Red Hat Gluster Storage 3.2 Container-Native Storage for OpenShift Container Platform

Deploying Container-Native Storage for OpenShift Container Platform 3.5
Edition 1

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Abstract

This guide describes the prerequisites and provides step-by-step instructions to deploy Container-Native Storage with OpenShift Platform.

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Chapter 1. Introduction to Containerized Red Hat Gluster Storage

This guide provides step-by-step instructions to deploy Containerized Red Hat Gluster Storage. The deployment addresses the use-case where applications require both shared file storage and the flexibility of a converged infrastructure with compute and storage instances being scheduled and run from the same set of hardware.

Containerized Red Hat Gluster Storage Solutions

The following table lists the Containerized Red Hat Gluster Storage solutions, a brief description, and the links to the documentation for more information about the solution.

Table 1.1. Containerized Red Hat Gluster Storage Solutions

Solution	Description	Documentation
Container-Native Storage (CNS)	This solution addresses the use-case where applications require both shared file storage and the flexibility of a converged infrastructure with compute and storage instances being scheduled and run from the same set of hardware.	For information on deploying CNS, see Chapter 2, *Container-Native Storage for OpenShift Container Platform* in this guide.
Container Ready Storage (CRS) with Heketi	This solution addresses the use-case where a dedicated Gluster cluster is available external to the OpenShift Origin cluster, and you provision storage from the Gluster cluster. In this mode, Heketi also runs outside the cluster and and can be co-located with a Red Hat Gluster Storage node.	For information on configuring CRS with Heketi, see Complete Example of Dynamic Provisioning Using Dedicated GlusterFS.
Container Ready Storage (CRS) without Heketi	This solution uses your OpenShift Container Platform cluster (without Heketi) to provision Red Hat Gluster Storage volumes (from a dedicated Red Hat Gluster Storage cluster) as persistent storage for containerized applications.	For information on creating OpenShift Container Platform cluster with persistent storage using Red Hat Gluster Storage, see Persistent Storage Using GlusterFS .

Chapter 2. Container-Native Storage for OpenShift Container Platform

This deployment delivers a hyper-converged solution, where the storage containers that host Red Hat Gluster Storage co-reside with the compute containers and serve out storage from the hosts that have local or direct attached storage to the compute containers. This solution integrates Red Hat Gluster Storage deployment and management with OpenShift services. As a result, persistent storage is delivered within an OpenShift pod that provides both compute and file storage.

Container-Native Storage for OpenShift Container Platform is built around three key technologies:

- OpenShift provides the platform as a service (PaaS) infrastructure based on Kubernetes container management. Basic OpenShift architecture is built around multiple master systems where each system contains a set of nodes.
- Red Hat Gluster Storage provides the containerized distributed storage based on Red Hat Gluster Storage 3.1.3 container. Each Red Hat Gluster Storage volume is composed of a collection of bricks, where each brick is the combination of a node and an export directory.
- Heketi provides the Red Hat Gluster Storage volume life cycle management. It creates the Red Hat Gluster Storage volumes dynamically and supports multiple Red Hat Gluster Storage clusters.

The following list provides the administrators a solution workflow. The administrators can:

- Create multiple persistent volumes (PV) and register these volumes with OpenShift.
- Developers then submit a persistent volume claim (PVC).
- A PV is identified and selected from a pool of available PVs and bound to the PVC.
- The OpenShift pod then uses the PV for persistent storage.

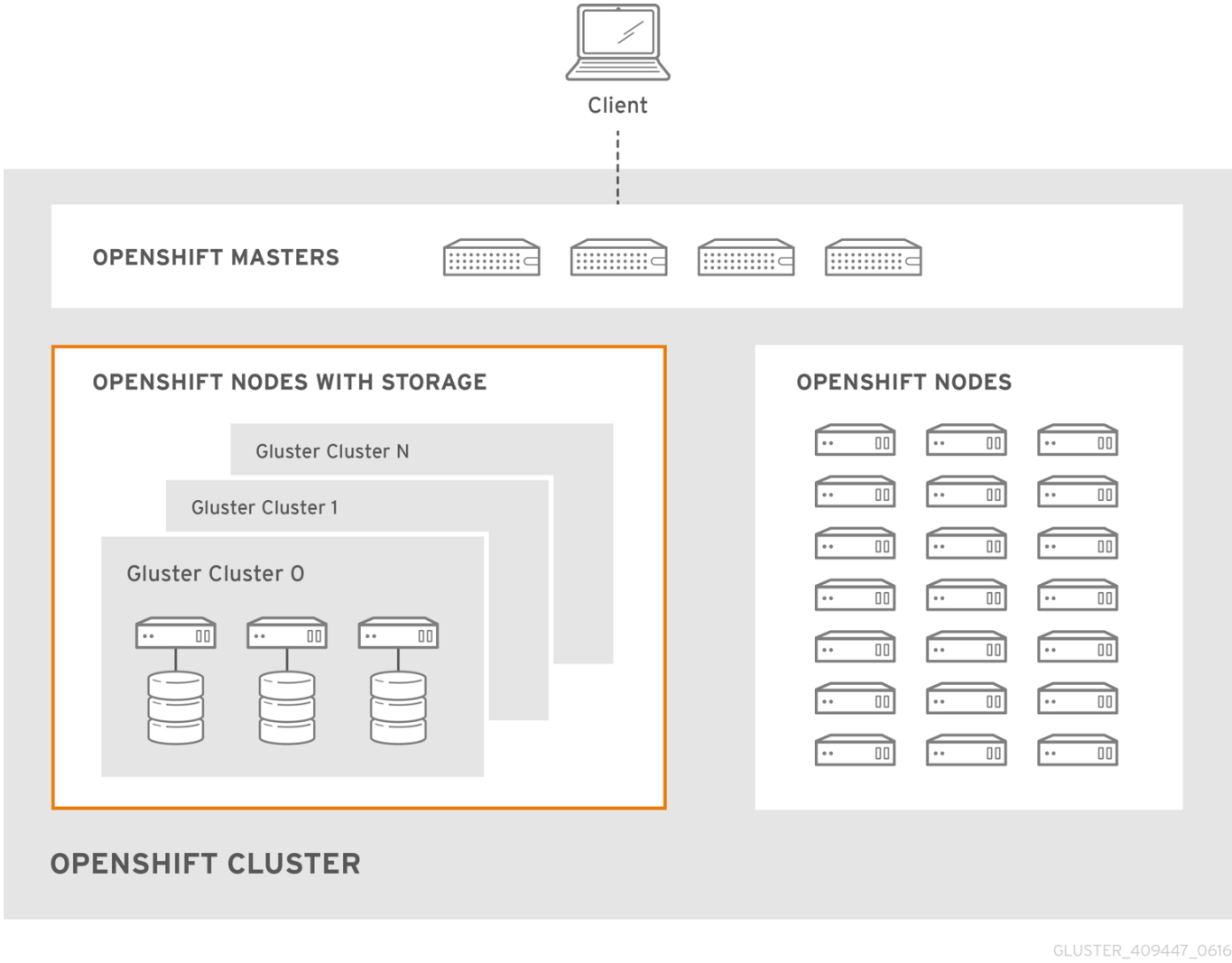


Figure 2.1. Architecture - Container-Native Storage for OpenShift Container Platform

Chapter 3. Support Requirements

This chapter describes and lists the various prerequisites to set up Red Hat Gluster Storage Container Native with OpenShift Container Platform.

