Red Hat OpenStack Platform 16.1

Manage Secrets with OpenStack Key Manager

How to integrate OpenStack Key Manager (Barbican) with your OpenStack deployment.

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Abstract

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CHAPTER 1. OVERVIEW

OpenStack Key Manager (barbican) is the secrets manager for Red Hat OpenStack Platform. You can use the barbican API and command line to centrally manage the certificates, keys, and passwords used by OpenStack services. Barbican currently supports the following use cases described in this guide:

- **Symmetric encryption keys** - used for Block Storage (cinder) volume encryption, ephemeral disk encryption, and Object Storage (swift) encryption, among others.

- **Asymmetric keys and certificates** - used for glance image signing and verification, among others.

In this release, barbican offers integration with the Block Storage (cinder) and Compute (nova) components.

CHAPTER 2. CHOOSING A BACKEND

Secrets (such as certificates, API keys, and passwords) can either be stored as an encrypted blob in the barbican database, or directly in a secure storage system.

To store the secrets as an encrypted blob in the barbican database, the following options are available.

- **Simple crypto plugin** - The simple crypto plugin is enabled by default and uses a single symmetric key to encrypt all secret payloads. This key is stored in plain text in the **barbican.conf** file, so it is important to prevent unauthorized access to this file.

- **PKCS#11 crypto plugin** - The PKCS#11 crypto plugin encrypts secrets with project-specific key encryption keys (pKEK), which are stored in the barbican database. These project-specific pKEKs are encrypted by a master key-encryption-key (KEK), which is stored in a hardware security module (HSM). All encryption and decryption operations take place in the HSM, rather than in-process memory. The PKCS#11 plugin communicates with the HSM through the PKCS#11 API. Because the encryption is done in secure hardware, and a different pKEK is used per project, this option is more secure than the simple crypto plugin. Red Hat supports the PKCS#11 backend with any of the following HSMs.

Device	Supported in release	High Availability (HA) support
ATOS Trustway Proteccio NetHSM	16.0+	16.1+
nCipher nShield Connect HSM	16.0+	Not supported
Thales Luna Network HSM	16.1 (Technology Preview)	16.1 (Technology Preview)

Alternatively, you can store the secrets directly in a secure storage system:

- **KMIP plugin** - The Key Management Interoperability Protocol (KMIP) plugin works with devices that have KIMP enabled, such as an HSM. Secrets are stored directly on the device instead of the barbican database. The plugin can authenticate to the device either with a username and password or a client certificate stored in the **barbican.conf** file.

- **Red Hat Certificate System (dogtag)**- Red Hat Certificate System is a Common Criteria and FIPS certified security framework for managing various aspects of Public Key Infrastructure (PKI). The *key recovery authority* (KRA) subsystem stores secrets as encrypted blobs in its database. The master encryption keys are stored in either a software-based Network Security Services (NSS) database or an HSM. For more information about Red Hat Certificate System, see Product Documentation for Red Hat Certificate System .

NOTE

Regarding high availability (HA) options: The barbican service runs within Apache and is configured by director to use HAProxy for high availability. HA options for the back end layer will depend on the back end being used. For example, for simple crypto, all the barbican instances have the same encryption key in the config file, resulting in a simple HA configuration.

2.1. MIGRATING BETWEEN BACKENDS

You can configure a single instance of Barbican to use more than one backend. When this is done, you must specify a backend as the **global default** backend. You can also specify a default backend per project. If no mapping exists for a project, the secrets for that project are stored using the global default backend.

For example you can configure Barbican to use both the Simple crypto and PKCS#11 plugins. If you set Simple crypto as the global default, then all projects will use that backend. You can then specify which projects use the PKCS#11 backend by setting PKCS#11 as the preferred backend for that project.

If you decide to migrate to a new backend, you can keep the original available while enabling the new backend as the global default or as a project-specific backend. As a result, the old secrets remain available through the old backend, and new secrets are stored in the new global default backend.

CHAPTER 3. DEPLOYING BARBICAN

Barbican is not enabled by default in Red Hat OpenStack Platform. This procedure describes how you can deploy barbican in an existing OpenStack deployment. Barbican runs as a containerized service, so this procedure also describes how to prepare and upload the new container images:

> **NOTE**
>
> This procedure configures barbican to use the **simple_crypto** backend. Additional backends are available, such as **PKCS11** which requires a different configuration, and different heat template files depending on which HSM is used. Other backends such as KMIP, Hashicorp Vault and DogTag are not supported in this release.

1. On the undercloud node, create an environment file for barbican. This will instruct director to install barbican (when its included in *openstack overcloud deploy [...]*)

```
$ cat /home/stack/configure-barbican.yaml
 parameter_defaults:
   BarbicanSimpleCryptoGlobalDefault: true
```

- **BarbicanSimpleCryptoGlobalDefault** - Sets this plugin as the global default plugin.
- Further options are also configurable:
  - **BarbicanPassword** - Sets a password for the barbican service account.
  - **BarbicanWorkers** - Sets the number of workers for **barbican::wsgi::apache**. Uses **'%{::processorcount}'** by default.
  - **BarbicanDebug** - Enables debugging.
  - **BarbicanPolicies** - Defines policies to configure for barbican. Uses a hash value, for example: **{ barbican-context_is_admin: { key: context_is_admin, value: 'role:admin' } }**. This entry is then added to **/etc/barbican/policy.json**. Policies are described in detail in a later section.
  - **BarbicanSimpleCryptoKek** - The Key Encryption Key (KEK) is generated by director, if none is specified.

2. This step prepares new container images for barbican. You will need to include the **configure-barbican.yaml** and all the relevant template files. Change the following example to suit your deployment:

```
$ openstack overcloud container image prepare \
 --namespace example.lab.local:5000/rhosp-rhel8 \
 --tag latest \
 --push-destination 192.168.100.1:8787 \
 --output-images-file ~/container-images-with-barbican.yaml \
 -e /home/stack/virt/config_lvm.yaml \
 -e /usr/share/openstack-tripleo-heat-templates/environments/network-isolation.yaml \
 -e /home/stack/virt/network/network-environment.yaml \
 -e /home/stack/virt/hostnames.yml \
 -e /home/stack/virt/nodes_data.yaml \
 -e /home/stack/virt/extra_templates.yaml \
 -e /home/stack/virt/docker-images.yaml \
```

```
 -e /usr/share/openstack-tripleo-heat-templates/environments/services/barbican.yaml \
 -e /usr/share/openstack-tripleo-heat-templates/environments/barbican-backend-simple-crypto.yaml \
 -e /home/stack/configure-barbican.yaml
```

3. Upload the new container images to the undercloud registry:

```
$ openstack overcloud container image upload --debug --config-file container-images-with-barbican.yaml
```

4. Prepare the new environment file:

```
$ openstack overcloud container image prepare \
  --tag latest \
  --namespace 192.168.100.1:8787/rhosp-rhel8 \
  --output-env-file ~/container-parameters-with-barbican.yaml \
  -e /home/stack/virt/config_lvm.yaml \
  -e /usr/share/openstack-tripleo-heat-templates/environments/network-isolation.yaml \
  -e /home/stack/virt/network/network-environment.yaml \
  -e /home/stack/virt/hostnames.yml \
  -e /home/stack/virt/nodes_data.yaml \
  -e /home/stack/virt/extra_templates.yaml \
  -e /home/stack/virt/docker-images.yaml \
  -e /usr/share/openstack-tripleo-heat-templates/environments/services/barbican.yaml \
  -e /usr/share/openstack-tripleo-heat-templates/environments/barbican-backend-simple-crypto.yaml \
  -e /home/stack/configure-barbican.yaml
```

5. To apply these changes to your deployment: update the overcloud and specify all the heat template files that you used in your previous *openstack overcloud deploy [...]* . For example:

```
$ openstack overcloud deploy \
    --timeout 100 \
    --templates /usr/share/openstack-tripleo-heat-templates \
    --stack overcloud \
    --libvirt-type kvm \
    --ntp-server clock.redhat.com \
    -e /home/stack/virt/config_lvm.yaml \
    -e /usr/share/openstack-tripleo-heat-templates/environments/network-isolation.yaml \
    -e /home/stack/virt/network/network-environment.yaml \
    -e /home/stack/virt/hostnames.yml \
    -e /home/stack/virt/nodes_data.yaml \
    -e /home/stack/virt/extra_templates.yaml \
    -e /home/stack/container-parameters-with-barbican.yaml \
    -e /usr/share/openstack-tripleo-heat-templates/environments/services/barbican.yaml \
    -e /usr/share/openstack-tripleo-heat-templates/environments/barbican-backend-simple-crypto.yaml \
    -e /home/stack/configure-barbican.yaml \
    --log-file overcloud_deployment_38.log
```

3.1. ADD USERS TO THE CREATOR ROLE ON OVERCLOUD

Users must be members of the **creator** role in order to create and edit barbican secrets, or to create encrypted volumes that store their secret in barbican.

1. Retrieve the **id** of the **creator** role:

```
openstack role show creator
+-----------+----------------------------------+
| Field     | Value                            |
+-----------+----------------------------------+
| domain_id | None                             |
| id        | 4e9c560c6f104608948450fbf316f9d7 |
| name      | creator                          |
+-----------+----------------------------------+
```

NOTE

You will not see the **creator** role unless OpenStack Key Manager (barbican) is installed.

