



NetApp Storage Integrations Overview

NetApp Solutions

NetApp
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NetApp Storage Integration Overview

NetApp provides a number of products to help you with orchestrating and managing persistent data in container based environments, such as Red Hat OpenShift.



NetApp Astra Control offers a rich set of storage and application-aware data management services for stateful Kubernetes workloads, powered by NetApp data protection technology. The Astra Control Service is available to support stateful workloads in cloud-native Kubernetes deployments. The Astra Control Center is available to support stateful workloads in on-premises deployments, like Red Hat OpenShift. For more information visit the NetApp Astra Control website [here](#).

NetApp Astra Trident is an open-source and fully-supported storage orchestrator for containers and Kubernetes distributions, including Red Hat OpenShift. For more information, visit the Astra Trident website [here](#).

The following pages have additional information about the NetApp products that have been validated for application and persistent storage management in the Red Hat OpenShift with NetApp solution:

- [NetApp Astra Control Center](#)
- [NetApp Astra Trident](#)

[Next: NetApp Astra Control Center Overview](#)

NetApp Astra Control Center overview

NetApp Astra Control Center offers a rich set of storage and application-aware data management services for stateful Kubernetes workloads deployed in an on-premises environment and powered by NetApp data protection technology.



NetApp Astra Control Center can be installed on a Red Hat OpenShift cluster that has the Astra Trident storage orchestrator deployed and configured with storage classes and storage backends to NetApp ONTAP storage systems.

For the installation and configuration of Astra Trident to support Astra Control Center, see [this document here](#).

In a cloud-connected environment, Astra Control Center uses Cloud Insights to provide advanced monitoring and telemetry. In the absence of a Cloud Insights connection, limited monitoring and telemetry (7-days worth of metrics) is available and exported to Kubernetes native monitoring tools (Prometheus and Grafana) through open metrics endpoints.

Astra Control Center is fully integrated into the NetApp AutoSupport and Active IQ ecosystem to provide support for users, provide assistance with troubleshooting, and display usage statistics.

In addition to the paid version of Astra Control Center, a 90-day evaluation license is available. The evaluation

version is supported through the email and community (Slack channel). Customers have access to these and other knowledge-base articles and the documentation available from the in-product support dashboard.

To get started with NetApp Astra Control Center, visit the [Astra website](#).

Astra Control Center installation prerequisites

1. One or more Red Hat OpenShift clusters. Versions 4.6 EUS and 4.7 are currently supported.
2. Astra Trident must already be installed and configured on each Red Hat OpenShift cluster.
3. One or more NetApp ONTAP storage systems running ONTAP 9.5 or greater.



It's best practice for each OpenShift install at a site to have a dedicated SVM for persistent storage. Multi-site deployments require additional storage systems.

4. A Trident storage backend must be configured on each OpenShift cluster with an SVM backed by an ONTAP cluster.
5. A default StorageClass configured on each OpenShift cluster with Astra Trident as the storage provisioner.
6. A load balancer must be installed and configured on each OpenShift cluster for load balancing and exposing OpenShift Services.



See the link [here](#) for information about load balancers that have been validated for this purpose.

7. A private image registry must be configured to host the NetApp Astra Control Center images.



See the link [here](#) to install and configure an OpenShift private registry for this purpose.

8. You must have Cluster Admin access to the Red Hat OpenShift cluster.
9. You must have Admin access to NetApp ONTAP clusters.
10. An admin workstation with docker or podman, tridentctl, and oc or kubectl tools installed and added to your \$PATH.



Docker installations must have docker version greater than 20.10 and Podman installations must have podman version greater than 3.0.

Install Astra Control Center

Using OperatorHub

Unresolved directive in containers/rh-os-n_overview_astra.adoc - include::containers/rh-os-n_overview_astra_cc_install_manual.adoc[]

Automated [Ansible]

Unresolved directive in containers/rh-os-n_overview_astra.adoc - include::containers/rh-os-n_overview_astra_cc_install_ansible.adoc[]

Post Install Steps

1. It might take several minutes for the installation to complete. Verify that all the pods and services in the `netapp-astra-cc` namespace are up and running.

```
[netapp-user@rhel7 ~]$ oc get all -n netapp-astra-cc
```

2. Check the `acc-operator-controller-manager` logs to ensure that the installation is completed.

```
[netapp-user@rhel7 ~]$ oc logs deploy/acc-operator-controller-manager -n netapp-acc-operator -c manager -f
```



The following message indicates the successful installation of Astra Control Center.

```
{"level":"info","ts":1624054318.029971,"logger":"controllers.AstraControlCenter","msg":"Successfully Reconciled AstraControlCenter in [seconds]s","AstraControlCenter":"netapp-astra-cc/astra","ae.Version":"[21.12.60]"}

```

3. The username for logging into Astra Control Center is the email address of the administrator provided in the CRD file and the password is a string `ACC-` appended to the Astra Control Center UUID. Run the following command:

```
[netapp-user@rhel7 ~]$ oc get astracontrolcenters -n netapp-astra-cc
NAME      UUID
astra     345c55a5-bf2e-21f0-84b8-b6f2bce5e95f
```



In this example, the password is `ACC-345c55a5-bf2e-21f0-84b8-b6f2bce5e95f`.

4. Get the `traefik` service load balancer IP.

```
[netapp-user@rhel7 ~]$ oc get svc -n netapp-astra-cc | egrep 'EXTERNAL|traefik'
```

| NAME | TYPE | CLUSTER-IP |
|---------------|-----------------------------|---------------|
| EXTERNAL-IP | PORT(S) | |
| AGE | | |
| traefik | LoadBalancer | 172.30.99.142 |
| 10.61.186.181 | 80:30343/TCP, 443:30060/TCP | |
| 16m | | |

5. Add an entry in the DNS server pointing the FQDN provided in the Astra Control Center CRD file to the

EXTERNAL-IP of the traefik service.

New Host

Name (uses parent domain name if blank):
astra-control-center

Fully qualified domain name (FQDN):
astra-control-center.cie.netapp.com.

IP address:
10.61.186.181

☒ Create associated pointer (PTR) record

☐ Allow any authenticated user to update DNS records with the same owner name

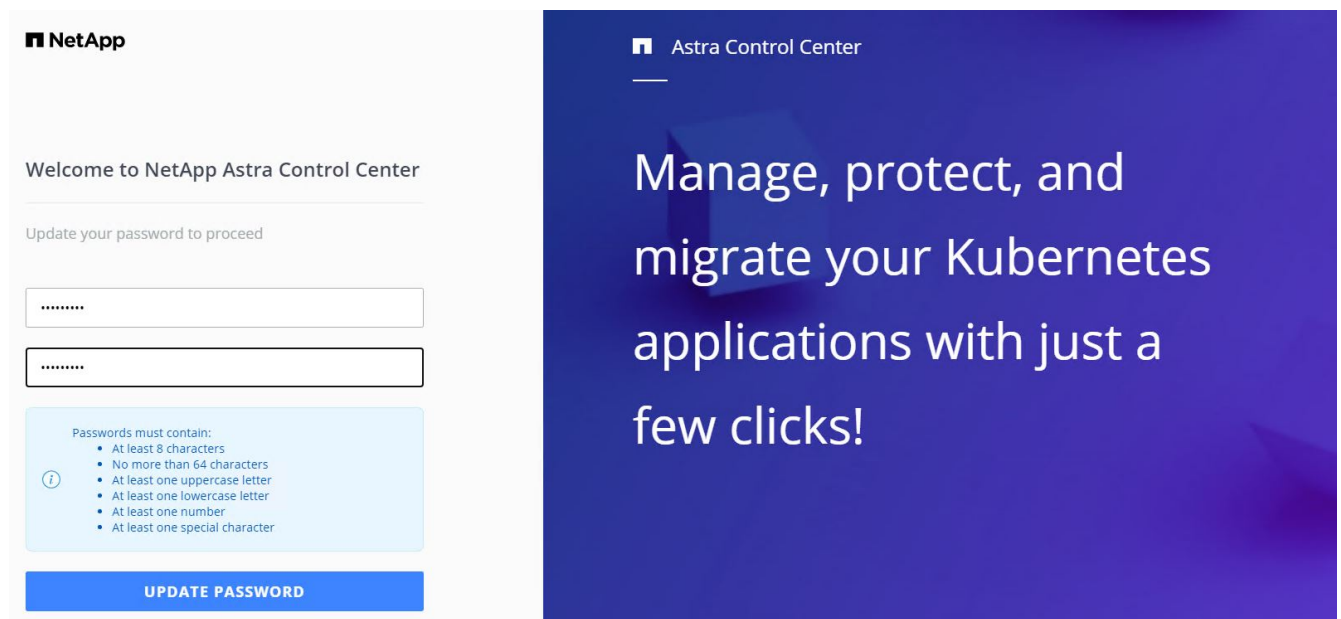
Add Host

Cancel

6. Log into the Astra Control Center GUI by browsing its FQDN.



7. When you log into Astra Control Center GUI for the first time using the admin email address provided in CRD, you need to change the password.