3.1. Supported Versions

The following table lists the supported versions of OpenShift Container Platform with Red Hat Gluster Storage Server.

Table 3.1. Supported Versions

Red Hat Gluster Storage	OpenShift Container Platform
3.2	3.5

3.2. Environment Requirements

The requirements for Red Hat Enterprise Linux Atomic Host, Red Hat OpenShift Container Platform, Red Hat Enterprise Linux, and Red Hat Gluster Storage is described in this section. A Red Hat Gluster Storage Container Native with OpenShift Container Platform environment consists of Red Hat OpenShift Container Platform installed on Red Hat Enterprise Linux Atomic Host or Red Hat Enterprise Linux.

3.2.1. Installing Red Hat Gluster Storage Container Native with OpenShift Container Platform on Red Hat Enterprise Linux 7 based OpenShift Container Platform Cluster

This section describes the procedures to install Red Hat Gluster Storage Container Native with OpenShift Container Platform on Red Hat Enterprise Linux 7 based OpenShift Container Platform 3.5.

3.2.1.1. Setting up the Openshift Master as the Client

You can use the OpenShift Master as a client to execute the **oc** commands across the cluster when installing OpenShift. Generally, this is setup as a non-scheduled node in the cluster. This is the default configuration when using the OpenShift installer. You can also choose to install their client on their local machine to access the cluster remotely. For more information, see https://access.redhat.com/documentation/en/openshift-container-platform/3.5/single/cli-reference/#installing-the-cli.

Subscribe to the Red Hat Gluster Storage repository

This enables you to install the heketi client packages which are required to setup the client for Red Hat Gluster Storage Container Native with OpenShift Container Platform.

```
# subscription-manager repos --enable=rh-gluster-3-for-rhel-7-server-rpms
```

```
# yum install cns-deploy heketi-client
```

3.2.1.2. Setting up the Red Hat Enterprise Linux 7 Client for Installing Red Hat Gluster Storage Container Native with OpenShift Container Platform

To set up the Red Hat Enterprise Linux 7 client for installing Red Hat Gluster Storage Container Native with OpenShift Container Platform, perform the following steps:

Subscribe to the Red Hat Gluster Storage repository

This enables you to install the heketi client packages which are required to setup the client for Red Hat Gluster Storage Container Native with OpenShift Container Platform.

```
# subscription-manager repos --enable=rh-gluster-3-for-rhel-7-server-rpms
```

```
# yum install cns-deploy heketi-client
```

Subscribe to the OpenShift Container Platform 3.5 repository

If you are using OpenShift Container Platform 3.5, subscribe to 3.5 repository to enable you to install the Openshift client packages

```
# subscription-manager repos --enable=rhel-7-server-ose-3.5-rpms --
enable=rhel-7-server-rpms
```

```
# yum install atomic-openshift-clients
```

```
# yum install atomic-openshift
```

3.2.2. Installing Red Hat Gluster Storage Container Native with OpenShift Container Platform on Red Hat Enterprise Linux Atomic Host OpenShift Container Platform Cluster

Red Hat Enterprise Linux Atomic host does not support the installation of additional RPMs. Hence, an external client is required on Red Hat Enterprise Linux to install the required packages. To set up the client for Red Hat Enterprise Linux Atomic Host based installations, refer Section 3.2.1.2, “Setting up the Red Hat Enterprise Linux 7 Client for Installing Red Hat Gluster Storage Container Native with OpenShift Container Platform”

3.2.3. Red Hat OpenShift Container Platform Requirements

The following list provides the Red Hat OpenShift Container Platform requirements:

- The OpenShift cluster must be up and running. For information on setting up OpenShift cluster, see https://access.redhat.com/documentation/en/openshift-container-platform/3.5/paged/installation-and-configuration.
- On each of the OpenShift nodes that will host the Red Hat Gluster Storage container, add the following rules to **`/etc/sysconfig/iptables`** in order to open the required ports:

```
-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
```

For more information about Red Hat Gluster Storage Server ports, see https://access.redhat.com/documentation/en-us/red_hat_gluster_storage/3.2/html/administration_guide/chap-getting_started.

- Execute the following command to reload the iptables:

```
# systemctl reload iptables
```

- Execute the following command on each node to verify if the iptables are updated:

```
# iptables -L
```

- A cluster-admin user must be created. For more information, see Appendix B, *Cluster Administrator Setup*
- At least three OpenShift nodes must be created as the storage nodes with at least one raw device each.
- All OpenShift nodes on Red Hat Enterprise Linux systems must have glusterfs-client RPM installed.
- It is recommended to persist the logs for the Heketi container. For more information on persisting logs, refer https://access.redhat.com/documentation/en/openshift-container-platform/3.5/single/installation-and-configuration/#install-config-aggregate-logging.

3.2.4. Red Hat Gluster Storage Requirements

The following list provides the details regarding the Red Hat Gluster Storage requirements:

- Installation of Heketi packages must have valid subscriptions to Red Hat Gluster Storage Server repositories.
- Red Hat Gluster Storage installations must adhere to the requirements outlined in the Red Hat Gluster Storage Installation Guide.
- The versions of Red Hat Enterprise OpenShift and Red Hat Gluster Storage integrated must be compatible, according to the information in Section 3.1, “Supported Versions” section.
- A fully-qualified domain name must be set for Red Hat Gluster Storage server node. Ensure that the correct DNS records exist, and that the fully-qualified domain name is resolvable via both forward and reverse DNS lookup.

Important

Restrictions for using Snapshot

- After a snapshot is created, it must be accessed though 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.

3.2.5. Planning Guidelines

The following are the guidelines for setting up Red Hat Gluster Storage Container Native with OpenShift Container Platform.

- Ensure that the Trusted Storage Pool is not scaled beyond 300 volumes per 3 nodes per 32GB of RAM.
- A trusted storage pool consists of a minimum of 3 nodes/peers.
- Distributed-Three-way replication is the only supported volume type.
- Each physical node that needs to host a Red Hat Gluster Storage peer:
  - will need a minimum of 32GB RAM.
  - is expected to have the same disk type.
  - by default the heketidb utilises 2 GB distributed replica volume.
- Red Hat Gluster Storage Container Native with OpenShift Container Platform supports up to 14 snapshots per volume.
- Creation of more than 300 volumes per trusted storage pool is not supported.
- Before running the **`cns-deploy`** tool, you must ensure that the **`dm_thin_pool`** module is loaded in the OpenShift Container Platform node. Execute the following command to verify if the **`dm_thin_pool`** module is loaded:

  ```
  # lsmod | grep dm_thin_pool
  ```

  If the **`dm_thin_pool`** module is not loaded, execute the following command to load the module:

  ```
  # modprobe dm_thin_pool
  ```

Chapter 4. Setting up the Environment

This chapter outlines the details for setting up the environment for Red Hat Gluster Storage Container Converged in OpenShift.

4.1. Preparing the Red Hat OpenShift Container Platform Cluster

Execute the following steps to prepare the Red Hat OpenShift Container Platform cluster:

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://dhcp46-
24.lab.eng.blr.redhat.com:8443 (openshift)
Username: test
Password:
Login successful.

