



Get started

NetApp public and hybrid cloud solutions

NetApp
February 04, 2026

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Get started

NetApp Hybrid Multicloud solutions for Red Hat OpenShift Container workloads

NetApp is seeing a significant increase in customers modernizing their legacy enterprise applications and building new applications using containers and orchestration platforms built around Kubernetes. Red Hat OpenShift Container Platform is one example that we see adopted by many of our customers.

Overview

As more and more customers begin adopting containers within their enterprises, NetApp is perfectly positioned to help serve the persistent storage needs of their stateful applications and classic data management needs such as data protection, data security, and data migration. However, these needs are met using different strategies, tools, and methods.

NetApp ONTAP based storage options listed below, deliver security, data protection, reliability, and flexibility for containers and Kubernetes deployments.

- Self-managed storage in on-premises:
 - NetApp Fabric Attached Storage (FAS), NetApp All Flash FAS Arrays (AFF), NetApp All SAN Array (ASA) and ONTAP Select
- Provider-managed storage in on-premises:
 - NetApp Keystone provides Storage as a Service (STaaS)
- Self-managed storage in the cloud:
 - NetApp Cloud Volumes ONTAP(CVO) provide self managed storage in the hyperscalers
- Provider-managed storage in the cloud:
 - Amazon FSx for NetApp ONTAP, Azure NetApp Files, and Google Cloud NetApp Volumes provide file-based storage in the cloud.

ONTAP feature highlights



<h3>Storage Administration</h3> <ul style="list-style-type: none"> • Multi-tenancy • FlexVol & FlexGroup • LUN • Quotas • ONTAP CLI & API • System Manager & BlueXP 	<h3>Performance & Scalability</h3> <ul style="list-style-type: none"> • FlexCache • FlexClone • nconnect, session trunking, multipathing • Scale-out clusters
<h3>Availability & Resilience</h3> <ul style="list-style-type: none"> • Multi-AZ HA deployment (MetroCluster) • SnapShot & SnapRestore • SnapMirror • SnapMirror Business Continuity • SnapMirror Cloud 	<h3>Access Protocols</h3> <ul style="list-style-type: none"> • NFS –v3, v4, v4.1, v4.2 • SMB – v2, v3 • iSCSI • Multi-protocol access
<h3>Storage Efficiency</h3> <ul style="list-style-type: none"> • Deduplication & Compression • Compaction • Thin provisioning • Data Tiering (Fabric Pool) 	<h3>Security & Compliance</h3> <ul style="list-style-type: none"> • Fpolicy & Vscan • Active Directory integration • LDAP & Kerberos • Certificate based authentication

NetApp BlueXP enables you to manage all of your storage and data assets from a single control plane/interface.

You can use BlueXP to create and administer cloud storage (for example, Cloud Volumes ONTAP and Azure NetApp Files), to move, protect, and analyze data, and to control many on-prem and edge storage devices.

NetApp Trident is a CSI Compliant Storage Orchestrator that enable quick and easy consumption of persistent storage backed by a variety of the above-mentioned NetApp storage options. It is an open-source software maintained and supported by NetApp.

Astra Trident CSI feature highlights



<h3>CSI specific</h3> <ul style="list-style-type: none"> • CSI NetApp® Snapshot™ copies and volume creation from CSI Snapshot copies • CSI topology • Volume expansion 	<h3>Security</h3> <ul style="list-style-type: none"> • Dynamic-export policy management • iSCSI initiator-groups dynamic management • iSCSI bidirectional CHAP
<h3>Control</h3> <ul style="list-style-type: none"> • Storage and performance consumption • Monitoring • Volume Import • Cross Namespace Volume Access 	<h3>Installation methods</h3> <ul style="list-style-type: none"> • Binary • Helm chart • Operator • GitOps
<h3>Choose your access mode</h3> <ul style="list-style-type: none"> • RWO (ReadWriteOnce, i.e 1↔1) • RWOP (ReadWriteOnce POD) • RWX (ReadWriteMany, i.e 1↔n) • ROX (ReadOnlyMany) 	<h3>Choose your protocol</h3> <ul style="list-style-type: none"> • NFS • SMB • iSCSI

Business critical container workloads need more than just persistent volumes. Their data management requirements require protection and migration of the application kubernetes objects as well.

Application data includes kubernetes objects in addition to the user data: Some examples are as follows:

- kubernetes objects such as pods specs, PVCs, deployments, services
- custom config objects such as config maps and secrets
- persistent data such as Snapshot copies, backups, clones
- custom resources such as CRs and CRDs

NetApp Trident Protect, available as an open-source, free software maintained by NetApp, provides for advanced application data management capabilities that enhance the functionality and availability of stateful Kubernetes applications backed by NetApp ONTAP storage systems and the NetApp Trident CSI storage provisioner. Trident protect simplifies the management, protection, and movement of containerized workloads across public clouds and on-premises environments. It also offers automation capabilities through its API and CLI.

This reference documentation provides validation of data protection of container-based applications, deployed on RedHat OpenShift platform using Trident Protect. In addition, the solution provides high-level details for the deployment and the use of Red Hat Advanced Cluster Management (ACM) for managing the container platforms. The document also highlights the details for the integration of NetApp storage with Red Hat OpenShift container platforms using Trident CSI provisioner.

