Technical Report

Big-Data Pipeline on ONTAP and Orchestration with Robin Cloud Platform

Ranga Sankar, Jayakumar Chendamarai, Aaron Carter, David Bellizzi, NetApp
July 2018 | TR-4706

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.

NetApp®

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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.

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

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.

Number of Applications	Robin Nodes Resource Usage	
	CPU Cores	**Memory**
4	30	25GB
8	90	60GB

Number of Applications	Robin Nodes Resource Usage	
	CPU Cores	**Memory**
16	120	210GB

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.

Figure 1) Robin dashboard: example 1.

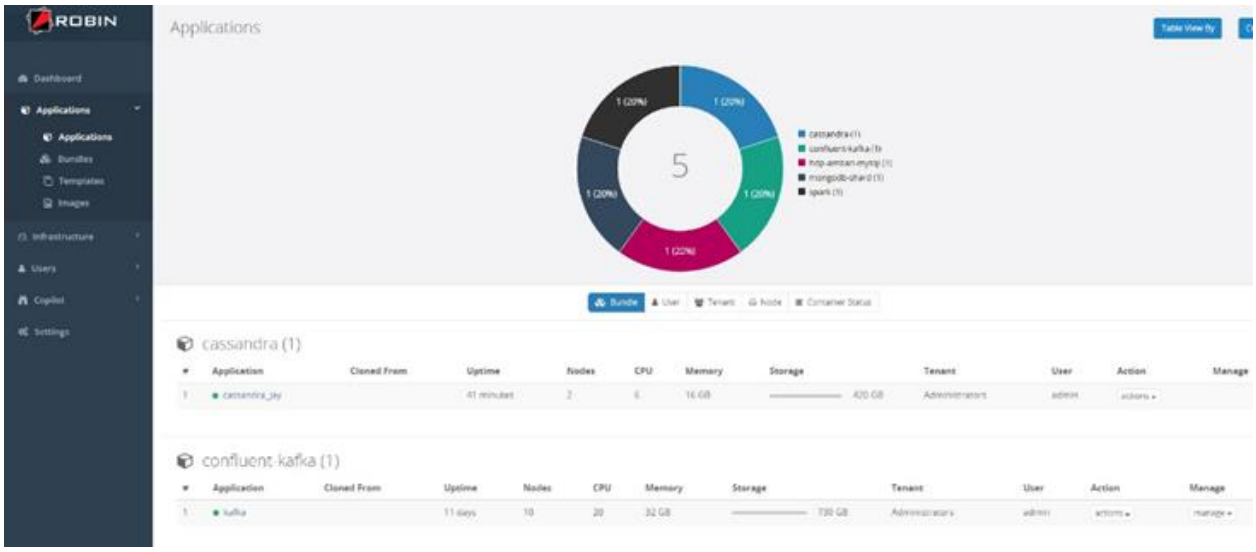


Figure 2) Robin dashboard: example 2.

