Red Hat OpenShift Service on AWS with FSxN

NetApp container solutions

NetApp
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Red Hat OpenShift Service on AWS with NetApp ONTAP

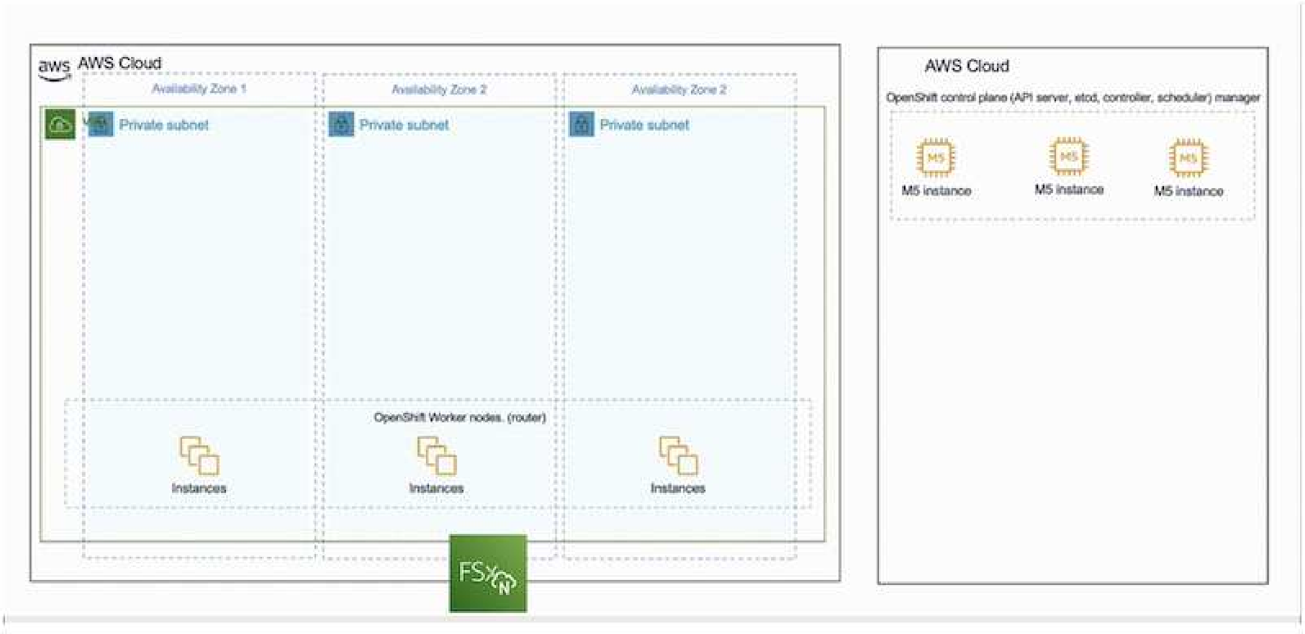
Overview

In this section, we will show how to utilize FSx for ONTAP as a persistent storage layer for applications running on ROSA. It will show the installation of the NetApp Trident CSI driver on a ROSA cluster, the provisioning of an FSx for ONTAP file system, and the deployment of a sample stateful application. It will also show strategies for backing up and restoring your application data. With this integrated solution, you can establish a shared storage framework that effortlessly scales across AZs, simplifying the processes of scaling, protecting, and restoring your data using the Trident CSI driver.

Prerequisites

- AWS account
- A Red Hat account
- IAM user with appropriate permissions to create and access ROSA cluster
- AWS CLI
- ROSA CLI
- OpenShift command-line interface (oc)
- Helm 3 documentation
- A HCP ROSA cluster
- Access to Red Hat OpenShift web console

This diagram shows the ROSA cluster deployed in multiple AZs. ROSA cluster’s master nodes, infrastructure nodes are in Red Hat’s VPC, while the worker nodes are in a VPC in the customer’s account . We’ll create an FSx for ONTAP file system within the same VPC and install the Trident driver in the ROSA cluster, allowing all the subnets of this VPC to connect to the file system.



Initial Setup

1. Provision FSx for NetApp ONTAP

Create a multi-AZ FSx for NetApp ONTAP in the same VPC as the ROSA cluster. There are several ways to do this. The details of creating FSxN using a CloudFormation Stack are provided

a.Clone the GitHub repository

```
$ git clone https://github.com/aws-samples/rosa-fsx-netapp-ontap.git
```

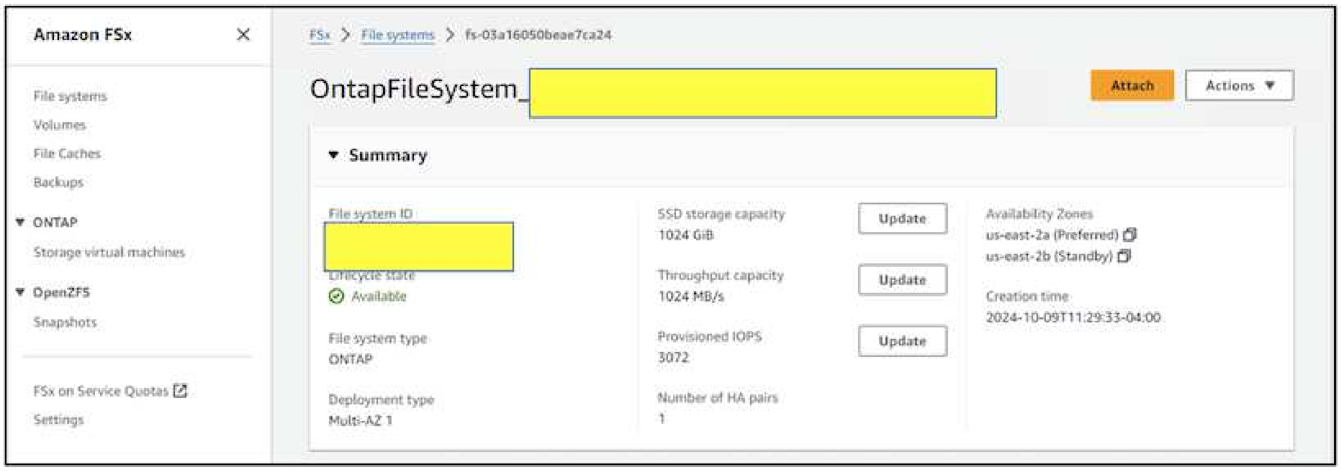
b.Run the CloudFormation Stack

Run the command below by replacing the parameter values with your own values:

```
$ cd rosa-fsx-netapp-ontap/fsx
$ aws cloudformation create-stack \
  --stack-name ROSA-FSXONTAP \
  --template-body file://./FSxONTAP.yaml \
  --region <region-name> \
  --parameters \
  ParameterKey=Subnet1ID,ParameterValue=[subnet1_ID] \
  ParameterKey=Subnet2ID,ParameterValue=[subnet2_ID] \
  ParameterKey=myVpc,ParameterValue=[VPC_ID] \
ParameterKey=FSxONTAPRouteTable,ParameterValue=[routetable1_ID,routetable2
_ID] \
  ParameterKey=FileSystemName,ParameterValue=ROSA-myFSxONTAP \
  ParameterKey=ThroughputCapacity,ParameterValue=1024 \
  ParameterKey=FSxAllowedCIDR,ParameterValue=[your_allowed_CIDR] \
  ParameterKey=FsxAdminPassword,ParameterValue=[Define Admin password] \
  ParameterKey=SvmAdminPassword,ParameterValue=[Define SVM password] \
  --capabilities CAPABILITY_NAMED_IAM
```

Where :
region-name: same as the region where the ROSA cluster is deployed
subnet1_ID : id of the Preferred subnet for FSxN
subnet2_ID: id of the Standby subnet for FSxN
VPC_ID: id of the VPC where the ROSA cluster is deployed
routetable1_ID, routetable2_ID: ids of the route tables associated with the subnets chosen above
your_allowed_CIDR: allowed CIDR range for the FSx for ONTAP security groups ingress rules to control access. You can use 0.0.0.0/0 or any appropriate CIDR to allow all
traffic to access the specific ports of FSx for ONTAP.
Define Admin password: A password to login to FSxN
Define SVM password: A password to login to SVM that will be created.

Verify that your file system and storage virtual machine (SVM) has been created using the Amazon FSx console, shown below:



OntapFileSystem_[redacted]

File system ID
[redacted]
Available

File system type
ONTAP

Deployment type
Multi-AZ 1

SSD storage capacity
1024 GiB

Throughput capacity
1024 MB/s

Provisioned IOPS
3072

Number of HA pairs
1

Availability Zones
us-east-2a (Preferred)
us-east-2b (Standby)

Creation time
2024-10-09T11:29:33-04:00

2.Install and configure Trident CSI driver for the ROSA cluster

b.Install Trident

ROSA cluster worker nodes come pre-configured with nfs tools that enable you to use NAS protocols for storage provisioning and access.

If you would like to use iSCSI instead, you need to prepare the worker nodes for iSCSI. Starting from Trident 25.02 release, you can easily prepare the worker nodes of the ROSA cluster(or any OpenShift cluster) to perform iSCSI operations on FSxN storage.
There are 2 easy ways of installing Trident 25.02 (or later) that automates worker node preparation for iSCSI.
1. using the node-prep-flag from the command line using tridentctl tool.
2. Using the Red Hat certified Trident operator from the operator hub and customizing it.
3.Using Helm.

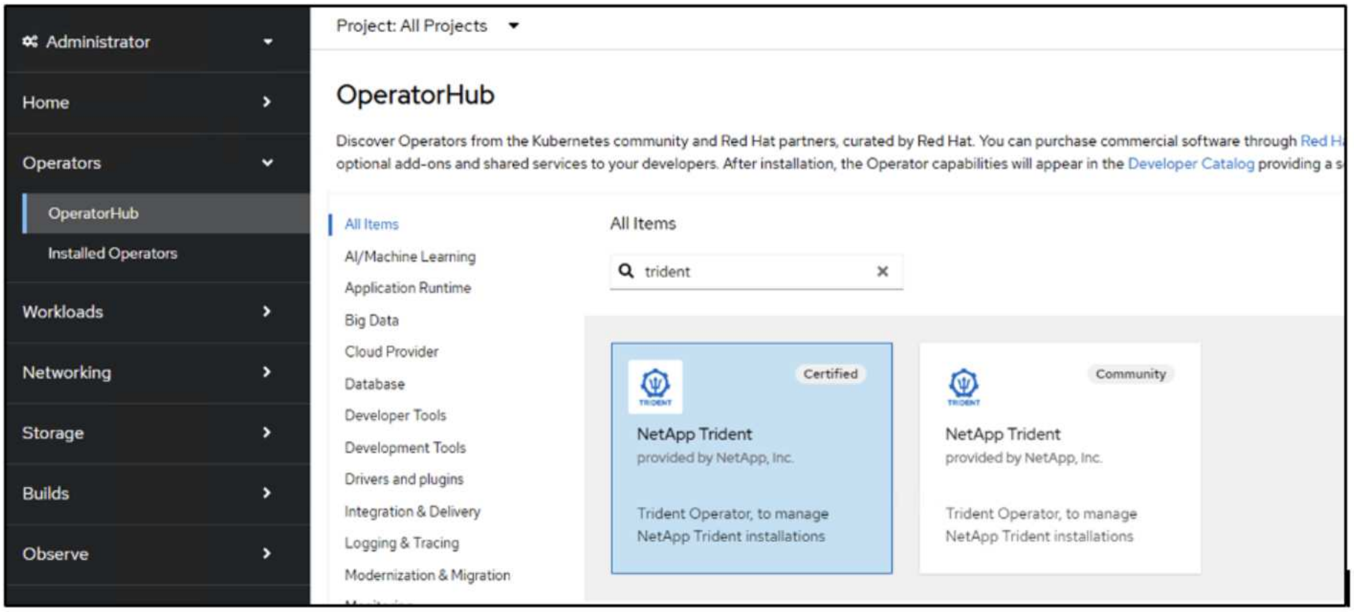
> Using any of the above methods without enabling the node-prep will allow you to only use NAS protocols for provisioning storage on FSxN.

Method 1: Use tridentctl tool

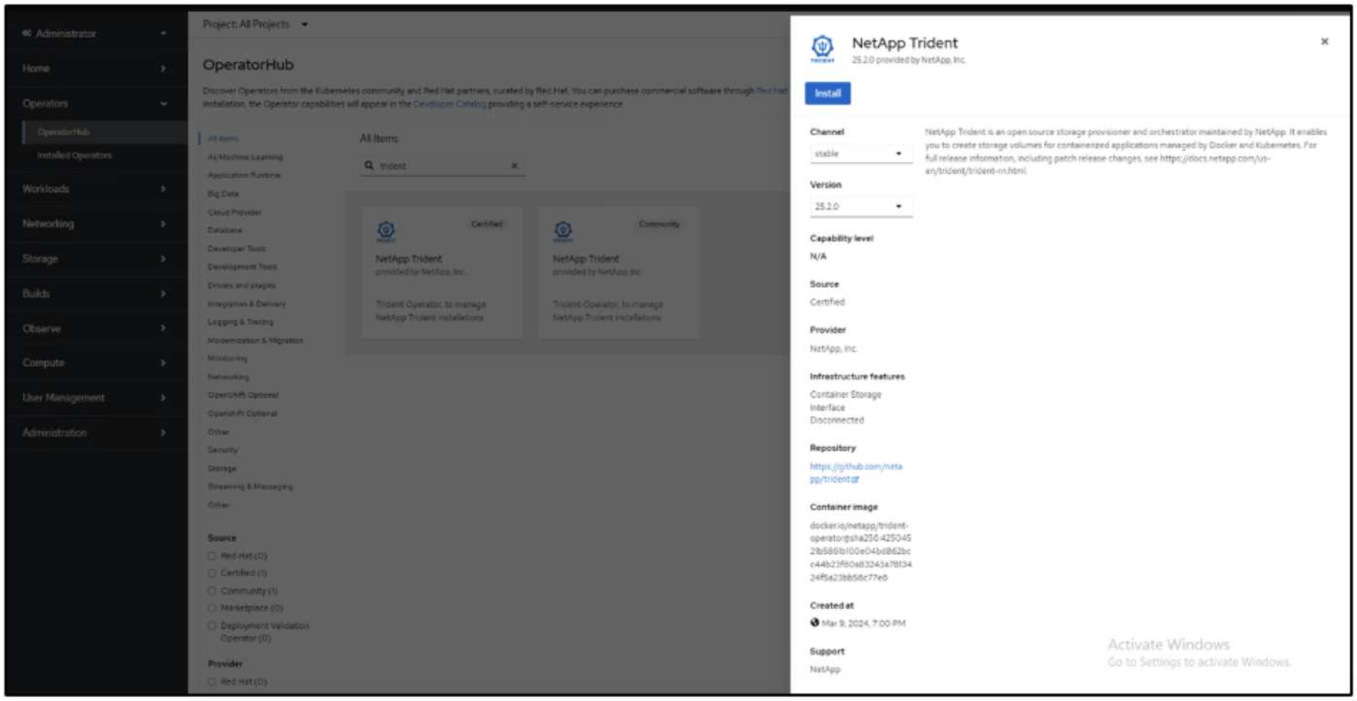
Use the node-prep flag and install Trident as shown.
Prior to issuing the install command, you should have downloaded installer package. Refer to the documentation here.

```
#./tridentctl install trident -n trident --node-prep=iscsi
```

Method 2: Use the Red Hat Certified Trident Operator and customize
From the OperatorHub, locate the Red Hat certified Trident operator and install it.



