



# Get started

## Astra Trident

NetApp  
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# Get started

## Try it out

NetApp provides a ready-to-use lab image that you can request through [NetApp Test Drive](#).

### Learn about the Test Drive

The Test Drive provides you with a sandbox environment that comes with a three-node Kubernetes cluster and Astra Trident installed and configured. It is a great way to familiarize yourself with Astra Trident and explore its features.

Another option is to see the [kubeadm Install Guide](#) provided by Kubernetes.



You should not use the Kubernetes cluster that you build using these instructions in production. Use the production deployment guides provided by your distribution for creating clusters that are production ready.

If this is the first time you're using Kubernetes, familiarize yourself with the concepts and tools [here](#).

## Requirements

Before installing Astra Trident you should review these general system requirements. Specific backends might have additional requirements.

### Critical information about Astra Trident 23.01

You must read the following critical information about Astra Trident.

#### Critical information about Astra Trident

- Kubernetes 1.27 is now supported in Trident. Upgrade Trident prior to upgrading Kubernetes.
- Astra Trident strictly enforces the use of multipathing configuration in SAN environments, with a recommended value of `find_multipaths: no` in `multipath.conf` file.

Use of non-multipathing configuration or use of `find_multipaths: yes` or `find_multipaths: smart` value in `multipath.conf` file will result in mount failures. Trident has recommended the use of `find_multipaths: no` since the 21.07 release.

### Supported frontends (orchestrators)

Astra Trident supports multiple container engines and orchestrators, including the following:

- Anthos On-Prem (VMware) and Anthos on bare metal 1.12
- Kubernetes 1.21 - 1.27
- Mirantis Kubernetes Engine 3.5

- OpenShift 4.9 - 4.12

The Trident operator is supported with these releases:

- Anthos On-Prem (VMware) and Anthos on bare metal 1.12
- Kubernetes 1.21 - 1.27
- OpenShift 4.9 - 4.12

Astra Trident also works with a host of other fully-managed and self-managed Kubernetes offerings, including Google Kubernetes Engine (GKE), Amazon Elastic Kubernetes Services (EKS), Azure Kubernetes Service (AKS), Rancher, and VMWare Tanzu Portfolio.



Before upgrading a Kubernetes cluster from 1.24 to 1.25 or later that has Astra Trident installed, see [Upgrade a Helm-based operator installation](#).

## Supported backends (storage)

To use Astra Trident, you need one or more of the following supported backends:

- Amazon FSx for NetApp ONTAP
- Azure NetApp Files
- Cloud Volumes ONTAP
- Cloud Volumes Service for GCP
- FAS/AFF/Select 9.5 or later
- NetApp All SAN Array (ASA)
- NetApp HCI/Element software 11 or above

## Feature requirements

The table below summarizes the features available with this release of Astra Trident and the versions of Kubernetes it supports.

Feature	Kubernetes version	Feature gates required?
CSI Trident	1.21 - 1.27	No
Volume Snapshots	1.21 - 1.27	No
PVC from Volume Snapshots	1.21 - 1.27	No
iSCSI PV resize	1.21 - 1.27	No
ONTAP Bidirectional CHAP	1.21 - 1.27	No
Dynamic Export Policies	1.21 - 1.27	No
Trident Operator	1.21 - 1.27	No

Feature	Kubernetes version	Feature gates required?
CSI Topology	1.21 - 1.27	No

## Tested host operating systems

Though Astra Trident does not officially support specific operating systems, the following are known to work:

- RedHat CoreOS (RHCOS) versions as supported by OpenShift Container Platform (AMD64 and ARM64)
- RHEL 8+ (AMD64 and ARM64)
- Ubuntu 22.04 or later (AMD64 and ARM64)
- Windows Server 2019 (AMD64)

By default, Astra Trident runs in a container and will, therefore, run on any Linux worker. However, those workers need to be able to mount the volumes that Astra Trident provides using the standard NFS client or iSCSI initiator, depending on the backends you are using.

The `tridentctl` utility also runs on any of these distributions of Linux.

## Host configuration

All worker nodes in the Kubernetes cluster must be able to mount the volumes you have provisioned for your pods. To prepare the worker nodes, you must install NFS or iSCSI tools based on your driver selection.

[Prepare the worker node](#)

## Storage system configuration

Astra Trident might require changes to a storage system before a backend configuration can use it.

[Configure backends](#)

## Astra Trident ports

Astra Trident requires access to specific ports for communication.

[Astra Trident ports](#)

## Container images and corresponding Kubernetes versions

For air-gapped installations, the following list is a reference of container images needed to install Astra Trident. Use the `tridentctl images` command to verify the list of needed container images.

Kubernetes version	Container image
v1.21.0	<ul style="list-style-type: none"> <li>• <a href="https://hub.docker.com/r/netapp/trident">docker.io/netapp/trident:23.04.0</a></li> <li>• <a href="https://hub.docker.com/r/netapp/trident-autosupport">docker.io/netapp/trident-autosupport:23.04</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/csi-provisioner">registry.k8s.io/sig-storage/csi-provisioner:v3.4.1</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/csi-attacher">registry.k8s.io/sig-storage/csi-attacher:v4.2.0</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/csi-resizer">registry.k8s.io/sig-storage/csi-resizer:v1.7.0</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/csi-snapshotter">registry.k8s.io/sig-storage/csi-snapshotter:v6.2.1</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/csi-node-driver-registrar">registry.k8s.io/sig-storage/csi-node-driver-registrar:v2.7.0</a></li> <li>• <a href="https://hub.docker.com/r/netapp/trident-operator">docker.io/netapp/trident-operator:23.04.0</a> (optional)</li> </ul>
v1.22.0	<ul style="list-style-type: none"> <li>• <a href="https://hub.docker.com/r/netapp/trident">docker.io/netapp/trident:23.04.0</a></li> <li>• <a href="https://hub.docker.com/r/netapp/trident-autosupport">docker.io/netapp/trident-autosupport:23.04</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/csi-provisioner">registry.k8s.io/sig-storage/csi-provisioner:v3.4.1</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/csi-attacher">registry.k8s.io/sig-storage/csi-attacher:v4.2.0</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/csi-resizer">registry.k8s.io/sig-storage/csi-resizer:v1.7.0</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/csi-snapshotter">registry.k8s.io/sig-storage/csi-snapshotter:v6.2.1</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/csi-node-driver-registrar">registry.k8s.io/sig-storage/csi-node-driver-registrar:v2.7.0</a></li> <li>• <a href="https://hub.docker.com/r/netapp/trident-operator">docker.io/netapp/trident-operator:23.04.0</a> (optional)</li> </ul>
v1.23.0	<ul style="list-style-type: none"> <li>• <a href="https://hub.docker.com/r/netapp/trident">docker.io/netapp/trident:23.04.0</a></li> <li>• <a href="https://hub.docker.com/r/netapp/trident-autosupport">docker.io/netapp/trident-autosupport:23.04</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/csi-provisioner">registry.k8s.io/sig-storage/csi-provisioner:v3.4.1</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/csi-attacher">registry.k8s.io/sig-storage/csi-attacher:v4.2.0</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/csi-resizer">registry.k8s.io/sig-storage/csi-resizer:v1.7.0</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/csi-snapshotter">registry.k8s.io/sig-storage/csi-snapshotter:v6.2.1</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/csi-node-driver-registrar">registry.k8s.io/sig-storage/csi-node-driver-registrar:v2.7.0</a></li> <li>• <a href="https://hub.docker.com/r/netapp/trident-operator">docker.io/netapp/trident-operator:23.04.0</a> (optional)</li> </ul>

