



Up to  
**4.7x the IOPS**  
and  
**5.1x the throughput**

per node in an NVMe-supported configuration\*

**Dependable,  
consistent  
performance**

vs. Vendor A, which had up to a 62% degradation in performance

Scale to more than  
**4.9M IOPS**  
and **140 GB/s**  
throughput

on a single 24-node multi-AZ cluster\*\*

*\*random read IOPS per node and sequential read operations per node vs. Vendor A*

*\*\*Results seen on a single 24-node NVMe-supported multi-AZ cluster*

## Scale up your storage with higher-performing Dell APEX Block Storage for AWS

Dell APEX Block Storage for AWS offered stronger and more consistent storage performance for better business agility than a Vendor A solution

Now that cloud providers can host diverse block workloads, enterprises with these kinds of datasets can shift from on-premises infrastructure to reap the business benefits that cloud environments provide. Despite the promise of increased agility, some enterprises may hesitate to jump to block storage in the cloud due to the rich storage efficiency and data protection features they enjoy with on-premises arrays. To augment cloud block storage options, some vendors offer virtual storage services for the cloud that combine the flexibility of the cloud with familiar enterprise storage features that maintain operational consistency with on-premises deployments, simplify data management, and improve resiliency. These features improve storage efficiency as capacity grows, which can help minimize costs over using native cloud storage alone.

Principled Technologies compared two such solutions: Dell APEX Block Storage for AWS, with a minimum node configuration of three, and a virtual storage service from a leading storage company we will call Vendor A, with a maximum node configuration of two. We used the Vdbench I/O workload utility to measure storage performance, simulating daily usage patterns. On configurations utilizing the EC2 NVMe instance store, Dell APEX Block Storage for AWS offered 4.7x the random read IOPS and 5.1x the throughput on sequential read operations per node of the Vendor A solution. Dell APEX Block Storage for AWS performed consistently, achieving similar performance across 10 runs, while the performance of the Vendor A solution declined over time to a lower steady-state on certain read test configurations. Solutions with steady performance allow organizations to meet use needs without issue or interruption.

Plus, Dell APEX Block Storage for AWS also offers better capacity and more options to scale—Dell reports that the solution scales to 512 storage nodes and 8 PBs raw capacity, while the Vendor A solution does not scale past two nodes.<sup>1</sup> In our testing of a single 24-node multi-AZ cluster, Dell APEX Block Storage for AWS scaled to more than 4.9M IOPS and 140 GB/s throughput. With stronger, steadier performance in our tests vs. a Vendor A solution and more options to scale out, Dell APEX Block Storage for AWS is poised to help your enterprise embrace the agility of the cloud with the storage efficiency features and protection you've come to rely on.

## About Dell APEX Block Storage for AWS

Dell APEX Block Storage for Public Cloud is compatible with two popular public cloud services: Microsoft Azure and AWS (we tested with AWS). Dell APEX Block Storage for AWS is poised to support a wide range of block workloads, including databases, analytics, dev/test applications, virtualization, and containers.<sup>2</sup> According to Dell, APEX Block Storage for AWS is extremely scalable, as it “allows you to independently scale compute up to 2,048 instances or storage up to 512 instances within a single cluster.”<sup>3</sup> In Dell’s own internal testing, they scaled the solution to 128 nodes and were able to achieve 31.5 million random read IOPS and 12.1 million random write IOPS.<sup>4</sup>

Enterprise-class storage efficiency features that Dell APEX Block Storage for AWS offers include thin provisioning, snapshots, and backup/restore. To bolster security, Dell APEX Block Storage for AWS offers multi-availability zone (AZ) support for high availability across three AZs; 6x9s of availability; and more.<sup>5</sup> To streamline management of multicloud environments, Dell APEX Block Storage for AWS integrates Dell APEX Navigator for Multicloud Storage, a SaaS-based management tool offering centralized deployment, monitoring, and management with security features including role-based access control, single sign-on, encryption, and federated identity policies.

To learn more about what Dell APEX Block Storage for AWS can offer your enterprise, visit [Dell.com/APEX-Block](https://Dell.com/APEX-Block).

## How we tested

While Amazon EBS lets users store data in cloud, Amazon EBS alone lacks the storage efficiency and data protection features that on-premises enterprise storage arrays typically provide, such as the ability to control capacity efficiency through thin provisioning; tools such as snapshots and replication; and more. To address this gap in features between on-premises arrays and cloud storage offerings, vendors offer their own software-defined storage available as native public cloud offerings to give enterprises the convenience of the cloud with the features they desire. We compared two such cloud-based virtual storage solutions: Dell APEX Block Storage for AWS and a Vendor A solution, testing both solutions in two different configurations, EBS only or local NVMe. We used the Vdbench tool to generate I/O load to measure the IOPS and throughput of two configurations from each vendor.

Table 1: Configuration details for the instances we tested. Source: Principled Technologies.

