Performance benchmark results: Amazon Web Services (AWS) SAN in the Cloud vs. comparable on-premises all-flash SAN solution

AWS SAN in the Cloud delivered 26 percent higher throughput with a synthetic I/O workload and 3 percent more new orders per minute (NOPM) with an online transaction processing (OLTP) workload

Many organizations choose on-premises storage area networks (SAN) because of their significant capacity, performance for transactional database workloads, and reliability. However, SAN solutions can be complex to manage and present challenges in maintaining performance while increasing capacity. To address these challenges, Amazon Web Services (AWS) now offers an on-demand SAN in the Cloud solution for workloads requiring low latency and high throughput. The AWS SAN in the Cloud configuration we tested consisted of Amazon Elastic Block Storage (EBS) io2 Block Express volumes and Amazon Elastic Cloud Computing (EC2) R5b.24xlarge instances.

We ran benchmarking tests to compare database performance of our AWS SAN in the Cloud solution and an on-premises SAN storage solution using an HPE 3PAR StoreServ 8450 array that we configured similarly to the AWS solution. Running a synthetic I/O workload, the AWS solution supported 26 percent more GB per second than the on-premises SAN solution. Handling more data can reduce the possibility of storage bottlenecks that slow access to data.

Running an OLTP workload, the AWS R5b instance backed by two io2 Block Express volumes processed more NOPM than the on-premises solution. With the performance of an EBS io2 Block Express and EC2 R5b solution, you can lift and shift business-critical OLTP workloads, satisfying current usage levels while also having the ability to scale out to the cloud for future data growth. In addition, moving the workload to an AWS SAN in the Cloud can provide the core cloud economic benefits of paying for only the compute and storage resources that you use without investing in physical infrastructure.

Exceeded OLTP performance after workload migration

3% more NOPM than an on-premises SAN solution

Processed more GB/s

26% higher throughput than a comparable on-premises SAN

EBS io2 Block Storage for EC2 R5b.24xlarge instances compared to an on-premises SAN solution in OLTP performance

To demonstrate the performance differences between the AWS EC2 R5b.24xlarge instance with io2 Block Express storage and an on-premises HPE 3PAR StoreServ 8450 SAN-based solution, we ran a synthetic I/O workload and an OLTP workload on both solutions. The synthetic I/O workload was a sequential, all-read I/O profile from CrystalDiskMark. The OLTP workload, known as TPROC-C, is part of the transaction processing benchmark HammerDB v4.2 and is derived from the TPC-C specification.

We aimed to match CPU specifications as closely as possible between the AWS solution and the on-premises SAN solution to offer comparable computing performance in terms of speed, core, and threads. Both the EC2 R5b instance and the on-premises solution used Intel® Xeon® processors from the same generation (Cascade Lake) and offered the same number of cores (24) and threads (48). An Intel Xeon Platinum 8259CL processor with a base core frequency of 2.50 GHz powered the EC2 R5b instance. An Intel Xeon Gold 6240R processor with a base core frequency of 2.40 GHz powered the SAN solution. We configured both the EC2 R5b instance and the SAN solution with 768 GB of memory.

We selected the R5b.24xlarge instance with support for up to 260K IOPS and 7.5GBps throughput to ensure that the instance type was not a bottleneck when testing the io2 Block Express storage. We intended to represent how a real-world customer might select an appropriate EC2 R5b instance based on compute, IOPS, and throughput for optimal database performance.

The EBS io2 Block Express volume offered 4 TB of data storage for the EC2 R5b instance, with two 2TB io2 volumes in a single stripe to use the instance's maximum throughput limit (a single io2 volume maxes out at 4GBps). The on-premises SAN solution had 4 TB of data storage consisting of two 2TB RAID 1 volumes from 48 SAS SSDs in a single stripe. This configuration allowed us to use multiple LUNs and do more with the SAN's two controllers, and the configuration offered parity with the two-io2 volume single-stripe configuration. Note that configuring multiple striped LUNs on the SAN may not be a common configuration, but it ensured equality for our testing.