8. If you wish to add a user to Astra Control Center, navigate to Account > Users, click Add, enter the details of the user, and click Add.

Add user
✕

USER DETAILS

First name

Nikhil

Last name

Kulkarni

Email address

tme_nik@netapp.com

PASSWORD

Temporary password

Confirm temporary password

ⓘ

Passwords must contain:

- At least 8 characters
- No more than 64 characters
- At least one lowercase letter
- At least one uppercase letter
- At least one number
- At least one special character

USER ROLE ⓘ

Role

Owner

▼

Cancel

Add ✓

ADD NEW USER

Add new user

Add a new user to your Astra Control Center account. New users will be prompted to update their password the first time they log in to Astra Control Center. They will also inherit access to account-wide credentials according to their role. Read more in [users](#).

9. Astra Control Center requires a license for all of its functionalities to work. To add a license, navigate to Account > License, click Add License, and upload the license file.

Account

Users

Credentials

Notifications

License

Connections

ASTRA CONTROL CENTER LICENSE

To get started with Astra Control Center, select Add license to manually upload the file.

Add license

ADD LICENSE

Select and add a license file.

License file

EvalNLF-AstraControlCenter-480Cores(vCPU)-100000002-ACC60f19...

⬆

✕

Cancel

Add



If you encounter issues with the install or configuration of NetApp Astra Control Center, the knowledge base of known issues is available [here](#).


Next: [Register your Red Hat OpenShift Clusters: Red Hat OpenShift with NetApp.](#)

Register your Red Hat OpenShift Clusters with the Astra Control Center


To enable the Astra Control Center to manage your workloads, you must first register your Red Hat OpenShift cluster.

Register Red Hat OpenShift clusters

1. The first step is to add the OpenShift clusters to the Astra Control Center and manage them. Go to Clusters and click Add a Cluster, upload the kubeconfig file for the OpenShift cluster, and click Select Storage.

 **Add cluster**

STEP 1/3: CREDENTIALS





CREDENTIALS

Provide Astra Control access to your Kubernetes and OpenShift clusters by entering a kubeconfig credential.
Follow [instructions](#) on how to create a dedicated admin-role kubeconfig.


[Upload file](#)

Paste from clipboard

Kubeconfig YAML file
ocp-vmw kubeconfig.txt

Credential name
ocp-vmw

 **ADDING A CLUSTER**

Adding a cluster is needed for Astra Control to discover your Kubernetes applications.

Select a cloud provider and input credentials to get started.

Read more in [Clusters](#).

Cancel

Configure storage →



The kubeconfig file can be generated to authenticate with a username and password or a token. Tokens expire after a limited amount of time and might leave the registered cluster unreachable. NetApp recommends using a kubeconfig file with a username and password to register your OpenShift clusters to Astra Control Center.

2. Astra Control Center detects the eligible storage classes. Now select the way that storageclass provisions volumes using Trident backed by an SVM on NetApp ONTAP and click Review. In the next pane, verify the details and click Add Cluster.

STORAGE

Existing storage classes are discovered and verified as eligible for use with Astra Control. You can use your existing default, or choose to set a new default at this time.
Applications with persistent volumes on eligible storage classes are validated for use with Astra Control.

| Set default | Storage class | Storage provisioner | Reclaim policy | Binding mode | Eligible |
|----------------------------------|------------------------------------|------------------------------|----------------|--------------|----------|
| <input checked="" type="radio"/> | ocp-trident <small>Default</small> | csi.trident.netapp.io | Delete | Immediate | |
| <input type="radio"/> | ocp-trident-iscsi | csi.trident.netapp.io | Delete | Immediate | |
| <input type="radio"/> | project-1-sc | csi.trident.netapp.io | Delete | Immediate | |
| <input type="radio"/> | thin | kubernetes.io/vsphere-volume | Delete | Immediate | |

[← Select credentials](#)
[Review →](#)

- Register both OpenShift clusters as described in step 1. When added, the clusters move to the Discovering status while Astra Control Center inspects them and installs the necessary agents. Cluster status changes to Running after they are successfully registered.

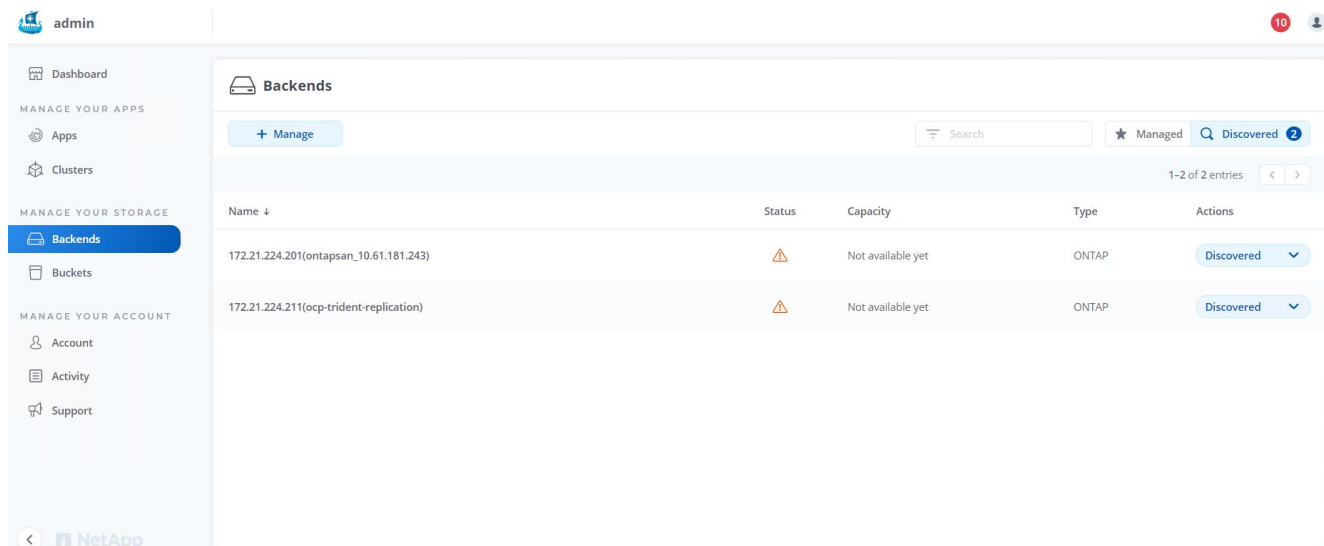
The screenshot shows the Astra Control Center interface. The left sidebar has a 'Clusters' tab selected. The main panel displays a table with the following data:

| Name | Ready | Type | Version | Actions |
|-------------|-------|-------------------|-----------------|---------|
| ocp-vmw | | Red Hat OpenShift | v1.20.0+df9c838 | Running |
| ocp-vmware2 | | Red Hat OpenShift | v1.20.0+c8905da | Running |



All Red Hat OpenShift clusters to be managed by Astra Control Center should have access to the image registry that was used for its installation as the agents installed on the managed clusters pull the images from that registry.

- Import ONTAP clusters as storage resources to be managed as backends by Astra Control Center. When OpenShift clusters are added to Astra and a storageclass is configured, it automatically discovers and inspects the ONTAP cluster backing the storageclass but does not import it into the Astra Control Center to be managed.



