Technical Report

# Performance Characterization of ONTAP Cloud with Application Workloads

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August 2016 | TR-4383

## Abstract

This technical report examines the performance and fit of application workloads running on NetApp® ONTAP® Cloud for Amazon Web Services (AWS).

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# 1 Introduction

To help NetApp customers select the most appropriate solutions for their IT infrastructure, NetApp provides up-to-date documentation describing its products. This technical report describes the results of performance tests for the NetApp ONTAP Cloud software running on an AWS EC2 instance. NetApp partners and employees can share this information with customers and use it to make informed decisions about which workloads are appropriate for ONTAP Cloud.

The test configuration environments described in this report consist of the following components:

- ONTAP Cloud: M4.2xlarge instance
- ONTAP Cloud: R3.2xlarge instance
- Windows 2012 R2 client: C4.2xlarge instance

The protocols used in the tests are iSCSI for block workloads.

## 1.1 Audience

The audience for this report is NetApp partners and employees who are investigating the performance characteristics of ONTAP Cloud.

# 2 Differences Between Instance Types

AWS describes the capabilities of instance types in terms of network, CPU, and memory. The specific combination of these components is what determines the overall performance of a particular instance. For ONTAP Cloud, the CPU capability contributes to overall general performance, whereas memory contributes heavily to read performance. The network capability acts as a throughput limiting factor that is independent of read and write performance levels.

Table 1 characterizes the capabilities of supported instance types.

**Table 1) Characterization of ONTAP Cloud instance types.**

| Instance | CPU | RAM | Network |
|---|---|---|---|
| M4.2xlarge | 8 | 32 | High |
| R3.2xlarge | 8 | 61 | High |

# 3 Test Configurations

All test configurations used the iSCSI protocol for block I/O connectivity. The tests' focus is on the following workloads:

- ONTAP Cloud instances were backed by three EBS general purpose SSD (GP2) volumes, each 2TB in size, for the R3.2Xlarge instance. Four 1TB GP2 volumes were used for the M4.2Xlarge instance.
- ONTAP Cloud version 8.3.2 was used. Version 8.3.2 includes new a feature called write speed.
- Iometer was used to generate the following workloads: OLTP, MongoDB, and elastic map reduce.
- A 4X500g LUN backed by four volumes was mounted with iSCSI on Windows 2012R2.
- The block size for the test run was 8KB.
- Tests were also run with ONTAP Cloud's high write speed feature enabled. Unless specified, all tests were run without the high write speed feature enabled.

# 4 Summary of Test Results

As ONTAP Cloud becomes increasingly available, it is likely that the AWS user base will have questions about the performance implications of using ONTAP Cloud. They might also have questions about which workloads are more appropriate for ONTAP Cloud versus physical FAS storage systems. Also, the new feature write speed can improve performance for certain workloads. The test results described in this report can help answer the following questions about the transition of workloads to all-cloud environments and hybrid-cloud environments.

**What is the performance of ONTAP Cloud for OLTP server workloads?**

Answer: ONTAP Cloud is an excellent choice for read-intensive database workloads that consume up to 90% of the available bandwidth on the ONTAP Cloud instance. Mixed workloads that consist of up to 25% writes also perform well. Write-intensive workloads require testing for a given I/O profile to determine final latency and throughput.

**What is the performance of ONTAP Cloud for NoSQL workloads?**

Answer: NoSQL workloads tend to be read heavy. In the MongoDB workload that we tested, one test consisted of 100% reads, and another consisted of 50% reads and 50% writes. ONTAP Cloud easily achieved both IOPS and latency levels for these workloads, which are representative of NoSQL workloads.

**Which other workloads work well with ONTAP Cloud?**

Answer: ONTAP Cloud is well suited for read-heavy workloads that process unstructured data. These workloads include OLTP, file shares, media distribution, and SharePoint workgroup services.

