Red Hat Openshift Container Storage 3.11

Operations Guide

Configuring and Managing Red Hat Openshift Container Storage.

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Abstract

This guide provides information about operating your Container Storage deployment.

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PART I. MANAGE

CHAPTER 1. MANAGING CLUSTERS

Heketi allows administrators to add and remove storage capacity by managing either a single or multiple Red Hat Gluster Storage clusters.

1.1. INCREASING STORAGE CAPACITY

You can increase the storage capacity using any of the following ways:

- Adding devices
- Adding new nodes
- Adding an entirely new cluster.

1.1.1. Adding New Devices

You can add more devices to existing nodes to increase storage capacity. When adding more devices, you must ensure to add devices as a set. For example, when expanding a distributed replicated volume with a replica count of replica 2, then one device should be added to at least two nodes. If using replica 3, then at least one device should be added to at least three nodes.

You can add a device by using CLI as follows:

Register the specified device. The following example command shows how to add a device **/dev/sde** to node **d6f2c22f2757bf67b1486d868dcb7794**:

```
# heketi-cli device add --name=/dev/sde --
node=d6f2c22f2757bf67b1486d868dcb7794
OUTPUT:
Device added successfully
```

1.1.2. Adding New Nodes

Another way to add storage to Heketi, is to add new nodes to the cluster. Like adding devices, you can add a new node to an existing cluster by using CLI. After you add a new node to the cluster, you must register new devices to that node.

NOTE

For adding a node to be successful, ensure the ports are opened for glusterd communication. For more information about the ports, see https://access.redhat.com/documentation/en-us/red_hat_gluster_storage/3.4/html/installation_guide/port_information

1. Scaleup the OCP cluster to add the new node. For more information see, https://access.redhat.com/documentation/en-us/openshift_container_platform/3.11/html-single/configuring_clusters/#adding-cluster-hosts_adding-hosts-to-cluster

> **NOTE**
>
> - If the new node is already part of OCP cluster then skip this step and proceed with Step 2.
> - The OCP cluster can be scaled up to add new nodes as either compute nodes or infra nodes. For example, for infra it is node3.example.com openshift_node_group_name='node-config-infra' and for compute node it is node3.example.com openshift_node_group_name='node-config-compute'.

2. Configure the firewall rules:

   > **NOTE**
   >
   > For adding a node to be successful, ensure the ports are opened for glusterd communication. For more information about the ports, see https://access.redhat.com/documentation/en-us/red_hat_gluster_storage/3.4/html/installation_guide/port_information

   1. Add the following rules /etc/sysconfig/iptables file of the newly added glusterfs node:

      ```
      -A OS_FIREWALL_ALLOW -p tcp -m state --state NEW -m tcp --dport
      24007 -j ACCEPT
      -A OS_FIREWALL_ALLOW -p tcp -m state --state NEW -m tcp --dport
      24008 -j ACCEPT
      -A OS_FIREWALL_ALLOW -p tcp -m state --state NEW -m tcp --dport
      2222 -j ACCEPT
      -A OS_FIREWALL_ALLOW -p tcp -m state --state NEW -m multiport --
      dports 49152:49664 -j ACCEPT
      -A OS_FIREWALL_ALLOW -p tcp -m state --state NEW -m tcp --dport
      24010 -j ACCEPT
      -A OS_FIREWALL_ALLOW -p tcp -m state --state NEW -m tcp --dport
      3260 -j ACCEPT
      -A OS_FIREWALL_ALLOW -p tcp -m state --state NEW -m tcp --dport
      111 -j ACCEPT
      ```

   2. Reload/restart the iptables:

      ```
      # systemctl restart iptables
      ```

3. Execute the following steps to add labels to the node where the RHGS Container will be deployed:

   1. Verify that Red Hat Openshift Container Storage is deployed and working as expected in the existing project by executing the following command:

      ```
      # oc get ds
      ```

      For example:

      ```
      # oc get ds
      NAME                DESIRED   CURRENT   READY     UP-TO-DATE
      AVAILABLE   NODE SELECTOR            AGE
      ```

```
    glusterfs-storage   3         3         3         3
    3           glusterfs=storage-host   1d
    ```

    2. Add the label for each node which is newly added, where the Red Hat Gluster Storage pods are to be added for the new cluster:

       ```
       # oc label node <NODE_NAME> glusterfs=<node_label>
       ```

       where,

       - NODE_NAME: is the name of the newly created node.
       - node_label: The name that is used in the existing daemonset. This is the value you get in the previous step when you execute **oc get ds**.

       For example:

       ```
       # oc label node 192.168.90.3 glusterfs=storage-host
       node "192.168.90.3" labeled
       ```

    3. Verify if the Red Hat Gluster Storage pods are running on the newly added node by executing the following command:

       Observe additional Gluster Storage pods spawned on these new nodes

       ```
       # oc get pods
       ```

       For example:

       ```
       # oc get pods
       NAME              READY     STATUS    RESTARTS   AGE
       glusterfs-356cf   1/1       Running   0          30d
       glusterfs-fh4gm   1/1       Running   0          30d
       glusterfs-hg4tk   1/1       Running   0          30d
       glusterfs-v759z   0/1       Running   0          1m
       ```

       You should see additional Gluster Storage pods, in this example 4 gluster pods instead of just 3 as before. It will take 1-2 minutes for them to become healthy. (i.e. glusterfs-v759z 0/1 not healthy yet).

    4. Verify if the Red Hat Gluster Storage pods are running

       ```
       # oc get pods -o wide -l glusterfs=storage-pod
       ```

4. Add a new node to the cluster by using Heketi CLI. Following shows an example of how to add new node in **zone 1** to **597fceb5d6c876b899e48f599b988f54** cluster using the CLI:

   ```
   # heketi-cli node add --zone=1 --
   cluster=597fceb5d6c876b899e48f599b988f54 --management-host-
   name=node4.example.com --storage-host-name=192.168.10.104

   OUTPUT:
   Node information:
   Id: 095d5f26b56dc6c64564a9bc17338cbf
   ```

```
State: online
Cluster Id: 597fceb5d6c876b899e48f599b988f54
Zone: 1
Management Hostname node4.example.com
Storage Hostname 192.168.10.104
```

5. Add devices to the cluster by using Heketi CLI. For more information on adding devices, refer Section 1.1.1, "Adding New Devices".

1.1.3. Adding a New Cluster

Storage capacity can also be increased by adding new clusters of Red Hat Gluster Storage. New clusters can be added in the following two ways based on the requirement:

- Adding a new cluster to an existing Red Hat Openshift Container Storage installation
- Adding another Red Hat Openshift Container Storage cluster in a new project

In all cases, the nodes of the new clusters must be prepared as either OCP nodes (converged mode) or RHGS nodes (independent mode).

1.1.3.1. Adding a New Cluster to an Existing Red Hat Openshift Container Storage Installation

To add a new cluster to an existing Red Hat Openshift Container Storage installation, execute the following commands:

1. Verify that Red Hat Openshift Container Storage is deployed and working as expected in the existing project by executing the following command. :

```
# oc get ds
```

For example:

```
# oc get ds
NAME                DESIRED   CURRENT   READY     UP-TO-DATE
AVAILABLE   NODE SELECTOR            AGE
glusterfs-storage   3         3         3         3            3
glusterfs=storage-host   1d
```

NOTE

Add new hosts by performing step 1 through step 3 in Section 1.1.2, "Adding New Nodes" section. Repeat the steps for all the nodes you want to add.

2. Verify if the Red Hat Gluster Storage pods are running by executing the following command:

```
# oc get pods
```

3. Add the label for each node which is newly added , where the Red Hat Gluster Storage pods are to be added for the new cluster to start by executing the following command:

```
# oc label node <NODE_NAME> glusterfs=<node_label>
```

▪

where,

- NODE_NAME: is the name of the newly created node
- node_label: The name that is used in the existing daemonset.

For example:

```
# oc label node 192.168.90.3 glusterfs=storage-host
node "192.168.90.3" labeled
```

Observe additional Gluster Storage pods spawned on these new nodes

```
# oc get pods
```

For example:

```
# oc get pods
NAME              READY     STATUS    RESTARTS   AGE
glusterfs-356cf   1/1       Running   0          30d
glusterfs-fh4gm   1/1       Running   0          30d
glusterfs-hg4tk   1/1       Running   0          30d
glusterfs-v759z   0/1       Running   0          1m
glusterfs-rgs3k   0/1       Running   0          1m
glusterfs-gtq9f   0/1       Running   0          1m
```

You should see additional Gluster Storage pods, in this example 6 gluster pods instead of just 3 as before. It will take 1-2 minutes for them to become healthy. (i.e. glusterfs-v759z, glusterfs-rgs3k, and glusterfs-gtq9f 0/1 not healthy yet).

4. Verify if the Red Hat Gluster Storage pods are running by executing the following command:

```
# oc get ds
```

For example:

```
# oc get ds
NAME                DESIRED   CURRENT   READY     UP-TO-DATE
AVAILABLE   NODE SELECTOR            AGE
glusterfs-storage   3         3         3         3            3
glusterfs=storage-host   1d
```

5. create a new cluster in Heketi by using the following command:

```
# heketi-cli cluster create
```

6. Add nodes and devices to the newly created cluster as described in sections Section 1.1.1, “Adding New Devices” and Section 1.1.2, “Adding New Nodes”.

1.1.3.2. Adding Another Red Hat Openshift Container Storage Cluster in a New Project

To add another Red Hat Openshift Container Storage in a new project to, execute the following commands:

NOTE

As Node label is global, there can be conflicts to start Red Hat Gluster Storage DaemonSets with the same label in two different projects. Node label is an argument to cns-deploy, thereby enabling deployment of multiple trusted storage pool by using a different label in a different project.

For more information on how to add a new cluster to the existing Red Hat Openshift Container Storage in independent mode, see https://access.redhat.com/documentation/en-us/red_hat_openshift_container_storage/3.11/html/deployment_guide/cns_deploy_optional.

1. Create a new project by executing the following command:

   ```
   # oc new-project <new_project_name>
   ```

   For example:

   ```
   # oc new-project storage-project-2

   Now using project "storage-project-2" on server
   "https://master.example.com:8443"
   ```

2. After the project is created, execute the following command on the master node to enable the deployment of the privileged containers as Red Hat Gluster Storage container can only run in the privileged mode.

   ```
   # oc adm policy add-scc-to-user privileged -z storage-project-2
   # oc adm policy add-scc-to-user privileged -z default
   ```

3. Create a new topology file for the new cluster. You must provide a topology file for the new cluster which describes the topology of the Red Hat Gluster Storage nodes and their attached storage devices. As a sample, a formatted topology file (topology-sample.json) is installed with the ‘heketi-client’ package in the /usr/share/heketi/ directory.

   For example:

   ```
   {
       "clusters": [
           {
               "nodes": [
                   {
                       "node": {
                           "hostnames": {
                               "manage": [
                                   "node1.example.com"
                               ],
                               "storage": [
                                   "192.168.68.3"
                               ]
                           },
   ```

```
                        "zone": 1
                    },
                    "devices": [
                        "/dev/sdb",
                        "/dev/sdc",
                        "/dev/sdd",
                        "/dev/sde",
                        "/dev/sdf",
                        "/dev/sdg",
                        "/dev/sdh",
                        "/dev/sdi"
                    ]
                },
                {
                    "node": {
                        "hostnames": {
                            "manage": [
                                "node2.example.com"
                            ],
                            "storage": [
                                "192.168.68.2"
                            ]
                        },
                        "zone": 2
                    },
                    "devices": [
                        "/dev/sdb",
                        "/dev/sdc",
                        "/dev/sdd",
                        "/dev/sde",
                        "/dev/sdf",
                        "/dev/sdg",
                        "/dev/sdh",
                        "/dev/sdi"
                    ]
                },

.......
.......
```

where,

- clusters: Array of clusters.

  Each element on the array is a map which describes the cluster as follows.

  - nodes: Array of OpenShift nodes that will host the Red Hat Gluster Storage container

    Each element on the array is a map which describes the node as follows

    - node: It is a map of the following elements:

      - zone: The value represents the zone number that the node belongs to; the zone number is used by heketi for choosing optimum position of bricks by having replicas of bricks in different zones. Hence zone number is similar to a failure domain.

        - hostnames: It is a map which lists the manage and storage addresses
            - manage: It is the hostname/IP Address that is used by Heketi to communicate with the node
            - storage: It is the IP address that is used by other OpenShift nodes to communicate with the node. Storage data traffic will use the interface attached to this IP. This must be the IP address and not the hostname because, in an OpenShift environment, Heketi considers this to be the endpoint too.
    - devices: Name of each disk to be added

Edit the topology file based on the Red Hat Gluster Storage pod hostname under the **`node.hostnames.manage`** section and **`node.hostnames.storage`** section with the IP address. For simplicity, the /usr/share/heketi/topology-sample.json file only sets up 4 nodes with 8 drives each.

4. Execute the following command on the client to deploy the heketi and Red Hat Gluster Storage pods:

```
# cns-deploy -n <namespace> --daemonset-label <NODE_LABEL> -g
topology.json
```

For example:

```
# cns-deploy -n storage-project-2 --daemonset-label glusterfs2 -g
topology.json
Welcome to the deployment tool for GlusterFS on Kubernetes and
OpenShift.

Before getting started, this script has some requirements of the
execution
environment and of the container platform that you should verify.

The client machine that will run this script must have:
 * Administrative access to an existing Kubernetes or OpenShift
cluster
 * Access to a python interpreter 'python'
 * Access to the heketi client 'heketi-cli'

Each of the nodes that will host GlusterFS must also have
appropriate firewall
rules for the required GlusterFS ports:
 * 2222  - sshd (if running GlusterFS in a pod)
 * 24007 - GlusterFS Daemon
 * 24008 - GlusterFS Management
 * 49152 to 49251 - Each brick for every volume on the host requires
its own
   port. For every new brick, one new port will be used starting at
49152. We
   recommend a default range of 49152-49251 on each host, though you
can adjust
   this to fit your needs.

In addition, for an OpenShift deployment you must:
 * Have 'cluster_admin' role on the administrative account doing the
deployment
 * Add the 'default' and 'router' Service Accounts to the
'privileged' SCC
 * Have a router deployed that is configured to allow apps to access
services
   running in the cluster

Do you wish to proceed with deployment?

[Y]es, [N]o? [Default: Y]: Y
Using OpenShift CLI.
NAME                 STATUS    AGE
storage-project-2    Active    2m
Using namespace "storage-project-2".
Checking that heketi pod is not running ... OK
template "deploy-heketi" created
serviceaccount "heketi-service-account" created
template "heketi" created
template "glusterfs" created
role "edit" added: "system:serviceaccount:storage-project-2:heketi-
service-account"
node "192.168.35.5" labeled
node "192.168.35.6" labeled
node "192.168.35.7" labeled
daemonset "glusterfs" created
Waiting for GlusterFS pods to start ... OK
service "deploy-heketi" created
route "deploy-heketi" created
deploymentconfig "deploy-heketi" created
Waiting for deploy-heketi pod to start ... OK
Creating cluster ... ID: fde139c21b0afcb6206bf272e0df1590
Creating node 192.168.35.5 ... ID: 0768a1ee35dce4cf707c7a1e9caa3d2a
Adding device /dev/vdc ... OK
Adding device /dev/vdd ... OK
Adding device /dev/vde ... OK
Adding device /dev/vdf ... OK
Creating node 192.168.35.6 ... ID: 63966f6ffd48c1980c4a2d03abeedd04
Adding device /dev/vdc ... OK
Adding device /dev/vdd ... OK
Adding device /dev/vde ... OK
Adding device /dev/vdf ... OK
Creating node 192.168.35.7 ... ID: de129c099193aaff2c64dca825f33558
Adding device /dev/vdc ... OK
Adding device /dev/vdd ... OK
Adding device /dev/vde ... OK
Adding device /dev/vdf ... OK
heketi topology loaded.
Saving heketi-storage.json
secret "heketi-storage-secret" created
endpoints "heketi-storage-endpoints" created
service "heketi-storage-endpoints" created
job "heketi-storage-copy-job" created
deploymentconfig "deploy-heketi" deleted
route "deploy-heketi" deleted
service "deploy-heketi" deleted
```

```
job "heketi-storage-copy-job" deleted
pod "deploy-heketi-1-d0qrs" deleted
secret "heketi-storage-secret" deleted
service "heketi" created
route "heketi" created
deploymentconfig "heketi" created
Waiting for heketi pod to start ... OK
heketi is now running.
Ready to create and provide GlusterFS volumes.
```

NOTE

For more information on the cns-deploy commands, see to the man page of the cns-deploy.

```
# cns-deploy --help
```

5. Verify that Red Hat Openshift Container Storage is deployed and working as expected in the new project with the new daemonSet label by executing the following command:

```
# oc get ds
```

For example:

```
# oc get ds
NAME         DESIRED    CURRENT    READY      NODE-SELECTOR
AGE
glusterfs    3          3          3          storagenode=glusterfs2
8m
```

1.2. REDUCING STORAGE CAPACITY

Heketi also supports the reduction of storage capacity. You can reduce storage by deleting devices, nodes, and clusters. These requests can only be performed by using the Heketi CLI or the API. For information on using command line API, see Heketi API https://github.com/heketi/heketi/wiki/API.

NOTE

- The IDs can be retrieved by executing the heketi-cli topology info command.

  ```
  # heketi-cli topology info
  ```

- The **heketidbstorage** volume cannot be deleted as it contains the heketi database.

1.2.1. Deleting Volumes

You can delete the volume using the following Heketi CLI command:

```
# heketi-cli volume delete <volume_id>
```

For example:

```
heketi-cli volume delete 12b2590191f571be9e896c7a483953c3
Volume 12b2590191f571be9e896c7a483953c3 deleted
```

1.2.2. Deleting Device

Deleting the device deletes devices from heketi's topology. Devices that have bricks cannot be deleted. You must ensure they are free of bricks by disabling and removing devices.

1.2.2.1. Disabling and Enabling a Device

Disabling devices stops further allocation of bricks onto the device. You can disable devices using the following Heketi CLI command:

```
# heketi-cli device disable <device_id>
```

For example:

```
# heketi-cli device disable f53b13b9de1b5125691ee77db8bb47f4
Device f53b13b9de1b5125691ee77db8bb47f4 is now offline
```

If you want to re-enable the device, execute the following command. Enabling the device allows allocation of bricks onto the device.