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

    default
    kube-system
    logging
    management-infra
    openshift
    openshift-infra
  * storage-project

Using project "storage-project".
```

2. On the master or client, execute the following command to create a project, which will contain all the containerized Red Hat Gluster Storage services:

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

For example:

```
# oc new-project storage-project

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

3. 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.

```
# oadm policy add-scc-to-user privileged -z storage-project
```

4. Execute the following steps on the master to set up the router:

Note

If a router already exists, proceed to Step 5.

a. Execute the following command to enable the deployment of the router:

```
# oadm policy add-scc-to-user privileged -z router
# oadm policy add-scc-to-user privileged -z default
```

b. Execute the following command to deploy the router:

```
# oadm router storage-project-router --replicas=1
```

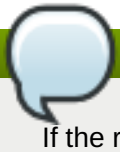
c. Edit the subdomain name in the config.yaml file located at **`/etc/origin/master/master-config.yaml`**.

For example:

```
subdomain: "cloudapps.mystorage.com"
```

d. Restart the master OpenShift services by executing the following command:

```
# systemctl restart atomic-openshift-master
```



Note

If the router setup fails, use the port forward method as described in Appendix C, *Client Configuration using Port Forwarding* .

For more information regarding router setup, see https://access.redhat.com/documentation/en/openshift-container-platform/3.5/paged/installation-and-configuration/chapter-4-setting-up-a-router

5. Execute the following command to verify if the router is running:

```
# oc get dc <router_name>
```

For example:

```
# oc get dc storage-project-router
NAME                     REVISION   DESIRED   CURRENT   TRIGGERED BY
storage-project-router   1          1         1         config
```

Note

Ensure you do not edit the **/etc/dnsmasq.conf** file until the router has started.

6. After the router is running, the client has to be setup to access the services in the OpenShift cluster. Execute the following steps on the client to set up the DNS.

    a. Edit the /etc/dnsmasq.conf file and add the following line to the file:

    ```
    address=/.cloudapps.mystorage.com/<Router_IP_Address>
    ```

    where, *Router_IP_Address* is the IP address of the node where the router is running.

    b. Restart the **dnsmasq** service by executing the following command:

    ```
    # systemctl restart dnsmasq
    ```

    c. Edit /etc/resolv.conf and add the following line:

    ```
    nameserver 127.0.0.1
    ```

    For more information regarding setting up the DNS, see https://access.redhat.com/documentation/en/openshift-container-platform/3.5/single/installation-and-configuration/#environment-requirements.

4.2. Deploying Container-Native Storage

The following section covers deployment of the Container-Native Storage pods using the **cns-deploy** tool. If you prefer to manually install Container-Native Storage, see Appendix A, *Manual Deployment*

Note

If you want to enable encryption on the Container Native Storage setup, refer Chapter 12, *Enabling Encryption* before proceeding with the following steps.

1. You must first provide a topology file for heketi which describes the topology of the Red Hat Gluster Storage nodes and their attached storage devices. A sample, formatted topology file (topology-sample.json) is installed with the 'heketi-client' package in the /usr/share/heketi/ directory.

```
{
    "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.

Important

Heketi stores its database on a Red Hat Gluster Storage volume. In cases where the volume is down, the Heketi service does not respond due to the unavailability of the volume served by a disabled trusted storage pool. To resolve this issue, restart the trusted storage pool which contains the Heketi volume.

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

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

For example:

```
# cns-deploy -n storage-project -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   Active    1h
Using namespace "storage-project".
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:heketi-service-account"
node "dhcp37-64.lab.eng.blr.redhat.com" labeled
node "dhcp37-79.lab.eng.blr.redhat.com" labeled
node "dhcp37-100.lab.eng.blr.redhat.com" 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: 94877b3f72b79273e87c1e94201ecd58
Creating node dhcp37-64.lab.eng.blr.redhat.com ... ID:
c718232efcc5f8ee50c91ed8d3e35364
Adding device /dev/vdc ... OK
Adding device /dev/vdd ... OK
Adding device /dev/vde ... OK
Adding device /dev/vdf ... OK
Creating node dhcp37-79.lab.eng.blr.redhat.com ... ID:
279f5caadce331f7d1df35e2697364a8
Adding device /dev/vdc ... OK
Adding device /dev/vdd ... OK
Adding device /dev/vde ... OK
Adding device /dev/vdf ... OK
Creating node dhcp37-100.lab.eng.blr.redhat.com ... ID:
4ae467b5da48d40118bd1992c85d5cdd
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-kd1zn" 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, refer to the man page of the cns-deploy.

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

3. Execute the following command to let the client communicate with the container:

```
# export  HEKETI_CLI_SERVER=http://heketi-<project_name>.
<sub_domain_name>
```

For example:

```
# export  HEKETI_CLI_SERVER=http://heketi-storage-
project.cloudapps.mystorage.com
```

To verify if Heketi is loaded with the topology execute the following command:

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

Note

The cns-deploy tool does not support scaling up of the cluster. To manually scale-up the cluster, refer Chapter 8, *Managing Clusters*

Chapter 5. 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.

You can provision volumes either statically or dynamically. In static provisioning of volumes a persistent volume claim has to be created which the administrator uses to create a persistent volume. More details about static provisioning of volumes is provided in Section 5.1, "Static Provisioning of Volumes".

From Container Native Storage 3.4 release onwards dynamic provisioning of volumes is introduced. With dynamic provisioning no administrator intervention is required to create a persistent volume. The volume will be created dynamically and provisioned to the application containers. More details about dynamic provisioning of volumes is provided in Section 5.2, "Dynamic Provisioning of Volumes".

5.1. Static Provisioning of Volumes

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

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.

1. To specify the endpoints you want to create, update the **`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:

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

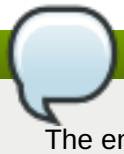
```
# cat sample-gluster-service.yaml
apiVersion: v1
kind: Service
metadata:
  name: glusterfs-cluster
spec:
  ports:
  - port: 1
```

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.

lables: 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/openshift-container-platform/3.5/single/installation-and-configuration/#install-config-storage-examples-gluster-example.

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

```
# oc get pods
```

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/openshift-container-platform/3.5/single/installation-and-configuration/#gluster-volume-security.

5.2. Dynamic Provisioning of Volumes

Dynamic provisioning enables provisioning of Red hat Gluster Storage volume to a running application container without having to pre-create 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

Dynamically provisioned Volumes are supported from Container Native Storage 3.4. If you have any statically provisioned volumes and require more information about managing it, then refer Section 5.1, “Static Provisioning of Volumes”

5.2.1. 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.

5.2.1.1. 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
parameters:
  resturl: "http://heketi-storage-project.cloudapps.mystorage.com"
  restuser: "admin"
  volumetype: "replicate:3"
  clusterid:
"630372ccdc720a92c681fb928f27b53f,796e6db1981f369ea0340913eeea4c9a"
  secretNamespace: "default"
  secretName: "heketi-secret"
```

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.

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.
```

5.2.1.2. Creating Secret for Heketi Authentication

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

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

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

where “mypassword” is Heketi’s admin user password.

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
```

5.2.1.3. 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:
  accessModes:
  - ReadWriteOnce
  resources:
    requests:
      storage: 4Gi
```

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.
```

5.2.1.4. 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
```

5.2.1.5. 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/openshift-container-platform/3.5/single/installation-and-configuration/#install-config-storage-examples-gluster-example.