2. Assign a user to the **creator** role and specify the relevant project. In this example, a user named **user1** in the **project_a** project is added to the **creator** role:

```
openstack role add --user user1 --project project_a 4e9c560c6f104608948450fbf316f9d7
```

3.1.1. Test barbican functionality

This section describes how to test that barbican is working correctly.

1. Create a test secret. For example:

```
$ openstack secret store --name testSecret --payload 'TestPayload'
+---------------+------------------------------------------------------------------------------------+
| Field         | Value                                                                              |
+---------------+------------------------------------------------------------------------------------+
| Secret href   | https://192.168.123.163/key-manager/v1/secrets/4cc5ffe0-eea2-449d-9e64-
b664d574be53 |
| Name          | testSecret                                                                         |
| Created       | None                                                                               |
| Status        | None                                                                               |
| Content types | None                                                                               |
| Algorithm     | aes                                                                                |
| Bit length    | 256                                                                                |
| Secret type   | opaque                                                                             |
| Mode          | cbc                                                                                |
| Expiration    | None                                                                               |
+---------------+------------------------------------------------------------------------------------+
```

2. Retrieve the payload for the secret you just created:

```
openstack secret get https://192.168.123.163/key-manager/v1/secrets/4cc5ffe0-eea2-449d-
9e64-b664d574be53 --payload
+---------+-------------+
| Field   | Value       |
+---------+-------------+
| Payload | TestPayload |
+---------+-------------+
```

3.2. UNDERSTANDING POLICIES

Barbican uses policies to determine which users are allowed to perform actions against the secrets, such as adding or deleting keys. To implement these controls, keystone project roles (such as **creator** you created earlier) are mapped to barbican internal permissions. As a result, users assigned to those project roles receive the corresponding barbican permissions.

3.2.1. Viewing the default policy

The default policy is defined in code and typically does not require any amendments. You can view the default policy by generating it from the **barbican** source code:

1. Perform the following steps on a non-production system, because additional components may be downloaded and installed. This example switches to the **queens** branch, so you must adapt this if using a different version.

    ```
    git clone https://github.com/openstack/barbican
    cd /home/stack/barbican
    git checkout origin/stable/queens
    tox -e genpolicy
    ```

    This generates a policy file within a subdirectory that contains the default settings: **etc/barbican/policy.yaml.sample**. Note that this path refers to a subdirectory within the repository, not your system's **/etc** directory. The contents of this file are explained in the following step.

2. The **policy.yaml.sample** file you generated describes the policies used by barbican. The policy is implemented by four different roles that define how a user interacts with secrets and secret metadata. A user receives these permissions by being assigned to a particular role:

    - **admin** - Can delete, create/edit, and read secrets.
    - **creator** - Can create/edit, and read secrets. Can not delete secrets.
    - **observer** - Can only read data.
    - **audit** - Can only read metadata. Can not read secrets.
      For example, the following entries list the **admin**, **observer**, and **creator** keystone roles for each project. On the right, notice that they are assigned the **role:admin**, **role:observer**, and **role:creator** permissions:

      ```
      #
      #"admin": "role:admin"

      #
      #"observer": "role:observer"

      #
      #"creator": "role:creator"
      ```

      These roles can also be grouped together by barbican. For example, rules that specify **admin_or_creator** can apply to members of either **rule:admin** or **rule:creator**.

3. Further down in the file, there are **secret:put** and **secret:delete** actions. To their right, notice which roles have permissions to execute these actions. In the following example, **secret:delete**

means that only **admin** and **creator** role members can delete secret entries. In addition, the rule states that users in the **admin** or **creator** role for that project can delete a secret in that project. The project match is defined by the **secret_project_match** rule, which is also defined in the policy.

```
secret:delete": "rule:admin_or_creator and rule:secret_project_match"
```

CHAPTER 4. MANAGING SECRETS IN BARBICAN

4.1. LISTING SECRETS

Secrets are identified by their URI, indicated as a href value. This example shows the secret you created in the previous step:

```
$ openstack secret list
+--------------------------------------------------------------------------------+------+---------------------------
+--------+------------------------------------------+-----------+------------+-------------+------+------------+
| Secret href                                                                    | Name | Created                   | Status |
Content types                            | Algorithm | Bit length | Secret type | Mode | Expiration |
+--------------------------------------------------------------------------------+------+---------------------------
+--------+------------------------------------------+-----------+------------+-------------+------+------------+
| https://192.168.123.169:9311/v1/secrets/24845e6d-64a5-4071-ba99-0fdd1046172e | None | 2018-
01-22T02:23:15+00:00 | ACTIVE | {u'default': u'application/octet-stream'} | aes       |        256 |
symmetric   | None | None       |
+--------------------------------------------------------------------------------+------+---------------------------
+--------+------------------------------------------+-----------+------------+-------------+------+------------+
```

4.2. ADDING NEW SECRETS

Create a test secret. For example:

```
$ openstack secret store --name testSecret --payload 'TestPayload'
+---------------+-----------------------------------------------------------------------------------+
| Field         | Value                                                                             |
+---------------+-----------------------------------------------------------------------------------+
| Secret href   | https://192.168.123.163:9311/v1/secrets/ecc7b2a4-f0b0-47ba-b451-0f7d42bc1746 |
| Name          | testSecret                                                                        |
| Created       | None                                                                              |
| Status        | None                                                                              |
| Content types | None                                                                              |
| Algorithm     | aes                                                                               |
| Bit length    | 256                                                                               |
| Secret type   | opaque                                                                            |
| Mode          | cbc                                                                               |
| Expiration    | None                                                                              |
+---------------+-----------------------------------------------------------------------------------+
```

4.3. UPDATING SECRETS

You cannot change the payload of a secret (other than deleting the secret), but if you initially created a secret without specifying a payload, you can later add a payload to it by using the **update** function. For example:

```
$ openstack secret update https://192.168.123.163:9311/v1/secrets/ca34a264-fd09-44a1-8856-
c6e7116c3b16 'TestPayload-updated'
$
```

4.4. DELETING SECRETS

You can delete a secret by specifying its URI. For example:

```
$ openstack secret delete https://192.168.123.163:9311/v1/secrets/ecc7b2a4-f0b0-47ba-b451-0f7d42bc1746
$
```

4.5. GENERATE A SYMMETRIC KEY

Symmetric keys are suitable for certain tasks, such as nova disk encryption and swift object encryption.

1. Generate a new 256-bit key using **order create** and store it in barbican. For example:

```
$ openstack secret order create --name swift_key --algorithm aes --mode ctr --bit-length 256
--payload-content-type=application/octet-stream key
+----------------+-----------------------------------------------------------------------------------+
| Field          | Value                                                                             |
+----------------+-----------------------------------------------------------------------------------+
| Order href     | https://192.168.123.173:9311/v1/orders/043383fe-d504-42cf-a9b1-
bc328d0b4832 |
| Type           | Key                                                                               |
| Container href | N/A                                                                               |
| Secret href    | None                                                                              |
| Created        | None                                                                              |
| Status         | None                                                                              |
| Error code     | None                                                                              |
| Error message  | None                                                                              |
+----------------+-----------------------------------------------------------------------------------+
```

- **--mode** - Generated keys can be configured to use a particular mode, such as **ctr** or **cbc**. For more information, see *NIST SP 800-38A*.

2. View the details of the order to identify the location of the generated key, shown here as the **Secret href** value:

```
$ openstack secret order get https://192.168.123.173:9311/v1/orders/043383fe-d504-42cf-
a9b1-bc328d0b4832
+----------------+------------------------------------------------------------------------------------+
| Field          | Value                                                                              |
+----------------+------------------------------------------------------------------------------------+
| Order href     | https://192.168.123.173:9311/v1/orders/043383fe-d504-42cf-a9b1-
bc328d0b4832  |
| Type           | Key                                                                                |
| Container href | N/A                                                                                |
| Secret href    | https://192.168.123.173:9311/v1/secrets/efcfec49-b9a3-4425-a9b6-
5ba69cb18719 |
| Created        | 2018-01-24T04:24:33+00:00                                                          |
| Status         | ACTIVE                                                                             |
| Error code     | None                                                                               |
| Error message  | None                                                                               |
+----------------+------------------------------------------------------------------------------------+
```

3. Retrieve the details of the secret:

```
$ openstack secret get https://192.168.123.173:9311/v1/secrets/efcfec49-b9a3-4425-a9b6-
```

```
5ba69cb18719
+---------------+-----------------------------------------------------------------------------------+
| Field         | Value                                                                             |
+---------------+-----------------------------------------------------------------------------------+
| Secret href   | https://192.168.123.173:9311/v1/secrets/efcfec49-b9a3-4425-a9b6-
5ba69cb18719 |
| Name          | swift_key                                                                         |
| Created       | 2018-01-24T04:24:33+00:00                                                         |
| Status        | ACTIVE                                                                            |
| Content types | {u'default': u'application/octet-stream'}                                         |
| Algorithm     | aes                                                                               |
| Bit length    | 256                                                                               |
| Secret type   | symmetric                                                                         |
| Mode          | ctr                                                                               |
| Expiration    | None                                                                              |
+---------------+-----------------------------------------------------------------------------------+
```

4.6. BACKUP AND RESTORE KEYS

The process for backup and restore of encryption keys will vary depending on the type of back end:

4.6.1. Backup and restore the simple crypto back end

Two separate components need to be backed up for *simple crypto* back end: the KEK and the database. It is recommended that you regularly test your backup and restore process.