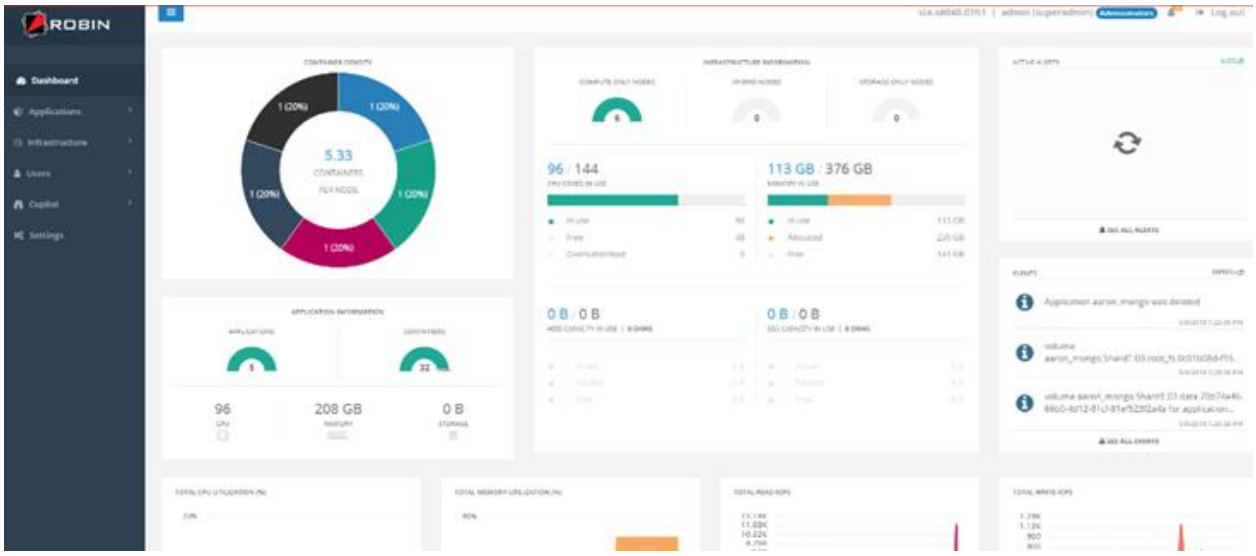


Table 3 lists the details of the RCP test cases.

Table 3) Test case details.

Test Case	Description	Workflow	Comments
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 Provision 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-s8080-01ab::*> storage failover show
                              Takeover
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-s8080-01ab::*> run * sysstat -i 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    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   35545      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    read  write     in    out    age
 13%       0       0      49     428     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      28      8     130      0   >60
  9%       0       0      86     767     88      44     24     658      0   >60
 12%       0       0      12      95     28      16      0      66      0   >60
```

   - Performing takeover of `ste-s8080-01a`.

```
ste-s8080-01ab::*> takeover -ofnode ste-s8080-01a
  (storage failover takeover)

ste-s8080-01ab::*>
ste-s8080-01ab::*>
ste-s8080-01ab::*> storage failover show
                              Takeover
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-s8080-01ab::*> storage failover show
                              Takeover
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.
```

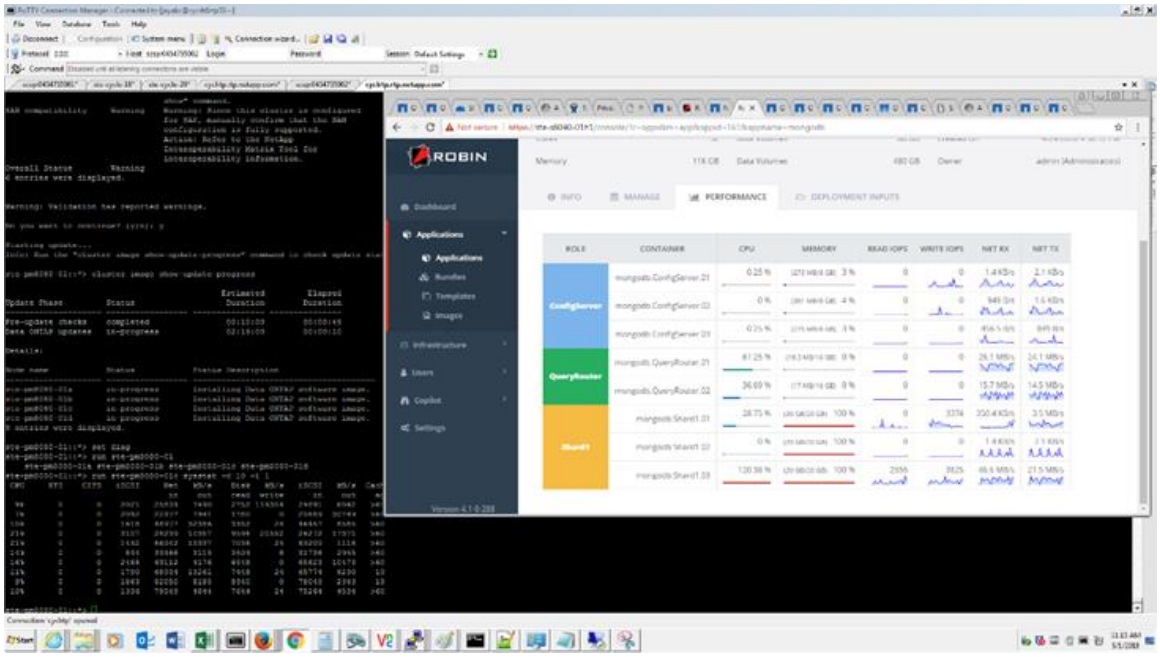
- The `sysstat` command shows that the cluster can serve 5k IOPS even when node `ste-s8080-01a` is down.

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

Node: ste-s8080-01a

Node is not responding.

Node: ste-s8080-01b
 CPU     NFS    CIFS   iSCSI     Net   kB/s    Disk   kB/s   iSCSI   kB/s  Cache
                             in    out    read  write     in    out    age
 25%       0       0    1594   86533   2431    1840     24   82805      0   >60
 25%       0       0    2855   72496   2012    1784     24   69116      0   >60
 37%       0       0    2754   67257   2667    7636 285696   64180      0   >60
 26%       0       0    4703   39459    872    2308 179220   37298      0   >60
 29%       0       0    4698   39105   1713    5804 467924   36925      0   >60
 25%       0       0    4539   38407   1656    3372  61044   36295      0   >60
 28%       0       0    4233   37269   1654    1476     24   35226      0   >60
```