About io2 Block Express volumes

Built on AWS EBS architecture, io2 Block Express storage is currently available for R5b instances in US East (Ohio), US East (N. Virginia), US West (Oregon), Asia Pacific (Singapore), Asia Pacific (Tokyo), and Europe (Frankfurt) regions. According to AWS, io2 Block Express volumes "deliver up to 4x higher throughput, IOPS, and capacity than io2 volumes, and are designed to deliver sub-millisecond latency and 99.999% durability."[1] AWS plans to support io2 Block Express in more regions and for more instance types in the future. To learn more about io2 Block Express, visit https://aws.amazon.com/ebs/provisioned-iops/.

Table 1 presents a side-by-side comparison of the two storage configurations.

Table 1: Configuration details for the storage we tested.

	AWS San in the Cloud solution	On-premises SAN solution
Operating system	Microsoft Windows Server 2019 Datacenter 10.0.17763 / Build 17763	Microsoft Windows Server 2019 Datacenter 10.0.17763 / Build 17763
Instance/server type	EC2 R5b.24xlarge	HPE ProLiant DL380 Gen10
Location	us-east-1c (data center region)	Principled Technologies data center
RDMS version	Microsoft SQL Server 2019 (KB4577194)	Microsoft SQL Server 2019 (KB4577194)
CPU vCPUs/threads	96	96
RAM (GB)	768	768
Storage type	EBS io2 Block Express	HPE 3PAR StoreServ 8450
Disk configuration for data/logs	2 x 2TB, single stripe	2 x 2TB, single stripe

SAN in the Cloud from Amazon delivered 26 percent higher throughput during a synthetic I/O workload

Our synthetic I/O workload from CrystalDiskMark was a 100-percent sequential-read I/O profile with 64k-sized blocks. The EBS io2 Block Express volume and EC2 R5b instance offered 26 percent higher throughput compared to the on-premises SAN solution. Figure 1 shows the median throughput for the AWS solution and the on-premises SAN solution in our 64k-block all-read I/O workload testing.

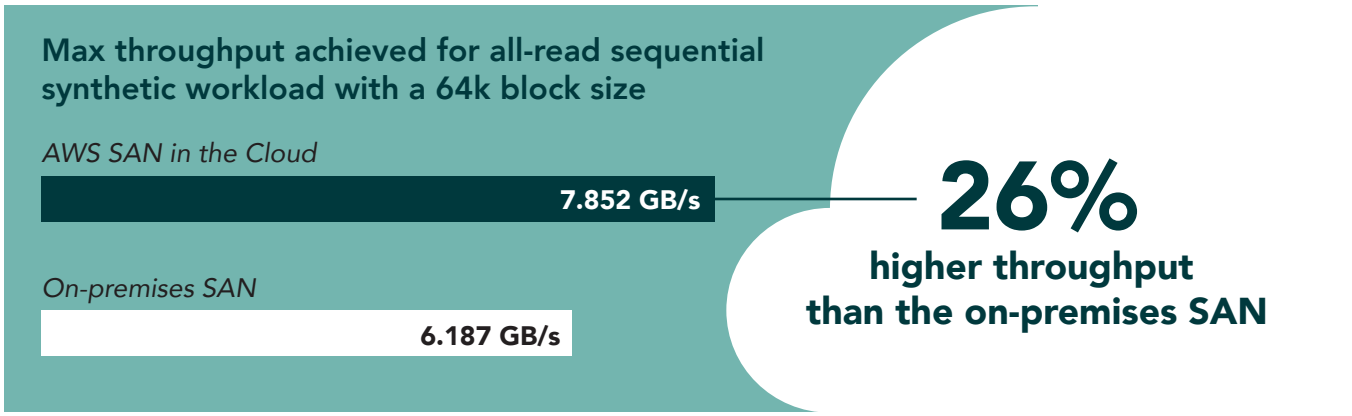

Figure 1: The max throughput, in GB per second, that the solutions achieved in our 100-percent sequential-read synthetic workload using 64k blocks. Higher is better. Source: Principled Technologies.

