



# A solution with Dell APEX Private Cloud and Dell APEX Data Storage Services Block delivered stronger Oracle Database performance at a lower cost than Amazon EBS io2 storage

We investigated the performance and costs associated with two solutions companies can use to get enterprise-level storage without purchasing storage arrays

Because the cost of purchasing and maintaining enterprise-class storage solutions can be considerable, some organizations pursue alternatives such as Amazon Web Services (AWS) and other cloud service providers. Yet another option for companies who wish to avoid purchasing storage is an on-premises storage as-a-service solution from Dell Technologies comprising two components, Dell APEX Private Cloud and Dell APEX Data Storage Services Block. In our tests, this solution not only outperformed similar cloud storage from AWS in a synthetic I/O workload, but it was much more affordable.

Our study explored the I/O performance and monthly cost of two solutions with similarly configured storage, each running four large virtual machines:

- **Dell APEX solution comprising Dell APEX Private Cloud and Dell APEX Data Storage Services Block** (50TB Balanced-tier block storage)
- **Amazon solution comprising Amazon Elastic Compute Cloud (Amazon EC2) instances and Amazon Elastic Block Store (Amazon EBS) io2 Storage** (16 x 1TB volumes with 22,000 provisioned IOPS each)

We found that not only did the Dell APEX solution deliver better performance using several different measures, but its monthly cost was up to 45.9 percent lower than the monthly subscription costs of the Amazon EBS io2 Storage solution. This makes the solution with APEX Private Cloud and APEX Data Storage Services Block an excellent choice for companies that need high-performance on-premise solutions priced with a cloud as-a-service approach.



## More cost-effective

Up to 45.9% lower monthly cost\*



## Better performance

9.8% greater IOPS and storage throughput\*

\*APEX Private Cloud and APEX Data Storage Services Block solution vs. 16 x 1TB volumes of Amazon EBS io2 Storage with a provisioned IOPS rate of 22,000 each when configured with similar quality-of-service (QoS) settings.



## Our test approach

### The hardware and software we tested

The Dell APEX solution comprised an APEX Private Cloud and APEX Balanced-tier block storage system connected to four Dell APEX Private Cloud servers powered by Intel® Xeon® Platinum 8358 processors. All hardware ran within a Dell Technologies data center, which the PT team accessed remotely for testing. Dell set up the hardware and connectivity between servers and storage. Dell also configured the four servers in a cluster with VMware® vSphere® 8. The PT team verified the configuration and had exclusive access to the test environment for the duration of testing.

We configured four test VMs (one per server), each with 64 vCPUs and 256 GB of RAM. We created sixteen 1TB storage volumes for each of the VMs and used raw device mapping (RDM) to attach these volumes to the VMs.

The Amazon solution consisted of sixteen 1TB Amazon EBS io2 volumes attached to four Amazon EC2 M6i series instances (m6i.16xlarge), with four volumes per instance. We chose io2 because it is the latest offering from Amazon, with the best specs. For provisioned IOPS beyond 32,000 per volume, io2 is also less expensive than io1. We chose a provisioned IOPS rate of 22,000 for each storage volume. This amount fulfilled our application requirements, was comparable to the Dell Technologies APEX solution, and let us avoid penalizing AWS from a cost perspective by provisioning additional unnecessary IOPS (AWS charges additional fees for more provisioned IOPS). See the box below for more detail. The M6i instances each contained 64 vCPUs and 256 GB of RAM, and ran in the East US 1 region. The default EBS service quotas for io2 are 100,000 provisioned IOPS and 20 TB of storage capacity. In preparation for testing, we used the AWS UI to request a service quota increase to 360,000 provisioned IOPS and 70 TB of storage capacity.

The VMs and instances in each solution ran Oracle® Linux 8.8 and Oracle Database 21c with Oracle Automatic Storage Management (ASM) configured at the file system level for the Oracle Database.

### About Dell APEX Private Cloud

According to Dell, APEX Private Cloud is “perfect for getting started with cloud or expanding your data center out to the edge.”<sup>1</sup> Dell provides APEX Private Cloud users with a single point of contact to assist with their cloud maintenance and needs. Dell claims the service provides a small footprint and features built-in lifecycle automation.