Kubernetes version	Container image
v1.24.0	<ul style="list-style-type: none"> <li>• <a href="https://registry.k8s.io/netapp/ Trident">docker.io/netapp/trident:23.04.0</a></li> <li>• <a href="https://registry.k8s.io/netapp/ Trident">docker.io/netapp/trident-autosupport:23.04</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/ CSI">registry.k8s.io/sig-storage/csi-provisioner:v3.4.1</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/ CSI">registry.k8s.io/sig-storage/csi-attacher:v4.2.0</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/ CSI">registry.k8s.io/sig-storage/csi-resizer:v1.7.0</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/ CSI">registry.k8s.io/sig-storage/csi-snapshotter:v6.2.1</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/ CSI">registry.k8s.io/sig-storage/csi-node-driver-registrar:v2.7.0</a></li> <li>• <a href="https://registry.k8s.io/netapp/ Trident">docker.io/netapp/trident-operator:23.04.0</a> (optional)</li> </ul>
v1.25.0	<ul style="list-style-type: none"> <li>• <a href="https://registry.k8s.io/netapp/ Trident">docker.io/netapp/trident:23.04.0</a></li> <li>• <a href="https://registry.k8s.io/netapp/ Trident">docker.io/netapp/trident-autosupport:23.04</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/ CSI">registry.k8s.io/sig-storage/csi-provisioner:v3.4.1</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/ CSI">registry.k8s.io/sig-storage/csi-attacher:v4.2.0</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/ CSI">registry.k8s.io/sig-storage/csi-resizer:v1.7.0</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/ CSI">registry.k8s.io/sig-storage/csi-snapshotter:v6.2.1</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/ CSI">registry.k8s.io/sig-storage/csi-node-driver-registrar:v2.7.0</a></li> <li>• <a href="https://registry.k8s.io/netapp/ Trident">docker.io/netapp/trident-operator:23.04.0</a> (optional)</li> </ul>
v1.26.0	<ul style="list-style-type: none"> <li>• <a href="https://registry.k8s.io/netapp/ Trident">docker.io/netapp/trident:23.04.0</a></li> <li>• <a href="https://registry.k8s.io/netapp/ Trident">docker.io/netapp/trident-autosupport:23.04</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/ CSI">registry.k8s.io/sig-storage/csi-provisioner:v3.4.1</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/ CSI">registry.k8s.io/sig-storage/csi-attacher:v4.2.0</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/ CSI">registry.k8s.io/sig-storage/csi-resizer:v1.7.0</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/ CSI">registry.k8s.io/sig-storage/csi-snapshotter:v6.2.1</a></li> <li>• <a href="https://registry.k8s.io/sig-storage/ CSI">registry.k8s.io/sig-storage/csi-node-driver-registrar:v2.7.0</a></li> <li>• <a href="https://registry.k8s.io/netapp/ Trident">docker.io/netapp/trident-operator:23.04.0</a> (optional)</li> </ul>

Kubernetes version	Container image
v1.27.0	<ul style="list-style-type: none"> <li>• <code>docker.io/netapp/trident:23.04.0</code></li> <li>• <code>docker.io/netapp/trident-autosupport:23.04</code></li> <li>• <code>registry.k8s.io/sig-storage/csi-provisioner:v3.4.1</code></li> <li>• <code>registry.k8s.io/sig-storage/csi-attacher:v4.2.0</code></li> <li>• <code>registry.k8s.io/sig-storage/csi-resizer:v1.7.0</code></li> <li>• <code>registry.k8s.io/sig-storage/csi-snapshotter:v6.2.1</code></li> <li>• <code>registry.k8s.io/sig-storage/csi-node-driver-registrar:v2.7.0</code></li> <li>• <code>docker.io/netapp/trident-operator:23.04.0</code> (optional)</li> </ul>



On Kubernetes version 1.21 and above, use the validated `registry.k8s.gcr.io/sig-storage/csi-snapshotter:v6.x` image only if the `v1` version is serving the `volumesnapshots.snapshot.storage.k8s.gcr.io` CRD. If the `v1beta1` version is serving the CRD with/without the `v1` version, use the validated `registry.k8s.gcr.io/sig-storage/csi-snapshotter:v3.x` image.

## Install Astra Trident

### Learn about Astra Trident installation

To ensure Astra Trident can be installed in a wide variety of environments and organizations, NetApp offers multiple installation options. You can install Astra Trident using the Trident operator (manually or using Helm) or with `tridentctl`. This topic provides important information for selecting the right installation process for you.

#### Critical information about Astra Trident 23.04

You must read the following critical information about Astra Trident.

#### Critical information about Astra Trident

- Kubernetes 1.27 is now supported in Trident. Upgrade Trident prior to upgrading Kubernetes.
- Astra Trident strictly enforces the use of multipathing configuration in SAN environments, with a recommended value of `find_multipaths: no` in `multipath.conf` file.

Use of non-multipathing configuration or use of `find_multipaths: yes` or `find_multipaths: smart` value in `multipath.conf` file will result in mount failures. Trident has recommended the use of `find_multipaths: no` since the 21.07 release.

#### Before you begin

Regardless of your installation path, you must have:



- Full privileges to a supported Kubernetes cluster running a supported version of Kubernetes and feature requirements enabled. Review the [requirements](#) for details.
- Access to a supported NetApp storage system.
- Capability to mount volumes from all of the Kubernetes worker nodes.
- A Linux host with `kubectl` (or `oc`, if you are using OpenShift) installed and configured to manage the Kubernetes cluster that you want to use.
- The `KUBECONFIG` environment variable set to point to your Kubernetes cluster configuration.
- If you are using Kubernetes with Docker Enterprise, [follow their steps to enable CLI access](#).



If you have not familiarized yourself with the [basic concepts](#), now is a great time to do that.

## Choose your installation method

Select the installation method that's right for you. You should also review the considerations for [moving between methods](#) before making your decision.

### Using the Trident operator

Whether deploying manually or using Helm, the Trident operator is a great way to simplify installation and dynamically manage Astra Trident resources. You can even [customize your Trident operator deployment](#) using the attributes in the `TridentOrchestrator` custom resource (CR).

The benefits of using the Trident operator include:

### Astra Trident object creation

The Trident operator automatically creates the following objects for your Kubernetes version.

- ServiceAccount for the operator
- ClusterRole and ClusterRoleBinding to the ServiceAccount
- Dedicated PodSecurityPolicy (for Kubernetes 1.25 and earlier)
- The operator itself

### Self-healing capability

The operator monitors Astra Trident installation and actively takes measures to address issues, such as when the deployment is deleted or if it is accidentally modified. A `trident-operator-<generated-id>` pod is created that associates a `TridentOrchestrator` CR with an Astra Trident installation. This ensures there is only one instance of Astra Trident in the cluster and controls its setup, making sure the installation is idempotent. When changes are made to the installation (such as, deleting the deployment or node daemonset), the operator identifies them and fixes them individually.

## Easy updates to existing installations

You can easily update an existing deployment with the operator. You only need to edit the `TridentOrchestrator` CR to make updates to an installation.

For example, consider a scenario where you need to enable Astra Trident to generate debug logs. To do this, patch your `TridentOrchestrator` to set `spec.debug` to `true`:

```
kubectl patch torc <trident-orchestrator-name> -n trident --type=merge
-p '{"spec":{"debug":true}}'
```

After `TridentOrchestrator` is updated, the operator processes the updates and patches the existing installation. This might trigger the creation of new pods to modify the installation accordingly.

## Automatic Kubernetes upgrade handling

When the Kubernetes version of the cluster is upgraded to a supported version, the operator updates an existing Astra Trident installation automatically and changes it to ensure that it meets the requirements of the Kubernetes version.



If the cluster is upgraded to an unsupported version, the operator prevents installing Astra Trident. If Astra Trident has already been installed with the operator, a warning is displayed to indicate that Astra Trident is installed on an unsupported Kubernetes version.

## Kubernetes cluster management using BlueXP (formerly Cloud Manager)

With [Astra Trident using BlueXP](#), you can upgrade to the latest version of Astra Trident, add and manage storage classes and connect them to Working Environments, and back up persistent volumes using Cloud Backup Service. BlueXP supports Astra Trident deployment using the Trident operator, either manually or using Helm.

## Using `tridentctl`

If you have an existing deployment that must be upgraded or if you are looking to highly customize your deployment, you should consider [installing using `tridentctl`](#). This is the conventional method of deploying Astra Trident.

You can [customize your `tridentctl` installation](#) to generate the manifests for Trident resources. This includes the deployment, daemonset, service account, and the cluster role that Astra Trident creates as part of its installation.



Beginning with the 22.04 release, AES keys will no longer be regenerated every time Astra Trident is installed. With this release, Astra Trident will install a new secret object that persists across installations. This means, `tridentctl` in 22.04 can uninstall previous versions of Trident, but earlier versions cannot uninstall 22.04 installations. Select the appropriate installation *method*.

## Choose your installation mode

Determine your deployment process based on the *installation mode* (Standard, Offline, or Remote) required by your organization.

### Standard installation

This is the easiest way to install Astra Trident and works for most environments that do not impose network restrictions. Standard installation mode uses default registries to store required Trident (`docker.io`) and CSI (`registry.k8s.io`) images.