- To import the ONTAP clusters, go to Backends, click the dropdown, and select Manage next to the ONTAP cluster to be managed. Enter the ONTAP cluster credentials, click Review Information, and then click Import Storage Backend.

Manage ONTAP storage backend STEP 1/2: CREDENTIALS

CREDENTIALS

Enter cluster administrator credentials for the ONTAP storage backend you want to manage.

Cluster management IP address: 172.21.224.201

User name: admin

Password: [masked]

MANAGE STORAGE BACKEND

Storage backends provide storage to your Kubernetes applications.

Managing storage clusters in Astra Control as a storage backend will allow you to get linkages between PVs and the storage backend. You will also see capacity and health details of the storage backend, including performance metrics if Astra Control is connected to Cloud Insights.

Read more in [Storage backend](#).

ONTAP

Cancel Review information →

- After the backends are added, the status changes to Available. These backends now have the information about the persistent volumes in the OpenShift cluster and the corresponding volumes on the ONTAP system.



- For backup and restore across OpenShift clusters using Astra Control Center, you must provision an object storage bucket that supports the S3 protocol. Currently supported options are ONTAP S3, StorageGRID, and AWS S3. For the purpose of this installation, we are going to configure an AWS S3 bucket. Go to Buckets, click Add bucket, and select Generic S3. Enter the details about the S3 bucket and credentials to access it, click the checkbox "Make this bucket the default bucket for the cloud," and then click Add.

Add bucket
✕

STORAGE BUCKET

Enter the access details of your existing object store bucket to allow Astra Control to store your application backups.

Type

Generic S3

Existing bucket name

ocp-vmware2-astra-cc

Description (optional)

S3 server name or IP address

s3.us-east-1.amazonaws.com

☒ Make this bucket the default bucket for this cloud

?

SELECT CREDENTIALS

Astra Control requires S3 access credentials with the roles necessary to facilitate Kubernetes application data management.

Add
Use existing

Access ID

AMW\$TFCFKDSU6HWSZXABD

Secret key

.....

Credential name

AWS-S3

Cancel

Add ✓

ADDING STORAGE BUCKETS

Astra Control stores backups in your existing object store buckets. The first bucket added for a selected cloud will be designated as the default bucket for backup and clone operations.

Read more in [storage buckets](#).

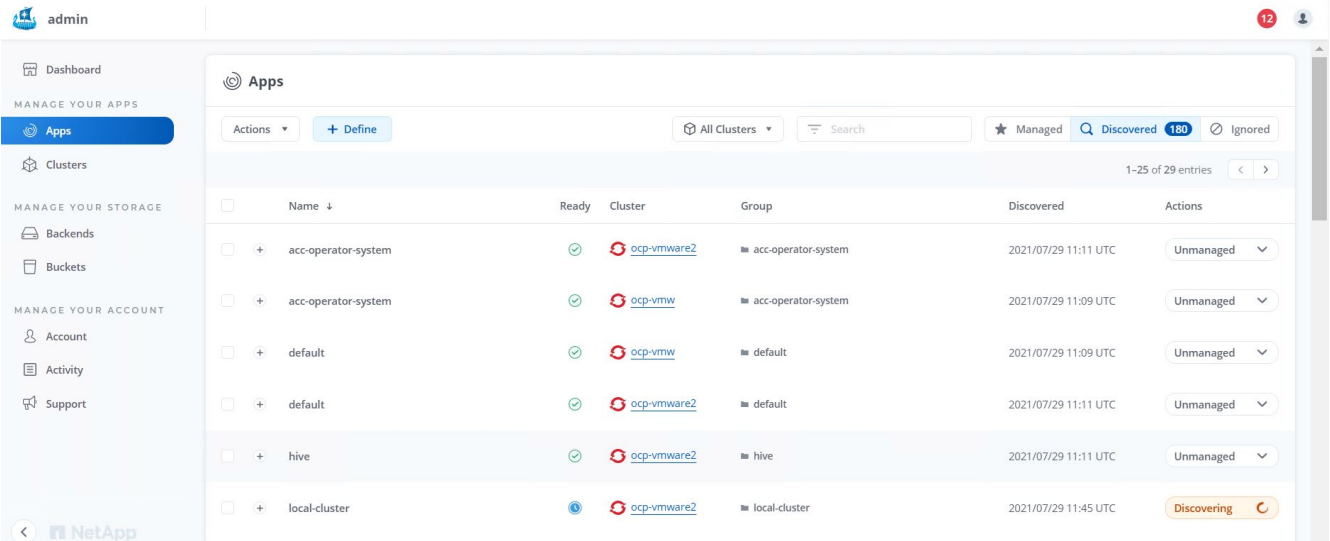
Next: [Choose the Applications To Protect.](#)

Choose the applications to protect

After you have registered your Red Hat OpenShift clusters, you can discover the applications that are deployed and manage them via the Astra Control Center.

Manage applications

1. After the OpenShift clusters and ONTAP backends are registered with the Astra Control Center, the control center automatically starts discovering the applications in all the namespaces that are using the storageclass configured with the specified ONTAP backend.



2. Navigate to Apps > Discovered and click the dropdown menu next to the application you would like to manage using Astra. Then click Manage.



1. The application enters the Available state and can be viewed under the Managed tab in the Apps section.

| <div> <div>Apps</div> <div> <div>Actions</div> <div>+ Define</div> <div>All Clusters</div> <div>Search</div> <div>Managed</div> <div>Discovered 175</div> <div>Ignored</div> </div> </div> | | | | | | | |
|--|---------------------------------------|-------|-----------|---------|-------------------------|----------------------|-----------|
| 1-1 of 1 entries | | | | | | | |
| <input type="checkbox"/> | Name ↓ | Ready | Protected | Cluster | Group | Discovered | Actions |
| <input type="checkbox"/> | wordpress-astra-ff4f9 | | | | ■ wordpress-astra-ff4f9 | 2021/07/29 11:09 UTC | Available |

Next: [Protect Your applications.](#)

Protect your applications

After application workloads are managed by Astra Control Center, you can configure the protection settings for those workloads.

Creating an application snapshot

A snapshot of an application creates an ONTAP Snapshot copy that can be used to restore or clone the application to a specific point in time based on that Snapshot copy.

1. To take a snapshot of the application, navigate to the Apps > Managed tab and click the application you would like to make a Snapshot copy of. Click the dropdown menu next to the application name and click Snapshot.

wp

APPLICATION STATUS

Healthy

APPLICATION PROTECTION STATUS

Unprotected

Images

docker.io/bitnami/mariadb:10.5.13-debian-10-r58

docker.io/bitnami/wordpress:5.9.0-debian-10-r1

Protection schedule

Disabled

Group

■ wp

Cluster

Running

Snapshot

Backup

Clone

Restore

Unmanage

2. Enter the snapshot details, click Next, and then click Snapshot. It takes about a minute to create the snapshot, and the status becomes Available after the snapshot is successfully created.

SNAPSHOT DETAILS

Name
wp-snapshot-20220228185949

CREATING APPLICATION SNAPSHOTS

Astra Control can take a quick snapshot of your application configuration and persistent storage. Enter a snapshot name to get started.

Read more in [Protect apps](#).

Application
wp

Namespace
wp

Cluster
ocp-vmw

Cancel

Next →

Creating an application backup

A backup of an application captures the active state of the application and the configuration of its resources, converts them into files, and stores them in a remote object storage bucket.

For the backup and restore of managed applications in the Astra Control Center, you must configure superuser settings for the backing ONTAP systems as a prerequisite. To do so, enter the following commands.

```
ONTAP::> export-policy rule modify -vserver ocp-trident -policyname
default -ruleindex 1 -superuser sys
ONTAP::> export-policy rule modify -policyname default -ruleindex 1 -anon
65534 -vserver ocp-trident
```

1. To create a backup of the managed application in the Astra Control Center, navigate to the Apps > Managed tab and click the application that you want to take a backup of. Click the dropdown menu next to the application name and click Backup.