**What is the performance with the write speed feature of ONTAP Cloud set to high?**

Answer: ONTAP Cloud with write speed set to high can enhance performance by 20% to 50%, depending on your application workload. From the workloads we have tested, we have seen a significant increase in performance when the workload is a mix of reads and writes.

# 5 Test Results and Analysis

Each tested configuration consisted of a unique workload that is representative of the workloads used in widely deployed POSIX applications. The OLTP workloads were designed to simulate a read-intensive transactional database application. Also, we simulated MongoDB workloads, which represent NoSQL workloads.

The test workloads differed markedly. However, collectively they represent workloads that can be considered for an ONTAP Cloud deployment. Because the workloads were so different, the results of each test are discussed separately in this section. Specifically, we present the results of the OLTP workloads and workloads on other instances.

## 5.1 OLTP Workload

The OLTP workload was performed using an Iometer profile. Transactional workloads tend to be read-heavy as data about an item is retrieved, but they involve a smaller number of writes as transactions are committed. Transactional workloads are highly sensitive to write latency, especially for writes to the transaction log. Typically, it is best for log writes not to exceed 10ms of latency. Lower latency is always better.

Workload consisted of 90% random reads and 10% random writes of 8KB blocks. The dataset was 4X500 LUNs backed by four volumes exported to a Windows 2012 R2 instance (C4.2xlarge). We increased the number of outstanding I/O operations to create the data points necessary to form a knee curve for IOPS and latency.

Figure 1 shows the read IOPS and latency of ONTAP Cloud with write speed set to normal. Figure 2 shows the write IOPS and latency of ONTAP Cloud with write speed set to normal. Reads and writes were plotted separately for convenience.