When you use standard mode, the Astra Trident installer:

- Fetches the container images over the Internet
- Creates a deployment or node daemonset, which spins up Astra Trident pods on all the eligible nodes in the Kubernetes cluster

### Offline installation

Offline installation mode might be required in an air-gapped or secure location. In this scenario, you can create a single private, mirrored registry or two mirrored registries to store required Trident and CSI images.



Regardless of your registry configuration, CSI images must reside in one registry.

### Remote installation

Here is a high-level overview of the remote installation process:

- Deploy the appropriate version of `kubectl` on the remote machine from where you want to deploy Astra Trident.
- Copy the configuration files from the Kubernetes cluster and set the `KUBECONFIG` environment variable on the remote machine.
- Initiate a `kubectl get nodes` command to verify that you can connect to the required Kubernetes cluster.
- Complete the deployment from the remote machine by using the standard installation steps.

## Select the process based on your method and mode

After you've made your decisions, select the appropriate process.

Method	Installation mode
Trident operator (manually)	<a href="#">Standard installation</a>
	<a href="#">Offline installation</a>
Trident operator (Helm)	<a href="#">Standard installation</a>
	<a href="#">Offline installation</a>

Method	Installation mode
tridentctl	<a href="#">Standard or offline installation</a>

## Moving between installation methods

You can decide to change your installation method. Before doing so, consider the following:

- Always use the same method for installing and uninstalling Astra Trident. If you have deployed with `tridentctl`, you should use the appropriate version of the `tridentctl` binary to uninstall Astra Trident. Similarly, if you are deploying with the operator, you should edit the `TridentOrchestrator` CR and set `spec.uninstall=true` to uninstall Astra Trident.
- If you have an operator-based deployment that you want to remove and use instead `tridentctl` to deploy Astra Trident, you should first edit `TridentOrchestrator` and set `spec.uninstall=true` to uninstall Astra Trident. Then delete `TridentOrchestrator` and the operator deployment. You can then install using `tridentctl`.
- If you have a manual operator-based deployment, and you want to use Helm-based Trident operator deployment, you should manually uninstall the operator first, and then perform the Helm install. This enables Helm to deploy the Trident operator with the required labels and annotations. If you do not do this, your Helm-based Trident operator deployment will fail with label validation error and annotation validation error. If you have a `tridentctl`-based deployment, you can use Helm-based deployment without running into issues.

## Other known configuration options

When installing Astra Trident on VMWare Tanzu Portfolio products:

- The cluster must support privileged workloads.
- The `--kubelet-dir` flag should be set to the location of kubelet directory. By default, this is `/var/vcap/data/kubelet`.

Specifying the kubelet location using `--kubelet-dir` is known to work for Trident Operator, Helm, and `tridentctl` deployments.

## Install using Trident operator

### Manually deploy the Trident operator (Standard mode)

You can manually deploy the Trident operator to install Astra Trident. This process applies to installations where the container images required by Astra Trident are not stored in a private registry. If you do have a private image registry, use the [process for offline deployment](#).

### Critical information about Astra Trident 23.04

You must read the following critical information about Astra Trident.

## Critical information about Astra Trident

- Kubernetes 1.27 is now supported in Trident. Upgrade Trident prior to upgrading Kubernetes.
- Astra Trident strictly enforces the use of multipathing configuration in SAN environments, with a recommended value of `find_multipaths: no` in `multipath.conf` file.

Use of non-multipathing configuration or use of `find_multipaths: yes` or `find_multipaths: smart` value in `multipath.conf` file will result in mount failures. Trident has recommended the use of `find_multipaths: no` since the 21.07 release.

## Manually deploy the Trident operator and install Trident

Review [the installation overview](#) to ensure you've met installation prerequisites and selected the correct installation option for your environment.

### Before you begin

Before you begin installation, log in to the Linux host and verify it is managing a working, [supported Kubernetes cluster](#) and that you have the necessary privileges.



With OpenShift, use `oc` instead of `kubectl` in all of the examples that follow, and log in as **system:admin** first by running `oc login -u system:admin` or `oc login -u kube-admin`.

1. Verify your Kubernetes version:

```
kubectl version
```

2. Verify cluster administrator privileges:

```
kubectl auth can-i '*' '*' --all-namespaces
```

3. Verify you can launch a pod that uses an image from Docker Hub and reach your storage system over the pod network:

```
kubectl run -i --tty ping --image=busybox --restart=Never --rm -- \
ping <management IP>
```

## Step 1: Download the Trident installer package

The Astra Trident installer package contains everything you need to deploy the Trident operator and install Astra Trident. Download and extract the latest version of the Trident installer from [the Assets section on GitHub](#).

```
wget https://github.com/NetApp/trident/releases/download/v23.04.0/trident-
installer-23.04.0.tar.gz
tar -xf trident-installer-23.04.0.tar.gz
cd trident-installer
```

## Step 2: Create the TridentOrchestrator CRD

Create the TridentOrchestrator Custom Resource Definition (CRD). You will create a TridentOrchestrator Custom Resources later. Use the appropriate CRD YAML version in `deploy/crds` to create the TridentOrchestrator CRD.

```
kubectl create -f
deploy/crds/trident.netapp.io_tridentorchestrators_crd_post1.16.yaml
```

## Step 3: Deploy the Trident operator

The Astra Trident installer provides a bundle file that can be used to install the operator and create associated objects. The bundle file is an easy way to deploy the operator and install Astra Trident using a default configuration.

- For clusters running Kubernetes 1.24 or earlier, use `bundle_pre_1_25.yaml`.
- For clusters running Kubernetes 1.25 or later, use `bundle_post_1_25.yaml`.

### Before you begin

- By default, the Trident installer deploys the operator in the `trident` namespace. If the `trident` namespace does not exist, create it using:

```
kubectl apply -f deploy/namespace.yaml
```

- To deploy the operator in a namespace other than the `trident` namespace, update `serviceaccount.yaml`, `clusterrolebinding.yaml` and `operator.yaml` and generate your bundle file using the `kustomization.yaml`.

1. Create the `kustomization.yaml` using the following command where `<bundle>` is `bundle_pre_1_25` or `bundle_post_1_25` based on your Kubernetes version.

```
cp kustomization_<bundle>.yaml kustomization.yaml
```

2. Compile the bundle using using the following command where `<bundle>` is `bundle_pre_1_25` or `bundle_post_1_25` based on your Kubernetes version.

```
kubectl kustomize deploy/ > deploy/<bundle>.yaml
```

## Steps

1. Create the resources and deploy the operator:

```
kubectl create -f deploy/<bundle>.yaml
```

2. Verify the operator, deployment, and replicaset were created.

```
kubectl get all -n <operator-namespace>
```



There should only be **one instance** of the operator in a Kubernetes cluster. Do not create multiple deployments of the Trident operator.

## Step 4: Create the `TridentOrchestrator` and install Trident

You can now create the `TridentOrchestrator` and install Astra Trident. Optionally, you can [customize your Trident installation](#) using the attributes in the `TridentOrchestrator` spec.

```

kubect1 create -f deploy/crds/tridentorchestrator_cr.yaml
tridentorchestrator.trident.netapp.io/trident created

kubect1 describe torc trident

Name:          trident
Namespace:
Labels:        <none>
Annotations:   <none>
API Version:   trident.netapp.io/v1
Kind:          TridentOrchestrator
...
Spec:
  Debug:       true
  Namespace:   trident
Status:
  Current Installation Params:
    IPv6:                false
    Autosupport Hostname:
    Autosupport Image:   netapp/trident-autosupport:23.04
    Autosupport Proxy:
    Autosupport Serial Number:
    Debug:               true
    Image Pull Secrets:
    Image Registry:
    k8sTimeout:          30
    Kubelet Dir:         /var/lib/kubelet
    Log Format:           text
    Silence Autosupport: false
    Trident Image:       netapp/trident:23.04.0
  Message:             Trident installed Namespace:
trident
  Status:              Installed
  Version:             v23.04.0
Events:
  Type Reason Age From Message ---- -
Installing 74s trident-operator.netapp.io Installing Trident Normal
Installed 67s trident-operator.netapp.io Trident installed

```

### Verify the installation

There are several ways to verify your installation.

### Using `TridentOrchestrator` status

The status of `TridentOrchestrator` indicates if the installation was successful and displays the version of



Trident installed. During the installation, the status of `TridentOrchestrator` changes from `Installing` to `Installed`. If you observe the `Failed` status and the operator is unable to recover by itself, [check the logs](#).