4.6.1.1. Backup and restore the KEK

For the *simple crypto* back end, you need to backup the **barbican.conf** file that contains the master KEK is written. This file must be backed up to a security hardened location. The actual data is stored in the Barbican database in an encrypted state, described in the next section.

- To restore the key from a backup, you need to copy the restored **barbican.conf** over the existing **barbican.conf**.

4.6.1.2. Backup and restore the back end database

This procedure describes how to backup and restore a barbican database for the simple crypto back end. To demonstrate this, you will generate a key and upload the secrets to barbican. You will then backup the barbican database, and delete the secrets you created. You will then restore the database and confirm that the secrets you created earlier have been recovered.

NOTE

Be sure you are also backing up the KEK, as this is also an important requirement. This is described in the previous section.

4.6.1.2.1. Create the test secret

1. On the overcloud, generate a new 256-bit key using **order create** and store it in barbican. For example:

```
(overcloud) [stack@undercloud-0 ~]$ openstack secret order create --name swift_key --
algorithm aes --mode ctr --bit-length 256 --payload-content-type=application/octet-stream key
```

```
+----------------+-----------------------------------------------------------------------+
| Field          | Value                                                                 |
+----------------+-----------------------------------------------------------------------+
| Order href     | http://10.0.0.104:9311/v1/orders/2a11584d-851c-4bc2-83b7-35d04d3bae86 |
| Type           | Key                                                                   |
| Container href | N/A                                                                   |
| Secret href    | None                                                                  |
| Created        | None                                                                  |
| Status         | None                                                                  |
| Error code     | None                                                                  |
| Error message  | None                                                                  |
+----------------+-----------------------------------------------------------------------+
```

2. Create a test secret:

```
(overcloud) [stack@undercloud-0 ~]$ openstack secret store --name testSecret --payload
'TestPayload'
+---------------+------------------------------------------------------------------------+
| Field         | Value                                                                  |
+---------------+------------------------------------------------------------------------+
| Secret href   | http://10.0.0.104:9311/v1/secrets/93f62cfd-e008-401f-be74-bf057c88b04a |
| Name          | testSecret                                                             |
| Created       | None                                                                   |
| Status        | None                                                                   |
| Content types | None                                                                   |
| Algorithm     | aes                                                                    |
| Bit length    | 256                                                                    |
| Secret type   | opaque                                                                 |
| Mode          | cbc                                                                    |
| Expiration    | None                                                                   |
+---------------+------------------------------------------------------------------------+
```

3. Confirm that the secrets were created:

```
(overcloud) [stack@undercloud-0 ~]$ openstack secret list
+------------------------------------------------------------------------+------------+------------------------
---+--------+-----------------------------------------+-----------+------------+-------------+------+------
------+
| Secret href                                                            | Name       | Created                   | Status |
Content types                           | Algorithm | Bit length | Secret type | Mode | Expiration |
+------------------------------------------------------------------------+------------+------------------------
---+--------+-----------------------------------------+-----------+------------+-------------+------+------
------+
| http://10.0.0.104:9311/v1/secrets/93f62cfd-e008-401f-be74-bf057c88b04a | testSecret |
2018-06-19T18:25:25+00:00 | ACTIVE | {u'default': u'text/plain'}               | aes       |        256 |
opaque      | cbc  | None       |
| http://10.0.0.104:9311/v1/secrets/f664b5cf-5221-47e5-9887-608972a5fefb | swift_key  |
2018-06-19T18:24:40+00:00 | ACTIVE | {u'default': u'application/octet-stream'} | aes       |
256 | symmetric   | ctr  | None       |
+------------------------------------------------------------------------+------------+------------------------
---+--------+-----------------------------------------+-----------+------------+-------------+------+------
------+
```

4.6.1.2.2. Backup the barbican database

Run these steps while logged in to the **controller-0** node.

> **NOTE**
>
> Only the user *barbican* has access to the *barbican* database. So the barbican user password is required to backup or restore the database.

1. Retrieve *barbican* user password. For example:

```
[heat-admin@controller-0 ~]$ sudo grep -r "barbican::db::mysql::password"
/etc/puppet/hieradata
/etc/puppet/hieradata/service_configs.json:    "barbican::db::mysql::password":
"seDJRsMNRrBdFryCmNUEFPPev",
```

2. Backup the *barbican* database:

```
[heat-admin@controller-0 ~]$ mysqldump -u barbican -p"seDJRsMNRrBdFryCmNUEFPPev"
barbican > barbican_db_backup.sql
```

3. Database backup is stored in */home/heat-admin*

```
[heat-admin@controller-0 ~]$ ll
total 36
-rw-rw-r--. 1 heat-admin heat-admin 36715 Jun 19 18:31 barbican_db_backup.sql
```

4.6.1.2.3. Delete the test secrets

1. On the overcloud, delete the secrets you created previously, and verify they no longer exist. For example:

```
(overcloud) [stack@undercloud-0 ~]$ openstack secret delete
http://10.0.0.104:9311/v1/secrets/93f62cfd-e008-401f-be74-bf057c88b04a
(overcloud) [stack@undercloud-0 ~]$ openstack secret delete
http://10.0.0.104:9311/v1/secrets/f664b5cf-5221-47e5-9887-608972a5fefb
(overcloud) [stack@undercloud-0 ~]$ openstack secret list

(overcloud) [stack@undercloud-0 ~]$
```

4.6.1.2.4. Restore the databases

Run these steps while logged in to the **controller-0** node.

1. Make sure you have the *barbican* database on the controller which grants access to the **barbican** user for database restoration:

```
[heat-admin@controller-0 ~]$ mysql -u barbican -p"seDJRsMNRrBdFryCmNUEFPPev"
Welcome to the MariaDB monitor.  Commands end with ; or \g.
Your MariaDB connection id is 3799
Server version: 10.1.20-MariaDB MariaDB Server

Copyright (c) 2000, 2016, Oracle, MariaDB Corporation Ab and others.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.
```

```
MariaDB [(none)]> SHOW DATABASES;
+--------------------+
| Database           |
+--------------------+
| barbican           |
| information_schema |
+--------------------+
2 rows in set (0.00 sec)

MariaDB [(none)]> exit
Bye
[heat-admin@controller-0 ~]$
```

9) Restore the backup file to the **barbican** database:

+

```
[heat-admin@controller-0 ~]$ sudo mysql -u barbican -p"seDJRsMNRrBdFryCmNUEFPPev"
barbican < barbican_db_backup.sql
[heat-admin@controller-0 ~]$
```

4.6.1.2.5. Verify the restore process

1. On the overcloud, verify that the test secrets were restored successfully:

```
(overcloud) [stack@undercloud-0 ~]$ openstack secret list
+------------------------------------------------------------------------+------------+------------------------
---+--------+-----------------------------------------+-----------+------------+-------------+------+------
------+
| Secret href                                                            | Name       | Created                | Status |
Content types                         | Algorithm | Bit length | Secret type | Mode | Expiration |
+------------------------------------------------------------------------+------------+------------------------
---+--------+-----------------------------------------+-----------+------------+-------------+------+------
------+
| http://10.0.0.104:9311/v1/secrets/93f62cfd-e008-401f-be74-bf057c88b04a | testSecret |
2018-06-19T18:25:25+00:00 | ACTIVE | {u'default': u'text/plain'}               | aes       |        256 |
opaque      | cbc  | None       |
| http://10.0.0.104:9311/v1/secrets/f664b5cf-5221-47e5-9887-608972a5fefb | swift_key  |
2018-06-19T18:24:40+00:00 | ACTIVE | {u'default': u'application/octet-stream'} | aes       |
256 | symmetric   | ctr  | None       |
+------------------------------------------------------------------------+------------+------------------------
---+--------+-----------------------------------------+-----------+------------+-------------+------+------
------+
(overcloud) [stack@undercloud-0 ~]$
```