	Dell APEX Block Storage for AWS	Vendor A solution
NVMe configuration details		
Instance type (controller nodes)	(3, 12, 24) x i3en.12xlarge	2 x m5dn.24xlarge (maximum node count)
Storage per controller node	4 x 7.5 TB NVMe disks	4 x 900 GB NVMe disks (read cache) 8 x 3.65TB gp3 EBS disks (16,000 IOPS / 1,000 MB/s)
EBS configuration details		
Instance type (controller nodes)	3 x c5n.9xlarge (minimum node count)	2 x c5n.9xlarge (maximum node count)
Storage per controller node	10 x 1.5 TB gp3 EBS disks (14,000 IOPS / 125 MB/s)	8 x 3.65 TB gp3 EBS disks (16,000 IOPS / 1,000 MB/s)

For the NVMe-supported configuration, the solutions supported different EC2 instances. In an effort to favor Vendor A, we selected instances with higher specifications, including higher network (100 GB/s vs. 50 GB/s) and EBS throughput (19,000 MB/s vs. 9,500 MB/s) capabilities, as well as a higher vCPU count (96 vs. 48). For the EBS-only configurations, both solutions supported the same EC2 instance type, but their EBS disks were configured with different IOPS and throughput values (we used the Dell recommendations of 14,000 IOPS and 125 MB/s, while the Vendor A solution used the maximum available 16,000 IOPS and 1,000 MB/s). For each of these four configurations, we assessed 1) performance (in IOPS and throughput), and 2) performance stability over 10 test runs. Additionally, we tested scalability with the NVMe-supported configuration on Dell APEX Block Storage for AWS using random read and sequential read workloads at 12-node and 24-node counts. The solutions we tested supported multi-AZ configurations for high availability, with Dell APEX Block Storage for AWS supporting three AZs (and providing 6x9s availability), and Vendor A supporting two AZs.

For performance testing, we used four Vdbench clients per controller node to give Vendor A the best performance possible. For scalability testing, to save cloud costs, we reduced the number of Vdbench clients to two per controller node because there was no noticeable difference on Dell APEX Block Storage for AWS with two or four Vdbench clients per controller node. Additionally, we ran scalability tests three times each because we saw no noticeable degradation of Dell APEX Block Storage for AWS performance between runs. A Dell technician also walked us through a demonstration of Dell APEX Navigator for Multicloud Storage, a centralized management tool. We conducted all testing using Dell-controlled cloud accounts and resources. We did not perform the setup of the solutions, but we worked closely with a Dell engineer to observe the setup and verified the configurations were fair. After setup, Dell gave us control of the instances for Vdbench testing.

To learn more about the configurations we tested as well as the step-by-step details of our testing, read the [science behind the report](#).

# What we found: Dell APEX Block Storage for AWS offered stronger storage performance

Supporting block storage arrays in the cloud requires a solution with strong, consistent performance to keep your business-critical workloads running without a hitch. To test the storage performance of Dell APEX Block Storage for AWS and the Vendor A solution, we tested both EBS-backed and NVMe-supported configurations, completing 10 runs of Vdbench testing. The IOPS and throughput numbers we report are the median of the last three test runs; we selected the thread count where Vendor A performed the highest. These are per-node results, meaning we divided the Dell APEX Block Storage for AWS solution's total by three and Vendor A total by two for a fair comparison. The stability charts show IOPS and throughput over the 10 runs.

For the Vdbench workloads, we ran each solution through a series of tests with the following configurations in this order for a single run. We captured several thread counts per IO profile during each run, and repeated this order for each additional run.

1. Random read, 4 KB IO size
2. Random write, 4 KB IO size
3. Sequential read 256 KB size
4. Sequential write 256 KB size
5. OLTP2-type with a mix of 8KB random read, 8KB read hits, 8KB random writes, 64KB sequential reads, and 64KB sequential writes

## NVMe-supported configurations: Performance and stability

For organizations that require faster storage performance, NVMe configurations are available on AWS for both Dell APEX Block Storage for AWS and the Vendor A solution. Dell APEX Block Storage for AWS supports a full NVMe-backed configuration, while the Vendor A NVMe-capable solution still uses EBS for the storage capacity, but uses NVMe as an extended read cache. Across all five IO profiles, we saw the Dell APEX Block Storage for AWS solution increase performance per node over the Vendor A solution in part because the Dell APEX Block Storage for AWS solution has full NVMe capabilities while the Vendor A solution does not. For random write and sequential write profiles, we saw an increase of 2.7x and 2.1x respectively for Dell APEX Block Storage for AWS versus the Vendor A solution. Below, we go into further detail on the increases we saw for random read, sequential read, and OLTP2 profiles.

Figure 1 compares the random read IOPS results per node from our Vdbench test runs for both the Dell APEX Block Storage for AWS solution and the Vendor A solution. Using each solution's NVMe-supported configuration, Dell APEX Block Storage for AWS increased random read performance, delivering 4.7x the IOPS on random read operations per node compared to Vendor A.

