Amazon FSx for NetApp ONTAP

Trident

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Amazon FSx for NetApp ONTAP

Use Trident with Amazon FSx for NetApp ONTAP

Amazon FSx for NetApp ONTAP is a fully managed AWS service that runs file systems powered by the NetApp ONTAP storage operating system. It provides ONTAP features, performance, and administration with the scalability and operational simplicity of AWS. A file system is the primary resource in Amazon FSx and is analogous to an on-premises ONTAP cluster. Each file system contains one or more storage virtual machines (SVMs), and each SVM contains one or more volumes that store files and directories. This integration enables Kubernetes clusters running in Amazon Elastic Kubernetes Service (EKS) to provision ONTAP-backed persistent volumes for block and file workloads.

Requirements

In addition to Trident requirements, to integrate FSx for ONTAP with Trident, you need:

- An existing Amazon EKS cluster or self-managed Kubernetes cluster with `kubectl` installed.
- An existing Amazon FSx for NetApp ONTAP file system and storage virtual machine (SVM) that is reachable from your cluster's worker nodes.
- Worker nodes that are prepared for NFS or iSCSI.

> Ensure you follow the node preparation steps required for Amazon Linux and Ubuntu Amazon Machine Images (AMIs) depending on your EKS AMI type.

Considerations

- SMB volumes:
  - SMB volumes are supported using the `ontap-nas` driver only.
  - SMB volumes are not supported with Trident EKS add-on.
  - Trident supports SMB volumes mounted to pods running on Windows nodes only. Refer to Prepare to provision SMB volumes for details.
- Prior to Trident 24.02, volumes created on Amazon FSx file systems that have automatic backups enabled, could not be deleted by Trident. To prevent this issue in Trident 24.02 or later, specify the `fsxFilesystemID`, AWS `apiRegion`, AWS `apikey`, and AWS `secretKey` in the backend configuration file for AWS FSx for ONTAP.

> If you are specifying an IAM role to Trident, then you can omit specifying the `apiRegion`, `apiKey`, and `secretKey` fields to Trident explicitly. For more information, refer to FSx for ONTAP configuration options and examples.

Simultaneous usage of Trident SAN/iSCSI and EBS-CSI driver

If you plan to use ontap-san drivers (e.g., iSCSI) with AWS (EKS, ROSA, EC2, or any other instance), the multipath configuration required on the nodes might conflict with the Amazon Elastic Block Store (EBS) CSI

driver. To ensure that multipathing functions without interfering with EBS disks on the same node, you need to exclude EBS in your multipathing setup. This example shows a `multipath.conf` file that includes the required Trident settings while excluding EBS disks from multipathing:

```
defaults {
    find_multipaths no
}
blacklist {
    device {
        vendor "NVME"
        product "Amazon Elastic Block Store"
    }
}
```

Authentication

Trident offers two modes of authentication.

- Credential-based(Recommended): Stores credentials securely in AWS Secrets Manager. You can use the `fsxadmin` user for your file system or the `vsadmin` user configured for your SVM.

> Trident expects to be run as a `vsadmin` SVM user or as a user with a different name that has the same role. Amazon FSx for NetApp ONTAP has an `fsxadmin` user that is a limited replacement of the ONTAP `admin` cluster user. We strongly recommend using `vsadmin` with Trident.

- Certificate-based: Trident will communicate with the SVM on your FSx file system using a certificate installed on your SVM.

For details on enabling authentication, refer to the authentication for your driver type:

- ONTAP NAS authentication
- ONTAP SAN authentication

Tested Amazon Machine Images (AMIs)

EKS cluster supports various operating systems, but AWS has optimized certain Amazon Machine Images (AMIs) for containers and EKS. The following AMIs have been tested with NetApp Trident 25.02.

AMI	NAS	NAS-economy	iSCSI	iSCSI-economy
AL2023_x86_64_STANDARD	Yes	Yes	Yes	Yes
AL2_x86_64	Yes	Yes	Yes*	Yes*
BOTTLEROCKET_x86_64	Yes**	Yes	N/A	N/A
AL2023_ARM_64_STANDARD	Yes	Yes	Yes	Yes

AL2_ARM_64	Yes	Yes	Yes*	Yes*
BOTTLEROCKET_ARM_64	Yes**	Yes	N/A	N/A

- * Unable to delete the PV without restarting the node
- ** Doesn't work with NFSv3 with Trident version 25.02.

If your desired AMI is not listed here, it does not mean that it is not supported; it simply means it has not been tested. This list serves as a guide for AMIs are known to work.

Tests performed with:

- EKS version: 1.32
- Installation Method: Helm 25.06 and as an AWS add-On 25.06
- For NAS both NFSv3 and NFSv4.1 were tested.
- For SAN only iSCSI was tested, not NVMe-oF.

Tests performed:

- Create: Storage Class, pvc, pod
- Delete: pod, pvc (regular, qtree/lun – economy, NAS with AWS backup)

Find more information

- Amazon FSx for NetApp ONTAP documentation
- Blog post on Amazon FSx for NetApp ONTAP

Create an IAM role and AWS Secret

You can configure Kubernetes pods to access AWS resources by authenticating as an AWS IAM role instead of by providing explicit AWS credentials.

To authenticate using an AWS IAM role, you must have a Kubernetes cluster deployed using EKS.

Create AWS Secrets Manager secret

Since Trident will be issuing APIs against an FSx vserver to manage the storage for you, it will need credentials to do so. The secure way to pass those credentials is through an AWS Secrets Manager secret. Therefore, if you don't already have one, you'll need to create an AWS Secrets Manager secret that contains the credentials for the vsadmin account.

This example creates an AWS Secrets Manager secret to store Trident CSI credentials:

```
aws secretsmanager create-secret --name trident-secret --description
"Trident CSI credentials"\
  --secret-string
"{\"username\":\"vsadmin\",\"password\":\"<svmpassword>\"}"
```

Create IAM Policy

Trident also needs AWS permissions to run correctly. Therefore, you need to create a policy that gives Trident the permissions it needs.

The following examples creates an IAM policy using the AWS CLI:

```
aws iam create-policy --policy-name AmazonFSxNCSIDriverPolicy --policy
-document file://policy.json
  --description "This policy grants access to Trident CSI to FSxN and
Secrets manager"
```

Policy JSON example:

```
{
  "Statement": [
    {
      "Action": [
        "fsx:DescribeFileSystems",
        "fsx:DescribeVolumes",
        "fsx:CreateVolume",
        "fsx:RestoreVolumeFromSnapshot",
        "fsx:DescribeStorageVirtualMachines",
        "fsx:UntagResource",
        "fsx:UpdateVolume",
        "fsx:TagResource",
        "fsx:DeleteVolume"
      ],
      "Effect": "Allow",
      "Resource": "*"
    },
    {
      "Action": "secretsmanager:GetSecretValue",
      "Effect": "Allow",
      "Resource": "arn:aws:secretsmanager:<aws-region>:<aws-account-
id>:secret:<aws-secret-manager-name>*"
    }
  ],
  "Version": "2012-10-17"
}
```

Create Pod Identity or IAM role for Service account association (IRSA)

You can configure a Kubernetes service account to assume an AWS Identity and Access Management (IAM) role with EKS Pod Identity or IAM role for Service account association (IRSA). Any Pods that are configured to use the service account can then access any AWS service that the role has permissions to access.

