Abstract

This document details the components of a data pipeline built on a distributed, highly available NetApp® ONTAP® infrastructure designed for fault-tolerant execution. ONTAP data management software enables backup and restore operations of big-data databases and supports multitenancy and quality of service (QoS) for big-data workloads.

This document also describes the various tests performed on a data pipeline. It highlights the resiliency and robustness of ONTAP, which is required for a data pipeline environment.
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</table>
1 Overview

A data pipeline consolidates data from multiple sources and makes it available for strategic use. This data typically powers internal analytics and product features. A data pipeline also refers to any set of processing elements that move data from one system to another, possibly transforming the data along the way. ONTAP data management software is a powerful platform on which a data pipeline can be hosted. To realize the benefits of a data pipeline, NetApp works with a host of real-time analytics applications that combine different framework pieces. Spark, Kafka, and Cassandra are among the most common applications, but there are many more that comprise the streaming big-data pipeline. Containers and microservices are finding favor over monolithic architectures for numerous reasons, not the least of which is that it is a complex task to get these pieces to work together, as well as to make changes and updates to them once they are working.

Robin Cloud Platform (RCP) uses containers as the underlying technology for installing a host of the real-time analytics application. This platform integrates with ONTAP data management software.

This document validates and describes the following:

- RCP as a robust, scalable, resilient management and orchestration tool for ONTAP
- ONTAP value proposition for a big-data pipeline solution environment

2 Configuration Information

The solution is an end-to-end, customer-focused qualification; therefore, the testbed should be set up with all the components that comprise the big-data pipeline

Table 1 list the testbed details such as configuration information, testbed information, and versions of ONTAP, Red Hat, RCP, and Cassandra.

Table 1) Testbed details.

<table>
<thead>
<tr>
<th>Component</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robin Systems Cloud Platform</td>
<td>3.0</td>
</tr>
<tr>
<td>Linux</td>
<td>RHEL 7.4</td>
</tr>
<tr>
<td>Multipathing</td>
<td>RHEL 7.4 – DM Multipath</td>
</tr>
<tr>
<td>Cassandra</td>
<td>3.4.5, 3.4.6</td>
</tr>
<tr>
<td>ONTAP API plug-in</td>
<td>2.1.0</td>
</tr>
<tr>
<td>ONTAP API client</td>
<td>RHEL 7.2 VM</td>
</tr>
<tr>
<td>ONTAP</td>
<td>9.3 x4</td>
</tr>
<tr>
<td>Controller model</td>
<td>AFF8080 (two-node)</td>
</tr>
<tr>
<td>Processors type/cache</td>
<td>Intel/20/130GB 2.2Ghz</td>
</tr>
<tr>
<td>Server</td>
<td>Fujitsu RX200 S8</td>
</tr>
<tr>
<td>Memory</td>
<td>128GB</td>
</tr>
</tbody>
</table>
2.1 Prerequisites

Before setting up a data pipeline, complete the following steps to have RCP manage storage from the ONTAP controllers:

1. Reimage all of the master and slave Robin nodes with Red Hat Enterprise Linux 7.4.
2. Enable multipathing across all of the Red Hat Enterprise Linux 7.4 Robin nodes.
3. Make sure that the Robin host names are persistent after a reboot.
4. Reboot the Linux hosts. Make sure that the host names remain persistent and the multipath works as desired.
5. Install ONTAP API Server on a host that has at least four CPUs and 12GB of memory.
6. Use a reserved subnet other than 172.20.* for Robin’s private subnet.
7. Set up a Docker repository such that the required Docker images can be downloaded automatically.
8. Create the required number of storage virtual machines (SVMs) on the controller and enable the iSCSI license on the SVMs such that RCP can provision from these SVMs. The SVMs can exist on NetApp ONTAP Select and/or ONTAP. Let the ONTAP API server discover the SVMs.
9. Install the RCP server and client agents on the Robin nodes.

Note: The RCP comes bundled with a variety of big-data applications.

For more information, see TR-4680: Enterprise Data Apps as a Service Using Robin Systems and the NetApp Data Fabric.

3 Test Focus

The intent of the tests is to make sure that customer use cases or workflows in a big-data pipeline hosted on an ONTAP platform work as desired. These workflows include backup, restore, multitenancy, ONTAP upgrades, and other operations. This document describes the detailed workflows and the test results. The results highlight the resiliency and robustness of ONTAP for data pipeline hosting big-data applications and databases.

4 Robin Cloud Platform Resiliency Testing

4.1 Scale Robin Cloud Platform

To scale RCP, follow these steps.