**Figure 1) Read IOPS and latency of ONTAP Cloud with write speed set to normal.**

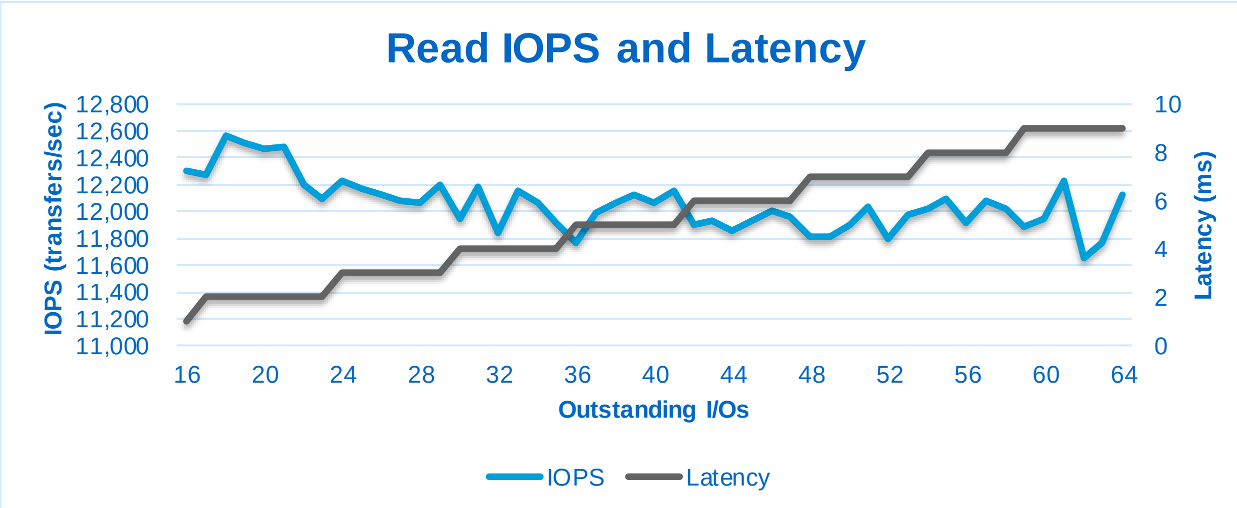



**Figure 2) Write IOPS and latency of ONTAP Cloud with write speed set to normal.**

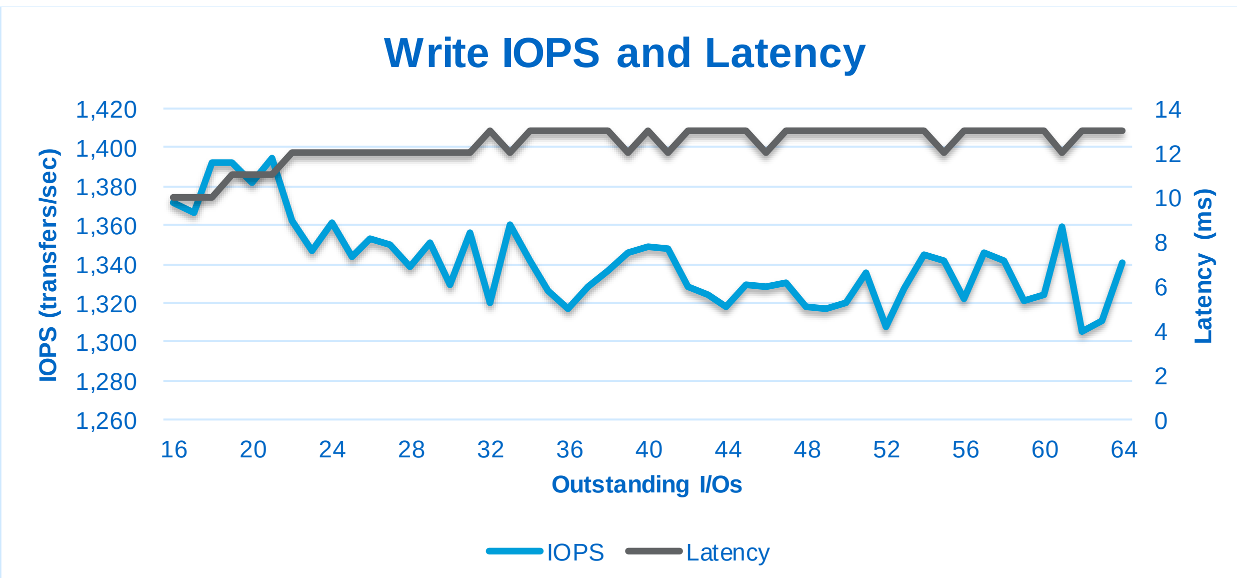



Figure 3 shows the read IOPS and throughput, and Figure 4 shows the write IOPS and latency for the R3.2xlarge instance of ONTAP Cloud with write speed set to normal.

Figure 3) Read IOPS and throughput of ONTAP Cloud with write speed set to normal.