Pod Identity

Amazon EKS Pod Identity associations provide the ability to manage credentials for your applications, similar to the way that Amazon EC2 instance profiles provide credentials to Amazon EC2 instances.

Install Pod Identity on your EKS cluster:

You can create Pod identity via the AWS console or using the following AWS CLI command:

```
aws eks create-addon --cluster-name <EKS_CLUSTER_NAME> --addon-name
eks-pod-identity-agent
```

For more information refer to Set up the Amazon EKS Pod Identity Agent.

Create trust-relationship.json:

Create trust-relationship.json to enable EKS Service Principal to assume this role for Pod Identity. Then create a role with this trust policy:

```
aws iam create-role \
  --role-name fsxn-csi-role --assume-role-policy-document file://trust-
relationship.json \
  --description "fsxn csi pod identity role"
```

trust-relationship.json file:

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Principal": {
        "Service": "pods.eks.amazonaws.com"
      },
      "Action": [
        "sts:AssumeRole",
        "sts:TagSession"
      ]
    }
  ]
}
```

Attach the role policy to the IAM role:

Attach the role policy from the previous step to the IAM role that was created:

```
aws iam attach-role-policy \
  --policy-arn arn:aws:iam::aws:111122223333:policy/fsxn-csi-policy \
  --role-name fsxn-csi-role
```

Create a pod identity association:

Create a pod identity association between IAM role and the Trident service account(trident-controller)

```
aws eks create-pod-identity-association \
  --cluster-name <EKS_CLUSTER_NAME> \
  --role-arn arn:aws:iam::111122223333:role/fsxn-csi-role \
  --namespace trident --service-account trident-controller
```

IAM role for Service account association (IRSA)

Using the AWS CLI:

```
aws iam create-role --role-name AmazonEKS_FSxN_CSI_DriverRole \
  --assume-role-policy-document file://trust-relationship.json
```

trust-relationship.json file:

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Principal": {
        "Federated": "arn:aws:iam::<account_id>:oidc-
provider/<oidc_provider>"
      },
      "Action": "sts:AssumeRoleWithWebIdentity",
      "Condition": {
        "StringEquals": {
          "<oidc_provider>:aud": "sts.amazonaws.com",
          "<oidc_provider>:sub":
"system:serviceaccount:trident:trident-controller"
        }
      }
    }
  ]
}
```

Update the following values in the `trust-relationship.json` file:

- **<account_id>** - Your AWS account ID
- **<oidc_provider>** - The OIDC of your EKS cluster. You can obtain the oidc_provider by running:

```
aws eks describe-cluster --name my-cluster --query
"cluster.identity.oidc.issuer"\
  --output text | sed -e "s/^https:\/\///"
```

Attach the IAM role with the IAM policy:

Once the role has been created, attach the policy (that was created in the step above) to the role using this command:

```
aws iam attach-role-policy --role-name my-role --policy-arn <IAM policy
ARN>
```

Verify OICD provider is associated:

Verify that your OIDC provider is associated with your cluster. You can verify it using this command:

```
aws iam list-open-id-connect-providers | grep $oidc_id | cut -d "/" -f4
```

If the output is empty, use the following command to associate IAM OIDC to your cluster:

```
eksctl utils associate-iam-oidc-provider --cluster $cluster_name
--approve
```

If you are using eksctl, use the following example to create an IAM role for service account in EKS:

```
eksctl create iamserviceaccount --name trident-controller --namespace
trident \
  --cluster <my-cluster> --role-name AmazonEKS_FSxN_CSI_DriverRole
--role-only \
  --attach-policy-arn <IAM-Policy ARN> --approve
```

Install Trident

Trident streamlines Amazon FSx for NetApp ONTAP storage management in Kubernetes to enable your developers and administrators focus on application deployment. You can install Trident using one of the following methods:

- Helm
- EKS add-on

If you want to make use of the snapshot functionality, install the CSI snapshot controller add-on. Refer to Enable snapshot functionality for CSI volumes for more information.

Install Trident via helm

Pod Identity

1. Add the Trident Helm repository:

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

2. Install Trident using the following example:

```
helm install trident-operator netapp-trident/trident-operator --version 100.2502.1 --namespace trident --create-namespace
```

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

```
helm list -n trident
```

```
NAME                NAMESPACE   REVISION    UPDATED
STATUS       CHART                           APP VERSION

trident-operator    trident     1           2024-10-14
14:31:22.463122 +0300 IDT    deployed     trident-operator-
100.2502.0    25.02.0
```

Service account association (IRSA)

1. Add the Trident Helm repository:

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

2. Set the values for **cloud provider** and **cloud identity**:

```
helm install trident-operator netapp-trident/trident-operator
--version 100.2502.1  \
--set cloudProvider="AWS" \
--set cloudIdentity="'eks.amazonaws.com/role-arn:
arn:aws:iam::<accountID>:role/<AmazonEKS_FSxN_CSI_DriverRole>'" \
--namespace trident \
--create-namespace
```

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

```
helm list -n trident
```

```
NAME                NAMESPACE   REVISION    UPDATED
STATUS       CHART                          APP VERSION

trident-operator    trident     1           2024-10-14
14:31:22.463122 +0300 IDT    deployed     trident-operator-
100.2510.0    25.10.0
```

If you're planning to use iSCSI, make sure iSCSI is enabled on your client machine. If you're using AL2023 Worker node OS, you can automate the installation of the iSCSI client by adding the node prep parameter in the helm installation:

```
helm install trident-operator netapp-trident/trident-operator
--version 100.2502.1 --namespace trident --create-namespace --
set nodePrep={iscsi}
```

Install Trident via the EKS add-on

The Trident EKS add-on includes the latest security patches, bug fixes, and is validated by AWS to work with Amazon EKS. The EKS add-on enables you to consistently ensure that your Amazon EKS clusters are secure and stable and reduce the amount of work that you need to do in order to install, configure, and update add-ons.

Prerequisites

Ensure that you have the following before configuring the Trident add-on for AWS EKS:

- An Amazon EKS cluster account with add-on subscription
- AWS permissions to the AWS marketplace:
  `"aws-marketplace:ViewSubscriptions",`
  `"aws-marketplace:Subscribe",`
  `"aws-marketplace:Unsubscribe`
- AMI type: Amazon Linux 2 (AL2_x86_64) or Amazon Linux 2 Arm(AL2_ARM_64)
- Node type: AMD or ARM
- An existing Amazon FSx for NetApp ONTAP file system

Enable the Trident add-on for AWS

Management console

1. Open the Amazon EKS console at https://console.aws.amazon.com/eks/home#/clusters.
2. On the left navigation pane, select **Clusters**.
3. Select the name of the cluster that you want to configure the NetApp Trident CSI add-on for.
4. Select **Add-ons** and then select **Get more add-ons**.
5. Follow these steps to select the add-on:
   a. Scroll down to the **AWS Marketplace add-ons** section and type **"Trident"** in the search box.
   b. Select the check box at the top right corner of the Trident by NetApp box.
   c. Select **Next**.
6. On the **Configure selected add-ons** settings page, do the following:

   Skip these steps if you are using Pod Identity association.

   a. Select the **Version** you would like to use.
   b. If you're using IRSA authentication, make sure to set configuration values available in the Optional configuration settings:
      - Select the **Version** you would like to use.
      - Follow the **Add-on configuration schema** and set the **configurationValues** parameter on the **Configuration values** section to the role-arn you created on the previous step (Value should be in the following format):

```
{

  "cloudIdentity": "'eks.amazonaws.com/role-arn: <role ARN>'",
  "cloudProvider": "AWS"

}
```

   If you select Override for the Conflict resolution method, one or more of the settings for the existing add-on can be overwritten with the Amazon EKS add-on settings. If you don't enable this option and there's a conflict with your existing settings, the operation fails. You can use the resulting error message to troubleshoot the conflict. Before selecting this option, make sure that the Amazon EKS add-on doesn't manage settings that you need to self-manage.