Learn more at [Dell.com/APEX-Private-Cloud](https://Dell.com/APEX-Private-Cloud).

### How we determined how many IOPS to provision on our AWS disks

During preliminary AWS testing, the I/O performance of the AWS VMs running Oracle Database plateaued around 19,000 to 20,000 IOPS. Based on this, we provisioned 22,000 per volume, which we believed allowed the VMs the resources they required, and would limit provisioned IOPS cost for AWS.

## The load generator we used

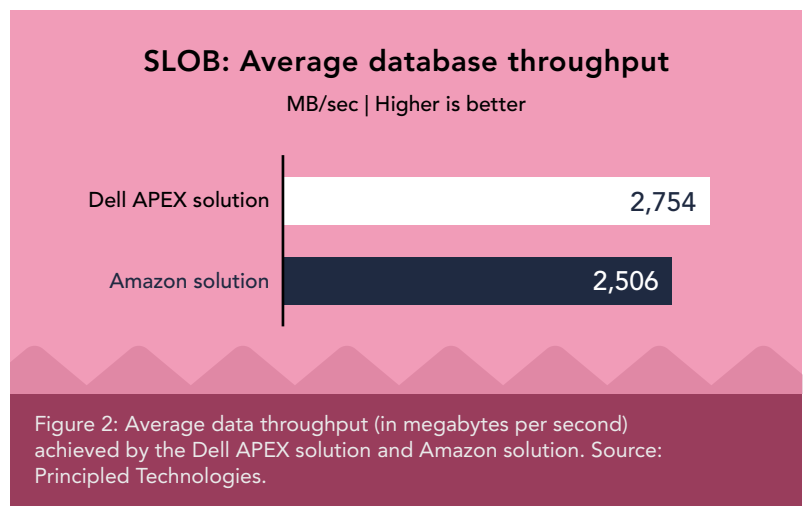
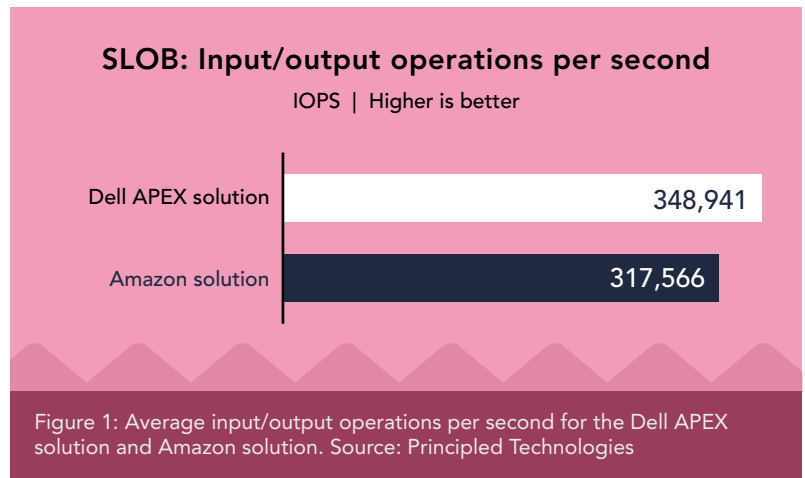
To measure performance on each solution, we employed a synthetic load generator for Oracle Database (Silly Little Oracle Benchmark, or SLOB).<sup>2</sup> To simulate the I/O profile of a common online transaction processing workload, we ran the SLOB workload on each VM at a 70:30 read/write ratio. Additionally, we configured the workload with 24 schemas at a 48GB scale to target an active dataset of roughly 1 TB per volume, or 4 TB total. To generate a high level of IOPS, we ran the workload at 0 think time. We used Oracle Automatic Workload Repository (AWR) reports to capture database performance.

## Results

### IOPS and throughput

Storage admins can configure Amazon EBS io2 volumes with specific IOPS maximums. To determine the rate of provisioned IOPS to set for each io2 volume, we first determined the average per-volume IOPS rate that the APEX solution was capable of while still achieving sub-millisecond database sequential read latency with our 16 database volumes. In our case, the average IOPS was 352,000 (22,000 per volume). This gave us comparable IOPS specs for each solution.

