long-term or business-critical projects (45%) as impacts to their organizations that could result from application downtime or lost data.<sup>11</sup>

ESG has confirmed that PowerStore DRE-DP support provides higher levels of resiliency and recoverability with no performance and capacity overhead compared to single parity. While the odds of losing data due to a dual drive failure are very low with modern solid-state drives, ESG recommends using dual parity because it has virtually zero performance or capacity overhead compared to single parity.

<sup>10</sup> The usable capacity is the same for single and dual parity for a resiliency group with 18 or more drives. Resiliency groups with less than 18 drives will see a slight reduction in usable capacity.

<sup>11</sup> ESG Survey Results, [Real-world SLAs and Availability Requirements](#), August 2020.

## The Bigger Truth

A recent ESG research survey indicates that 27% of storage purchasing decision-makers believe that the capacity of their on-premises primary/active data will grow over 50% annually over the next three years.<sup>12</sup> And it does not look like that growth will be slowing down any time soon. Those organizations need a future-proof storage solution that can cost-effectively scale up and out to meet the growing capacity—and performance—needs of the business.

With over 40 years of experience in the storage industry, Dell Technologies (with the acquisition of EMC) has built dozens of storage solutions. PowerStore, Dell's flagship enterprise storage solution, which first became available in 2020, has already grown to support than 1.5 exabytes of effective capacity.

The data-centric, intelligent, and adaptable PowerStore architecture was designed with the goal of providing IT professionals with a future-proof data infrastructure that can cost-effectively adapt to changing requirements. Future-proof capabilities of PowerStore include a 3-year satisfaction guarantee; a 4:1 data reduction guarantee; on-demand consumption models; Anytime Upgrade, which eliminates forklift migrations, and all-inclusive software that is continuously improving.

ESG has validated that software features included in PowerStoreOS v2.1 have improved performance, scalability, and data resilience:

- A software-only upgrade from PowerStoreOS v1.0 to PowerStoreOS v2.1 improved write performance by 55% and mixed read/write performance by 30%.
- Recently added NVMe-TCP protocol support that leverages commodity Ethernet infrastructure delivered nearly the same performance as Fibre Channel and up to 23% more performance than iSCSI.
- A two-appliance Scale-out PowerStore 500T cluster delivered twice the performance of a single PowerStore appliance.
- DRE-DP increased resilience and availability with the same performance and capacity overhead as DRE single parity for a 22-drive resiliency group.

If your organization is looking to overcome the limitations of legacy and competitive storage solutions and wants to future proof its data infrastructure with an enterprise storage solution that can deliver more performance, scalability, and resiliency with a software-only upgrade, ESG recommends taking a deeper look at Dell PowerStore.

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<sup>12</sup> Source: ESG Survey Results, [2021 Data Infrastructure Trends](#), September 2021.

## Appendix

**Table 2. Comparing Performance of PowerStoreOS v1.0 and v2.1**

Configuration: random, 8K block size, VDBench generated	
PowerStore model	PowerStore 5000T
Deployment mode	Block-optimized
Number of drives used	21
Dynamic Resiliency Engine (DRE) type	Single Parity (single drive failure tolerance)
Number of volumes	36 total
Number of volumes/server	18
Client load generator	Bare metal Linux servers
Client info	CentOS 8.4 clients
Access protocol	Fibre Channel
Test comparison	PowerStoreOS v1.0 and v2.1

**Table 3. Comparing Performance of NVMe-TCP, FC, and iSCSI**

Configuration: random, 8K block size, VDBench generated	
PowerStoreOS version	2.1
PowerStore model	PowerStore 5000T
Deployment mode	Block-optimized
Number of drives used	21
Dynamic Resiliency Engine (DRE) type	Single Parity (single drive failure tolerance)
Number of volumes <sup>13</sup>	36 total
Number of volumes/server	18
Client load generator	Bare metal Linux servers
Client info	CentOS 8.4 clients
Test comparison	Access protocols: NVMe-TCP, FC, and iSCSI

<sup>13</sup> iSCSI was tested with 16 total volumes, 9 volumes/server.

**Table 4. Comparing Performance of One and Two Appliances**

Configuration: random, 8K block size, VDBench generated	
PowerStoreOS version	2.1
PowerStore model	PowerStore 500T
Deployment mode	Block-optimized
Number of drives used	17 (per appliance)
Dynamic Resiliency Engine (DRE) type	Single Parity (single drive failure tolerance)
Number of clusters	1 (with 2 appliances)
Client load generator	VMware ESXi servers
Test comparison	<ul style="list-style-type: none"> <li>• 1 appliance: 24 volumes serviced</li> <li>• 2 appliances: 24 volumes distributed evenly across 2 appliances, 1 cluster with both appliances active</li> </ul>

**Table 5. Comparing Performance of DRE Single Parity and Dual Parity**

Configuration: random, 8K block size, VDBench generated	
PowerStoreOS version	2.1
PowerStore model	PowerStore 5000T
Deployment mode	Block-optimized
Number of drives used	21
Number of volumes	32 total
Number of volumes/server	16
Client load generator	Bare metal Linux servers
Client info	CentOS 8.4 clients
Test comparison	<ul style="list-style-type: none"> <li>• Single Parity (single drive failure tolerance)</li> <li>• Dual Parity (double drive failure tolerance)</li> </ul>

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