7. Choose **Next**.
8. On the **Review and add** page, choose **Create**.

   After the add-on installation is complete, you see your installed add-on.

AWS CLI

1. Create the `add-on.json` file:

For Pod Identity, use the following format:

Use the

```
{
  "clusterName": "<eks-cluster>",
  "addonName": "netapp_trident-operator",
  "addonVersion": "v25.6.0-eksbuild.1",
}
```

For IRSA authentication, use the following format:

```
{
  "clusterName": "<eks-cluster>",
  "addonName": "netapp_trident-operator",
  "addonVersion": "v25.6.0-eksbuild.1",
  "serviceAccountRoleArn": "<role ARN>",
  "configurationValues": {
    "cloudIdentity": "'eks.amazonaws.com/role-arn: <role ARN>'",
    "cloudProvider": "AWS"
  }
}
```

Replace `<role ARN>` with the ARN of the role that was created in the previous step.

2. Install the Trident EKS add-on.

```
aws eks create-addon --cli-input-json file://add-on.json
```

eksctl

The following example command installs the Trident EKS add-on:

```
eksctl create addon --name netapp_trident-operator --cluster
<cluster_name> --force
```

Update the Trident EKS add-on

Management console

1. Open the Amazon EKS console https://console.aws.amazon.com/eks/home#/clusters.
2. On the left navigation pane, select **Clusters**.
3. Select the name of the cluster that you want to update the NetApp Trident CSI add-on for.
4. Select the **Add-ons** tab.
5. Select **Trident by NetApp** and then select **Edit**.
6. On the **Configure Trident by NetApp** page, do the following:
   a. Select the **Version** you would like to use.
   b. Expand the **Optional configuration settings** and modify as needed.
   c. Select **Save changes**.

AWS CLI

The following example updates the EKS add-on:

```
aws eks update-addon --cluster-name <eks_cluster_name> --addon-name
netapp_trident-operator --addon-version v25.6.0-eksbuild.1 \
  --service-account-role-arn <role-ARN> --resolve-conflict preserve \
  --configuration-values "{\"cloudIdentity\":
\"'eks.amazonaws.com/role-arn: <role ARN>'\"}"
```

eksctl

- Check the current version of your FSxN Trident CSI add-on. Replace `my-cluster` with your cluster name.

```
eksctl get addon --name netapp_trident-operator --cluster my-cluster
```

Example output:

```
NAME                          VERSION              STATUS    ISSUES
IAMROLE    UPDATE AVAILABLE    CONFIGURATION VALUES
netapp_trident-operator    v25.6.0-eksbuild.1    ACTIVE    0
{"cloudIdentity":"'eks.amazonaws.com/role-arn:
arn:aws:iam::139763910815:role/AmazonEKS_FSXN_CSI_DriverRole'"}
```

- Update the add-on to the version returned under UPDATE AVAILABLE in the output of the previous step.

```
eksctl update addon --name netapp_trident-operator --version
v25.6.0-eksbuild.1 --cluster my-cluster --force
```

If you remove the `--force` option and any of the Amazon EKS add-on settings conflict with your existing settings, then updating the Amazon EKS add-on fails; you receive an error message to help you resolve the conflict. Before specifying this option, make sure that the Amazon EKS add-on does not manage settings that you need to manage, because those settings are overwritten with this option.
For more information about other options for this setting, see Addons.
For more information about Amazon EKS Kubernetes field management, see Kubernetes field management.

Uninstall/remove the Trident EKS add-on

You have two options for removing an Amazon EKS add-on:

- **Preserve add-on software on your cluster** – This option removes Amazon EKS management of any settings. It also removes the ability for Amazon EKS to notify you of updates and automatically update the Amazon EKS add-on after you initiate an update. However, it preserves the add-on software on your cluster. This option makes the add-on a self-managed installation, rather than an Amazon EKS add-on. With this option, there's no downtime for the add-on. Retain the `--preserve` option in the command to preserve the add-on.
- **Remove add-on software entirely from your cluster** – NetApp recommends that you remove the Amazon EKS add-on from your cluster only if there are no resources on your cluster that are dependent on it. Remove the `--preserve` option from the `delete` command to remove the add-on.

If the add-on has an IAM account associated with it, the IAM account is not removed.

Management console

1. Open the Amazon EKS console at https://console.aws.amazon.com/eks/home#/clusters.
2. In the left navigation pane, select **Clusters**.
3. Select the name of the cluster that you want to remove the NetApp Trident CSI add-on for.
4. Select the **Add-ons** tab and then select **Trident by NetApp**.*
5. Select **Remove**.
6. In the **Remove netapp_trident-operator confirmation** dialog, do the following:
   a. If you want Amazon EKS to stop managing settings for the add-on, select **Preserve on cluster**. Do this if you want to retain the add-on software on your cluster so that you can manage all of the settings of the add-on on your own.
   b. Enter **netapp_trident-operator**.
   c. Select **Remove**.

AWS CLI

Replace `my-cluster` with the name of your cluster, and then run the following command.

```
aws eks delete-addon --cluster-name my-cluster --addon-name
netapp_trident-operator --preserve
```

eksctl

The following command uninstalls the Trident EKS add-on:

```
eksctl delete addon --cluster K8s-arm --name netapp_trident-operator
```

Configure a storage class

The Kubernetes StorageClass object identifies a provisioner and instructs the provisioner how to provision volumes. This section shows you how to configure a Kubernetes StorageClass object that specifies Trident as the provisioner.

Create a StorageClass Object

When you create a StorageClass for FSx for ONTAP, Trident will automatically create the backend configuration.

> If you'd like to manually configure the storage backend, please refer to the [create-a-kubernetes-storageclass-without-automatic-backend-configuration] section for how to create the Trident backend and storage class separately.

Specify required StorageClass parameters

The following three parameters need to be defined when creating a StorageClass:

Parameter	Required	Type	Description
`fsxFilesystemID`	Yes	string	FSx for NetApp ONTAP filesystem ID
`storageDriverName`	Yes	string	Trident storage driver (for example, `ontap-nas` or `ontap-san`)
`credentialsName`	Yes	string	Name of the Kubernetes Secret that contains FSx for ONTAP credentials

Specify optional parameters

You can pass optional backend parameters through the StorageClass. Define all optional values as strings in the StorageClass `parameters` section. For a complete list of backend parameters, see: FSx for NetApp ONTAP backend configuration.

Example StorageClass configuration files.

The following example shows a StorageClass that triggers automatic backend configuration.