Value propositions of NetApp Hybrid Multicloud solutions for Red Hat OpenShift Container workloads

Most customers do not just start out building Kubernetes based environments without any existing infrastructure. Perhaps they are a traditional IT shop running most of their enterprise applications on virtual machines (in large VMware environments for example). Then they start building small container-based environments to satisfy the needs of their modern application development teams. These initiatives usually start small and begin to become more pervasive as the teams learn these new technologies and skills, and begin to recognize the many benefits of adopting them.

The good news for customers is that NetApp can serve the needs of both environments. This set of solutions for hybrid multicloud with Red Hat OpenShift will empower NetApp customers to adopt modern cloud technologies and services without having to overhaul their entire infrastructure and organization. Whether customer applications and data are hosted on-premises, in cloud, run on virtual machines, or on containers, NetApp can provide consistent data management, protection, security, and portability. With these new solutions, the same value NetApp has delivered in on-premises data center environments for decades will be available across the enterprise entire data horizon, without requiring significant investment to retool, acquire new skills, or build new teams. NetApp is positioned well to help customers solve these business challenges regardless of what phase of their cloud journey they are in.

NetApp Hybrid Multi-Cloud with Red Hat Openshift:

- Gives customers validated designs and practices which demonstrate the best ways for customers to manage, protect, secure, and migrate their data and applications when using Red Hat OpenShift with

NetApp based storage solutions.

- Present best practices for customers running Red Hat OpenShift with NetApp storage in VMware environments, bare metal infrastructure, or a combination of both.
- Demonstrate strategies and options for both on-prem and cloud environments, as well as hybrid environments where both are used.

Supported Solutions of NetApp Hybrid Multicloud for Red Hat OpenShift Container workloads

The solution tests and validates Migration & Centralized Data Protection with OpenShift container platform (OCP), OpenShift Advanced Cluster Manager (ACM), NetApp ONTAP, NetApp BlueXP and NetApp Trident Protect (ACC).

For this solution, the following scenarios are tested and validated by NetApp. The solution is separated into multiple scenarios based on the following characteristics:

- on-premises
- cloud
 - self-managed OpenShift clusters and self-managed NetApp storage
 - provider-managed OpenShift clusters and provider-managed NetApp storage

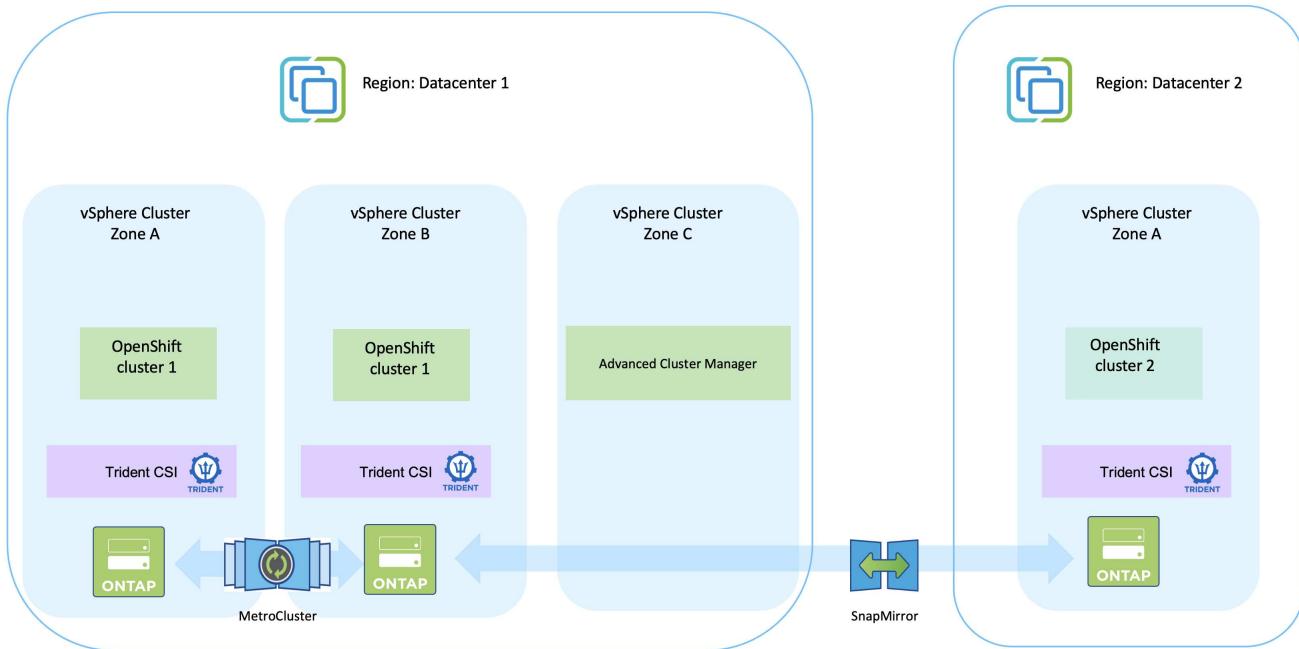
We will be building out additional solutions and use cases in the future.

Scenario 1: Data protection and migration within the on-premises environment using Trident Protect

On-premises: self-managed OpenShift clusters and self-managed NetApp storage

- Using ACC, create Snapshot copies, backups and restores for data protection.
- Using ACC, perform a SnapMirror replication of container applications.