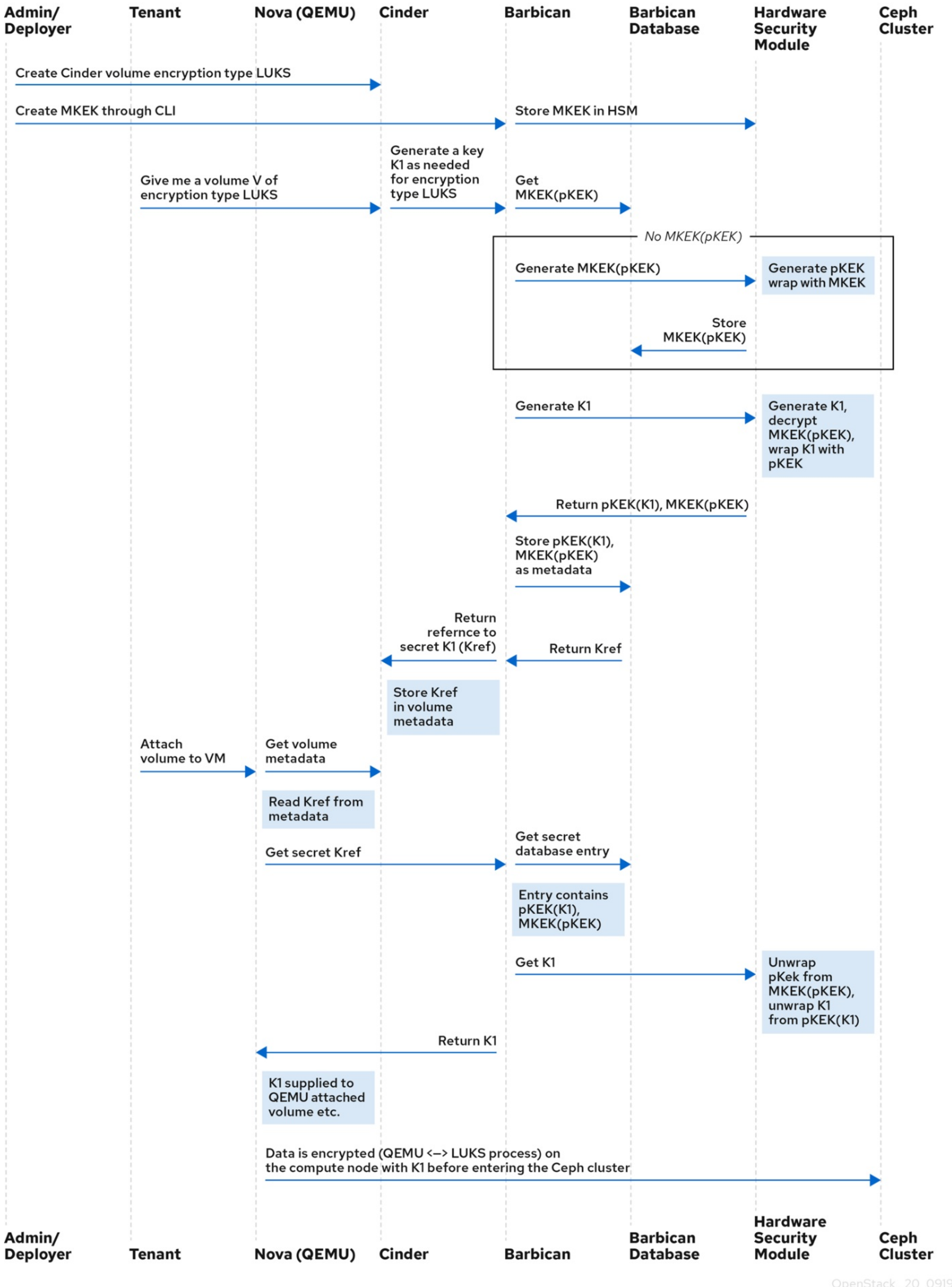
== Barbican Hardware Security Module (HSM) Integration

OpenStack Key Manager (Barbican) is the secrets manager for Red Hat OpenStack Platform. You can use the Barbican API and command line to centrally manage the certificates, keys, and passwords used by OpenStack services. Barbican currently supports the following use cases described in this guide:

- **Symmetric encryption keys** - used for Block Storage (cinder) volume encryption, ephemeral disk encryption, Object Storage (Sswift) encryption, among others.

- **Asymmetric keys and certificates** - glance image signing and verification, octavia TLS load balancing, among others.

In this release, Barbican offers integration with the Block Storage (cinder), Networking (neutron), and Compute (nova) components.



4.7. CHOOSING A BACKEND

Secrets (such as certificates, API keys, and passwords) can either be stored as an encrypted blob in the Barbican database, directly in a secure storage system, including a Hardware Security Module (HSM) appliance.

4.7.1. Simple crypto

The *simple crypto* plugin is enabled by default and uses a single symmetric key to encrypt all secret payloads. This key is stored in plain text in the **barbican.conf** file.

4.7.2. PKCS#11

You must plan the overcloud network topology so that the Controller nodes where the Barbican containers are run have network access to the HSM that will be used by the PKCS#11 backend. You also need a password-protected HTTPS server to host the client software provided by your HSM vendor. At deployment time, these client files are downloaded to the Controller nodes.

4.8. HARDWARE SECURITY MODULE (HSM) SUPPORT

This guide explains how to integrate Barbican with various HSM appliances.

You can use the PKCS#11 crypto plugin to store the secrets in a Hardware Security Module (HSM), which are physical rack-mounted appliances produced by third party vendors. These secrets are encrypted using the pKEK, which in turn is also stored in the Barbican database. The pKEK is encrypted and an HMAC operation is applied using the MKEK and HMAC keys, which are also stored in the HSM.

There are additional plugins that can be used, such as the **KMIP plugin** and **Red Hat Certificate System (dogtag)**, however these are not supported at this time.

NOTE

Regarding high availability (HA) options: The Barbican service runs within Apache and is configured by director to use HAProxy for high availability. Your HA options for the backend layer will depend on the which backend is used: For example, with simple crypto, all the Barbican instances have the same encryption key in the configuration file, resulting in a simple HA configuration.

4.9. MIGRATING BETWEEN BACKENDS

Barbican allows you to define a different backend for a project. If no mapping exists for a project, then secrets are stored in the global default backend. This means that multiple backends can be configured, but there must be only one global backend defined. The heat templates supplied for the different backends contain the parameters that set each backend as the default.

If you do store secrets in a certain backend and then decide to migrate to a new backend, you can keep the old backend available while enabling the new backend as the global default (or as a project-specific backend). As a result, the old secrets remain available through the old backend.

CHAPTER 5. INTEGRATING BARBICAN WITH AN HSM APPLIANCE

Integrate your Red Hat OpenStack Platform deployment with hardware security module (HSM) appliances to increase your security posture by using hardware based cryptographic processing.

5.1. INTEGRATE BARBICAN WITH AN ATOS HSM

You can integrate the PKCS#11 back end with your Trustway Proteccio Net HSM appliance. You can enable HA by listing two or more HSMs below the **atos_hsms** parameter.

Prerequisites

- A password-protected HTTPS server that provides vendor software for the Atos HSM

Table 5.1. Files provided by the HTTPS server

File	Example	Provided by
Proteccio Client Software ISO image file	Proteccio1.09.05.iso	HSM Vendor
SSL server certificate	proteccio.CRT	HSM administrator
SSL client certificate	client.CRT	HSM administrator
SSL Client key	client.KEY	HSM administrator

Procedure

1. Create a **configure-barbican.yaml** environment file for Barbican and add the following parameters:

```
parameter_defaults
  BarbicanSimpleCryptoGlobalDefault: false
  BarbicanPkcs11CryptoGlobalDefault: true
  BarbicanPkcs11CryptoLogin: ********
  BarbicanPkcs11CryptoSlotId: 1
  ATOSVars:
    atos_client_iso_name: Proteccio1.09.05.iso
    atos_client_iso_location: https://user@PASSWORD:example.com/Proteccio1.09.05.iso
    atos_client_cert_location: https://user@PASSWORD:example.com/client.CRT
    atos_client_key_location: https://user@PASSWORD:example.com/client.KEY
    atos_hsms:
      - name: myHsm1
        server_cert_location: https://user@PASSWORD:example.com/myHsm1.CRT
        ip: 192.168.1.101
      - name: myHsm2
        server_cert_location: https://user@PASSWORD:example.com/myHsm2.CRT
        ip: ip: 192.168.1.102
```

NOTE

The **atos_hsms** parameter supersedes the parameters **atos_hsm_ip_address** and **atos_server_cert_location** which have been deprecated and will be removed in a future release.

Table 5.2. Heat parameters

Parameter	Value
BarbicanSimpleCryptoGlobalDefault	This is a boolean that determines if **simplecrypto** will be the global default.
BarbicanPkcs11GlobalDefault	This is a boolean that determines if **PKCS#11** will be the global default.
BarbicanPkcs11CryptoSlotId	Slot ID for the Virtual HSM to be used by Barbican.
ATOSVars	
atos_client_iso_name	The filename for the Atos client software ISO. This value must match the filename in the URL for the **atos_client_iso_location** parameter.
atos_client_iso_location	The URL, including the username and password, that specifies the HTTPS server location of the Proteccio Client Software ISO image.
atos_client_cert_location	The URL, including the username and password, that specifies the HTTPS server location of the SSL client certificate.
atos_client_key_location	The URL, including the username and password, that specifies the HTTPS server location of the SSL client key. This must be the matching key for the client certificate above.
atos_hsms	A list of one or more HSMs that specifies the name, certificate location and IP address of the HSM. When you include more than one HSM in this list, Barbican configures the HSMs for load balancing and high availability.