YAML

```yaml
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  name: ontap-fsx-demo
  annotations:
    description: "Demo StorageClass for FSx for NetApp ONTAP"
provisioner: csi.trident.netapp.io
parameters:
  fsxFilesystemID: "fs-0abc123"
  storageDriverName: "ontap-nas"
  credentialsName: trident-fsx-credentials
allowVolumeExpansion: true
reclaimPolicy: Delete
volumeBindingMode: Immediate
```

JSON

```json
{
  "apiVersion": "storage.k8s.io/v1",
  "kind": "StorageClass",
  "metadata": {
    "name": "ontap-fsx-demo",
    "annotations": {
      "description": "Demo StorageClass for FSx for NetApp ONTAP"
    }
  },
  "provisioner": "csi.trident.netapp.io",
  "parameters": {
    "fsxFilesystemID": "fs-0abc123",
    "storageDriverName": "ontap-nas",
    "credentialsName": "trident-fsx-credentials"
  },
  "allowVolumeExpansion": true,
  "reclaimPolicy": "Delete",
  "volumeBindingMode": "Immediate"
}
```

Create the StorageClass

Once you have created you configuration file, run the following command to create the storage class.

```
kubectl create -f storage-class-ontapnas.yaml
```

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

```
kubectl get sc basic-csi
```

```
NAME         PROVISIONER             AGE
basic-csi    csi.trident.netapp.io   15h
```

After you apply the StorageClass, Trident creates the backend automatically. You can then create PersistentVolumeClaims that reference this StorageClass.

Verify backend configuration status

Trident records the result of backend creation in StorageClass annotations.

Annotation	Description
`trident.netapp.io/configuratorStatus`	Configuration result (`Success` or `Failure`)
`trident.netapp.io/configuratorMessage`	Detailed status or error message
`trident.netapp.io/configuratorName`	Name of the internal configurator resource
`trident.netapp.io/managed`	Indicates the StorageClass is managed by Trident
`trident.netapp.io/additionalStoragePools`	Storage pools created for this backend

To verify status, run:

```
kubectl get storageclass ontap-fsx-demo -o yaml
```

Confirm that `trident.netapp.io/configuratorStatus` is set to `Success`. If the value is `Failure`, review `trident.netapp.io/configuratorMessage` for the error.

Add additional FSxN file systems

If you need additional storage capacity while continuing to use the same StorageClass, add additional FSxN file system IDs.

Edit the StorageClass and add the following annotation:

```
metadata:
  annotations:
    trident.netapp.io/additionalFsxNFileSystemID: '["fs-
xxxxxxxxxxxxxxxxxx"]'
```

After you apply the change, Trident updates the backend configuration and updates the StorageClass annotations.

Operational considerations and limitations

- Deleting a StorageClass that as the automatic backend configuration usually deletes the associated Trident backend. This can disrupt storage connectivity and break running workloads. Validate the impact before you delete a managed StorageClass.
- Automatic backend configuration is supported only for AWS FSx for NetApp ONTAP.

Create a Kubernetes StorageClass without automatic backend configuration

If you want to create the Trident backend and StorageClass separately then follow these steps.

Understand how automatic backend configuration works

Trident derives backend configuration from the StorageClass definition. When you apply the StorageClass, Trident validates the required parameters, creates the backend, and annotates the StorageClass with status.

Trident creates the VolumeSnapshotClass only once. Trident reuses the same VolumeSnapshotClass for subsequent StorageClasses.

Create the Trident backend

To create a Trident backend, you need to create a configuration file in either JSON or YAML format. The file needs to specify the type of storage you want (NAS or SAN), the file system, and SVM to get it from and how to authenticate with it. The following example shows how to define NAS-based storage and using an AWS secret to store the credentials to the SVM you want to use:

YAML

```
apiVersion: trident.netapp.io/v1
kind: TridentBackendConfig
metadata:
  name: backend-tbc-ontap-nas
  namespace: trident
spec:
  version: 1
  storageDriverName: ontap-nas
  backendName: tbc-ontap-nas
  svm: svm-name
  aws:
    fsxFilesystemID: fs-xxxxxxxxxx
  credentials:
    name: "arn:aws:secretsmanager:us-west-2:xxxxxxxx:secret:secret-
name"
    type: awsarn
```

JSON

```
{
  "apiVersion": "trident.netapp.io/v1",
  "kind": "TridentBackendConfig",
  "metadata": {
    "name": "backend-tbc-ontap-nas"
    "namespace": "trident"
  },
  "spec": {
    "version": 1,
    "storageDriverName": "ontap-nas",
    "backendName": "tbc-ontap-nas",
    "svm": "svm-name",
    "aws": {
      "fsxFilesystemID": "fs-xxxxxxxxxx"
    },
    "managementLIF": null,
    "credentials": {
      "name": "arn:aws:secretsmanager:us-west-2:xxxxxxxx:secret:secret-
name",
      "type": "awsarn"
    }
  }
}
```

FSx for ONTAP driver details

You can integrate Trident with Amazon FSx for NetApp ONTAP using the following drivers:

Driver Name	Description
`ontap-san`	Each PV provisioned is a LUN within its own Amazon FSx for NetApp ONTAP volume. Recommended for block storage.
`ontap-nas`	Each PV provisioned is a full Amazon FSx for NetApp ONTAP volume. Recommended for NFS and SMB.
`ontap-san-economy`	Each PV provisioned is a LUN with a configurable number of LUNs per Amazon FSx for NetApp ONTAP volume.
`ontap-nas-economy`	Each PV provisioned is a qtree, with a configurable number of qtrees per Amazon FSx for NetApp ONTAP volume.
`ontap-nas-flexgroup`	Each PV provisioned is a full Amazon FSx for NetApp ONTAP FlexGroup volume.

For driver details, refer to NAS drivers and SAN drivers.

Create the backend

After creating the configuration file run the following commands to create and validate the Trident Backend Configuration (TBC):

- Create trident backend configuration (TBC) from yaml file and run the following command:

```
kubectl create -f backendconfig.yaml -n trident
```

```
tridentbackendconfig.trident.netapp.io/backend-tbc-ontap-nas created
```

- Validate the trident backend configuration (TBC) was created successfully:

```
Kubectl get tbc -n trident
```

```
NAME                          BACKEND NAME          BACKEND UUID
PHASE   STATUS

backend-tbc-ontap-nas         tbc-ontap-nas         933e0071-66ce-4324-
b9ff-f96d916ac5e9   Bound   Success
```

For more information on other configuration options, see the [Backend-advanced-configuration-and-examples] section below.

Configure a Storage Class without automatic backend configuration

The following are examples of Storage Class configurations for use with Trident and FSx for ONTAP.

Storage Class for NFS

You can use this example to setup StorageClass for volumes using NFS (Refer to Trident Attribute section below for the full list of attributes):

```
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  name: ontap-gold
provisioner: csi.trident.netapp.io
parameters:
  backendType: "ontap-nas"
  provisioningType: "thin"
  snapshots: "true"
```

Storage Calss for iSCSI

Use this example to setup StorageClass for volumes using iSCSI:

```
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  name: ontap-gold
provisioner: csi.trident.netapp.io
parameters:
  backendType: "ontap-san"
  provisioningType: "thin"
  snapshots: "true"
```

Storage Class using NFSv3 and AWS Bottlerocket

To provision NFSv3 volumes on AWS Bottlerocket, add the required `mountOptions` to the storage class:

```
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  name: ontap-gold
provisioner: csi.trident.netapp.io
parameters:
  backendType: "ontap-nas"
  media: "ssd"
  provisioningType: "thin"
  snapshots: "true"
mountOptions:
  - nfsvers=3
  - nolock
```

Trident StorageClass attributes

These parameters determine which Trident-managed storage pools should be utilized to provision volumes of a given type.