1. Install the following big-data applications and verify that RCP scales successfully.

   Note: Capture the Robin nodes and ONTAP resource usage.

   a. Use RCP to install applications for a data pipeline on ONTAP, ONTAP Select, and ONTAP Cloud.
   b. Install Kafka to use storage from ONTAP Select.
   c. Install Hadoop, Cassandra, and MongoDB to use NetApp AFF (ONTAP).

Table 2) Applications and Robin resource usage.

<table>
<thead>
<tr>
<th>Number of Applications</th>
<th>Robin Nodes Resource Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CPU Cores</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
</tr>
<tr>
<td>8</td>
<td>90</td>
</tr>
</tbody>
</table>
Figure 1 and Figure 2 show the Robin dashboard with various applications. The applications are multiple instances of a mix of Kafka, Hadoop, Cassandra, and MongoDB.

Table 3 lists the details of the RCP test cases.
<table>
<thead>
<tr>
<th>Test Case</th>
<th>Description</th>
<th>Workflow</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Application Provisioning  | In this test case, we provision MongoDB and Cassandra applications and run I/O to the application using ONTAP storage on the back end.                                                                     | 1. Provision RCP.  
2. Create storage for the MongoDB and Cassandra applications.  
3. Deploy the MongoDB and Cassandra applications.  
4. Run I/O using Yahoo! Cloud Serving Benchmark (YCSB) to MongoDB and run I/O to Cassandra.                                                                 | Verified that I/O to various applications completed successfully.                                                                                                                                          |
| Storage Failover (SFO)    | In this test case, we verify the resiliency of RCP when SFO occurs. The SFOs that take place are take/give, reboot/give, and panic/give.                                                                      | 1. Follow the steps in the Application Provisioning test case to deploy the MongoDB and Cassandra applications.  
2. Perform one SFO every 60 minutes.  
3. Verify that the applications stay up and I/O continues to run.                                                                                                                                  | Verified that I/O to various applications completed successfully without failure.                                                                                                                        |
| Vol Move                  | In this test case, we verify that the application stays up and I/O continues to run to the application when the volume is moving between aggregates.                                                           | 1. Follow the steps in the Application Provisioning test case to deploy the MongoDB and Cassandra applications.  
2. Move the volume between aggregates from where the application provisioned by RCP is running.  
3. Verify that the application stays up and I/O continues to run.                                                                                                                                  | Verified that volume migration completed successfully without any I/O failures.                                                                                                                          |
| LIF Migrate               | In this test case, we verify that the application stays up and I/O continues to run when logical interfaces (LIFs) on the storage virtual machine (SVM) are rotating between nodes. | 1. Follow the steps in the Application Provisioning test case to deploy the MongoDB and Cassandra applications.  
2. Migrate the LIFs on the SVM that is connected to RCP from where the MongoDB and Cassandra applications are running.  
3. Verify that the application stays up and I/O continues to run.                                                                                                                                  | Verified that there were no I/O failures.                                                                                                                                                               |

2. With RCP at 75% usage, gracefully remove a Robin node (resiliency in the face of failures).  
   - **Expected result:** Verified applications continue to run without failure and are properly reallocated.  
   - **Observed result:** No application failures were observed. Robin node was gracefully removed.  
3. With RCP at 75% usage, move a container to a different Robin node.  
   - **Expected result:** Container is moved to a different node and applications continue to run without failure.  
   - **Observed result:** Container was moved to a different node without any application failure.  
4. With RCP at 75% usage, power off a Robin node (resiliency in face of failures).  
   - **Expected result:** Verified applications continue to run without failure.
- **Observed result**: The applications were moved to other available Robin nodes.