Status	Description
Installing	The operator is installing Astra Trident using this <code>TridentOrchestrator</code> CR.
Installed	Astra Trident has successfully installed.
Uninstalling	The operator is uninstalling Astra Trident, because <code>spec.uninstall=true</code> .
Uninstalled	Astra Trident is uninstalled.
Failed	The operator could not install, patch, update or uninstall Astra Trident; the operator will automatically try to recover from this state. If this state persists you will require troubleshooting.
Updating	The operator is updating an existing installation.
Error	The <code>TridentOrchestrator</code> is not used. Another one already exists.

### Using pod creation status

You can confirm if the Astra Trident installation completed by reviewing the status of the created pods:

```
kubectl get pods -n trident
```

NAME	READY	STATUS	RESTARTS
trident-controller-7d466bf5c7-v4cpw 1m	6/6	Running	0
trident-node-linux-mr6zc 1m	2/2	Running	0
trident-node-linux-xrp7w 1m	2/2	Running	0
trident-node-linux-zh2jt 1m	2/2	Running	0
trident-operator-766f7b8658-ldzsv 3m	1/1	Running	0

### Using `tridentctl`

You can use `tridentctl` to check the version of Astra Trident installed.

```
./tridentctl -n trident version
```

```
+-----+-----+
| SERVER VERSION | CLIENT VERSION |
+-----+-----+
| 23.04.0        | 23.04.0        |
+-----+-----+
```

### What's next

Now you can [create a backend and storage class, provision a volume, and mount the volume in a pod](#).

### Manually deploy the Trident operator (Offline mode)

You can manually deploy the Trident operator to install Astra Trident. This process applies to installations where the container images required by Astra Trident are stored in a private registry. If you do not have a private image registry, use the [process for standard deployment](#).

#### Critical information about Astra Trident 23.04

**You must read the following critical information about Astra Trident.**

#### Critical information about Astra Trident

- Kubernetes 1.27 is now supported in Trident. Upgrade Trident prior to upgrading Kubernetes.
- Astra Trident strictly enforces the use of multipathing configuration in SAN environments, with a recommended value of `find_multipaths: no` in `multipath.conf` file.

Use of non-multipathing configuration or use of `find_multipaths: yes` or `find_multipaths: smart` value in `multipath.conf` file will result in mount failures. Trident has recommended the use of `find_multipaths: no` since the 21.07 release.

### Manually deploy the Trident operator and install Trident

Review [the installation overview](#) to ensure you've met installation prerequisites and selected the correct installation option for your environment.

### Before you begin

Log in to the Linux host and verify it is managing a working and [supported Kubernetes cluster](#) and that you have the necessary privileges.



With OpenShift, use `oc` instead of `kubectl` in all of the examples that follow, and log in as **system:admin** first by running `oc login -u system:admin` or `oc login -u kube-admin`.

1. Verify your Kubernetes version:

```
kubectl version
```

2. Verify cluster administrator privileges:

```
kubectl auth can-i '*' '*' --all-namespaces
```

3. Verify you can launch a pod that uses an image from Docker Hub and reach your storage system over the pod network:

```
kubectl run -i --tty ping --image=busybox --restart=Never --rm -- \
ping <management IP>
```

### Step 1: Download the Trident installer package

The Astra Trident installer package contains everything you need to deploy the Trident operator and install Astra Trident. Download and extract the latest version of the Trident installer from [the Assets section on GitHub](#).

```
wget https://github.com/NetApp/trident/releases/download/v23.04.0/trident-
installer-23.04.0.tar.gz
tar -xf trident-installer-23.04.0.tar.gz
cd trident-installer
```

### Step 2: Create the `TridentOrchestrator` CRD

Create the `TridentOrchestrator` Custom Resource Definition (CRD). You will create a `TridentOrchestrator` Custom Resources later. Use the appropriate CRD YAML version in `deploy/crds` to create the `TridentOrchestrator` CRD:

```
kubectl create -f deploy/crds/<VERSION>.yaml
```

### Step 3: Update the registry location in the operator

In `/deploy/operator.yaml`, update `image: docker.io/netapp/trident-operator:23.04.0` to reflect the location of your image registry. Your [Trident and CSI images](#) can be located in one registry or different registries, but all CSI images must be located in the same registry. For example:

- `image: <your-registry>/trident-operator:23.04.0` if your images are all located in one registry.

- `image: <your-registry>/netapp/trident-operator:23.04.0` if your Trident image is located in a different registry from your CSI images.

#### Step 4: Deploy the Trident operator

The Astra Trident installer provides a bundle file that can be used to install the operator and create associated objects. The bundle file is an easy way to deploy the operator and install Astra Trident using a default configuration.

- For clusters running Kubernetes 1.24 or earlier, use `bundle_pre_1_25.yaml`.
- For clusters running Kubernetes 1.25 or later, use `bundle_post_1_25.yaml`.

#### Before you begin

- By default, the Trident installer deploys the operator in the `trident` namespace. If the `trident` namespace does not exist, create it using:

```
kubectl apply -f deploy/namespace.yaml
```

- To deploy the operator in a namespace other than the `trident` namespace, update `serviceaccount.yaml`, `clusterrolebinding.yaml` and `operator.yaml` and generate your bundle file using the `kustomization.yaml`.

1. Create the `kustomization.yaml` using the following command where `<bundle>` is `bundle_pre_1_25` or `bundle_post_1_25` based on your Kubernetes version.

```
cp kustomization_<bundle>.yaml kustomization.yaml
```

2. Compile the bundle using using the following command where `<bundle>` is `bundle_pre_1_25` or `bundle_post_1_25` based on your Kubernetes version.

```
kubectl kustomize deploy/ > deploy/<bundle>.yaml
```

#### Steps

1. Create the resources and deploy the operator:

```
kubectl kustomize deploy/ > deploy/<bundle>.yaml
```

2. Verify the operator, deployment, and replicaset were created.

```
kubectl get all -n <operator-namespace>
```



There should only be **one instance** of the operator in a Kubernetes cluster. Do not create multiple deployments of the Trident operator.

## Step 5: Update the image registry location in the `TridentOrchestrator`

Your [Trident and CSI images](#) can be located in one registry or different registries, but all CSI images must be located in the same registry. Update `deploy/crds/tridentorchestrator_cr.yaml` to add the additional location specs based on your registry configuration.

### Images in one registry

```
imageRegistry: "<your-registry>"
autosupportImage: "<your-registry>/trident-autosupport:23.04"
tridentImage: "<your-registry>/trident:23.04.0"
```

### Images in different registries

You must append `sig-storage` to the `imageRegistry` to use different registry locations.

```
imageRegistry: "<your-registry>/sig-storage"
autosupportImage: "<your-registry>/netapp/trident-autosupport:23.04"
tridentImage: "<your-registry>/netapp/trident:23.04.0"
```

## Step 6: Create the `TridentOrchestrator` and install Trident

You can now create the `TridentOrchestrator` and install Astra Trident. Optionally, you can further [customize your Trident installation](#) using the attributes in the `TridentOrchestrator` spec. The following example shows an installation where Trident and CSI images are located in different registries.

```

kubect1 create -f deploy/crds/tridentorchestrator_cr.yaml
tridentorchestrator.trident.netapp.io/trident created

kubect1 describe torc trident

Name:          trident
Namespace:
Labels:        <none>
Annotations:   <none>
API Version:   trident.netapp.io/v1
Kind:          TridentOrchestrator
...
Spec:
  Autosupport Image: <your-registry>/netapp/trident-autosupport:23.04
  Debug:              true
  Image Registry:    <your-registry>/sig-storage
  Namespace:         trident
  Trident Image:     <your-registry>/netapp/trident:23.04.0
Status:
  Current Installation Params:
    IPv6:              false
    Autosupport Hostname:
    Autosupport Image: <your-registry>/netapp/trident-
autosupport:23.04
    Autosupport Proxy:
    Autosupport Serial Number:
    Debug:              true
    Http Request Timeout: 90s
    Image Pull Secrets:
    Image Registry:    <your-registry>/sig-storage
    k8sTimeout:        30
    Kubelet Dir:       /var/lib/kubelet
    Log Format:         text
    Probe Port:        17546
    Silence Autosupport: false
    Trident Image:     <your-registry>/netapp/trident:23.04.0
  Message:            Trident installed
  Namespace:          trident
  Status:              Installed
  Version:             v23.04.0
Events:
  Type Reason Age From Message ---- -
-----
Normal
Installing 74s trident-operator.netapp.io Installing Trident Normal
Installed 67s trident-operator.netapp.io Trident installed

```

## Verify the installation

There are several ways to verify your installation.