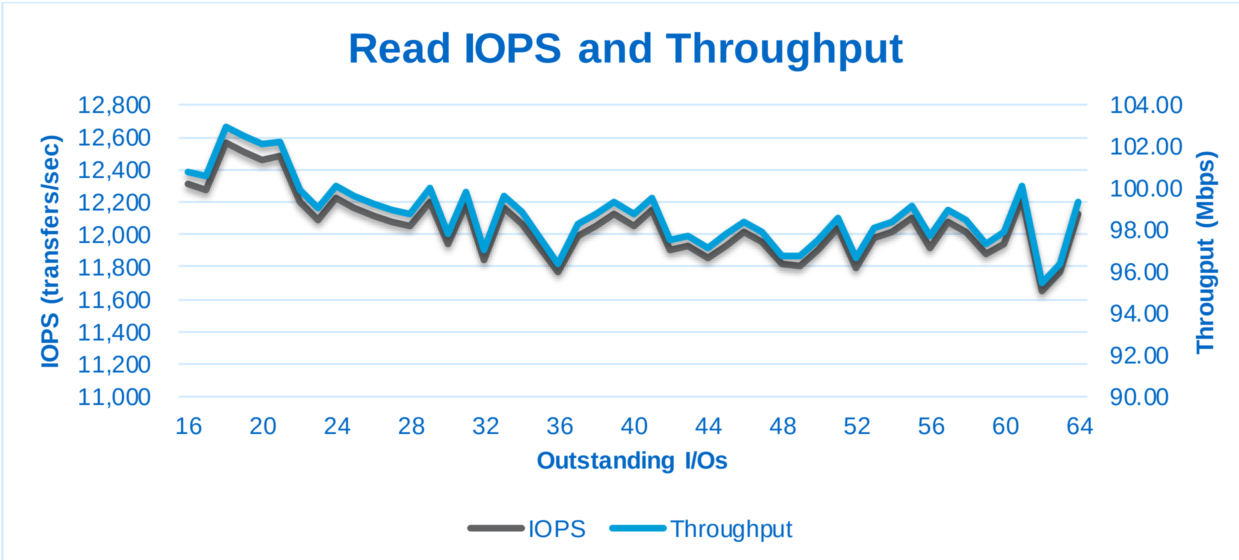



Figure 4) Write IOPS and latency of ONTAP Cloud with write speed set to normal.

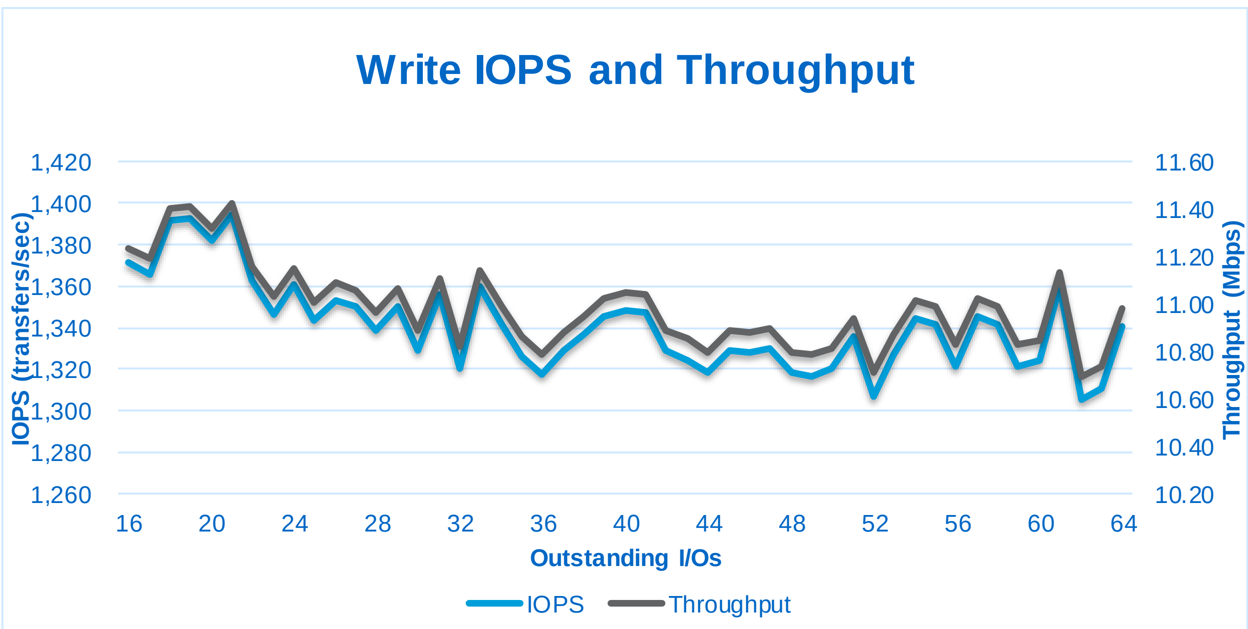



Figure 5 shows the read IOPS and latency of ONTAP Cloud with write speed set to high, and Figure 6 shows the write IOPS and latency of ONTAP Cloud with write speed set to high. Reads and writes were plotted separately for convenience.