Attribute	Type	Values	Offer	Request	Supported by
media[1]	string	hdd, hybrid, ssd	Pool contains media of this type; hybrid means both	Media type specified	ontap-nas, ontap-nas-economy, ontap-nas-flexgroup, ontap-san, solidfire-san
provisioningType	string	thin, thick	Pool supports this provisioning method	Provisioning method specified	thick: all ontap; thin: all ontap & solidfire-san
backendType	string	ontap-nas, ontap-nas-economy, ontap-nas-flexgroup, ontap-san, solidfire-san, azure-netapp-files, ontap-san-economy	Pool belongs to this type of backend	Backend specified	All drivers
snapshots	bool	true, false	Pool supports volumes with snapshots	Volume with snapshots enabled	ontap-nas, ontap-san, solidfire-san
clones	bool	true, false	Pool supports cloning volumes	Volume with clones enabled	ontap-nas, ontap-san, solidfire-san

Attribute	Type	Values	Offer	Request	Supported by
encryption	bool	true, false	Pool supports encrypted volumes	Volume with encryption enabled	ontap-nas, ontap-nas-economy, ontap-nas-flexgroups, ontap-san
IOPS	int	positive integer	Pool is capable of guaranteeing IOPS in this range	Volume guaranteed these IOPS	solidfire-san

[1]: Not supported by ONTAP Select or FSx for ONTAP systems

Refer to Kubernetes and Trident objects for details on how storage classes interact with the `PersistentVolumeClaim` and parameters for controlling how Trident provisions volumes.

Create the storage class

Once you have configured the StorageClass, you can create it in Kubernetes.

Steps

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

```
kubectl create -f storage-class-ontapnas.yaml
```

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

```
kubectl get sc basic-csi
```

```
NAME          PROVISIONER             AGE
basic-csi     csi.trident.netapp.io   15h
```

Provision SMB volumes

You can provision SMB volumes using the `ontap-nas` driver.
However, to do so you must complete these steps: Prepare to provision SMB volumes.

Backend advanced configuration and examples

See the following table for the backend configuration options:

Parameter	Description	Example
`version`		Always 1

Parameter	Description	Example
`storageDriverName`	Name of the storage driver	`ontap-nas`, `ontap-nas-economy`, `ontap-nas-flexgroup`, `ontap-san`, `ontap-san-economy`
`backendName`	Custom name or the storage backend	Driver name + "_" + dataLIF
`managementLIF`	IP address of a cluster or SVM management LIF A fully-qualified domain name (FQDN) can be specified. Can be set to use IPv6 addresses if Trident was installed using the IPv6 flag. IPv6 addresses must be defined in square brackets, such as [28e8:d9fb:a825:b7bf:69a8:d02f:9e7b:3555]. If you provide the `fsxFilesystemID` under the `aws` field, you need not to provide the `managementLIF` because Trident retrieves the SVM `managementLIF` information from AWS. So, you must provide credentials for a user under the SVM (For example: vsadmin) and the user must have the `vsadmin` role.	"10.0.0.1", "[2001:1234:abcd::fefe]"

Parameter	Description	Example
`dataLIF`	IP address of protocol LIF. **ONTAP NAS drivers**: NetApp recommends specifying dataLIF. If not provided, Trident fetches dataLIFs from the SVM. You can specify a fully-qualified domain name (FQDN) to be used for the NFS mount operations, allowing you to create a round-robin DNS to load-balance across multiple dataLIFs. Can be changed after initial setting. **ONTAP SAN drivers**: Do not specify for iSCSI. Trident uses ONTAP Selective LUN Map to discover the iSCI LIFs needed to establish a multi path session. A warning is generated if dataLIF is explicitly defined. Can be set to use IPv6 addresses if Trident was installed using the IPv6 flag. IPv6 addresses must be defined in square brackets, such as [28e8:d9fb:a825:b7bf:69a8:d02f:9e7b:3555].	
`autoExportPolicy`	Enable automatic export policy creation and updating [Boolean]. Using the `autoExportPolicy` and `autoExportCIDRs` options, Trident can manage export policies automatically.	`false`
`autoExportCIDRs`	List of CIDRs to filter Kubernetes' node IPs against when `autoExportPolicy` is enabled. Using the `autoExportPolicy` and `autoExportCIDRs` options, Trident can manage export policies automatically.	"["0.0.0.0/0", "::/0"]"
`labels`	Set of arbitrary JSON-formatted labels to apply on volumes	""
`clientCertificate`	Base64-encoded value of client certificate. Used for certificate-based auth	""

Parameter	Description	Example
`clientPrivateKey`	Base64-encoded value of client private key. Used for certificate-based auth	""
`trustedCACertificate`	Base64-encoded value of trusted CA certificate. Optional. Used for certificate-based authentication.	""
`username`	Username to connect to the cluster or SVM. Used for credential-based authentication. For example, vsadmin.	
`password`	Password to connect to the cluster or SVM. Used for credential-based authentication.	
`svm`	Storage virtual machine to use	Derived if an SVM managementLIF is specified.
`storagePrefix`	Prefix used when provisioning new volumes in the SVM. Cannot be modified after creation. To update this parameter, you will need to create a new backend.	`trident`
`limitAggregateUsage`	**Do not specify for Amazon FSx for NetApp ONTAP.** The provided `fsxadmin` and `vsadmin` do not contain the permissions required to retrieve aggregate usage and limit it using Trident.	Do not use.
`limitVolumeSize`	Fail provisioning if requested volume size is above this value. Also restricts the maximum size of the volumes it manages for qtrees and LUNs, and the `qtreesPerFlexvol` option allows customizing the maximum number of qtrees per FlexVol volume	"" (not enforced by default)
`lunsPerFlexvol`	Maximum LUNs per Flexvol volume, must be in range [50, 200]. SAN only.	“100”

Parameter	Description	Example
`debugTraceFlags`	Debug flags to use when troubleshooting. Example, {"api":false, "method":true} Do not use `debugTraceFlags` unless you are troubleshooting and require a detailed log dump.	null
`nfsMountOptions`	Comma-separated list of NFS mount options. The mount options for Kubernetes-persistent volumes are normally specified in storage classes, but if no mount options are specified in a storage class, Trident will fall back to using the mount options specified in the storage backend's configuration file. If no mount options are specified in the storage class or the configuration file, Trident will not set any mount options on an associated persistent volume.	""
`nasType`	Configure NFS or SMB volumes creation. Options are `nfs`, `smb`, or null. **Must set to `smb` for SMB volumes.** Setting to null defaults to NFS volumes.	`nfs`
`qtreesPerFlexvol`	Maximum Qtrees per FlexVol volume, must be in range [50, 300]	`"200"`
`smbShare`	You can specify one of the following: the name of an SMB share created using the Microsoft Management Console or ONTAP CLI or a name to allow Trident to create the SMB share. This parameter is required for Amazon FSx for ONTAP backends.	`smb-share`

Parameter	Description	Example
`useREST`	Boolean parameter to use ONTAP REST APIs. When set to `true`, Trident will use ONTAP REST APIs to communicate with the backend. This feature requires ONTAP 9.11.1 and later. In addition, the ONTAP login role used must have access to the `ontap` application. This is satisfied by the pre-defined `vsadmin` and `cluster-admin` roles.	`false`
`aws`	You can specify the following in the configuration file for AWS FSx for ONTAP: - `fsxFilesystemID`: Specify the ID of the AWS FSx file system. - `apiRegion`: AWS API region name. - `apikey`: AWS API key. - `secretKey`: AWS secret key.	"" "" ""
`credentials`	Specify the FSx SVM credentials to store in AWS Secrets Manager. - `name`: Amazon Resource Name (ARN) of the secret, which contains the credentials of SVM. - `type`: Set to `awsarn`. Refer to Create an AWS Secrets Manager secret for more information.	