```
# heketi-cli device enable <device_id>
```

For example:

```
# heketi-cli device enable f53b13b9de1b5125691ee77db8bb47f4
Device f53b13b9de1b5125691ee77db8bb47f4 is now online
```

1.2.2.2. Removing and Deleting the Device

Removing devices moves existing bricks from the device to other devices. This helps in ensuring the device is free of bricks. A device can be removed only after disabling it.

1. Remove device using the following command:

   ```
    # heketi-cli device remove <device_id>
   ```

   For example:

   ```
   heketi-cli device remove e9ef1d9043ed3898227143add599e1f9
   Device e9ef1d9043ed3898227143add599e1f9 is now removed
   ```

2. Delete the device using the following command:

   ```
   # heketi-cli device delete <device_id>
   ```

   For example:

```
heketi-cli device delete 56912a57287d07fad0651ba0003cf9aa
Device 56912a57287d07fad0651ba0003cf9aa deleted
```

The only way to reuse a deleted device is by adding the device to heketi's topology again.

1.2.2.3. Replacing a Device

Heketi does not allow one-to-one replacement of a device with another. However, in case of a failed device, follow the example below for the sequence of operations that are required to replace a failed device.

1. Locate the device that has failed using the following command:

   ```
   # heketi-cli topology info
   ```

   ```
   …
   …
   ...
       Nodes:
   Node Id: 8faade64a9c8669de204b66bc083b10d
   ...
   ...
   …
                   Id:a811261864ee190941b17c72809a5001   Name:/dev/vdc
   State:online    Size (GiB):499     Used (GiB):281     Free (GiB):218
                           Bricks:

   Id:34c14120bef5621f287951bcdfa774fc   Size (GiB):280     Path:
   /var/lib/heketi/mounts/vg_a811261864ee190941b17c72809a5001/brick_34c
   14120bef5621f287951bcdfa774fc/brick
   …
   …
   ...
   ```

   The example below illustrates the sequence of operations that are required to replace a failed device. The example uses device ID **a811261864ee190941b17c72809a5001** which belongs to node with id **8faade64a9c8669de204b66bc083b10das**.

2. Add a new device preferably to the same node as the device being replaced.

   ```
   # heketi-cli device add --name /dev/vdd --node
   8faade64a9c8669de204b66bc083b10d
   Device added successfully
   ```

3. Disable the failed device.

   ```
   # heketi-cli device disable a811261864ee190941b17c72809a5001
   Device a811261864ee190941b17c72809a5001 is now offline
   ```

4. Remove the failed device.

   ```
   # heketi-cli device remove a811261864ee190941b17c72809a5001
    Device a811261864ee190941b17c72809a5001 is now removed
   ```

At this stage, the bricks are migrated from the failed device. Heketi chooses a suitable device based on the brick allocation algorithm. As a result, there is a possibility that all the bricks might not be migrated to the new added device.

5. Delete the failed device.

   ```
   # heketi-cli device delete a811261864ee190941b17c72809a5001
   Device a811261864ee190941b17c72809a5001 deleted
   ```

6. Before repeating the above sequence of steps on another device, you must wait for the self-heal operation to complete. You can verify that the self-heal operation completed when the Number of entries value returns a 0 value.

   ```
   # oc rsh <any_gluster_pod_name>
   for each in $(gluster volume list) ; do gluster vol heal $each info
   | grep "Number of entries:" ; done
   Number of entries: 0
   Number of entries: 0
   Number of entries: 0
   ```

1.2.3. Deleting Node

Nodes that have devices added to it cannot be deleted. To delete the node, the devices that are associated with the node have to be deleted. Disabling and removing the node ensures all the underlying devices are removed too. Once the node is removed, all the devices in it can be deleted and finally the node can be deleted

1.2.3.1. Disabling and Enabling a Node

Disabling node stops further allocation of bricks to all the devices associated to the node. You can disable nodes using the following Heketi CLI command:

```
# heketi-cli node disable <node_id>
```

For example:

```
heketi-cli node disable 5f0af88b968ed1f01bf959fe4fe804dc
Node 5f0af88b968ed1f01bf959fe4fe804dc is now offline
```

If you want to re-enable the node, execute the following command.

```
# heketi-cli node enable <node_id>
```

For example:

```
heketi-cli node enable 5f0af88b968ed1f01bf959fe4fe804dc
Node 5f0af88b968ed1f01bf959fe4fe804dc is now online
```

1.2.3.2. Removing and Deleting the Node

Removing nodes moves existing bricks from all the devices in the node to other devices in the cluster. This helps in ensuring all the device in the node is free of bricks. A device can be removed only after disabling it.

1. To remove the node execute the following command:

   ```
   # heketi-cli node remove <node_id>
   ```

   For example:

   ```
   heketi-cli node remove 5f0af88b968ed1f01bf959fe4fe804dc
   Node 5f0af88b968ed1f01bf959fe4fe804dc is now removed
   ```

2. Delete the devices associated with the node by executing the following command as the nodes that have devices associated with it cannot be deleted:

   ```
   # heketi-cli device delete <device_id>
   ```

   For example:

   ```
   heketi-cli device delete 56912a57287d07fad0651ba0003cf9aa
   Device 56912a57287d07fad0651ba0003cf9aa deleted
   ```

   Execute the command for every device on the node.

3. Delete the node using the following command:

   ```
   # heketi-cli node delete <node_id>
   ```

   For example:

   ```
   heketi-cli node delete 5f0af88b968ed1f01bf959fe4fe804dc
   Node 5f0af88b968ed1f01bf959fe4fe804dc deleted
   ```

   Deleting the node deletes the node from the heketi topology. The only way to reuse a deleted node is by adding the node to heketi's topology again

1.2.3.3. Replacing a Node

Heketi does not allow one-to-one replacement of a node with another. However, in case of a failed node, follow the example below for the sequence of operations that are required to replace a failed node and its respective devices.

1. Locate the node that has failed using the following command:

   ```
   # heketi-cli topology info

   …
   …
   ...
       Nodes:
   Node Id: 8faade64a9c8669de204b66bc083b10d
   ...
   ```

```
...
…
                Id:a811261864ee190941b17c72809a5001   Name:/dev/vdc
State:online    Size (GiB):499     Used (GiB):281     Free (GiB):218
                        Bricks:

Id:34c14120bef5621f287951bcdfa774fc   Size (GiB):280     Path:
/var/lib/heketi/mounts/vg_a811261864ee190941b17c72809a5001/brick_34c
14120bef5621f287951bcdfa774fc/brick
…
…
...
```

The example below illustrates the sequence of operations that are required to replace a failed node. The example uses node ID 8faade64a9c8669de204b66bc083b10d.

Scale up the OCP cluster to add the replacement node. For more detail how to add a node, refer to the steps in section Section 1.1.2, “Adding New Nodes”.

NOTE

If the replacement node is already part of OCP cluster then skip this step and proceed with step 2.

2. Add a new node, preferably that has the same devices as the node being replaced.

```
# heketi-cli node add --zone=1 --
cluster=597fceb5d6c876b899e48f599b988f54 --management-host-
name=node4.example.com --storage-host-name=192.168.10.104

# heketi-cli device add --name /dev/vdd --node
8faade64a9c8669de204b66bc083b10d

Node and device added successfully
```

3. Disable the failed node.

```
# heketi-cli node disable 8faade64a9c8669de204b66bc083b10d
Node 8faade64a9c8669de204b66bc083b10d is now offline
```

4. Remove the failed node.

```
# heketi-cli node remove 8faade64a9c8669de204b66bc083b10d
 Node 8faade64a9c8669de204b66bc083b10d is now removed
```

At this stage, the bricks are migrated from the failed node. Heketi chooses a suitable device based on the brick allocation algorithm.

5. Delete the devices associated with the node by executing the following command as the nodes that have devices associated with it cannot be deleted:

```
# heketi-cli device delete <device_id>
```

For example:

```
heketi-cli device delete 56912a57287d07fad0651ba0003cf9aa
Device 56912a57287d07fad0651ba0003cf9aa deleted
```

Execute the command for every device on the node.

6. Delete the failed node.

```
# heketi-cli node delete 8faade64a9c8669de204b66bc083b10d
Node 8faade64a9c8669de204b66bc083b10d deleted
```

1.2.4. Deleting Clusters

You can delete the cluster using the following Heketi CLI command:

NOTE

Before a cluster is deleted, ensure that all the nodes inside the cluster are deleted.

```
# heketi-cli cluster delete <cluster_id>
```

For example:

```
heketi-cli cluster delete 0e949d91c608d13fd3fc4e96f798a5b1
Cluster 0e949d91c608d13fd3fc4e96f798a5b1 deleted
```

CHAPTER 2. OPERATIONS ON A RED HAT GLUSTER STORAGE POD IN AN OPENSHIFT ENVIRONMENT

This chapter lists out the various operations that can be performed on a Red Hat Gluster Storage pod (gluster pod):

1. To list the pods, execute the following command :

   ```
   # oc get pods -n <storage_project_name>
   ```

   For example:

   ```
   # oc get pods -n storage-project
   NAME                                                     READY
   STATUS     RESTARTS   AGE
   storage-project-router-1-v89qc                           1/1
   Running   0          1d
   glusterfs-dc-node1.example.com                           1/1
   Running   0          1d
   glusterfs-dc-node2.example.com                           1/1
   Running   1          1d
   glusterfs-dc-node3.example.com                           1/1
   Running   0          1d
   heketi-1-k1u14                                           1/1
   Running   0          23m
   ```

   Following are the gluster pods from the above example:

   ```
   glusterfs-dc-node1.example.com
   glusterfs-dc-node2.example.com
   glusterfs-dc-node3.example.com
   ```

   NOTE

   The topology.json file will provide the details of the nodes in a given Trusted Storage Pool (TSP) . In the above example all the 3 Red Hat Gluster Storage nodes are from the same TSP.

2. To enter the gluster pod shell, execute the following command:

   ```
   # oc rsh <gluster_pod_name> -n <storage_project_name>
   ```

   For example:

   ```
   # oc rsh glusterfs-dc-node1.example.com -n storage-project

   sh-4.2#
   ```

3. To get the peer status, execute the following command:

   ```
   # gluster peer status
   ```

For example:

```
# gluster peer status

Number of Peers: 2

Hostname: node2.example.com
Uuid: 9f3f84d2-ef8e-4d6e-aa2c-5e0370a99620
State: Peer in Cluster (Connected)
Other names:
node1.example.com

Hostname: node3.example.com
Uuid: 38621acd-eb76-4bd8-8162-9c2374affbbd
State: Peer in Cluster (Connected)
```

4. To list the gluster volumes on the Trusted Storage Pool, execute the following command:

```
# gluster volume info
```

For example:

```
Volume Name: heketidbstorage
Type: Distributed-Replicate
Volume ID: 2fa53b28-121d-4842-9d2f-dce1b0458fda
Status: Started
Number of Bricks: 2 x 3 = 6
Transport-type: tcp
Bricks:
Brick1:
192.168.121.172:/var/lib/heketi/mounts/vg_1be433737b71419dc9b395e221
255fb3/brick_c67fb97f74649d990c5743090e0c9176/brick
Brick2:
192.168.121.233:/var/lib/heketi/mounts/vg_0013ee200cdefaeb6dfedd28e5
0fd261/brick_6ebf1ee62a8e9e7a0f88e4551d4b2386/brick
Brick3:
192.168.121.168:/var/lib/heketi/mounts/vg_e4b32535c55c88f9190da7b7ef
d1fcab/brick_df5db97aa002d572a0fec6bcf2101aad/brick
Brick4:
192.168.121.233:/var/lib/heketi/mounts/vg_0013ee200cdefaeb6dfedd28e5
0fd261/brick_acc82e56236df912e9a1948f594415a7/brick
Brick5:
192.168.121.168:/var/lib/heketi/mounts/vg_e4b32535c55c88f9190da7b7ef
d1fcab/brick_65dceb1f749ec417533ddeae9535e8be/brick
Brick6:
192.168.121.172:/var/lib/heketi/mounts/vg_7ad961dbd24e16d62cabe10fd8
bf8909/brick_f258450fc6f025f99952a6edea203859/brick
Options Reconfigured:
performance.readdir-ahead: on

Volume Name: vol_9e86c0493f6b1be648c9deee1dc226a6
Type: Distributed-Replicate
Volume ID: 940177c3-d866-4e5e-9aa0-fc9be94fc0f4
Status: Started
Number of Bricks: 2 x 3 = 6
```

```
Transport-type: tcp
Bricks:
Brick1:
192.168.121.168:/var/lib/heketi/mounts/vg_3fa141bf2d09d30b899f2f260c
494376/brick_9fb4a5206bdd8ac70170d00f304f99a5/brick
Brick2:
192.168.121.172:/var/lib/heketi/mounts/vg_7ad961dbd24e16d62cabe10fd8
bf8909/brick_dae2422d518915241f74fd90b426a379/brick
Brick3:
192.168.121.233:/var/lib/heketi/mounts/vg_5c6428c439eb6686c5e4cee565
32bacf/brick_b3768ba8e80863724c9ec42446ea4812/brick
Brick4:
192.168.121.172:/var/lib/heketi/mounts/vg_7ad961dbd24e16d62cabe10fd8
bf8909/brick_0a13958525c6343c4a7951acec199da0/brick
Brick5:
192.168.121.168:/var/lib/heketi/mounts/vg_17fbc98d84df86756e7826326f
b33aa4/brick_af42af87ad87ab4f01e8ca153abbbee9/brick
Brick6:
192.168.121.233:/var/lib/heketi/mounts/vg_5c6428c439eb6686c5e4cee565
32bacf/brick_ef41e04ca648efaf04178e64d25dbdcb/brick
Options Reconfigured:
performance.readdir-ahead: on
```

5. To get the volume status, execute the following command:

```
# gluster volume status <volname>
```

For example:

```
# gluster volume status vol_9e86c0493f6b1be648c9deee1dc226a6

Status of volume: vol_9e86c0493f6b1be648c9deee1dc226a6
Gluster process                             TCP Port  RDMA Port
Online  Pid
----------------------------------------------------------------
--------------
Brick 192.168.121.168:/var/lib/heketi/mounts/v
g_3fa141bf2d09d30b899f2f260c494376/brick_9f
b4a5206bdd8ac70170d00f304f99a5/brick        49154     0          Y
3462
Brick 192.168.121.172:/var/lib/heketi/mounts/v
g_7ad961dbd24e16d62cabe10fd8bf8909/brick_da
e2422d518915241f74fd90b426a379/brick        49154     0          Y
115939
Brick 192.168.121.233:/var/lib/heketi/mounts/v
g_5c6428c439eb6686c5e4cee56532bacf/brick_b3
768ba8e80863724c9ec42446ea4812/brick        49154     0          Y
116134
Brick 192.168.121.172:/var/lib/heketi/mounts/v
g_7ad961dbd24e16d62cabe10fd8bf8909/brick_0a
13958525c6343c4a7951acec199da0/brick        49155     0          Y
115958
Brick 192.168.121.168:/var/lib/heketi/mounts/v
g_17fbc98d84df86756e7826326fb33aa4/brick_af
42af87ad87ab4f01e8ca153abbbee9/brick        49155     0          Y
```

```
3481
Brick 192.168.121.233:/var/lib/heketi/mounts/v
g_5c6428c439eb6686c5e4cee56532bacf/brick_ef
41e04ca648efaf04178e64d25dbdcb/brick        49155     0          Y
116153
NFS Server on localhost                     2049      0          Y
116173
Self-heal Daemon on localhost               N/A       N/A        Y
116181
NFS Server on node1.example.com
2049      0          Y       3501
Self-heal Daemon on node1.example.com
N/A       N/A        Y       3509
NFS Server on 192.168.121.172                  2049      0
Y       115978
Self-heal Daemon on 192.168.121.172            N/A       N/A
Y       115986

Task Status of Volume vol_9e86c0493f6b1be648c9deee1dc226a6
----------------------------------------------------------------
--------------
There are no active volume tasks
```

6. To use the snapshot feature, load the snapshot module using the following command on one of the nodes:

```
# modprobe dm_snapshot
```

IMPORTANT

Restrictions for using Snapshot

- After a snapshot is created, it must be accessed through the user-serviceable snapshots feature only. This can be used to copy the old versions of files into the required location.

  Reverting the volume to a snapshot state is not supported and should never be done as it might damage the consistency of the data.

- On a volume with snapshots, volume changing operations, such as volume expansion, must not be performed.

7. To take the snapshot of the gluster volume, execute the following command:

```
# gluster snapshot create <snapname> <volname>
```

For example:

```
# gluster snapshot create snap1 vol_9e86c0493f6b1be648c9deee1dc226a6

snapshot create: success: Snap snap1_GMT-2016.07.29-13.05.46 created
successfully
```

8. To list the snapshots, execute the following command:

   ```
   # gluster snapshot list
   ```

   For example:

   ```
   # gluster snapshot list

   snap1_GMT-2016.07.29-13.05.46
   snap2_GMT-2016.07.29-13.06.13
   snap3_GMT-2016.07.29-13.06.18
   snap4_GMT-2016.07.29-13.06.22
   snap5_GMT-2016.07.29-13.06.26
   ```

9. To delete a snapshot, execute the following command:

   ```
   # gluster snap delete <snapname>
   ```

   For example:

   ```
   # gluster snap delete snap1_GMT-2016.07.29-13.05.46

   Deleting snap will erase all the information about the snap. Do you
   still want to continue? (y/n) y
   snapshot delete: snap1_GMT-2016.07.29-13.05.46: snap removed
   successfully
   ```

   For more information about managing snapshots, see https://access.redhat.com/documentation/en-us/red_hat_gluster_storage/3.4/html-single/administration_guide/#chap-Managing_Snapshots.

10. You can set up Red Hat Openshift Container Storage volumes for geo-replication to a non-Red Hat Openshift Container Storage remote site. Geo-replication uses a master–slave model. Here, the Red Hat Openshift Container Storage volume acts as the master volume. To set up geo-replication, you must run the geo-replication commands on gluster pods. To enter the gluster pod shell, execute the following command:

    ```
     # oc rsh <gluster_pod_name> -n <storage_project_name>
    ```

    For more information about setting up geo-replication, see https://access.redhat.com/documentation/en-us/red_hat_gluster_storage/3.4/html/administration_guide/chap-managing_geo-replication.

11. Brick multiplexing is a feature that allows including multiple bricks into one process. This reduces resource consumption, allowing you to run more bricks than earlier with the same memory consumption.

    Brick multiplexing is enabled by default from Container-Native Storage 3.6. If you want to turn it off, execute the following command:

    ```
    # gluster volume set all cluster.brick-multiplex off
    ```

12. The **`auto_unmount`** option in glusterfs libfuse, when enabled, ensures that the file system is unmounted at FUSE server termination by running a separate monitor process that performs the unmount.

    The GlusterFS plugin in Openshift enables the **`auto_unmount`** option for gluster mounts.

PART II. OPERATIONS

CHAPTER 3. CREATING PERSISTENT VOLUMES

OpenShift Container Platform clusters can be provisioned with persistent storage using GlusterFS.

Persistent volumes (PVs) and persistent volume claims (PVCs) can share volumes across a single project. While the GlusterFS-specific information contained in a PV definition could also be defined directly in a pod definition, doing so does not create the volume as a distinct cluster resource, making the volume more susceptible to conflicts.

Binding PVs by Labels and Selectors

Labels are an OpenShift Container Platform feature that support user-defined tags (key-value pairs) as part of an object's specification. Their primary purpose is to enable the arbitrary grouping of objects by defining identical labels among them. These labels can then be targeted by selectors to match all objects with specified label values. It is this functionality we will take advantage of to enable our PVC to bind to our PV.

You can use labels to identify common attributes or characteristics shared among volumes. For example, you can define the gluster volume to have a custom attribute (key) named **storage-tier** with a value of **gold** assigned. A claim will be able to select a PV with **storage-tier=gold** to match this PV.

More details for provisioning volumes in file-based storage is provided in Section 3.1, “File Storage”. Similarly, further details for provisioning volumes in block-based storage is provided in Section 3.2, “Block Storage”.

3.1. FILE STORAGE

File storage, also called file-level or file-based storage, stores data in a hierarchical structure. The data is saved in files and folders, and presented to both the system storing it and the system retrieving it in the same format. You can provision volumes either statically or dynamically for file-based storage.

3.1.1. Static Provisioning of Volumes

To enable persistent volume support in OpenShift and Kubernetes, few endpoints and a service must be created:

NOTE

The following steps are not required if OpenShift Container Storage was deployed using the (default) Ansible installer

The sample glusterfs endpoint file (sample-gluster-endpoints.yaml) and the sample glusterfs service file (sample-gluster-service.yaml) are available at `/usr/share/heketi/templates/` directory.

The sample endpoints and services file will not be available for ansible deployments since /usr/share/heketi/templates/ directory will not be created for such deployments.

NOTE

Ensure to copy the sample glusterfs endpoint file / glusterfs service file to a location of your choice and then edit the copied file. For example:

```
# cp /usr/share/heketi/templates/sample-gluster-endpoints.yaml
/<path>/gluster-endpoints.yaml
```

1. To specify the endpoints you want to create, update the copied **`sample-gluster-endpoints.yaml`** file with the endpoints to be created based on the environment. Each Red Hat Gluster Storage trusted storage pool requires its own endpoint with the IP of the nodes in the trusted storage pool.

    ```
    # cat sample-gluster-endpoints.yaml
    apiVersion: v1
    kind: Endpoints
    metadata:
      name: glusterfs-cluster
    subsets:
      - addresses:
          - ip: 192.168.10.100
        ports:
          - port: 1
      - addresses:
          - ip: 192.168.10.101
        ports:
          - port: 1
      - addresses:
          - ip: 192.168.10.102
        ports:
          - port: 1
    ```

    name: is the name of the endpoint

    ip: is the ip address of the Red Hat Gluster Storage nodes.

2. Execute the following command to create the endpoints:

    ```
    # oc create -f <name_of_endpoint_file>
    ```

    For example:

    ```
    # oc create -f sample-gluster-endpoints.yaml
    endpoints "glusterfs-cluster" created
    ```

3. To verify that the endpoints are created, execute the following command:

    ```
    # oc get endpoints
    ```

    For example:

    ```
    # oc get endpoints
    NAME                       ENDPOINTS
    ```

```
AGE
storage-project-router
192.168.121.233:80,192.168.121.233:443,192.168.121.233:1936   2d
glusterfs-cluster
192.168.121.168:1,192.168.121.172:1,192.168.121.233:1         3s
heketi                     10.1.1.3:8080
2m
heketi-storage-endpoints
192.168.121.168:1,192.168.121.172:1,192.168.121.233:1         3m
```

4. Execute the following command to create a gluster service:

```
# oc create -f <name_of_service_file>
```

For example:

```
# cat sample-gluster-service.yaml
apiVersion: v1
kind: Service
metadata:
  name: glusterfs-cluster
spec:
  ports:
    - port: 1
```

```
# oc create -f sample-gluster-service.yaml
service "glusterfs-cluster" created
```

5. To verify that the service is created, execute the following command:

```
# oc get service
```

For example:

```
# oc get service
NAME                       CLUSTER-IP      EXTERNAL-IP   PORT(S)
AGE
storage-project-router     172.30.94.109   <none>
80/TCP,443/TCP,1936/TCP   2d
glusterfs-cluster          172.30.212.6    <none>        1/TCP
5s
heketi                     172.30.175.7    <none>        8080/TCP
2m
heketi-storage-endpoints   172.30.18.24    <none>        1/TCP
3m
```

NOTE

The endpoints and the services must be created for each project that requires a persistent storage.

6. Create a 100G persistent volume with Replica 3 from GlusterFS and output a persistent volume specification describing this volume to the file pv001.json:

```
$ heketi-cli volume create --size=100 --persistent-volume-
file=pv001.json
```

```
cat pv001.json
{
  "kind": "PersistentVolume",
  "apiVersion": "v1",
  "metadata": {
    "name": "glusterfs-f8c612ee",
    "creationTimestamp": null
  },
  "spec": {
    "capacity": {
      "storage": "100Gi"
    },
    "glusterfs": {
      "endpoints": "TYPE ENDPOINT HERE",
      "path": "vol_f8c612eea57556197511f6b8c54b6070"
    },
    "accessModes": [
      "ReadWriteMany"
    ],
    "persistentVolumeReclaimPolicy": "Retain"
  },
  "status": {}
```

IMPORTANT

You must manually add the **Labels** information to the .json file.

Following is the example YAML file for reference:

```
apiVersion: v1
kind: PersistentVolume
metadata:
  name: pv-storage-project-glusterfs1
  labels:
    storage-tier: gold
spec:
  capacity:
    storage: 12Gi
  accessModes:
    - ReadWriteMany
  persistentVolumeReclaimPolicy: Retain
  glusterfs:
    endpoints: TYPE END POINTS NAME HERE,
    path: vol_e6b77204ff54c779c042f570a71b1407
```

name: The name of the volume.

storage: The amount of storage allocated to this volume

glusterfs: The volume type being used, in this case the glusterfs plug-in

endpoints: The endpoints name that defines the trusted storage pool created

path: The Red Hat Gluster Storage volume that will be accessed from the Trusted Storage Pool.

accessModes: accessModes are used as labels to match a PV and a PVC. They currently do not define any form of access control.

labels: Use labels to identify common attributes or characteristics shared among volumes. In this case, we have defined the gluster volume to have a custom attribute (key) named **storage-tier** with a value of **gold** assigned. A claim will be able to select a PV with **storage-tier=gold** to match this PV.

NOTE

- heketi-cli also accepts the endpoint name on the command line (--persistent-volume-endpoint=”TYPE ENDPOINT HERE”). This can then be piped to **`oc create -f -`** to create the persistent volume immediately.
- If there are multiple Red Hat Gluster Storage trusted storage pools in your environment, you can check on which trusted storage pool the volume is created using the **`heketi-cli volume list`** command. This command lists the cluster name. You can then update the endpoint information in the **`pv001.json`** file accordingly.
- When creating a Heketi volume with only two nodes with the replica count set to the default value of three (replica 3), an error "No space" is displayed by Heketi as there is no space to create a replica set of three disks on three different nodes.
- If all the heketi-cli write operations (ex: volume create, cluster create..etc) fails and the read operations (ex: topology info, volume info ..etc) are successful, then the possibility is that the gluster volume is operating in read-only mode.

7. Edit the pv001.json file and enter the name of the endpoint in the endpoint's section:

```
cat pv001.json
{
  "kind": "PersistentVolume",
  "apiVersion": "v1",
  "metadata": {
    "name": "glusterfs-f8c612ee",
    "creationTimestamp": null,
    "labels": {
      "storage-tier": "gold"
    }
  },
  "spec": {
    "capacity": {
      "storage": "12Gi"
    },
    "glusterfs": {
      "endpoints": "glusterfs-cluster",
      "path": "vol_f8c612eea57556197511f6b8c54b6070"
    },
    "accessModes": [
      "ReadWriteMany"
    ],
    "persistentVolumeReclaimPolicy": "Retain"
  },
  "status": {}
}
```

8. Create a persistent volume by executing the following command:

   ```
   # oc create -f pv001.json
   ```

   For example:

   ```
   # oc create -f pv001.json
   persistentvolume "glusterfs-4fc22ff9" created
   ```

9. To verify that the persistent volume is created, execute the following command:

   ```
   # oc get pv
   ```

   For example:

   ```
   # oc get pv

   NAME                 CAPACITY    ACCESSMODES    STATUS       CLAIM
   REASON    AGE
   glusterfs-4fc22ff9   100Gi       RWX            Available
   4s
   ```

10. Create a persistent volume claim file. For example:

    ```
    # cat pvc.yaml
    apiVersion: v1
    kind: PersistentVolumeClaim
    metadata:
      name: glusterfs-claim
    spec:
      accessModes:
        - ReadWriteMany
      resources:
        requests:
          storage: 100Gi
        selector:
          matchLabels:
            storage-tier: gold
    ```

11. Bind the persistent volume to the persistent volume claim by executing the following command:

    ```
    # oc create -f pvc.yaml
    ```

    For example:

```
# oc create -f pvc.yaml
persistentvolumeclaim"glusterfs-claim" created
```

12. To verify that the persistent volume and the persistent volume claim is bound, execute the following commands:

    ```
    # oc get pv
    # oc get pvc
    ```

    For example:

    ```
    # oc get pv

    NAME                 CAPACITY   ACCESSMODES   STATUS    CLAIM
    REASON    AGE
    glusterfs-4fc22ff9   100Gi      RWX           Bound     storage-
    project/glusterfs-claim             1m
    ```

    ```
    # oc get pvc

    NAME              STATUS    VOLUME               CAPACITY
    ACCESSMODES   AGE
    glusterfs-claim   Bound     glusterfs-4fc22ff9   100Gi      RWX
    11s
    ```

13. The claim can now be used in the application:

    For example:

    ```
    # cat app.yaml

    apiVersion: v1
    kind: Pod
    metadata:
      name: busybox
    spec:
      containers:
        - image: busybox
          command:
            - sleep
            - "3600"
          name: busybox
          volumeMounts:
            - mountPath: /usr/share/busybox
              name: mypvc
      volumes:
        - name: mypvc
          persistentVolumeClaim:
            claimName: glusterfs-claim
    ```

    ```
    # oc create -f app.yaml
    pod "busybox" created
    ```

For more information about using the glusterfs claim in the application see, https://access.redhat.com/documentation/en-us/openshift_container_platform/3.11/html-single/configuring_clusters/#install-config-storage-examples-gluster-example.

14. To verify that the pod is created, execute the following command:

```
# oc get pods -n <storage_project_name>
```

For example:

```
# oc get pods -n storage-project

NAME                               READY     STATUS    RESTARTS
AGE
block-test-router-1-deploy         0/1       Running     0
4h
busybox                            1/1       Running   0
43s
glusterblock-provisioner-1-bjpz4   1/1       Running   0
4h
glusterfs-7l5xf                    1/1       Running   0
4h
glusterfs-hhxtk                    1/1       Running   3
4h
glusterfs-m4rbc                    1/1       Running   0
4h
heketi-1-3h9nb                     1/1       Running   0
4h
```

15. To verify that the persistent volume is mounted inside the container, execute the following command:

```
# oc rsh busybox
```

```
/ $ df -h
Filesystem                Size      Used Available Use% Mounted on
/dev/mapper/docker-253:0-1310998-
81732b5fd87c197f627a24bcd2777f12eec4ee937cc2660656908b2fa6359129
                      100.0G     34.1M     99.9G   0% /
tmpfs                     1.5G         0      1.5G   0% /dev
tmpfs                     1.5G         0      1.5G   0%
/sys/fs/cgroup
192.168.121.168:vol_4fc22ff934e531dec3830cfbcad1eeae
                       99.9G     66.1M     99.9G   0%
/usr/share/busybox
tmpfs                     1.5G         0      1.5G   0%
/run/secrets
/dev/mapper/vg_vagrant-lv_root
                       37.7G      3.8G     32.0G  11%
/dev/termination-log
tmpfs                     1.5G     12.0K      1.5G   0%
/var/run/secretgit s/kubernetes.io/serviceaccount
```

NOTE

If you encounter a permission denied error on the mount point, then refer to section Gluster Volume Security at: https://access.redhat.com/documentation/en-us/openshift_container_platform/3.11/html-single/configuring_clusters/#install-config-storage-examples-gluster-example.

3.1.2. Dynamic Provisioning of Volumes

Dynamic provisioning enables you to provision a Red Hat Gluster Storage volume to a running application container without pre-creating the volume. The volume will be created dynamically as the claim request comes in, and a volume of exactly the same size will be provisioned to the application containers.

NOTE

The steps outlined below are not necessary when OpenShift Container Storage was deployed using the (default) Ansible installer and the default storage class (glusterfs-storage) created during the installation will be used.

3.1.2.1. Configuring Dynamic Provisioning of Volumes

To configure dynamic provisioning of volumes, the administrator must define StorageClass objects that describe named "classes" of storage offered in a cluster. After creating a Storage Class, a secret for heketi authentication must be created before proceeding with the creation of persistent volume claim.

3.1.2.1.1. Creating Secret for Heketi Authentication

To create a secret for Heketi authentication, execute the following commands:

NOTE

If the **admin-key** value (secret to access heketi to get the volume details) was not set during the deployment of Red Hat Openshift Container Storage, then the following steps can be omitted.

1. Create an encoded value for the password by executing the following command:

   ```
   # echo -n "<key>" | base64
   ```

   where “key” is the value for "**admin-key**" that was created while deploying Red Hat Openshift Container Storage

   For example:

   ```
   # echo -n "mypassword" | base64
   bXlwYXNzd29yZA==
   ```

2. Create a secret file. A sample secret file is provided below:

   ```
   # cat glusterfs-secret.yaml
   ```

```
apiVersion: v1
kind: Secret
metadata:
  name: heketi-secret
  namespace: default
data:
  # base64 encoded password. E.g.: echo -n "mypassword" | base64
  key: bXlwYXNzd29yZA==
type: kubernetes.io/glusterfs
```

3. Register the secret on Openshift by executing the following command:

```
# oc create -f glusterfs-secret.yaml
secret "heketi-secret" created
```

3.1.2.1.2. Registering a Storage Class

When configuring a StorageClass object for persistent volume provisioning, the administrator must describe the type of provisioner to use and the parameters that will be used by the provisioner when it provisions a PersistentVolume belonging to the class.

1. To create a storage class execute the following command:

```
# cat > glusterfs-storageclass.yaml


apiVersion: storage.k8s.io/v1beta1
kind: StorageClass
metadata:
  name: gluster-container
provisioner: kubernetes.io/glusterfs
reclaimPolicy: Retain
parameters:
  resturl: "http://heketi-storage-project.cloudapps.mystorage.com"
  restuser: "admin"
  volumetype: "replicate:3"
  clusterid:
"630372ccdc720a92c681fb928f27b53f,796e6db1981f369ea0340913eeea4c9a"
  secretNamespace: "default"
  secretName: "heketi-secret"
  volumeoptions: "client.ssl on, server.ssl on"
  volumenameprefix: "test-vol"
allowVolumeExpansion: true
```

where,

resturl: Gluster REST service/Heketi service url which provision gluster volumes on demand. The general format must be IPaddress:Port and this is a mandatory parameter for GlusterFS dynamic provisioner. If Heketi service is exposed as a routable service in openshift/kubernetes setup, this can have a format similar to http://heketi-storage-project.cloudapps.mystorage.com where the fqdn is a resolvable heketi service url.

restuser : Gluster REST service/Heketi user who has access to create volumes in the trusted storage pool

volumetype: It specifies the volume type that is being used.

NOTE

Distributed-Three-way replication is the only supported volume type.

clusterid: It is the ID of the cluster which will be used by Heketi when provisioning the volume. It can also be a list of comma-separated cluster IDs. This is an optional parameter.

NOTE

To get the cluster ID, execute the following command:

```
# heketi-cli cluster list
```

secretNamespace + secretName: Identification of Secret instance that contains the user password that is used when communicating with the Gluster REST service. These parameters are optional. Empty password will be used when both secretNamespace and secretName are omitted.

NOTE

When the persistent volumes are dynamically provisioned, the Gluster plugin automatically creates an endpoint and a headless service in the name gluster-dynamic-<claimname>. This dynamic endpoint and service will be deleted automatically when the persistent volume claim is deleted.

volumeoptions: This is an optional parameter. It allows you to create glusterfs volumes with encryption enabled by setting the parameter to "client.ssl on, server.ssl on". For more information on enabling encryption, see Chapter 8, *Enabling Encryption*.

NOTE

Do not add this parameter in the storageclass if encryption is not enabled.

volumenameprefix: This is an optional parameter. It depicts the name of the volume created by heketi. For more information see Section 3.1.2.1.5, “(Optional) Providing a Custom Volume Name Prefix for Persistent Volumes”

NOTE

The value for this parameter cannot contain `_` in the storageclass.

allowVolumeExpansion: To increase the PV claim value, ensure to set the **`allowVolumeExpansion`** parameter in the storageclass file to **`true`**. For more information, see Section 3.1.2.1.7, “Expanding Persistent Volume Claim”.

2. To register the storage class to Openshift, execute the following command:

```
# oc create -f glusterfs-storageclass.yaml
storageclass "gluster-container" created
```

3. To get the details of the storage class, execute the following command:

```
# oc describe storageclass gluster-container

Name: gluster-container
IsDefaultClass: No
Annotations: <none>
Provisioner: kubernetes.io/glusterfs
Parameters: resturl=http://heketi-storage-
project.cloudapps.mystorage.com,restuser=admin,secretName=heketi-
secret,secretNamespace=default
No events.
```

3.1.2.1.3. Creating a Persistent Volume Claim

To create a persistent volume claim execute the following commands:

1. Create a Persistent Volume Claim file. A sample persistent volume claim is provided below:

```
# cat glusterfs-pvc-claim1.yaml
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: claim1
  annotations:
    volume.beta.kubernetes.io/storage-class: gluster-container
spec:
  persistentVolumeReclaimPolicy: Retain
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 5Gi
```

persistentVolumeReclaimPolicy:This is an optional parameter. When this parameter is set to "Retain" the underlying persistent volume is retained even after the corresponding persistent volume claim is deleted.

NOTE

When PVC is deleted, the underlying heketi and gluster volumes are not deleted if "persistentVolumeReclaimPolicy:" is set to "Retain". To delete the volume, you must use heketi cli and then delete the PV.

2. Register the claim by executing the following command:

```
# oc create -f glusterfs-pvc-claim1.yaml
persistentvolumeclaim "claim1" created
```

3. To get the details of the claim, execute the following command:

```
# oc describe pvc <claim_name>
```

For example:

```
# oc describe pvc claim1

Name: claim1
Namespace: default
StorageClass: gluster-container
Status: Bound
Volume: pvc-54b88668-9da6-11e6-965e-54ee7551fd0c
Labels: <none>
Capacity: 4Gi
Access Modes: RWO
No events.
```

3.1.2.1.4. Verifying Claim Creation

To verify if the claim is created, execute the following commands:

1. To get the details of the persistent volume claim and persistent volume, execute the following command:

```
# oc get pv,pvc

NAME                                          CAPACITY
ACCESSMODES   RECLAIMPOLICY   STATUS     CLAIM
REASON    AGE
pv/pvc-962aa6d1-bddb-11e6-be23-5254009fc65b   4Gi        RWO
Delete          Bound      storage-project/claim1             3m

NAME         STATUS    VOLUME
CAPACITY   ACCESSMODES   AGE
pvc/claim1   Bound     pvc-962aa6d1-bddb-11e6-be23-5254009fc65b
4Gi        RWO           4m
```

2. To validate if the endpoint and the services are created as part of claim creation, execute the following command:

```
# oc get endpoints,service

NAME                          ENDPOINTS
AGE
ep/storage-project-router
192.168.68.3:443,192.168.68.3:1936,192.168.68.3:80   28d
ep/gluster-dynamic-claim1
192.168.68.2:1,192.168.68.3:1,192.168.68.4:1         5m
ep/heketi                     10.130.0.21:8080
21d
ep/heketi-storage-endpoints
192.168.68.2:1,192.168.68.3:1,192.168.68.4:1         25d

NAME                           CLUSTER-IP       EXTERNAL-IP
PORT(S)                   AGE
```

```
svc/storage-project-router     172.30.166.64    <none>
80/TCP,443/TCP,1936/TCP   28d
svc/gluster-dynamic-claim1     172.30.52.17     <none>        1/TCP
5m
svc/heketi                     172.30.129.113   <none>
8080/TCP                  21d
svc/heketi-storage-endpoints   172.30.133.212   <none>        1/TCP
25d
```

3.1.2.1.5. (Optional) Providing a Custom Volume Name Prefix for Persistent Volumes

You can provide a custom volume name prefix to the persistent volume that is created. By providing a custom volume name prefix, users can now easily search/filter the volumes based on:

- Any string that was provided as the field value of "volnameprefix" in the storageclass file.
- Persistent volume claim name.
- Project / Namespace name.

To set the name, ensure that you have added the parameter **`volumenameprefix`** to the storage class file. For more information, see Section 3.1.2.1.2, “Registering a Storage Class”

NOTE

The value for this parameter cannot contain `_` in the storageclass.

To verify if the custom volume name prefix is set, execute the following command:

```
# oc describe pv <pv_name>
```

For example:

```
    # oc describe pv pvc-f92e3065-25e8-11e8-8f17-005056a55501
    Name:            pvc-f92e3065-25e8-11e8-8f17-005056a55501
    Labels:          <none>
    Annotations:     Description=Gluster-Internal: Dynamically provisioned
PV
                     gluster.kubernetes.io/heketi-volume-
id=027c76b24b1a3ce3f94d162f843529c8
                     gluster.org/type=file
                     kubernetes.io/createdby=heketi-dynamic-provisioner
                     pv.beta.kubernetes.io/gid=2000
                     pv.kubernetes.io/bound-by-controller=yes
                     pv.kubernetes.io/provisioned-
by=kubernetes.io/glusterfs
                     volume.beta.kubernetes.io/mount-options=auto_unmount
    StorageClass:    gluster-container-prefix
    Status:          Bound
    Claim:           glusterfs/claim1
    Reclaim Policy:  Delete
    Access Modes:    RWO
    Capacity:        1Gi
    Message:
```

```
    Source:
        Type:           Glusterfs (a Glusterfs mount on the host that
shares a pod's lifetime)
        EndpointsName:  glusterfs-dynamic-claim1
        Path:           test-vol_glusterfs_claim1_f9352e4c-25e8-11e8-
b460-005056a55501
        ReadOnly:       false
    Events:             <none>
```

The value for **`Path`** will have the custom volume name prefix attached to the namespace and the claim name, which is "test-vol" in this case.

3.1.2.1.6. Using the Claim in a Pod

Execute the following steps to use the claim in a pod.

1. To use the claim in the application, for example

```
# cat app.yaml

apiVersion: v1
kind: Pod
metadata:
  name: busybox
spec:
  containers:
    - image: busybox
      command:
        - sleep
        - "3600"
      name: busybox
      volumeMounts:
        - mountPath: /usr/share/busybox
          name: mypvc
  volumes:
    - name: mypvc
      persistentVolumeClaim:
        claimName: claim1
```

```
# oc create -f app.yaml
pod "busybox" created
```

For more information about using the glusterfs claim in the application see, https://access.redhat.com/documentation/en-us/openshift_container_platform/3.11/html-single/configuring_clusters/#install-config-storage-examples-gluster-example.

2. To verify that the pod is created, execute the following command:

```
# oc get pods -n storage-project

NAME                                 READY     STATUS
RESTARTS   AGE
storage-project-router-1-at7tf       1/1       Running        0
13d
busybox                              1/1       Running        0
```

```
8s
glusterfs-dc-192.168.68.2-1-hu28h   1/1       Running        0
7d
glusterfs-dc-192.168.68.3-1-ytnlg   1/1       Running        0
7d
glusterfs-dc-192.168.68.4-1-juqcq   1/1       Running        0
13d
heketi-1-9r47c                      1/1       Running        0
13d
```

3. To verify that the persistent volume is mounted inside the container, execute the following command:

```
# oc rsh busybox
```

```
/ $ df -h
Filesystem                Size      Used Available Use% Mounted on
/dev/mapper/docker-253:0-666733-
38050a1d2cdb41dc00d60f25a7a295f6e89d4c529302fb2b93d8faa5a3205fb9
                         10.0G     33.8M      9.9G   0% /
tmpfs                    23.5G         0     23.5G   0% /dev
tmpfs                    23.5G         0     23.5G   0%
/sys/fs/cgroup
/dev/mapper/rhgs-root
                         17.5G      3.6G     13.8G  21%
/run/secrets
/dev/mapper/rhgs-root
                         17.5G      3.6G     13.8G  21%
/dev/termination-log
/dev/mapper/rhgs-root
                         17.5G      3.6G     13.8G  21%
/etc/resolv.conf
/dev/mapper/rhgs-root
                         17.5G      3.6G     13.8G  21%
/etc/hostname
/dev/mapper/rhgs-root
                         17.5G      3.6G     13.8G  21% /etc/hosts
shm                      64.0M         0     64.0M   0% /dev/shm
192.168.68.2:vol_5b05cf2e5404afe614f8afa698792bae
                          4.0G     32.6M      4.0G   1%
/usr/share/busybox
tmpfs                    23.5G     16.0K     23.5G   0%
/var/run/secrets/kubernetes.io/serviceaccount
tmpfs                    23.5G         0     23.5G   0%
/proc/kcore
tmpfs                    23.5G         0     23.5G   0%
/proc/timer_stats
```

3.1.2.1.7. Expanding Persistent Volume Claim

To increase the PV claim value, ensure to set the **allowVolumeExpansion** parameter in the storageclass file to **true**. For more information refer, Section 3.1.2.1.2, “Registering a Storage Class”

NOTE

You can also resize a PV via the OpenShift Container Platform 3.11 Web Console.

To expand the persistent volume claim value, execute the following commands:

1. If the feature gates **`ExpandPersistentVolumes`**, and the admissionconfig **`PersistentVolumeClaimResize`** are not enabled, then edit the master.conf file located at /etc/origin/master/master-config.yaml on the master to enable them. For example:

   To enable feature gates **`ExpandPersistentVolumes`**

   ```
       apiServerArguments:
             runtime-config:
             - apis/settings.k8s.io/v1alpha1=true
             storage-backend:
             - etcd3
             storage-media-type:
             - application/vnd.kubernetes.protobuf
             feature-gates:
             - ExpandPersistentVolumes=true
       controllerArguments:
             feature-gates:
             - ExpandPersistentVolumes=true
   ```

   To enable admissionconfig **`PersistentVolumeClaimResize`** add the following under admission config in the master-config file.

   ```
   admissionConfig:
     pluginConfig:
       PersistentVolumeClaimResize:
         configuration:
           apiVersion: v1
           disable: false
           kind: DefaultAdmissionConfig
   ```

    1. Restart the OpenShift master by running the following commands:

       ```
         # /usr/local/bin/master-restart api
         # /usr/local/bin/master-restart controllers
       ```

2. To check the existing persistent volume size, execute the following command on the app pod:

   ```
   # oc rsh busybox
   ```

   ```
   # df -h
   ```

   For example:

   ```
   # oc rsh busybox
   / # df -h
   Filesystem                Size      Used Available Use% Mounted on
   /dev/mapper/docker-253:0-100702042-
   ```

```
0fa327369e7708b67f0c632d83721cd9a5b39fd3a7b3218f3ff3c83ef4320ce7
                         10.0G     34.2M      9.9G   0% /
tmpfs                    15.6G         0     15.6G   0% /dev
tmpfs                    15.6G         0     15.6G   0%
/sys/fs/cgroup
/dev/mapper/rhel_dhcp47--150-root
                         50.0G      7.4G     42.6G  15%
/dev/termination-log
/dev/mapper/rhel_dhcp47--150-root
                         50.0G      7.4G     42.6G  15%
/run/secrets
/dev/mapper/rhel_dhcp47--150-root
                         50.0G      7.4G     42.6G  15%
/etc/resolv.conf
/dev/mapper/rhel_dhcp47--150-root
                         50.0G      7.4G     42.6G  15%
/etc/hostname
/dev/mapper/rhel_dhcp47--150-root
                         50.0G      7.4G     42.6G  15% /etc/hosts
shm                      64.0M         0     64.0M   0% /dev/shm
10.70.46.177:test-vol_glusterfs_claim10_d3e15a8b-26b3-11e8-acdf-
005056a55501
                          2.0G     32.6M      2.0G   2%
/usr/share/busybox
tmpfs                    15.6G     16.0K     15.6G   0%
/var/run/secrets/kubernetes.io/serviceaccount
tmpfs                    15.6G         0     15.6G   0%
/proc/kcore
tmpfs                    15.6G         0     15.6G   0%
/proc/timer_list
tmpfs                    15.6G         0     15.6G   0%
/proc/timer_stats
tmpfs                    15.6G         0     15.6G   0%
/proc/sched_debug
tmpfs                    15.6G         0     15.6G   0% /proc/scsi
tmpfs                    15.6G         0     15.6G   0%
/sys/firmware
```

In this example the persistent volume size is 2Gi

3. To edit the persistent volume claim value, execute the following command and edit the following storage parameter:

```
resources:
    requests:
      storage: <storage_value>
```

```
# oc edit pvc <claim_name>
```

For example, to expand the storage value to 20Gi:

```
# oc edit pvc claim3
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  annotations:
    pv.kubernetes.io/bind-completed: "yes"
    pv.kubernetes.io/bound-by-controller: "yes"
    volume.beta.kubernetes.io/storage-class: gluster-container2
    volume.beta.kubernetes.io/storage-provisioner:
kubernetes.io/glusterfs
  creationTimestamp: 2018-02-14T07:42:00Z
  name: claim3
  namespace: storage-project
  resourceVersion: "283924"
  selfLink: /api/v1/namespaces/storage-
project/persistentvolumeclaims/claim3
  uid: 8a9bb0df-115a-11e8-8cb3-005056a5a340
spec:
  accessModes:
  - ReadWriteOnce
  resources:
    requests:
      storage: 20Gi
  volumeName: pvc-8a9bb0df-115a-11e8-8cb3-005056a5a340
status:
  accessModes:
  - ReadWriteOnce
  capacity:
    storage: 2Gi
  phase: Bound
```

4. To verify, execute the following command on the app pod:

```
# oc rsh busybox
```

```
/ # df -h
```

For example:

```
# oc rsh busybox
# df -h
Filesystem                Size      Used Available Use% Mounted on
/dev/mapper/docker-253:0-100702042-
0fa327369e7708b67f0c632d83721cd9a5b39fd3a7b3218f3ff3c83ef4320ce7
                         10.0G     34.2M      9.9G   0% /
tmpfs                    15.6G         0     15.6G   0% /dev
tmpfs                    15.6G         0     15.6G   0%
/sys/fs/cgroup
/dev/mapper/rhel_dhcp47--150-root
                         50.0G      7.4G     42.6G  15%
/dev/termination-log
/dev/mapper/rhel_dhcp47--150-root
                         50.0G      7.4G     42.6G  15%
/run/secrets
/dev/mapper/rhel_dhcp47--150-root
                         50.0G      7.4G     42.6G  15%
/etc/resolv.conf
/dev/mapper/rhel_dhcp47--150-root
                         50.0G      7.4G     42.6G  15%
```

```
/etc/hostname
/dev/mapper/rhel_dhcp47--150-root
                         50.0G      7.4G     42.6G  15% /etc/hosts
shm                      64.0M         0     64.0M   0% /dev/shm
10.70.46.177:test-vol_glusterfs_claim10_d3e15a8b-26b3-11e8-acdf-
005056a55501
                         20.0G     65.3M     19.9G   1%
/usr/share/busybox
tmpfs                    15.6G     16.0K     15.6G   0%
/var/run/secrets/kubernetes.io/serviceaccount
tmpfs                    15.6G         0     15.6G   0%
/proc/kcore
tmpfs                    15.6G         0     15.6G   0%
/proc/timer_list
tmpfs                    15.6G         0     15.6G   0%
/proc/timer_stats
tmpfs                    15.6G         0     15.6G   0%
/proc/sched_debug
tmpfs                    15.6G         0     15.6G   0% /proc/scsi
tmpfs                    15.6G         0     15.6G   0%
/sys/firmware
```

It is observed that the size is changed from 2Gi (earlier) to 20Gi.

3.1.2.1.8. Deleting a Persistent Volume Claim

NOTE

If the "persistentVolumeReclaimPolicy" parameter was set to "Retain" when registering the storageclass, the underlying PV and the corresponding volume remains even when a PVC is deleted.

1. To delete a claim, execute the following command:

```
# oc delete pvc <claim-name>
```

For example:

```
# oc delete pvc claim1
persistentvolumeclaim "claim1" deleted
```

2. To verify if the claim is deleted, execute the following command:

```
# oc get pvc <claim-name>
```

For example:

```
# oc get pvc claim1
No resources found.
```

When the user deletes a persistent volume claim that is bound to a persistent volume created by dynamic provisioning, apart from deleting the persistent volume claim, Kubernetes will also delete the persistent volume, endpoints, service, and the actual volume. Execute the following commands if this has to be verified:

- To verify if the persistent volume is deleted, execute the following command:

  ```
  # oc get pv <pv-name>
  ```

  For example:

  ```
  # oc get pv pvc-962aa6d1-bddb-11e6-be23-5254009fc65b
  No resources found.
  ```

- To verify if the endpoints are deleted, execute the following command:

  ```
  # oc get endpoints <endpointname>
  ```

  For example:

  ```
  # oc get endpoints gluster-dynamic-claim1
  No resources found.
  ```

- To verify if the service is deleted, execute the following command:

  ```
  # oc get service <servicename>
  ```

  For example:

  ```
  # oc get service gluster-dynamic-claim1
  No resources found.
  ```

3.1.3. Volume Security

Volumes come with a UID/GID of 0 (root). For an application pod to write to the volume, it should also have a UID/GID of 0 (root). With the volume security feature the administrator can now create a volume with a unique GID and the application pod can write to the volume using this unique GID

Volume security for statically provisioned volumes

To create a statically provisioned volume with a GID, execute the following command:

```
$ heketi-cli volume create --size=100 --persistent-volume-file=pv001.json
--gid=590
```

In the above command, a 100G persistent volume with a GID of 590 is created and the output of the persistent volume specification describing this volume is added to the pv001.json file.

For more information about accessing the volume using this GID, see https://access.redhat.com/documentation/en-us/openshift_container_platform/3.11/html/configuring_clusters/persistent-storage-examples#install-config-storage-examples-gluster-example.

Volume security for dynamically provisioned volumes

Two new parameters, gidMin and gidMax, are introduced with dynamic provisioner. These values allow the administrator to configure the GID range for the volume in the storage class. To set up the GID values and provide volume security for dynamically provisioned volumes, execute the following commands:

1. Create a storage class file with the GID values. For example:

   ```
   # cat glusterfs-storageclass.yaml

   apiVersion: storage.k8s.io/v1beta1
   kind: StorageClass
   metadata:
     name:gluster-container
   provisioner: kubernetes.io/glusterfs
   parameters:
     resturl: "http://heketi-storage-project.cloudapps.mystorage.com"
     restuser: "admin"
     secretNamespace: "default"
     secretName: "heketi-secret"
     gidMin: "2000"
     gidMax: "4000"
   ```

   NOTE

   If the gidMin and gidMax value are not provided, then the dynamic provisioned volumes will have the GID between 2000 and 2147483647.

2. Create a persistent volume claim. For more information see, Section 3.1.2.1.3, “Creating a Persistent Volume Claim”

3. Use the claim in the pod. Ensure that this pod is non-privileged. For more information see, Section 3.1.2.1.6, “Using the Claim in a Pod”

4. To verify if the GID is within the range specified, execute the following command:

   ```
   # oc rsh busybox
   ```

   ```
   $ id
   ```

   For example:

   ```
   $ id
   uid=1000060000 gid=0(root) groups=0(root),2001
   ```

   where, 2001 in the above output is the allocated GID for the persistent volume, which is within the range specified in the storage class. You can write to this volume with the allocated GID.

   NOTE

   When the persistent volume claim is deleted, the GID of the persistent volume is released from the pool.

3.2. BLOCK STORAGE

Block storage allows the creation of high performance individual storage units. Unlike the traditional file storage capability that glusterfs supports, each storage volume/block device can be treated as an independent disk drive, so that each storage volume/block device can support an individual file system.

gluster-block is a distributed management framework for block devices. It aims to make Gluster-backed block storage creation and maintenance as simple as possible. gluster-block can provision block devices and export them as iSCSI LUN's across multiple nodes, and uses iSCSI protocol for data transfer as SCSI block/commands.

NOTE

- Block volume expansion is not supported in OpenShift Container Storage 3.11.
- Static provisioning of volumes is not supported for Block storage. Dynamic provisioning of volumes is the only method supported.
- The recommended Red Hat Enterprise Linux (RHEL) version for block storage is RHEL-7.5.4. Please ensure that your kernel version matches with 3.10.0-862.14.4.el7.x86_64. To verify execute:

  ```
  # uname -r
  ```

  Reboot the node for the latest kernel update to take effect.

3.2.1. Dynamic Provisioning of Volumes for Block Storage

Dynamic provisioning enables you to provision a Red Hat Gluster Storage volume to a running application container without pre-creating the volume. The volume will be created dynamically as the claim request comes in, and a volume of exactly the same size will be provisioned to the application containers.

NOTE

The steps outlined below are not necessary when OpenShift Container Storage was deployed using the (default) Ansible installer and the default storage class (glusterfs-storage-block) created during the installation will be used.

3.2.1.1. Configuring Dynamic Provisioning of Volumes

To configure dynamic provisioning of volumes, the administrator must define StorageClass objects that describe named "classes" of storage offered in a cluster. After creating a Storage Class, a secret for heketi authentication must be created before proceeding with the creation of persistent volume claim.

3.2.1.1.1. Configuring Multipathing on all Initiators

To ensure the iSCSI initiator can communicate with the iSCSI targets and achieve HA using multipathing, execute the following steps on all the OpenShift nodes (iSCSI initiator) where the app pods are hosted:

1. To install initiator related packages on all the nodes where initiator has to be configured, execute the following command:

   ```
   # yum install iscsi-initiator-utils device-mapper-multipath
   ```

2. To enable multipath, execute the following command:

```
# mpathconf --enable
```

3. Create and add the following content to the multipath.conf file:

NOTE

In case of upgrades, make sure that the changes to multipath.conf and reloading of multipathd are done only after all the server nodes are upgraded.