APPLICATION STATUS

Healthy

APPLICATION PROTECTION STATUS

Unprotected

Images
docker.io/bitnami/mariadb:10.5.13-debian-10-r58
docker.io/bitnami/wordpress:5.9.0-debian-10-r1

Protection schedule
Disabled

Group
wp

Cluster
ocp-vmw

Running

Snapshot
Backup
Clone
Restore
Unmanage

2. Enter the backup details, select the object storage bucket to hold the backup files, click Next, and, after reviewing the details, click Backup. Depending on the size of the application and data, the backup can take several minutes, and the status of the backup becomes Available after the backup is completed successfully.

Backup application

STEP 1/2: DETAILS

X

BACKUP DETAILS

Name

wp-backup

☐ Backup from an existing snapshot

BACKUP DESTINATION

Bucket

na-ocp-astra/na-ocp-acc Available

CREATING APPLICATION BACKUPS

Astra Control can take a backup of your application configuration and persistent storage. Persistent storage backups are transferred to your object store. Enter a backup name to get started.

Read more in [Application backups](#).

Application

wp

Namespace

wp

Cluster

ocp-vmw

Cancel

Next →

Restoring an application

At the push of a button, you can restore an application to the originating namespace in the same cluster or to a remote cluster for application protection and disaster recovery purposes.

- To restore an application, navigate to Apps > Managed tab and click the app in question. Click the dropdown menu next to the application name and click **Restore**.

wp

Running

APPLICATION STATUS

Healthy

APPLICATION PROTECTION STATUS

Partially protected

Images

docker.io/bitnami/mariadb:10.5.13-debian-10-r58

docker.io/bitnami/wordpress:5.9.0-debian-10-r1

Protection schedule

Disabled

Group

wp

Cluster

ocp-vmw

Snapshot

Backup

Clone

Restore

Unmanage

- Enter the name of the restore namespace, select the cluster you want to restore it to, and choose if you want to restore it from an existing snapshot or from a backup of the application. Click **Next**.

Restore application

STEP 1/2: DETAILS

RESTORE DETAILS

Destination cluster

ocp-vmw

Destination namespace

wp

RESTORE SOURCE

Filter

Snapshots

Backups

| Application backup | Ready | On-Schedule/On-Demand | Created ↑ |
|--------------------|-------|-----------------------|----------------------|
| wp-backup | ✓ | On-Demand | 2022/02/28 18:54 UTC |

RESTORING APPLICATIONS

Astra Control can restore your application configuration and persistent storage. Select a source snapshot or backup for the restored application.

- Application wp
- Namespace wp
- Cluster ocp-vmw

Cancel

Next →

- On the review pane, enter `restore` and click **Restore** after you have reviewed the details.

Restore application

STEP 2/2: SUMMARY

REVIEW RESTORE INFORMATION

⚠️

All existing resources associated with this application will be deleted and replaced with the source backup "wp-backup" taken on 2022/02/28 18:54 UTC. Persistent volumes will be deleted and recreated. External resources with dependencies on this application may be impacted.

We recommend taking a snapshot or a backup of your application before proceeding.

BACKUP

wp-backup

ORIGINAL GROUP

wp

ORIGINAL CLUSTER

ocp-vmw

RESOURCE LABELS

ClusterRole

kubernetes.io/bootstrapping: rbac-defaults +1

ClusterRoleBinding

RESTORE

wp

DESTINATION GROUP

wp

DESTINATION CLUSTER

ocp-vmw

RESOURCE LABELS

ClusterRole

kubernetes.io/bootstrapping: rbac-defaults +1

ClusterRoleBinding

Are you sure you want to restore the application "wp"?

Type **restore** below to confirm.

Confirm to restore

restore

← Back

Restore ✓

- The new application goes to the Restoring state while Astra Control Center restores the application on the selected cluster. After all the resources of the application are installed and detected by Astra, the application goes to the Available state.

Actions ▾

+ Define

▾

Search

★

🔍

110

🗑

🔄

1-1 of 1 entries

<

>

| <input type="checkbox"/> | Name ↓ | Ready | Protected | Cluster | Group | Discovered | Actions |
|--------------------------|--------------------|-------|-----------------------------------|--|-------------------------------------|----------------------|-----------------------------------|
| <input type="checkbox"/> | wp | ✔ | <div><div></div><div></div></div> | <div><div></div><div>ocp-vmw</div></div> | <div><div></div><div>wp</div></div> | 2022/02/28 18:34 UTC | <div>Available</div> <div>▾</div> |

Cloning an application

You can clone an application to the originating cluster or to a remote cluster for dev/test or application protection and disaster recovery purposes. Cloning an application within the same cluster on the same storage backend uses NetApp FlexClone technology, which clones the PVCs instantly and saves storage space.

1. To clone an application, navigate to the Apps > Managed tab and click the app in question. Click the dropdown menu next to the application name and click Clone.


 **wp**

Running 

 APPLICATION STATUS


Healthy 


 APPLICATION PROTECTION STATUS

Partially protected 

Images
 docker.io/bitnami/mariadb:10.5.13-debian-10-r58
 docker.io/bitnami/wordpress:5.9.0-debian-10-r1

Protection schedule
 Disabled

Group
 wp

Cluster
 ocp-vmw

Snapshot


Backup

Clone

Restore

Unmanage

2. Enter the details of the new namespace, select the cluster you want to clone it to, and choose if you want to clone it from an existing snapshot or a backup or the current state of the application. Then click Next and click Clone on review pane once you have reviewed the details.

 **Clone application**

STEP 1/2: DETAILS

✕

CLONE DETAILS


Clone name

wp-clone


Clone namespace

wp-clone

Destination cluster


 ocp-vmw ▾


☐ Clone from an existing snapshot or backup




CLONING APPLICATIONS

Astra Control can create a clone of your application configuration and persistent storage. Persistent storage backups are transferred from your object store, so choosing a clone from an existing backup will complete the fastest. Enter a clone name to get started.


Read more in [Clone applications](#) .

 Application

wp

 Namespace

wp

 Cluster

ocp-vmw

Cancel

Next →

3. The new application goes to the Discovering state while Astra Control Center creates the application on the

selected cluster. After all the resources of the application are installed and detected by Astra, the application goes to the Available state.

Applications

Actions

+ Define

Search

★

🔍

110

🚫

🔄

1-2 of 2 entries

<

>

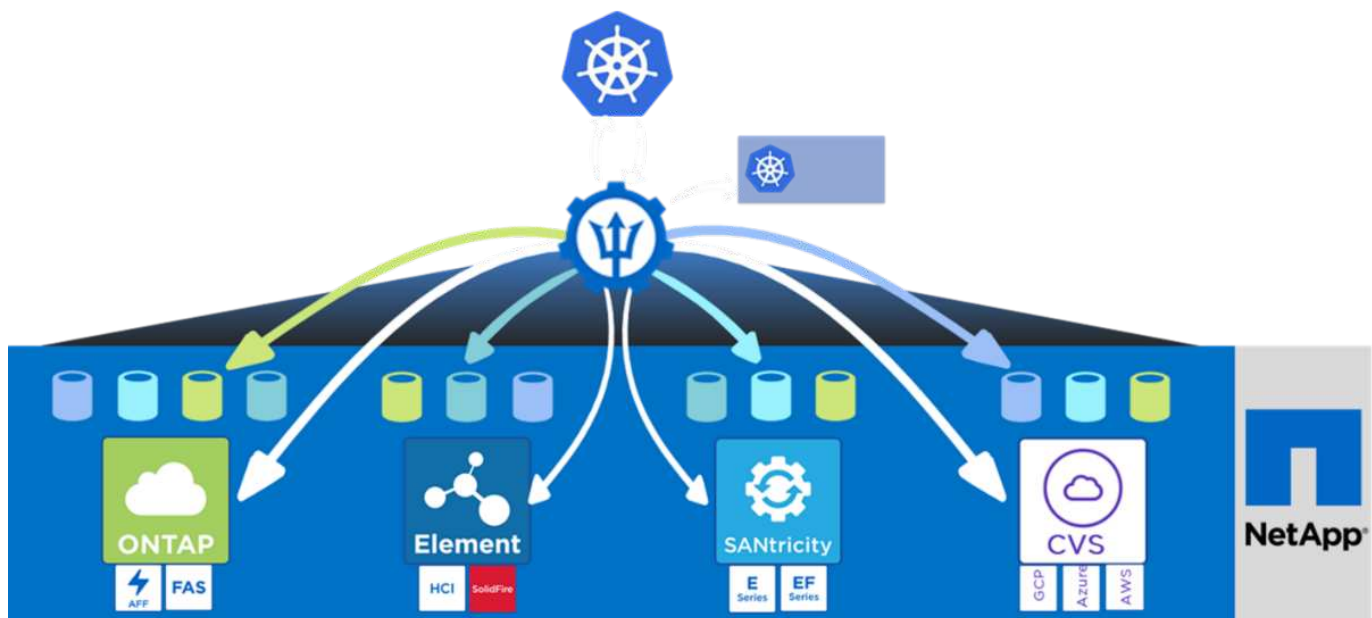
| <input type="checkbox"/> | Name ↓ | Ready | Protected | Cluster | Group | Discovered | Actions |
|--------------------------|--------------------------|-------|--------------|--------------------------------------|-----------------------|----------------------|-----------------------------------|
| <input type="checkbox"/> | wp | ✔ | <div>🔒</div> | <div>🔄</div> ocp-vmw | <div>📁</div> wp | 2022/02/28 18:34 UTC | <div>Available</div> <div>▼</div> |
| <input type="checkbox"/> | wp-clone | ✔ | <div>⚠</div> | <div>🔄</div> ocp-vmw | <div>📁</div> wp-clone | 2022/02/28 19:21 UTC | <div>Available</div> <div>▼</div> |