> **NOTE**
>
> By default, the HSM can have a maximum of 32 concurrent connections. If you exceed this number, you might experience a memory error from the PKCS#11 client. You can calculate the number of connections as follows:
>
> - Each Controller has one **barbican-api** and one **barbican-worker** process.
> - Each Barbican API process is executed with **N** Apache workers - (where **N** defaults to the number of CPUs).
> - Each worker has one connection to the HSM.
>
> Each **barbican-worker** process has one connection to the database. You can use the **BarbicanWorkers** heat parameter to define the number of Apache workers for each API process. By default, the number of Apache workers matches the CPU count.
>
> For example, if you have three Controllers, each with 32 cores, then the Barbican API on each Controller uses 32 Apache workers. Consequently, one Controller consumes all 32 HSM connections available. To avoid this contention, limit the number of Barbican Apache workers configured for each node. In this example, set **BarbicanWorkers** to **10** so that all three Controllers can make ten concurrent connections each to the HSM.

2. Include the custom **configure-barbican.yaml**, **barbican.yaml** and ATOS specific **barbican-backend-pkcs11-atos.yaml** environment files in the deployment command, as well as any other environment files relevant to your deployment:

```
$ openstack overcloud deploy \
    --timeout 100 \
    --templates /usr/share/openstack-tripleo-heat-templates \
    --stack overcloud \
    --libvirt-type kvm \
    --ntp-server clock.redhat.com \
    -e /home/stack/virt/config_lvm.yaml \
    -e /usr/share/openstack-tripleo-heat-templates/environments/network-isolation.yaml \
    -e /home/stack/virt/network/network-environment.yaml \
    -e /home/stack/virt/hostnames.yml \
    -e /home/stack/virt/nodes_data.yaml \
    -e /home/stack/virt/extra_templates.yaml \
    -e /home/stack/container-parameters-with-barbican.yaml \
    -e /usr/share/openstack-tripleo-heat-templates/environments/services/barbican.yaml \
    -e /usr/share/openstack-tripleo-heat-templates/environments/barbican-backend-pkcs11-
atos.yaml \
    -e /home/stack/configure-barbican.yaml \
    --log-file overcloud_deployment_with_atos.log
```

Verification

1. Create a test secret:

```
$ openstack secret store --name testSecret --payload 'TestPayload'
+---------------+------------------------------------------------------------------------------------+
| Field         | Value                                                                              |
```

```
+---------------+-----------------------------------------------------------------------------------+
| Secret href   | https://192.168.123.163/key-manager/v1/secrets/4cc5ffe0-eea2-449d-9e64-
b664d574be53 |
| Name          | testSecret                                                                        |
| Created       | None                                                                              |
| Status        | None                                                                              |
| Content types | None                                                                              |
| Algorithm     | aes                                                                               |
| Bit length    | 256                                                                               |
| Secret type   | opaque                                                                            |
| Mode          | cbc                                                                               |
| Expiration    | None                                                                              |
+---------------+-----------------------------------------------------------------------------------+
```

2. Retrieve the payload for the secret that you just created:

```
openstack secret get https://192.168.123.163/key-manager/v1/secrets/4cc5ffe0-eea2-449d-
9e64-b664d574be53 --payload
+---------+-------------+
| Field   | Value       |
+---------+-------------+
| Payload | TestPayload |
+---------+-------------+
```

5.2. INTEGRATING BARBICAN WITH AN NCIPHER NSHIELD CONNECT XC

You can integrate the PKCS#11 backend with your nCipher nShield Connect XC HSM. Use an Ansible role to download and install the nCipher client software on the Controller, and a Barbican configuration file to include the predefined HSM IP and credentials.

Prerequisites

- A password-protected HTTPS server that provides vendor software for the nCipher nShield Connect XC.

Procedure

1. Create a **configure-barbican.yaml** environment file for Barbican and add parameters specific to your environment. Use the following snippet as an example:

```
  parameter_defaults:
    SwiftEncryptionEnabled: true
    ComputeExtraConfig:
      nova::glance::verify_glance_signatures: true
  nova::compute::verify_glance_signatures: true
    BarbicanPkcs11CryptoLogin: 'sample string'
    BarbicanPkcs11CryptoSlotId: '492971158'
    BarbicanPkcs11CryptoGlobalDefault: true
    BarbicanPkcs11CryptoLibraryPath: '/opt/nfast/toolkits/pkcs11/libcknfast.so'
    BarbicanPkcs11CryptoEncryptionMechanism: 'CKM_AES_CBC'
    BarbicanPkcs11CryptoHMACKeyType: 'CKK_SHA256_HMAC'
    BarbicanPkcs11CryptoHMACKeygenMechanism:
'CKM_NC_SHA256_HMAC_KEY_GEN'
```

```
        BarbicanPkcs11CryptoMKEKLabel: 'barbican_mkek_10'
        BarbicanPkcs11CryptoMKEKLength: '32'
        BarbicanPkcs11CryptoHMACLabel: 'barbican_hmac_10'
        BarbicanPkcs11CryptoThalesEnabled: true
        BarbicanPkcs11CryptoEnabled: true
        ThalesVars:
          thales_client_working_dir: /tmp/thales_client_install
          thales_client_tarball_location: https://your server/CipherTools-linux64-dev-12.40.2.tgz
          thales_client_tarball_name: CipherTools-linux64-dev-12.40.2.tgz
          thales_client_path: linux/libc6_11/amd64/nfast
          thales_client_uid: 42481
          thales_client_gid: 42481
          thales_km_data_location: https://your server/kmdata_post_card_creation.tar.gz
          thales_km_data_tarball_name: kmdata_post_card_creation.tar.gz
          thales_hsm_ip_address: 192.168.10.10
          thales_rfs_server_ip_address: 192.168.10.11
          thales_hsm_config_location: hsm-C90E-02E0-D947
          thales_rfs_user: root
          thales_rfs_key: |
            -----BEGIN RSA PRIVATE KEY-----
Sample private key
-----END RSA PRIVATE KEY-----

resource_registry:
  OS::TripleO::Services::BarbicanBackendPkcs11Crypto: /home/stack/tripleo-heat-
templates/puppet/services/barbican-backend-pkcs11-crypto.yaml
```

Table 5.3. Heat parameters

Parameter	Value
BarbicanSimpleCryptoGlobalDefault	This is a boolean that determines if **simplecrypto** will be the global default.
BarbicanPkcs11GlobalDefault	This is a boolean that determines if **PKCS#11** will be the global default.
BarbicanPkcs11CryptoSlotId	Slot ID for the Virtual HSM to be used by Barbican.
BarbicanPkcs11CryptoMKEKLabel	This parameter defines the name of the mKEK generated in the HSM. Director creates this key in the HSM using this name.
BarbicanPkcs11CryptoHMACLabel	This parameter defines the name of the HMAC key generated in the HSM. Director creates this key in the HSM using this name.
ThalesVars	
thales_client_working_dir	A user-defined temporary working directory.

Parameter	Value
thales_client_tarball_location	The URL that specifies the HTTPS server location of the nCipher software.
thales_km_data_tarball_name	The name of the nCipher software tarball.
thales_rfs_key	A private key used to obtain an SSH connection to the RFS server. You must add this as an authorized key to the RFS server.

2. Include the custom **configure-barbican.yaml** environment file, along with the **barbican.yaml** and Thales specific **barbican-backend-pkcs11-thales.yaml** environment files, and any other templates needed for you deployment when running the **openstack overcloud deploy** command:

```
$ openstack overcloud deploy \
    --timeout 100 \
    --templates /usr/share/openstack-tripleo-heat-templates \
    --stack overcloud \
    --libvirt-type kvm \
    --ntp-server clock.redhat.com \
    -e /home/stack/virt/config_lvm.yaml \
    -e /usr/share/openstack-tripleo-heat-templates/environments/network-isolation.yaml \
    -e /home/stack/virt/network/network-environment.yaml \
    -e /home/stack/virt/hostnames.yml \
    -e /home/stack/virt/nodes_data.yaml \
    -e /home/stack/virt/extra_templates.yaml \
    -e /home/stack/container-parameters-with-barbican.yaml \
    -e /usr/share/openstack-tripleo-heat-templates/environments/services/barbican.yaml \
    -e /usr/share/openstack-tripleo-heat-templates/environments/barbican-backend-pkcs11-
thales.yaml \
    -e /home/stack/configure-barbican.yaml \
    --log-file overcloud_deployment_with_atos.log
```

Verification

1. Create a test secret:

```
$ openstack secret store --name testSecret --payload 'TestPayload'
+---------------+-----------------------------------------------------------------------------------+
| Field         | Value                                                                             |
+---------------+-----------------------------------------------------------------------------------+
| Secret href   | https://192.168.123.163/key-manager/v1/secrets/4cc5ffe0-eea2-449d-9e64-
b664d574be53 |
| Name          | testSecret                                                                        |
| Created       | None                                                                              |
| Status        | None                                                                              |
| Content types | None                                                                              |
| Algorithm     | aes                                                                               |
| Bit length    | 256                                                                               |
| Secret type   | opaque                                                                            |
```

```
| Mode          | cbc                                                                   |
| Expiration    | None                                                                  |
+---------------+-----------------------------------------------------------------------+
```

2. Retrieve the payload for the secret that you just created:

```
openstack secret get https://192.168.123.163/key-manager/v1/secrets/4cc5ffe0-eea2-449d-9e64-b664d574be53 --payload
+---------+-------------+
| Field   | Value       |
+---------+-------------+
| Payload | TestPayload |
+---------+-------------+
```

5.3. REVIEWING TLS ACTIVITY BETWEEN BARBICAN AND THE HSM

Barbican communicates with the HSM through the vendor-provided PKCS#11 library. For example, for an ATOS Proteccio HSM, you can configure the HSM client to communicate with the HSM using TLS by configuring the **proteccio.rc** file.