### Using `TridentOrchestrator` status

The status of `TridentOrchestrator` indicates if the installation was successful and displays the version of Trident installed. During the installation, the status of `TridentOrchestrator` changes from `Installing` to `Installed`. If you observe the `Failed` status and the operator is unable to recover by itself, [check the logs](#).

Status	Description
Installing	The operator is installing Astra Trident using this <code>TridentOrchestrator</code> CR.
Installed	Astra Trident has successfully installed.
Uninstalling	The operator is uninstalling Astra Trident, because <code>spec.uninstall=true</code> .
Uninstalled	Astra Trident is uninstalled.
Failed	The operator could not install, patch, update or uninstall Astra Trident; the operator will automatically try to recover from this state. If this state persists you will require troubleshooting.
Updating	The operator is updating an existing installation.
Error	The <code>TridentOrchestrator</code> is not used. Another one already exists.

### Using pod creation status

You can confirm if the Astra Trident installation completed by reviewing the status of the created pods:

```
kubectl get pods -n trident
```

```
NAME                                READY   STATUS    RESTARTS
AGE
trident-controller-7d466bf5c7-v4cpw 6/6     Running   0
1m
trident-node-linux-mr6zc             2/2     Running   0
1m
trident-node-linux-xrp7w            2/2     Running   0
1m
trident-node-linux-zh2jt            2/2     Running   0
1m
trident-operator-766f7b8658-ldzsv   1/1     Running   0
3m
```

## Using `tridentctl`

You can use `tridentctl` to check the version of Astra Trident installed.

```
./tridentctl -n trident version

+-----+-----+
| SERVER VERSION | CLIENT VERSION |
+-----+-----+
| 23.04.0       | 23.04.0       |
+-----+-----+
```

### What's next

Now you can [create a backend and storage class, provision a volume, and mount the volume in a pod](#).

### Deploy Trident operator using Helm (Standard mode)

You can deploy the Trident operator and install Astra Trident using Helm. This process applies to installations where the container images required by Astra Trident are not stored in a private registry. If you do have a private image registry, use the [process for offline deployment](#).

#### Critical information about Astra Trident 23.04

**You must read the following critical information about Astra Trident.**

#### Critical information about Astra Trident

- Kubernetes 1.27 is now supported in Trident. Upgrade Trident prior to upgrading Kubernetes.
- Astra Trident strictly enforces the use of multipathing configuration in SAN environments, with a recommended value of `find_multipaths: no` in `multipath.conf` file.

Use of non-multipathing configuration or use of `find_multipaths: yes` or `find_multipaths: smart` value in `multipath.conf` file will result in mount failures. Trident has recommended the use of `find_multipaths: no` since the 21.07 release.

#### Deploy the Trident operator and install Astra Trident using Helm

Using the Trident [Helm Chart](#) you can deploy the Trident operator and install Trident in one step.

Review [the installation overview](#) to ensure you've met installation prerequisites and selected the correct installation option for your environment.

#### Before you begin

In addition to the [deployment prerequisites](#) you need [Helm version 3](#).

#### Steps



1. Add the Astra Trident Helm repository:

```
helm repo add netapp-trident https://netapp.github.io/trident-helm-chart
```

2. Use `helm install` and specify a name for your deployment as in the following example where `23.04.0` is the version of Astra Trident you are installing.

```
helm install <name> netapp-trident/trident-operator --version 23.04.0  
--create-namespace --namespace <trident-namespace>
```



If you already created a namespace for Trident, the `--create-namespace` parameter will not create an additional namespace.

You can use `helm list` to review installation details such as name, namespace, chart, status, app version, and revision number.

### Pass configuration data during install

There are two ways to pass configuration data during the install:

Option	Description
<code>--values</code> (or <code>-f</code> )	Specify a YAML file with overrides. This can be specified multiple times and the rightmost file will take precedence.
<code>--set</code>	Specify overrides on the command line.

For example, to change the default value of `debug`, run the following `--set` command where `23.04.0` is the version of Astra Trident you are installing:

```
helm install <name> netapp-trident/trident-operator --version 23.04.0  
--create-namespace --namespace --set tridentDebug=true
```

### Configuration options

This table and the `values.yaml` file, which is part of the Helm chart, provide the list of keys and their default values.

Option	Description	Default
<code>nodeSelector</code>	Node labels for pod assignment	
<code>podAnnotations</code>	Pod annotations	
<code>deploymentAnnotations</code>	Deployment annotations	

Option	Description	Default
<code>tolerations</code>	Tolerations for pod assignment	
<code>affinity</code>	Affinity for pod assignment	
<code>tridentControllerPluginNodeSelector</code>	Additional node selectors for pods. Refer to <a href="#">Understanding controller pods and node pods</a> for details.	
<code>tridentControllerPluginTolerations</code>	Overrides Kubernetes tolerations for pods. Refer to <a href="#">Understanding controller pods and node pods</a> for details.	
<code>tridentNodePluginNodeSelector</code>	Additional node selectors for pods. Refer to <a href="#">Understanding controller pods and node pods</a> for details.	
<code>tridentNodePluginTolerations</code>	Overrides Kubernetes tolerations for pods. Refer to <a href="#">Understanding controller pods and node pods</a> for details.	
<code>imageRegistry</code>	Identifies the registry for the <code>trident-operator</code> , <code>trident</code> , and other images. Leave empty to accept the default.	""
<code>imagePullPolicy</code>	Sets the image pull policy for the <code>trident-operator</code> .	IfNotPresent
<code>imagePullSecrets</code>	Sets the image pull secrets for the <code>trident-operator</code> , <code>trident</code> , and other images.	
<code>kubeletDir</code>	Allows overriding the host location of kubelet's internal state.	"/var/lib/kubelet"
<code>operatorLogLevel</code>	Allows the log level of the Trident operator to be set to: <code>trace</code> , <code>debug</code> , <code>info</code> , <code>warn</code> , <code>error</code> , or <code>fatal</code> .	"info"
<code>operatorDebug</code>	Allows the log level of the Trident operator to be set to debug.	true
<code>operatorImage</code>	Allows the complete override of the image for <code>trident-operator</code> .	""
<code>operatorImageTag</code>	Allows overriding the tag of the <code>trident-operator</code> image.	""
<code>tridentIPv6</code>	Allows enabling Astra Trident to work in IPv6 clusters.	false
<code>tridentK8sTimeout</code>	Overrides the default 30-second timeout for most Kubernetes API operations (if non-zero, in seconds).	0

Option	Description	Default
<code>tridentHttpRequestTimeout</code>	Overrides the default 90-second timeout for the HTTP requests, with 0s being an infinite duration for the timeout. Negative values are not allowed.	"90s"
<code>tridentSilenceAutosupport</code>	Allows disabling Astra Trident periodic AutoSupport reporting.	false
<code>tridentAutosupportImageTag</code>	Allows overriding the tag of the image for Astra Trident AutoSupport container.	<version>
<code>tridentAutosupportProxy</code>	Allows Astra Trident AutoSupport container to phone home via an HTTP proxy.	""
<code>tridentLogFormat</code>	Sets the Astra Trident logging format (text or json).	"text"
<code>tridentDisableAuditLog</code>	Disables Astra Trident audit logger.	true
<code>tridentLogLevel</code>	Allows the log level of Astra Trident to be set to: trace, debug, info, warn, error, or fatal.	"info"
<code>tridentDebug</code>	Allows the log level of Astra Trident to be set to debug.	false
<code>tridentLogWorkflows</code>	Allows specific Astra Trident workflows to be enabled for trace logging or log suppression.	""
<code>tridentLogLayers</code>	Allows specific Astra Trident layers to be enabled for trace logging or log suppression.	""
<code>tridentImage</code>	Allows the complete override of the image for Astra Trident.	""
<code>tridentImageTag</code>	Allows overriding the tag of the image for Astra Trident.	""
<code>tridentProbePort</code>	Allows overriding the default port used for Kubernetes liveness/readiness probes.	""
<code>windows</code>	Allows Astra Trident to be installed on Windows worker node.	false
<code>enableForceDetach</code>	Allows enabling the force detach feature.	false
<code>excludePodSecurityPolicy</code>	Excludes the operator pod security policy from creation.	false

## Understanding controller pods and node pods

Astra Trident runs as a single controller pod, plus a node pod on each worker node in the cluster. The node pod must be running on any host where you want to potentially mount an Astra Trident volume.

Kubernetes [node selectors](#) and [tolerations and taints](#) are used to constrain a pod to run on a specific or preferred node. Using the `ControllerPlugin` and NodePlugin, you can specify constraints and overrides.`

- The controller plugin handles volume provisioning and management, such as snapshots and resizing.
- The node plugin handles attaching the storage to the node.