Scenario 1

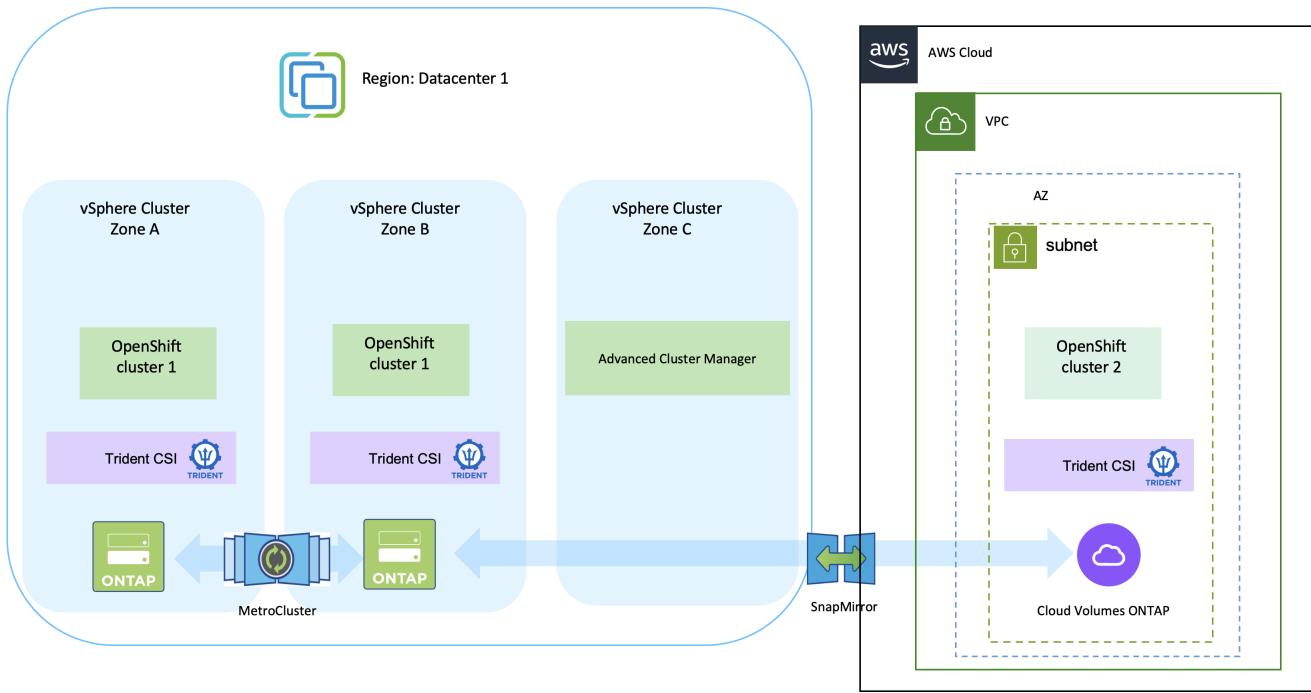


Scenario 2: Data protection and migration from the on-premises environment to AWS environment using Trident Protect

On-premises: Self-managed OpenShift cluster and self-managed storage
 AWS Cloud: Self-managed OpenShift cluster and self-managed storage

- Using ACC, perform backups and restores for data protection.
- Using ACC, perform a SnapMirror replication of container applications.

Scenario 2



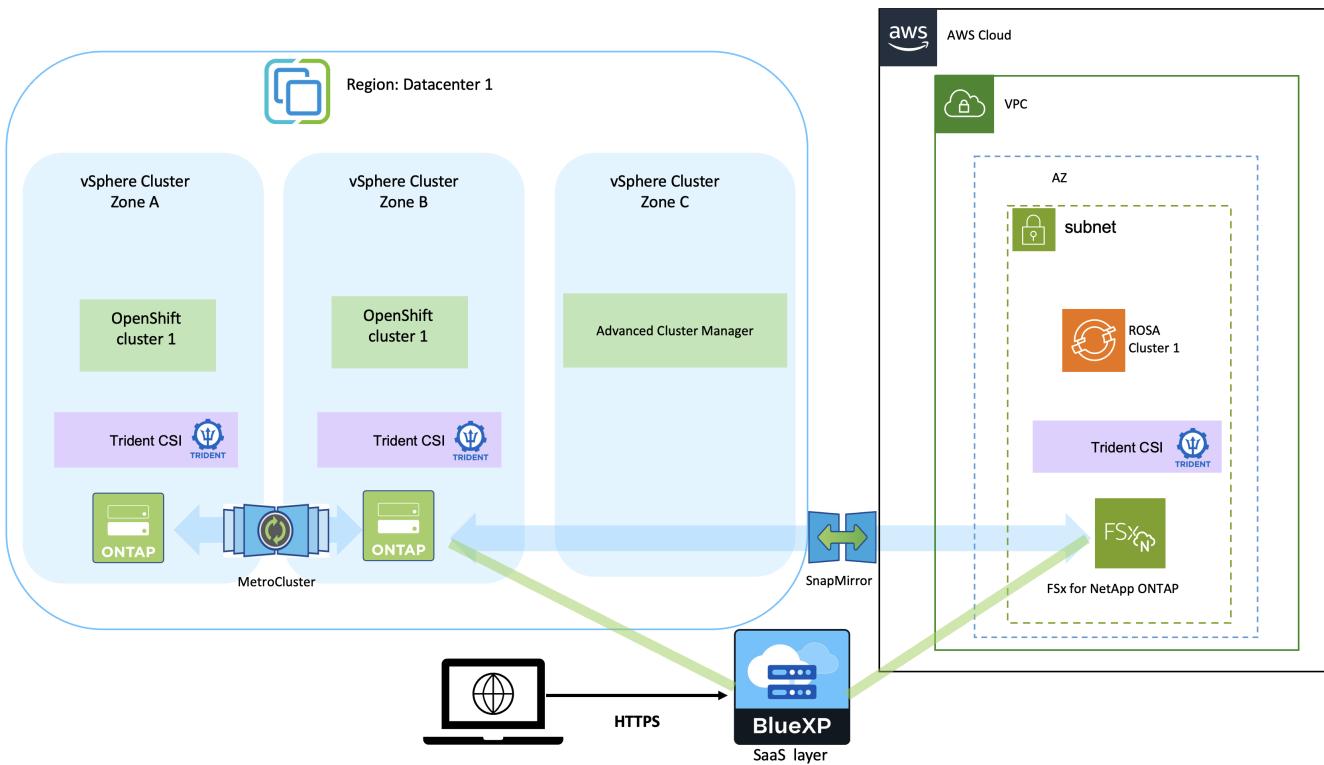
Scenario 3: Data protection and migration from the on-premises environment to AWS environment