Next: [Solution Validation/Use Cases](#).

Astra Trident Overview

Astra Trident is an open-source and fully supported storage orchestrator for containers and Kubernetes distributions, including Red Hat OpenShift. Trident works with the entire NetApp storage portfolio, including the NetApp ONTAP and Element storage systems, and it also supports NFS and iSCSI connections. Trident accelerates the DevOps workflow by allowing end users to provision and manage storage from their NetApp storage systems without requiring intervention from a storage administrator.

An administrator can configure a number of storage backends based on project needs and storage system models that enable advanced storage features, including compression, specific disk types, or QoS levels that guarantee a certain level of performance. After they are defined, these backends can be used by developers in their projects to create persistent volume claims (PVCs) and to attach persistent storage to their containers on demand.



Astra Trident has a rapid development cycle, and just like Kubernetes, is released four times a year.

The latest version of Astra Trident is 22.01 released in January 2022. A support matrix for what version of Trident has been tested with which Kubernetes distribution can be found [here](#).

Starting with the 20.04 release, Trident setup is performed by the Trident operator. The operator makes large scale deployments easier and provides additional support including self healing for pods that are deployed as a part of the Trident install.

With the 21.01 release, a Helm chart was made available to ease the installation of the Trident Operator.

Download Astra Trident

To install Trident on the deployed user cluster and provision a persistent volume, complete the following steps:

1. Download the installation archive to the admin workstation and extract the contents. The current version of Trident is 22.01, which can be downloaded [here](#).

```
[netapp-user@rhel7 ~]$ wget
https://github.com/NetApp/trident/releases/download/v22.01.0/trident-
installer-22.01.0.tar.gz
--2021-05-06 15:17:30--
https://github.com/NetApp/trident/releases/download/v22.01.0/trident-
installer-22.01.0.tar.gz
Resolving github.com (github.com)... 140.82.114.3
Connecting to github.com (github.com)|140.82.114.3|:443... connected.
HTTP request sent, awaiting response... 302 Found
Location: https://github-
releases.githubusercontent.com/77179634/a4fa9f00-a9f2-11eb-9053-
98e8e573d4ae?X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-
Credential=AKIAIWNJYAX4CSVEH53A%2F20210506%2Fus-east-
1%2Fs3%2Faws4_request&X-Amz-Date=20210506T191643Z&X-Amz-Expires=300&X-
Amz-
Signature=8a49a2a1e08c147d1ddd8149ce45a5714f9853fee19bb1c507989b9543eb36
30&X-Amz-
SignedHeaders=host&actor_id=0&key_id=0&repo_id=77179634&response-
content-disposition=attachment%3B%20filename%3Dtrident-installer-
22.01.0.tar.gz&response-content-type=application%2Foctet-stream
[following]
--2021-05-06 15:17:30-- https://github-
releases.githubusercontent.com/77179634/a4fa9f00-a9f2-11eb-9053-
98e8e573d4ae?X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-
Credential=AKIAIWNJYAX4CSVEH53A%2F20210506%2Fus-east-
1%2Fs3%2Faws4_request&X-Amz-Date=20210506T191643Z&X-Amz-Expires=300&X-
Amz-
Signature=8a49a2a1e08c147d1ddd8149ce45a5714f9853fee19bb1c507989b9543eb36
30&X-Amz-
SignedHeaders=host&actor_id=0&key_id=0&repo_id=77179634&response-
content-disposition=attachment%3B%20filename%3Dtrident-installer-
22.01.0.tar.gz&response-content-type=application%2Foctet-stream
```

```
Resolving github-releases.githubusercontent.com (github-
releases.githubusercontent.com)... 185.199.108.154, 185.199.109.154,
185.199.110.154, ...
Connecting to github-releases.githubusercontent.com (github-
releases.githubusercontent.com)|185.199.108.154|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 38349341 (37M) [application/octet-stream]
Saving to: 'trident-installer-22.01.0.tar.gz'
```

```
100%[=====
=====>] 38,349,341  88.5MB/s
in 0.4s
```

```
2021-05-06 15:17:30 (88.5 MB/s) - 'trident-installer-22.01.0.tar.gz'
saved [38349341/38349341]
```

2. Extract the Trident install from the downloaded bundle.

```
[netapp-user@rhel7 ~]$ tar -xzf trident-installer-22.01.0.tar.gz
[netapp-user@rhel7 ~]$ cd trident-installer/
[netapp-user@rhel7 trident-installer]$
```

Install the Trident Operator with Helm

1. First set the location of the user cluster's `kubeconfig` file as an environment variable so that you don't have to reference it, because Trident has no option to pass this file.

```
[netapp-user@rhel7 trident-installer]$ export KUBECONFIG=~/.ocp-
install/auth/kubeconfig
```

2. Run the Helm command to install the Trident operator from the tarball in the helm directory while creating the trident namespace in your user cluster.

```
[netapp-user@rhel7 trident-installer]$ helm install trident
helm/trident-operator-22.01.0.tgz --create-namespace --namespace trident
NAME: trident
LAST DEPLOYED: Fri May  7 12:54:25 2021
NAMESPACE: trident
STATUS: deployed
REVISION: 1
TEST SUITE: None
NOTES:
Thank you for installing trident-operator, which will deploy and manage
NetApp's Trident CSI
storage provisioner for Kubernetes.

Your release is named 'trident' and is installed into the 'trident'
namespace.
Please note that there must be only one instance of Trident (and
trident-operator) in a Kubernetes cluster.

To configure Trident to manage storage resources, you will need a copy
of tridentctl, which is
available in pre-packaged Trident releases. You may find all Trident
releases and source code
online at https://github.com/NetApp/trident.

To learn more about the release, try:

$ helm status trident
$ helm get all trident
```

3. You can verify that Trident is successfully installed by checking the pods that are running in the namespace or by using the tridentctl binary to check the installed version.

```
[netapp-user@rhel7 trident-installer]$ oc get pods -n trident
```

| NAME | READY | STATUS | RESTARTS | AGE |
|----------------------------------|-------|---------|----------|-----|
| trident-csi-5z451 | 1/2 | Running | 2 | 30s |
| trident-csi-696b685cf8-htdb2 | 6/6 | Running | 0 | 30s |
| trident-csi-b74p2 | 2/2 | Running | 0 | 30s |
| trident-csi-lrw4n | 2/2 | Running | 0 | 30s |
| trident-operator-7c748d957-gr2gw | 1/1 | Running | 0 | 36s |

```
[netapp-user@rhel7 trident-installer]$ ./tridentctl -n trident version
```

| SERVER VERSION | CLIENT VERSION |
|----------------|----------------|
| 22.01.0 | 22.01.0 |



In some cases, customer environments might require the customization of the Trident deployment. In these cases, it is also possible to manually install the Trident operator and update the included manifests to customize the deployment.