```
# cat >> /etc/multipath.conf <<EOF
# LIO iSCSI
devices {
        device {
                vendor "LIO-ORG"
                user_friendly_names "yes" # names like mpatha
                path_grouping_policy "failover" # one path per
group
                hardware_handler "1 alua"
                path_selector "round-robin 0"
                failback immediate
                path_checker "tur"
                prio "alua"
                no_path_retry 120
        }
}
EOF
```

4. Execute the following commands to start multipath daemon and [re]load the multipath configuration:

```
# systemctl start multipathd
```

```
# systemctl reload multipathd
```

3.2.1.1.2. Creating Secret for Heketi Authentication

To create a secret for Heketi authentication, execute the following commands:

NOTE

If the **admin-key** value (secret to access heketi to get the volume details) was not set during the deployment of Red Hat Openshift Container Storage, then the following steps can be omitted.

1. Create an encoded value for the password by executing the following command:

```
# echo -n "<key>" | base64
```

where “**key**” is the value for **admin-key** that was created while deploying CNS

For example:

```
# echo -n "mypassword" | base64
bXlwYXNzd29yZA==
```

2. Create a secret file. A sample secret file is provided below:

```
# cat glusterfs-secret.yaml

apiVersion: v1
kind: Secret
metadata:
  name: heketi-secret
  namespace: default
data:
  # base64 encoded password. E.g.: echo -n "mypassword" | base64
  key: bXlwYXNzd29yZA==
type: gluster.org/glusterblock
```

3. Register the secret on Openshift by executing the following command:

```
# oc create -f glusterfs-secret.yaml
secret "heketi-secret" created
```

3.2.1.1.3. Registering a Storage Class

When configuring a StorageClass object for persistent volume provisioning, the administrator must describe the type of provisioner to use and the parameters that will be used by the provisioner when it provisions a PersistentVolume belonging to the class.

1. Create a storage class. A sample storage class file is presented below:

```
# cat > glusterfs-block-storageclass.yaml

apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
 name: gluster-block
provisioner: gluster.org/glusterblock
reclaimPolicy: Retain
parameters:
 resturl: "http://heketi-storage-project.cloudapps.mystorage.com"
 restuser: "admin"
 restsecretnamespace: "default"
 restsecretname: "heketi-secret"
 hacount: "3"
 clusterids:
"630372ccdc720a92c681fb928f27b53f,796e6db1981f369ea0340913eeea4c9a"
 chapauthenabled: "true"
 volumenameprefix: "test-vol"
```

where,

resturl: Gluster REST service/Heketi service url which provision gluster volumes on demand. The general format must be IPaddress:Port and this is a mandatory parameter for GlusterFS dynamic provisioner. If Heketi service is exposed as a routable service in openshift/kubernetes setup, this can have a format similar to http://heketi-storage-project.cloudapps.mystorage.com where the fqdn is a resolvable heketi service url.

restuser : Gluster REST service/Heketi user who has access to create volumes in the trusted storage pool

restsecretnamespace + **restsecretname** : Identification of Secret instance that contains user password to use when talking to Gluster REST service. These parameters are optional. Empty password will be used when both **`restsecretnamespace`** and **`restsecretname`** are omitted.

hacount: It is the count of the number of paths to the block target server. **`hacount`** provides high availability via multipathing capability of iSCSI. If there is a path failure, the I/Os will not be interrupted and will be served via another available paths.

clusterids: It is the ID of the cluster which will be used by Heketi when provisioning the volume. It can also be a list of comma-separated cluster IDs. This is an optional parameter.

NOTE

To get the cluster ID, execute the following command:

```
# heketi-cli cluster list
```

chapauthenabled: If you want to provision block volume with CHAP authentication enabled, this value has to be set to true. This is an optional parameter.

volumenameprefix: This is an optional parameter. It depicts the name of the volume created by heketi. For more information see, Section 3.2.1.1.6, “(Optional) Providing a Custom Volume Name Prefix for Persistent Volumes”

NOTE

The value for this parameter cannot contain `_` in the storageclass.

2. To register the storage class to Openshift, execute the following command:

```
# oc create -f glusterfs-block-storageclass.yaml
storageclass "gluster-block" created
```

3. To get the details of the storage class, execute the following command:

```
# oc describe storageclass gluster-block
Name:          gluster-block
IsDefaultClass:    No
Annotations:    <none>
Provisioner:    gluster.org/glusterblock
Parameters:
chapauthenabled=true,hacount=3,opmode=heketi,restsecretname=heketi-
```

```
secret,restsecretnamespace=default,resturl=http://heketi-storage-
project.cloudapps.mystorage.com,restuser=admin
Events:        <none>
```

3.2.1.1.4. Creating a Persistent Volume Claim

To create a persistent volume claim execute the following commands:

1. Create a Persistent Volume Claim file. A sample persistent volume claim is provided below:

```
# cat glusterfs-block-pvc-claim.yaml
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: claim1
  annotations:
    volume.beta.kubernetes.io/storage-class: gluster-block
spec:
  persistentVolumeReclaimPolicy: Retain
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 5Gi
```

persistentVolumeReclaimPolicy:This is an optional parameter. When this parameter is set to "Retain" the underlying persistent volume is retained even after the corresponding persistent volume claim is deleted.

NOTE

When PVC is deleted, the underlying heketi and gluster volumes are not deleted if "persistentVolumeReclaimPolicy:" is set to "Retain". To delete the volume, you must use heketi cli and then delete the PV.

2. Register the claim by executing the following command:

```
# oc create -f glusterfs-block-pvc-claim.yaml
persistentvolumeclaim "claim1" created
```

3. To get the details of the claim, execute the following command:

```
# oc describe pvc <claim_name>
```

For example:

```
# oc describe pvc claim1

Name:         claim1
Namespace:     block-test
StorageClass:     gluster-block
Status:        Bound
Volume:        pvc-ee30ff43-7ddc-11e7-89da-5254002ec671
```

```
Labels:        <none>
Annotations:    control-plane.alpha.kubernetes.io/leader=
{"holderIdentity":"8d7fecb4-7dba-11e7-a347-
0a580a830002","leaseDurationSeconds":15,"acquireTime":"2017-08-
10T15:02:30Z","renewTime":"2017-08-10T15:02:58Z","lea...
       pv.kubernetes.io/bind-completed=yes
       pv.kubernetes.io/bound-by-controller=yes
       volume.beta.kubernetes.io/storage-class=gluster-block
       volume.beta.kubernetes.io/storage-
provisioner=gluster.org/glusterblock
Capacity:    5Gi
Access Modes:    RWO
Events:
 FirstSeen    LastSeen    Count    From
SubObjectPath    Type        Reason            Message
 ---------    --------    -----    ----
-------------    --------    ------            -------
 1m        1m        1    gluster.org/glusterblock 8d7fecb4-7dba-
11e7-a347-0a580a830002            Normal        Provisioning
External provisioner is provisioning volume for claim "block-
test/claim1"
 1m        1m        18    persistentvolume-controller
Normal        ExternalProvisioning    cannot find provisioner
"gluster.org/glusterblock", expecting that a volume for the claim is
provisioned either manually or via external software
 1m        1m        1    gluster.org/glusterblock 8d7fecb4-7dba-
11e7-a347-0a580a830002            Normal
ProvisioningSucceeded    Successfully provisioned volume pvc-
ee30ff43-7ddc-11e7-89da-5254002ec671
```

3.2.1.1.5. Verifying Claim Creation

To verify if the claim is created, execute the following commands:

1. To get the details of the persistent volume claim and persistent volume, execute the following command:

```
# oc get pv,pvc

NAME                                          CAPACITY
ACCESSMODES   RECLAIMPOLICY   STATUS    CLAIM
STORAGECLASS    REASON    AGE
pv/pvc-ee30ff43-7ddc-11e7-89da-5254002ec671   5Gi        RWO
Delete          Bound     block-test/claim1   gluster-block
3m

NAME         STATUS    VOLUME
CAPACITY   ACCESSMODES   STORAGECLASS    AGE
pvc/claim1   Bound     pvc-ee30ff43-7ddc-11e7-89da-5254002ec671
5Gi        RWO           gluster-block   4m
```

3.2.1.1.6. (Optional) Providing a Custom Volume Name Prefix for Persistent Volumes

You can provide a custom volume name prefix to the persistent volume that is created. By providing a custom volume name prefix, users can now easily search/filter the volumes based on:

- Any string that was provided as the field value of "volnameprefix" in the storageclass file.
- Persistent volume claim name.
- Project / Namespace name.

To set the name, ensure that you have added the parameter **`volumenameprefix`** to the storage class file. For more information, refer Section 3.2.1.1.3, “Registering a Storage Class”

NOTE

The value for this parameter cannot contain `_` in the storageclass.

To verify if the custom volume name prefix is set, execute the following command:

```
# oc describe pv <pv_name>
```

For example:

```
# oc describe pv pvc-4e97bd84-25f4-11e8-8f17-005056a55501
    Name:            pvc-4e97bd84-25f4-11e8-8f17-005056a55501
    Labels:          <none>
    Annotations:     AccessKey=glusterblk-67d422eb-7b78-4059-9c21-
a58e0eabe049-secret
                     AccessKeyNs=glusterfs

Blockstring=url:http://172.31.251.137:8080,user:admin,secret:heketi-
secret,secretnamespace:glusterfs
                     Description=Gluster-external: Dynamically
provisioned PV
                     gluster.org/type=block
                     gluster.org/volume-
id=cd37c089372040eba20904fb60b8c33e
                     glusterBlkProvIdentity=gluster.org/glusterblock
                     glusterBlockShare=test-
vol_glusterfs_bclaim1_4eab5a22-25f4-11e8-954d-0a580a830003
                     kubernetes.io/createdby=heketi
                     pv.kubernetes.io/provisioned-
by=gluster.org/glusterblock
                     v2.0.0=v2.0.0
    StorageClass:    gluster-block-prefix
    Status:          Bound
    Claim:           glusterfs/bclaim1
    Reclaim Policy:  Delete
    Access Modes:    RWO
    Capacity:        5Gi
    Message:
    Source:
        Type:               ISCSI (an ISCSI Disk resource that is
attached to a kubelet's host machine and then exposed to the pod)
        TargetPortal:       10.70.46.177
        IQN:                iqn.2016-12.org.gluster-block:67d422eb-7b78-
4059-9c21-a58e0eabe049
        Lun:                0
        ISCSIInterface      default
        FSType:             xfs
        ReadOnly:           false
        Portals:            [10.70.46.142 10.70.46.4]
        DiscoveryCHAPAuth:  false
        SessionCHAPAuth:    true
        SecretRef:          {glusterblk-67d422eb-7b78-4059-9c21-
a58e0eabe049-secret }
        InitiatorName:      <none>
    Events:                 <none>
```

The value for **glusterBlockShare** will have the custom volume name prefix attached to the namespace and the claim name, which is "test-vol" in this case.

3.2.1.1.7. Using the Claim in a Pod

Execute the following steps to use the claim in a pod.

1. To use the claim in the application, for example

```
# cat app.yaml

apiVersion: v1
kind: Pod
metadata:
  name: busybox
spec:
  containers:
    - image: busybox
      command:
        - sleep
        - "3600"
      name: busybox
      volumeMounts:
        - mountPath: /usr/share/busybox
          name: mypvc
  volumes:
    - name: mypvc
      persistentVolumeClaim:
        claimName: claim1
```

```
# oc create -f app.yaml
pod "busybox" created
```

For more information about using the glusterfs claim in the application see, https://access.redhat.com/documentation/en-us/openshift_container_platform/3.11/html-single/configuring_clusters/#install-config-storage-examples-gluster-example.

2. To verify that the pod is created, execute the following command:

```
# oc get pods -n storage-project

NAME                                  READY     STATUS     RESTARTS
AGE
block-test-router-1-deploy            0/1       Running      0
4h
```

```
busybox                            1/1       Running   0
43s
glusterblock-provisioner-1-bjpz4   1/1       Running   0
4h
glusterfs-7l5xf                    1/1       Running   0
4h
glusterfs-hhxtk                    1/1       Running   3
4h
glusterfs-m4rbc                    1/1       Running   0
4h
heketi-1-3h9nb                     1/1       Running   0
4h
```

3. To verify that the persistent volume is mounted inside the container, execute the following command:

```
# oc rsh busybox
```

```
/  # df -h
Filesystem                Size      Used Available Use% Mounted on
/dev/mapper/docker-253:1-11438-
39febd9d64f3a3594fc11da83d6cbaf5caf32e758eb9e2d7bdd798752130de7e
                        10.0G     33.9M      9.9G   0% /
tmpfs                     3.8G         0      3.8G   0% /dev
tmpfs                     3.8G         0      3.8G   0%
/sys/fs/cgroup
/dev/mapper/VolGroup00-LogVol00
                         7.7G      2.8G      4.5G  39%
/dev/termination-log
/dev/mapper/VolGroup00-LogVol00
                         7.7G      2.8G      4.5G  39%
/run/secrets
/dev/mapper/VolGroup00-LogVol00
                         7.7G      2.8G      4.5G  39%
/etc/resolv.conf
/dev/mapper/VolGroup00-LogVol00
                         7.7G      2.8G      4.5G  39%
/etc/hostname
/dev/mapper/VolGroup00-LogVol00
                         7.7G      2.8G      4.5G  39% /etc/hosts
shm                      64.0M         0     64.0M   0% /dev/shm
/dev/mpatha                  5.0G     32.2M      5.0G   1%
/usr/share/busybox
tmpfs                     3.8G     16.0K      3.8G   0%
/var/run/secrets/kubernetes.io/serviceaccount
tmpfs                     3.8G         0      3.8G   0%
/proc/kcore
tmpfs                     3.8G         0      3.8G   0%
/proc/timer_list
tmpfs                     3.8G         0      3.8G   0%
/proc/timer_stats
tmpfs                     3.8G         0      3.8G   0%
/proc/sched_debug
```

3.2.1.1.8. Deleting a Persistent Volume Claim

NOTE

If the "persistentVolumeReclaimPolicy" parameter was set to "Retain" when registering the storageclass, the underlying PV and the corresponding volume remains even when a PVC is deleted.

1. To delete a claim, execute the following command:

   ```
   # oc delete pvc <claim-name>
   ```

   For example:

   ```
   # oc delete pvc claim1
   persistentvolumeclaim "claim1" deleted
   ```

2. To verify if the claim is deleted, execute the following command:

   ```
   # oc get pvc <claim-name>
   ```

   For example:

   ```
   # oc get pvc claim1
   No resources found.
   ```

   When the user deletes a persistent volume claim that is bound to a persistent volume created by dynamic provisioning, apart from deleting the persistent volume claim, Kubernetes will also delete the persistent volume, endpoints, service, and the actual volume. Execute the following commands if this has to be verified:

   - To verify if the persistent volume is deleted, execute the following command:

     ```
     # oc get pv <pv-name>
     ```

     For example:

     ```
     # oc get pv pvc-962aa6d1-bddb-11e6-be23-5254009fc65b
     No resources found.
     ```

Next step: If you are installing Red Hat Openshift Container Storage 3.11, and you want to use block storage as the backend storage for logging and metrics, proceed to Chapter 7, *Gluster Block Storage as Backend for Logging and Metrics*.

3.2.2. Replacing a Block on Block Storage

If you want to replace a block from a node that is out of resource or is faulty, it can be replaced to a new node.

Execute the following commands

1. Execute the following command to fetch the zone and cluster info from heketi

```
# heketi-cli topology info --user=<user> --secret=<user key>
```

--user - heketi user

--secret - Secret key for a specified user

2. After obtaining the cluster id and zone id add a new node to heketi by executing the following command:

NOTE

Before adding the node, ensure the node is labeled as a glusterfs storage host by adding the label "glusterfs=storage-host", using the following command;

```
# oc label node <NODENAME> glusterfs=storage-host
```

```
# heketi-cli node add --zone=<zoneid> --cluster=<clusterid> --
management-host-name=<new hostname> --storage-host-name=<new node
ip> --user=<user> --secret=<user key>
```

--cluster - The cluster in which the node should reside

--management-host-name - Management hostname. This is the new node that has to be added.

--storage-host-name - Storage hostname.

--zone - The zone in which the node should reside

--user - heketi user.

--secret - Secret key for a specified user

For example:

```
heketi-cli node add --zone=1 --
cluster=607204cb27346a221f39887a97cf3f90 --management-host-
name=dhcp43-241.lab.eng.blr.redhat.com --storage-host-
name=10.70.43.241 --user=admin --secret=adminkey

Node information:
Id: 2639c473a2805f6e19d45997bb18cb9c
State: online
Cluster Id: 607204cb27346a221f39887a97cf3f90
Zone: 1
Management Hostname dhcp43-241.lab.eng.blr.redhat.com
Storage Hostname 10.70.43.241
```

3. Execute the following command to add the device

```
# heketi-cli device add --name=<device name> --node=<node id> --
user=<user> --secret=<user key>
```

--name - Name of device to add

--node - Newly added node id

For example:

```
# heketi-cli device add --name=/dev/vdc --
node=2639c473a2805f6e19d45997bb18cb9c --user=admin --secret=adminkey
Device added successfully
```

4. After the new node and its associated devices are added to heketi, the faulty or unwanted node can be removed from heketi

   To remove any node from heketi, follow this workflow:

   - node disable (Disallow usage of a node by placing it offline)
   - node replace (Removes a node and all its associated devices from Heketi)
   - device delete (Deletes a device from Heketi node)
   - node delete (Deletes a node from Heketi management)

5. Execute the following command to fetch the node list from heketi

```
#heketi-cli node list --user=<user> --secret=<user key>
```

   For example:

```
# heketi-cli node list --user=admin --secret=adminkey
Id:05746c562d6738cb5d7de149be1dac04
Cluster:607204cb27346a221f39887a97cf3f90
Id:ab37fc5aabbd714eb8b09c9a868163df
Cluster:607204cb27346a221f39887a97cf3f90
Id:c513da1f9bda528a9fd6da7cb546a1ee
Cluster:607204cb27346a221f39887a97cf3f90
Id:e6ab1fe377a420b8b67321d9e60c1ad1
Cluster:607204cb27346a221f39887a97cf3f90
```

6. Execute the following command to fetch the node info of the node, that has to be deleted from heketi:

```
# heketi-cli node info <nodeid> --user=<user> --secret=<user key>
```

   For example:

```
# heketi-cli node info c513da1f9bda528a9fd6da7cb546a1ee --user=admin
--secret=adminkey
Node Id: c513da1f9bda528a9fd6da7cb546a1ee
State: online
Cluster Id: 607204cb27346a221f39887a97cf3f90
Zone: 1
Management Hostname: dhcp43-171.lab.eng.blr.redhat.com
Storage Hostname: 10.70.43.171
Devices:
Id:3a1e0717e6352a8830ab43978347a103   Name:/dev/vdc
State:online    Size (GiB):499     Used (GiB):100     Free (GiB):399
```