5. Verify that RCP and the applications are highly available during ONTAP outages (takeover/giveback)
   - The *sysstat* command shows approximately 5k iSCSI IOPS before takeover on ste-s8080-01a.

```
ste-s8080-01a@test> storage failover show
Node   Partner    Possible   State Description
------- ----------- --------- ---------------------
ste-s8080-01a ste-s8080-01b   true    Connected to ste-s8080-01b
ste-s8080-01b ste-s8080-01a   true    Connected to ste-s8080-01a
2 entries were displayed.
```

```
ste-s8080-01a@test> run * sysstat -l 1
2 entries were acted on.
```

```
Node: ste-s8080-01a
CPU  NFS  CIFS  iSCSI  Net  kB/s  Disk  kB/s  iSCSI  kB/s  Cache
    in    out    in    out     read  write  in    out    age
34%   0     0     4577  37988 1491   6462   24   35923   0 >60
31%   0     0     4502  38291 1479   6012   8     36241   0 >60
31%   0     0     4492  37744 1486   6620   0     35713   0 >60
31%   0     0     4235  37167 1411   6072   24   35209   0 >60
34%   0     0     4371  37586 1410   7856  19984  36545   0 >60
39%   0     0     4372  37297 1460  16476 533508 35254   0 >60
```

```
Node: ste-s8080-01b
CPU  NFS  CIFS  iSCSI  Net  kB/s  Disk  kB/s  iSCSI  kB/s  Cache
    in    out    in    out     read  write  in    out    age
13%   0     0     4197  4286   64    16    24   348    0 >60
12%   0     0     17    93    263  3492  13100    74    0 >60
11%   0     0     10    99    33   432   444    53    0 >60
10%   0     0     35    374   24   1564  1564   287    0 >60
13%   0     0     19   195   1934   20    0   120    0 >60
12%   0     0     86    767   38    44    24   658    0 >60
12%   0     0     12    55    28    16    0    66    0 >60
```

- Performing takeover of ste-s8080-01a.

```
ste-s8080-01a@test> takeover -ofnode ste-s8080-01a
(storage failover takeover)
```

```
ste-s8080-01a@test> storage failover show
```

```
ste-s8080-01a@test> storage failover show
Node   Partner    Possible   State Description
------- ----------- --------- ---------------------
ste-s8080-01a ste-s8080-01b   -       Unknown
ste-s8080-01b ste-s8080-01a false   In takeover
2 entries were displayed.
```

```
ste-s8080-01a@test> storage failover show
```

```
ste-s8080-01a@test> storage failover show
Node   Partner    Possible   State Description
------- ----------- --------- ---------------------
ste-s8080-01a ste-s8080-01b   -       Waiting for giveback
ste-s8080-01b ste-s8080-01a false   In takeover
2 entries were displayed.
```

```
- The `sysstat` command shows that the cluster can serve 5k IOPS even when node `ste-s8080-01a` is down.

```
ste-s8080-01ab:*> run * sysstat -i 1
2 entries were acted on.
Node: ste-s8080-01a

Node is not responding.
```

<table>
<thead>
<tr>
<th>CPU</th>
<th>NFS</th>
<th>CIFS</th>
<th>iSCSI</th>
<th>Net</th>
<th>kB/s</th>
<th>Disk</th>
<th>kB/s</th>
<th>iSCSI</th>
<th>kB/s</th>
<th>Cache</th>
</tr>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>25%</td>
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<td>0</td>
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<td>86533</td>
<td>2431</td>
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<td>24</td>
<td>82805</td>
<td>0</td>
<td>&gt;60</td>
</tr>
<tr>
<td>25%</td>
<td>0</td>
<td>0</td>
<td>2855</td>
<td>72496</td>
<td>2012</td>
<td>1784</td>
<td>24</td>
<td>69116</td>
<td>0</td>
<td>&gt;60</td>
</tr>
<tr>
<td>37%</td>
<td>0</td>
<td>0</td>
<td>2754</td>
<td>67287</td>
<td>2667</td>
<td>7636</td>
<td>285696</td>
<td>64180</td>
<td>0</td>
<td>&gt;60</td>
</tr>
<tr>
<td>26%</td>
<td>0</td>
<td>0</td>
<td>4703</td>
<td>39459</td>
<td>872</td>
<td>2200</td>
<td>179220</td>
<td>37208</td>
<td>0</td>
<td>&gt;60</td>
</tr>
<tr>
<td>29%</td>
<td>0</td>
<td>0</td>
<td>4998</td>
<td>31015</td>
<td>1713</td>
<td>5804</td>
<td>467924</td>
<td>36925</td>
<td>0</td>
<td>&gt;60</td>
</tr>
<tr>
<td>25%</td>
<td>0</td>
<td>0</td>
<td>4599</td>
<td>39847</td>
<td>1656</td>
<td>3372</td>
<td>61044</td>
<td>36285</td>
<td>0</td>
<td>&gt;60</td>
</tr>
<tr>
<td>28%</td>
<td>0</td>
<td>0</td>
<td>4233</td>
<td>37269</td>
<td>1654</td>
<td>1476</td>
<td>24</td>
<td>35226</td>
<td>0</td>
<td>&gt;60</td>
</tr>
</tbody>
</table>

6. Upgrade ONTAP (9.3 x23 to 9.4 x17) without any application or RCP failures.
- The `sysstat` command shows that there are IOPS on the 9.3 x23 cluster version.