For the Atos HSM, the files containing the CA, server certificate, and key are located on the Controller, and are owned by the **barbican** user. Note that the **barbican** user does not exist on the Controller, and is the **barbican** user as defined in the Barbican container. As a result, file ownership is indicated through the **barbican** UID, which is 400; these files are then bind mounted by the Barbican container.

For the nCipher nShield Connect XC, to view additional logs on the pkcs#11 transactions between the HSM and the client software, add the following entries to **/opt/nfast/cknfastrc**:

```
CKNFAST_DEBUG=9
CKNFAST_DEBUGFILE=/tmp/hsm_log.txt
```

5.4. KEY STORAGE CONSIDERATIONS

The Barbican MKEK and HMAC keys are generated using Barbican utilities that communicate with the HSM using the vendor's PKCS#11 library. Therefore the MKEK and HMAC keys are generated in the HSM and never leave the HSM.

In a director-based deployment, these utilities are executed within containers on the first Controller; the undercloud is never involved in this process.

5.5. ROTATING THE KEYS

You can rotate the MKEK and HMAC keys using a director update.

> **NOTE**
>
> The MKEK and HMAC have the same key type. This is a limitation in Barbican, and is currently expected to be addressed at a later time.

1. To rotate the keys, add the following parameter to your deployment environment files:

```
BarbicanPkcs11CryptoRewrapKeys:        true
```

2. Change the labels on the MKEK and HMAC keys For example, if your labels are similar to these:

```
BarbicanPkcs11CryptoMKEKLabel: 'barbican_mkek_10'
BarbicanPkcs11CryptoHMACLabel: 'barbican_hmac_10'
```

   You can change the labels by incrementing the values:

```
BarbicanPkcs11CryptoMKEKLabel: 'barbican_mkek_11'
BarbicanPkcs11CryptoHMACLabel: 'barbican_hmac_11'
```

   NOTE

   Do not change the HMAC key type.

3. Re-deploy using director to apply the update. Director checks whether the keys that are labelled for the MKEK and HMAC exist, and then creates them. In addition, with the **BarbicanPkcs11CryptoRewrapKeys** parameter set to **True**, director calls **barbican-manage hsm pkek_rewrap** to rewrap all existing pKEKs.

5.6. PLANNING BACKUP FOR BARBICAN AND THE HSM

The section describes the components you will need to consider when planning your Barbican and HSM backup strategy.

- Barbican secrets - These are stored in the database, and must be backed up regularly.
- MKEK and HMAC keys - These are stored in the HSM. Check with your HSM vendor for recommended practices.
- HSM client certificates and keys - These are located on the Controller, and must be included in your Controller’s file backup procedure. Note that these files are sensitive credentials.
- Barbican configuration files

CHAPTER 6. ENCRYPTING CINDER VOLUMES

You can use barbican to manage your Block Storage (cinder) encryption keys. This configuration uses LUKS to encrypt the disks attached to your instances, including boot disks. Key management is transparent to the user; when you create a new volume using **luks** as the encryption type, cinder generates a symmetric key secret for the volume and stores it in barbican. When booting the instance (or attaching an encrypted volume), nova retrieves the key from barbican and stores the secret locally as a Libvirt secret on the Compute node.

> **IMPORTANT**
>
> Nova formats encrypted volumes during their first use if they are unencrypted. The resulting block device is then presented to the Compute node.

> **NOTE**
>
> If you intend to update any configuration files, be aware that certain OpenStack services now run within containers; this applies to keystone, nova, and cinder, among others. As a result, there are administration practices to consider:
>
> - Do not update any configuration file you might find on the physical node's host operating system, for example, **/etc/cinder/cinder.conf**. The containerized service does not reference this file.
> - Do not update the configuration file running within the container. Changes are lost once you restart the container.
>   Instead, if you must change containerized services, update the configuration file in **/var/lib/config-data/puppet-generated/**, which is used to generate the container.
>
>   For example:
> - keystone: **/var/lib/config-data/puppet-generated/keystone/etc/keystone/keystone.conf**
> - cinder: **/var/lib/config-data/puppet-generated/cinder/etc/cinder/cinder.conf**
> - nova: **/var/lib/config-data/puppet-generated/nova/etc/nova/nova.conf**
>   Changes are applied after you restart the container.

1. On nodes running the **cinder-volume** and **nova-compute** services, confirm that nova and cinder are both configured to use barbican for key management:

```
$ crudini --get /var/lib/config-data/puppet-generated/cinder/etc/cinder/cinder.conf
key_manager backend
castellan.key_manager.barbican_key_manager.BarbicanKeyManager

$ crudini --get /etc/nova/nova.conf key_manager backend
castellan.key_manager.barbican_key_manager.BarbicanKeyManager
```

2. Create a volume template that uses encryption. When you create new volumes they can be modeled off the settings you define here:

```
$ openstack volume type create --encryption-provider
```

```
nova.volume.encryptors.luks.LuksEncryptor --encryption-cipher aes-xts-plain64 --encryption-
key-size 256 --encryption-control-location front-end LuksEncryptor-Template-256
+-------------+---------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------+
| Field       | Value
|
+-------------+---------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------+
| description | None
|
| encryption  | cipher='aes-xts-plain64', control_location='front-end', encryption_id='9df604d0-
8584-4ce8-b450-e13e6316c4d3', key_size='256',
provider='nova.volume.encryptors.luks.LuksEncryptor' |
| id          | 78898a82-8f4c-44b2-a460-40a5da9e4d59
|
| is_public   | True
|
| name        | LuksEncryptor-Template-256
|
+-------------+---------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------+
```

3. Create a new volume and specify that it uses the **LuksEncryptor-Template-256** settings:

NOTE

Ensure that the user creating the encrypted volume has the **creator** barbican role on the project. For more information, see the **Grant user access to the creator role** section.

```
$ openstack volume create --size 1 --type LuksEncryptor-Template-256 'Encrypted-Test-
Volume'
+---------------------+--------------------------------------+
| Field               | Value                                |
+---------------------+--------------------------------------+
| attachments         | []                                   |
| availability_zone   | nova                                 |
| bootable            | false                                |
| consistencygroup_id | None                                 |
| created_at          | 2018-01-22T00:19:06.000000           |
| description         | None                                 |
| encrypted           | True                                 |
| id                  | a361fd0b-882a-46cc-a669-c633630b5c93 |
| migration_status    | None                                 |
| multiattach         | False                                |
| name                | Encrypted-Test-Volume                |
| properties          |                                      |
| replication_status  | None                                 |
| size                | 1                                    |
| snapshot_id         | None                                 |
| source_volid        | None                                 |
| status              | creating                             |
| type                | LuksEncryptor-Template-256           |
```

```
| updated_at          | None                                 |
| user_id             | 0e73cb3111614365a144e7f8f1a972af     |
+---------------------+--------------------------------------+
```

The resulting secret is automatically uploaded to the barbican backend.

4. Use barbican to confirm that the disk encryption key is present. In this example, the timestamp matches the LUKS volume creation time:

```
$ openstack secret list
+------------------------------------------------------------------------------------+------+---------------------------+--------+-------------------------------------------+-----------+------------+-------------+------+------------+
| Secret href                                                                        | Name | Created                   | Status | Content types                             | Algorithm | Bit length | Secret type | Mode | Expiration |
+------------------------------------------------------------------------------------+------+---------------------------+--------+-------------------------------------------+-----------+------------+-------------+------+------------+
| https://192.168.123.169:9311/v1/secrets/24845e6d-64a5-4071-ba99-0fdd1046172e | None | 2018-01-22T02:23:15+00:00 | ACTIVE | {u'default': u'application/octet-stream'} | aes       | 256 | symmetric   | None | None       |
+------------------------------------------------------------------------------------+------+---------------------------+--------+-------------------------------------------+-----------+------------+-------------+------+------------+
```

5. Attach the new volume to an existing instance. For example:

```
$ openstack server add volume testInstance Encrypted-Test-Volume
```

The volume is then presented to the guest operating system and can be mounted using the built-in tools.

6.1. MIGRATE EXISTING VOLUME KEYS TO BARBICAN

Previously, deployments might have used **ConfKeyManager** to manage disk encryption keys. This meant that a fixed key was generated and then stored in the nova and cinder configuration files. The key IDs can be migrated to barbican using the following procedure. This utility works by scanning the databases for **encryption_key_id** entries within scope for migration to barbican. Each entry gets a new barbican key ID and the existing **ConfKeyManager** secret is retained.

NOTE

Previously, you could reassign ownership for volumes encrypted using **ConfKeyManager**. This is not possible for volumes that have their keys managed by barbican.

NOTE

Activating barbican will not break your existing **keymgr** volumes.