Backend configuration options for provisioning volumes

You can control default provisioning using these options in the `defaults` section of the configuration. For an example, see the configuration examples below.

Parameter	Description	Default
`spaceAllocation`	Space-allocation for LUNs	`true`
`spaceReserve`	Space reservation mode; "none" (thin) or "volume" (thick)	`none`
`snapshotPolicy`	Snapshot policy to use	`none`

Parameter	Description	Default
`qosPolicy`	QoS policy group to assign for volumes created. Choose one of qosPolicy or adaptiveQosPolicy per storage pool or backend. Using QoS policy groups with Trident requires ONTAP 9.8 or later. You should use a non-shared QoS policy group and ensuring the policy group is applied to each constituent individually. A shared QoS policy group enforces the ceiling for the total throughput of all workloads.	""
`adaptiveQosPolicy`	Adaptive QoS policy group to assign for volumes created. Choose one of qosPolicy or adaptiveQosPolicy per storage pool or backend. Not supported by ontap-nas-economy.	""
`snapshotReserve`	Percentage of volume reserved for snapshots "0"	If `snapshotPolicy` is `none`, `else` ""
`splitOnClone`	Split a clone from its parent upon creation	`false`
`encryption`	Enable NetApp Volume Encryption (NVE) on the new volume; defaults to `false`. NVE must be licensed and enabled on the cluster to use this option. If NAE is enabled on the backend, any volume provisioned in Trident will be NAE enabled. For more information, refer to: How Trident works with NVE and NAE.	`false`
`luksEncryption`	Enable LUKS encryption. Refer to Use Linux Unified Key Setup (LUKS). SAN only.	""
`tieringPolicy`	Tiering policy to use `none`	
`unixPermissions`	Mode for new volumes. **Leave empty for SMB volumes.**	""

Parameter	Description	Default
`securityStyle`	Security style for new volumes. NFS supports `mixed` and `unix` security styles. SMB supports `mixed` and `ntfs` security styles.	NFS default is `unix`. SMB default is `ntfs`.

Configure a PVC

This sections includes instructions on how to create a PersistentVolumeClaim (PVC) that uses the configured Kubernetes StorageClass to request a PV.
If successful, you can then mount the PV to a pod.

Create the PVC

A *PersistentVolumeClaim* (PVC) is a request for access to the PersistentVolume on the cluster. The PVC can be configured to request storage of a certain size or access mode. Using the associated StorageClass, the cluster administrator can control more than PersistentVolume size and access mode—such as performance or service level.

After you create the Trident backend and StorageClass you can create a PVC. After the PVC is created, you can mount the volume in a pod.

Sample manifests

The following examples show basic PVC configuration options.

PVC with RWX access

This example shows a basic PVC with RWX access that is associated with a StorageClass named `basic-csi`.

```
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: pvc-storage
spec:
  accessModes:
    - ReadWriteMany
  resources:
    requests:
      storage: 1Gi
  storageClassName: ontap-gold
```

PVC using iSCSI example

This example shows a basic PVC for iSCSI with RWO access that is associated with a StorageClass named

`protection-gold`.

```
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: pvc-san
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 1Gi
  storageClassName: protection-gold
```

Create PVC

Steps

1. Create the PVC.

   ```
   kubectl create -f pvc.yaml
   ```

2. Verify the PVC status.

   ```
   kubectl get pvc
   ```

```
NAME        STATUS VOLUME     CAPACITY ACCESS MODES STORAGECLASS AGE
pvc-storage Bound  pv-name 2Gi      RWO                         5m
```

Refer to Kubernetes and Trident objects for details on how storage classes interact with the `PersistentVolumeClaim` and parameters for controlling how Trident provisions volumes.

Deploy an application

When the storage class and PVC are created, you can mount the PV to a pod. This section lists the example command and configuration to attach the PV to a pod.

Deploy a sample application

Steps

1. Mount the volume in a pod.

```
kubectl create -f pv-pod.yaml
```

These examples show basic configurations to attach the PVC to a pod:
Basic configuration:

```
kind: Pod
apiVersion: v1
metadata:
  name: pv-pod
spec:
  volumes:
    - name: pv-storage
      persistentVolumeClaim:
       claimName: basic
  containers:
    - name: pv-container
      image: nginx
      ports:
        - containerPort: 80
          name: "http-server"
      volumeMounts:
        - mountPath: "/my/mount/path"
          name: pv-storage
```

You can monitor the progress using `kubectl get pod --watch`.

2. Verify that the volume is mounted on `/my/mount/path`.

```
kubectl exec -it pv-pod -- df -h /my/mount/path
```

```
Filesystem                                                      Size
Used  Avail Use%  Mounted on
192.168.188.78:/trident_pvc_ae45ed05_3ace_4e7c_9080_d2a83ae03d06  1.1G
320K  1.0G   1%   /my/mount/path
```

You can now delete the Pod. The Pod application will no longer exist, but the volume will remain.

```
kubectl delete pod pv-pod
```

Configure the Trident EKS add-on on an EKS cluster

NetApp Trident streamlines Amazon FSx for NetApp ONTAP storage management in Kubernetes to enable your developers and administrators focus on application deployment. The NetApp Trident EKS add-on includes the latest security patches, bug fixes, and is validated by AWS to work with Amazon EKS. The EKS add-on enables you to consistently ensure that your Amazon EKS clusters are secure and stable and reduce the amount of work that you need to do in order to install, configure, and update add-ons.