Discover Operators from the Kubernetes community and Red Hat partners, curated by Red Hat. You can purchase commercial software through Red H
optional add-ons and shared services to your developers. After installation, the Operator capabilities will appear in the Developer Catalog providing a s



Project: All Projects

OperatorHub

Discover Operators from the Kubernetes community and Red Hat partners, curated by Red Hat. You can purchase commercial software through Red Hat … installation, the Operator capabilities will appear in the Developer Catalog providing a self-service experience.

Source

- ☐ Red Hat (0)
- ☐ Certified (1)
- ☐ Community (1)
- ☐ Marketplace (0)
- ☐ Deployment Validation Operator (0)

Provider

- ☐ Red Hat (0)

All Items

trident ×

NetApp Trident (Certified)
provided by NetApp, Inc.
Trident Operator, to manage NetApp Trident installations

NetApp Trident (Community)
provided by NetApp, Inc.
Trident Operator, to manage NetApp Trident installations

NetApp Trident
25.2.0 provided by NetApp, Inc.

NetApp Trident is an open source storage provisioner and orchestrator maintained by NetApp. It enables you to create storage volumes for containerized applications managed by Docker and Kubernetes. For full release information, including patch release changes, see https://docs.netapp.com/us-en/trident/trident-rn.html.

Channel
stable

Version
25.2.0

Capability level
N/A

Source
Certified

Provider
NetApp, Inc.

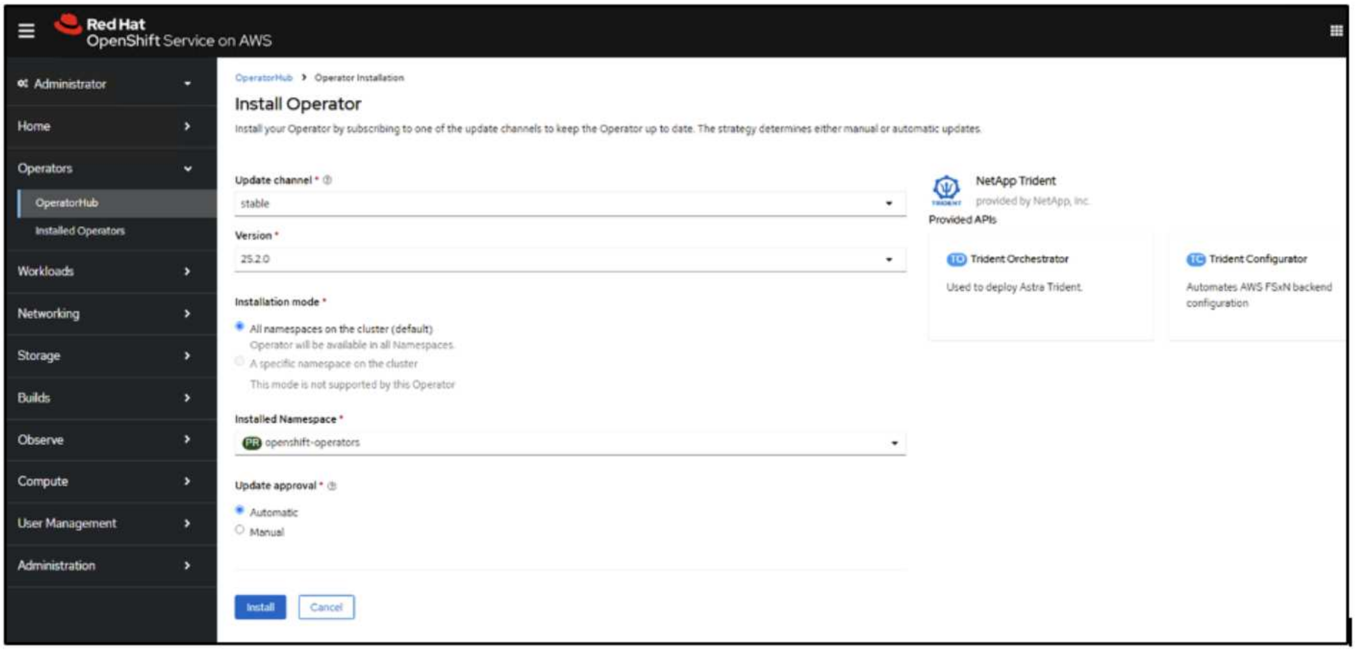
Infrastructure features
Container Storage Interface
Disconnected

Repository
https://github.com/netapp/trident

Container image
docker.io/netapp/trident-operator@sha256:4250452fb586b100e04bd862bcc44b23f60a83243a78134 24f5a23bb56c77e6

Created at
Mar 9, 2024, 7:00 PM

Support
NetApp



OperatorHub > Operator Installation

Install Operator

Install your Operator by subscribing to one of the update channels to keep the Operator up to date. The strategy determines either manual or automatic updates.

Update channel *
stable

Version *
25.2.0

Installation mode *
- ● All namespaces on the cluster (default)
  Operator will be available in all Namespaces.
- ○ A specific namespace on the cluster
  This mode is not supported by this Operator

Installed Namespace *
PR openshift-operators

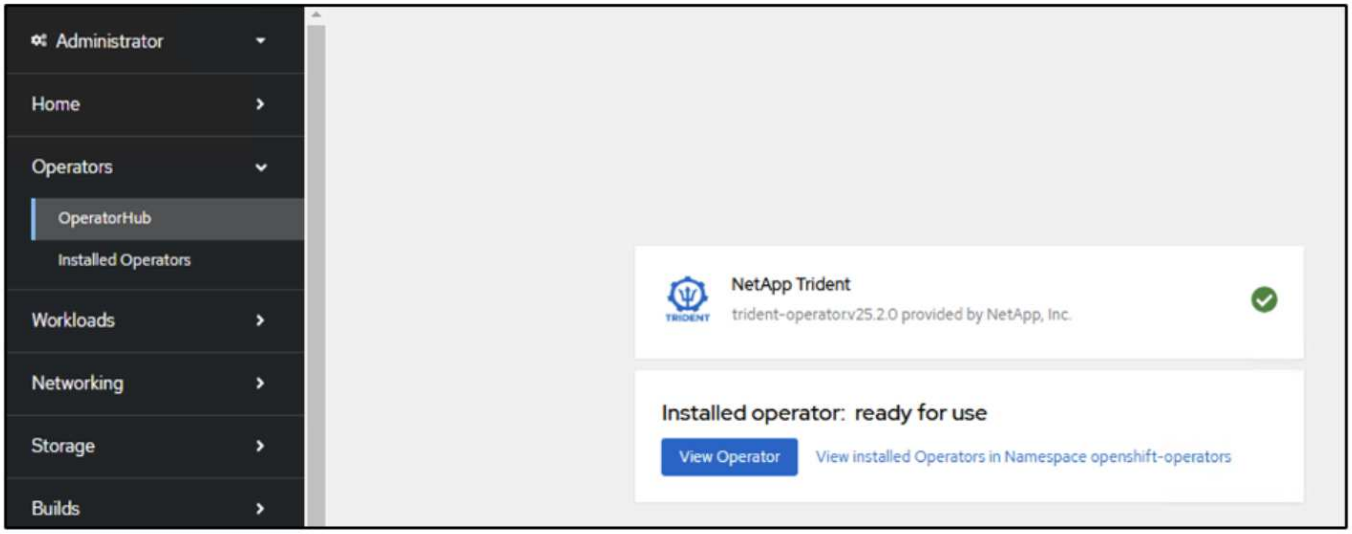
Update approval *
- ● Automatic
- ○ Manual

NetApp Trident
provided by NetApp, Inc.

Provided APIs

TO Trident Orchestrator
Used to deploy Astra Trident.

TC Trident Configurator
Automates AWS FSxN backend configuration

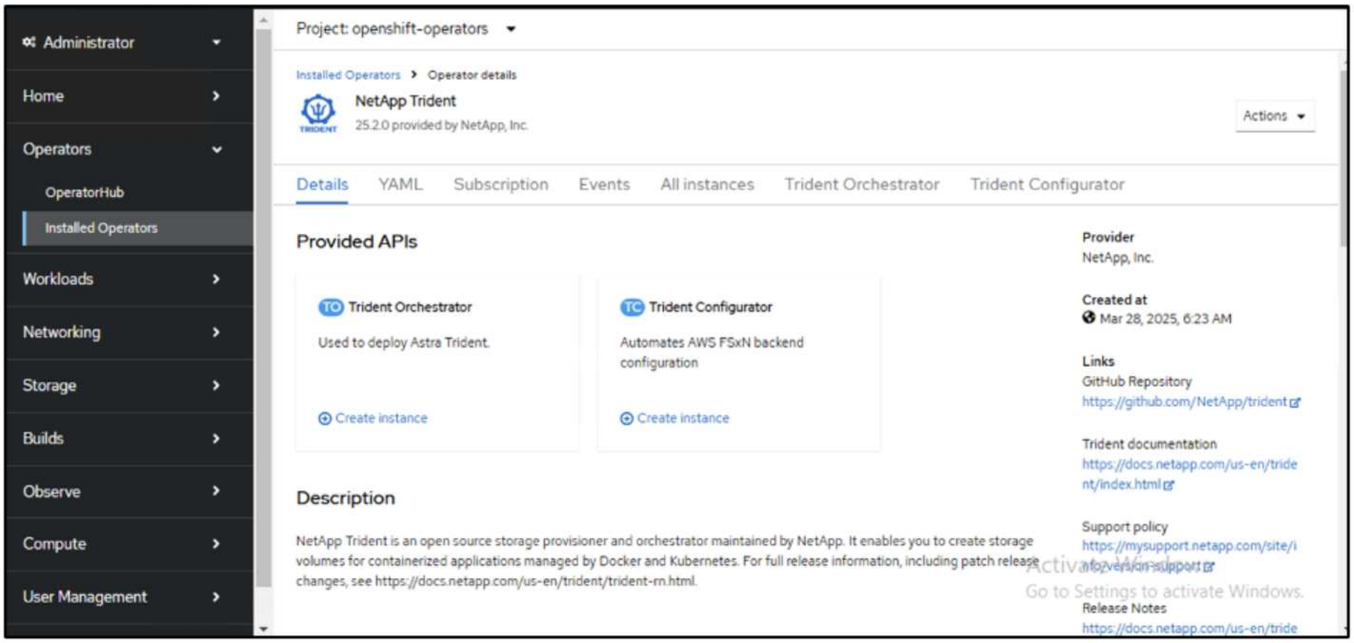


NetApp Trident

trident-operator.v25.2.0 provided by NetApp, Inc.

Installed operator: ready for use

Next, create the Trident Orchestrator instance. Use the YAML view to set any custom values or enable iscsi node prep during installation.



NetApp Trident

25.2.0 provided by NetApp, Inc.

Provided APIs

Trident Orchestrator

Used to deploy Astra Trident.

Trident Configurator

Automates AWS FSxN backend configuration

Description

NetApp Trident is an open source storage provisioner and orchestrator maintained by NetApp. It enables you to create storage volumes for containerized applications managed by Docker and Kubernetes. For full release information, including patch release changes, see https://docs.netapp.com/us-en/trident/trident-rn.html.

Provider
NetApp, Inc.