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

```
# oc get pods

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
```

5.2.1.6. Deleting a Persistent Volume Claim

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.
```

5.3. 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, refer https://access.redhat.com/documentation/en/openshift-container-platform/3.5/single/installation-and-configuration/#install-config-storage-examples-gluster-example.

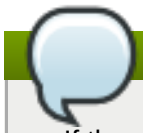
Volume security for dynamically provisioned volumes

Two new parameters, gidMin and gidMax, are introduced with dynamic provisioner. These values allows 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 5.2.1.3, “Creating a Persistent Volume Claim”
3. Use the claim in the pod. Ensure that this pod is non-privileged. For more information see, Section 5.2.1.5, “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.

Chapter 6. Updating the Registry with Container-Native 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. Container-Native 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, refer to https://access.redhat.com/documentation/en-us/openshift_container_platform/3.5/html-single/installation_and_configuration/#setting-up-the-registry

6.1. 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.
```

6.2. Converting the Openshift Container Platform Registry with Container-Native 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:

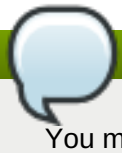
```
# oc project default
```

   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-storage-endpoints -o yaml --
namespace=storage-project > 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. Remove all the metadata except for **`name`**, 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-endpoints -o yaml --
namespace=storage-project > gluster-registry-service.yaml
```

7. Edit the **`gluster-registry-service.yaml`** file. Remove all the metadata except for name. 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. 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.

a. Make the old registry readonly by executing the following command:

```
# oc set env dc/docker-registry
REGISTRY_STORAGE_MAINTENANCE_READONLY_ENABLED=true
```

b. Add the Red Hat Gluster Storage registry to the old registry deployment configuration (dc) by

executing the following command:

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

c. 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)}}')
```

d. Run rsync of data from old registry to the Red Hat Gluster Storage registry by executing the following command:

```
# oc rsync $REGISTRY_POD:/registry/ $REGISTRY_POD:/gluster-
registry/
```

e. Remove the Red Hat Gluster Storage registry form the old dc registry by executing the following command:

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

f. Swap the existing registry storage volume for the new Red Hat Gluster Storage volume by executing the following command:

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

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

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

For more information about accessing the registry, see https://access.redhat.com/documentation/en-us/openshift_container_platform/3.5/html-single/installation_and_configuration/#install-config-registry-accessing.

Chapter 7. 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
```

For example:

```
# oc get pods
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
rhel1                                                     1/1
Running   0          26s
```

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>
```

For example:

```
# oc rsh glusterfs-dc-node1.example.com

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_1be433737b71419dc9b395e22125
5fb3/brick_c67fb97f74649d990c5743090e0c9176/brick
Brick2:
192.168.121.233:/var/lib/heketi/mounts/vg_0013ee200cdefaeb6dfedd28e50f
d261/brick_6ebf1ee62a8e9e7a0f88e4551d4b2386/brick
Brick3:
192.168.121.168:/var/lib/heketi/mounts/vg_e4b32535c55c88f9190da7b7efd1
fcab/brick_df5db97aa002d572a0fec6bcf2101aad/brick
Brick4:
192.168.121.233:/var/lib/heketi/mounts/vg_0013ee200cdefaeb6dfedd28e50f
d261/brick_acc82e56236df912e9a1948f594415a7/brick
Brick5:
192.168.121.168:/var/lib/heketi/mounts/vg_e4b32535c55c88f9190da7b7efd1
fcab/brick_65dceb1f749ec417533ddeae9535e8be/brick
Brick6:
192.168.121.172:/var/lib/heketi/mounts/vg_7ad961dbd24e16d62cabe10fd8bf
8909/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_3fa141bf2d09d30b899f2f260c49
4376/brick_9fb4a5206bdd8ac70170d00f304f99a5/brick
Brick2:
192.168.121.172:/var/lib/heketi/mounts/vg_7ad961dbd24e16d62cabe10fd8bf
8909/brick_dae2422d518915241f74fd90b426a379/brick
Brick3:
192.168.121.233:/var/lib/heketi/mounts/vg_5c6428c439eb6686c5e4cee56532
bacf/brick_b3768ba8e80863724c9ec42446ea4812/brick
Brick4:
192.168.121.172:/var/lib/heketi/mounts/vg_7ad961dbd24e16d62cabe10fd8bf
8909/brick_0a13958525c6343c4a7951acec199da0/brick
Brick5:
192.168.121.168:/var/lib/heketi/mounts/vg_17fbc98d84df86756e7826326fb3
3aa4/brick_af42af87ad87ab4f01e8ca153abbbee9/brick
Brick6:
192.168.121.233:/var/lib/heketi/mounts/vg_5c6428c439eb6686c5e4cee56532
bacf/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:

```
# - modprobe dm_snapshot
```

Important

Restrictions for using Snapshot

- After a snapshot is created, it must be accessed though 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, refer https://access.redhat.com/documentation/en-us/red_hat_gluster_storage/3.2/html-single/administration_guide/#chap-Managing_Snapshots.

10. You can set up Container Native Storage volumes for geo-replication to a non-Container Native Storage remote site. Geo-replication uses a master–slave model. Here, the Container Native 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>
```

For more information about setting up geo-replication, refer https://access.redhat.com/documentation/en-us/red_hat_gluster_storage/3.2/html/administration_guide/chap-managing_geo-replication.

Chapter 8. Managing Clusters

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

8.1. Increasing Storage Capacity

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

- Adding devices
- Increasing cluster size
- Adding an entirely new cluster.

8.1.1. 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 either using CLI, or the API, or by updating the topology JSON file. The sections ahead describe using heketi CLI and updating topology JSON file. For information on adding new devices using API, see Heketi API https://github.com/heketi/heketi/wiki/API#device_add

8.1.1.1. Using Heketi CLI

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
```

8.1.1.2. Updating Topology File

You can add the new device to the node description in your topology JSON used to setup the cluster. Then rerun the command to load the topology.

Following is an example where a new **/dev/sde** drive added to the node:

In the file:

```
    {
                    "node": {
                        "hostnames": {
                            "manage": [
                                "node4.example.com"
                            ],
                            "storage": [
                                "192.168.10.100"
                            ]
```

```
                    },
                    "zone": 1
                },
                "devices": [
                    "/dev/sdb",
                    "/dev/sdc",
                    "/dev/sdd",
                    "/dev/sde"
                ]
            }
```

Load the topology file:

```
# heketi-cli topology load --json=topology-sample.json
    Found node 192.168.10.100 on cluster d6f2c22f2757bf67b1486d868dcb7794
        Found device /dev/sdb
        Found device /dev/sdc
        Found device /dev/sdd
        Adding device /dev/sde ... OK
    Found node 192.168.10.101 on cluster d6f2c22f2757bf67b1486d868dcb7794
        Found device /dev/sdb
        Found device /dev/sdc
        Found device /dev/sdd
    Found node 192.168.10.102 on cluster d6f2c22f2757bf67b1486d868dcb7794
        Found device /dev/sdb
        Found device /dev/sdc
        Found device /dev/sdd
    Found node 192.168.10.103 on cluster d6f2c22f2757bf67b1486d868dcb7794
        Found device /dev/sdb
        Found device /dev/sdc
        Found device /dev/sdd
```

8.1.2. Increasing Cluster Size

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 either using CLI or the API or by updating the topology JSON file. When you add a new node to the cluster, then you must register new devices to that node.

The sections ahead describe using heketi CLI and updating topology JSON file. For information on adding new devices using API, see Heketi API: https://github.com/heketi/heketi/wiki/API#node_add

Note

Red Hat Gluster Storage pods have to be configured before proceeding with the following steps. To manually deploy the Red Hat Gluster Storage pods, refer Section A.2, “Deploying the Containers”

8.1.2.1. 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
```