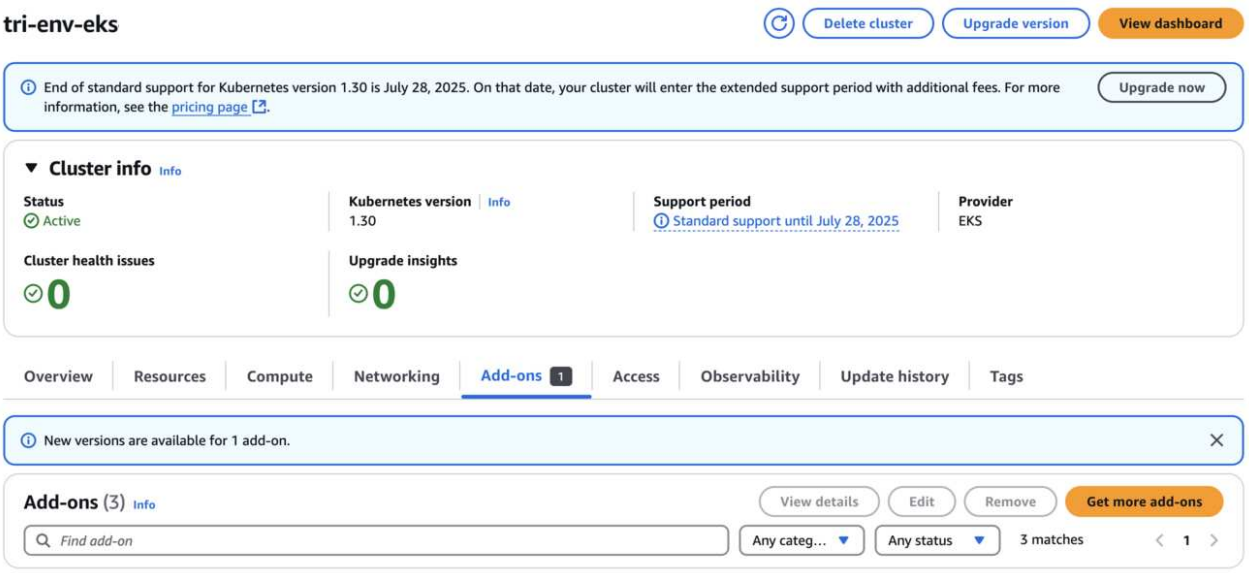
Prerequisites

Ensure that you have the following before configuring the Trident add-on for AWS EKS:

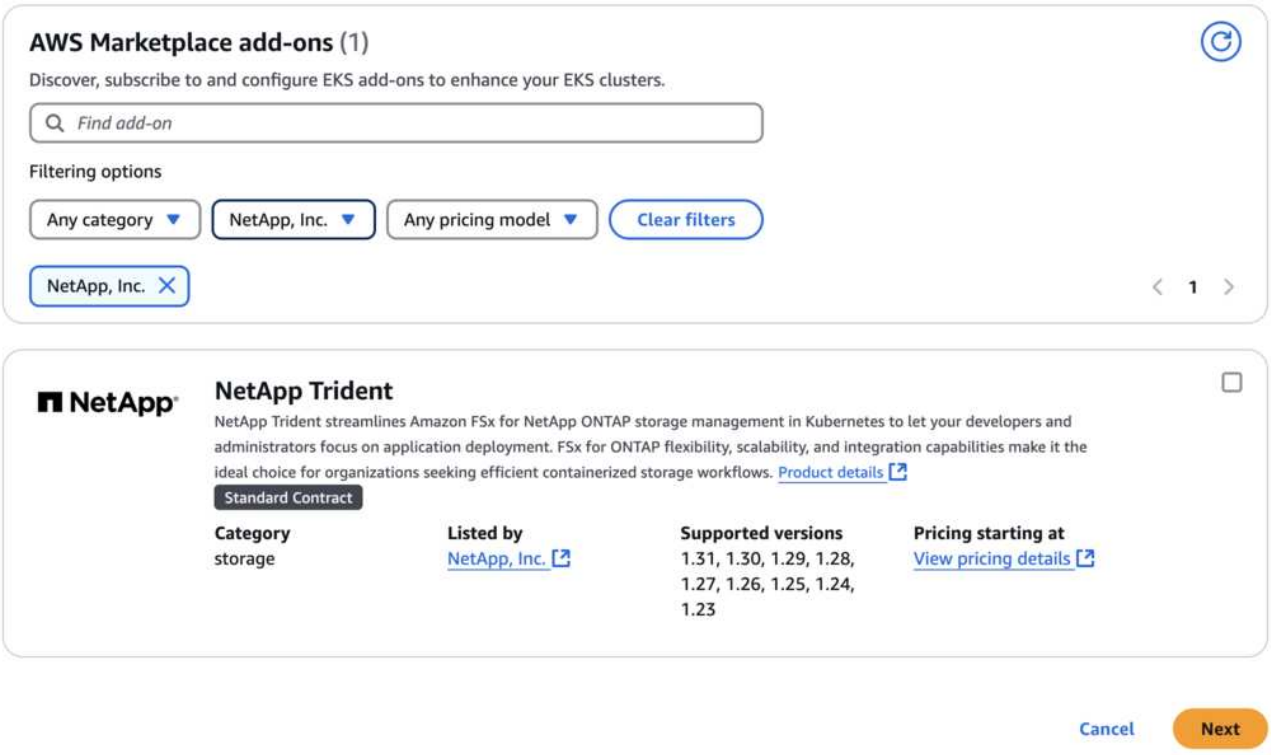
- An Amazon EKS cluster account with permissions to work with add-ons. Refer to Amazon EKS add-ons.
- AWS permissions to the AWS marketplace:
  ```
  "aws-marketplace:ViewSubscriptions",
  "aws-marketplace:Subscribe",
  "aws-marketplace:Unsubscribe
  ```
- AMI type: Amazon Linux 2 (AL2_x86_64) or Amazon Linux 2 Arm(AL2_ARM_64)
- Node type: AMD or ARM
- An existing Amazon FSx for NetApp ONTAP file system

Steps

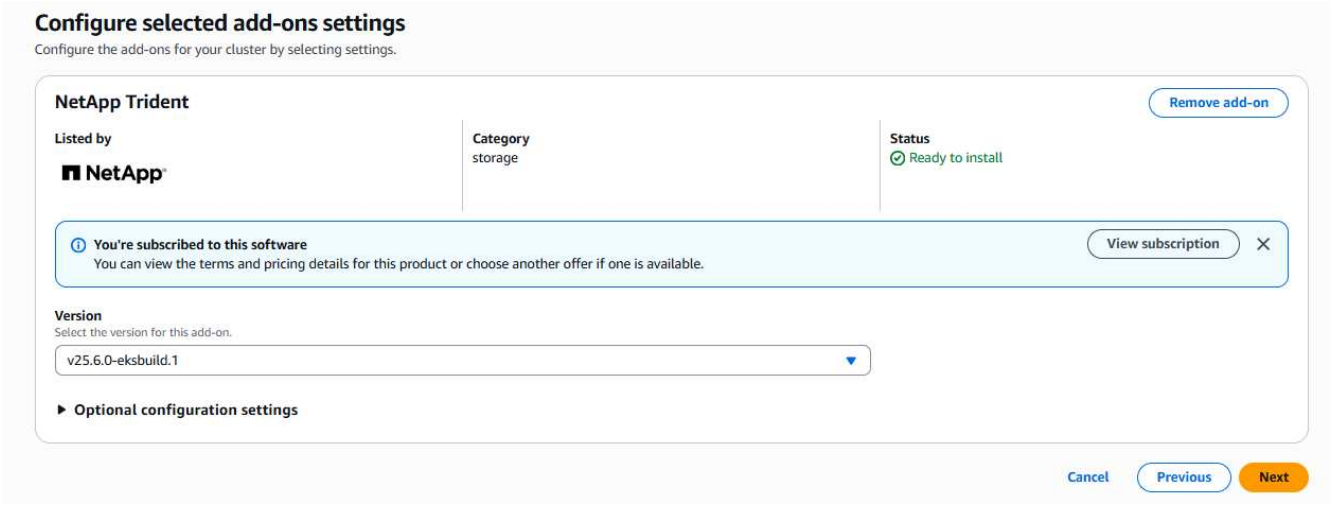
1. Make sure to create IAM role and AWS secret to enable EKS pods to access AWS resources. For instructions, see Create an IAM role and AWS Secret.
2. On your EKS Kubernetes cluster, navigate to the **Add-ons** tab.