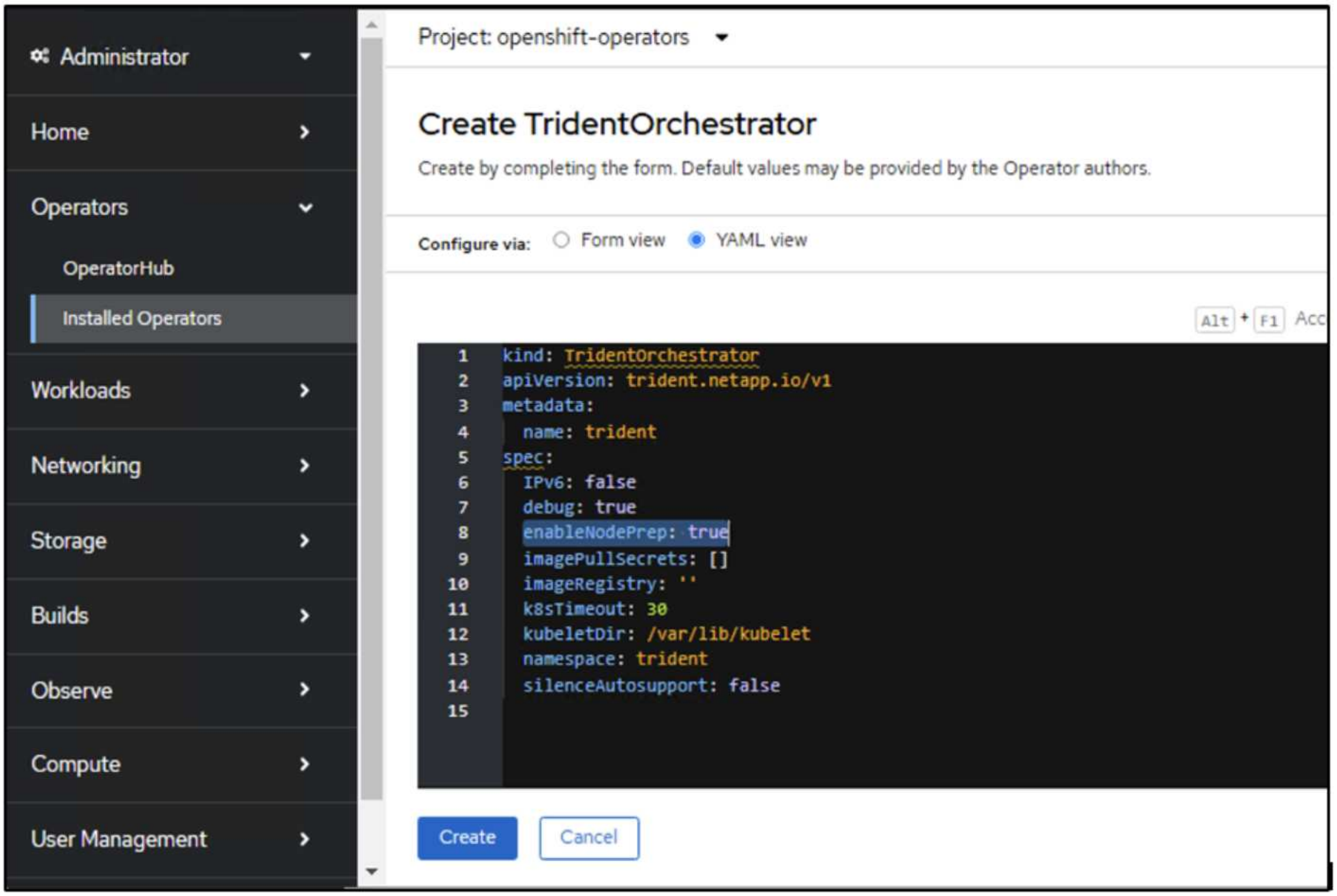
Created at
Mar 28, 2025, 6:23 AM

Links
GitHub Repository
https://github.com/NetApp/trident

Trident documentation
https://docs.netapp.com/us-en/trident/index.html

Support policy
https://mysupport.netapp.com/site/info/version-support

Release Notes
https://docs.netapp.com/us-en/tride

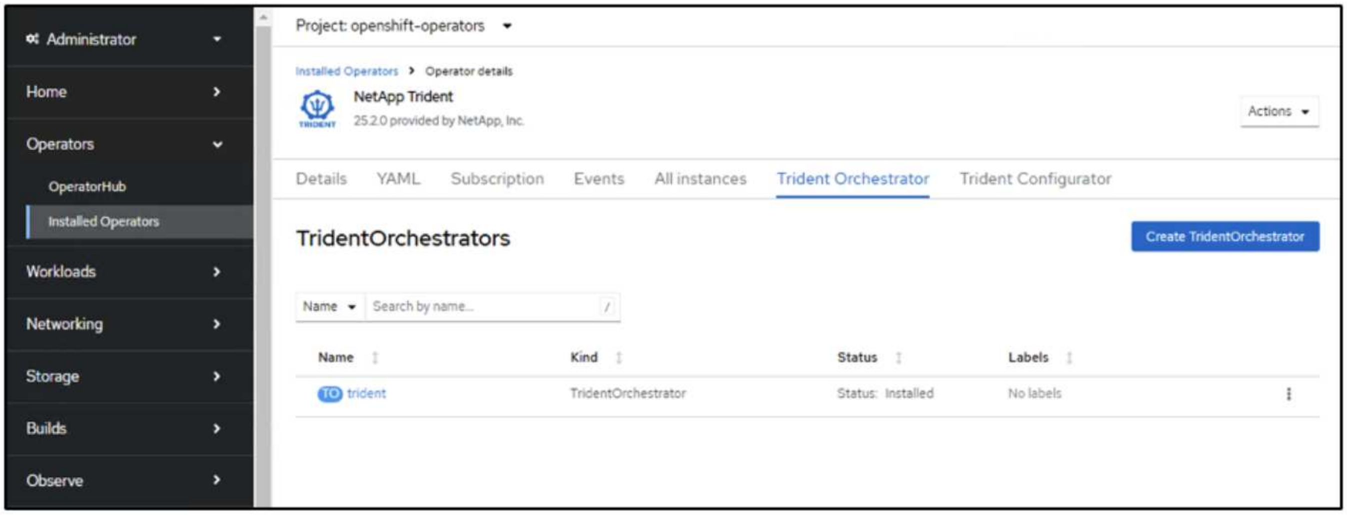


Create TridentOrchestrator

Create by completing the form. Default values may be provided by the Operator authors.

Configure via: ○ Form view ● YAML view

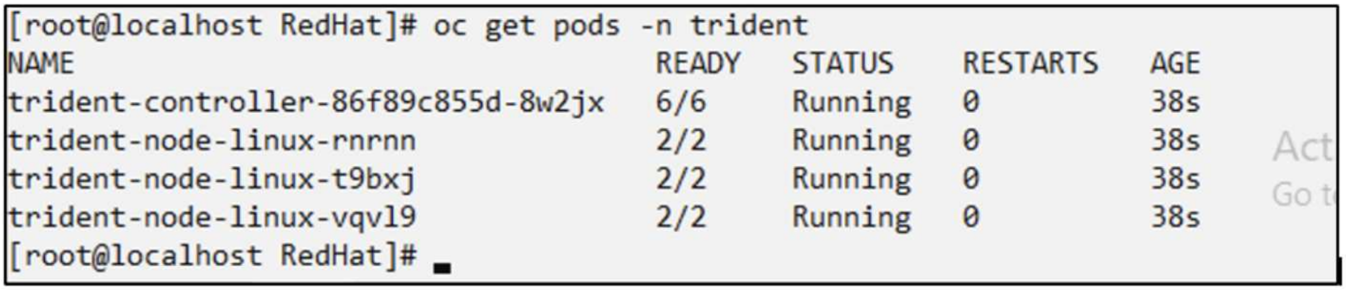
```
kind: TridentOrchestrator
apiVersion: trident.netapp.io/v1
metadata:
  name: trident
spec:
  IPv6: false
  debug: true
  enableNodePrep: true
  imagePullSecrets: []
  imageRegistry: ''
  k8sTimeout: 30
  kubeletDir: /var/lib/kubelet
  namespace: trident
  silenceAutosupport: false

```



NetApp Trident
25.2.0 provided by NetApp, Inc.

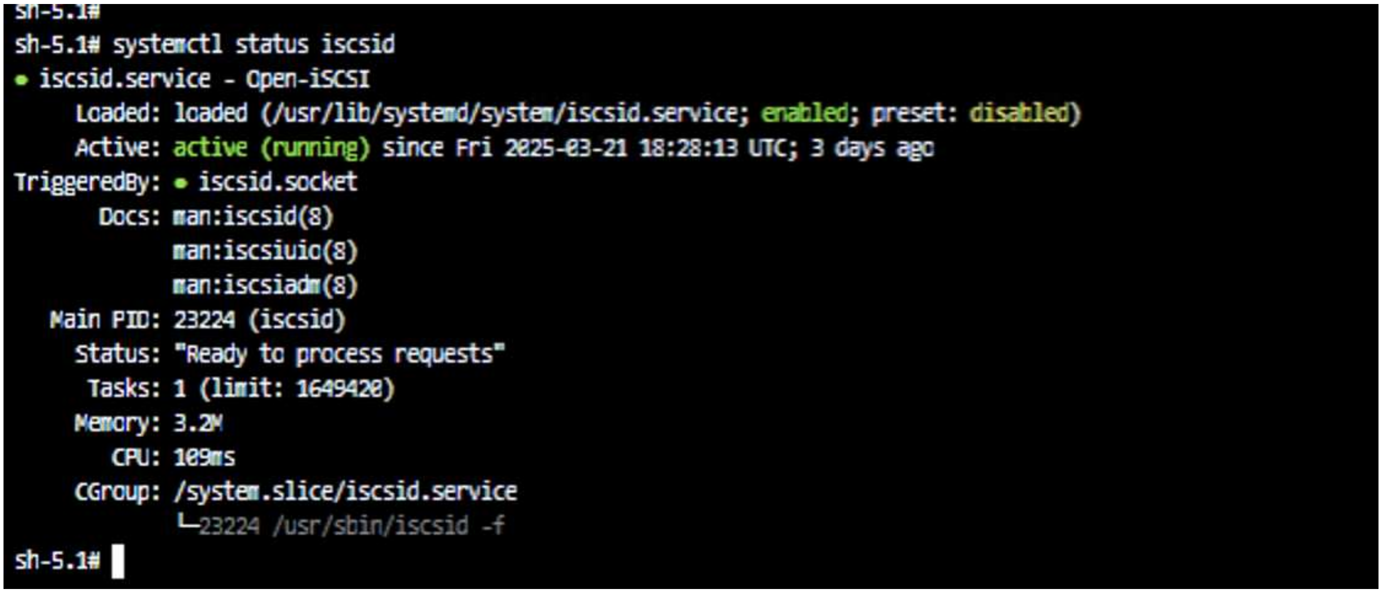
TridentOrchestrators

Name	Kind	Status	Labels
TO trident	TridentOrchestrator	Status: Installed	No labels

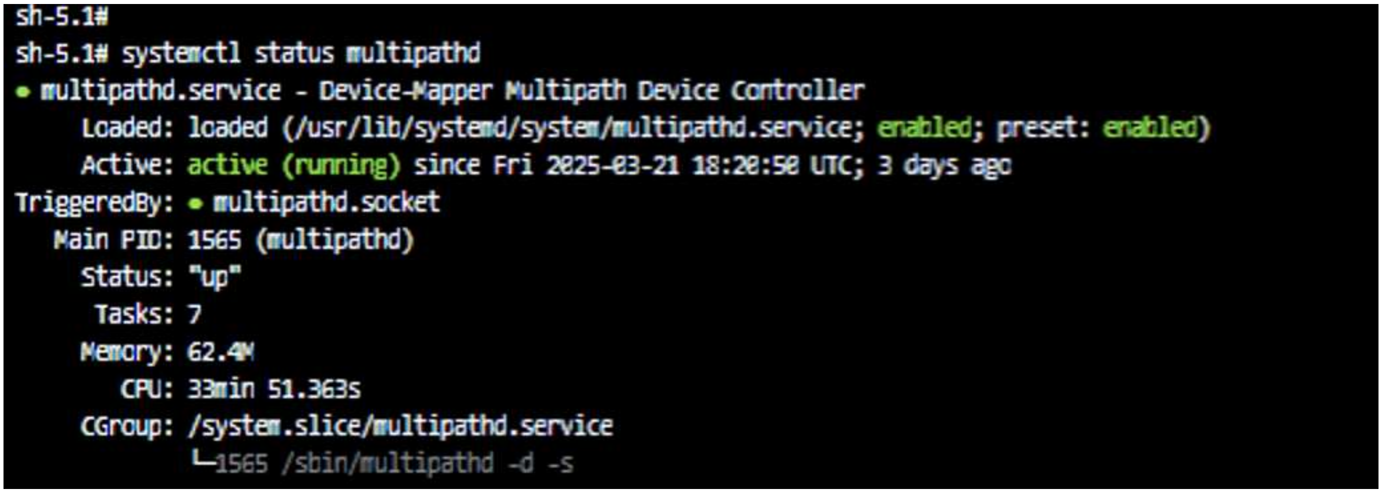


```
[root@localhost RedHat]# oc get pods -n trident
NAME                              READY   STATUS    RESTARTS   AGE
trident-controller-86f89c855d-8w2jx   6/6     Running   0          38s
trident-node-linux-rnrnn          2/2     Running   0          38s
trident-node-linux-t9bxj          2/2     Running   0          38s
trident-node-linux-vqvl9          2/2     Running   0          38s
[root@localhost RedHat]# _
```

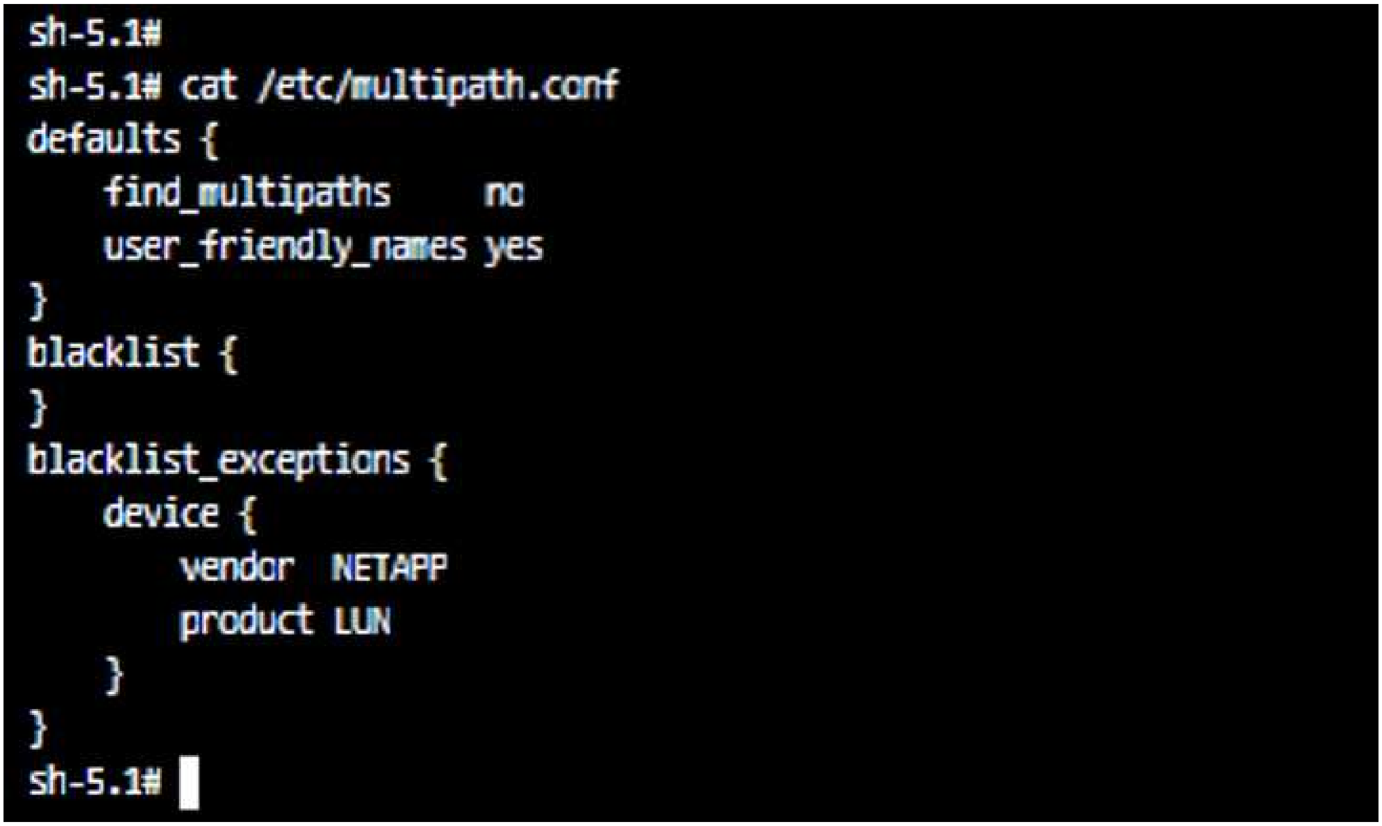
Installing Trident using any of the above methods will prepare the ROSA cluster worker nodes for iSCSI by starting the iscsid and multipathd services and setting the following in /etc/multipath.conf file



```
sh-5.1#
sh-5.1# systemctl status iscsid
● iscsid.service - Open-iSCSI
     Loaded: loaded (/usr/lib/systemd/system/iscsid.service; enabled; preset: disabled)
     Active: active (running) since Fri 2025-03-21 18:28:13 UTC; 3 days ago
TriggeredBy: ● iscsid.socket
       Docs: man:iscsid(8)
             man:iscsiuio(8)
             man:iscsiadm(8)
   Main PID: 23224 (iscsid)
     Status: "Ready to process requests"
      Tasks: 1 (limit: 1649420)
     Memory: 3.2M
        CPU: 109ms
     CGroup: /system.slice/iscsid.service
             └─23224 /usr/sbin/iscsid -f
sh-5.1# █
```