The following example command shows how to register **/dev/sdb** and **/dev/sdc** devices for **095d5f26b56dc6c64564a9bc17338cbf** node:

```
# heketi-cli device add --name=/dev/sdb --
node=095d5f26b56dc6c64564a9bc17338cbf
OUTPUT:
Device added successfully

# heketi-cli device add --name=/dev/sdc --
node=095d5f26b56dc6c64564a9bc17338cbf
OUTPUT:
Device added successfully
```

8.1.2.2. Updating Topology File

You can expand a cluster by adding a new node to your topology JSON file. When adding the new node you must add this node information **after** the existing ones so that the Heketi CLI identifies on which cluster this new node should be part of.

Following shows an example of how to add a new node and devices:

```
                {
                    "node": {
                        "hostnames": {
                            "manage": [
                                "node4.example.com"
                            ],
                            "storage": [
                                "192.168.10.104"
                            ]
                        },
                        "zone": 1
                    },
                    "devices": [
                        "/dev/sdb",
                        "/dev/sdc"
                     ]
                }
```

Load the topology file:

```
# heketi-cli topology load --json=topology-sample.json
    Found node 192.168.10.100 on cluster d6f2c22f2757bf67b1486d868dcb7794
        Found device /dev/sdb
```

```
        Found device /dev/sdc
        Found device /dev/sdd
        Found device /dev/sde
    Found node 192.168.10.101 on cluster d6f2c22f2757bf67b1486d868dcb7794
        Found device /dev/sdb
        Found device /dev/sdc
        Found device /dev/sdd
    Found node 192.168.10.102 on cluster d6f2c22f2757bf67b1486d868dcb7794
        Found device /dev/sdb
        Found device /dev/sdc
        Found device /dev/sdd
    Found node 192.168.10.103 on cluster d6f2c22f2757bf67b1486d868dcb7794
        Found device /dev/sdb
        Found device /dev/sdc
        Found device /dev/sdd
    Creating node node4.example.com ... ID: ff3375aca6d98ed8a004787ab823e293
        Adding device /dev/sdb ... OK
        Adding device /dev/sdc ... OK
```

8.1.3. 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 the existing Container Native Storage
- Adding another Container Native Storage cluster in a new project

8.1.3.1. Adding a New Cluster to the Existing Container Native Storage

To add a new cluster to the existing container native storage, execute the following commands:

1. Verify that CNS 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     NODE-SELECTOR
   AGE
   glusterfs    3         3         3         storagenode=glusterfs    8m
   ```

2. Add the label for each node, 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> storagenode=<node_label>
   ```

   where,

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

For example:

```
# oc label node 192.168.90.3 storagenode=glusterfs
node "192.168.90.3" labeled
```

3. Verify if the Red Hat Gluster Storage pods are running by executing the folowing command:

```
# oc get ds
```

For example:

```
# oc get ds
NAME        DESIRED   CURRENT   READY     NODE-SELECTOR
AGE
glusterfs   6         6         6         storagenode=glusterfs    8m
```

4. 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. A sample, 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.

5. For the existing cluster, heketi-cli will be available to load the new topology. Run the command to add the new topology to heketi:

```
# heketi-cli topology load --json=<topology file path>
```

For example:

```
# heketi-cli topology load --json=topology.json
Creating cluster ... ID: 94877b3f72b79273e87c1e94201ecd58
 Creating node node4.example.com ... ID:
95cefa174c7210bd53072073c9c041a3
        Adding device /dev/sdb ... OK
        Adding device /dev/sdc ... OK
        Adding device /dev/sdd ... OK
        Adding device /dev/sde ... OK
    Creating node node5.example.com ... ID:
f9920995e580f0fe56fa269d3f3f8428
        Adding device /dev/sdb ... OK
        Adding device /dev/sdc ... OK
        Adding device /dev/sdd ... OK
        Adding device /dev/sde ... OK
    Creating node node6.example.com ... ID:
73fe4aa89ba35c51de4a51ecbf52544d
        Adding device /dev/sdb ... OK
        Adding device /dev/sdc ... OK
        Adding device /dev/sdd ... OK
        Adding device /dev/sde ... OK
```

8.1.3.2. Adding Another Container Native Storage Cluster in a New Project

To add another container native 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 same label in two different projects. Node label is an argument to cns-deploy, thereby enabling deploying multiple trusted storage pool by using a different label in different project.

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.

```
# oadm policy add-scc-to-user privileged -z storage-project-2
# oadm 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. A sample, 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, refer to the man page of the cns-deploy.

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

5. Verify that CNS 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
```

8.2. 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.

8.2.1. 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
```

8.2.2. Deleting Devices

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.

You can delete the device using the following Heketi CLI 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.

8.2.2.1. Disabling Devices

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
```

After disabling the device, you must enable it. Enabling the device allows allocation of bricks onto the device using the following command:

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

For example:

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

8.2.2.2. Removing Devices

Removing devices moves existing bricks from the device to other devices. This helps in ensuring the device is free of bricks.

Warning

Remove device operation triggers a self-heal operation in the background. The time taken to complete the self-heal operation is proportional to the data on the removed device. Before you perform the remove device operation, you must ensure that the self-heal operations are complete on all the volumes.

Run the following command to access shell on gluster pod:

```
# oc rsh <gluster_pod_name>
```

Run the following command to obtain the volume names:

```
# gluster volume list
```

Run the following command on each volume to check the self-heal status:

```
# gluster volume heal <volname> info
```

You can remove devices using the following Heketi CLI command:

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

For example:

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

8.2.2.3. Replacing Devices

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_34c14
120bef5621f287951bcdfa774fc/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
```

8.2.3. Deleting Nodes

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

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

For example:

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

8.2.4. Deleting Clusters

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

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

For example:

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

Chapter 9. Upgrading your Container-Native Storage Environment

This chapter describes the procedure to upgrade your environment from OpenShift 3.4 to OpenShift 3.5.

9.1. Upgrading cns-deploy and Heketi Server

1. Execute the following command to update the heketi client and cns-deploy packages:

```
# yum update cns-deploy -y
# yum update heketi-client -y
```

2. Execute the following command to delete the heketi template

```
# oc delete templates heketi
```

3. Execute the following command to install the heketi template:

```
# oc create -f /usr/share/heketi/templates/heketi-template.yaml
template "heketi" created
```

4. Execute the following command to grant the heketi Service Account the neccessary privileges:

```
# oc policy add-role-to-user edit system:serviceaccount:
<project_name>:heketi-service-account
# oc adm policy add-scc-to-user privileged -z heketi-service-account
```

   For example,

```
# oc policy add-role-to-user edit system:serviceaccount:storage-
project:heketi-service-account
# oc adm policy add-scc-to-user privileged -z heketi-service-account
```

5. Execute the following command to delete the deployment configuration, service, and route for heketi:

```
# oc delete deploymentconfig,service,route heketi
```

6. Execute the following command to deploy the Heketi service which will be used to create persistent volumes for OpenShift:

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

   For example:

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

service "heketi" created
route "heketi" created
deploymentconfig "heketi" created
```

7. Execute the following command to verify that the containers are running:

```
# oc get pods
```

For example:

```
# oc get pods
NAME                                READY     STATUS    RESTARTS   AGE
glusterfs-0h68l                     1/1       Running   0          3d
glusterfs-0vcf3                     1/1       Running   0          3d
glusterfs-gr9gh                     1/1       Running   0          3d
heketi-1-zpw4d                      1/1       Running   0          3h
storage-project-router-2-db2wl      1/1       Running   0          4d
```

9.2. Upgrading the Red Hat Gluster Storage Pods

Following are the steps for updating a DaemonSet for glusterfs:

1. Execute the following command to delete the DeamonSet:

```
# oc delete ds <ds-name> --cascade=false
```

Using **`--cascade=false`** option while deleting the old DaemonSet does not delete the gluster pods but deletes only the DaemonSet. After deleting the old DaemonSet, you must load the new one. When you manually delete the old pods, the new pods which are created will have the configurations of the new DaemonSet.

For example,

```
# oc delete ds glusterfs  --cascade=false
daemonset "glusterfs" deleted
```

2. Execute the following commands to verify all the old pods are up:

```
# oc get pods
```

For example,

```
# oc get pods
NAME                                READY     STATUS    RESTARTS   AGE
glusterfs-0h68l                     1/1       Running   0          3d
glusterfs-0vcf3                     1/1       Running   0          3d
glusterfs-gr9gh                     1/1       Running   0          3d
heketi-1-zpw4d                      1/1       Running   0          3h
storage-project-router-2-db2wl      1/1       Running   0          4d
```

3. Execute the following command to delete the old glusterfs template:

```
# oc delete templates glusterfs
```

For example,

```
# oc delete templates glusterfs
template “glusterfs” deleted
```

4. Execute the following command to register new gluster template:

```
# oc create -f /usr/share/heketi/templates/glusterfs-template.yaml
```

For example,

```
# oc create -f /usr/share/heketi/templates/glusterfs-template.yaml
template “glusterfs” created
```

5. Execute the following commands to start the gluster DeamonSet:

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

For example,

```
# oc process glusterfs | oc create -f -
Deamonset “glusterfs” created
```

6. Execute the following command to identify the old gluster pods that needs to be deleted:

```
# oc get pods
```

For example,

```
# oc get pods
NAME                              READY     STATUS    RESTARTS   AGE
glusterfs-0h68l                   1/1       Running   0          3d
glusterfs-0vcf3                   1/1       Running   0          3d
glusterfs-gr9gh                   1/1       Running   0          3d
heketi-1-zpw4d                    1/1       Running   0          3h
storage-project-router-2-db2wl    1/1       Running   0          4d
```

7. Execute the following command to delete the old gluster pods:

```
# oc delete pod <gluster_pod>
```

For example,

```
# oc delete pod glusterfs-0vcf3
pod  “glusterfs-0vcf3” deleted
```

The delete pod command will terminate the old pod and create a new pod. Run **# oc get pods -w** and check the **Age** of the pod and **READY** status should be 1/1. The following is the example output showing the status progression from termination to creation of the pod.

```
# oc get pods -w
NAME                              READY     STATUS        RESTARTS
AGE
glusterfs-0vcf3                   1/1       Terminating   0
```

```
3d
…

# oc get pods -w
NAME                              READY     STATUS
RESTARTS   AGE
glusterfs-pqfs6                   0/1       ContainerCreating   0
1s
…

# oc get pods -w
NAME                              READY     STATUS        RESTARTS
AGE
glusterfs-pqfs6                   1/1       Running       0
2m
```

8. Repeat Step 7 to delete all the gluster pods. **`Gluster pods should follow rolling upgrade. Hence, you must ensure that the new pod is running before deleting the next old gluster pod. In this release, we support OnDelete Strategy DaemonSet update strategy`** . With **`OnDelete Strategy`** update strategy, after you update a DaemonSet template, new DaemonSet pods will only be created when you manually delete old DaemonSet pods.

9. Execute the following command to verify that the pods are running:

```
# oc get pods
```

   For example,

```
# oc get pods
NAME                              READY     STATUS    RESTARTS   AGE
glusterfs-j241c                   1/1       Running   0          4m
glusterfs-pqfs6                   1/1       Running   0          7m
glusterfs-wrn6n                   1/1       Running   0          12m
heketi-1-zpw4d                    1/1       Running   0          4h
storage-project-router-2-db2wl    1/1       Running   0          4d
```

10. Execute the following command to verify if you have upgraded the pod to the latest version:

```
# oc rsh <gluster_pod_name> glusterd --version
```

Chapter 10. Troubleshooting

This chapter describes the most common troubleshooting scenarios related to Container-Native Storage.

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 like 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**.

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 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 11. Uninstalling Containerized Red Hat Gluster Storage

This chapter outlines the details for uninstalling containerized Red Hat Gluster Storage.

Perform the following steps for uninstalling:

1. **Cleanup Red Hat Gluster Storage using Heketi**

    a. Remove any containers using the persistent volume claim from Red Hat Gluster Storage.

    b. Remove the appropriate persistent volume claim and persistent volume:

    ```
    # oc delete pvc <pvc_name>
    # oc delete pv <pv_name>
    ```

2. **Remove all OpenShift objects**

    a. Delete all project specific pods, services, routes, and deployment configurations:

    ```
    # oc delete daemonset/glusterfs

    # oc delete deploymentconfig heketi

    # oc delete service heketi heketi-storage-endpoints

    # oc delete route heketi

    # oc delete endpoints heketi-storage-endpoints
    ```

    Wait until all the pods have been terminated.

    b. Check and delete the gluster service and endpoints from the projects that required a persistent storage:

    ```
    # oc get endpoints,service

    # oc delete endpoints <glusterfs-endpoint-name>

    # oc delete service <glusterfs-service-name>
    ```

3. **Cleanup the persistent directories**

    a. To cleanup the persistent directories execute the following command on each node as a root user:

    ```
    # rm -rf /var/lib/heketi \
       /etc/glusterfs \
       /var/lib/glusterd \
       /var/log/glusterfs
    ```

4. **Force cleanup the disks**

    a. Execute the following command to cleanup the disks:

```
# wipefs -a -f /dev/<disk-id>
```

Chapter 12. Enabling Encryption

Encryption is the process of converting data into a cryptic format, or code when it is transmitted on a network. Encryption prevents unauthorized use of the data.

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.

12.1. 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, refer https://access.redhat.com/documentation/en-us/red_hat_gluster_storage/3.2/html-single/administration_guide/#chap-Network_Encryption-Prereqs.

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.

12.2. Enabling Encryption for a New Container Native Storage Setup

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

12.2.1. 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 12.2.2, “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, ie. 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
```

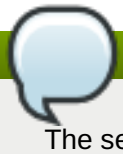
Note

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 Container Native Storage. For more information, see Section 4.2, “ Deploying Container-Native Storage”

12.2.2. 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 Container Native Storage is deployed before proceeding with further steps. For more information see, Section 4.2, “ Deploying Container-Native Storage”

2. You can either create a statically provisioned volume or a dynamically provisioned volume. For more information about static provisioning of volumes, see Section 5.1, “Static Provisioning of Volumes” . For more information about dynamic provisioning of volumes, see Section 5.2, “Dynamic Provisioning of Volumes”

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
```

12.3. Enabling Encryption for an Existing Container Native Storage Setup

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

12.3.1. 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.