Figure 5) Read IOPS and latency of ONTAP Cloud with write speed set to high.

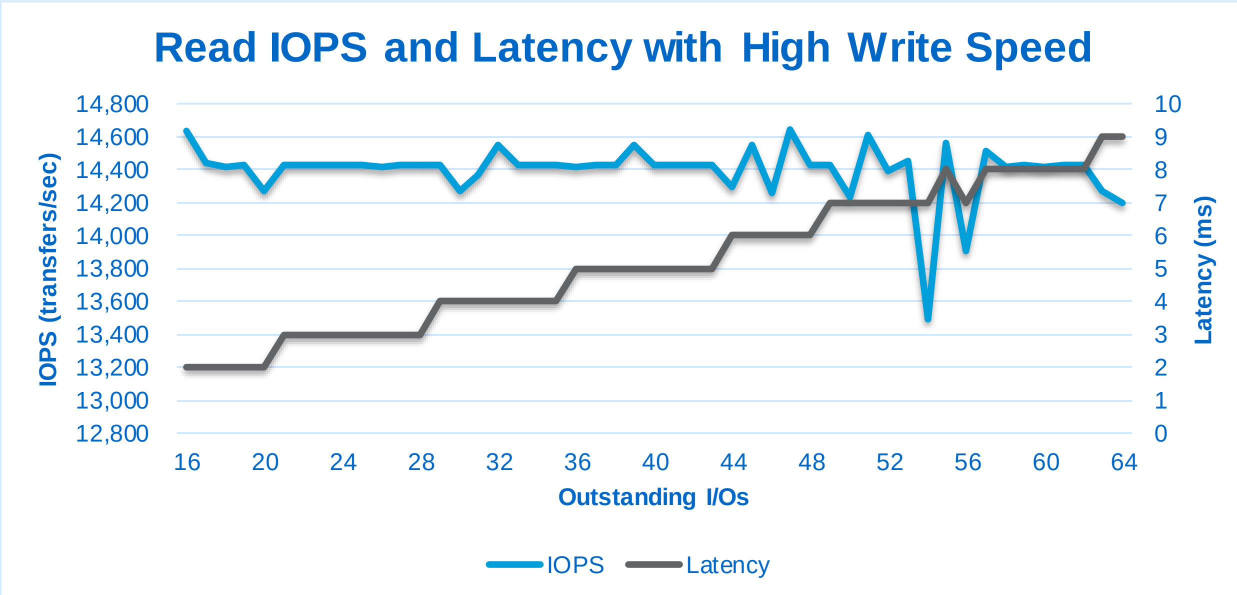



Figure 6) Write IOPS and latency of ONTAP Cloud with write speed set to high.