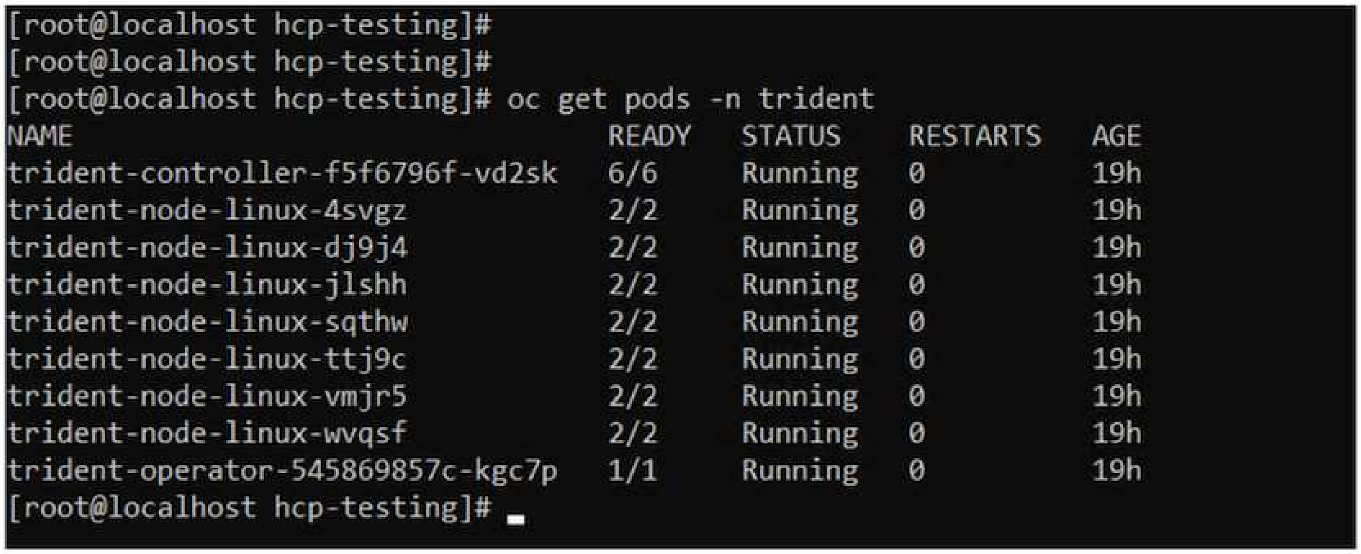


```
sh-5.1#
sh-5.1# systemctl status multipathd
● multipathd.service - Device-Mapper Multipath Device Controller
     Loaded: loaded (/usr/lib/systemd/system/multipathd.service; enabled; preset: enabled)
     Active: active (running) since Fri 2025-03-21 18:20:50 UTC; 3 days ago
TriggeredBy: ● multipathd.socket
   Main PID: 1565 (multipathd)
     Status: "up"
      Tasks: 7
     Memory: 62.4M
        CPU: 33min 51.363s
     CGroup: /system.slice/multipathd.service
             └─1565 /sbin/multipathd -d -s
```



```
sh-5.1#
sh-5.1# cat /etc/multipath.conf
defaults {
    find_multipaths     no
    user_friendly_names yes
}
blacklist {
}
blacklist_exceptions {
    device {
        vendor  NETAPP
        product LUN
    }
}
sh-5.1#
```

c.Verify that all Trident pods are in the running state



```
[root@localhost hcp-testing]#
[root@localhost hcp-testing]#
[root@localhost hcp-testing]# oc get pods -n trident
NAME                                READY   STATUS    RESTARTS   AGE
trident-controller-f5f6796f-vd2sk   6/6     Running   0          19h
trident-node-linux-4svgz            2/2     Running   0          19h
trident-node-linux-dj9j4            2/2     Running   0          19h
trident-node-linux-jlshh            2/2     Running   0          19h
trident-node-linux-sqthw            2/2     Running   0          19h
trident-node-linux-ttj9c            2/2     Running   0          19h
trident-node-linux-vmjr5            2/2     Running   0          19h
trident-node-linux-wvqsf            2/2     Running   0          19h
trident-operator-545869857c-kgc7p   1/1     Running   0          19h
[root@localhost hcp-testing]#
```

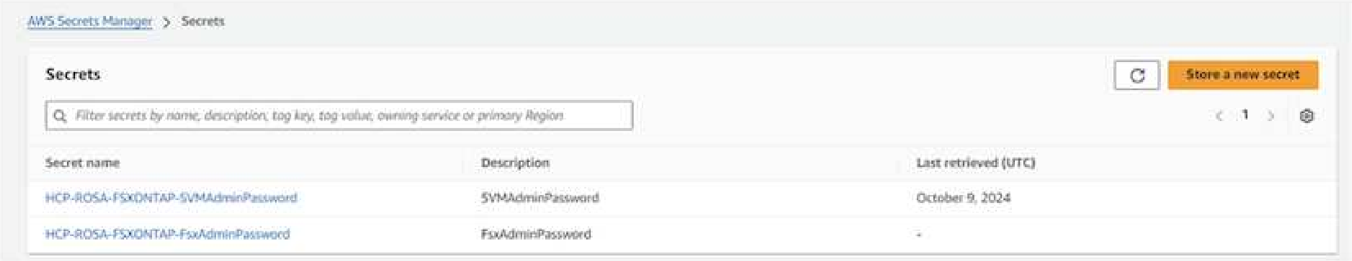
3. Configure the Trident CSI backend to use FSx for ONTAP (ONTAP NAS)

The Trident back-end configuration tells Trident how to communicate with the storage system (in this case, FSx for ONTAP). For creating the backend, we will provide the credentials of the Storage Virtual machine to connect to, along with the Cluster Management and the NFS data interfaces. We will use the ontap-nas driver to provision storage volumes in FSx file system.

a. First, create a secret for the SVM credentials using the following yaml

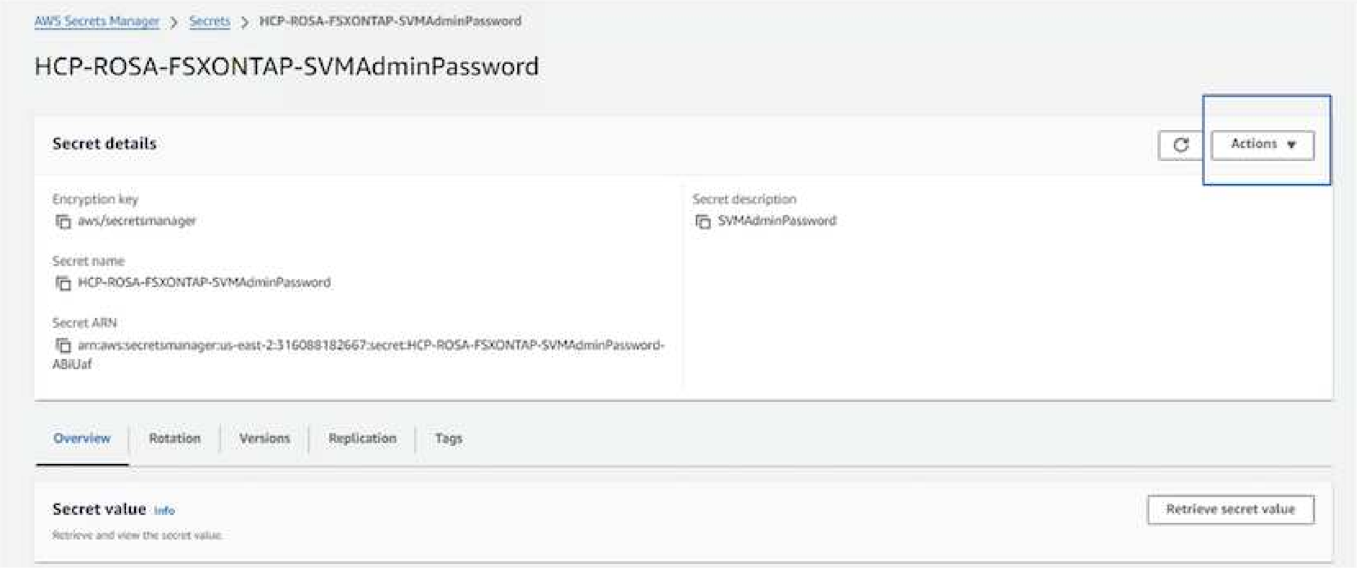
```
apiVersion: v1
kind: Secret
metadata:
  name: backend-fsx-ontap-nas-secret
  namespace: trident
type: Opaque
stringData:
  username: vsadmin
  password: <value provided for Define SVM password as a parameter to the
Cloud Formation Stack>
```

You can also retrieve the SVM password created for FSxN from the AWS Secrets Manager as shown below.


AWS Secrets Manager > Secrets
Store a new secret
Filter secrets by name, description, tag key, tag value, owning service or primary Region
1

Secrets

Secret name	Description	Last retrieved (UTC)
HCP-ROSA-FSXONTAP-SVMAdminPassword	SVMAdminPassword	October 9, 2024
HCP-ROSA-FSXONTAP-FsxAdminPassword	FsxAdminPassword	-



HCP-ROSA-FSXONTAP-SVMAdminPassword

Secret details

Encryption key
aws/secretsmanager

Secret name
HCP-ROSA-FSXONTAP-SVMAdminPassword

Secret ARN
arn:aws:secretsmanager:us-east-2:316088182667:secret:HCP-ROSA-FSXONTAP-SVMAdminPassword-ABiUaf

Secret description
SVMAdminPassword

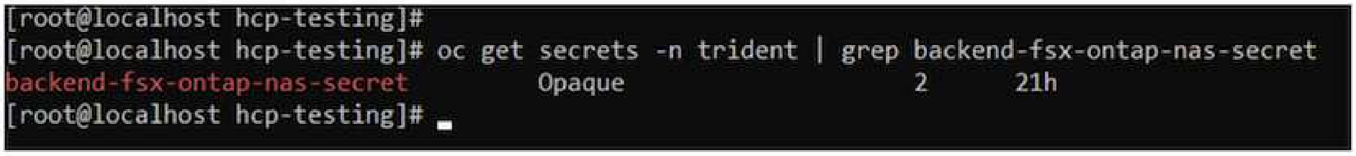
Secret value
Retrieve and view the secret value.

b.Next, add the secret for the SVM credentials to the ROSA cluster using the following command

```
$ oc apply -f svm_secret.yaml
```

You can verify that the secret has been added in the trident namespace using the following command

```
$ oc get secrets -n trident |grep backend-fsx-ontap-nas-secret
```



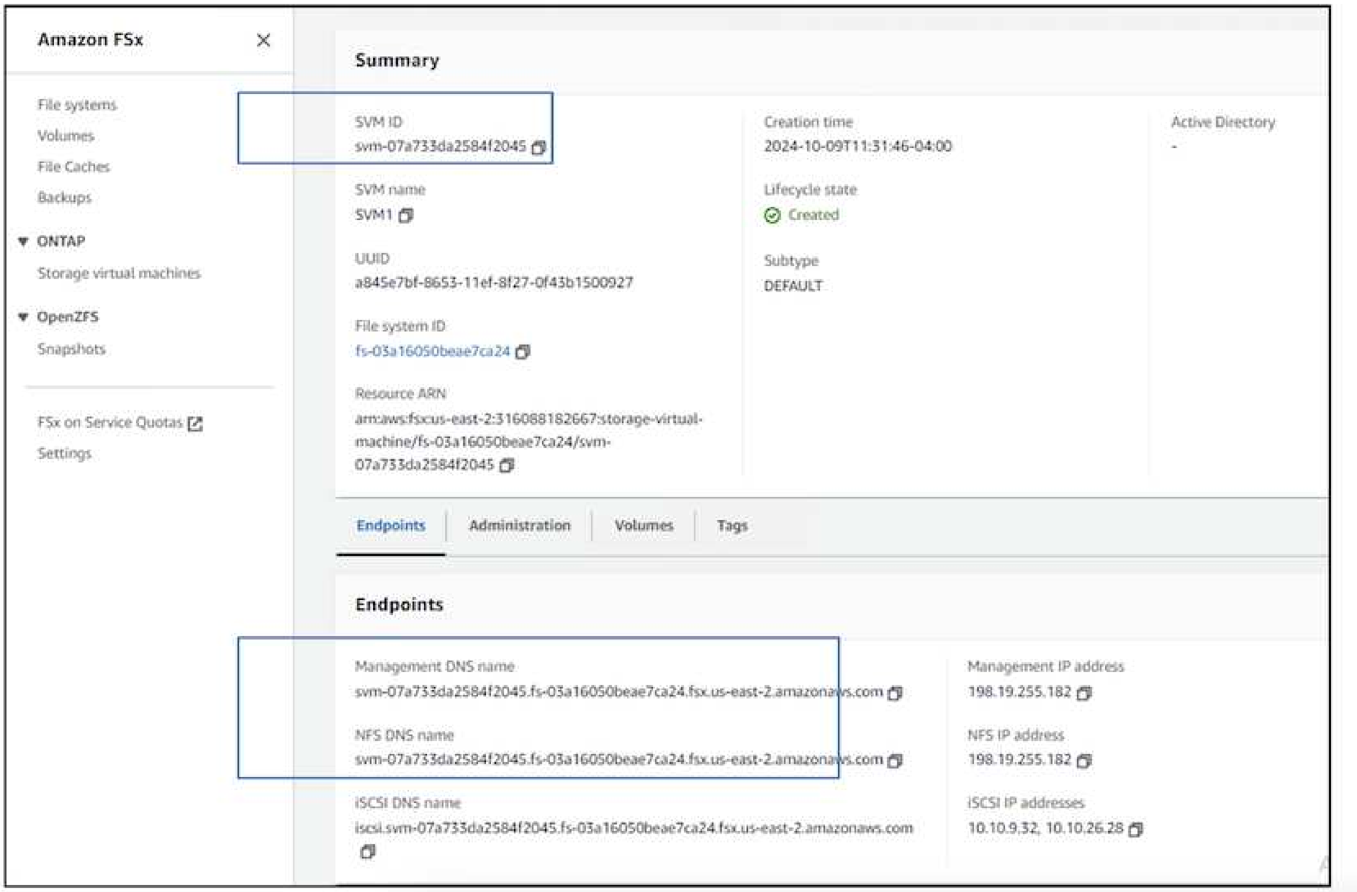
```
[root@localhost hcp-testing]#
[root@localhost hcp-testing]# oc get secrets -n trident | grep backend-fsx-ontap-nas-secret
backend-fsx-ontap-nas-secret        Opaque                      2      21h
[root@localhost hcp-testing]# _
```

c. Next, create the backend object
For this, move into the **fsx** directory of your cloned Git repository. Open the file backend-ontap-nas.yaml.
Replace the following:
managementLIF with the Management DNS name
dataLIF with the NFS DNS name of the Amazon FSx SVM and
svm with the SVM name. Create the backend object using the following command.