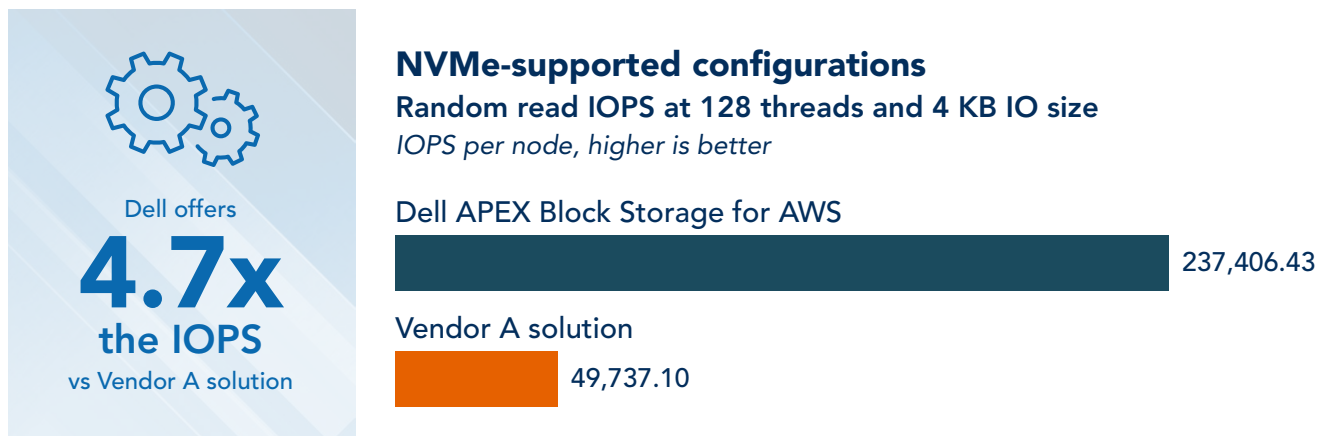


Figure 1: Average random read IOPS results per node on the Vdbench benchmark for Dell APEX Block Storage for AWS and the Vendor A solution using each vendor's NVMe-supported configuration. Results reflect multi-AZ configurations. Higher is better. Source: Principled Technologies.

Figure 2 shows the throughput per node, in MB/s, that the two solutions with NVMe-supported configurations achieved in our Vdbench testing. Again, Dell APEX Block Storage for AWS delivered greater storage performance, achieving 5.1x the throughput per node on sequential read operations compared to the solution from Vendor A.

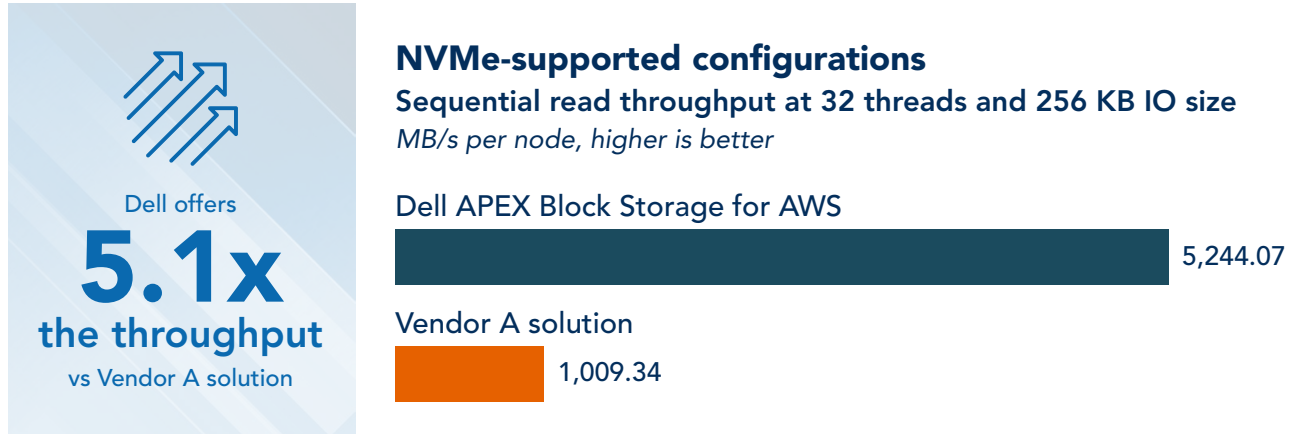


Figure 2: Sequential read throughput per node, in MB/s, on the Vdbench benchmark for Dell APEX Block Storage for AWS and the Vendor A solution using each vendor's NVMe-supported configuration. Results reflect multi-AZ configurations. Higher is better. Source: Principled Technologies.

For the NVMe-supported configurations, we also compared the OLTP2 IOPS that the solutions achieved. OLTP2 IOPS reflect OLTP-like mixed I/O performance that represents mixed tasks like searching and then making a purchase from an ecommerce site. As Figure 3 shows, Dell APEX Block Storage for AWS delivered 2.5x the IOPS per node of the Vendor A solution.