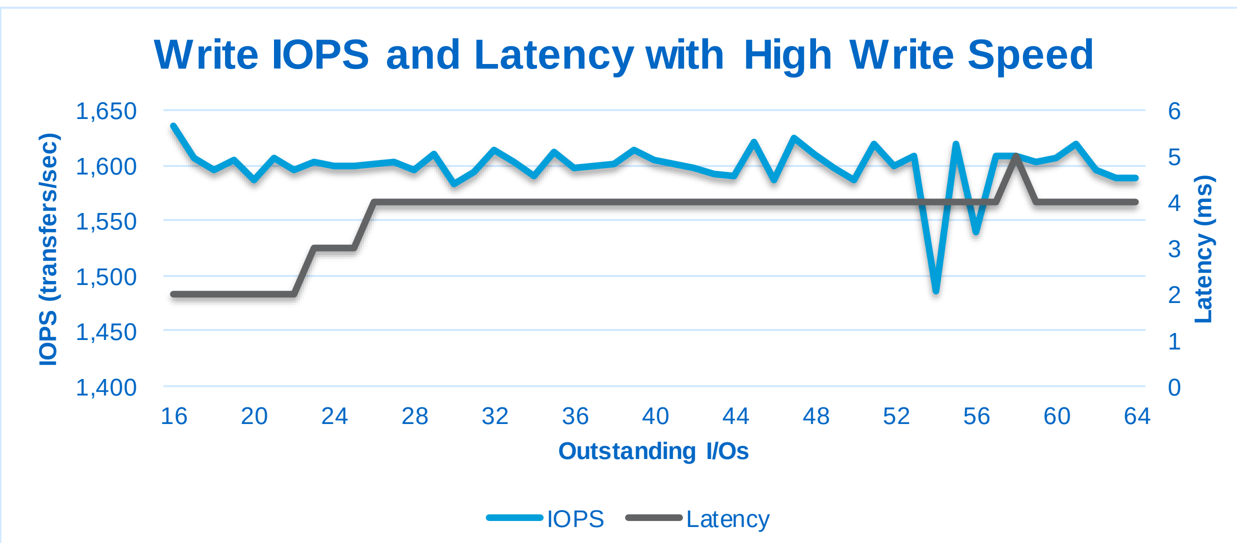



Figure 7 shows the read IOPS and throughput for the R3.2xlarge instance of ONTAP Cloud with write speed set to high. Figure 8 shows the write IOPS and throughput for the R3.2xlarge instance of ONTAP Cloud with write speed enabled.

Figure 7) Read IOPS and throughput of ONTAP Cloud with write speed set to high.

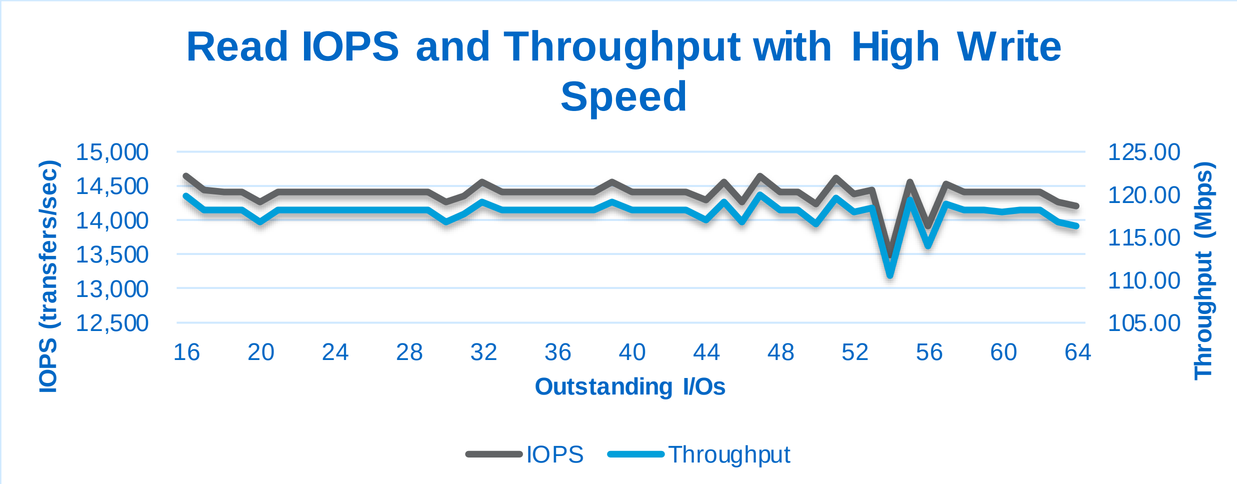
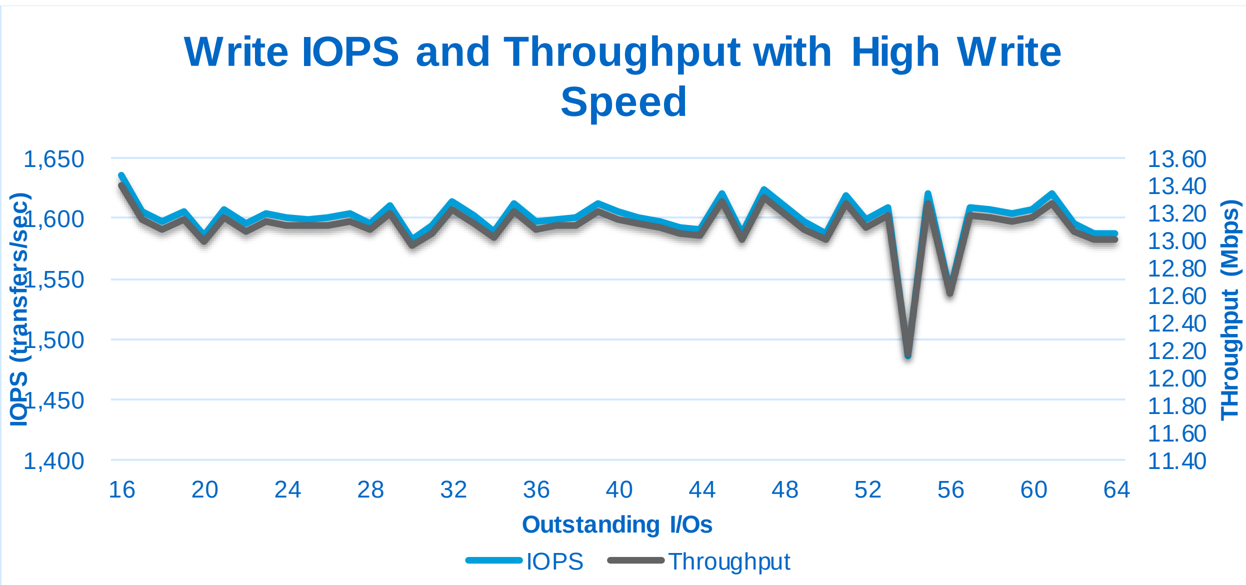