On-premises: Self-managed OpenShift cluster and self-managed storage

AWS Cloud: Provider-managed OpenShift cluster (ROSA) and provider-managed storage (FSx ONTAP)

- Using BlueXP, perform replication of persistent volumes (FSx ONTAP).
- Using OpenShift GitOps, recreate application metadata.

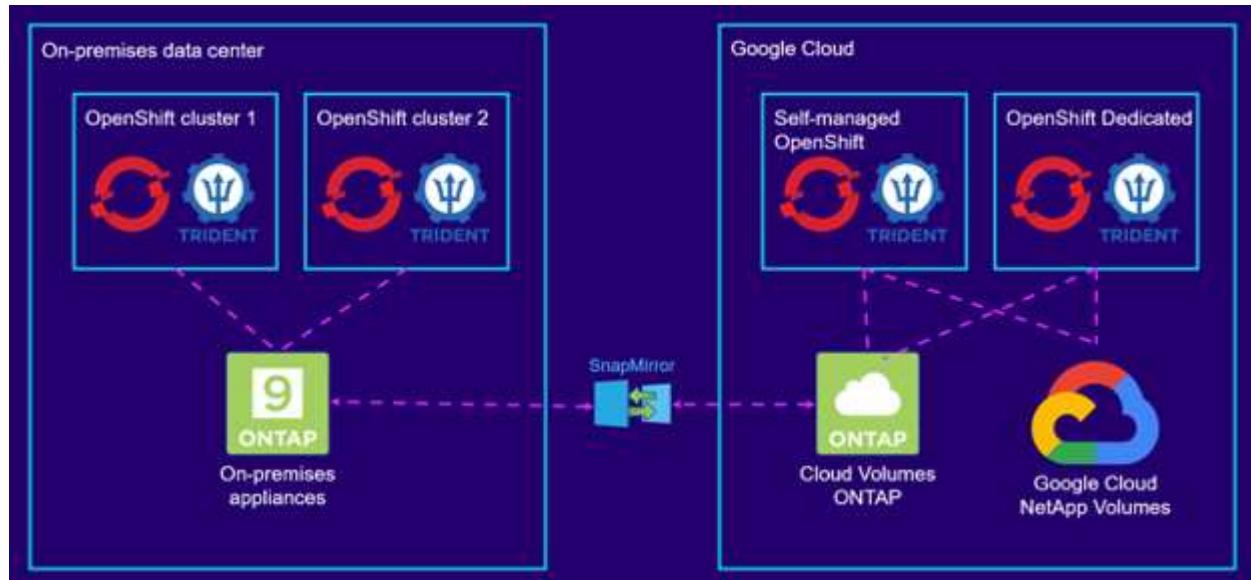
Scenario 3



Scenario 4: Data protection and migration from the on-premises environment to GCP environment using Trident Protect

On-premises: Self-managed OpenShift cluster and self-managed storage
Google Cloud: Self-managed OpenShift cluster and self-managed storage

- Using ACC, perform backups and restores for data protection.
- Using ACC, perform a SnapMirror replication of container applications.