After it is enabled, the migration process runs automatically, but it requires some configuration, described in the next section. The actual migration runs in the **cinder-volume** and **cinder-backup** process, and you can track the progress in the cinder log files.

- **cinder-volume** - migrates keys stored in cinder's Volumes and Snapshots tables.

- **cinder-backup** - migrates keys in the Backups table.

6.1.1. Overview of the migration steps

1. Deploy the barbican service.
2. Add the **creator** role to the cinder service. For example:

```
#openstack role create creator
#openstack role add --user cinder creator  --project service
```

3. Restart the **cinder-volume** and **cinder-backup** services.
4. **cinder-volume** and **cinder-backup** automatically begin the migration process.
5. Monitor the logs for the message indicating migration has finished and check that no more volumes are using the **ConfKeyManager** all-zeros encryption key ID.
6. Remove the **fixed_key** option from **cinder.conf** and **nova.conf**. You must determine which nodes have this setting configured.
7. Remove the **creator** role from the cinder service.

6.1.2. Behavioral differences

Barbican-managed encrypted volumes behave differently than volumes that use **ConfKeyManager**:

- You cannot transfer ownership of encrypted volumes, because it is not currently possible to transfer ownership of the barbican secret.
- Barbican is more restrictive about who is allowed to read and delete secrets, which can affect some cinder volume operations. For example, a user cannot attach, detach, or delete a different user's volumes.

6.1.3. Reviewing the migration process

This section describes how you can view the status of the migration tasks. After you start the process, one of these entries appears in the logs. This indicates whether the migration started correctly, or it identifies the issue it encountered:

- **Not migrating encryption keys because the ConfKeyManager is still in use.**
- **Not migrating encryption keys because the ConfKeyManager's fixed_key is not in use.**
- **Not migrating encryption keys because migration to the 'XXX' key_manager backend is not supported.** - This message is unlikely to appear; it is a safety check to handle the code ever encountering another Key Manager backend other than barbican. This is because the code only supports one migration scenario: *From* ConfKeyManager *to* barbican.
- **Not migrating encryption keys because there are no volumes associated with this host.** - This may occur when **cinder-volume** is running on multiple hosts, and a particular host has no volumes associated with it. This arises because every host is responsible for handling its own volumes.
- **Starting migration of ConfKeyManager keys.**

- **Migrating volume <UUID> encryption key to Barbican** - During migration, all of the host's volumes are examined, and if a volume is still using the ConfKeyManager's key ID (identified by the fact that it's all zeros (**00000000-0000-0000-0000-000000000000**)), then this message appears.
    - For **cinder-backup**, this message uses slightly different capitalization: **Migrating Volume [...]** or **Migrating Backup [...]**
- After each host examines all of its volumes, the host displays a summary status message:

    > `No volumes are using the ConfKeyManager's encryption_key_id.`
    > `No backups are known to be using the ConfKeyManager's encryption_key_id.`

    You may also see the following entries:

    There are still %d volume(s) using the ConfKeyManager's all-zeros encryption key ID.There are still %d backup(s) using the ConfKeyManager's all-zeros encryption key ID. Note that both of these messages can appear in the **cinder-volume** and **cinder-backup** logs. Whereas each service only handles the migration of its own entries, the service is aware of the the other's status. As a result, **cinder-volume** knows if **cinder-backup** still has backups to migrate, and **cinder-backup** knows if the **cinder-volume** service has volumes to migrate.

    Although each host migrates only its own volumes, the summary message is based on a global assessment of whether any volume still requires migration This allows you to confirm that migration for all volumes is complete. Once you receive confirmation, remove the **fixed_key** setting from **cinder.conf** and **nova.conf**. See the *Clean up the fixed keys* section below for more information.

6.1.4. Troubleshooting the migration process

6.1.4.1. Role assignment

The barbican secret can only be created when the requestor has the **creator** role. This means that the cinder service itself requires the creator role, otherwise a log sequence similar to this will occur:

1. **Starting migration of ConfKeyManager keys.**
2. **Migrating volume <UUID> encryption key to Barbican**
3. **Error migrating encryption key: Forbidden: Secret creation attempt not allowed - please review your user/project privileges**
4. **There are still %d volume(s) using the ConfKeyManager's all-zeros encryption key ID.**

The key message is the third one: **Secret creation attempt not allowed.** To fix the problem, update the **cinder** account's privileges:

1. Run **openstack role add --project service --user cinder creator**
2. Restart the **cinder-volume** and **cinder-backup** services.

As a result, the next attempt at migration should succeed.

6.1.5. Clean up the fixed keys

> **IMPORTANT**
>
> The **encryption_key_id** was only recently added to the **Backup** table, as part of the Queens release. As a result, pre-existing backups of encrypted volumes are likely to exist. The all-zeros **encryption_key_id** is stored on the backup itself, but it won't appear in the **Backup** database. As such, it is impossible for the migration process to know for certain whether a backup of an encrypted volume exists that still relies on the all-zeros **ConfKeyMgr** key ID.

After migrating your key IDs into barbican, the fixed key remains in the configuration files. This may present a security concern to some users, because the **fixed_key** value is not encrypted in the **.conf** files. To address this, you can manually remove the **fixed_key** values from your nova and cinder configurations. However, first complete testing and review the output of the log file before you proceed, because disks that are still dependent on this value will not be accessible.

1. Review the existing **fixed_key** values. The values must match for both services.

```
crudini --get /var/lib/config-data/puppet-generated/cinder/etc/cinder/cinder.conf keymgr
fixed_key
crudini --get /etc/nova/nova.conf keymgr fixed_key
```

> **IMPORTANT**
>
> Make a backup of the existing **fixed_key** values. This allows you to restore the value if something goes wrong, or if you need to restore a backup that uses the old encryption key.

2. Delete the **fixed_key** values:

```
crudini --del /var/lib/config-data/puppet-generated/cinder/etc/cinder/cinder.conf keymgr
fixed_key
crudini --del /etc/nova/nova.conf keymgr fixed_key
```

6.2. AUTOMATIC DELETION OF VOLUME IMAGE ENCRYPTION KEY

The Block Storage service (cinder) creates an encryption key in the Key Management service (barbican) when it uploads an encrypted volume to the Image service (glance). This creates a 1:1 relationship between an encryption key and a stored image.

Encryption key deletion prevents unlimited resource consumption of the Key Management service. The Block Storage, Key Management, and Image services automatically manage the key for an encrypted volume, including the deletion of the key.

The Block Storage service automatically adds two properties to a volume image:

- **cinder_encryption_key_id** - The identifier of the encryption key that the Key Management service stores for a specific image.
- **cinder_encryption_key_deletion_policy** - The policy that tells the Image service to tell the Key Management service whether to delete the key associated with this image.

IMPORTANT

The values of these properties are automatically assigned. **To avoid unintentional data loss, do not adjust these values**.

When you create a volume image, the Block Storage service sets the **cinder_encryption_key_deletion_policy** property to **on_image_deletion**. When you delete a volume image, the Image service deletes the corresponding encryption key if the **cinder_encryption_key_deletion_policy** equals **on_image_deletion**.

IMPORTANT

Red Hat does not recommend manual manipulation of the **cinder_encryption_key_id** or **cinder_encryption_key_deletion_policy** properties. If you use the encryption key that is identified by the value of **cinder_encryption_key_id** for any other purpose, you risk data loss.

CHAPTER 7. ENCRYPT AT-REST SWIFT OBJECTS

By default, objects uploaded to Object Storage are stored unencrypted. Because of this, it is possible to access objects directly from the file system. This can present a security risk if disks are not properly erased before they are discarded. When you have barbican enabled, the Object Storage service (swift) can transparently encrypt and decrypt your stored (at-rest) objects. At-rest encryption is distinct from in-transit encryption in that it refers to the objects being encrypted while being stored on disk.

Swift performs these encryption tasks transparently, with the objects being automatically encrypted when uploaded to swift, then automatically decrypted when served to a user. This encryption and decryption is done using the same (symmetric) key, which is stored in barbican.

> **NOTE**
>
> You cannot disable encryption after you have enabled encryption and added data to the swift cluster, because the data is now stored in an encrypted state. Consequently, the data will not be readable if encryption is disabled, until you re-enable encryption with the same key.

7.1. ENABLE AT-REST ENCRYPTION FOR SWIFT

1. You can enable the swift encryption capabilities by including **SwiftEncryptionEnabled: True** in your environment file, then re-running **openstack overcloud deploy** using **/home/stack/overcloud_deploy.sh**. Note that you still need to enable barbican, as described in the *Install Barbican* chapter.

2. Confirm that swift is configured to use at-rest encryption:

```
$ crudini --get /var/lib/config-data/puppet-generated/swift/etc/swift/proxy-server.conf pipeline-main pipeline

pipeline = catch_errors healthcheck proxy-logging cache ratelimit bulk tempurl formpost authtoken keystone staticweb copy container_quotas account_quotas slo dlo versioned_writes kms_keymaster encryption proxy-logging proxy-server
```

   The result should include an entry for **encryption**.