Create the backend object using the following command.

```
$ oc apply -f backend-ontap-nas.yaml
```

ⓘ You can get the Management DNS name, NFS DNS name and the SVM name from the Amazon FSx Console as shown in the screenshot below



Summary

SVM ID
svm-07a733da2584f2045

SVM name
SVM1

UUID
a845e7bf-8653-11ef-8f27-0f43b1500927

File system ID
fs-03a16050beae7ca24

Resource ARN
arn:aws:fsx:us-east-2:316088182667:storage-virtual-machine/fs-03a16050beae7ca24/svm-07a733da2584f2045

Creation time
2024-10-09T11:31:46-04:00

Lifecycle state
Created

Subtype
DEFAULT

Active Directory
-

Endpoints

Management DNS name
svm-07a733da2584f2045.fs-03a16050beae7ca24.fsx.us-east-2.amazonaws.com

NFS DNS name
svm-07a733da2584f2045.fs-03a16050beae7ca24.fsx.us-east-2.amazonaws.com

iSCSI DNS name
iscsi.svm-07a733da2584f2045.fs-03a16050beae7ca24.fsx.us-east-2.amazonaws.com

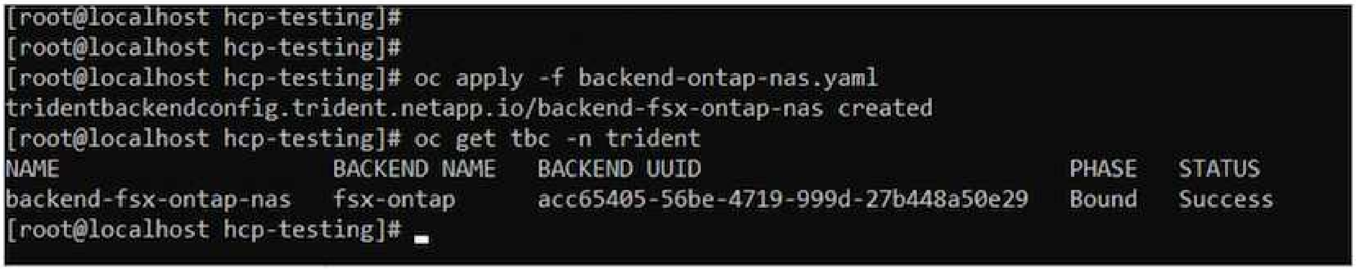
Management IP address
198.19.255.182

NFS IP address
198.19.255.182

iSCSI IP addresses
10.10.9.32, 10.10.26.28

d. Now, run the following command to verify that the backend object has been created and Phase is

showing Bound and Status is Success



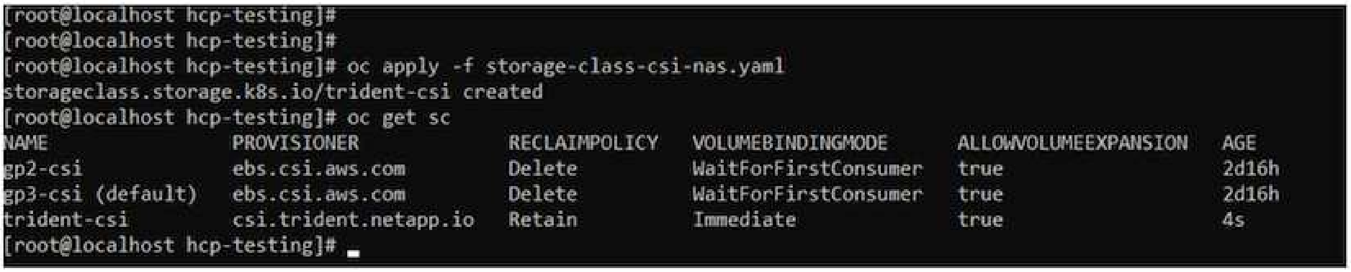
```
[root@localhost hcp-testing]#
[root@localhost hcp-testing]#
[root@localhost hcp-testing]# oc apply -f backend-ontap-nas.yaml
tridentbackendconfig.trident.netapp.io/backend-fsx-ontap-nas created
[root@localhost hcp-testing]# oc get tbc -n trident
NAME                    BACKEND NAME   BACKEND UUID                           PHASE   STATUS
backend-fsx-ontap-nas   fsx-ontap      acc65405-56be-4719-999d-27b448a50e29   Bound   Success
[root@localhost hcp-testing]#
```

4. Create Storage Class
Now that the Trident backend is configured, you can create a Kubernetes storage class to use the backend. Storage class is a resource object made available to the cluster. It describes and classifies the type of storage that you can request for an application.

a. Review the file storage-class-csi-nas.yaml in the fsx folder.

```
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  name: trident-csi
provisioner: csi.trident.netapp.io
parameters:
  backendType: "ontap-nas"
  fsType: "ext4"
allowVolumeExpansion: True
reclaimPolicy: Retain
```

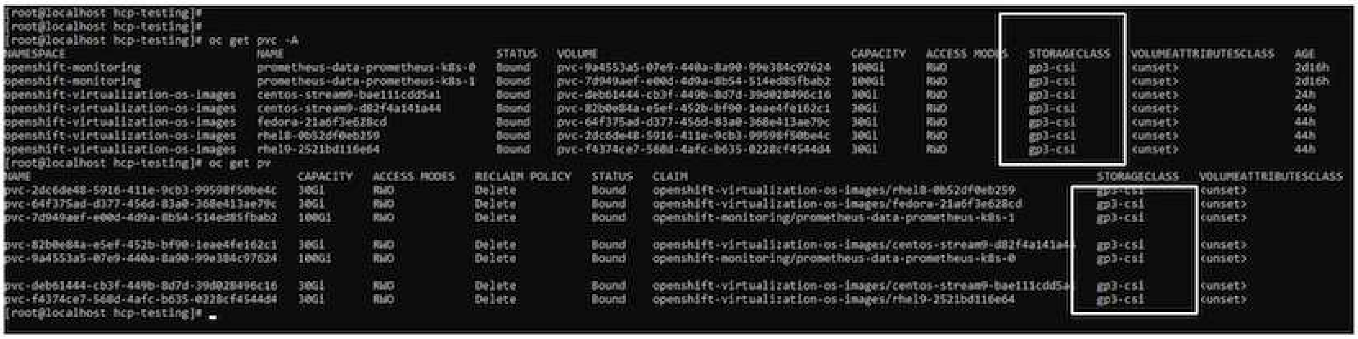
b. Create Storage Class in ROSA cluster and verify that trident-csi storage class has been created.



```
[root@localhost hcp-testing]#
[root@localhost hcp-testing]#
[root@localhost hcp-testing]# oc apply -f storage-class-csi-nas.yaml
storageclass.storage.k8s.io/trident-csi created
[root@localhost hcp-testing]# oc get sc
NAME                PROVISIONER             RECLAIMPOLICY   VOLUMEBINDINGMODE      ALLOWVOLUMEEXPANSION   AGE
gp2-csi             ebs.csi.aws.com         Delete          WaitForFirstConsumer   true                   2d16h
gp3-csi (default)   ebs.csi.aws.com         Delete          WaitForFirstConsumer   true                   2d16h
trident-csi         csi.trident.netapp.io   Retain          Immediate              true                   4s
[root@localhost hcp-testing]#
```

This completes the installation of Trident CSI driver and its connectivity to FSx for ONTAP file system. Now you can deploy a sample Postgresql stateful application on ROSA using file volumes on FSx for ONTAP.

c. Verify that there are no PVCs and PVs created using the trident-csi storage class.



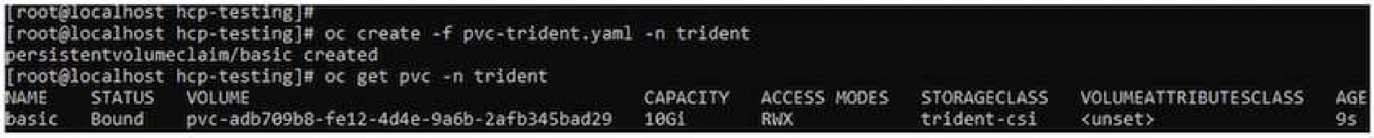
```
[root@localhost hcp-testing]#
[root@localhost hcp-testing]#
[root@localhost hcp-testing]# oc get pvc -A
NAMESPACE                           NAME                                STATUS   VOLUME                                     CAPACITY   ACCESS MODES   STORAGECLASS   VOLUMEATTRIBUTESCLASS   AGE
openshift-monitoring                prometheus-data-prometheus-k8s-0    Bound    pvc-9a4553a5-07e9-440a-8a90-99e384c97624   100Gi      RWO            gp3-csi        <unset>                 2d16h
openshift-monitoring                prometheus-data-prometheus-k8s-1    Bound    pvc-7d949aef-e00d-4d9a-8b54-514ed85fbab2   100Gi      RWO            gp3-csi        <unset>                 2d16h
openshift-virtualization-os-images  centos-stream9-bae111cdd5a1         Bound    pvc-deb61444-cb3f-449b-8d7d-39d028496c16   30Gi       RWO            gp3-csi        <unset>                 24h
openshift-virtualization-os-images  centos-stream9-d82f4a141a44         Bound    pvc-82b0e84a-e5ef-452b-bf90-1eae4fe162c1   30Gi       RWO            gp3-csi        <unset>                 44h
openshift-virtualization-os-images  fedora-21a6f3e628cd                 Bound    pvc-64f375ad-d377-456d-83a0-368e413ae79c   30Gi       RWO            gp3-csi        <unset>                 44h
openshift-virtualization-os-images  rhel8-0b52df0eb259                  Bound    pvc-2dc6de48-5916-411e-9cb3-99598f50be4c   30Gi       RWO            gp3-csi        <unset>                 44h
openshift-virtualization-os-images  rhel9-2521bd116e64                  Bound    pvc-f4374ce7-560d-4afc-b635-0228cf4544d4   30Gi       RWO            gp3-csi        <unset>                 44h
[root@localhost hcp-testing]# oc get pv
NAME                                       CAPACITY   ACCESS MODES   RECLAIM POLICY   STATUS   CLAIM                                                           STORAGECLASS   VOLUMEATTRIBUTESCLASS
pvc-2dc6de48-5916-411e-9cb3-99598f50be4c   30Gi       RWO            Delete           Bound    openshift-virtualization-os-images/rhel8-0b52df0eb259          gp3-csi        <unset>
pvc-64f375ad-d377-456d-83a0-368e413ae79c   30Gi       RWO            Delete           Bound    openshift-virtualization-os-images/fedora-21a6f3e628cd         gp3-csi        <unset>
pvc-7d949aef-e00d-4d9a-8b54-514ed85fbab2   100Gi      RWO            Delete           Bound    openshift-monitoring/prometheus-data-prometheus-k8s-1          gp3-csi        <unset>

pvc-82b0e84a-e5ef-452b-bf90-1eae4fe162c1   30Gi       RWO            Delete           Bound    openshift-virtualization-os-images/centos-stream9-d82f4a141a44 gp3-csi        <unset>
pvc-9a4553a5-07e9-440a-8a90-99e384c97624   100Gi      RWO            Delete           Bound    openshift-monitoring/prometheus-data-prometheus-k8s-0          gp3-csi        <unset>

pvc-deb61444-cb3f-449b-8d7d-39d028496c16   30Gi       RWO            Delete           Bound    openshift-virtualization-os-images/centos-stream9-bae111cdd5a  gp3-csi        <unset>
pvc-f4374ce7-560d-4afc-b635-0228cf4544d4   30Gi       RWO            Delete           Bound    openshift-virtualization-os-images/rhel9-2521bd116e64          gp3-csi        <unset>
[root@localhost hcp-testing]# _
```

d. Verify that applications can create PV using Trident CSI.

Create a PVC using the pvc-trident.yaml file provided in the **fsx** folder.

```
pvc-trident.yaml
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: basic
spec:
  accessModes:
    - ReadWriteMany
  resources:
    requests:
      storage: 10Gi
  storageClassName: trident-csi
```

```
You can issue the following commands to create a pvc and verify that it
has been created.
```



```
[root@localhost hcp-testing]#
[root@localhost hcp-testing]# oc create -f pvc-trident.yaml -n trident
persistentvolumeclaim/basic created
[root@localhost hcp-testing]# oc get pvc -n trident
NAME    STATUS   VOLUME                                     CAPACITY   ACCESS MODES   STORAGECLASS   VOLUMEATTRIBUTESCLASS   AGE
basic   Bound    pvc-adb709b8-fe12-4d4e-9a6b-2afb345bad29   10Gi       RWX            trident-csi    <unset>                 9s
```