We found that the APEX solution delivered 9.8 percent more IOPS and 9.8 percent greater storage throughput than the Amazon EBS io2 solution. Figures 1 and 2 illustrate these results.



## Cost analysis

After investigating the I/O and throughput performance of the two solutions and determining the advantage of the Dell APEX solution in both metrics, we wanted to look at cost-effectiveness. We researched the monthly cost to run each solution using the capacity and performance levels consistent with our test results. We found that the Dell APEX solution had a significantly lower monthly cost than the Amazon solution.

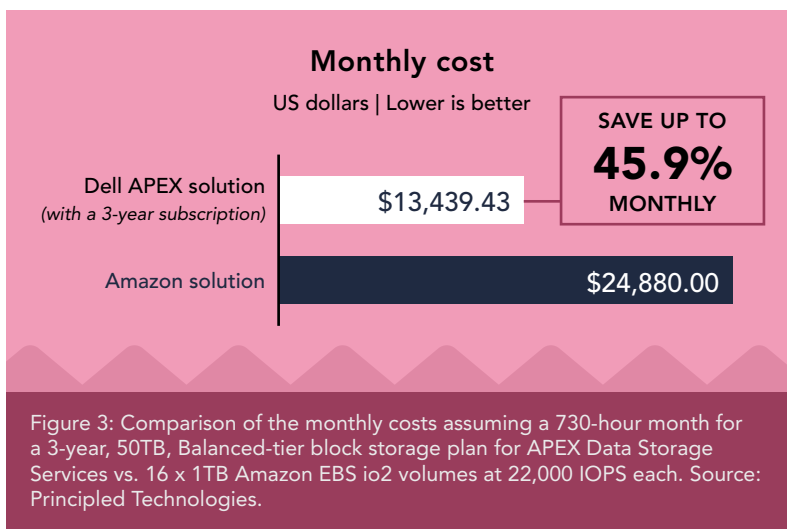
Table 1 shows a breakdown of costs associated with the Amazon solution we tested provisioned for a 730-hour month. Amazon EBS io2 had a rate of \$0.125 per GB per month for storage and \$0.065 per provisioned IOPS per month for up to 32,000 IOPS. Getting the 16 Amazon EBS io2 volumes to perform comparably to the APEX solution (~350K IOPS) would cost \$24,880.00 in total monthly storage costs—much less than purchasing a million-dollar storage solution outright, but still a significant monthly expenditure.<sup>3</sup>

Table 1: Breakdown of total monthly cost in US dollars to run 16 x 1TB Amazon EBS io2 volumes, each with an average performance rate of 22,000 provisioned IOPS assuming a 730-hour month. Cost info current as of September 5, 2023. Source: Principled Technologies.

Amazon solution cost analysis			
Monthly rate	Per volume	Total usage (16 volumes)	Monthly cost
Storage			
\$0.125/GB	1 TB	16 TB	\$2,000.00
Provisioned IOPS			
\$0.065/IOPS	22,000 IOPS	352,000 IOPS	\$22,880.00
<b>Total monthly cost</b>			<b>\$24,880.00</b>

Table 2: Breakdown of total monthly cost in US dollars for 1- and 3-year subscriptions to a Dell APEX solution with 50TB of Balanced-tier block storage assuming a 730-hour month. Cost info current as of September 5, 2023. Source: Principled Technologies.

Dell APEX solution cost analysis	
APEX solution monthly cost (50TB)	
1-year subscription (total monthly rate)	\$19,348.85
3-year subscription (total monthly rate)	\$13,439.43



By subscribing to on-premises storage as-a-service from Dell Technologies, a company could save up to 45.9 percent of the cost of the Amazon solution we tested. Table 2 shows the breakdown in costs for the APEX solution: A 1-year subscription to APEX capable of the same amount of work as the Amazon solution would cost a company just \$19,348.85 per month. A company that chooses a 3-year subscription for the same solution would pay just \$13,439.43 per month.<sup>5</sup> Figure 3 illustrates the total monthly cost of each solution.