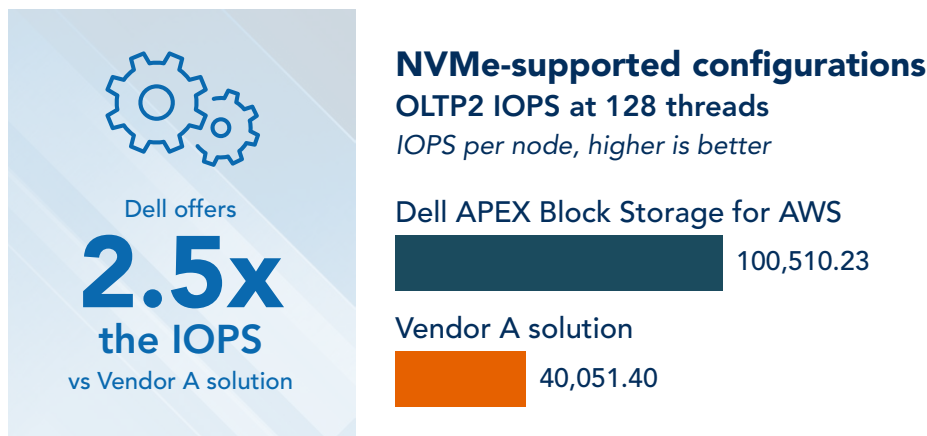


Figure 3: Average OLTP2 IOPS per node results on the Vdbench benchmark for Dell APEX Block Storage for AWS and the Vendor A solution using each vendor's NVMe-supported configuration. Results reflect multi-AZ configurations. Higher is better. Source: Principled Technologies.

Dell APEX Block Storage for AWS offered consistent performance in an NVMe configuration. Figure 4 shows the sequential read performance per node of both NVMe-supported configurations over ten Vdbench runs. Throughput was higher and remained consistent across all 10 test runs for the Dell APEX Block Storage for AWS solution, varying in performance by 3 percent. In contrast, the throughput for the Vendor A solution varied greatly, and dropped by as much as 62 percent.

### Sequential read performance over 10 runs at 32 threads with NVMe-supported configuration *MB/s per node*

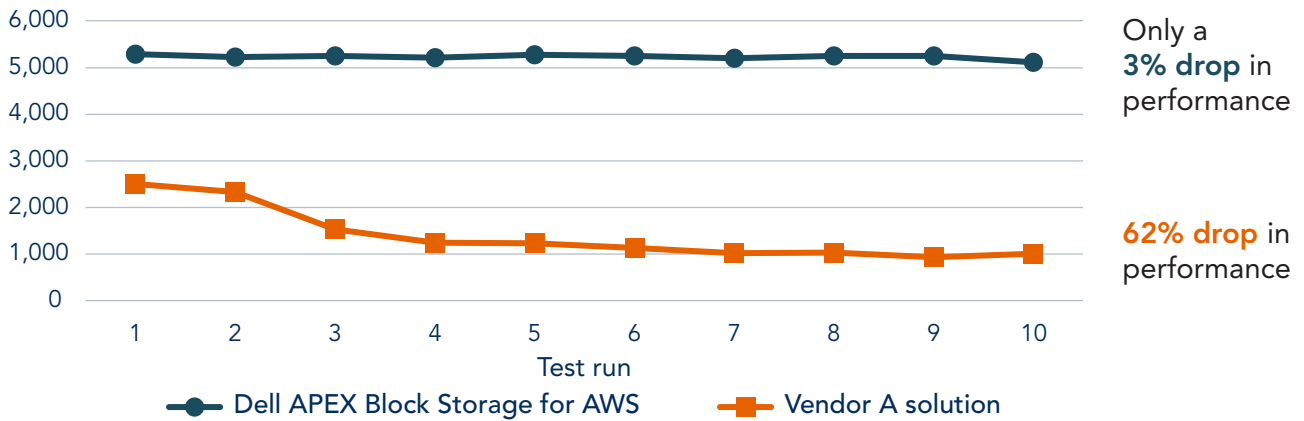


Figure 4: Sequential read throughput per node, in MB/s, on the Vdbench benchmark over 10 test runs for Dell APEX Block Storage for AWS and the Vendor A solution using each vendor’s NVMe-supported configuration. Results reflect multi-AZ configurations. Higher, more stable performance is better. Source: Principled Technologies.

Figure 5 shows the random read performance per node of both NVMe-supported configurations over 10 Vdbench runs. Again, throughput remained consistent across all ten test runs for the Dell APEX Block Storage for AWS solution, varying in performance by less than 1 percent. In contrast, the throughput for the Vendor A solution dropped by 45 percent over the 10 runs.