Manually install the Trident Operator

1. First, set the location of the user cluster's `kubeconfig` file as an environment variable so that you don't have to reference it, because Trident has no option to pass this file.

```
[netapp-user@rhel7 trident-installer]$ export KUBECONFIG=~/.ocp-install/auth/kubeconfig
```

2. The `trident-installer` directory contains manifests for defining all the required resources. Using the appropriate manifests, create the `TridentOrchestrator` custom resource definition.

```
[netapp-user@rhel7 trident-installer]$ oc create -f
deploy/crds/trident.netapp.io_tridentorchestrators_crd_post1.16.yaml
customresourcedefinition.apiextensions.k8s.io/tridentorchestrators.trident.netapp.io created
```

3. If one does not exist, create a Trident namespace in your cluster using the provided manifest.

```
[netapp-user@rhel7 trident-installer]$ oc apply -f deploy/namespace.yaml
namespace/trident created
```

4. Create the resources required for the Trident operator deployment, such as a `ServiceAccount` for the operator, a `ClusterRole` and `ClusterRoleBinding` to the `ServiceAccount`, a dedicated

PodSecurityPolicy, or the operator itself.

```
[netapp-user@rhel7 trident-installer]$ oc create -f deploy/bundle.yaml
serviceaccount/trident-operator created
clusterrole.rbac.authorization.k8s.io/trident-operator created
clusterrolebinding.rbac.authorization.k8s.io/trident-operator created
deployment.apps/trident-operator created
podsecuritypolicy.policy/tridentoperatorpods created
```

5. You can check the status of the operator after it's deployed with the following commands:

```
[netapp-user@rhel7 trident-installer]$ oc get deployment -n trident
NAME                READY    UP-TO-DATE    AVAILABLE    AGE
trident-operator    1/1      1              1            23s
[netapp-user@rhel7 trident-installer]$ oc get pods -n trident
NAME                                READY    STATUS    RESTARTS    AGE
trident-operator-66f48895cc-lzczk    1/1      Running    0            41s
```

6. With the operator deployed, we can now use it to install Trident. This requires creating a `TridentOrchestrator`.

```
[netapp-user@rhel7 trident-installer]$ oc create -f
deploy/crds/tridentorchestrator_cr.yaml
tridentorchestrator.trident.netapp.io/trident created
[netapp-user@rhel7 trident-installer]$ oc describe torc trident
Name:                trident
Namespace:
Labels:               <none>
Annotations:          <none>
API Version:          trident.netapp.io/v1
Kind:                 TridentOrchestrator
Metadata:
  Creation Timestamp:  2021-05-07T17:00:28Z
  Generation:          1
  Managed Fields:
    API Version:        trident.netapp.io/v1
    Fields Type:         FieldsV1
    fieldsV1:
      f:spec:
        .:
        f:debug:
        f:namespace:
  Manager:             kubect1-create
  Operation:            Update
```

```

Time:          2021-05-07T17:00:28Z
API Version:   trident.netapp.io/v1
Fields Type:   FieldsV1
fieldsV1:
  f:status:
    .:
    f:currentInstallationParams:
      .:
      f:IPv6:
      f:autosupportHostname:
      f:autosupportImage:
      f:autosupportProxy:
      f:autosupportSerialNumber:
      f:debug:
      f:enableNodePrep:
      f:imagePullSecrets:
      f:imageRegistry:
      f:k8sTimeout:
      f:kubeletDir:
      f:logFormat:
      f:silenceAutosupport:
      f:tridentImage:
    f:message:
    f:namespace:
    f:status:
    f:version:
  Manager:      trident-operator
  Operation:    Update
  Time:         2021-05-07T17:00:28Z
  Resource Version: 931421
  Self Link:
/apis/trident.netapp.io/v1/tridentorchestrators/trident
  UID:          8a26a7a6-dde8-4d55-9b66-a7126754d81f
Spec:
  Debug:        true
  Namespace:    trident
Status:
  Current Installation Params:
    IPv6:          false
    Autosupport Hostname:
    Autosupport Image:      netapp/trident-autosupport:21.01
    Autosupport Proxy:
    Autosupport Serial Number:
    Debug:              true
    Enable Node Prep:    false
    Image Pull Secrets:

```

```

Image Registry:
k8sTimeout:      30
Kubelet Dir:     /var/lib/kubelet
Log Format:      text
Silence Autosupport: false
Trident Image:   netapp/trident:22.01.0
Message:         Trident installed
Namespace:       trident
Status:          Installed
Version:         v22.01.0

Events:
  Type    Reason          Age   From                                Message
  ----    -
Normal    Installing      80s   trident-operator.netapp.io         Installing
Trident
Normal    Installed       68s   trident-operator.netapp.io         Trident
installed

```

7. You can verify that Trident is successfully installed by checking the pods that are running in the namespace or by using the `tridentctl` binary to check the installed version.

```

[netapp-user@rhel7 trident-installer]$ oc get pods -n trident
NAME                                READY   STATUS    RESTARTS   AGE
trident-csi-bb64c6cb4-lmd6h         6/6     Running   0           82s
trident-csi-gn59q                    2/2     Running   0           82s
trident-csi-m4szj                    2/2     Running   0           82s
trident-csi-sb9k9                    2/2     Running   0           82s
trident-operator-66f48895cc-lzczk    1/1     Running   0           2m39s

[netapp-user@rhel7 trident-installer]$ ./tridentctl -n trident version
+-----+-----+
| SERVER VERSION | CLIENT VERSION |
+-----+-----+
| 22.01.0        | 22.01.0        |
+-----+-----+

```

Prepare worker nodes for storage

NFS

Most Kubernetes distributions come with the packages and utilities to mount NFS backends installed by default, including Red Hat OpenShift.

However, for NFSv3, there is no mechanism to negotiate concurrency between the client and the server. Hence the maximum number of client-side sunrpc slot table entries must be manually synced with supported value on the server to ensure the best performance for the NFS connection without the server having to

decrease the window size of the connection.

For ONTAP, the supported maximum number of sunrpc slot table entries is 128 i.e. ONTAP can serve 128 concurrent NFS requests at a time. However, by default, Red Hat CoreOS/Red Hat Enterprise Linux has maximum of 65,536 sunrpc slot table entries per connection. We need to set this value to 128 and this can be done using Machine Config Operator (MCO) in OpenShift.

To modify the maximum sunrpc slot table entries in OpenShift worker nodes, complete the following steps:

1. Log into the OCP web console and navigate to Compute > Machine Configs. Click Create Machine Config. Copy and paste the YAML file and click Create.

```
apiVersion: machineconfiguration.openshift.io/v1
kind: MachineConfig
metadata:
  name: 98-worker-nfs-rpc-slot-tables
  labels:
    machineconfiguration.openshift.io/role: worker
spec:
  config:
    ignition:
      version: 3.2.0
    storage:
      files:
        - contents:
            source: data:text/plain;charset=utf-8;base64,b3B0aW9ucyBzdW5ycGMgdGNwX21heF9zbG90X3RhYmxlX2VudHJpZXM9MTI4Cg==
            filesystem: root
            mode: 420
            path: /etc/modprobe.d/sunrpc.conf
```

2. After the MCO is created, the configuration needs to be applied on all worker nodes and rebooted one by one. The whole process takes approximately 20 to 30 minutes. Verify whether the machine config is applied by using `oc get mcp` and make sure that the machine config pool for workers is updated.

```
[netapp-user@rhel7 openshift-deploy]$ oc get mcp
```

| NAME | CONFIG | UPDATED | UPDATING |
|----------|--|---------|----------|
| DEGRADED | | | |
| master | rendered-master-a520ae930e1d135e0dee7168 | True | False |
| False | | | |
| worker | rendered-worker-de321b36eeba62df41feb7bc | True | False |
| False | | | |

iSCSI

To prepare worker nodes to allow for the mapping of block storage volumes through the iSCSI protocol, you must install the necessary packages to support that functionality.