Figure 8) Write IOPS and throughput of ONTAP Cloud with write speed set to high.




## Detailed Test Results

The OLTP workload was a mix of 90% random reads and 10% random writes. The network bandwidth for the EC2 R3.2xlarge instance that we used to host ONTAP Cloud was characterized by AWS as `High`. Increasing outstanding I/O operations further would simply have added more latency because we could not push more data through the pipe. ONTAP Cloud had excellent read performance characteristics in this use case. In the case of ONTAP Cloud with the write speed feature set to high, we observed an R3.2xlarge instance throughput limit of 125Mbps. With the write speed feature set to normal, we utilized 90% of the throughput limit for R3.2xlarge.

These test results suggest that ONTAP Cloud would not be a good match for larger transactional database write workloads. NetApp Private Storage for Cloud would be a better choice for this use case.

As we qualify more and varied AMI configurations or disk configurations for ONTAP Cloud in the future, there will be more choices at more performance points. In addition, as underlying AWS EBS storage improves, ONTAP Cloud will inherit those performance gains.

## 5.2 Workloads on Other Instances

We ran OLTP and MongoDB workloads on different instance families. The three basic workloads were OLTP and two variations of MongoDB. Table 2 defines the characteristics of these workloads.

**Table 2) Test workload definitions.**

| Test Name | Read/Write Profile | I/O Size and Pattern |
|---|---|---|
| OLTP | 90% reads/10% writes | 8KB, 100% random |
| MongoDB | 100% reads | 8KB, 100% sequential |
| MongoDB: update | 50% reads/50% writes | 8KB, 100% sequential |

Iometer was used to generate the load. Two workers were configured with a single disk target. The number of outstanding I/O operations was increasing, starting from 16 to 64 after a 1-minute interval.

### Detailed Test Results

Figure 9 presents the results of the tests for the workloads and comparison between ONTAP Cloud with the write speed feature set to normal and set to high in an R3.2Xlarge instance.