### What's next

Now you can [create a backend and storage class, provision a volume, and mount the volume in a pod.](#)

## Deploy Trident operator using Helm (Offline mode)

You can deploy the Trident operator and install Astra Trident using Helm. This process applies to installations where the container images required by Astra Trident are stored in a private registry. If you do not have a private image registry, use the [process for standard deployment](#).

### Critical information about Astra Trident 23.04

**You must read the following critical information about Astra Trident.**

#### Critical information about Astra Trident

- Kubernetes 1.27 is now supported in Trident. Upgrade Trident prior to upgrading Kubernetes.
- Astra Trident strictly enforces the use of multipathing configuration in SAN environments, with a recommended value of `find_multipaths: no` in `multipath.conf` file.

Use of non-multipathing configuration or use of `find_multipaths: yes` or `find_multipaths: smart` value in `multipath.conf` file will result in mount failures. Trident has recommended the use of `find_multipaths: no` since the 21.07 release.

## Deploy the Trident operator and install Astra Trident using Helm

Using the Trident [Helm Chart](#) you can deploy the Trident operator and install Trident in one step.

Review [the installation overview](#) to ensure you've met installation prerequisites and selected the correct installation option for your environment.

### Before you begin

In addition to the [deployment prerequisites](#) you need [Helm version 3](#).

### Steps

1. Add the Astra Trident Helm repository:

```
helm repo add netapp-trident https://netapp.github.io/trident-helm-chart
```

2. Use `helm install` and specify a name for your deployment and image registry location. Your [Trident and CSI images](#) can be located in one registry or different registries, but all CSI images must be located in the same registry. In the examples, `23.04.0` is the version of Astra Trident you are installing.

### Images in one registry

```
helm install <name> netapp-trident/trident-operator --version  
23.04.0 --set imageRegistry=<your-registry> --create-namespace  
--namespace <trident-namespace>
```

### Images in different registries

You must append `sig-storage` to the `imageRegistry` to use different registry locations.

```
helm install <name> netapp-trident/trident-operator --version  
23.04.0 --set imageRegistry=<your-registry>/sig-storage --set  
operatorImage=<your-registry>/netapp/trident-operator:23.04.0 --set  
tridentAutosupportImage=<your-registry>/netapp/trident-  
autosupport:23.04 --set tridentImage=<your-  
registry>/netapp/trident:23.04.0 --create-namespace --namespace  
<trident-namespace>
```



If you already created a namespace for Trident, the `--create-namespace` parameter will not create an additional namespace.

You can use `helm list` to review installation details such as name, namespace, chart, status, app version, and revision number.

### Pass configuration data during install

There are two ways to pass configuration data during the install:

Option	Description
<code>--values</code> (or <code>-f</code> )	Specify a YAML file with overrides. This can be specified multiple times and the rightmost file will take precedence.
<code>--set</code>	Specify overrides on the command line.

For example, to change the default value of `debug`, run the following `--set` command where `23.04.0` is the version of Astra Trident you are installing:

```
helm install <name> netapp-trident/trident-operator --version 23.04.0
--create-namespace --namespace --set tridentDebug=true
```

### Configuration options

This table and the `values.yaml` file, which is part of the Helm chart, provide the list of keys and their default values.

Option	Description	Default
<code>nodeSelector</code>	Node labels for pod assignment	
<code>podAnnotations</code>	Pod annotations	
<code>deploymentAnnotations</code>	Deployment annotations	
<code>tolerations</code>	Tolerations for pod assignment	
<code>affinity</code>	Affinity for pod assignment	
<code>tridentControllerPluginNodeSelector</code>	Additional node selectors for pods. Refer to <a href="#">Understanding controller pods and node pods</a> for details.	
<code>tridentControllerPluginTolerations</code>	Overrides Kubernetes tolerations for pods. Refer to <a href="#">Understanding controller pods and node pods</a> for details.	
<code>tridentNodePluginNodeSelector</code>	Additional node selectors for pods. Refer to <a href="#">Understanding controller pods and node pods</a> for details.	
<code>tridentNodePluginTolerations</code>	Overrides Kubernetes tolerations for pods. Refer to <a href="#">Understanding controller pods and node pods</a> for details.	
<code>imageRegistry</code>	Identifies the registry for the <code>trident-operator</code> , <code>trident</code> , and other images. Leave empty to accept the default.	""
<code>imagePullPolicy</code>	Sets the image pull policy for the <code>trident-operator</code> .	IfNotPresent
<code>imagePullSecrets</code>	Sets the image pull secrets for the <code>trident-operator</code> , <code>trident</code> , and other images.	
<code>kubeletDir</code>	Allows overriding the host location of kubelet's internal state.	"/var/lib/kubelet"
<code>operatorLogLevel</code>	Allows the log level of the Trident operator to be set to: <code>trace</code> , <code>debug</code> , <code>info</code> , <code>warn</code> , <code>error</code> , or <code>fatal</code> .	"info"

Option	Description	Default
operatorDebug	Allows the log level of the Trident operator to be set to debug.	true
operatorImage	Allows the complete override of the image for trident-operator.	""
operatorImageTag	Allows overriding the tag of the trident-operator image.	""
tridentIPv6	Allows enabling Astra Trident to work in IPv6 clusters.	false
tridentK8sTimeout	Overrides the default 30-second timeout for most Kubernetes API operations (if non-zero, in seconds).	0
tridentHttpRequestTimeout	Overrides the default 90-second timeout for the HTTP requests, with 0s being an infinite duration for the timeout. Negative values are not allowed.	"90s"
tridentSilenceAutosupport	Allows disabling Astra Trident periodic AutoSupport reporting.	false
tridentAutosupportImageTag	Allows overriding the tag of the image for Astra Trident AutoSupport container.	<version>
tridentAutosupportProxy	Allows Astra Trident AutoSupport container to phone home via an HTTP proxy.	""
tridentLogFormat	Sets the Astra Trident logging format (text or json).	"text"
tridentDisableAuditLog	Disables Astra Trident audit logger.	true
tridentLogLevel	Allows the log level of Astra Trident to be set to: trace, debug, info, warn, error, or fatal.	"info"
tridentDebug	Allows the log level of Astra Trident to be set to debug.	false
tridentLogWorkflows	Allows specific Astra Trident workflows to be enabled for trace logging or log suppression.	""
tridentLogLayers	Allows specific Astra Trident layers to be enabled for trace logging or log suppression.	""
tridentImage	Allows the complete override of the image for Astra Trident.	""
tridentImageTag	Allows overriding the tag of the image for Astra Trident.	""

Option	Description	Default
<code>tridentProbePort</code>	Allows overriding the default port used for Kubernetes liveness/readiness probes.	""
<code>windows</code>	Allows Astra Trident to be installed on Windows worker node.	<code>false</code>
<code>enableForceDetach</code>	Allows enabling the force detach feature.	<code>false</code>
<code>excludePodSecurityPolicy</code>	Excludes the operator pod security policy from creation.	<code>false</code>

## Understanding controller pods and node pods

Astra Trident runs as a single controller pod, plus a node pod on each worker node in the cluster. The node pod must be running on any host where you want to potentially mount an Astra Trident volume.

Kubernetes [node selectors](#) and [tolerations and taints](#) are used to constrain a pod to run on a specific or preferred node. Using the `ControllerPlugin` and NodePlugin, you can specify constraints and overrides.`

- The controller plugin handles volume provisioning and management, such as snapshots and resizing.
- The node plugin handles attaching the storage to the node.

### What's next

Now you can [create create a backend and storage class, provision a volume, and mount the volume in a pod.](#)

## Customize Trident operator installation

The Trident operator allows you to customize Astra Trident installation using the attributes in the `TridentOrchestrator` spec. If you want to customize the installation beyond what `TridentOrchestrator` arguments allow, consider using `tridentctl` to generate custom YAML manifests to modify as needed.

### Understanding controller pods and node pods

Astra Trident runs as a single controller pod, plus a node pod on each worker node in the cluster. The node pod must be running on any host where you want to potentially mount an Astra Trident volume.

Kubernetes [node selectors](#) and [tolerations and taints](#) are used to constrain a pod to run on a specific or preferred node. Using the `ControllerPlugin` and NodePlugin, you can specify constraints and overrides.`

- The controller plugin handles volume provisioning and management, such as snapshots and resizing.
- The node plugin handles attaching the storage to the node.