In Red Hat OpenShift, this is handled by applying an MCO (Machine Config Operator) to your cluster after it is deployed.

To configure the worker nodes to run iSCSI services, complete the following steps:

1. Log into the OCP web console and navigate to Compute > Machine Configs. Click Create Machine Config. Copy and paste the YAML file and click Create.

When not using multipathing:

```
apiVersion: machineconfiguration.openshift.io/v1
kind: MachineConfig
metadata:
  labels:
    machineconfiguration.openshift.io/role: worker
  name: 99-worker-element-iscsi
spec:
  config:
    ignition:
      version: 3.2.0
    systemd:
      units:
        - name: iscsid.service
          enabled: true
          state: started
  osImageURL: ""
```

When using multipathing:

```

apiVersion: machineconfiguration.openshift.io/v1
kind: MachineConfig
metadata:
  name: 99-worker-ontap-iscsi
  labels:
    machineconfiguration.openshift.io/role: worker
spec:
  config:
    ignition:
      version: 3.2.0
    storage:
      files:
      - contents:
          source: data:text/plain;charset=utf-8;base64,ZGVmYXVsdHMgewogICAgICAgIHVzZXJfZnJpZW5kbHlfbmFtZXMgYm8KICAgICAgICBmaW5kX211bHRpcGF0aHMgYm8KfQoKYmxhY2tsaXN0X2V4Y2VwdGlvbnMgewogICAgICAgIHByb3BlcnR5ICIoU0NTSV9JREV0VF98SURfV1dOKSfQoKYmxhY2tsaXN0IHsKfQoK
          verification: {}
        filesystem: root
        mode: 400
        path: /etc/multipath.conf
    systemd:
      units:
      - name: iscsid.service
        enabled: true
        state: started
      - name: multipathd.service
        enabled: true
        state: started
  osImageURL: ""

```

2. After the configuration is created, it takes approximately 20 to 30 minutes to apply the configuration to the worker nodes and reload them. Verify whether the machine config is applied by using `oc get mcp` and make sure that the machine config pool for workers is updated. You can also log into the worker nodes to confirm that the `iscsid` service is running (and the `multipathd` service is running if using multipathing).

```
[netapp-user@rhel7 openshift-deploy]$ oc get mcp
NAME          CONFIG                                UPDATED    UPDATING
DEGRADED
master    rendered-master-a520ae930e1d135e0dee7168    True      False
False
worker    rendered-worker-de321b36eeba62df41feb7bc    True      False
False

[netapp-user@rhel7 openshift-deploy]$ ssh core@10.61.181.22 sudo
systemctl status iscsid
● iscsid.service - Open-iSCSI
   Loaded: loaded (/usr/lib/systemd/system/iscsid.service; enabled;
   vendor preset: disabled)
   Active: active (running) since Tue 2021-05-26 13:36:22 UTC; 3 min ago
     Docs: man:iscsid(8)
           man:iscsiadm(8)
  Main PID: 1242 (iscsid)
    Status: "Ready to process requests"
     Tasks: 1
   Memory: 4.9M
      CPU: 9ms
   CGroup: /system.slice/iscsid.service
           └─1242 /usr/sbin/iscsid -f

[netapp-user@rhel7 openshift-deploy]$ ssh core@10.61.181.22 sudo
systemctl status multipathd
● multipathd.service - Device-Mapper Multipath Device Controller
   Loaded: loaded (/usr/lib/systemd/system/multipathd.service; enabled;
   vendor preset: enabled)
   Active: active (running) since Tue 2021-05-26 13:36:22 UTC; 3 min ago
  Main PID: 918 (multipathd)
    Status: "up"
     Tasks: 7
   Memory: 13.7M
      CPU: 57ms
   CGroup: /system.slice/multipathd.service
           └─918 /sbin/multipathd -d -s
```



It is also possible to confirm that the MachineConfig has been successfully applied and services have been started as expected by running the `oc debug` command with the appropriate flags.

Create storage-system backends

After completing the Astra Trident Operator install, you must configure the backend for the specific NetApp storage platform you are using. Follow the links below in order to continue the setup and configuration of Astra Trident.

- [NetApp ONTAP NFS](#)
- [NetApp ONTAP iSCSI](#)
- [NetApp Element iSCSI](#)

Next: [Solution Validation/Use Cases: Red Hat OpenShift with NetApp](#).

NetApp ONTAP NFS configuration

To enable Trident integration with the NetApp ONTAP storage system, you must create a backend that enables communication with the storage system.

1. There are sample backend files available in the downloaded installation archive in the `sample-input` folder hierarchy. For NetApp ONTAP systems serving NFS, copy the `backend-ontap-nas.json` file to your working directory and edit the file.

```
[netapp-user@rhel7 trident-installer]$ cp sample-input/backends-samples/ontap-nas/backend-ontap-nas.json ./
[netapp-user@rhel7 trident-installer]$ vi backend-ontap-nas.json
```

2. Edit the `backendName`, `managementLIF`, `dataLIF`, `svm`, `username`, and `password` values in this file.

```
{
  "version": 1,
  "storageDriverName": "ontap-nas",
  "backendName": "ontap-nas+10.61.181.221",
  "managementLIF": "172.21.224.201",
  "dataLIF": "10.61.181.221",
  "svm": "trident_svm",
  "username": "cluster-admin",
  "password": "password"
}
```



It is a best practice to define the custom `backendName` value as a combination of the `storageDriverName` and the `dataLIF` that is serving NFS for easy identification.

3. With this backend file in place, run the following command to create your first backend.


```
[netapp-user@rhel7 trident-installer]$ ./tridentctl -n trident create
backend -f backend-ontap-nas.json
```

| NAME | STATE | VOLUMES | STORAGE DRIVER | UUID |
|-------------------------|--------|---------|----------------|--------------------------------------|
| ontap-nas+10.61.181.221 | online | 0 | ontap-nas | be7a619d-c81d-445c-b80c-5c87a73c5b1e |

4. With the backend created, you must next create a storage class. Just as with the backend, there is a sample storage class file that can be edited for the environment available in the sample-inputs folder. Copy it to the working directory and make necessary edits to reflect the backend created.

```
[netapp-user@rhel7 trident-installer]$ cp sample-input/storage-class-
samples/storage-class-csi.yaml.tmpl ./storage-class-basic.yaml
[netapp-user@rhel7 trident-installer]$ vi storage-class-basic.yaml
```

5. The only edit that must be made to this file is to define the `backendType` value to the name of the storage driver from the newly created backend. Also note the `name-field` value, which must be referenced in a later step.

```
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  name: basic-csi
provisioner: csi.trident.netapp.io
parameters:
  backendType: "ontap-nas"
```



There is an optional field called `fsType` that is defined in this file. This line can be deleted in NFS backends.

6. Run the `oc` command to create the storage class.

```
[netapp-user@rhel7 trident-installer]$ oc create -f storage-class-
basic.yaml
storageclass.storage.k8s.io/basic-csi created
```

7. With the storage class created, you must then create the first persistent volume claim (PVC). There is a sample `pvc-basic.yaml` file that can be used to perform this action located in `sample-inputs` as well.

```
[netapp-user@rhel7 trident-installer]$ cp sample-input/pvc-samples/pvc-basic.yaml ./
[netapp-user@rhel7 trident-installer]$ vi pvc-basic.yaml
```

8. The only edit that must be made to this file is ensuring that the `storageClassName` field matches the one just created. The PVC definition can be further customized as required by the workload to be provisioned.

```
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: basic
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 1Gi
  storageClassName: basic-csi
```

9. Create the PVC by issuing the `oc` command. Creation can take some time depending on the size of the backing volume being created, so you can watch the process as it completes.

```
[netapp-user@rhel7 trident-installer]$ oc create -f pvc-basic.yaml
persistentvolumeclaim/basic created

[netapp-user@rhel7 trident-installer]$ oc get pvc
NAME          STATUS    VOLUME                                     CAPACITY
ACCESS MODES  STORAGECLASS  AGE
basic         Bound        pvc-b4370d37-0fa4-4c17-bd86-94f96c94b42d  1Gi
RWO           basic-csi     7s
```

[Next: Solution validation/use cases.](#)

NetApp ONTAP iSCSI configuration

To enable Trident integration with the NetApp ONTAP storage system, you must create a backend that enables communication with the storage system.