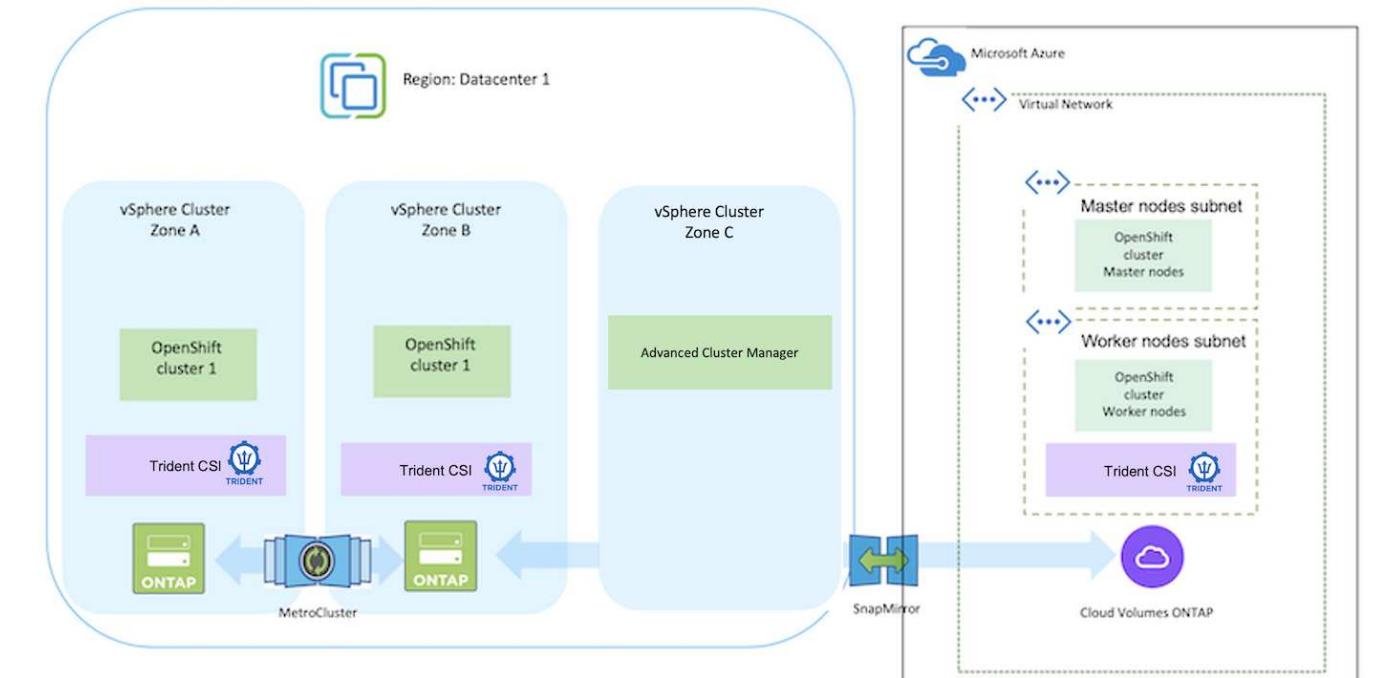
For considerations when using ONTAP in a MetroCluster configuration, refer [here](#).

Scenario 5: Data protection and migration from the on-premises environment to Azure environment using Trident Protect

On-premises: Self-managed OpenShift cluster and self-managed storage

Azure Cloud: Self-managed OpenShift cluster and self-managed storage

- Using ACC, perform backups and restores for data protection.
- Using ACC, perform a SnapMirror replication of container applications.



For considerations when using ONTAP in a MetroCluster configuration, refer [here](#).

Versions of various components used in the solution validation

The solution tests and validates Migration & Centralized Data Protection with OpenShift container platform, OpenShift Advanced Cluster Manager, NetApp ONTAP, and NetApp Trident Protect.

Scenarios 1, 2 and 3 of the solution were validated using the versions as shown in the table below:

Component	Version
VMware	vSphere Client version 8.0.0.10200 VMware ESXi, 8.0.0, 20842819
Hub Cluster	OpenShift 4.11.34
Source and Destination Clusters	OpenShift 4.12.9 on-premises and in AWS
NetApp Trident	Trident Server and Client 23.04.0

NetApp Trident Protect	Trident Protect 22.11.0-82
NetApp ONTAP	ONTAP 9.12.1
AWS FSx ONTAP	Single AZ

Scenario 4 of the solution was validated using the versions as shown in the table below:

Component	Version
VMware	vSphere Client version 8.0.2.00000 VMware ESXi, 8.0.2, 22380479
Hub Cluster	OpenShift 4.13.13
Source and Destination Clusters	OpenShift 4.13.12 on-premises and in Google Cloud
NetApp Trident	Trident Server and Client 23.07.0
NetApp ONTAP	ONTAP 9.12.1
Cloud Volumes ONTAP	Single AZ, Single node, 9.14.0