## The effect of thin provisioning on data charges

In our tests, Oracle databases consumed 48 TB of storage space on each service. We ordered the Dell APEX solution that had 50 TB of base capacity included in its subscription. With APEX Data Storage Services thin provisioning, allocated but unused capacity does not affect billing, so if our storage needs expanded, we would pay no additional charges until we wrote more data to disk than our base capacity. In contrast, Amazon EBS io2, charges its on-demand rate for the entire capacity of each volume you provision, regardless of how much data you write to each volume. The different charging models could significantly affect storage costs at scale.

### What is Dell APEX Data Storage Services?

A storage as-a-service offering from Dell Technologies, APEX Data Storage Services lets organizations subscribe to hardware, infrastructure maintenance, and elastic capacity that they can manage via the APEX Console.

APEX Data Storage Services provides on-premises block and file storage at several performance tiers. We tested a solution with 50 TB of block storage in the Balanced performance tier, which is the middle performance tier of the APEX Data Storage Services offering. Dell Technologies claims to have a defined time-to-value objective of as little as 14 days for the APEX Data Storage Services offerings.<sup>4</sup> In a previous Principled Technologies study, it took us only 13 days to purchase, receive, and activate an APEX Data Storage Services solution.<sup>5</sup>

To learn more, visit  
<http://www.DellTechnologies.com/APEX-Storage>.

### About the Intel Xeon Platinum 8358 Processor

Part of the 3<sup>rd</sup> Generation Intel Xeon Scalable Processor family, the Intel Xeon Platinum 8358 Processor has 32 cores, 64 threads, a maximum turbo frequency of 3.50 GHz, a processor base frequency of 2.90 GHz, and a 56MB cache. According to Intel, this processor family offers optimization for "cloud, enterprise, HPC, network, security, and IoT workloads with 8 to 40 powerful cores and a wide range of frequency, feature, and power levels."<sup>6</sup>

## Conclusion

Purchasing and maintaining a comprehensive enterprise-class storage solution in your own on-site data center can be a multimillion-dollar proposition. While many companies turn to the public cloud to avoid this investment, cloud storage solutions can also be very costly. We found that companies can save by choosing a third alternative, a solution comprising Dell APEX Private Cloud and APEX Data Storage Services Block.

In our tests using an Oracle Database I/O generator workload, the APEX solution provided an on-premises cloud storage solution with better performance than a similarly configured Amazon solution for a much lower cost. In contrast to the \$24,880.00 monthly cost of the Amazon solution we tested, the APEX solution cost only \$13,439.43 per month for a 3-year subscription and \$19,348.85 per month for a 1-year subscription.

Companies could save dramatically by subscribing to Dell APEX Private Cloud and Dell APEX Data Storage Services Block rather than using public cloud resources. To learn more about this solution, visit [Dell.com/APEX-Private-Cloud](https://Dell.com/APEX-Private-Cloud) and [Dell.com/APEX-Storage](https://Dell.com/APEX-Storage).

1. Dell Technologies, "Dell APEX Private Cloud," accessed September 5, 2023, <https://Dell.com/APEX-Private-Cloud>.
2. Kevin Closson, "Introducing SLOB - The Simple Database I/O Testing Toolkit for Oracle Database," accessed September 5, 2023, <https://kevinclosson.net/2012/02/06/introducing-slob-the-silly-little-oracle-benchmark/>.
3. Amazon, "Amazon EBS Provisioned IOPS Volume," accessed September 5, 2023, <https://aws.amazon.com/ebs/provisioned-iops/>.
4. Dell Technologies, "APEX Data Storage Services," accessed September 5, 2023, <https://www.delltechnologies.com/en-us/apex/data-storage-services.htm>.
5. Dell Technologies, "Get up and running faster with Dell Technologies APEX Data Storage Services," accessed September 5, 2023, <https://www.principledtechnologies.com/Dell/APEX-HPE-Greenlake-procurement-1121.pdf>.
6. Intel, "3<sup>rd</sup> Gen Intel® Xeon® Scalable Processors," accessed September 5, 2023, <https://www.intel.com/content/www/us/en/products/docs/processors/xeon/3rd-gen-xeon-scalable-processors-brief.html>.

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