   ```
   # 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.

12.3.2. Enabling Management Encryption

Though, Red Hat Gluster Storage can be configured only for I/O encryption without using management encryption, management encryption is recommended. 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 deamonset by executing the following 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.

12.4. Disabling Encryption

You can disable encryption for on Container Native Storage setup in the following two scenarios:

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

12.4.1. 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
```

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 deamonset by executing the following 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.

12.4.2. 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 deamonset by executing the following 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.

Appendix A. Manual Deployment

The following section covers the steps required to manually deploy Container-Native Storage.

A.1. Installing the Templates

Execute the following steps to register the Red Hat Gluster Storage and Heketi templates with OpenShift:

1. Use the newly created containerized Red Hat Gluster Storage project:

```
# oc project project_name
```

For example,

```
# oc project storage-project
Using project "storage-project" on server
"https://master.example.com:8443".
```

2. Execute the following commands to install the templates:

```
# oc create -f /usr/share/heketi/templates/deploy-heketi-template.yaml
template "deploy-heketi" created
```

```
# oc create -f /usr/share/heketi/templates/glusterfs-template.yaml
template "glusterfs" created
```

```
# oc create -f /usr/share/heketi/templates/heketi-service-account.yaml
serviceaccount  "heketi-service-account" created
```

```
# oc create -f /usr/share/heketi/templates/heketi-template.yaml
template "heketi" created
```

3. Execute the following command to verify that the templates are installed:

```
# oc get templates
```

For example:

```
# oc get templates

NAME            DESCRIPTION                           PARAMETERS
OBJECTS
deploy-heketi   Bootstrap Heketi installation        2 (2 blank)   3
glusterfs       GlusterFS DaemonSet template         0 (all set)   1
heketi          Heketi service deployment template   2 (2 blank)   3
```

4. Execute the following command to verify that the serviceaccount is created:

```
# oc get serviceaccount heketi-service-account
```

For example:

```
# oc get serviceaccount heketi-service-account
NAME                     SECRETS   AGE
heketi-service-account   2         7d
```

A.2. Deploying the Containers

Execute the following commands to deploy the Red Hat Gluster Storage container on the nodes:

1. List out the hostnames of the nodes on which the Red Hat Gluster Storage container has to be deployed:

```
# oc get nodes
```

For example:

```
# oc get nodes

NAME                     STATUS                     AGE
node1.example.com        Ready                      12d
node2.example.com        Ready                      12d
node3.example.com        Ready                      12d
master.example.com       Ready,SchedulingDisabled   12d
```

2. Execute the following command to label all nodes that will run Red Hat Gluster Storage pods:

```
# oc label node <NODENAME> storagenode=glusterfs
```

For example:

```
# oc label nodes 192.168.90.3 storagenode=glusterfs
node "192.168.90.3" labeled
```

Repeat this command for every node that will be in the GlusterFS cluster.

Verify the label has set properly by running the following command:

```
# oc get nodes --show-labels
192.168.90.2   Ready                      12d
beta.kubernetes.io/arch=amd64,beta.kubernetes.io/os=linux,kubernetes.i
o/hostname=192.168.90.2,storagenode=glusterfs
192.168.90.3   Ready                      12d
beta.kubernetes.io/arch=amd64,beta.kubernetes.io/os=linux,kubernetes.i
o/hostname=192.168.90.3,storagenode=glusterfs
192.168.90.4   Ready                      12d
beta.kubernetes.io/arch=amd64,beta.kubernetes.io/os=linux,kubernetes.i
o/hostname=192.168.90.4,storagenode=glusterfs
192.168.90.5   Ready,SchedulingDisabled   12d
beta.kubernetes.io/arch=amd64,beta.kubernetes.io/os=linux,kubernetes.i
o/hostname=192.168.90.5
```

3. Execute the following command to deploy the Red Hat Gluster Storage pods:

```
# oc process glusterfs | oc create -f -
daemonset "glusterfs" created
```

Note

This does not initialize the hardware or create trusted storage pools. That aspect will be taken care by heketi which is explained in the further steps.

4. Execute the following command to grant the heketi Service Account the neccessary privileges:

```
# oc policy add-role-to-user edit system:serviceaccount:
<project_name>:heketi-service-account
# oc adm policy add-scc-to-user privileged -z heketi-service-account
```

For example:

```
# oc policy add-role-to-user edit system:serviceaccount:storage-
project:heketi-service-account
# oc adm policy add-scc-to-user privileged -z heketi-service-account
```

5. Execute the following command to deploy deploy-heketi:

```
# oc process deploy-heketi | oc create -f -
```

For example:

```
# oc process deploy-heketi | oc create -f -

service "deploy-heketi" created
route "deploy-heketi" created
deploymentconfig "deploy-heketi" created
```

6. Execute the following command to verify that the containers are running:

```
# oc get pods
```

For example:

```
# oc get pods
NAME                      READY     STATUS    RESTARTS   AGE
storage-project-router-1-pj9ea     1/1       Running   0          1d
deploy-heketi-1-m7x8g   1/1       Running   0          1m
glusterfs-41lfl         1/1       Running   0          1m
glusterfs-dtyr4         1/1       Running   0          1m
glusterfs-ral2d         1/1       Running   0          1m
```

A.3. Setting up the Heketi Server

After deploying the containers and installing the templates, the system is now ready to load the Heketi topology file. Heketi provides a RESTful management interface which can be used to manage the lifecycle of

Red Hat Gluster Storage volumes.

A sample, formatted topology file (topology-sample.json) is installed with the 'heketi-templates' package in the **/usr/share/heketi/** directory.

```
{
    "clusters": [
                {
                   "nodes": [
                                {
                         "node": {
                             "hostnames": {
                                 "manage": [
                                     "node1.example.com"
                                 ],
                                 "storage": [
                                     "192.168.121.168"
                                  ]
                             },
                             "zone": 1
                         },
                         "devices": [
                             "/dev/sdb",
                             "/dev/sdc",
                             "/dev/sdd",
                             "/dev/sde"
                         ]
                },...
```

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.

Important

Heketi stores its database on a Red Hat Gluster Storage volume. Heketi service does not respond if the volume is down.

To resolve this issue, restart the gluster pods hosting the Heketi volume.