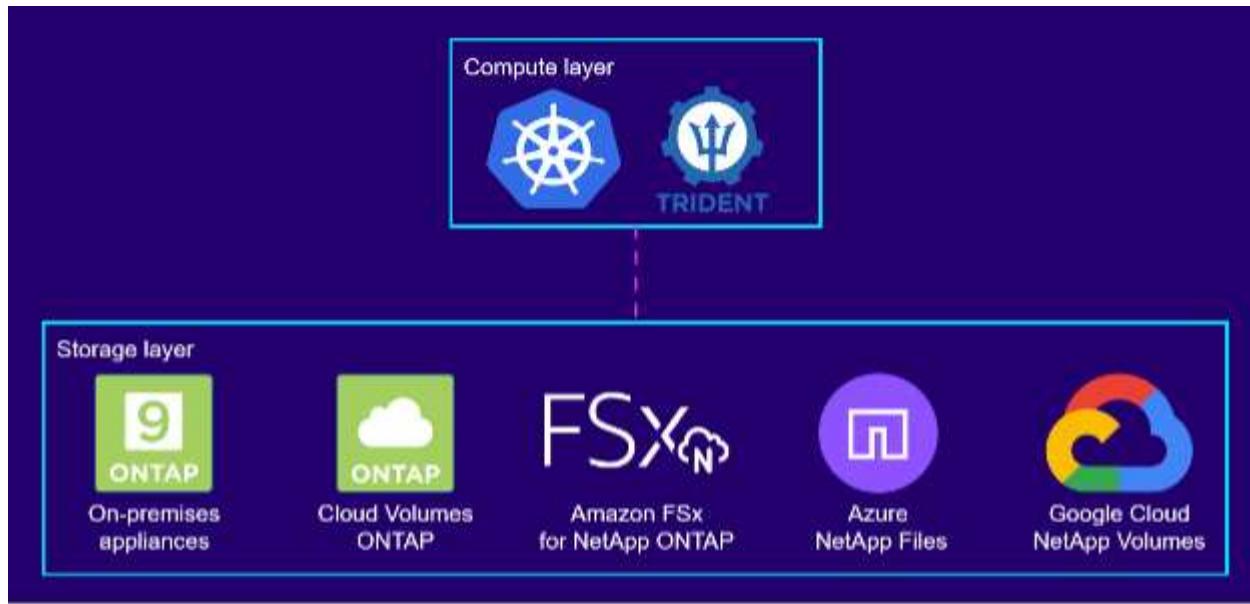
Scenario 5 of the solution was validated using the versions as shown in the table below:

Component	Version
VMware	vSphere Client version 8.0.2.00000 VMware ESXi, 8.0.2, 22380479
Source and Destination Clusters	OpenShift 4.13.25 on-premises and in Azure
NetApp Trident	Trident Server and Client and Astra Control Provisioner 23.10.0
NetApp Trident Protect	Trident Protect 23.10
NetApp ONTAP	ONTAP 9.12.1
Cloud Volumes ONTAP	Single AZ, Single node, 9.14.0

Supported NetApp Storage integrations with Red Hat OpenShift Containers

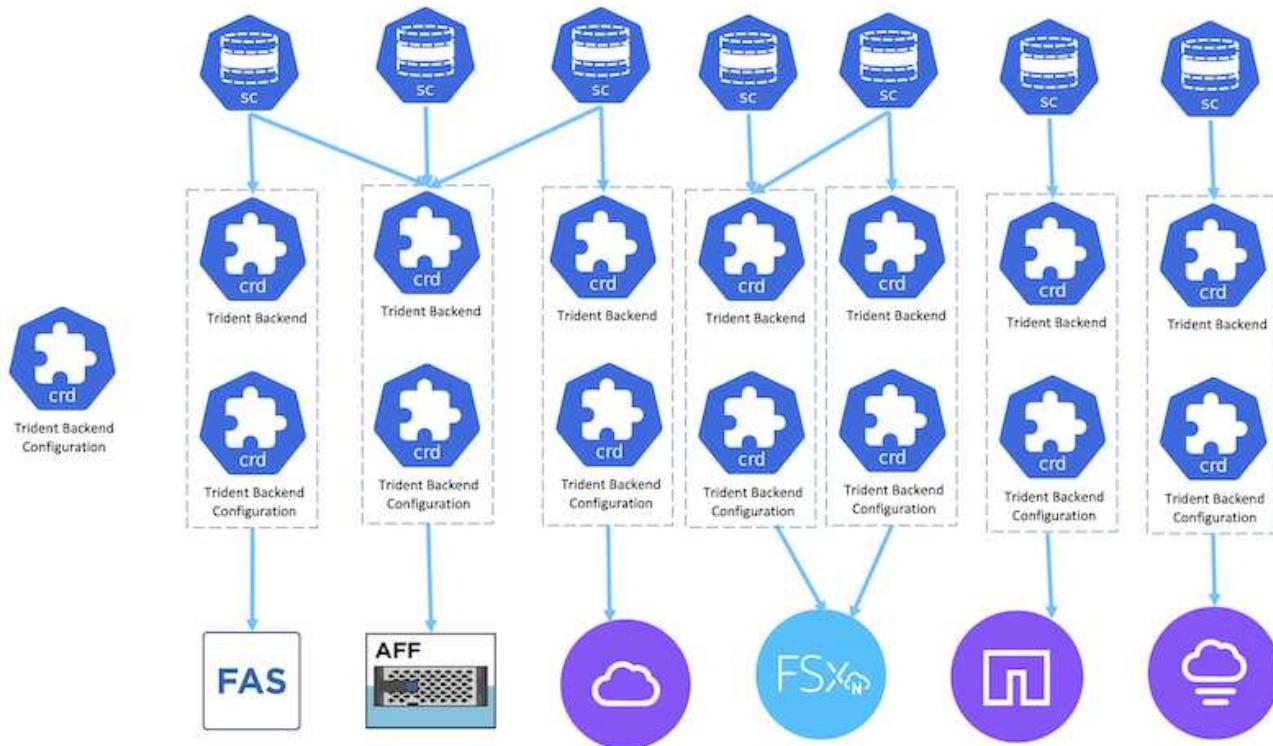
Whether the Red Hat OpenShift containers are running on VMware or in the hyperscalers, NetApp Trident can be used as the CSI provisioner for the various types of backend NetApp storage that it supports.