### Configuration options





`spec.namespace` is specified in `TridentOrchestrator` to signify the namespace where Astra Trident is installed. This parameter **cannot be updated after Astra Trident is installed**. Attempting to do so causes the `TridentOrchestrator` status to change to `Failed`. Astra Trident is not intended to be migrated across namespaces.

This table details `TridentOrchestrator` attributes.

Parameter	Description	Default
<code>namespace</code>	Namespace to install Astra Trident in	"default"
<code>debug</code>	Enable debugging for Astra Trident	false
<code>enableForceDetach</code>	<code>ontap-san</code> and <code>ontap-san-economy</code> only.  Works with Kubernetes Non-Graceful Node Shutdown (NGNS) to grant cluster administrators ability to safely migrate workloads with mounted volumes to new nodes should a node become unhealthy.  <b>This is an experimental feature in 23.04.</b> Refer to <a href="#">Details about force detach</a> for important details.	false
<code>windows</code>	Setting to <code>true</code> enables installation on Windows worker nodes.	false
<code>useIPv6</code>	Install Astra Trident over IPv6	false
<code>k8sTimeout</code>	Timeout for Kubernetes operations	30sec
<code>silenceAutosupport</code>	Don't send autosupport bundles to NetApp automatically	false
<code>autosupportImage</code>	The container image for Autosupport Telemetry	"netapp/trident-autosupport:23.07"
<code>autosupportProxy</code>	The address/port of a proxy for sending Autosupport Telemetry	"http://proxy.example.com:8888"
<code>uninstall</code>	A flag used to uninstall Astra Trident	false
<code>logFormat</code>	Astra Trident logging format to be used [text,json]	"text"
<code>tridentImage</code>	Astra Trident image to install	"netapp/trident:23.07"

Parameter	Description	Default
imageRegistry	Path to internal registry, of the format <registry FQDN>[:port] [/subpath]	"k8s.gcr.io/sig-storage" (k8s 1.19+) or "quay.io/k8s/scsi"
kubeletDir	Path to the kubelet directory on the host	"/var/lib/kubelet"
wipeout	A list of resources to delete to perform a complete removal of Astra Trident	
imagePullSecrets	Secrets to pull images from an internal registry	
imagePullPolicy	Sets the image pull policy for the the Trident operator. Valid values are:  Always to always pull the image.  IfNotPresent to pull the image only if it does not already exist on the node.  Never to never pull the image.	IfNotPresent
controllerPluginNodeSelector	Additional node selectors for pods. Follows same format as pod.spec.nodeSelector.	No default; optional
controllerPluginTolerations	Overrides Kubernetes tolerations for pods. Follows the same format as pod.spec.Tolerations.	No default; optional
nodePluginNodeSelector	Additional node selectors for pods. Follows same format as pod.spec.nodeSelector.	No default; optional
nodePluginTolerations	Overrides Kubernetes tolerations for pods. Follows the same format as pod.spec.Tolerations.	No default; optional



For more information on formatting pod parameters, see [Assigning Pods to Nodes](#).

### Details about force detach

Force detach is available for `ontap-san` and `ontap-san-economy` only. Before enabling force detach, non-graceful node shutdown (NGNS) must be enabled on the Kubernetes cluster. For more information, refer to [Kubernetes: Non Graceful node shutdown](#).



Because Astra Trident relies on Kubernetes NGNS, do not remove `out-of-service` taints from an unhealthy node until all non-tolerable workloads are rescheduled. Recklessly applying or removing the taint can jeopardize backend data protection.

When the Kubernetes cluster administrator has applied the `node.kubernetes.io/out-of-service=nodeshutdown:NoExecute` taint to the node and `enableForceDetach` is set to `true`, Astra Trident will determine the node status and:

1. Cease backend I/O access for volumes mounted to that node.
2. Mark the Astra Trident node object as `dirty` (not safe for new publications).



The Trident controller will reject new publish volume requests until the node is re-qualified (after having been marked as `dirty`) by the Trident node pod. Any workloads scheduled with a mounted PVC (even after the cluster node is healthy and ready) will be not be accepted until Astra Trident can verify the node `clean` (safe for new publications).

When node health is restored and the taint is removed, Astra Trident will:

1. Identify and clean stale published paths on the node.
2. If the node is in a `cleanable` state (the out-of-service taint has been removed and the node is in `Ready` state) and all stale, published paths are clean, Astra Trident will readmit the node as `clean` and allow new published volumes to the node.

### Sample configurations

You can use the attributes mentioned above when defining `TridentOrchestrator` to customize your installation.

#### Example 1: Basic custom configuration

This is an example for a basic custom configuration.

```
cat deploy/crds/tridentorchestrator_cr_imagepullsecrets.yaml
apiVersion: trident.netapp.io/v1
kind: TridentOrchestrator
metadata:
  name: trident
spec:
  debug: true
  namespace: trident
  imagePullSecrets:
  - thisisasecret
```

## Example 2: Deploy with node selectors

This example illustrates how Trident can be deployed with node selectors:

```
apiVersion: trident.netapp.io/v1
kind: TridentOrchestrator
metadata:
  name: trident
spec:
  debug: true
  namespace: trident
  controllerPluginNodeSelector:
    nodetype: master
  nodePluginNodeSelector:
    storage: netapp
```

## Example 3: Deploy on Windows worker nodes

This example illustrates deployment on a Windows worker node.

```
cat deploy/crds/tridentorchestrator_cr.yaml
apiVersion: trident.netapp.io/v1
kind: TridentOrchestrator
metadata:
  name: trident
spec:
  debug: true
  namespace: trident
  windows: true
```

## Install using tridentctl

### Install using tridentctl

You can install Astra Trident using `tridentctl`. This process applies to installations where the container images required by Astra Trident are stored either in a private registry or not. To customize your `tridentctl` deployment, refer to [Customize tridentctl deployment](#).

### Critical information about Astra Trident 23.04

**You must read the following critical information about Astra Trident.**

## Critical information about Astra Trident

- Kubernetes 1.27 is now supported in Trident. Upgrade Trident prior to upgrading Kubernetes.
- Astra Trident strictly enforces the use of multipathing configuration in SAN environments, with a recommended value of `find_multipaths: no` in `multipath.conf` file.

Use of non-multipathing configuration or use of `find_multipaths: yes` or `find_multipaths: smart` value in `multipath.conf` file will result in mount failures. Trident has recommended the use of `find_multipaths: no` since the 21.07 release.

### Install Astra Trident using `tridentctl`

Review [the installation overview](#) to ensure you've met installation prerequisites and selected the correct installation option for your environment.

### Before you begin

Before you begin installation, log in to the Linux host and verify it is managing a working, [supported Kubernetes cluster](#) and that you have the necessary privileges.



With OpenShift, use `oc` instead of `kubectl` in all of the examples that follow, and log in as **system:admin** first by running `oc login -u system:admin` or `oc login -u kube-admin`.

1. Verify your Kubernetes version:

```
kubectl version
```

2. Verify cluster administrator privileges:

```
kubectl auth can-i '*' '*' --all-namespaces
```

3. Verify you can launch a pod that uses an image from Docker Hub and reach your storage system over the pod network:

```
kubectl run -i --tty ping --image=busybox --restart=Never --rm -- \
ping <management IP>
```

### Step 1: Download the Trident installer package

The Astra Trident installer package creates a Trident pod, configures the CRD objects that are used to maintain its state, and initializes the CSI sidecars to perform actions such as provisioning and attaching volumes to the cluster hosts. Download and extract the latest version of the Trident installer from [the Assets section on GitHub](#). Update `<trident-installer-XX.XX.X.tar.gz>` in the example with your selected Astra Trident

version.

```
wget https://github.com/NetApp/trident/releases/download/v23.04.0/trident-  
installer-23.04.0.tar.gz  
tar -xf trident-installer-23.04.0.tar.gz  
cd trident-installer
```

## Step 2: Install Astra Trident

Install Astra Trident in the desired namespace by executing the `tridentctl install` command. You can add additional arguments to specify image registry location.