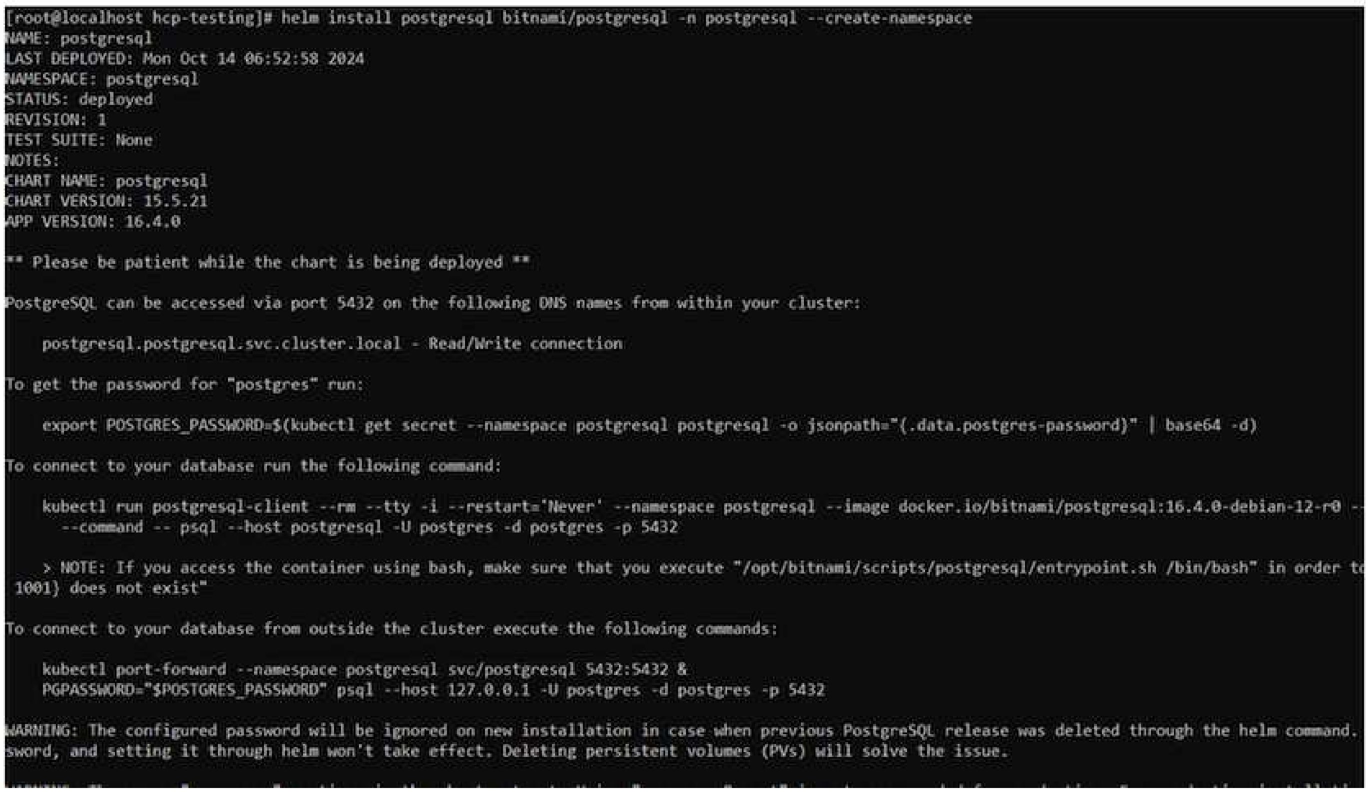
ⓘ To use iSCSI, you should have enabled iSCSI on the worker nodes as shown previously and you need to create an iSCSI backend and storage class. Here are some sample yaml files.

```
cat tbc.yaml
apiVersion: v1
kind: Secret
metadata:
  name: backend-tbc-ontap-san-secret
type: Opaque
stringData:
  username: fsxadmin
  password: <password for the fsxN filesystem>
---
apiVersion: trident.netapp.io/v1
kind: TridentBackendConfig
metadata:
  name: backend-tbc-ontap-san
spec:
  version: 1
  storageDriverName: ontap-san
  managementLIF: <management lif of fsxN filesystem>
  backendName: backend-tbc-ontap-san
  svm: svm_FSxNForROSAiSCSI
  credentials:
    name: backend-tbc-ontap-san-secret

cat sc.yaml
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  name: trident-csi
provisioner: csi.trident.netapp.io
parameters:
  backendType: "ontap-san"
  media: "ssd"
  provisioningType: "thin"
  snapshots: "true"
allowVolumeExpansion: true
```

5. Deploy a sample Postgresql stateful application

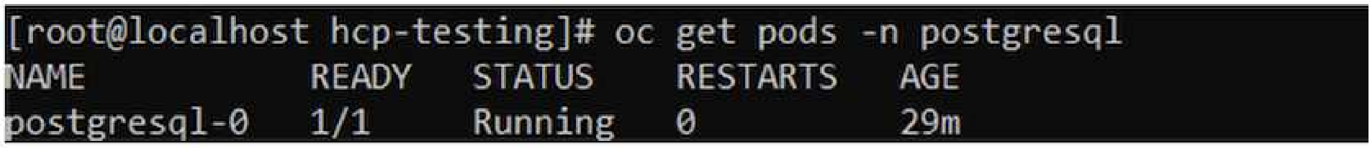
a. Use helm to install postgresql

```
$ helm install postgresql bitnami/postgresql -n postgresql --create
-namespace
```

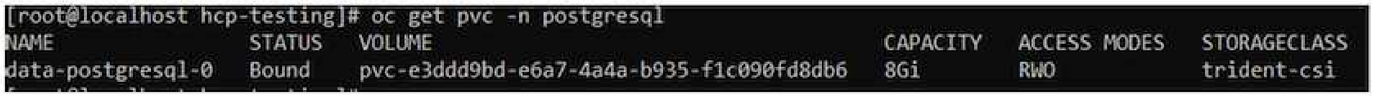


```
[root@localhost hcp-testing]# helm install postgresql bitnami/postgresql -n postgresql --create-namespace
NAME: postgresql
LAST DEPLOYED: Mon Oct 14 06:52:58 2024
NAMESPACE: postgresql
STATUS: deployed
REVISION: 1
TEST SUITE: None
NOTES:
CHART NAME: postgresql
CHART VERSION: 15.5.21
APP VERSION: 16.4.0

** Please be patient while the chart is being deployed **

PostgreSQL can be accessed via port 5432 on the following DNS names from within your cluster:

    postgresql.postgresql.svc.cluster.local - Read/Write connection

To get the password for "postgres" run:

    export POSTGRES_PASSWORD=$(kubectl get secret --namespace postgresql postgresql -o jsonpath="{.data.postgres-password}" | base64 -d)

To connect to your database run the following command:

    kubectl run postgresql-client --rm --tty -i --restart='Never' --namespace postgresql --image docker.io/bitnami/postgresql:16.4.0-debian-12-r0 --
      --command -- psql --host postgresql -U postgres -d postgres -p 5432

    > NOTE: If you access the container using bash, make sure that you execute "/opt/bitnami/scripts/postgresql/entrypoint.sh /bin/bash" in order to
 1001} does not exist"

To connect to your database from outside the cluster execute the following commands:

    kubectl port-forward --namespace postgresql svc/postgresql 5432:5432 &
    PGPASSWORD="$POSTGRES_PASSWORD" psql --host 127.0.0.1 -U postgres -d postgres -p 5432

WARNING: The configured password will be ignored on new installation in case when previous PostgreSQL release was deleted through the helm command.
sword, and setting it through helm won't take effect. Deleting persistent volumes (PVs) will solve the issue.
```

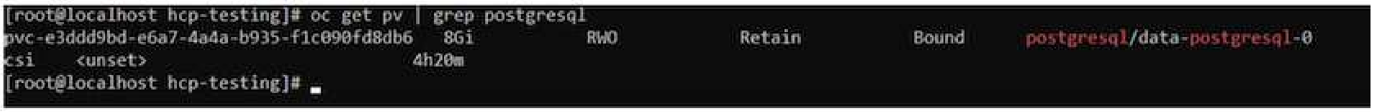
b. Verify that the application pod is running, and a PVC and PV is created for the application.



```
[root@localhost hcp-testing]# oc get pods -n postgresql
NAME             READY   STATUS    RESTARTS   AGE
postgresql-0     1/1     Running   0          29m
```



```
[root@localhost hcp-testing]# oc get pvc -n postgresql
NAME                STATUS   VOLUME                                     CAPACITY   ACCESS MODES   STORAGECLASS
data-postgresql-0   Bound    pvc-e3ddd9bd-e6a7-4a4a-b935-f1c090fd8db6   8Gi        RWO            trident-csi
```



```
[root@localhost hcp-testing]# oc get pv | grep postgresql
pvc-e3ddd9bd-e6a7-4a4a-b935-f1c090fd8db6   8Gi        RWO           Retain          Bound       postgresql/data-postgresql-0
csi    <unset>                        4h20m
[root@localhost hcp-testing]#
```

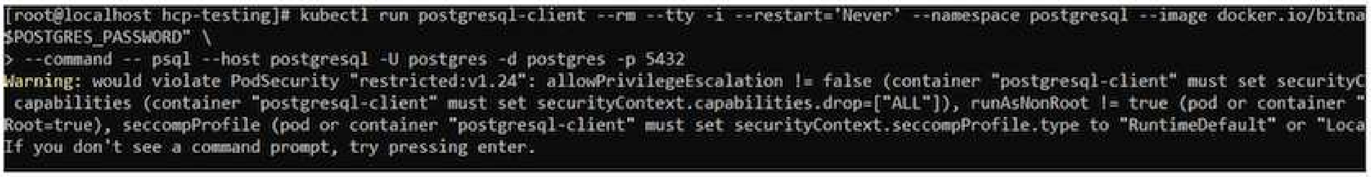
c. Deploy a Postgresql client

Use the following command to get the password for the postgresql server that was installed.

```
$ export POSTGRES_PASSWORD=$(kubectl get secret --namespace postgresql
postgresql -o jsoata.postgres-password}" | base64 -d)
```

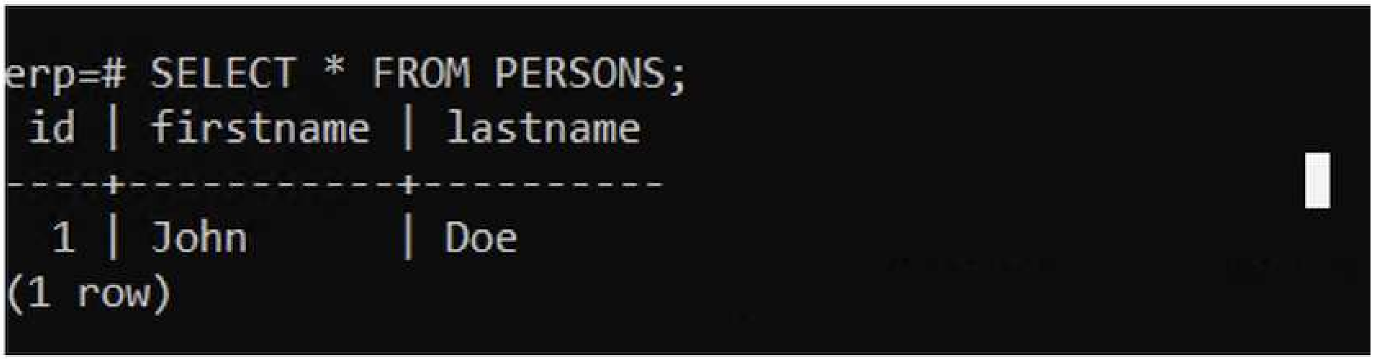
Use the following command to run a postgresql client and connect to the server using the password

```
$ kubectl run postgresql-client --rm --tty -i --restart='Never'
--namespace postgresql --image docker.io/bitnami/postgresql:16.2.0-debian-
11-r1 --env="PGPASSWORD=$POSTGRES_PASSWORD" \
> --command -- psql --host postgresql -U postgres -d postgres -p 5432
```

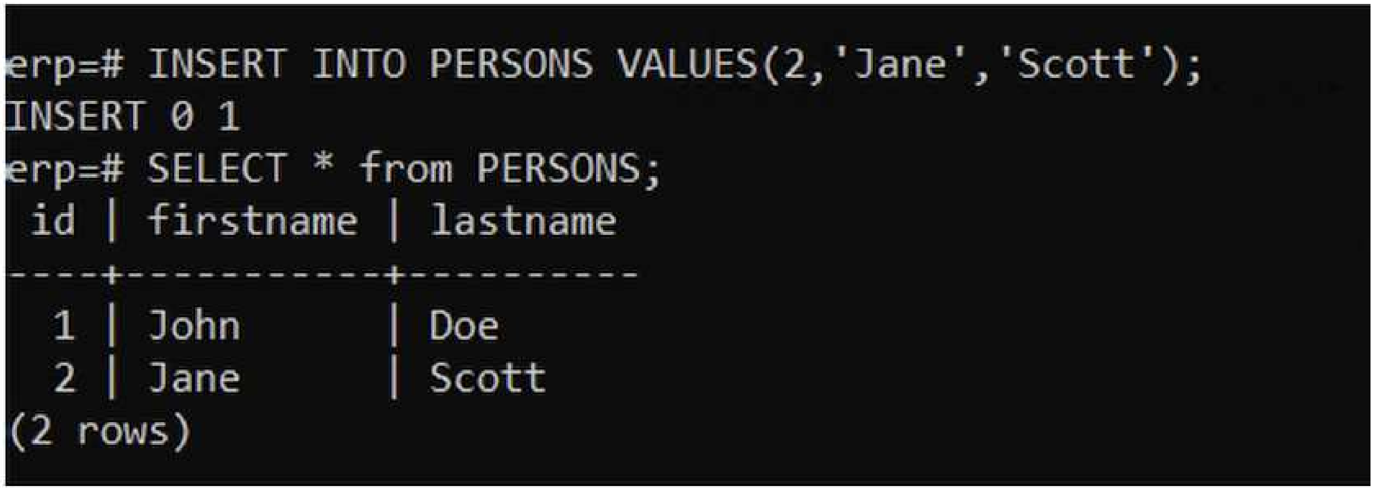


```
[root@localhost hcp-testing]# kubectl run postgresql-client --rm --tty -i --restart='Never' --namespace postgresql --image docker.io/bitna
$POSTGRES_PASSWORD" \
> --command -- psql --host postgresql -U postgres -d postgres -p 5432
Warning: would violate PodSecurity "restricted:v1.24": allowPrivilegeEscalation != false (container "postgresql-client" must set securityC
 capabilities (container "postgresql-client" must set securityContext.capabilities.drop=["ALL"]), runAsNonRoot != true (pod or container "
Root=true), seccompProfile (pod or container "postgresql-client" must set securityContext.seccompProfile.type to "RuntimeDefault" or "Loca
If you don't see a command prompt, try pressing enter.
```

d. Create a database and a table. Create a schema for the table and insert 2 rows of data into the table.



```
erp=# SELECT * FROM PERSONS;
 id | firstname | lastname
----+-----------+----------
  1 | John      | Doe
(1 row)
```



```
erp=# INSERT INTO PERSONS VALUES(2,'Jane','Scott');
INSERT 0 1
erp=# SELECT * from PERSONS;
 id | firstname | lastname
----+-----------+----------
  1 | John      | Doe
  2 | Jane      | Scott
(2 rows)
```

Red Hat OpenShift Service on AWS with NetApp ONTAP

This document will outline how to use NetApp ONTAP with the Red Hat OpenShift Service on AWS (ROSA).

Create Volume Snapshot

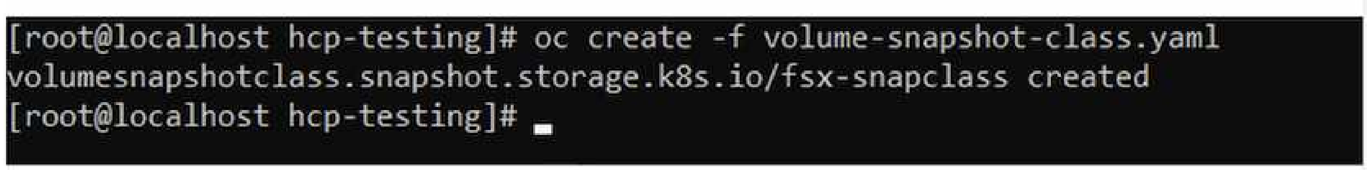
1. Create a Snapshot of the app volume

In this section, we will show how to create a trident snapshot of the volume associated with the app.This will be a point in time copy of the app data. If the application data is lost, we can recover the data from this point in time copy.
NOTE: This snapshot is stored in the same aggregate as the original volume in ONTAP(on-premises or in the cloud). So if the ONTAP storage aggregate is lost, we cannot recover the app data from its snapshot.

