Technical Report

Performance Characterization of ONTAP Cloud with Application Workloads

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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>
<thead>
<tr>
<th>Instance</th>
<th>CPU</th>
<th>RAM</th>
<th>Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>M4.2xlarge</td>
<td>8</td>
<td>32</td>
<td>High</td>
</tr>
<tr>
<td>R3.2xlarge</td>
<td>8</td>
<td>61</td>
<td>High</td>
</tr>
</tbody>
</table>

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.
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.

![Read IOPS and Latency](image1)

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

![Write IOPS and Latency](image2)

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.

![Read IOPS and Throughput](image1)

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

![Write IOPS and Throughput](image2)

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.
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>
<thead>
<tr>
<th>Test Name</th>
<th>Read/Write Profile</th>
<th>I/O Size and Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLTP</td>
<td>90% reads/10% writes</td>
<td>8KB, 100% random</td>
</tr>
<tr>
<td>MongoDB</td>
<td>100% reads</td>
<td>8KB, 100% sequential</td>
</tr>
<tr>
<td>MongoDB: update</td>
<td>50% reads/50% writes</td>
<td>8KB, 100% sequential</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Test Name</th>
<th>IOPS/Latency</th>
<th>IOPS Write Speed/Latency</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLTP</td>
<td>15,000/8ms</td>
<td>16,000/8ms</td>
</tr>
<tr>
<td>MongoDB</td>
<td>13,000/8ms</td>
<td>15,000/5ms</td>
</tr>
<tr>
<td>MongoDB: update</td>
<td>4, 400/36ms</td>
<td>22,000/6ms</td>
</tr>
</tbody>
</table>

Table 3 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.

<table>
<thead>
<tr>
<th>Test Name</th>
<th>IOPS</th>
<th>Latency</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLTP</td>
<td>15,000</td>
<td>6ms</td>
</tr>
<tr>
<td>MongoDB</td>
<td>10,000</td>
<td>8ms</td>
</tr>
<tr>
<td>MongoDB: update</td>
<td>22,000</td>
<td>8ms</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Document Version History</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version 1.2</td>
<td>August 2016</td>
<td>Updates for new write speed feature</td>
</tr>
<tr>
<td>Version 1.1</td>
<td>January 2015</td>
<td>Updates from testing additional instance types</td>
</tr>
<tr>
<td>Version 1.0</td>
<td>February 2015</td>
<td>Initial release</td>
</tr>
</tbody>
</table>
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