### Standard mode

```
./tridentctl install -n trident
```

### Images in one registry

```
./tridentctl install -n trident --image-registry <your-registry>  
--autosupport-image <your-registry>/trident-autosupport:23.04 --trident  
-image <your-registry>/trident:23.04.0
```

### Images in different registries

You must append `sig-storage` to the `imageRegistry` to use different registry locations.

```
./tridentctl install -n trident --image-registry <your-registry>/sig-  
storage --autosupport-image <your-registry>/netapp/trident-  
autosupport:23.04 --trident-image <your-  
registry>/netapp/trident:23.04.0
```

Your installation status should look something like this.

```

.....
INFO Starting Trident installation.                namespace=trident
INFO Created service account.
INFO Created cluster role.
INFO Created cluster role binding.
INFO Added finalizers to custom resource definitions.
INFO Created Trident service.
INFO Created Trident secret.
INFO Created Trident deployment.
INFO Created Trident daemonset.
INFO Waiting for Trident pod to start.
INFO Trident pod started.                        namespace=trident
pod=trident-controller-679648bd45-cv2mx
INFO Waiting for Trident REST interface.
INFO Trident REST interface is up.                version=23.04.0
INFO Trident installation succeeded.
.....

```

### Verify the installation

You can verify your installation using pod creation status or `tridentctl`.

### Using pod creation status

You can confirm if the Astra Trident installation completed by reviewing the status of the created pods:

```
kubectl get pods -n trident
```

NAME	READY	STATUS	RESTARTS	AGE
trident-controller-679648bd45-cv2mx	6/6	Running	0	5m29s
trident-node-linux-vgc8n	2/2	Running	0	5m29s



If the installer does not complete successfully or `trident-controller-<generated id>` (`trident-csi-<generated id>` in versions prior to 23.01) does not have a **Running** status, the platform was not installed. Use `-d` to [turn on debug mode](#) and troubleshoot the issue.

### Using `tridentctl`

You can use `tridentctl` to check the version of Astra Trident installed.

```
./tridentctl -n trident version
```

```
+-----+-----+
| SERVER VERSION | CLIENT VERSION |
+-----+-----+
| 23.04.0        | 23.04.0        |
+-----+-----+
```

## Sample configurations

### Example 1: Enable Astra Trident to run on Windows nodes

To enable Astra Trident to run on Windows nodes:

```
tridentctl install --windows -n trident
```

### Example 2: Enable force detach

For more information about force detach, refer to [Customize Trident operator installation](#).

```
tridentctl install --enable-force-detach=true -n trident
```

## What's next

Now you can [create a backend and storage class](#), [provision a volume](#), and [mount the volume in a pod](#).

## Customize `tridentctl` installation

You can use the Astra Trident installer to customize installation.

### Learn about the installer

The Astra Trident installer enables you to customize attributes. For example, if you have copied the Trident image to a private repository, you can specify the image name by using `--trident-image`. If you have copied the Trident image as well as the needed CSI sidecar images to a private repository, it might be preferable to specify the location of that repository by using the `--image-registry` switch, which takes the form `<registry FQDN>[:port]`.

If you are using a distribution of Kubernetes, where `kubelet` keeps its data on a path other than the usual `/var/lib/kubelet`, you can specify the alternate path by using `--kubelet-dir`.

If you need to customize the installation beyond what the installer's arguments allow, you can also customize the deployment files. Using the `--generate-custom-yaml` parameter creates the following YAML files in the installer's `setup` directory:



- trident-clusterrolebinding.yaml
- trident-deployment.yaml
- trident-crds.yaml
- trident-clusterrole.yaml
- trident-daemonset.yaml
- trident-service.yaml
- trident-namespace.yaml
- trident-serviceaccount.yaml
- trident-resourcequota.yaml

After you have generated these files, you can modify them according to your needs and then use `--use-custom-yaml` to install your custom deployment.

```
./tridentctl install -n trident --use-custom-yaml
```

## What's next?

After you install Astra Trident, you can proceed with creating a backend, creating a storage class, provisioning a volume, and mounting the volume in a pod.

### Step 1: Create a backend

You can now go ahead and create a backend that will be used by Astra Trident to provision volumes. To do this, create a `backend.json` file that contains the necessary parameters. Sample configuration files for different backend types can be found in the `sample-input` directory.

See [here](#) for more details about how to configure the file for your backend type.

```
cp sample-input/<backend template>.json backend.json
vi backend.json
```

```
./tridentctl -n trident create backend -f backend.json
```

NAME	STORAGE DRIVER	UUID
nas-backend	ontap-nas	98e19b74-aec7-4a3d-8dcf-128e5033b214
online	0	

If the creation fails, something was wrong with the backend configuration. You can view the logs to determine the cause by running the following command:

```
./tridentctl -n trident logs
```

After you address the problem, simply go back to the beginning of this step and try again. For more troubleshooting tips, see [the troubleshooting](#) section.

## Step 2: Create a storage class

Kubernetes users provision volumes by using persistent volume claims (PVCs) that specify a [storage class](#) by name. The details are hidden from the users, but a storage class identifies the provisioner that is used for that class (in this case, Trident), and what that class means to the provisioner.

Create a storage class Kubernetes users will specify when they want a volume. The configuration of the class needs to model the backend that you created in the previous step, so that Astra Trident will use it to provision new volumes.

The simplest storage class to start with is one based on the `sample-input/storage-class-csi.yaml.template` file that comes with the installer, replacing `BACKEND_TYPE` with the storage driver name.

```

./tridentctl -n trident get backend
+-----+-----+-----+
+-----+-----+
|   NAME   | STORAGE DRIVER |           UUID           |
STATE | VOLUMES |
+-----+-----+-----+
+-----+-----+
| nas-backend | ontap-nas      | 98e19b74-aec7-4a3d-8dcf-128e5033b214 |
online |         0 |
+-----+-----+-----+
+-----+-----+

cp sample-input/storage-class-csi.yaml.templ sample-input/storage-class-
basic-csi.yaml

# Modify __BACKEND_TYPE__ with the storage driver field above (e.g.,
ontap-nas)
vi sample-input/storage-class-basic-csi.yaml

```

This is a Kubernetes object, so you use `kubectl` to create it in Kubernetes.

```
kubectl create -f sample-input/storage-class-basic-csi.yaml
```

You should now see a **basic-csi** storage class in both Kubernetes and Astra Trident, and Astra Trident should have discovered the pools on the backend.

```

kubect1 get sc basic-csi
NAME          PROVISIONER          AGE
basic-csi    csi.trident.netapp.io 15h

./tridentctl -n trident get storageclass basic-csi -o json
{
  "items": [
    {
      "Config": {
        "version": "1",
        "name": "basic-csi",
        "attributes": {
          "backendType": "ontap-nas"
        },
        "storagePools": null,
        "additionalStoragePools": null
      },
      "storage": {
        "ontapnas_10.0.0.1": [
          "aggr1",
          "aggr2",
          "aggr3",
          "aggr4"
        ]
      }
    }
  ]
}

```

### Step 3: Provision your first volume

Now you are ready to dynamically provision your first volume. This is done by creating a Kubernetes [persistent volume claim](#) (PVC) object.

Create a PVC for a volume that uses the storage class that you just created.

See `sample-input/pvc-basic-csi.yaml` for an example. Make sure the storage class name matches the one that you created.

```
kubectl create -f sample-input/pvc-basic-csi.yaml
```

```
kubectl get pvc --watch
```

NAME	STATUS	VOLUME	CAPACITY
basic	Pending		
basic	1s		
basic	Pending	pvc-3acb0d1c-b1ae-11e9-8d9f-5254004dfdb7	0
basic	5s		
basic	Bound	pvc-3acb0d1c-b1ae-11e9-8d9f-5254004dfdb7	1Gi
RWO	basic	7s	

## Step 4: Mount the volumes in a pod

Now let us mount the volume. We will launch an nginx pod that mounts the PV under /usr/share/nginx/html.

```
cat << EOF > task-pv-pod.yaml
kind: Pod
apiVersion: v1
metadata:
  name: task-pv-pod
spec:
  volumes:
    - name: task-pv-storage
      persistentVolumeClaim:
        claimName: basic
  containers:
    - name: task-pv-container
      image: nginx
      ports:
        - containerPort: 80
          name: "http-server"
      volumeMounts:
        - mountPath: "/usr/share/nginx/html"
          name: task-pv-storage
EOF
kubectl create -f task-pv-pod.yaml
```

```
# Wait for the pod to start
kubectl get pod --watch

# Verify that the volume is mounted on /usr/share/nginx/html
kubectl exec -it task-pv-pod -- df -h /usr/share/nginx/html

# Delete the pod
kubectl delete pod task-pv-pod
```

At this point, the pod (application) no longer exists but the volume is still there. You can use it from another pod if you want to.

To delete the volume, delete the claim:

```
kubectl delete pvc basic
```

You can now do additional tasks, such as the following:

- [Configure additional backends.](#)
- [Create additional storage classes.](#)

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