### Random read performance over 10 runs at 128 threads with NVMe-supported configuration *IOPS per node*

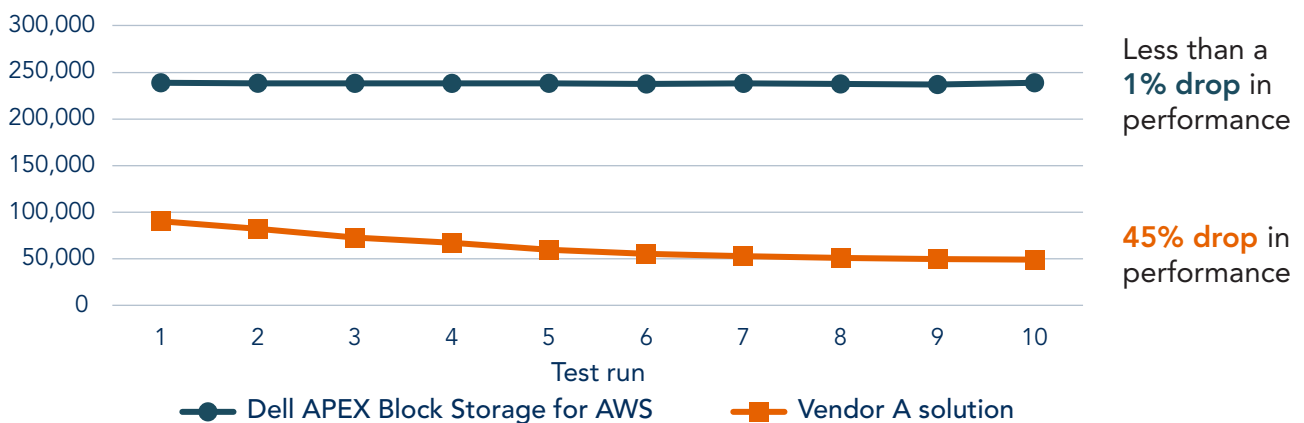


Figure 5: Random read performance per node, in IOPS, on the Vdbench benchmark over 10 test runs for Dell APEX Block Storage for AWS and the Vendor A solution using each vendor’s NVMe-supported configuration. Results reflect multi-AZ configurations. Higher, more stable performance is better. Source: Principled Technologies.

The importance of consistent storage performance is clear: steady storage performance keeps applications running smoothly, and allows for appropriate storage planning to meet company needs.

## EBS-backed configurations: Performance and stability

We then tested both solutions using similar EBS-backed storage configurations. According to AWS, EBS storage is ideal "...for data that must be quickly accessible and requires long-term persistence. EBS volumes are particularly well-suited for use as the primary storage for file systems, databases, or for any applications that require fine granular updates and access to raw, unformatted, block-level storage."<sup>6</sup>

In our EBS testing, Vendor A performed well on random writes, with a 27 percent increase in IOPS per node and a 38 percent increase in IOPS per node on OLTP2 performance compared to Dell APEX Block Storage for AWS. However, Dell APEX Block Storage for AWS outperformed the Vendor A solution on sequential writes by 11 percent and even more significantly on random and sequential read workloads.

Figure 6 compares the random read IOPS results per node from our Vdbench test runs at 128 threads for both the Dell APEX Block Storage for AWS solution and the Vendor A solution. In an all EBS-backed configuration, Dell APEX Block Storage for AWS increased random read performance per node by 83 percent compared to Vendor A.

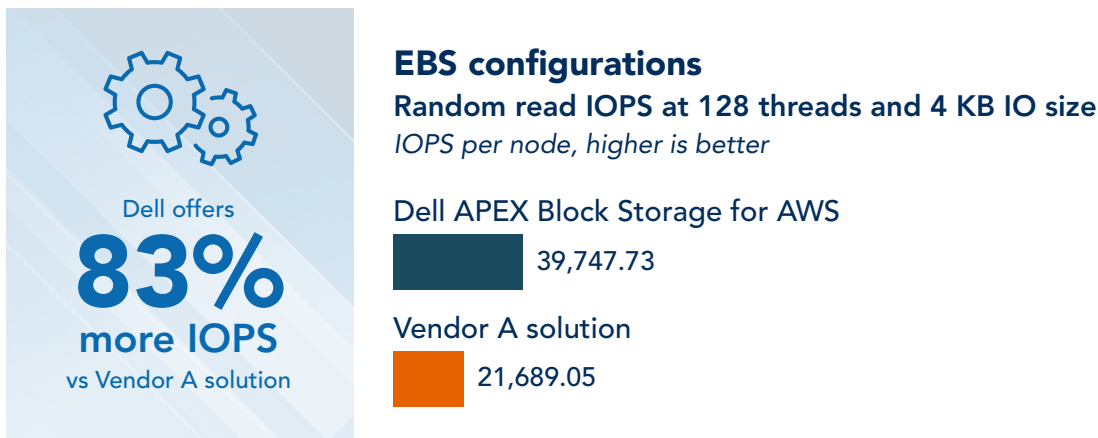


Figure 6: Average random read IOPS per node results on the Vdbench benchmark for Dell APEX Block Storage for AWS in an all EBS-backed configuration vs. the Vendor A solution. Results reflect multi-AZ configurations. Higher is better. Source: Principled Technologies.