The following diagram depicts the various backend NetApp storage that can be integrated with OpenShift clusters using NetApp Trident.



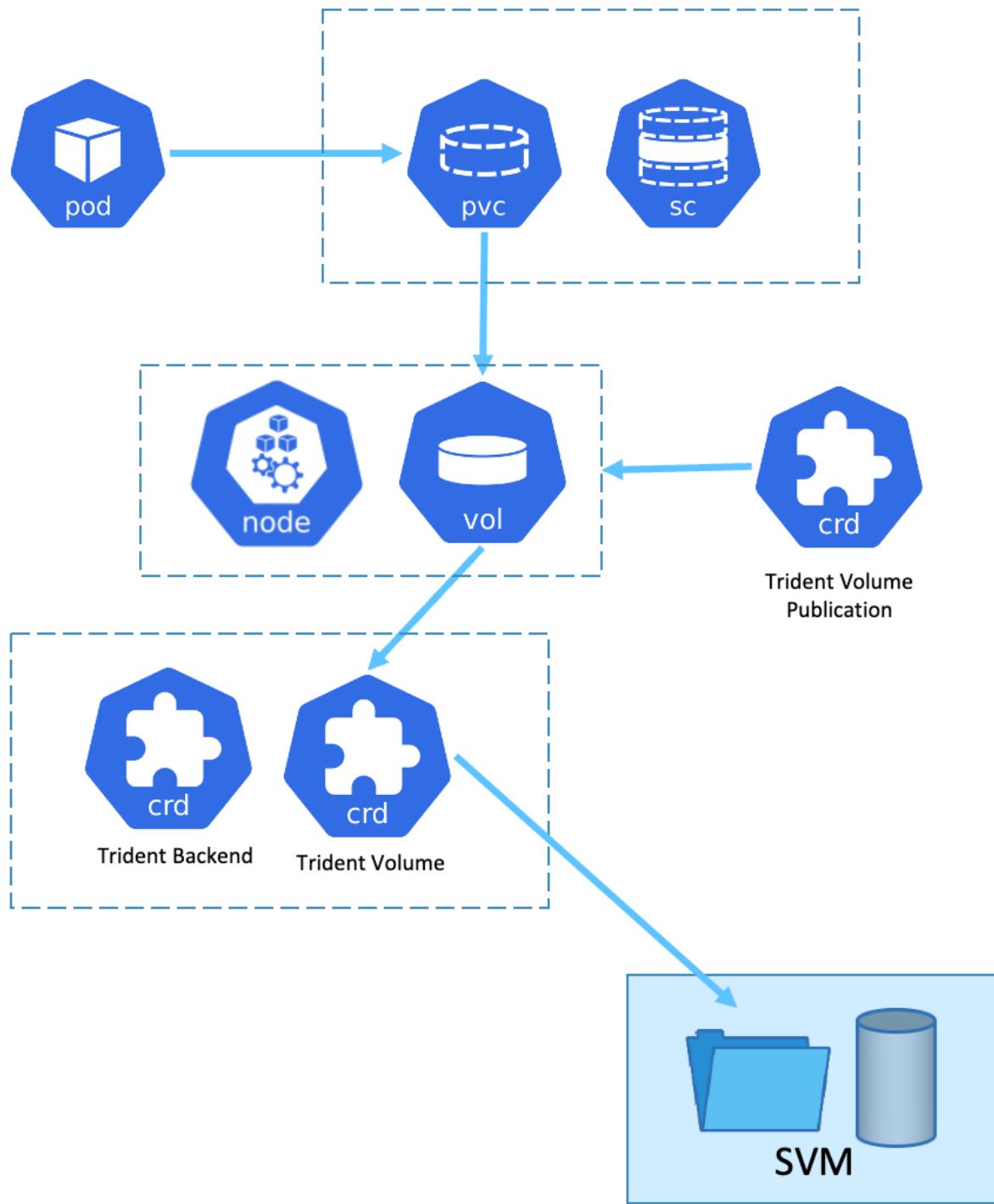
ONTAP Storage Virtual Machine (SVM) provides secure multi-tenancy. A Single OpenShift cluster can connect to single SVM or multiple SVMs or even to multiple ONTAP clusters. Storage class filters the backend storage based on parameters or by labels. Storage administrators define the parameters to connect to storage system using trident backend configuration. On successful connection establishment, it creates the trident backend and populates the information which the storage class can filter.

The relationship between the storageclass and backend is shown below.



Application owner requests persistent volume using storage class. The storage class filters the backend storage.

The relationship between the pod and backend storage is shown below.



Container Storage Interface (CSI) Options

On vSphere environments, customers can pick VMware CSI driver and/or Trident CSI to integrate with ONTAP. With VMware CSI, the persistent volumes are consumed as local SCSI disks, whereas with Trident, it is consumed with network.

As VMware CSI does not support RWX access modes with ONTAP, applications need to use Trident CSI if RWX mode is required. With FC based deployments, VMware CSI is preferred and SnapMirror Business Continuity (SMBC) provides zone level high availability.