```
ste-0080-01c:*> run ste-pm0800-01c sysstat -o 10 -i 1
```

```
ste-pm0800-01c:*> run ste-pm0800-01c sysstat -o 10 -i 1
CPU | NFS | CIFS | iSCSI | Net | kB/s | Disk | kB/s | iSCSI | kB/s | Cache |
-----|-----|------|-------|-----|------|------|------|-------|------|-------|
|     |     |      |       |     |      |      |      |       |      |       |
| 11% | 0   | 0    | 1616  | 110040| 3292 | 7752 | 24   | 104968| 0    | >60   |
| 12% | 0   | 0    | 1707  | 116657| 2942 | 8392 | 8    | 111178| 0    | >60   |
| 9%  | 0   | 0    | 1296  | 69037 | 2631 | 6284 | 24   | 83599 | 0    | >60   |
| 10% | 0   | 0    | 1359  | 92738 | 2260 | 7392 | 0    | 88707 | 0    | >60   |
| 32% | 0   | 0    | 1799  | 116885| 3321 | 26332| 355612| 113697| 0    | >60   |
| 22% | 0   | 0    | 1799  | 123718| 3920 | 17206| 851272| 117244| 0    | >60   |
| 11% | 0   | 0    | 1362  | 93710 | 3649 | 8092 | 77336 | 88957 | 0    | >60   |
| 9%  | 0   | 0    | 1343  | 90854 | 2133 | 6612 | 24   | 56258 | 0    | >60   |
| 6%  | 0   | 0    | 959   | 62461 | 2780 | 4824 | 0    | 59417 | 0    | >60   |
| 14% | 0   | 0    | 1735  | 118983| 2548 | 10292| 2020 | 113299| 0    | >60   |

ste-pm0800-01c:*> version
NetApp Release 9.3X23; Thu Jan 04 10:56:26 UTC 2018
```

- The `sysstat` command and the Robin performance UI show that the IOPS is not disrupted while the upgrade is in progress.
The `sysstat` command and Robin performance UI also show that the IOPS is not disrupted after the cluster version is upgraded to 9.4 x17.

### 4.2 Workload and Tenant Segregation with Data Fabric Multitenancy Support

Workload segregation with multitenancy creates two SVMs on AFF. Using RCP, install the two applications that use storage from the two SVMs.

Use RCP QoS knobs to manage application-level resources questions:

- The ONTAP CLI shows the configured QoS policy group by Robin systems.
- QoS is tunable from the Robin system's UI.

4.3 Back Up and Restore MongoDB Database by Using RCP

To back up and restore a MongoDB database by using RCP, follow these steps:

1. Create a MongoDB cluster.
2. Create a database.
3. Using YCSB, create a table.
4. Back up the application and delete the database or table.
5. Restore the MongoDB instance and verify the result.

    **Expected result:** The backup and restore operation from RCP should occur with the tables/database restored correctly.

    **Observed result:** The backup and restore operations from the Robin system's UI completed successfully.
6. Create a NetApp SnapMirror® relationship from ONTAP Select to ONTAP (Data Mobility).
7. Create a SnapMirror relationship from ONTAP Select to AFF (ONTAP Select to ONTAP).
8. From RCP, establish a SnapMirror relationship from ONTAP Select to ONTAP.
9. After creating the application, from the Manage tab, configure the Snapshot copy schedule to create an hourly/daily/weekly Snapshot copy.
10. Configure the backup schedule to create an hourly/daily/weekly/monthly backup that will be mirrored to a different cluster.
   To create a SnapMirror relationship to a different cluster, select a different aggregate for the Select an SVM to Which Snapshots Will Be Backed Up option.

The following SnapMirror relationships were created by RCF:
11. Create a SnapMirror relationship from ONTAP Select to AFF (Edge to ONTAP Select).

12. From RCP, establish a SnapMirror relationship from ONTAP Select to ONTAP. Perform a take/give operation while orchestrating a mobility event.

13. Perform an SFO on the destination node hosting the SnapMirror relationship and then trigger SnapMirror by selecting the Backup Snapshot option.
Where to Find Additional Information

To learn more about the information described in this document, refer to the following documents and/or websites:

- NetApp ONTAP 9 Documentation Center  
  http://docs.netapp.com/ontap-9/index.jsp
- NetApp ONTAP Resources page  
  http://mysupport.netapp.com/ontap/resources
- NetApp Product Documentation page  
  https://docs.netapp.com

Version History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Document Version History</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version 1.0</td>
<td>July 2018</td>
<td>Initial release.</td>
</tr>
</tbody>
</table>
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