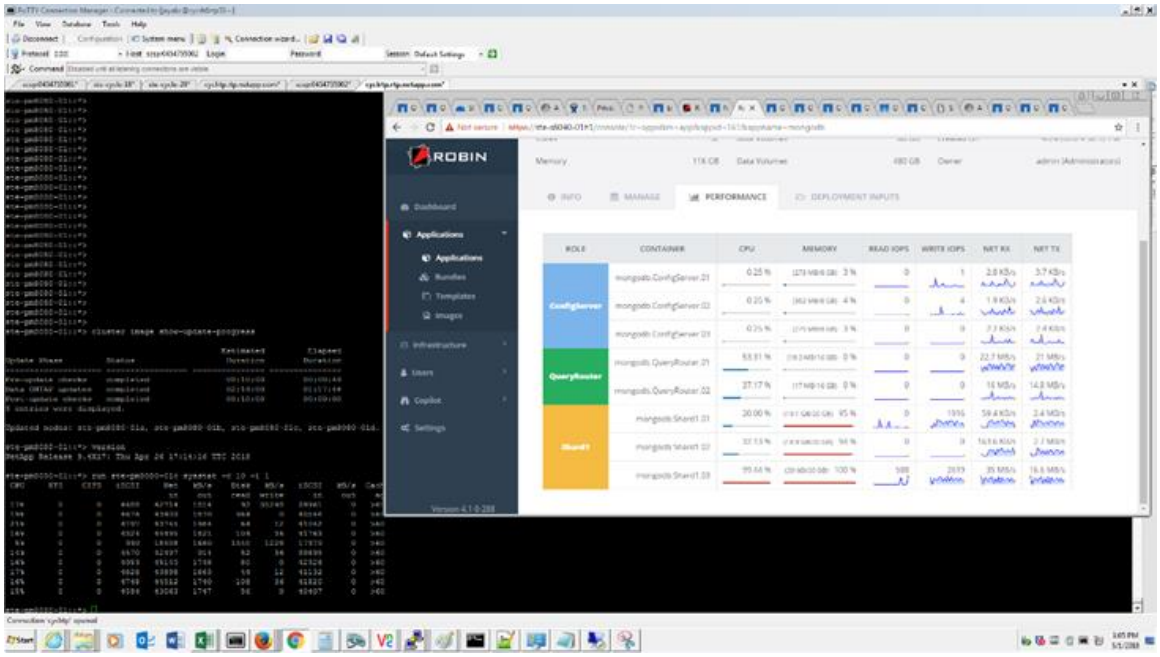
6. Upgrade ONTAP (9.3 x23 to 9.4 x17) without any application or RCP failures.
   - The `sysstat` command shows that there are IOPS on the 9.3 x23 cluster version.

```
ste-pm8080-01::*> run ste-pm8080-01c sysstat -c 10 -i 1
 CPU     NFS    CIFS   iSCSI     Net   kB/s    Disk   kB/s   iSCSI   kB/s  Cache
                             in    out    read  write     in    out    age
 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    1286   88057   2631    6284     24   83599      0   >60