Execute the following steps to set up the Heketi server:

1. Execute the following command to check if the bootstrap container is running:

   ```
   # curl http://deploy-heketi-<project_name>.<sub-domain_name>/hello
   ```

   For example:

   ```
   # curl http://deploy-heketi-storage-
   project.cloudapps.mystorage.com/hello
   Hello from Heketi
   ```

2. Execute the following command to load the topology file:

```
# export  HEKETI_CLI_SERVER=http://deploy-heketi-<project_name>.
<sub_domain_name>
```

For example:

```
# export HEKETI_CLI_SERVER=http://deploy-heketi-storage-
project.cloudapps.mystorage.com
```

```
# heketi-cli topology load --json=topology.json
```

For example:

```
# heketi-cli topology load --json=topology.json
Creating cluster ... ID: 94877b3f72b79273e87c1e94201ecd58
 Creating node node1.example.com ... ID:
95cefa174c7210bd53072073c9c041a3
        Adding device /dev/sdb ... OK
        Adding device /dev/sdc ... OK
        Adding device /dev/sdd ... OK
        Adding device /dev/sde ... OK
    Creating node node2.example.com ... ID:
f9920995e580f0fe56fa269d3f3f8428
        Adding device /dev/sdb ... OK
        Adding device /dev/sdc ... OK
        Adding device /dev/sdd ... OK
        Adding device /dev/sde ... OK
    Creating node node3.example.com ... ID:
73fe4aa89ba35c51de4a51ecbf52544d
        Adding device /dev/sdb ... OK
        Adding device /dev/sdc ... OK
        Adding device /dev/sdd ... OK
        Adding device /dev/sde ... OK
```

3. Execute the following command to verify that the topology is loaded:

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

4. Execute the following command to create the Heketi storage volume which will store the database on a reliable Red Hat Gluster Storage volume:

```
# heketi-cli setup-openshift-heketi-storage
```

For example:

```
# heketi-cli setup-openshift-heketi-storage
Saving heketi-storage.json
```

5. Execute the following command to create a job which will copy the database from deploy-heketi bootstrap container to the volume.

```
# oc create -f heketi-storage.json
```

For example:

```
# oc create -f heketi-storage.json
secret "heketi-storage-secret" created
endpoints "heketi-storage-endpoints" created
service "heketi-storage-endpoints" created
job "heketi-storage-copy-job" created
```

6. Execute the following command to verify that the job has finished successfully:

```
# oc get jobs
```

For example:

```
# oc get jobs
NAME                      DESIRED   SUCCESSFUL   AGE
heketi-storage-copy-job   1            1               2m
```

7. Execute the following command to remove all resources used to bootstrap heketi:

```
# oc delete all,job,template,secret --selector="deploy-heketi"
```

For example:

```
# oc delete all,job,template,secret --selector="deploy-heketi"
deploymentconfig "deploy-heketi" deleted
route "deploy-heketi" deleted
service "deploy-heketi" deleted
pod "deploy-heketi-1-4k1fh" deleted
job "heketi-storage-copy-job" deleted
template "deploy-heketi" deleted
```

8. Execute the following command to deploy the Heketi service which will be used to create persistent volumes for OpenShift:

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

For example:

```
# oc process heketi | oc create -f -
service "heketi" created
route "heketi" created
deploymentconfig "heketi" created
```

9. Execute the following command to let the client communicate with the container:

```
# export  HEKETI_CLI_SERVER=http://heketi-<project_name>.
<sub_domain_name>
```

For example:

```
# export  HEKETI_CLI_SERVER=http://heketi-storage-
project.cloudapps.mystorage.com
```

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

Appendix B. 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.

```
  # oadm policy add-cluster-role-to-user cluster-admin admin
```

For more information on authentication methods, see https://access.redhat.com/documentation/en-us/openshift_container_platform/3.5/html-single/installation_and_configuration/#identity-providers.

Appendix C. 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 D. Heketi CLI Commands

This section provides a list of some of the useful heketi-cli commands:

- **heketi-cli topology info**

  This command retreives information about the current Topology.

- **heketi-cli cluster list**

  Lists the clusters managed by Heketi

  For example:

```
# heketi-cli cluster list
Clusters:
9460bbea6f6b1e4d833ae803816122c6
```

- **heketi-cli cluster info <cluster_id>**

  Retrieves the information about the cluster.

  For example:

```
# heketi-cli cluster info 9460bbea6f6b1e4d833ae803816122c6
Cluster id: 9460bbea6f6b1e4d833ae803816122c6
Nodes:
1030f9361cff8c6bfde7b9b079327c78
30f2ab4d971da572b03cfe33a1ba525f
f648e1ddc0b95f3069bd2e14c7e34475
Volumes:
142e0ec4a4c1d1cc082071329a0911c6
638d0dc6b1c85f5eaf13bd5c7ed2ee2a
```

- **heketi-cli node info <node_id>**

  Retrieves the information about the node.

  For example:

```
# heketi-cli node info 1030f9361cff8c6bfde7b9b079327c78
Node Id: 1030f9361cff8c6bfde7b9b079327c78
State: online
Cluster Id: 9460bbea6f6b1e4d833ae803816122c6
Zone: 1
Management Hostname: node1.example.com
Storage Hostname: 10.70.41.202
Devices:
Id:69214867a4d32251aaf1dcd77cb7f359   Name:/dev/vdg
State:online    Size (GiB):4999    Used (GiB):253     Free (GiB):4746
Id:6cd437c304979ea004abc2c4da8bdaf4   Name:/dev/vde
State:online    Size (GiB):4999    Used (GiB):354     Free (GiB):4645
Id:d2e9fcd9da04999ddab11cab651e18d2   Name:/dev/vdf
State:online    Size (GiB):4999    Used (GiB):831     Free (GiB):4168
```

- **heketi-cli volume list**

  Lists the volumes managed by Heketi

  For example:

```
# heketi-cli volume list
Id:142e0ec4a4c1d1cc082071329a0911c6
Cluster:9460bbea6f6b1e4d833ae803816122c6    Name:heketidbstorage
Id:638d0dc6b1c85f5eaf13bd5c7ed2ee2a
Cluster:9460bbea6f6b1e4d833ae803816122c6    Name:scalevol-1
```

For more information, refer to the man page of the heketi-cli.

```
# heketi-cli --help
```

The command line program for Heketi.

Usage

- heketi-cli [flags]
- heketi-cli [command]

For example:

```
# export HEKETI_CLI_SERVER=http://localhost:8080
```

```
# heketi-cli volume list
```

The available commands are listed below:

- **cluster**

  Heketi cluster management

- **device**

  Heketi device management

- **setup-openshift-heketi-storage**

  Setup OpenShift/Kubernetes persistent storage for Heketi

- **node**

  Heketi Node Management

- **topology**

  Heketi Topology Management

- **volume**

  Heketi Volume Management

Appendix E. Known Issues

This chapter outlines the known issues at the time of release.

BZ#1441675

Adding a node to the trusted storage pool will fail if the first node of the trusted storage pool is not reachable. This is because Heketi always performs a **`gluster peer probe`** operation from the first node in the trusted storage pool.

BZ#1409848

The following two lines might be repeatedly logged in the rhgs-server-docker container/gluster container logs.

```
[MSGID: 106006] [glusterd-svc-mgmt.c:323:glusterd_svc_common_rpc_notify] 0-
management: nfs has disconnected from glusterd.
[socket.c:701:__socket_rwv] 0-nfs: readv on
/var/run/gluster/1ab7d02f7e575c09b793c68ec2a478a5.socket failed (Invalid
argument)
```

These logs are added as glusterd is unable to start the NFS service. There is no functional impact as NFS export is not supported in Containerized Red Hat Gluster Storage.

Appendix F. Revision History

Revision 1.0-4	**Mon Apr 03 2017**	**Bhavana Mohana**
Modified the oc delete command for bug 1419812		
Revision 1.0-1	**Fri Mar 31 2017**	**Divya Muntimadugu**
Updated installation instructions.		