Figure 7 shows the throughput per node, in MB/s, that the two solutions with EBS-backed configurations achieved in our Vdbench testing. Again, Dell APEX Block Storage for AWS delivered greater storage performance, achieving 2.2x the throughput per node on sequential read operations compared to the solution from Vendor A.

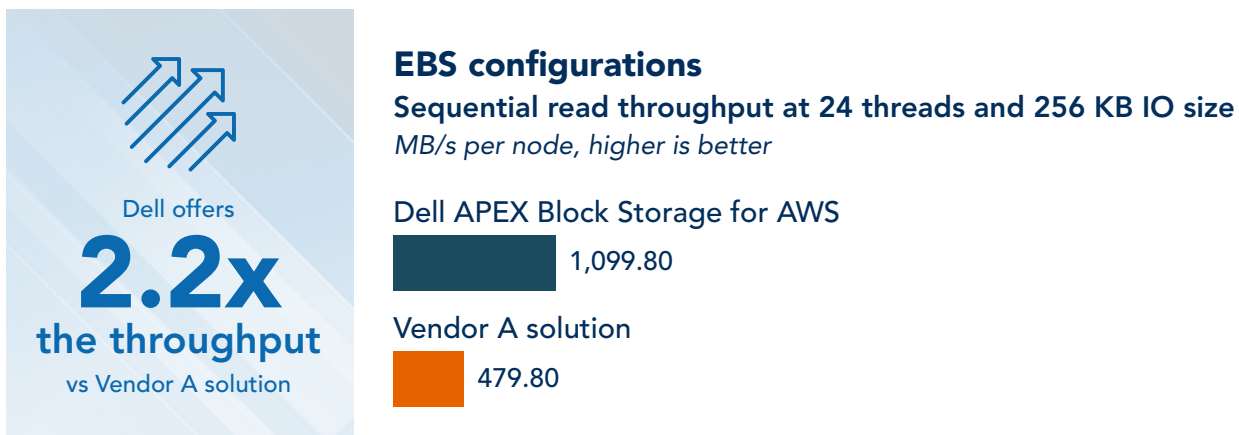


Figure 7: Sequential read throughput per node, in MB/s, on the Vdbench benchmark for Dell APEX Block Storage for AWS in an all EBS-backed configuration vs. the Vendor A solution. Results reflect multi-AZ configurations. Higher is better. Source: Principled Technologies.

Figure 8 shows the sequential read performance per node of both EBS-backed configurations over ten Vdbench runs. As the data shows, the throughput per node was higher and remained consistent across all ten test runs for the Dell APEX Block Storage for AWS solution, varying in performance by less than 1 percent. In contrast, the throughput for the Vendor A solution dropped significantly as we completed more test runs—dropping by 57 percent from the initial test to the lowest-performing run.

### Sequential read performance over 10 runs at 24 threads with EBS configuration MB/s per node

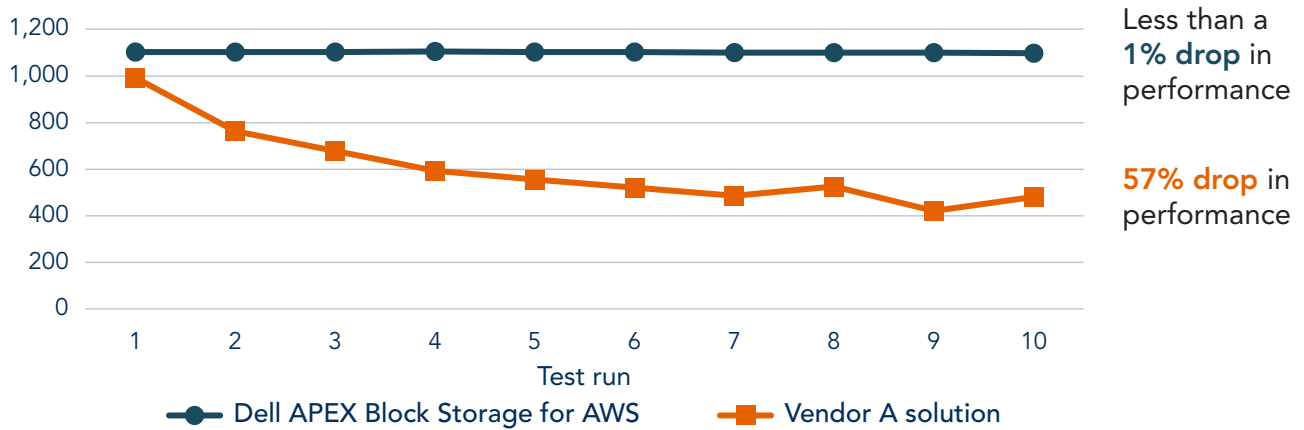


Figure 8: Sequential read throughput per node, in MB/s, on the Vdbench benchmark over 10 test runs for Dell APEX Block Storage for AWS in an all EBS-backed configuration vs. the Vendor A solution. Results reflect multi-AZ configurations. Higher, more stable performance is better. Source: Principled Technologies.