 10%       0       0    1359   92738   2260    7392      0   88707      0   >60
 32%       0       0    1739  118885   3321   26332 335612  113697      0   >60
 22%       0       0    1799  123376   3920   17208 851272  117244      0   >60
 11%       0       0    1362   93718   3649    8092  77336   88957      0   >60
  9%       0       0    1343   90584   2133    6612     24   86258      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-pm8080-01::*> 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.

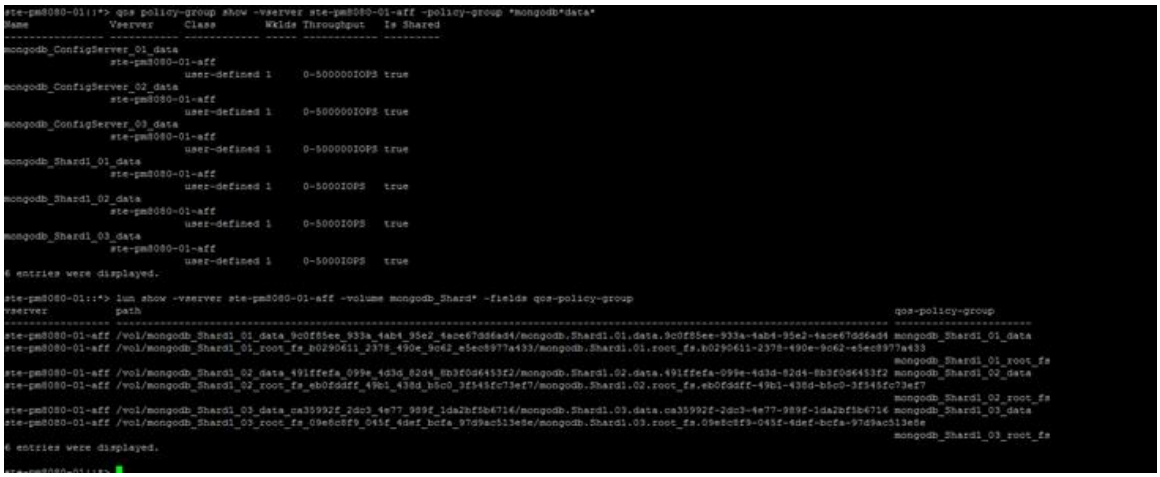


4.2 Workload and Tenant Segregation with Data Fabric Multitenancy Support

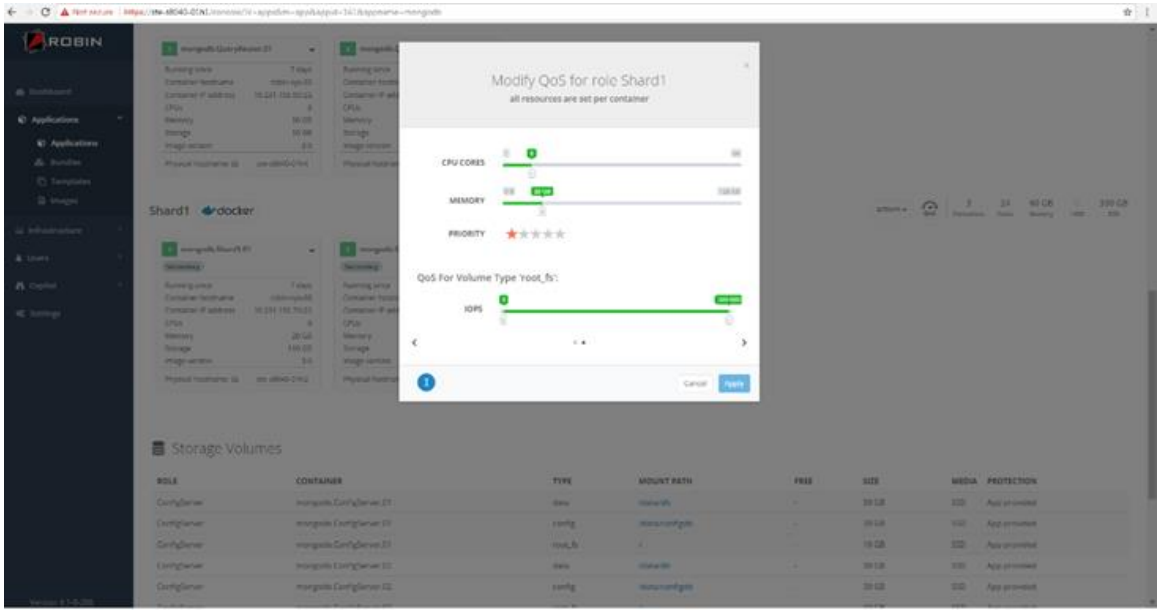
Workload segregation with multitenancy creates two SVMs on AFF. Using RCP, install the two applications that use storage from the two SVMs.

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.



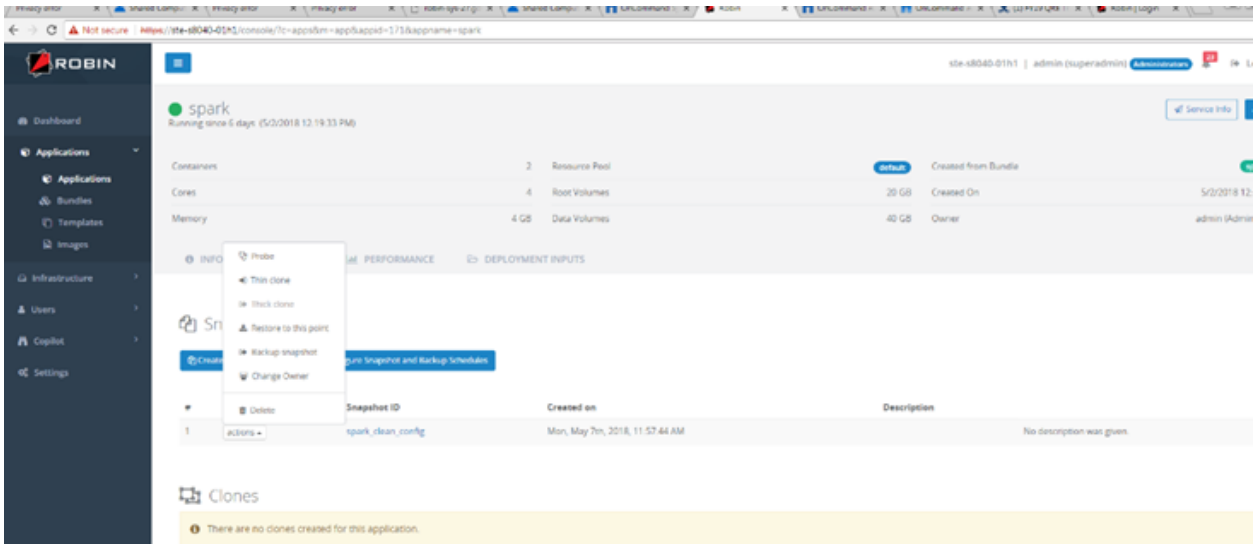
4.3 Back Up and Restore MongoDB Database by Using RCP

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.