AWS SAN in the Cloud processed 3 percent more NOPM for an OLTP workload

Figure 2 shows the median NOPM from our OLTP workload testing for our AWS and on-premises SAN solutions. The EBS io2 Block Express volume and EC2 R5b instance handled 3 percent more NOPM than the on-premises SAN solution.

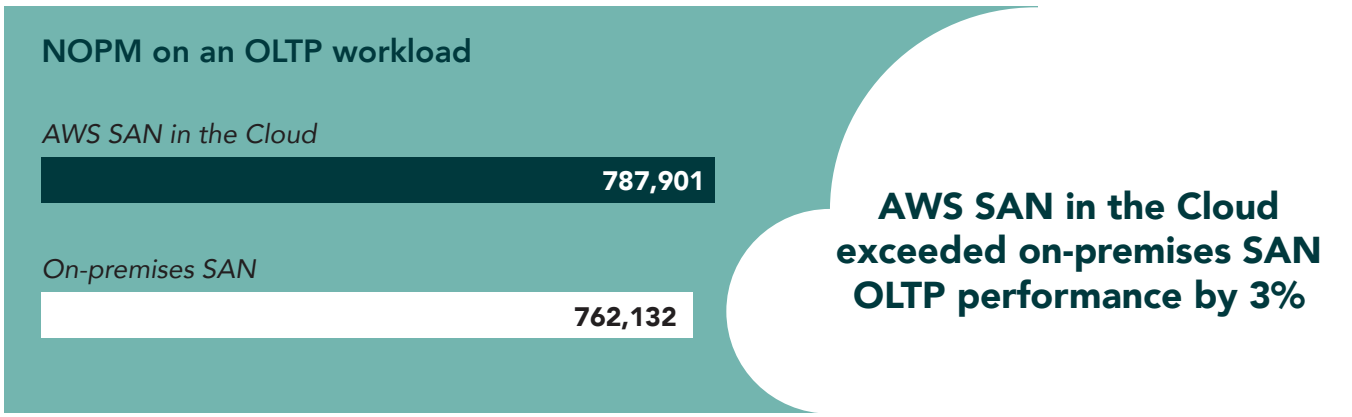

Figure 2: The NOPM that the EBS io2 Block Express volume and EC2 R5b instance and the on-premises SAN solution delivered while running an OLTP workload. Larger is better. Source: Principled Technologies.

Why NOPM?

NOPM is a metric for OLTP workloads that shows only the number of new order transactions completed in one minute as part of a serialized business workload. HammerDB claims that because NOPM is "independent of any particular database implementation [it] is the recommended primary metric to use."[2]

Conclusion

Migrating OLTP or read-heavy I/O workloads to an AWS SAN in the Cloud solution could be an alternative to on-premises SAN solutions. We found that EBS io2 Block Express storage and EC2 R5b instances delivered 26 percent higher throughput in GB per second and exceeded transactional database performance in NOPM (3 percent more) compared to an on-premises SAN solution. Lifting and shifting those workloads could allow you to meet current usage levels and help your organization grow by taking advantage of more capacity in the cloud.

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1 "AWS Announces General Availability of Amazon EBS io2 Block Express Volumes Amazon EBS io2 Block Express Volumes," accessed August 24, 2021, https://aws.amazon.com/about-aws/whats-new/2021/07/aws-announces-general-availability-amazon-ebs-block-express-volumes/.

2 HammerDB, "Comparing HammerDB results," accessed August 24, 2021, https://www.hammerdb.com/docs/ch03s04.html.

Read the science behind this report at http://facts.pt/3zTs2lU ►

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