```
Bricks:1
Id:89a57ace1c3184826e1317fef785e6b7   Name:/dev/vdd
State:online    Size (GiB):499     Used (GiB):10      Free (GiB):489
Bricks:5
```

7. Execute the following command to disable the node from heketi. This makes the node go offline:

   ```
   # heketi-cli node disable <node-id> --user=<user> --secret=<user
   key>
   ```

   For example:

   ```
   # heketi-cli node disable ab37fc5aabbd714eb8b09c9a868163df --
   user=admin --secret=adminkey
   Node ab37fc5aabbd714eb8b09c9a868163df is now offline
   ```

8. Execute the following command to remove a node and all its associated devices from Heketi:

   ```
   #heketi-cli node remove <node-id> --user=<user> --secret=<user key>
   ```

   For example:

   ```
   # heketi-cli node remove ab37fc5aabbd714eb8b09c9a868163df --
   user=admin --secret=adminkey
   Node ab37fc5aabbd714eb8b09c9a868163df is now removed
   ```

9. Execute the following command to delete the devices from heketi node:

   ```
   # heketi-cli device delete <device-id> --user=<user> --secret=<user
   key>
   ```

   For example:

   ```
   # heketi-cli device delete 0fca78c3a94faabfbe5a5a9eef01b99c --
   user=admin --secret=adminkey
   Device 0fca78c3a94faabfbe5a5a9eef01b99c deleted
   ```

10. Execute the following command to delete a node from Heketi management:

    ```
    #heketi-cli node delete <nodeid> --user=<user> --secret=<user key>
    ```

    For example:

    ```
    # heketi-cli node delete ab37fc5aabbd714eb8b09c9a868163df --
    user=admin --secret=adminkey
    Node ab37fc5aabbd714eb8b09c9a868163df deleted
    ```

11. Execute the following commands on any one of the gluster pods to replace the faulty node with the new node:

1. Execute the following command to get list of blockvolumes hosted under block-hosting-volume

   ```
   # gluster-block list <block-hosting-volume> --json-pretty
   ```

2. Execute the following command to find out which all blockvolumes are hosted on the old node, with the help of info command

   ```
   # gluster-block info <block-hosting-volume>/<block-volume> --
   json-pretty
   ```

3. Execute the following command to replace the faulty node with the new node:

   ```
   # gluster-block replace <volname/blockname> <old-node> <new-node>
   [force]
   ```

   For example:

   ```
   {
     "NAME":"block",
     "CREATE SUCCESS":"192.168.124.73",
     "DELETE SUCCESS":"192.168.124.63",
     "REPLACE PORTAL SUCCESS ON":[
       "192.168.124.79"
     ],
     "RESULT":"SUCCESS"
   }

   Note: If the old node is down and does not come up again then you
   can force replace:
   gluster-block replace sample/block 192.168.124.63 192.168.124.73
   force --json-pretty

   {
     "NAME":"block",
     "CREATE SUCCESS":"192.168.124.73",
     "DELETE FAILED (ignored)":"192.168.124.63",
     "REPLACE PORTAL SUCCESS ON":[
       "192.168.124.79"
     ],
     "RESULT":"SUCCESS"
   }
   ```

NOTE

The next steps henceforth are to be executed only if the block that is to be replaced is still in use.

12. Logout of the old portal by executing the following command on the initiator:

    ```
    # iscsiadm -m node -T <targetname> -p <old node> -u
    ```

    For example:

```
# iscsiadm -m node -T iqn.2016-12.org.gluster-block:d6d18f43-8a74-
4b2c-a5b7-df1fa3f5bc9a -p 192.168.124.63 -u
Logging out of session [sid: 8, target: iqn.2016-12.org.gluster-
block:d6d18f43-8a74-4b2c-a5b7-df1fa3f5bc9a, portal:
192.168.124.63,3260]
Logout of [sid: 8, target: iqn.2016-12.org.gluster-block:d6d18f43-
8a74-4b2c-a5b7-df1fa3f5bc9a, portal: 192.168.124.63,3260]
successful.
```

13. To re-discover the new node execute the following command:

```
# iscsiadm -m discovery -t st -p <new node>
```

For example:

```
# iscsiadm -m discovery -t st -p 192.168.124.73
192.168.124.79:3260,1 iqn.2016-12.org.gluster-block:d6d18f43-8a74-
4b2c-a5b7-df1fa3f5bc9a
192.168.124.73:3260,2 iqn.2016-12.org.gluster-block:d6d18f43-8a74-
4b2c-a5b7-df1fa3f5bc9a
```

14. Login to the new portal by executing the following command:

```
# iscsiadm -m node -T <targetname> -p <new node ip> -l
```

For example:

```
# iscsiadm -m node -T iqn.2016-12.org.gluster-block:d6d18f43-8a74-
4b2c-a5b7-df1fa3f5bc9a -p 192.168.124.73 -l
```

15. To verify if the enabled hosting volume is replaced and running successfully, execute the following command on the initiator:

```
# ll /dev/disk/by-path/ip-* | grep <targetname> | grep <“new node
ip”>
```

CHAPTER 4. SHUTTING DOWN GLUSTER-BLOCK CLIENT NODES

Follow this procedure to shutdown gluster-block client nodes:

1. Evacuate the pods. For more information, refer https://access.redhat.com/documentation/en-us/openshift_container_platform/3.11/html-single/cluster_administration/#evacuating-pods-on-nodes

2. Ensure that no gluster block mounts exist in the system.

3. Reboot the nodes. For more information, refer https://access.redhat.com/documentation/en-us/openshift_container_platform/3.11/html-single/cluster_administration/#rebooting-nodes

CHAPTER 5. S3 COMPATIBLE OBJECT STORE IN A RED HAT OPENSHIFT CONTAINER STORAGE ENVIRONMENT

IMPORTANT

Support for S3 compatible Object Store in Container-Native Storage is under technology preview. Technology Preview features are not fully supported under Red Hat service-level agreements (SLAs), may not be functionally complete, and are not intended for production use.

Tech Preview features provide early access to upcoming product innovations, enabling customers to test functionality and provide feedback during the development process.

As Red Hat considers making future iterations of Technology Preview features generally available, we will provide commercially reasonable efforts to resolve any reported issues that customers experience when using these features.

Object Store provides a system for data storage that enables users to access the same data, both as an object and as a file, thus simplifying management and controlling storage costs. The S3 API is the de facto standard for HTTP based access to object storage services.

5.1. SETTING UP S3 COMPATIBLE OBJECT STORE FOR RED HAT OPENSHIFT CONTAINER STORAGE

NOTE

Ensure that cns-deploy package has been installed before setting up S3 Compatible Object Store. For more information on how to install cns-deploy package, see https://access.redhat.com/documentation/en-us/red_hat_openshift_container_storage/3.11/html-single/deployment_guide/#part-Appendix

Execute the following steps from the /usr/share/heketi/templates/ directory to set up S3 compatible object store for Red Hat Openshift Container Storage:

1. (Optional): If you want to create a secret for heketi, then execute the following command:

   ```
   # oc create secret generic heketi-${NAMESPACE}-admin-secret
   --from-literal=key=${ADMIN_KEY} --type=kubernetes.io/glusterfs
   ```

   For example:

   ```
   # oc create secret generic heketi-storage-project-admin-secret
   --from-literal=key=abcd  --type=kubernetes.io/glusterfs
   ```

    1. Execute the following command to label the secret:

       ```
       # oc label --overwrite secret heketi-${NAMESPACE}-admin-secret
       glusterfs=s3-heketi-${NAMESPACE}-admin-secret
       gluster-s3=heketi-${NAMESPACE}-admin-secret
       ```

For example:

```
# oc label --overwrite secret heketi-storage-project-admin-secret
glusterfs=s3-heketi-storage-project-admin-secret
gluster-s3=heketi-storage-project-admin-secret
```

2. Create a GlusterFS StorageClass file. Use the **`HEKETI_URL`** and **`NAMESPACE`** from the current setup and set a **`STORAGE_CLASS`** name.

```
# sed -e 's/${HEKETI_URL}/<HEKETI_URL>/g'  -e
's/${STORAGE_CLASS}/<STORAGE_CLASSNAME>/g' -e
's/${NAMESPACE}/<NAMESPACE_NAME>/g'
/usr/share/heketi/templates/gluster-s3-storageclass.yaml | oc create
-f -
```

For example:

```
# sed  -e 's/${HEKETI_URL}/heketi-storage-
project.cloudapps.mystorage.com/g'  -e 's/${STORAGE_CLASS}/gluster-
s3-store/g' -e 's/${NAMESPACE}/storage-project/g'
/usr/share/heketi/templates/gluster-s3-storageclass.yaml | oc create
-f -storageclass "gluster-s3-store" created
```

NOTE

- You can run the following command to obtain the HEKETI_URL:

  ```
  # oc get routes --all-namespaces | grep heketi
  ```

  A sample output of the command is as follows:

  ```
              glusterfs   heketi-storage
              heketi-storage-
  glusterfs.router.default.svc.cluster.local
              heketi-storage   <all>          None
  ```

  If there are multiple lines in the output then you can choose the most relevant one.

- You can run the following command to obtain the NAMESPACE:

  ```
  oc get project
  ```

  A sample output of the command is as follows:

  ```
  # oc project
            Using project "glusterfs" on server
  "master.example.com:8443"
  ```

  where, glusterfs is the NAMESPACE.

3. Create the Persistent Volume Claims using the storage class.

```
# sed -e 's/${VOLUME_CAPACITY}/<NEW SIZE in Gi>/g'  -e
's/${STORAGE_CLASS}/<STORAGE_CLASSNAME>/g'
/usr/share/heketi/templates/gluster-s3-pvcs.yaml | oc create -f -
```

For Example:

```
          # sed -e 's/${VOLUME_CAPACITY}/2Gi/g'  -e
's/${STORAGE_CLASS}/gluster-s3-store/g'
/usr/share/heketi/templates/gluster-s3-pvcs.yaml | oc create -f -
persistentvolumeclaim "gluster-s3-claim" created
persistentvolumeclaim "gluster-s3-meta-claim" created
```

Use the **STORAGE_CLASS** created from the previous step. Modify the **VOLUME_CAPACITY** as per the environment requirements. Wait till the PVC is bound. Verify the same using the following command:

```
# oc get pvc
NAME                    STATUS    VOLUME
CAPACITY   ACCESSMODES   AGE
gluster-s3-claim        Bound     pvc-0b7f75ef-9920-11e7-9309-
00151e000016   2Gi         RWX           2m
gluster-s3-meta-claim   Bound     pvc-0b87a698-9920-11e7-9309-
00151e000016   1Gi         RWX           2m
```

4. Start the glusters3 object storage service using the template. Set the **S3_ACCOUNT** name, **S3_USER** name, and **S3_PASSWORD**. **PVC** and **META_PVC** are obtained from the previous step.

```
# oc new-app  /usr/share/heketi/templates/gluster-s3-template.yaml \
--param=S3_ACCOUNT=testvolume  --param=S3_USER=adminuser \
--param=S3_PASSWORD=itsmine --param=PVC=gluster-s3-claim \
--param=META_PVC=gluster-s3-meta-claim
--> Deploying template "storage-project/gluster-s3" for
"/usr/share/heketi/templates/gluster-s3-template.yaml" to project
storage-project

     gluster-s3
     ---------
     Gluster s3 service template


     * With parameters:
        * S3 Account Name=testvolume
        * S3 User=adminuser
        * S3 User Password=itsmine
        * Primary GlusterFS-backed PVC=gluster-s3-claim
        * Metadata GlusterFS-backed PVC=gluster-s3-meta-claim

--> Creating resources ...
    service "gluster-s3-service" created
    route "gluster-s3-route" created
    deploymentconfig "gluster-s3-dc" created
--> Success
    Run 'oc status' to view your app.
```

5. Execute the following command to verify if the S3 pod is up:

```
# oc get pods -o wide
NAME                             READY     STATUS    RESTARTS
AGE       IP              NODE
gluster-s3-azkys                 1/1       Running   0          4m
10.130.0.29    node3
..
```

5.2. OBJECT OPERATIONS

This section lists some of the object operation that can be performed:

- Get the URL of the route which provides S3 OS

  ```
  # s3_storage_url=$(oc get routes   | grep "gluster.*s3"  | awk
  '{print $2}')
  ```

  NOTE

  Ensure to download the s3curl tool from https://aws.amazon.com/code/128. This tool will be used for verifying the object operations.

  - s3curl.pl requires Digest::HMAC_SHA1 and Digest::MD5. Install the perl-Digest-HMAC package to get this. You can install the perl-Digest-HMAC package by running this command:

    ```
    # yum install perl-Digest-HMAC
    ```

  - Update the s3curl.pl perl script with glusters3object url which was retrieved:

    For example:

    ```
    my @endpoints = ( 'glusters3object-storage-
    project.cloudapps.mystorage.com');
    ```

- To perform **PUT** operation of the bucket:

  ```
  s3curl.pl --debug --id "testvolume:adminuser" --key "itsmine"  --put
  /dev/null  -- -k -v  http://$s3_storage_url/bucket1
  ```

- To perform **PUT** operation of the object inside the bucket:

  ```
  s3curl.pl --debug --id "testvolume:adminuser" --key "itsmine" --put
  my_object.jpg  -- -k -v -s
  http://$s3_storage_url/bucket1/my_object.jpg
  ```

- To verify listing of objects in the bucket:

  ```
  s3curl.pl --debug --id "testvolume:adminuser" --key "itsmine"  -- -k
  -v -s http://$s3_storage_url/bucket1/
  ```

–

CHAPTER 6. CLUSTER ADMINISTRATOR SETUP

Authentication

Set up the authentication using **AllowAll Authentication** method.

AllowAll Authentication

Set up an authentication model which allows all passwords. Edit **`/etc/origin/master/master-config.yaml`** on the OpenShift master and change the value of **`DenyAllPasswordIdentityProvider`** to **`AllowAllPasswordIdentityProvider`**. Then restart the OpenShift master.

1. Now that the authentication model has been setup, login as a user, for example admin/admin:

   ```
   # oc login openshift master e.g. https://1.1.1.1:8443  --
   username=admin --password=admin
   ```

2. Grant the admin user account the **`cluster-admin`** role.

   ```
     # oc login -u system:admin -n default
     Logged into "https:// <<openshift_master_fqdn>>:8443" as
   "system:admin" using existing credentials.

     You have access to the following projects and can switch between
   them with 'oc project <projectname>':

     *default
      glusterfs
      infra-storage
      kube-public
      kube-system
      management-infra
      openshift
      openshift-infra
      openshift-logging
      openshift-node
      openshift-sdn
      openshift-web-console

     Using project "default".

     # oc adm policy add-cluster-role-to-user cluster-admin admin
     cluster role "cluster-admin" added: "admin"
   ```

For more information on authentication methods, see https://access.redhat.com/documentation/en-us/openshift_container_platform/3.11/html-single/configuring_clusters/#identity-providers-configuring.

CHAPTER 7. GLUSTER BLOCK STORAGE AS BACKEND FOR LOGGING AND METRICS

Following section guides to configure Gluster Block Storage as the backend storage for logging and metrics

NOTE

Block volume expansion is not supported in OCS 3.11. Administrators are required to do proper capacity planning while using Gluster Block as backend storage when using dynamic provisioning.

7.1. PREREQUISITES

Before setting gluster block storage as the backend for logging or metrics, check if the following prerequisites are met:

- In the storageclass file, check if the default storage class is set to the storage class of gluster block. For example:

  ```
  # oc get storageclass
  NAME                TYPE
  gluster-block        gluster.org/glusterblock
  ```

- If the default is not set to **`gluster-block`** (or any other name that you have provided) then execute the following command. For example:

  ```
  # oc patch storageclass gluster-block -p '{"metadata":
  {"annotations":{"storageclass.kubernetes.io/is-default-
  class":"true"}}}'
  ```

  - Execute the following command to verify:

    ```
    oc get storageclass
    NAME                     TYPE
    gluster-block (default)   gluster.org/glusterblock
    ```

7.2. ENABLING GLUSTER BLOCK STORAGE AS BACKEND FOR LOGGING

Follow the tasks mentioned below to enable Gluster Block Storage as backend for logging:

1. To enable logging in Openshift Container platform, see https://access.redhat.com/documentation/en-us/openshift_container_platform/3.11/html-single/configuring_clusters/#install-config-aggregate-logging

2. The **`openshift_logging_es_pvc_dynamic`** ansible variable has to be set to true.

   ```
   [OSEv3:vars] openshift_logging_es_pvc_dynamic=true
   ```

   For example, a sample set of variables for openshift_logging_ are listed below.

```
openshift_logging_install_logging=true
openshift_logging_es_pvc_dynamic=true
openshift_logging_kibana_nodeselector={"node-
role.kubernetes.io/infra": "true"}
openshift_logging_curator_nodeselector={"node-
role.kubernetes.io/infra": "true"}
openshift_logging_es_nodeselector={"node-role.kubernetes.io/infra":
"true"}
openshift_logging_es_pvc_size=10Gi
openshift_logging_es_pvc_storage_class_name="glusterfs-registry-
block"
```

3. Run the Ansible playbook. For more information, see .https://access.redhat.com/documentation/en-us/openshift_container_platform/3.11/html-single/configuring_clusters/#install-config-aggregate-logging

4. To verify, execute the following command:

```
# oc get pods -n openshift-logging
```

NOTE

For more information regarding logging storage considerations, see https://access.redhat.com/documentation/en-us/openshift_container_platform/3.11/html-single/configuring_clusters/#install-config-aggregate-logging-sizing-guidelines-storage.

7.3. ENABLING GLUSTER BLOCK STORAGE AS BACKEND FOR METRICS

Follow the tasks mentioned below to enable Gluster Block Storage as backend for metrics

NOTE

By default, since Container Native Storage performs three-way replication, data will be available to the restarted node from anywhere in the cluster. As a result, it is recommended that Cassandra-level replication is turned off to avoid capacity overhead

1. To enable metrics in Openshift Container platform, see https://access.redhat.com/documentation/en-us/openshift_container_platform/3.11/html-single/configuring_clusters/#install-config-cluster-metrics

2. The **openshift_metrics_cassandra_storage_type** ansible variable should be set to **dynamic**:

```
[OSEv3:vars]openshift_metrics_cassandra_storage_type=dynamic
```

For example, a sample set of variables for openshift_metrics_ are listed below.