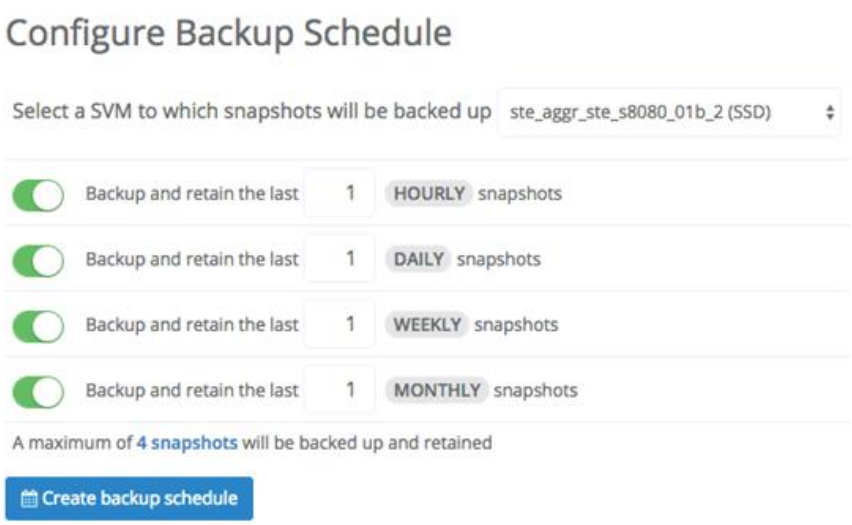
   Expected result: The backup and restore operation from RCP should occur with the tables/database restored correctly.

   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.

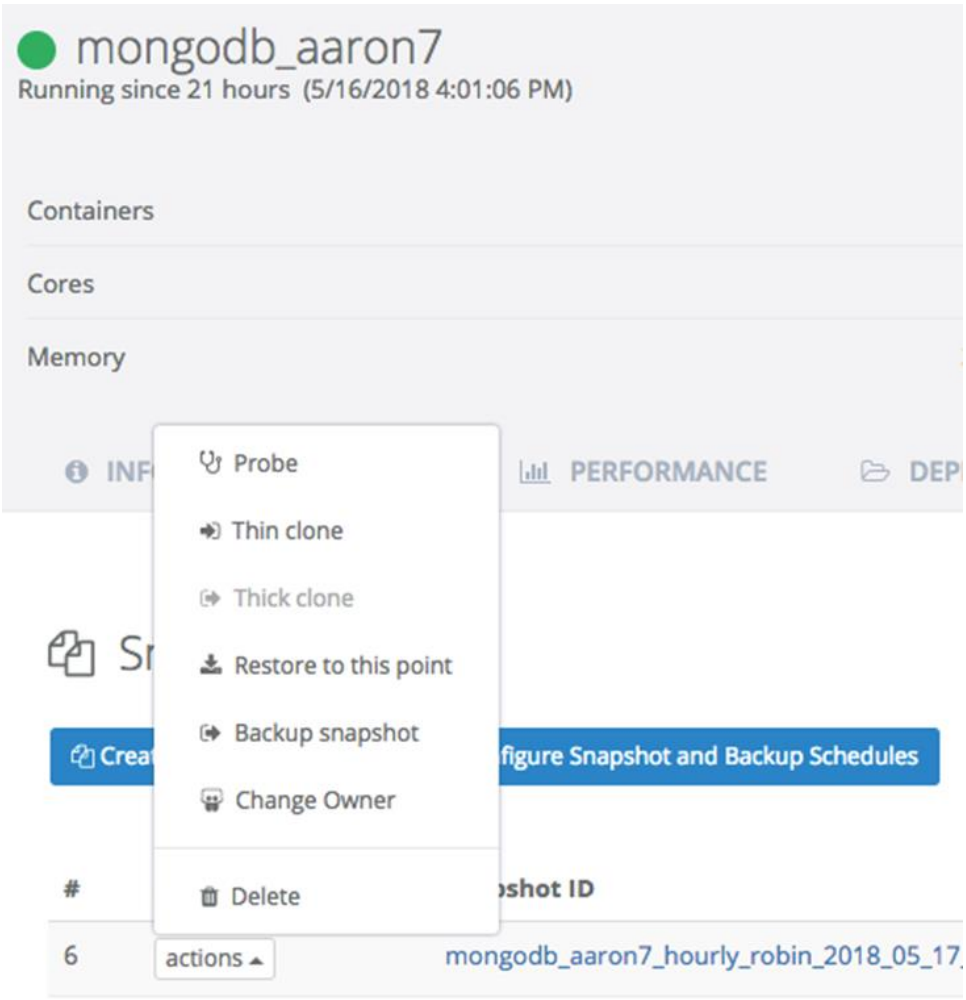
    To create a SnapMirror relationship to a different cluster, select a different aggregate for the Select an SVM to Which Snapshots Will Be Backed Up option.



The following SnapMirror relationships were created by RCF:

```
ste-pm8080-02a1469220978::*> snapmirror show -vserver vs_mongodb_1
                                                                       Progress
Source            Destination Mirror  Relationship   Total             Last
Path        Type  Path        State   Status         Progress  Healthy Updated
----------- ---- ------------ ------- -------------- --------- ------- --------
test_robin_sys:mongodb_aaron7_ConfigServer_01_config_7ba86627_a8bf_41bd_ba20_e5c0628339b8
            XDP  vs_mongodb_1:mongodb_aaron7_ConfigServer_01_config_7ba86627_a8bf_41bd_ba20_e5c0628339b8_robin_backup
                              Snapmirrored
                                      Idle           -         true    -
test_robin_sys:mongodb_aaron7_ConfigServer_01_data_df739b11_b6c1_48b0_941c_6caa71955852
            XDP  vs_mongodb_1:mongodb_aaron7_ConfigServer_01_data_df739b11_b6c1_48b0_941c_6caa71955852_robin_backup
                              Snapmirrored
                                      Idle           -         true    -
test_robin_sys:mongodb_aaron7_ConfigServer_01_root_fs_c1e04283_4f61_4dc1_baad_384b890e58ae
            XDP  vs_mongodb_1:mongodb_aaron7_ConfigServer_01_root_fs_c1e04283_4f61_4dc1_baad_384b890e58ae_robin_backup
                              Snapmirrored
                                      Idle           -         true    -
test_robin_sys:mongodb_aaron7_ConfigServer_02_config_29364f3b_29d0_40f3_b258_05acac44083b
            XDP  vs_mongodb_1:mongodb_aaron7_ConfigServer_02_config_29364f3b_29d0_40f3_b258_05acac44083b_robin_backup
                              Snapmirrored
                                      Idle           -         true    -
test_robin_sys:mongodb_aaron7_ConfigServer_02_data_46d92004_16eb_41c0_8af0_4a47e4dbb031
            XDP  vs_mongodb_1:mongodb_aaron7_ConfigServer_02_data_46d92004_16eb_41c0_8af0_4a47e4dbb031_robin_backup
                              Snapmirrored
                                      Idle           -         true    -
test_robin_sys:mongodb_aaron7_ConfigServer_02_root_fs_8e736a0f_7dbd_4962_874b_c336867ed489
            XDP  vs_mongodb_1:mongodb_aaron7_ConfigServer_02_root_fs_8e736a0f_7dbd_4962_874b_c336867ed489_robin_backup
                              Snapmirrored
                                      Idle           -         true    -
test_robin_sys:mongodb_aaron7_ConfigServer_03_config_dde67e2f_f1bc_4a86_959a_150fe6108a82
            XDP  vs_mongodb_1:mongodb_aaron7_ConfigServer_03_config_dde67e2f_f1bc_4a86_959a_150fe6108a82_robin_backup
                              Snapmirrored
                                      Idle           -         true    -
test_robin_sys:mongodb_aaron7_ConfigServer_03_data_9fef010b_86b3_4136_83b7_8538fa30e47e
            XDP  vs_mongodb_1:mongodb_aaron7_ConfigServer_03_data_9fef010b_86b3_4136_83b7_8538fa30e47e_robin_backup
                              Snapmirrored
                                      Idle           -         true    -
test_robin_sys:mongodb_aaron7_ConfigServer_03_root_fs_d04a62e7_c28e_4c7e_a463_da9591808b0d