1. There are sample backend files available in the downloaded installation archive in the `sample-input` folder hierarchy. For NetApp ONTAP systems serving iSCSI, copy the `backend-ontap-san.json` file to your working directory and edit the file.

```
[netapp-user@rhel7 trident-installer]$ cp sample-input/backends-samples/ontap-san/backend-ontap-san.json ./
[netapp-user@rhel7 trident-installer]$ vi backend-ontap-san.json
```

2. Edit the managementLIF, dataLIF, svm, username, and password values in this file.

```
{
  "version": 1,
  "storageDriverName": "ontap-san",
  "managementLIF": "172.21.224.201",
  "dataLIF": "10.61.181.240",
  "svm": "trident_svm",
  "username": "admin",
  "password": "password"
}
```

3. With this backend file in place, run the following command to create your first backend.

```
[netapp-user@rhel7 trident-installer]$ ./tridentctl -n trident create
backend -f backend-ontap-san.json
+-----+-----+
+-----+-----+-----+-----+
|          NAME          | STORAGE DRIVER |          UUID          |
| STATE | VOLUMES |          |          |          |
+-----+-----+-----+-----+
+-----+-----+-----+-----+
| ontapsan_10.61.181.241 | ontap-san      | 6788533c-7fea-4a35-b797- |
| fb9bb3322b91 | online |          0 |          |
+-----+-----+-----+-----+
+-----+-----+-----+-----+
```

4. With the backend created, you must next create a storage class. Just as with the backend, there is a sample storage class file that can be edited for the environment available in the sample-inputs folder. Copy it to the working directory and make necessary edits to reflect the backend created.

```
[netapp-user@rhel7 trident-installer]$ cp sample-input/storage-class-samples/storage-class-csi.yaml.templ ./storage-class-basic.yaml
[netapp-user@rhel7 trident-installer]$ vi storage-class-basic.yaml
```

5. The only edit that must be made to this file is to define the backendType value to the name of the storage driver from the newly created backend. Also note the name-field value, which must be referenced in a later step.

```

apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  name: basic-csi
provisioner: csi.trident.netapp.io
parameters:
  backendType: "ontap-san"

```



There is an optional field called `fsType` that is defined in this file. In iSCSI backends, this value can be set to a specific Linux filesystem type (XFS, ext4, etc) or can be deleted to allow OpenShift to decide what filesystem to use.

6. Run the `oc` command to create the storage class.

```

[netapp-user@rhel7 trident-installer]$ oc create -f storage-class-
basic.yaml
storageclass.storage.k8s.io/basic-csi created

```

7. With the storage class created, you must then create the first persistent volume claim (PVC). There is a sample `pvc-basic.yaml` file that can be used to perform this action located in `sample-inputs` as well.

```

[netapp-user@rhel7 trident-installer]$ cp sample-input/pvc-samples/pvc-
basic.yaml ./
[netapp-user@rhel7 trident-installer]$ vi pvc-basic.yaml

```

8. The only edit that must be made to this file is ensuring that the `storageClassName` field matches the one just created. The PVC definition can be further customized as required by the workload to be provisioned.

```

kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: basic
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 1Gi
  storageClassName: basic-csi

```

9. Create the PVC by issuing the `oc` command. Creation can take some time depending on the size of the backing volume being created, so you can watch the process as it completes.

```
[netapp-user@rhel7 trident-installer]$ oc create -f pvc-basic.yaml
persistentvolumeclaim/basic created

[netapp-user@rhel7 trident-installer]$ oc get pvc
NAME      STATUS    VOLUME                                     CAPACITY
ACCESS MODES   STORAGECLASS  AGE
basic       Bound        pvc-7ceac1ba-0189-43c7-8f98-094719f7956c  1Gi
RWO           basic-csi     3s
```

Next: [Solution validation/use cases](#).

NetApp Element iSCSI configuration

To enable Trident integration with the NetApp Element storage system, you must create a backend that enables communication with the storage system using the iSCSI protocol.

1. There are sample backend files available in the downloaded installation archive in the `sample-input` folder hierarchy. For NetApp Element systems serving iSCSI, copy the `backend-solidfire.json` file to your working directory and edit the file.

```
[netapp-user@rhel7 trident-installer]$ cp sample-input/backends-
samples/solidfire/backend-solidfire.json ./
[netapp-user@rhel7 trident-installer]$ vi ./backend-solidfire.json
```

- a. Edit the user, password, and MVIP value on the `EndPoint` line.
- b. Edit the `SVIP` value.

```
{
  "version": 1,
  "storageDriverName": "solidfire-san",
  "Endpoint": "https://trident:password@172.21.224.150/json-
rpc/8.0",
  "SVIP": "10.61.180.200:3260",
  "TenantName": "trident",
  "Types": [{"Type": "Bronze", "Qos": {"minIOPS": 1000, "maxIOPS":
2000, "burstIOPS": 4000}},
            {"Type": "Silver", "Qos": {"minIOPS": 4000, "maxIOPS":
6000, "burstIOPS": 8000}},
            {"Type": "Gold", "Qos": {"minIOPS": 6000, "maxIOPS":
8000, "burstIOPS": 10000}}]
}
```

2. With this back-end file in place, run the following command to create your first backend.

```
[netapp-user@rhel7 trident-installer]$ ./tridentctl -n trident create
backend -f backend-solidfire.json
```

| NAME | STATE | VOLUMES | STORAGE DRIVER | UUID |
|-------------------------|--------|---------|----------------|--------------------------------------|
| solidfire_10.61.180.200 | online | 0 | solidfire-san | b90783ee-e0c9-49af-8d26-3ea87ce2efdf |

3. With the backend created, you must next create a storage class. Just as with the backend, there is a sample storage class file that can be edited for the environment available in the sample-inputs folder. Copy it to the working directory and make necessary edits to reflect the backend created.

```
[netapp-user@rhel7 trident-installer]$ cp sample-input/storage-class-
samples/storage-class-csi.yaml.templ ./storage-class-basic.yaml
[netapp-user@rhel7 trident-installer]$ vi storage-class-basic.yaml
```

4. The only edit that must be made to this file is to define the `backendType` value to the name of the storage driver from the newly created backend. Also note the `name-field` value, which must be referenced in a later step.

```
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  name: basic-csi
provisioner: csi.trident.netapp.io
parameters:
  backendType: "solidfire-san"
```



There is an optional field called `fsType` that is defined in this file. In iSCSI backends, this value can be set to a specific Linux filesystem type (XFS, ext4, and so on), or it can be deleted to allow OpenShift to decide what filesystem to use.

5. Run the `oc` command to create the storage class.

```
[netapp-user@rhel7 trident-installer]$ oc create -f storage-class-
basic.yaml
storageclass.storage.k8s.io/basic-csi created
```

6. With the storage class created, you must then create the first persistent volume claim (PVC). There is a sample `pvc-basic.yaml` file that can be used to perform this action located in `sample-inputs` as well.

```
[netapp-user@rhel7 trident-installer]$ cp sample-input/pvc-samples/pvc-basic.yaml ./
[netapp-user@rhel7 trident-installer]$ vi pvc-basic.yaml
```

7. The only edit that must be made to this file is ensuring that the `storageClassName` field matches the one just created. The PVC definition can be further customized as required by the workload to be provisioned.

```
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: basic
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 1Gi
  storageClassName: basic-csi
```

8. Create the PVC by issuing the `oc` command. Creation can take some time depending on the size of the backing volume being created, so you can watch the process as it completes.

```
[netapp-user@rhel7 trident-installer]$ oc create -f pvc-basic.yaml
persistentvolumeclaim/basic created

[netapp-user@rhel7 trident-installer]$ oc get pvc
NAME      STATUS    VOLUME                                     CAPACITY
ACCESS MODES  STORAGECLASS  AGE
basic      Bound       pvc-3445b5cc-df24-453d-a1e6-b484e874349d  1Gi
RWO                basic-csi          5s
```

[Next: Solution validation/use cases.](#)

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