VMware CSI supports

- Core Block based datastores (FC, FCoE, iSCSI, NVMeoF)
- Core File based datastores (NFS v3, v4)
- vVol datastores (block and file)

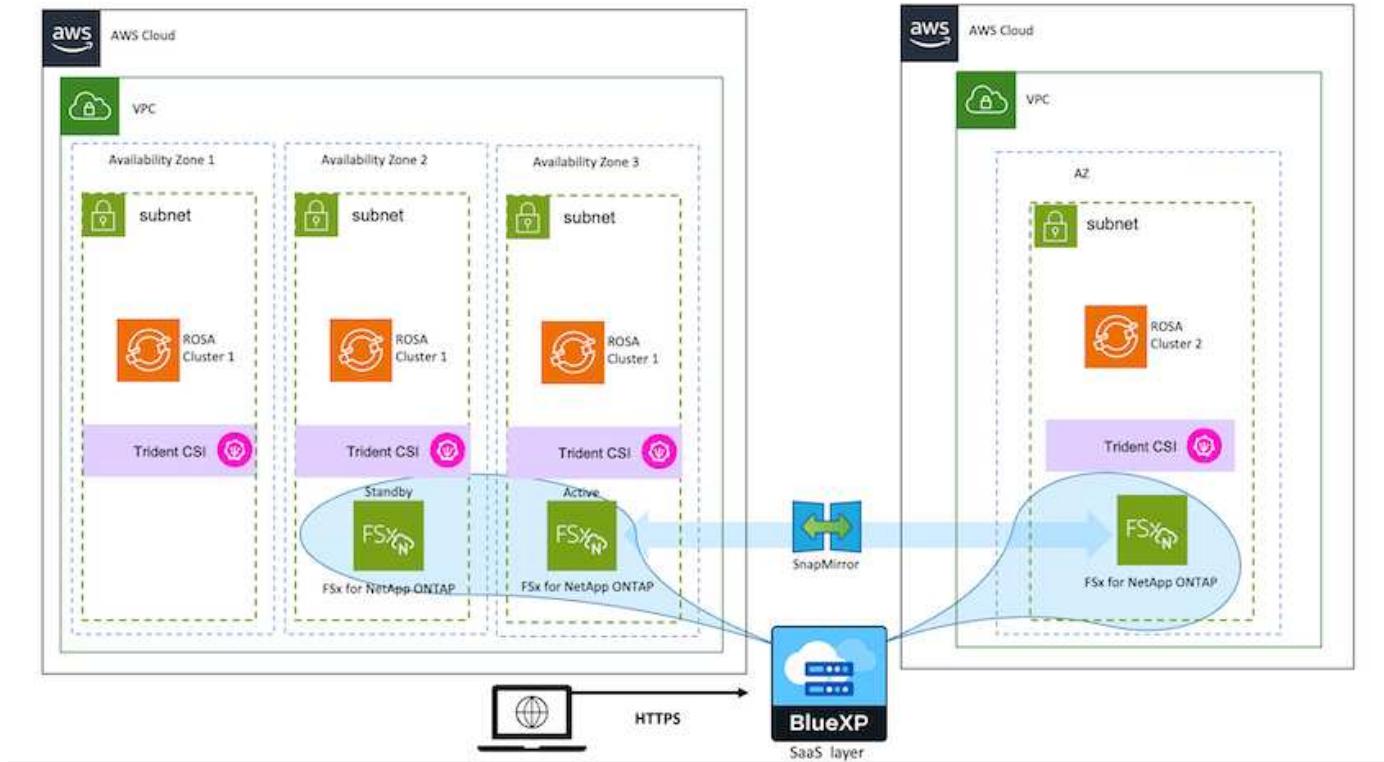
Trident has following drivers to support ONTAP

- ontap-san (dedicated volume)
- ontap-san-economy (shared volume)
- ontap-nas (dedicated volume)
- ontap-nas-economy (shared volume)
- ontap-nas-flexgroup (dedicated large scale volume)

For both VMware CSI and Trident CSI, ONTAP supports nconnect, session trunking, kerberos, etc. for NFS and multipathing, chap authentication, etc. for block protocols.

In AWS, Amazon FSx for NetApp ONTAP (FSx ONTAP) can be deployed in single Availability Zone (AZ) or in Multi AZ. For production workloads that requires high availability, multi-AZ provides zonal level fault tolerance and has better NVMe read cache compared to single AZ. For more info, check [AWS performance guidelines](#).

To save cost on disaster recovery site, single AZ FSx ONTAP can be utilized.



For number of SVMs that are supported by FSx ONTAP, refer [managing FSx ONTAP storage virtual machine](#)

Additional Documentation

Here are some additional documentation for reference:

1. [VMware vSphere](#)
2. [OpenShift Container platform product documentation](#)
3. [Installing OpenShift container platform clusters](#)
4. [Advanced cluster management product documentation](#)
5. [Creating a cluster using ACM](#)
6. [Deploying Red Hat Quay on OpenShift](#)
7. [Trident](#)
8. [ONTAP 9](#)
9. [NetApp Verda](#) - Verda (Open source) has a collection of reference execution hooks for popular cloud native data-intensive applications
10. [NetApp BlueXP](#)
11. [Red Hat OpenShift Service on AWS](#)
12. [Amazon FSx ONTAP](#)
13. [Installing OpenShift Clusters on GCP](#)
14. [Installing OpenShift Clusters on Azure](#)

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