            XDP  vs_mongodb_1:mongodb_aaron7_ConfigServer_03_root_fs_d04a62e7_c28e_4c7e_a463_da9591808b0d_robin_backup
                              Snapmirrored
                                      Idle           -         true    -
test_robin_sys:mongodb_aaron7_QueryRouter_01_root_fs_5cab60c6_9130_4bf0_9cd7_00737f781e38
            XDP  vs_mongodb_1:mongodb_aaron7_QueryRouter_01_root_fs_5cab60c6_9130_4bf0_9cd7_00737f781e38_robin_backup
                              Snapmirrored
                                      Idle           -         true    -
test_robin_sys:mongodb_aaron7_QueryRouter_02_root_fs_ffdb5a4d_d664_4878_8560_c5b5bab19be8
            XDP  vs_mongodb_1:mongodb_aaron7_QueryRouter_02_root_fs_ffdb5a4d_d664_4878_8560_c5b5bab19be8_robin_backup
                              Snapmirrored
                                      Idle           -         true    -
test_robin_sys:mongodb_aaron7_Shard1_01_data_f1c8e592_c6a8_4a5d_ba0c_0e16e4d4859c
            XDP  vs_mongodb_1:mongodb_aaron7_Shard1_01_data_f1c8e592_c6a8_4a5d_ba0c_0e16e4d4859c_robin_backup
                              Snapmirrored
                                      Idle           -         true    -
test_robin_sys:mongodb_aaron7_Shard1_01_root_fs_51fae0f6_1e5f_4f91_9fbd_282f641c42bd
            XDP  vs_mongodb_1:mongodb_aaron7_Shard1_01_root_fs_51fae0f6_1e5f_4f91_9fbd_282f641c42bd_robin_backup
                              Snapmirrored
                                      Idle           -         true    -
test_robin_sys:mongodb_aaron7_Shard1_02_data_db6f15ed_4ed1_4d38_8b29_e8cbfd6b633a
            XDP  vs_mongodb_1:mongodb_aaron7_Shard1_02_data_db6f15ed_4ed1_4d38_8b29_e8cbfd6b633a_robin_backup
                              Snapmirrored
                                      Idle           -         true    -
test_robin_sys:mongodb_aaron7_Shard1_02_root_fs_4ddc4b4a_5b1b_4991_8dba_78274f2b47e4
            XDP  vs_mongodb_1:mongodb_aaron7_Shard1_02_root_fs_4ddc4b4a_5b1b_4991_8dba_78274f2b47e4_robin_backup
                              Snapmirrored
                                      Idle           -         true    -
test_robin_sys:mongodb_aaron7_Shard1_03_data_70bc342e_2c30_48c2_96a8_febf7ac1fa2e
            XDP  vs_mongodb_1:mongodb_aaron7_Shard1_03_data_70bc342e_2c30_48c2_96a8_febf7ac1fa2e_robin_backup
                              Snapmirrored
                                      Idle           -         true    -
test_robin_sys:mongodb_aaron7_Shard1_03_root_fs_dd1cc66a_96f3_4070_9e6b_79a14c624af0
            XDP  vs_mongodb_1:mongodb_aaron7_Shard1_03_root_fs_dd1cc66a_96f3_4070_9e6b_79a14c624af0_robin_backup
                              Snapmirrored
                                      Idle           -         true    -
17 entries were displayed.
```

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

Version	Date	Document Version History
Version 1.0	July 2018	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.

Copyright Information

Trademark Information

TR-4706-0718