```
openshift_metrics_install_metrics=true
openshift_metrics_storage_kind=dynamic
openshift_metrics_hawkular_nodeselector={"node-
role.kubernetes.io/infra": "true"}
```

```
openshift_metrics_cassandra_nodeselector={"node-
role.kubernetes.io/infra": "true"}
openshift_metrics_heapster_nodeselector={"node-
role.kubernetes.io/infra": "true"}
openshift_metrics_storage_volume_size=10Gi
openshift_metrics_cassandra_pvc_storage_class_name="glusterfs-
registry-block"
```

3. Run the Ansible playbook. For more information, see https://access.redhat.com/documentation/en-us/openshift_container_platform/3.11/html-single/configuring_clusters/#install-config-cluster-metrics.

4. To verify, execute the following command:

```
# oc get pods --namespace openshift-infra
```

   It should list the following pods running:

```
heapster-cassandra
heapster-metrics
hawkular-&*9
```

NOTE

For more information regarding metrics storage considerations, see https://access.redhat.com/documentation/en-us/openshift_container_platform/3.11/html-single/configuring_clusters/#metrics-data-storage.

7.4. VERIFYING IF GLUSTER BLOCK IS SETUP AS BACKEND

Execute the following commands to verify if gluster block is setup as the backend for logging and metrics:

1. To get an overview of the infrastructure, execute the following command:

```
# oc get pods -n logging -o jsonpath='{range
.items[*].status.containerStatuses[*]}{"Name: "}{.name}{"\n  "}
{"Image: "}{.image}{"\n"}{"  State: "}{.state}{"\n"}{end}'
```

2. To get the details of all the persistent volume claims, execute the following command:

```
# oc get pvc
```

3. To get the details of the pvc, execute the following command:

```
# oc describe pvc <claim_name>
```

   Verify the volume is mountable and that permissions allow read/write. Also, PVC claim name should match the dynamically provisioned gluster block storage class.

For more information, see https://access.redhat.com/documentation/en-us/openshift_container_platform/3.11/html-single/configuring_clusters/#install-config-aggregate-logging-sizing.

PART III. SECURITY

CHAPTER 8. ENABLING ENCRYPTION

Red Hat Gluster Storage supports network encryption using TLS/SSL. Red Hat Gluster Storage uses TLS/SSL for authentication and authorization, in place of the home grown authentication framework used for normal connections. Red Hat Gluster Storage supports the following encryption types:

- I/O encryption - encryption of the I/O connections between the Red Hat Gluster Storage clients and servers.
- Management encryption - encryption of the management (glusterd) connections within a trusted storage pool.

8.1. PREREQUISITES

To enable encryption it is necessary to have 3 certificates per node (glusterfs.key, gluserfs.pem and glusterfs.ca). For more information about the steps to be performed as prerequisites, see https://access.redhat.com/documentation/en-us/red_hat_gluster_storage/3.4/html-single/administration_guide/#chap-Network_Encryption-Prereqs.

Ensure to enable encryption while registering the storageclass file using the volumeoptions parameter. For more information on registering a storageclass file for File storage, see https://access.qa.redhat.com/documentation/en-us/red_hat_openshift_container_storage/3.11/html-single/operations_guide/#chap-Documentation-Red_Hat_Gluster_Storage_Container_Native_with_OpenShift_Platform-OpenShift_Creating_Persistent_Volumes-Dynamic_Prov.

NOTE

- Ensure to perform the steps on all the OpenShift nodes except master.
- All the Red Hat Gluster Storage volumes are mounted on the OpenShift nodes and then bind mounted to the application pods. Hence, it is not required to perform any encryption related operations specifically on the application pods.

8.2. ENABLING ENCRYPTION FOR A NEW RED HAT OPENSHIFT CONTAINER STORAGE SETUP

You can configure network encryption for a new Red Hat Openshift Container Storage setup for both I/O encryption and management encryption.

8.2.1. Enabling Management Encryption

Though Red Hat Gluster Storage can be configured only for I/O encryption without using management encryption, it is recommended to have management encryption. If you want to enable SSL only on the I/O path, skip this section and proceed with Section 8.2.2, “Enabling I/O encryption for a Volume”.

On the server

Perform the following on all the server, ie, the OpenShift nodes on which Red Hat Gluster Storage pods are running.

1. Create the /var/lib/glusterd/secure-access file.

```
# touch /var/lib/glusterd/secure-access
```

On the clients

Perform the following on the clients, that is, on all the remaining OpenShift nodes on which Red Hat Gluster Storage is not running.

1. Create the /var/lib/glusterd/secure-access file.

   ```
   # touch /var/lib/glusterd/secure-access
   ```

NOTE

All the Red Hat Gluster Storage volumes are mounted on the OpenShift nodes and then bind mounted to the application pods. Hence, it is not required to perform any encryption related operations specifically on the application pods.

After running the commands on the server and clients, deploy Red Hat Openshift Container Storage. For more information, see https://access.redhat.com/documentation/en-us/red_hat_openshift_container_storage/3.11/html-single/deployment_guide/#chap-Documentation-Red_Hat_Gluster_Storage_Container_Native_with_OpenShift_Platform-Setting_the_environment-Deploy_CNS

8.2.2. Enabling I/O encryption for a Volume

Enable the I/O encryption between the servers and clients:

NOTE

The servers are the OpenShift nodes on which Red Hat Gluster Storage pods are running.

The clients are the remaining OpenShift nodes on which Red Hat Gluster Storage is not running.

1. Ensure Red Hat Openshift Container Storage is deployed before proceeding with further steps. For more information see, https://access.redhat.com/documentation/en-us/red_hat_openshift_container_storage/3.11/html-single/deployment_guide/#chap-Documentation-Red_Hat_Gluster_Storage_Container_Native_with_OpenShift_Platform-Setting_the_environment-Deploy_CNS

2. You can either create a statically provisioned volume or a dynamically provisioned volume. For more information about static provisioning of volumes, see https://access.redhat.com/documentation/en-us/red_hat_openshift_container_storage/3.11/html-single/operations_guide/#chap-Documentation-Red_Hat_Gluster_Storage_Container_Native_with_OpenShift_Platform-OpenShift_Creating_Persistent_Volumes-Static_Prov. For more information about dynamic provisioning of volumes, see https://access.redhat.com/documentation/en-us/red_hat_openshift_container_storage/3.11/html-single/operations_guide/#chap-Documentation-Red_Hat_Gluster_Storage_Container_Native_with_OpenShift_Platform-OpenShift_Creating_Persistent_Volumes-Dynamic_Prov

NOTE

To enable encryption during the creation of statically provisioned volume, execute the following command:

```
 # heketi-cli volume create --size=100 --gluster-volume-
options="client.ssl on","server.ssl on"
```

3. Stop the volume by executing the following command:

   ```
   # oc rsh <gluster_pod_name> gluster volume stop VOLNAME
   ```

   The *gluster pod name* is the name of one of the Red Hat Gluster Storage pods of the trusted storage pool to which the volume belongs.

   NOTE

   To get the VOLNAME, execute the following command:

   ```
   # oc describe pv <pv_name>
   ```

   For example:

   ```
   # oc describe pv  pvc-01569c5c-1ec9-11e7-a794-
   005056b38171
   Name:           pvc-01569c5c-1ec9-11e7-a794-005056b38171
   Labels:         <none>
   StorageClass:   fast
   Status:         Bound
   Claim:          storage-project/storage-claim68
   Reclaim Policy: Delete
   Access Modes:   RWO
   Capacity:       1Gi
   Message:
   Source:
       Type:               Glusterfs (a Glusterfs mount on
   the host that shares a pod's lifetime)
       EndpointsName:      glusterfs-dynamic-storage-claim68
       Path:
   vol_0e81e5d6e46dcbf02c11ffd9721fca28
       ReadOnly:           false
   No events.
   ```

   The VOLNAME is the value of "path" in the above output.

4. Set the list of common names of all the servers to access the volume. Ensure to include the common names of clients which will be allowed to access the volume.

   ```
   # oc rsh <gluster_pod_name> gluster volume set VOLNAME auth.ssl-
   allow 'server1,server2,server3,client1,client2,client3'
   ```

> **NOTE**
>
> If you set auth.ssl-allow option with * as value, any TLS authenticated clients can mount and access the volume from the application side. Hence, you set the option's value to * or provide common names of clients as well as the nodes in the trusted storage pool.

5. Enable the client.ssl and server.ssl options on the volume.

```
# oc rsh <gluster_pod_name> gluster volume set VOLNAME client.ssl on
# oc rsh <gluster_pod_name> gluster volume set VOLNAME server.ssl on
```

6. Start the volume.

```
# oc rsh <gluster_pod_name> gluster volume start VOLNAME
```

8.3. ENABLING ENCRYPTION FOR AN EXISTING RED HAT OPENSHIFT CONTAINER STORAGE SETUP

You can configure network encryption for an existing Red Hat Openshift Container Storage Storage setup for both I/O encryption and management encryption.

8.3.1. Enabling I/O encryption for a Volume

Enable the I/O encryption between the servers and clients for a volume:

> **NOTE**
>
> The servers are the OpenShift nodes on which Red Hat Gluster Storage pods are running.
>
> The clients are the remaining OpenShift nodes on which Red Hat Gluster Storage is not running.

1. Stop all the application pods that have the Red Hat Gluster Storage volumes.

2. Stop the volume.

```
# oc rsh <gluster_pod_name> gluster volume stop VOLNAME
```

The *gluster pod name* is the name of one of the Red Hat Gluster Storage pods of the trusted storage pool to which the volume belongs.

3. Set the list of common names for clients allowed to access the volume. Be sure to include the common names of all the servers.

```
# oc rsh <gluster_pod_name> gluster volume set VOLNAME auth.ssl-
allow 'server1,server2,server3,client1,client2,client3'
```

NOTE

If you set auth.ssl-allow option with * as value, any TLS authenticated clients can mount and access the volume from the application side. Hence, you set the option's value to * or provide common names of clients as well as the nodes in the trusted storage pool.

4. Enable client.ssl and server.ssl on the volume by using the following command:

```
# oc rsh <gluster_pod_name> gluster volume set VOLNAME client.ssl on
# oc rsh <gluster_pod_name> gluster volume set VOLNAME server.ssl on
```

5. Start the volume.

```
# oc rsh <gluster_pod_name> gluster volume start VOLNAME
```

6. Start the application pods to use the I/O encrypted Red Hat Gluster Storage volumes.

8.3.2. Enabling Management Encryption

Management encryption is recommended, even though, Red Hat Gluster Storage can be configured only for I/O encryption without using management encryption. On an existing installation, with running servers and clients, schedule a downtime of volumes, applications, clients, and other end-users to enable management encryption.

You cannot currently change between unencrypted and encrypted connections dynamically. Bricks and other local services on the servers and clients do not receive notifications from glusterd if they are running when the switch to management encryption is made.

1. Stop all the application pods that have the Red Hat Gluster Storage volumes.

2. Stop all the volumes.

```
# oc rsh <gluster_pod_name> gluster volume stop VOLNAME
```

3. Stop the Red Hat Gluster Storage pods.

```
# oc delete daemonset glusterfs
```

4. On deletion of daemon set the pods go down. To verify if the pods are down, execute the following command:

```
# oc get pods
```

5. Create the /var/lib/glusterd/secure-access file on all OpenShift nodes.

```
# touch /var/lib/glusterd/secure-access
```

6. Create the Red Hat Gluster Storage daemonset by executing the following command:

NOTE

For Ansible deployments, the image name and the version has to be specified in the template, before executing the command.

```
# oc process glusterfs | oc create -f -
```

7. On creation of daemon set the pods are started. To verify if the pods are started, execute the following command:

```
# oc get pods
```

8. Start all the volumes.

```
# oc rsh <gluster_pod_name> gluster volume start VOLNAME
```

9. Start the application pods to use the management encrypted Red Hat Gluster Storage.

8.4. DISABLING ENCRYPTION

You can disable encryption for on Red Hat Openshift Container Storage setup in the following two scenarios:

- Disabling I/O Encryption for a Volume
- Disabling Management Encryption

8.4.1. Disabling I/O Encryption for all the Volumes

Execute the following commands to disable the I/O encryption between the servers and clients for a volume:

NOTE

The servers are the OpenShift nodes on which Red Hat Gluster Storage pods are running.

The clients are the remaining OpenShift nodes on which Red Hat Gluster Storage is not running.

1. Stop all the application pods that have the Red Hat Gluster Storage volumes.

2. Stop all the volumes.

```
# oc rsh <gluster_pod_name> gluster volume stop VOLNAME
```

3. Reset all the encryption options for a volume:

```
# oc rsh <gluster_pod_name> gluster volume reset VOLNAME auth.ssl-allow
# oc rsh <gluster_pod_name> gluster volume reset VOLNAME client.ssl
# oc rsh <gluster_pod_name> gluster volume reset VOLNAME server.ssl
```

4. Delete the files that were used for network encryption using the following command on all the OpenShift nodes:

   ```
   # rm /etc/ssl/glusterfs.pem /etc/ssl/glusterfs.key
   /etc/ssl/glusterfs.ca
   ```

   NOTE

   Deleting these files in a setup where management encryption is enabled will result in glusterd failing on all gluster pods and hence should be avoided.

5. Stop the Red Hat Gluster Storage pods.

   ```
   # oc delete daemonset glusterfs
   ```

6. On deletion of daemon set the pods go down. To verify if the pods are down, execute the following command:

   ```
   # oc get pods
   ```

7. Create the Red Hat Gluster Storage daemonset by executing the following command:

   NOTE

   For Ansible deployments, the image name and the version has to be specified in the template, before executing the command.

   ```
   # oc process glusterfs | oc create -f -
   ```

8. On creation of daemon set the pods are started. To verify if the pods are started, execute the following command:

   ```
   # oc get pods
   ```

9. Start the volume.

   ```
   # oc rsh <gluster_pod_name> gluster volume start VOLNAME
   ```

10. Start the application pods to use the I/O encrypted Red Hat Gluster Storage volumes.

8.4.2. Disabling Management Encryption

You cannot currently change between unencrypted and encrypted connections dynamically. Bricks and other local services on the servers and clients do not receive notifications from glusterd if they are running when the switch to management encryption is made.

Execute the following commands to disable the management encryption

1. Stop all the application pods that have the Red Hat Gluster Storage volumes.

2. Stop all the volumes.

   ```
   # oc rsh <gluster_pod_name> gluster volume stop VOLNAME
   ```

3. Stop the Red Hat Gluster Storage pods.

   ```
   # oc delete daemonset glusterfs
   ```

4. On deletion of daemon set the pods go down. To verify if the pods are down, execute the following command:

   ```
   # oc get pods
   ```

5. Delete the /var/lib/glusterd/secure-access file on all OpenShift nodes to disable management encryption.

   ```
   # rm /var/lib/glusterd/secure-access
   ```

6. Delete the files that were used for network encryption using the following command on all the OpenShift nodes:

   ```
   # rm /etc/ssl/glusterfs.pem /etc/ssl/glusterfs.key
   /etc/ssl/glusterfs.ca
   ```

7. Create the Red Hat Gluster Storage daemonset by executing the following command:

   NOTE

   For Ansible deployments, the image name and the version has to be specified in the template, before executing the command.

   ```
   # oc process glusterfs | oc create -f -
   ```

8. On creation of daemon set the pods are started. To verify if the pods are started, execute the following command:

   ```
   # oc get pods
   ```

9. Start all the volumes.

   ```
   # oc rsh <gluster_pod_name> gluster volume start VOLNAME
   ```

10. Start the application pods to use the management encrypted Red Hat Gluster Storage.

PART IV. MIGRATION

CHAPTER 9. UPDATING THE REGISTRY WITH RED HAT OPENSHIFT CONTAINER STORAGE AS THE STORAGE BACK-END

OpenShift Container Platform provides an integrated registry with storage using an NFS-backed persistent volume that is automatically setup. Red Hat Openshift Container Storage allows you to replace this with a Gluster persistent volume for registry storage. This provides increased reliability, scalability and failover.

For additional information about OpenShift Container Platform and the docker-registry, see https://access.redhat.com/documentation/en-us/openshift_container_platform/3.11/html/configuring_clusters/setting-up-the-registry .

9.1. VALIDATING THE OPENSHIFT CONTAINER PLATFORM REGISTRY DEPLOYMENT

To verify that the registry is properly deployed, execute the following commands:

1. On the master or client, execute the following command to login as the cluster admin user:

   ```
   # oc login
   ```

   For example:

   ```
   # oc login

   Authentication required for https://master.example.com:8443
   (openshift)
   Username: <cluster-admin-user>
   Password: <password>
   Login successful.

   You have access to the following projects and can switch between
   them with 'oc project <projectname>':

     * default
       management-infra
       openshift
       openshift-infra

   Using project "default".
   ```

   If you are not automatically logged into project default, then switch to it by executing the following command:

   ```
   # oc project default
   ```

2. To verify that the pod is created, execute the following command:

   ```
   # oc get pods
   ```

   For example:

```
# oc get pods
NAME                        READY     STATUS    RESTARTS   AGE
docker-registry-2-mbu0u     1/1       Running   4          6d
docker-registry-2-spw0o     1/1       Running   3          6d
registry-console-1-rblwo    1/1       Running   3          6d
```

3. To verify that the endpoints are created, execute the following command:

```
# oc get endpoints
```

For example:

```
# oc get endpoints
NAME               ENDPOINTS
AGE
docker-registry    10.128.0.15:5000,10.129.0.9:5000
7d
kubernetes
192.168.234.143:8443,192.168.234.143:8053,192.168.234.143:8053
7d
registry-console   10.128.0.17:9090
7d
router
192.168.234.144:443,192.168.234.145:443,192.168.234.144:1936 + 3
more...   7d
```

4. To verify that the persistent volume is created, execute the following command:

```
# oc get pv
NAME   CAPACITY   ACCESSMODES   RECLAIMPOLICY   STATUS      CLAIM
REASON    AGE
registry-volume           5Gi        RWX           Retain
Bound       default/registry-claim             7d
```

5. To obtain the details of the persistent volume that was created for the NFS registry, execute the following command:

```
# oc describe pv registry-volume
Name:        registry-volume
Labels:        <none>
StorageClass:
Status:        Bound
Claim:        default/registry-claim
Reclaim Policy:    Retain
Access Modes:    RWX
Capacity:    5Gi
Message:
Source:
    Type:    NFS (an NFS mount that lasts the lifetime of a pod)
    Server:    cns30.rh73
    Path:    /exports/registry
    ReadOnly:    false
No events.
```

9.2. CONVERTING THE OPENSHIFT CONTAINER PLATFORM REGISTRY WITH RED HAT OPENSHIFT CONTAINER STORAGE

This section provides the steps to create a Red Hat Gluster Storage volume and use it to provide storage for the integrated registry.

Setting up a Red Hat Gluster Storage Persistent Volume

Execute the following commands to create a Red Hat Gluster Storage volume to store the registry data and create a persistent volume.

> **NOTE**
>
> The commands must be executed in the **`default`** project.

1. Login to the **`default`** project:

   ```
   # oc project default
   ```

   For example:

   ```
   # oc project default
   Now using project "default" on server "https://cns30.rh73:8443"
   ```

2. Execute the following command to create the **`gluster-registry-endpoints.yaml`** file:

   ```
    oc get endpoints <heketi-db-storage-endpoint-name> -o yaml --
   namespace=<project-name> >  gluster-registry-endpoints.yaml
   ```

   > **NOTE**
   >
   > You must create an endpoint for each project from which you want to utilize the Red Hat Gluster Storage registry. Hence, you will have a service and an endpoint in both the **`default`** project and the new project (**`storage-project`**) created in earlier steps.

3. Edit the **`gluster-registry-endpoints.yaml`** file. Change the name to gluster-registry-endpoints and remove all the other metadata, leaving everything else the same.

   ```
   # cat gluster-registry-endpoints.yaml
   apiVersion: v1
   kind: Endpoints
   metadata:
     name: gluster-registry-endpoints
   subsets:
     - addresses:
         - ip: 192.168.124.114
         - ip: 192.168.124.52
         - ip: 192.168.124.83
       ports:
         - port: 1
           protocol: TCP
   ```

4. Execute the following command to create the endpoint:

```
# oc create -f gluster-registry-endpoints.yaml
endpoints "gluster-registry-endpoints" created
```

5. To verify the creation of the endpoint, execute the following command:

```
# oc get endpoints
NAME                       ENDPOINTS
AGE
docker-registry            10.129.0.8:5000,10.130.0.5:5000
28d
gluster-registry-endpoints
192.168.124.114:1,192.168.124.52:1,192.168.124.83:1
10s
kubernetes
192.168.124.250:8443,192.168.124.250:8053,192.168.124.250:8053
28d
registry-console           10.131.0.6:9090
28d
router
192.168.124.114:443,192.168.124.83:443,192.168.124.114:1936 + 3
more...   28d
```

6. Execute the following command to create the **gluster-registry-service.yaml** file:

```
 oc get services <heketi-storage-endpoint-name> -o yaml --namespace=
<project-name> >  gluster-registry-service.yaml
```

7. Edit the **gluster-registry-service.yaml** file. Change the name to gluster-registry-service and remove all the other metadata. Also, remove the specific cluster IP addresses:

```
# cat gluster-registry-service.yaml
apiVersion: v1
kind: Service
metadata:
  name: gluster-registry-service
spec:
  ports:
    - port: 1
      protocol: TCP
      targetPort: 1
  sessionAffinity: None
  type: ClusterIP
status:
  loadBalancer: {}
```

8. Execute the following command to create the service:

```
# oc create -f gluster-registry-service.yaml
services "gluster-registry-service" created
```

9. Execute the following command to verify if the service are running:

```
# oc get services
NAME                          CLUSTER-IP       EXTERNAL-IP   PORT(S)
AGE
docker-registry               172.30.197.118   <none>        5000/TCP
28d
gluster-registry-service      172.30.0.183     <none>        1/TCP
6s
kubernetes                    172.30.0.1       <none>
443/TCP,53/UDP,53/TCP        29d
registry-console              172.30.146.178   <none>        9000/TCP
28d
router                        172.30.232.238   <none>
80/TCP,443/TCP,1936/TCP      28d
```

10. Execute the following command to obtain the fsGroup GID of the existing docker-registry pods:

```
# export GID=$(oc get po --selector="docker-registry=default" -o go-
template --template='{{printf "%.0f" ((index .items
0).spec.securityContext.fsGroup)}}')
```

11. Execute the following command to create a volume

```
# heketi-cli volume create --size=5 --name=gluster-registry-volume -
-gid=${GID}
```

12. Create the persistent volume file for the Red Hat Gluster Storage volume:

```
# cat gluster-registry-volume.yaml
kind: PersistentVolume
apiVersion: v1
metadata:
  name: gluster-registry-volume
  labels:
    glusterfs: registry-volume
spec:
  capacity:
    storage: 5Gi
  glusterfs:
    endpoints: gluster-registry-endpoints
    path: gluster-registry-volume
  accessModes:
    - ReadWriteMany
  persistentVolumeReclaimPolicy: Retain
```

13. Execute the following command to create the persistent volume:

```
# oc create -f gluster-registry-volume.yaml
```

14. Execute the following command to verify and get the details of the created persistent volume:

```
# oc get pv/gluster-registry-volume
NAME                         CAPACITY   ACCESSMODES   RECLAIMPOLICY
STATUS      CLAIM     REASON    AGE
```

```
gluster-registry-volume   5Gi        RWX           Retain
Available                      21m
```

15. Create a new persistent volume claim. Following is a sample Persistent Volume Claim that will be used to replace the existing registry-storage volume claim.

```
# cat gluster-registry-claim.yaml
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: gluster-registry-claim
spec:
  accessModes:
    - ReadWriteMany
  resources:
    requests:
      storage: 5Gi
  selector:
    matchLabels:
      glusterfs: registry-volume
```

16. Create the persistent volume claim by executing the following command:

```
# oc create -f gluster-registry-claim.yaml
```

For example:

```
# oc create -f gluster-registry-claim.yaml
persistentvolumeclaim "gluster-registry-claim" created
```

17. Execute the following command to verify if the claim is bound:

```
# oc get pvc/gluster-registry-claim
```

For example:

```
# oc get pvc/gluster-registry-claim
NAME                     STATUS    VOLUME
CAPACITY   ACCESSMODES   AGE
gluster-registry-claim   Bound     gluster-registry-volume   5Gi
RWX           22s
```

18. Make the registry read-only by executing the following command:

```
# oc set env -n default dc/docker-registry
'REGISTRY_STORAGE_MAINTENANCE_READONLY={"enabled":true}'
```

To confirm the value is set to readonly, execute the following command:

```
# oc set env -n default dc/docker-registry --list
```

19. If you want to migrate the data from the old registry to the Red Hat Gluster Storage registry, then execute the following commands:

    NOTE

    These steps are optional.

    1. Add the Red Hat Gluster Storage registry to the old registry deployment configuration (dc) by executing the following command:

       ```
       # oc set volume dc/docker-registry --add --name=gluster-registry-
       storage -m /gluster-registry -t pvc --claim-name=gluster-
       registry-claim
       ```

    2. Save the Registry pod name by executing the following command:

       ```
       # export REGISTRY_POD=$(oc get po --selector="docker-
       registry=default" -o go-template --template='{{printf "%s"
       ((index .items 0).metadata.name)}}')
       ```

    3. Copy the data from the old registry directory to the Red Hat Gluster Storage registry directory by executing the following command:

       ```
       # oc rsh $REGISTRY_POD cp -a /registry/ /gluster-registry/
       ```

    4. Remove the Red Hat Gluster Storage registry from the old dc registry by executing the following command:

       ```
       # oc volume dc/docker-registry --remove --name=gluster-registry-
       storage
       ```

20. Replace the existing registry-storage volume with the new gluster-registry-claim PVC:

    ```
    # oc set volume dc/docker-registry --add --name=registry-storage -t
    pvc --claim-name=gluster-registry-claim --overwrite
    ```

21. Make the registry read write by executing the following command:

    ```
    # oc set env dc/docker-registry
    REGISTRY_STORAGE_MAINTENANCE_READONLY-
    ```

    To validate if the setting is set to read write, execute the following command:

    ```
    # oc set env -n default dc/docker-registry --list
    ```

For more information about accessing the registry, see https://access.redhat.com/documentation/en-us/openshift_container_platform/3.11/html/configuring_clusters/setting-up-the-registry#install-config-registry-accessing.

PART V. MONITORING

CHAPTER 10. ENABLING VOLUME METRICS

To enable volume metrics for glusterfs plugin in order to collect the statistics of GlusterFS PVs, set up Prometheus, a monitoring toolkit. You can use Prometheus to visualize metrics and alerts for OpenShift Container Platform system resources.

For more information on how to setup Prometheus, see https://access.redhat.com/documentation/en-us/openshift_container_platform/3.10/html-single/configuring_clusters/#openshift-prometheus

NOTE

The following steps are supported only for OCP 3.10.

10.1. ENABLING VOLUME METRICS FOR FILE STORAGE AND BLOCK STORAGE

Following is the list of different metrics of the PVs that can be viewed on Prometheus:

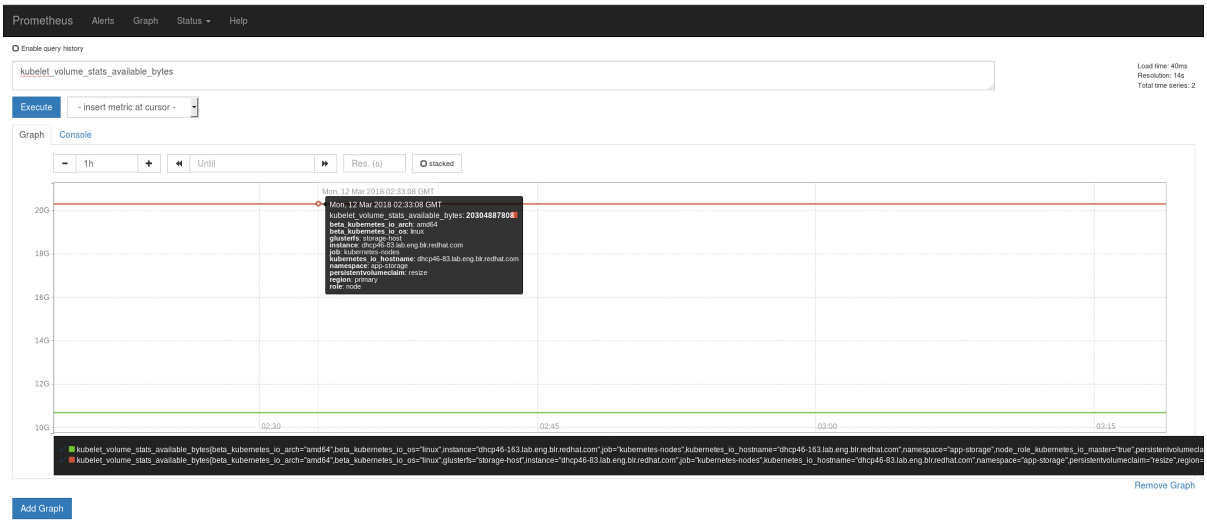
- **`kubelet_volume_stats_available_bytes`**: Number of available bytes in the volume.
- **`kubelet_volume_stats_capacity_bytes`**: Capacity in bytes of the volume.
- **`kubelet_volume_stats_inodes`**: Maximum number of inodes in the volume.
- **`kubelet_volume_stats_inodes_free`**: Number of free inodes in the volume.
- **`kubelet_volume_stats_inodes_used`**: Number of used inodes in the volume.
- **`kubelet_volume_stats_used_bytes`**: Number of used bytes in the volume.
- **`heketi_cluster_count`**: Number of clusters.
- **`heketi_device_brick_count`**: Number of bricks on device.
- **`heketi_device_count`**: Number of devices on host.
- **`heketi_device_free`**: Amount of free space available on the device.
- **`heketi_device_size`**: Total size of the device.
- **`heketi_device_used`**: Amount of space used on the device.
- **`heketi_nodes_count`**: Number of nodes on the cluster.
- **`heketi_up`**: Verifies if heketi is running.
- **`heketi_volumes_count`**: Number of volumes on cluster.

Viewing Metrics

To view any metrics:

1. Add the metrics name in **Prometheus**, and click **Execute**.
2. In the **Graph** tab, the value for the metrics for the volume is displayed as a graph.

For example, in the following image, to check the available bytes, **`kubelet_volume_stats_available_bytes`** metric is added to the search bar on **Prometheus**. On clicking **`Execute`**, the available bytes value is depicted as a graph. You can hover the mouse on the line to get more details. (To view the image in detail, right-click and select View Image.)



kubelet_volume_stats_available_bytes

Load time: 40ms
Resolution: 14s
Total time series: 2

Mon, 12 Mar 2018 02:33:08 GMT

Mon, 12 Mar 2018 02:33:08 GMT
kubelet_volume_stats_available_bytes: **20304887808**
beta_kubernetes_io_arch: amd64
beta_kubernetes_io_os: linux
glusterfs: storage-host
instance: dhcp46-83.lab.eng.blr.redhat.com
job: kubernetes-nodes
kubernetes_io_hostname: dhcp46-83.lab.eng.blr.redhat.com
namespace: app-storage
persistentvolumeclaim: resize
region: primary
role: node

🟩 kubelet_volume_stats_available_bytes{beta_kubernetes_io_arch="amd64",beta_kubernetes_io_os="linux",instance="dhcp46-163.lab.eng.blr.redhat.com",job="kubernetes-nodes",kubernetes_io_hostname="dhcp46-163.lab.eng.blr.redhat.com",namespace="app-storage",node_role_kubernetes_io_master="true",persistentvolumecla
🟥 kubelet_volume_stats_available_bytes{beta_kubernetes_io_arch="amd64",beta_kubernetes_io_os="linux",glusterfs="storage-host",instance="dhcp46-83.lab.eng.blr.redhat.com",job="kubernetes-nodes",kubernetes_io_hostname="dhcp46-83.lab.eng.blr.redhat.com",namespace="app-storage",persistentvolumeclaim="resize",region=

Viewing Heketi Metrics

To view Heketi metrics on **Prometheus**, execute the following commands:

1. Add annotations to the **`heketi-storage`**.

```
# oc annotate svc heketi-storage prometheus.io/scheme=http
# oc annotate svc heketi-storage prometheus.io/scrape=true
```

```
            # oc describe svc heketi-storage
            Name:               heketi-storage
            Namespace:          app-storage
            Labels:             glusterfs=heketi-storage-service
                                heketi=storage-service
            Annotations:        description=Exposes Heketi service
                                prometheus.io/scheme=http
                                 prometheus.io/scrape=true
            Selector:           glusterfs=heketi-storage-pod
            Type:               ClusterIP
            IP:                 172.30.90.87
            Port:               heketi  8080/TCP
            TargetPort:         8080/TCP
            Endpoints:          172.18.14.2:8080
            Session Affinity:   None
```

2. Add the **`app-storage`** namespace for the heketi service in the Prometheus configmap.

```
            # oc get cm prometheus -o yaml -n openshift-metrics
            ....
            - job_name: 'kubernetes-service-endpoints'

                tls_config:
                ca_file:
```

```
/var/run/secrets/kubernetes.io/serviceaccount/ca.crt
                 # TODO: this should be per target
                insecure_skip_verify: true

                kubernetes_sd_configs:
                - role: endpoints

                relabel_configs:
                # only scrape infrastructure components
                - source_labels: [__meta_kubernetes_namespace]
                action: keep
                regex: 'default|logging|metrics|kube-
.+|openshift|openshift-.+|app-storage'
```

3. Restart the **`prometheus-0`** pod to query the Heketi metrics in Prometheus.

PART VI. TROUBLESHOOT

CHAPTER 11. TROUBLESHOOTING

This chapter describes the most common troubleshooting scenarios related to Red Hat Openshift Container Storage.

- **What to do if a Red Hat Openshift Container Storage node Fails**

  If a Red Hat Openshift Container Storage node fails, and you want to delete it, then, disable the node before deleting it. For more information, see Section 1.2.3, “Deleting Node”.

  If a Red Hat Openshift Container Storage node fails and you want to replace it, see Section 1.2.3.3, “Replacing a Node”.

- **What to do if a Red Hat Openshift Container Storage device fails**

  If a Red Hat Openshift Container Storage device fails, and you want to delete it, then, disable the device before deleting it. For more information, see Section 1.2.2, “Deleting Device ”.

  If a Red Hat Openshift Container Storage device fails, and you want to replace it, see Section 1.2.2.3, “Replacing a Device”.

- **What to do if Red Hat Openshift Container Storage volumes require more capacity:**

  You can increase the storage capacity by either adding devices, increasing the cluster size, or adding an entirely new cluster. For more information, see Section 1.1, “Increasing Storage Capacity”.

- **How to upgrade Openshift when Red Hat Openshift Container Storage is installed**

  To upgrade Openshift Container Platform, see https://access.redhat.com/documentation/en-us/openshift_container_platform/3.11/html/upgrading_clusters/install-config-upgrading-automated-upgrades#upgrading-to-ocp-3-10.

- **Viewing Log Files**

  - **Viewing Red Hat Gluster Storage Container Logs**

    Debugging information related to Red Hat Gluster Storage containers is stored on the host where the containers are started. Specifically, the logs and configuration files can be found at the following locations on the openshift nodes where the Red Hat Gluster Storage server containers run:

    - /etc/glusterfs
    - /var/lib/glusterd
    - /var/log/glusterfs

  - **Viewing Heketi Logs**

    Debugging information related to Heketi is stored locally in the container or in the persisted volume that is provided to Heketi container.

    You can obtain logs for Heketi by running the **`docker logs`** ***`container-id`*** command on the openshift node where the container is being run.

- **Heketi command returns with no error or empty error**

Sometimes, running heketi-cli command returns with no error or empty error like **Error**. It is mostly due to heketi server not properly configured. You must first ping to validate that the Heketi server is available and later verify with a **curl** command and /**hello endpoint**.

```
# curl http://deploy-heketi-storage-
project.cloudapps.mystorage.com/hello
```

- **Heketi reports an error while loading the topology file**

  Running heketi-cli reports : Error "Unable to open topology file" error while loading the topology file. This could be due to the use of old syntax of single hyphen (-) as a prefix for JSON option. You must use the new syntax of double hyphens and reload the topology file.

- **cURL command to heketi server fails or does not respond**

  If the router or heketi is not configured properly, error messages from the heketi may not be clear. To troubleshoot, ping the heketi service using the endpoint and also using the IP address. If ping by the IP address succeeds and ping by the endpoint fails, it indicates a router configuration error.

  After the router is setup properly, run a simple curl command like the following:

  ```
  # curl http://deploy-heketi-storage-
  project.cloudapps.mystorage.com/hello
  ```

  If heketi is configured correctly, a welcome message from heketi is displayed. If not, check the heketi configuration.

- **Heketi fails to start when Red Hat Gluster Storage volume is used to store heketi.db file**

  Sometimes Heketi fails to start when Red Hat Gluster Storage volume is used to store heketi.db and reports the following error:

  ```
  [heketi] INFO 2016/06/23 08:33:47 Loaded kubernetes executor
  [heketi] ERROR 2016/06/23 08:33:47
  /src/github.com/heketi/heketi/apps/glusterfs/app.go:149: write
  /var/lib/heketi/heketi.db: read-only file system
  ERROR: Unable to start application
  ```

  The read-only file system error as shown above could be seen while using a Red Hat Gluster Storage volume as backend. This could be when the quorum is lost for the Red Hat Gluster Storage volume. In a replica-3 volume, this would be seen if 2 of the 3 bricks are down. You must ensure the quorum is met for heketi gluster volume and it is able to write to heketi.db file again.

  Even if you see a different error, it is a recommended practice to check if the Red Hat Gluster Storage volume serving heketi.db file is available or not. Access deny to heketi.db file is the most common reason for it to not start.

CHAPTER 12. CLIENT CONFIGURATION USING PORT FORWARDING

If a router is not available, you may be able to set up port forwarding so that heketi-cli can communicate with the Heketi service. Execute the following commands for port forwarding:

1. Obtain the Heketi service pod name by running the following command:

   ```
   # oc get pods
   ```

2. To forward the port on your local system to the pod, execute the following command on another terminal of your local system:

   ```
   # oc port-forward <heketi pod name> 8080:8080
   ```

3. On the original terminal execute the following command to test the communication with the server:

   ```
   # curl http://localhost:8080/hello
   ```

   This will forward the local port 8080 to the pod port 8080.

4. Setup the Heketi server environment variable by running the following command:

   ```
   # export HEKETI_CLI_SERVER=http://localhost:8080
   ```

5. Get information from Heketi by running the following command:

   ```
   # heketi-cli topology info
   ```

APPENDIX A. REVISION HISTORY

Revision 1.0-02	**Wed Mar 27 2019**	**Bhavana Mohan**

Publishing for Red Hat Openshift Container Storage 3.11 Update 2

Revision 1.0-01	**Wed Mar 27 2019**	**Bhavana Mohan**

Updated the procedure to add new nodes to the existing cluster by using Heketi CLI.

Updated the "Adding a New Cluster" chapter with relevant steps.

Resolved broken links in the guide.

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