No matter the workloads they run, organizations moving their block storage solutions to the cloud need assurance that their virtual storage solution can provide steady, predictable performance to keep applications running smoothly.

#### About Vdbench

Vdbench is an open-source benchmarking tool that generates input/output loads to stress storage arrays and simulate real-world workloads. It shows the maximum rate of IOPS a solution can handle, as well as the latency and bandwidth a solution delivers while processing those IOPS. For details on the workloads that we configured and used in our testing, see the [science behind the report](#).



## Look to the future with a block storage solution that scales

Enterprises with large storage needs—or the possibility of expansion—must also consider the scalability of the cloud block storage solution they choose.

Dell APEX Block Storage for AWS offers organizations options for more capacity and performance than does the Vendor A solution. While the Vendor A solution does not scale past two nodes, Dell APEX Block Storage for AWS allows for scaling up to 512 storage nodes in a single cluster. The ability to manage larger datasets in a single cluster can help optimize performance, because your workloads aren't weighed down by the overhead of many clusters with data spread among them.

While we did not expand to 512 nodes in our testing, we tested scalability from 3 nodes to 12 nodes to 24 nodes. Figures 9 and 10 show the total cluster throughput and IOPS scaling of the Dell APEX Block Storage for AWS solution across the node counts we tested in a multi-AZ configuration. At 24 nodes, the Dell APEX Block Storage for AWS solution achieved 140,073.88 MB/s sequential reads and 4,916,349.50 random read IOPS.

### Scalability: Total cluster throughput from 3 nodes to 24 nodes

*Sequential reads MB/s*

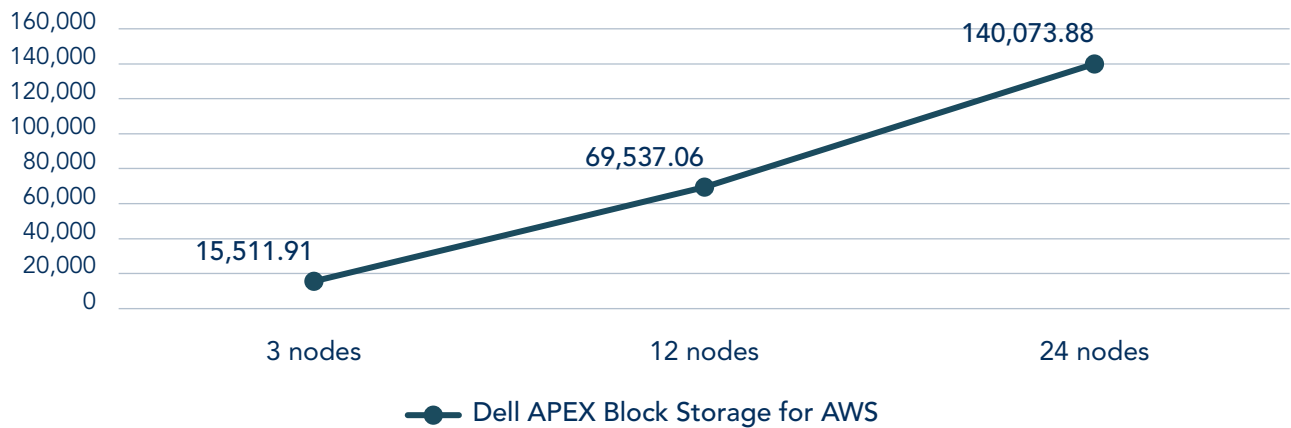


Figure 9: Total cluster throughput (in MB/s) for the Dell APEX Block Storage for AWS solution at 3 nodes, 12 nodes, and 24 nodes. Source: Principled Technologies.