**a. Create a VolumeSnapshotClass
Save the following manifest in a file called volume-snapshot-class.yaml

```
apiVersion: snapshot.storage.k8s.io/v1
kind: VolumeSnapshotClass
metadata:
 name: fsx-snapclass
driver: csi.trident.netapp.io
deletionPolicy: Delete
```

Create a snapshot by using the above manifest.



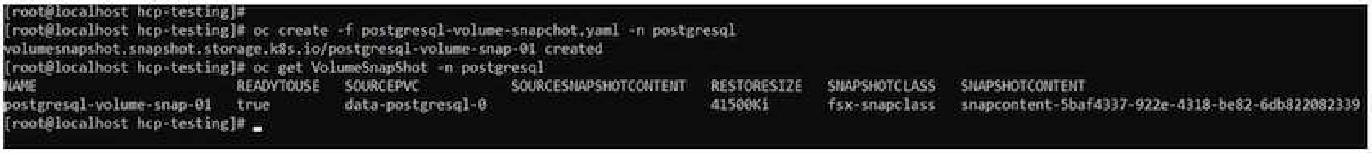
```
[root@localhost hcp-testing]# oc create -f volume-snapshot-class.yaml
volumesnapshotclass.snapshot.storage.k8s.io/fsx-snapclass created
[root@localhost hcp-testing]#
```

b. Next, create a snapshot
Create a snapshot of the existing PVC by creating VolumeSnapshot to take a point-in-time copy of your Postgresql data. This creates an FSx snapshot that takes almost no space in the filesystem backend. Save the following manifest in a file called volume-snapshot.yaml:

```
apiVersion: snapshot.storage.k8s.io/v1
kind: VolumeSnapshot
metadata:
 name: postgresql-volume-snap-01
spec:
 volumeSnapshotClassName: fsx-snapclass
 source:
   persistentVolumeClaimName: data-postgresql-0
```

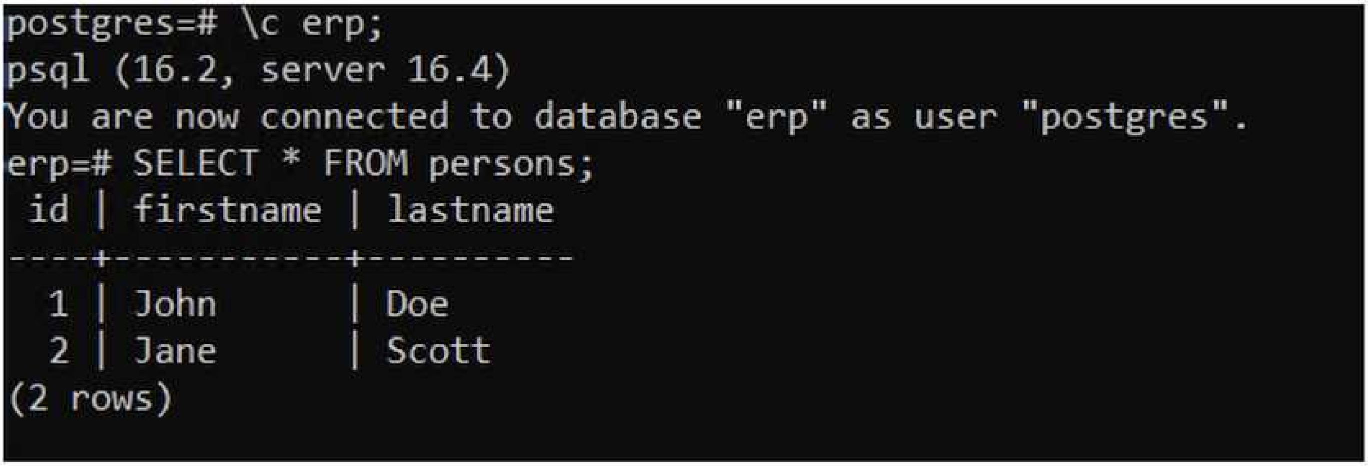
c. Create the volume snapshot and confirm that it is created

Delete the database to simulate the loss of data (data loss can happen due to a variety of reasons, here we are just simulating it by deleting the database)

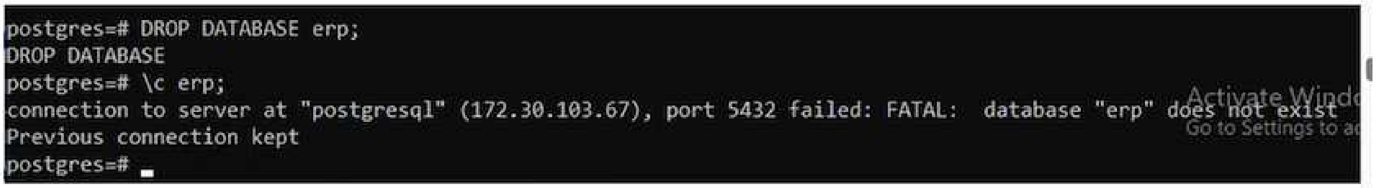


```
[root@localhost hcp-testing]#
[root@localhost hcp-testing]# oc create -f postgresql-volume-snapchot.yaml -n postgresql
volumesnapshot.snapshot.storage.k8s.io/postgresql-volume-snap-01 created
[root@localhost hcp-testing]# oc get VolumeSnapShot -n postgresql
NAME                        READYTOUSE   SOURCEPVC           SOURCESNAPSHOTCONTENT   RESTORESIZE   SNAPSHOTCLASS   SNAPSHOTCONTENT
postgresql-volume-snap-01   true         data-postgresql-0                           41500Ki       fsx-snapclass   snapcontent-5baf4337-922e-4318-be82-6db822082339
[root@localhost hcp-testing]#
```

d. Delete the database to simulate the loss of data (data loss can happen due to a variety of reasons, here we are just simulating it by deleting the database)



```
postgres=# \c erp;
psql (16.2, server 16.4)
You are now connected to database "erp" as user "postgres".
erp=# SELECT * FROM persons;
 id | firstname | lastname
----+-----------+----------
  1 | John      | Doe
  2 | Jane      | Scott
(2 rows)
```



```
postgres=# DROP DATABASE erp;
DROP DATABASE
postgres=# \c erp;
connection to server at "postgresql" (172.30.103.67), port 5432 failed: FATAL:  database "erp" does not exist
Previous connection kept
postgres=# _
```

Restore from Volume Snapshot

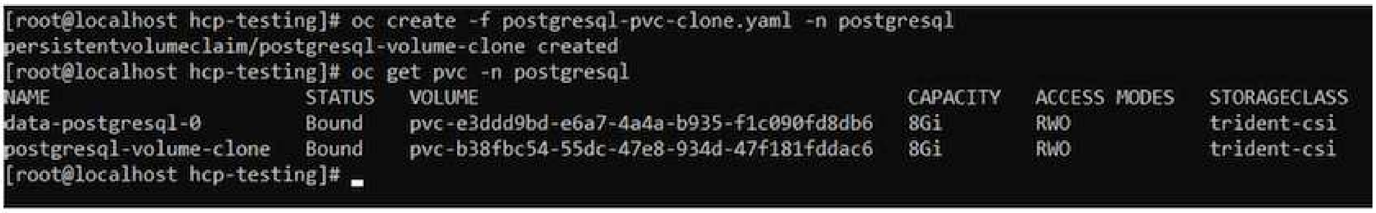
1. Restore from Snapshot
In this section, we will show how to restore an application from the trident snapshot of the app volume.

a. Create a volume clone from the snapshot

To restore the volume to its previous state, you must create a new PVC based on the data in the snapshot you took. To do this, save the following manifest in a file named pvc-clone.yaml

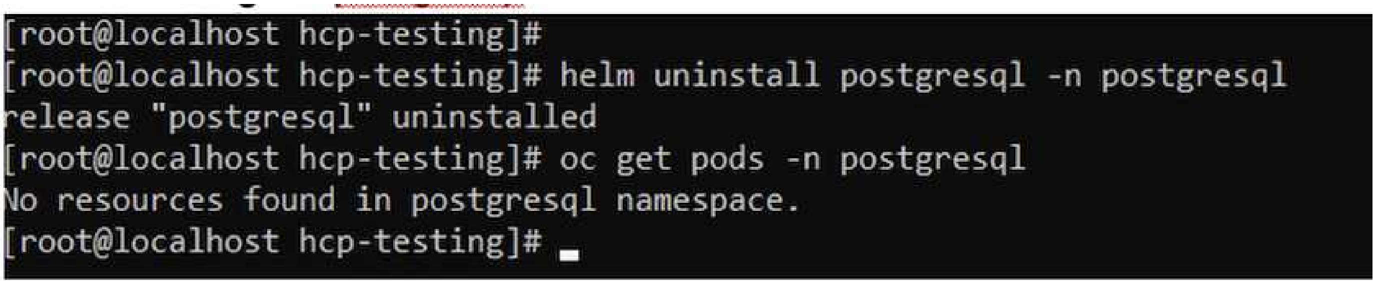
```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
 name: postgresql-volume-clone
spec:
 accessModes:
   - ReadWriteOnce
 storageClassName: trident-csi
 resources:
   requests:
     storage: 8Gi
 dataSource:
   name: postgresql-volume-snap-01
   kind: VolumeSnapshot
   apiGroup: snapshot.storage.k8s.io
```

Create a clone of the volume by creating a PVC using the snapshot as the source using the above manifest. Apply the manifest and ensure that the clone is created.



```
[root@localhost hcp-testing]# oc create -f postgresql-pvc-clone.yaml -n postgresql
persistentvolumeclaim/postgresql-volume-clone created
[root@localhost hcp-testing]# oc get pvc -n postgresql
NAME                      STATUS   VOLUME                                     CAPACITY   ACCESS MODES   STORAGECLASS
data-postgresql-0         Bound    pvc-e3ddd9bd-e6a7-4a4a-b935-f1c090fd8db6   8Gi        RWO            trident-csi
postgresql-volume-clone   Bound    pvc-b38fbc54-55dc-47e8-934d-47f181fddac6   8Gi        RWO            trident-csi
[root@localhost hcp-testing]#
```

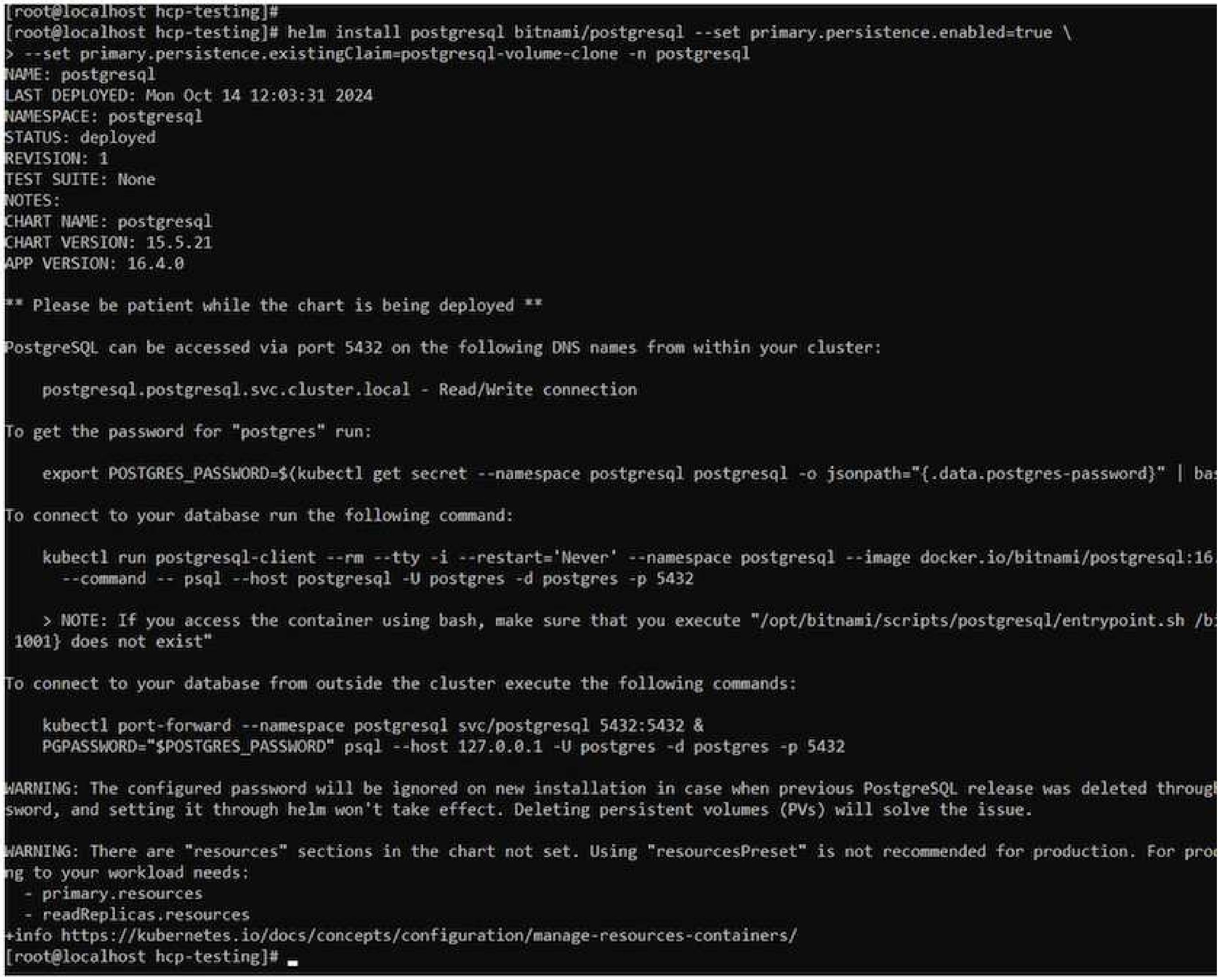
b. Delete the original postgresql installation



```
[root@localhost hcp-testing]#
[root@localhost hcp-testing]# helm uninstall postgresql -n postgresql
release "postgresql" uninstalled
[root@localhost hcp-testing]# oc get pods -n postgresql
No resources found in postgresql namespace.
[root@localhost hcp-testing]#
```