CHAPTER 8. VALIDATE GLANCE IMAGES

After enabling Barbican, you can configure the Image Service (glance) to verify that an uploaded image has not been tampered with. In this implementation, the image is first signed with a key that is stored in barbican. The image is then uploaded to glance, along with the accompanying signing information. As a result, the image's signature is verified before each use, with the instance build process failing if the signature does not match.

Barbican's integration with glance means that you can use the **openssl** command with your private key to sign glance images before uploading them.

8.1. ENABLE GLANCE IMAGE VALIDATION

In your environment file, enable image verification with the **VerifyGlanceSignatures: True** setting. You must re-run the **openstack overcloud deploy** command for this setting to take effect.

To verify that glance image validation is enabled, run the following command on an overcloud Compute node:

```
$ sudo crudini --get /var/lib/config-data/puppet-generated/nova_libvirt/etc/nova/nova.conf glance
verify_glance_signatures
```

NOTE

If you use Ceph as the back end for the Image and Compute services, a CoW clone is created. Therefore, Image signing verification cannot be performed.

8.2. VALIDATE AN IMAGE

To configure a glance image for validation, complete the following steps:

1. Confirm that glance is configured to use barbican:

```
$ sudo crudini --get /var/lib/config-data/puppet-generated/glance_api/etc/glance/glance-
api.conf key_manager backend
castellan.key_manager.barbican_key_manager.BarbicanKeyManager
```

2. Generate a private key and convert it to the required format:

```
openssl genrsa -out private_key.pem 1024
openssl rsa -pubout -in private_key.pem -out public_key.pem
openssl req -new -key private_key.pem -out cert_request.csr
openssl x509 -req -days 14 -in cert_request.csr -signkey private_key.pem -out
x509_signing_cert.crt
```

3. Add the key to the barbican secret store:

```
$ source ~/overcloudrc
$ openstack secret store --name signing-cert --algorithm RSA --secret-type certificate --
payload-content-type "application/octet-stream" --payload-content-encoding base64  --
payload "$(base64 x509_signing_cert.crt)" -c 'Secret href' -f value
https://192.168.123.170:9311/v1/secrets/5df14c2b-f221-4a02-948e-48a61edd3f5b
```

NOTE

Record the resulting UUID for use in a later step. In this example, the certificate's UUID is **5df14c2b-f221-4a02-948e-48a61edd3f5b**.

4. Use **private_key.pem** to sign the image and generate the **.signature** file. For example:

```
$ openssl dgst -sha256 -sign private_key.pem -sigopt rsa_padding_mode:pss -out cirros-
0.4.0.signature cirros-0.4.0-x86_64-disk.img
```

5. Convert the resulting **.signature** file into *base64* format:

```
$ base64 -w 0 cirros-0.4.0.signature  > cirros-0.4.0.signature.b64
```

6. Load the *base64* value into a variable to use it in the subsequent command:

```
$ cirros_signature_b64=$(cat cirros-0.4.0.signature.b64)
```

7. Upload the signed image to glance. For **img_signature_certificate_uuid**, you must specify the UUID of the signing key you previously uploaded to barbican:

```
 openstack image create \
--container-format bare --disk-format qcow2 \
--property img_signature="$cirros_signature_b64" \
--property img_signature_certificate_uuid="5df14c2b-f221-4a02-948e-48a61edd3f5b"\
--property img_signature_hash_method="SHA-256" \
--property img_signature_key_type="RSA-PSS" cirros_0_4_0_signed \
--file cirros-0.4.0-x86_64-disk.img
+--------------------------------+----------------------------------------------------------------------------------
----+
| Property                       | Value                                                                            |
+--------------------------------+----------------------------------------------------------------------------------
----+
| checksum                       | None                                                                             |
| container_format               | bare                                                                             |
| created_at                     | 2018-01-23T05:37:31Z                                                             |
| disk_format                    | qcow2                                                                            |
| id                             | d3396fa0-2ea2-4832-8a77-d36fa3f2ab27                                             |
| img_signature                  |
lcI7nGgoKxnCyOcsJ4abbEZEpzXByFPIgiPeiT+Otjz0yvW00KNN3fI0AA6tn9EXrp7fb2xBDE4Ua
O3v |
|                                |
lFquV/s3mU4LcCiGdBAl3pGsMlmZZIQFVNcUPOaayS1kQYKY7kxYmU9iq/AZYyPw37KQI52s
mC/zoO54 |
|                                | zZ+JpnfwIsM=                                                                     |
| img_signature_certificate_uuid | ba3641c2-6a3d-445a-8543-851a68110eab
|
| img_signature_hash_method      | SHA-256                                                                          |
| img_signature_key_type         | RSA-PSS                                                                          |
| min_disk                       | 0                                                                                |
| min_ram                        | 0                                                                                |
| name                           | cirros_0_4_0_signed                                                              |
| owner                          | 9f812310df904e6ea01e1bacb84c9f1a
|
```

```
| protected                    | False                                                                       |
| size                         | None                                                                        |
| status                       | queued                                                                      |
| tags                         | []                                                                          |
| updated_at                   | 2018-01-23T05:37:31Z                                                        |
| virtual_size                 | None                                                                        |
| visibility                   | shared                                                                      |
+------------------------------+-----------------------------------------------------------------------------
----+
```

8. You can view glance's image validation activities in the Compute log: **/var/log/containers/nova/nova-compute.log**. For example, you can expect the following entry when the instance is booted:

```
2018-05-24 12:48:35.256 1 INFO nova.image.glance [req-7c271904-4975-4771-9d26-
cbea6c0ade31 b464b2fd2a2140e9a88bbdacf67bdd8c a3db2f2beaee454182c95b646fa7331f
- default default] Image signature verification succeeded for image d3396fa0-2ea2-4832-
8a77-d36fa3f2ab27
```

CHAPTER 9. VALIDATE IMAGES USED FOR VOLUME CREATION

The Block Storage Service (cinder) automatically validates the signature of any downloaded, signed image during volume from image creation. The signature is validated before the image is written to the volume.

To improve performance, you can use the Block Storage Image-Volume cache to store validated images for creating new volumes. For more information, see Configure and Enable the Image-Volume Cache in the *Storage Guide*.

NOTE

Cinder image signature validation does not work with Red Hat Ceph Storage or RBD volumes.

9.1. VALIDATE THE IMAGE SIGNATURE ON A NEW VOLUME

This procedure demonstrates how you can use validate a volume signature created from a signed image.

1. Log in to a controller node.
2. View cinder's image validation activities in the **Volume** log, **/var/log/containers/cinder/cinder-volume.log**.
   For example, you can expect the following entry when the instance is booted:

```
2018-05-24 12:48:35.256 1 INFO cinder.image.image_utils [req-7c271904-4975-4771-9d26-cbea6c0ade31 b464b2fd2a2140e9a88bbdacf67bdd8c a3db2f2beaee454182c95b646fa7331f - default default] Image signature verification succeeded for image d3396fa0-2ea2-4832-8a77-d36fa3f2ab27
```

Alternatively, you can use the **openstack volume list** and **cinder volume show** commands.

1. Use the **openstack volume list** command to locate the volume ID.
2. Run the **cinder volume show** command on a compute node:

```
cinder volume show <VOLUME_ID>
```

3. Locate the **volume_image_metadata** section with the line **signature verified : True**.

```
$ cinder show d0db26bb-449d-4111-a59a-6fbb080bb483
+--------------------------------+-------------------------------------------------+
| Property                       | Value                                           |
+--------------------------------+-------------------------------------------------+
| attached_servers               | []                                              |
| attachment_ids                 | []                                              |
| availability_zone              | nova                                            |
| bootable                       | true                                            |
| consistencygroup_id            | None                                            |
| created_at                     | 2018-10-12T19:04:41.000000                      |
| description                    | None                                            |
| encrypted                      | True                                            |
```

```
| id                             | d0db26bb-449d-4111-a59a-6fbb080bb483           |
| metadata                       |                                                |
| migration_status               | None                                           |
| multiattach                    | False                                          |
| name                           | None                                           |
| os-vol-host-attr:host          | centstack.localdomain@nfs#nfs                  |
| os-vol-mig-status-attr:migstat | None                                           |
| os-vol-mig-status-attr:name_id | None                                           |
| os-vol-tenant-attr:tenant_id   | 1a081dd2505547f5a8bb1a230f2295f4               |
| replication_status             | None                                           |
| size                           | 1                                              |
| snapshot_id                    | None                                           |
| source_volid                   | None                                           |
| status                         | available                                      |
| updated_at                     | 2018-10-12T19:05:13.000000                     |
| user_id                        | ad9fe430b3a6416f908c79e4de3bfa98               |
| volume_image_metadata          | checksum : f8ab98ff5e73ebab884d80c9dc9c7290    |
|                                | container_format : bare                        |
|                                | disk_format : qcow2                            |
|                                | image_id : 154d4d4b-12bf-41dc-b7c4-35e5a6a3482a |
|                                | image_name : cirros-0.3.5-x86_64-disk          |
|                                | min_disk : 0                                   |
|                                | min_ram : 0                                    |
|                                | signature_verified : False                     |
|                                | size : 13267968                                |
| volume_type                    | nfs                                            |
+--------------------------------+------------------------------------------------+
```