**Figure 9) Workload comparison for ONTAP Cloud at high and normal write speed.**

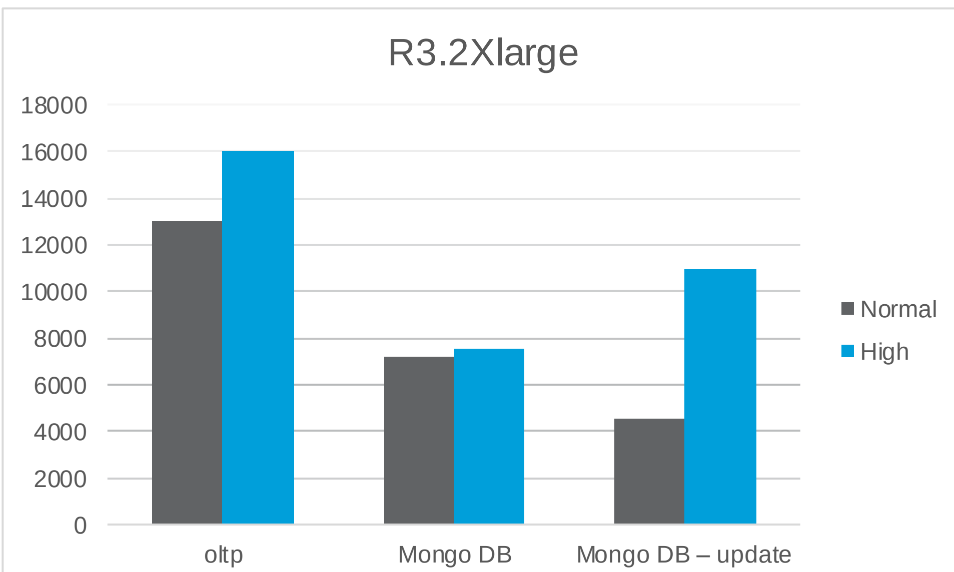



**Table 3) IOPS and latency of test workloads.**

| Test Name | IOPS/Latency | IOPS Write Speed/Latency |
|---|---|---|
| OLTP | 15,000/8ms | 16,000/8ms |
| MongoDB | 13,000/8ms | 15,000/5ms |
| MongoDB: update | 4, 400/36ms | 22,000/6ms |

Table 4 represents the results of a test workload of ONTAP Cloud with the write speed feature set to high on an M4.2XLarge instance.

Table 4) IOPS and latency of test workloads for M4.2XL instance.

| Test Name | IOPS | Latency |
|---|---|---|
| OLTP | 15,000 | 6ms |
| MongoDB | 10,000 | 8ms |
| MongoDB: update | 22,000 | 8ms |

Overall, ONTAP Cloud performed very well for this set of workloads. The strong point was again the read performance. Without a strict requirement for transactional write latency, ONTAP Cloud also performed well for the workloads that consisted of 50% writes. For these types of workloads on smaller datasets, ONTAP Cloud is fully capable of doing the job. For workloads that scale to much larger dataset sizes or higher I/O levels, however, NetApp Private Storage for Cloud and physical FAS storage systems are likely a better fit.

# 6 Conclusion

NetApp has a long history of providing high-performance and feature-rich storage systems. ONTAP Cloud extends this legacy to AWS. With ONTAP Cloud, NetApp continues to develop leading-edge storage solutions that provide the agility and mobility that current NetApp customers desire and that future NetApp customers want. ONTAP Cloud is part of a family of products that stretch from the private cloud to the hybrid cloud to the public cloud and that run the NetApp ONTAP storage software. Understanding the performance characteristics of ONTAP Cloud is critical for setting our customers' expectations and enabling their continued success.

# Version History

| Version | Date | Document Version History |
|---|---|---|
| Version 1.2 | August 2016 | Updates for new write speed feature |
| Version 1.1 | January 2015 | Updates from testing additional instance types |
| Version 1.0 | February 2015 | Initial release |

Refer to the Interoperability Matrix Tool (IMT) on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.