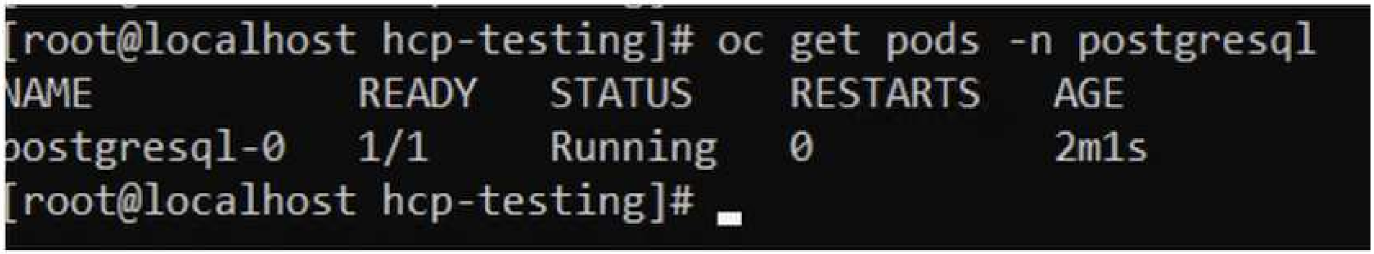
c. Create a new postgresql application using the new clone PVC

```
$ helm install postgresql bitnami/postgresql --set
primary.persistence.enabled=true --set
primary.persistence.existingClaim=postgresql-volume-clone -n postgresql
```



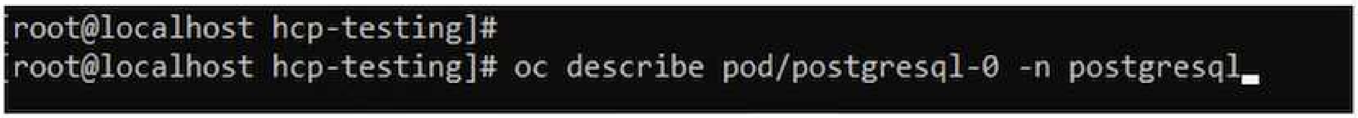
```
[root@localhost hcp-testing]#
[root@localhost hcp-testing]# helm install postgresql bitnami/postgresql --set primary.persistence.enabled=true \
> --set primary.persistence.existingClaim=postgresql-volume-clone -n postgresql
NAME: postgresql
LAST DEPLOYED: Mon Oct 14 12:03:31 2024
NAMESPACE: postgresql
STATUS: deployed
REVISION: 1
TEST SUITE: None
NOTES:
CHART NAME: postgresql
CHART VERSION: 15.5.21
APP VERSION: 16.4.0

** Please be patient while the chart is being deployed **

PostgreSQL can be accessed via port 5432 on the following DNS names from within your cluster:

    postgresql.postgresql.svc.cluster.local - Read/Write connection

To get the password for "postgres" run:

    export POSTGRES_PASSWORD=$(kubectl get secret --namespace postgresql postgresql -o jsonpath="{.data.postgres-password}" | bas

To connect to your database run the following command:

    kubectl run postgresql-client --rm --tty -i --restart='Never' --namespace postgresql --image docker.io/bitnami/postgresql:16.
      --command -- psql --host postgresql -U postgres -d postgres -p 5432

    > NOTE: If you access the container using bash, make sure that you execute "/opt/bitnami/scripts/postgresql/entrypoint.sh /bi
 1001} does not exist"

To connect to your database from outside the cluster execute the following commands:

    kubectl port-forward --namespace postgresql svc/postgresql 5432:5432 &
    PGPASSWORD="$POSTGRES_PASSWORD" psql --host 127.0.0.1 -U postgres -d postgres -p 5432

WARNING: The configured password will be ignored on new installation in case when previous PostgreSQL release was deleted through
sword, and setting it through helm won't take effect. Deleting persistent volumes (PVs) will solve the issue.

WARNING: There are "resources" sections in the chart not set. Using "resourcesPreset" is not recommended for production. For prod
ng to your workload needs:
  - primary.resources
  - readReplicas.resources
+info https://kubernetes.io/docs/concepts/configuration/manage-resources-containers/
[root@localhost hcp-testing]#
```

d. Verify that the application pod is in the running state

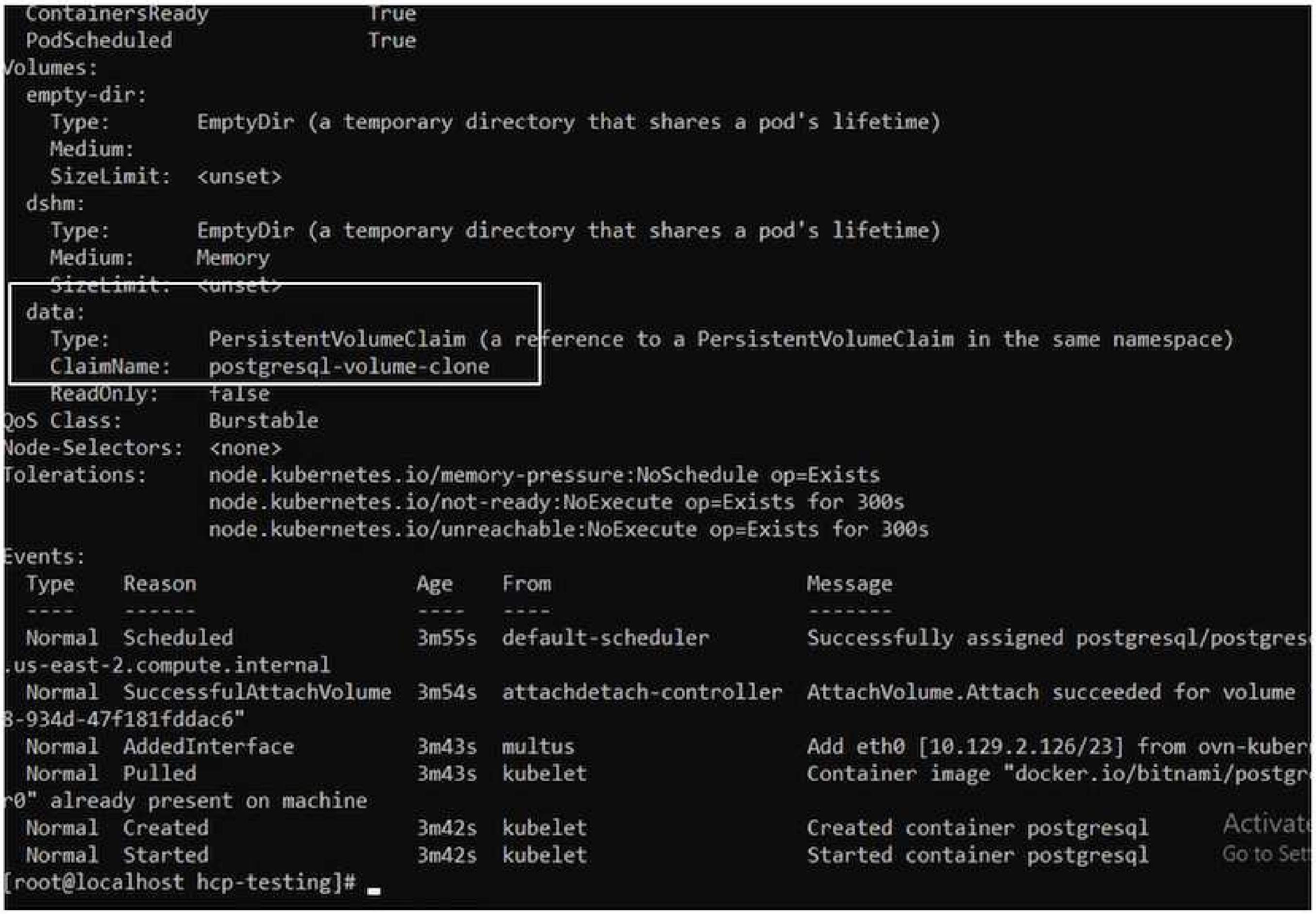


```
[root@localhost hcp-testing]# oc get pods -n postgresql
NAME           READY   STATUS    RESTARTS   AGE
postgresql-0   1/1     Running   0          2m1s
[root@localhost hcp-testing]#
```

e. Verify that the pod uses the clone as its PVC

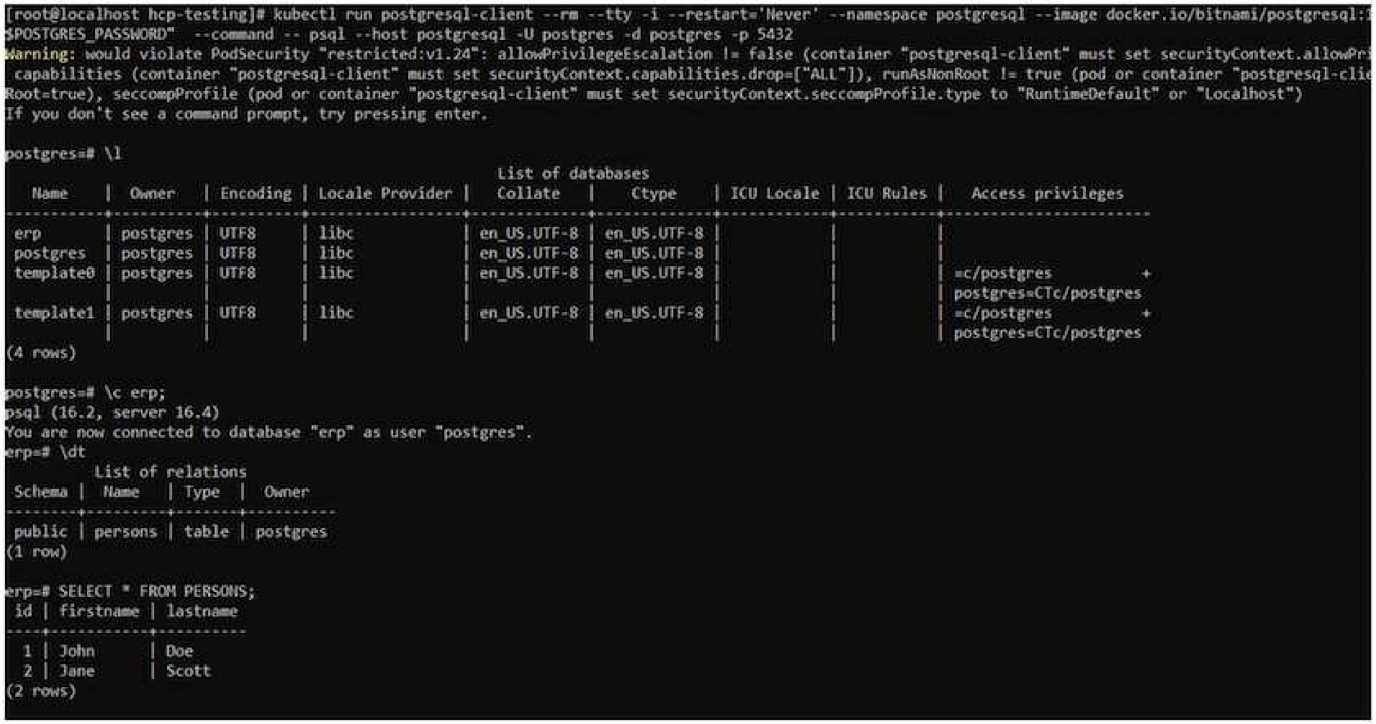


```
[root@localhost hcp-testing]#
[root@localhost hcp-testing]# oc describe pod/postgresql-0 -n postgresql
```



```
  ContainersReady             True
  PodScheduled                True
Volumes:
  empty-dir:
    Type:       EmptyDir (a temporary directory that shares a pod's lifetime)
    Medium:
    SizeLimit:  <unset>
  dshm:
    Type:       EmptyDir (a temporary directory that shares a pod's lifetime)
    Medium:     Memory
    SizeLimit:  <unset>
  data:
    Type:        PersistentVolumeClaim (a reference to a PersistentVolumeClaim in the same namespace)
    ClaimName:   postgresql-volume-clone
    ReadOnly:    false
QoS Class:       Burstable
Node-Selectors:  <none>
Tolerations:     node.kubernetes.io/memory-pressure:NoSchedule op=Exists
                 node.kubernetes.io/not-ready:NoExecute op=Exists for 300s
                 node.kubernetes.io/unreachable:NoExecute op=Exists for 300s
Events:
  Type    Reason                  Age    From                     Message
  ----    ------                  ----   ----                     -------
  Normal  Scheduled               3m55s  default-scheduler        Successfully assigned postgresql/postgres
.us-east-2.compute.internal
  Normal  SuccessfulAttachVolume  3m54s  attachdetach-controller  AttachVolume.Attach succeeded for volume
3-934d-47f181fddac6"
  Normal  AddedInterface          3m43s  multus                   Add eth0 [10.129.2.126/23] from ovn-kuber
  Normal  Pulled                  3m43s  kubelet                  Container image "docker.io/bitnami/postgr
r0" already present on machine
  Normal  Created                 3m42s  kubelet                  Created container postgresql
  Normal  Started                 3m42s  kubelet                  Started container postgresql
[root@localhost hcp-testing]# _
```

f) To validate that the database has been restored as expected, go back to the container console and show the existing databases



```
[root@localhost hcp-testing]# kubectl run postgresql-client --rm --tty -i --restart='Never' --namespace postgresql --image docker.io/bitnami/postgresql:1
$POSTGRES_PASSWORD"  --command -- psql --host postgresql -U postgres -d postgres -p 5432
Warning: would violate PodSecurity "restricted:v1.24": allowPrivilegeEscalation != false (container "postgresql-client" must set securityContext.allowPri
 capabilities (container "postgresql-client" must set securityContext.capabilities.drop=["ALL"]), runAsNonRoot != true (pod or container "postgresql-clie
Root=true), seccompProfile (pod or container "postgresql-client" must set securityContext.seccompProfile.type to "RuntimeDefault" or "Localhost")
If you don't see a command prompt, try pressing enter.

postgres=# \l
                                                       List of databases
   Name    |  Owner   | Encoding | Locale Provider |   Collate   |    Ctype    | ICU Locale | ICU Rules |   Access privileges
-----------+----------+----------+-----------------+-------------+-------------+------------+-----------+-----------------------
 erp       | postgres | UTF8     | libc            | en_US.UTF-8 | en_US.UTF-8 |            |           |
 postgres  | postgres | UTF8     | libc            | en_US.UTF-8 | en_US.UTF-8 |            |           |
 template0 | postgres | UTF8     | libc            | en_US.UTF-8 | en_US.UTF-8 |            |           | =c/postgres          +
           |          |          |                 |             |             |            |           | postgres=CTc/postgres
 template1 | postgres | UTF8     | libc            | en_US.UTF-8 | en_US.UTF-8 |            |           | =c/postgres          +
           |          |          |                 |             |             |            |           | postgres=CTc/postgres
(4 rows)

postgres=# \c erp;
psql (16.2, server 16.4)
You are now connected to database "erp" as user "postgres".
erp=# \dt
          List of relations
 Schema |  Name   | Type  |  Owner
--------+---------+-------+----------
 public | persons | table | postgres
(1 row)

erp=# SELECT * FROM PERSONS;
 id | firstname | lastname
----+-----------+----------
  1 | John      | Doe
  2 | Jane      | Scott
(2 rows)
```

Demo video

Amazon FSx for NetApp ONTAP wth Red Hat OpenShift Service on AWS using Hosted Control Plane

More videos on Red Hat OpenShift and OpenShift solutions can be found here.