### Scalability: Total cluster IOPS from 3 nodes to 24 nodes

*Random read IOPS*

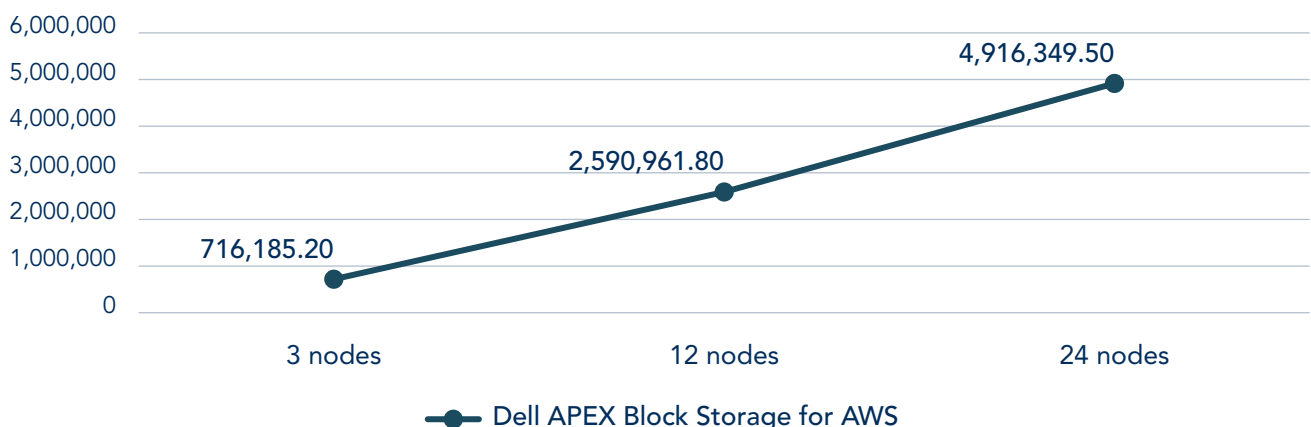


Figure 10: Total cluster IOPS for the Dell APEX Block Storage for AWS solution at 3 nodes, 12 nodes, and 24 nodes. Source: Principled Technologies.

## Dell APEX Navigator

Dell APEX Navigator for Multicloud Storage provides a centralized management experience for Dell APEX Block Storage for AWS. According to Dell, Navigator will soon support other Dell storage endpoints across multiple clouds. While our team did not use APEX Navigator in our tests, we met with Dell engineers who walked us through the process of deploying Dell APEX Block Storage for AWS using APEX Navigator in a thorough demonstration. We were able to see the entire process from start to finish.

### **Dell APEX Navigator offers:**

#### **Security features**

We saw first-hand that APEX Navigator offers security features that are rooted in a Zero Trust approach that validates users at each stage, leveraging a single sign-on (SSO) experience and federated IDs to improve security. Navigator also uses role-based access control (RBAC) to enforce policies and control access to an organization's important data.

#### **Ease of deployment**

Watching the Dell engineer deploy Dell APEX Block Storage for AWS, we saw first-hand that it took only four simple steps to deploy. The Dell engineer stated that using the APEX Navigator, full deployment takes around 2 hours, which is mostly hands-off (though time varies based on each individual cloud).

#### **Data mobility**

APEX Navigator makes data mobility easy to align to various business requirements, allowing for movement of data between on-premises and AWS environments, as well as between different regions in the public cloud.

#### **Management and monitoring**

IT teams can manage and monitor in a centralized experience, and have easy access to specialized tools like Dell CloudIQ for more in depth information.

To learn more about Dell APEX Navigator, visit [Dell.com/Navigator](https://Dell.com/Navigator).

## Conclusion

Enterprises desiring the flexibility and convenience of the cloud for their block storage workloads can find fast-performing solutions with the enterprise storage features they're used to in on-premises infrastructure by selecting Dell APEX Block Storage for AWS.

Our hands-on tests showed that compared to the Vendor A solution, Dell APEX Block Storage for AWS offered stronger, more consistent storage performance in both NVMe-supported and EBS-backed configurations. Using NVMe-supported configurations, Dell APEX Block Storage for AWS achieved 4.7x the random read IOPS and 5.1x the throughput on sequential read operations per node vs. Vendor A. In our EBS-backed comparison, Dell APEX Block Storage for AWS offered 2.2x the throughput per node on sequential read operations vs. Vendor A.

Plus, the ability to scale beyond three nodes—up to 512 storage nodes with capacity of up to 8 PBs—enables Dell APEX Block Storage for AWS to help ensure performance and capacity as your team plans for the future.

1. Dell, "Dell APEX Block Storage for AWS and Microsoft Azure," accessed February 16, 2024, <https://www.delltechnologies.com/asset/en-us/solutions/apex/briefs-summaries/apex-block-storage-for-aws-and-microsoft-azure-solution-brief.pdf>.
2. Dell, "Elevate your multicloud experience one block at a time," accessed February 8, 2024, <https://www.dell.com/en-us/dt/apex/storage/public-cloud/block.htm>.
3. Dell, "Dell APEX Block Storage for AWS – Solution Brief," accessed February 8, 2024, <https://www.delltechnologies.com/asset/en-us/solutions/apex/technical-support/apex-block-storage-for-aws-solution-brief.pdf>.
4. Dell, "Node scaling performance," accessed April 8, 2024, <https://info-hub.delltechnologies.com/en-US/l/performance-results-for-dell-apex-block-storage-for-aws/node-scaling-performance-3/>.
5. Dell, "Dell APEX Block Storage for AWS – Solution Brief."
6. AWS, "Amazon Elastic Block Store (Amazon EBS)," accessed February 13, 2024, <https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/AmazonEBS.html>.

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