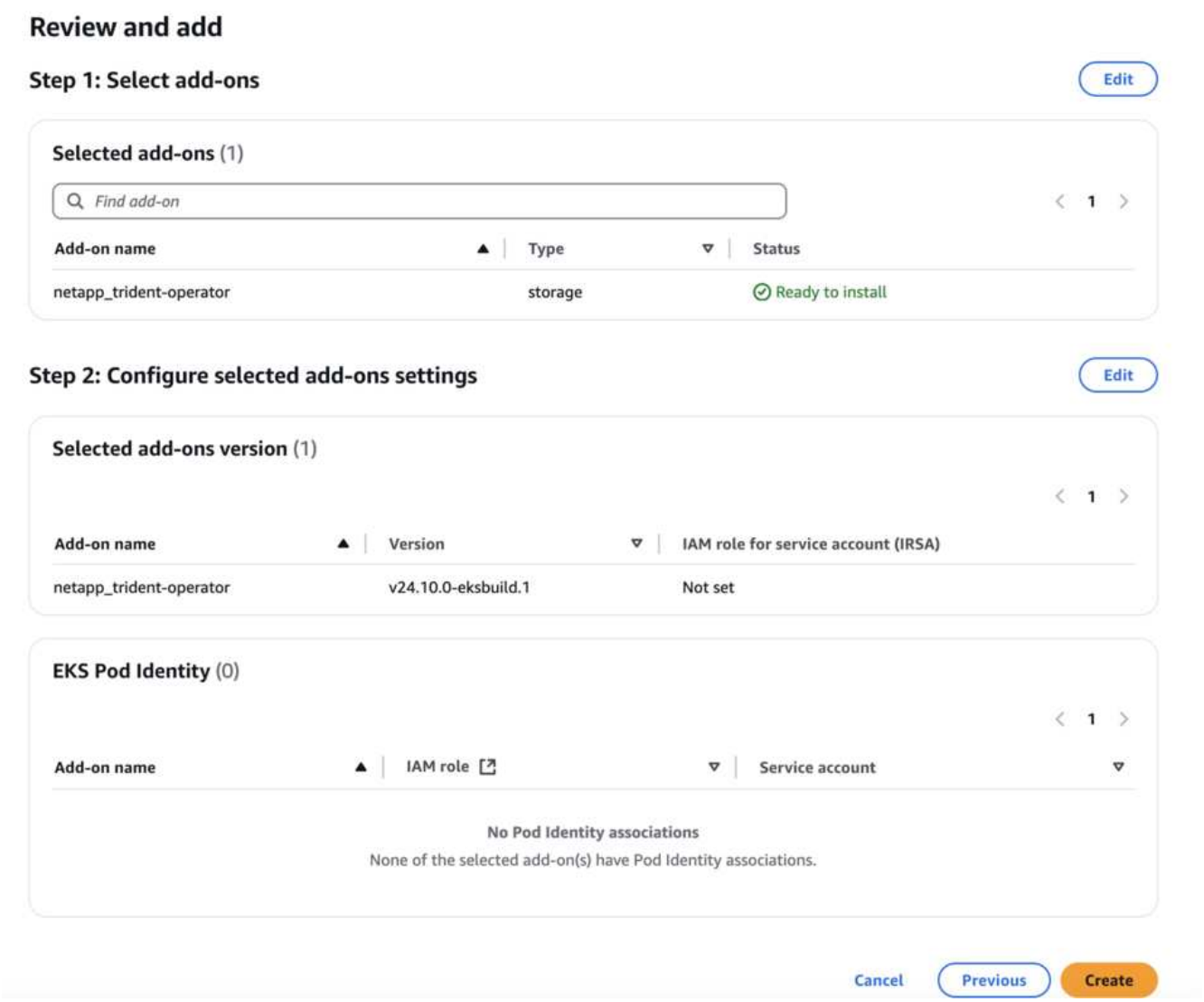
3. Go to **AWS Marketplace add-ons** and choose the *storage* category.



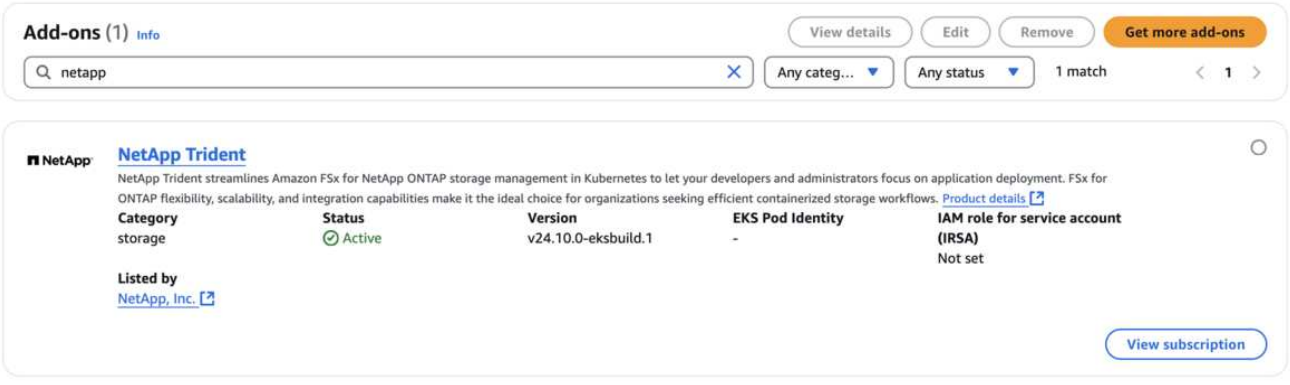
4. Locate **NetApp Trident** and select the checkbox for the Trident add-on, and click **Next**.
5. Choose the desired version of the add-on.



6. Configure the required add-on settings.



7. If you are using IRSA (IAM roles for service account), refer to the additional configuration steps here.
8. Select **Create**.
9. Verify that the status of the add-on is *Active*.



10. Run the following command to verify that Trident is properly installed on the cluster:

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

11. Continue the setup and configure the storage backend. For information, see Configure the Storage Backend.

Install/uninstall the Trident EKS add-on using CLI

Install the NetApp Trident EKS add-on using CLI:

The following example command installs the Trident EKS add-on:
`eksctl create addon --cluster clusterName --name netapp_trident-operator --version v25.6.0-eksbuild.1` (with a dedicated version)

The following example command installs the Trident EKS add-on version 25.6.1:
`eksctl create addon --cluster clusterName --name netapp_trident-operator --version v25.6.1-eksbuild.1` (with a dedicated version)

The following example command installs the Trident EKS add-on version 25.6.2:
`eksctl create addon --cluster clusterName --name netapp_trident-operator --version v25.6.2-eksbuild.1` (with a dedicated version)

Uninstall the NetApp Trident EKS add-on using CLI:

The following command uninstalls the Trident EKS add-on:

```
eksctl delete addon --cluster K8s-arm --name netapp_trident-operator
```

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