SUSE Virtualization

Integrating SUSE® Virtualization with NetApp® Storage

Enabling Persistent Storage for Virtual Machines Using NetApp ONTAP and Trident

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NetApp ONTAP
NetApp Trident

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Summary

This guide covers how to integrate NetApp® external storage with SUSE® Virtualization to provide persistent storage for virtual machines. It provides detailed steps for provisioning LUNs, configuring iSCSI and multipath, installing and configuring Trident™ Container Storage Interface (CSI), and using a NetApp-backed StorageClass to create and attach volumes to virtual machines.

Contents

1 Introduction

SUSE® Virtualization is a cloud-native virtualization platform that unifies virtual machine (VM) and container management, streamlining operations, and boosting efficiency with a single, cohesive platform for hybrid cloud infrastructure. NetApp® ONTAP® delivers unified data management, allowing you to manage, protect, and move data across your hybrid environment. By leveraging NetApp® Trident™, you can deliver high-performance storage for virtual machines (VMs) hosted in your SUSE® Virtualization environment.

1.1 Scope

This guide covers the detailed steps required for setting up a three-node SUSE Virtualization cluster to consume NetApp storage. It includes steps for LUN provisioning, multipath configuration, Trident installation, StorageClass definition, and basic validation.

1.2 Audience

This guide is intended for IT professionals responsible for virtualization and infrastructure management, such as infrastructure architects, systems administrators, or platform engineers.

To successfully follow this guide, you should have:

- Familiarity with SUSE Virtualization deployment and configuration
- Experience with NetApp storage provisioning and management
- Understanding of iSCSI concepts and configuration
- Working knowledge of Kubernetes

1.3 Prerequisites

You will need the following, minimum resources to implement the described integration:

- **SUSE Virtualization cluster** with at least three nodes for high availability

SUSE Virtualization (https://www.suse.com/products/harvester) ↗ is a modern, open, interoperable, hyperconverged infrastructure (HCI) solution built on Kubernetes. It is an open source alternative designed for operators seeking a cloud-native HCI solution. SUSE Virtualization runs on bare metal servers and provides integrated virtualization and distributed storage capabilities.
See SUSE Virtualization: Hardware and Network Requirements (https://documentation.suse.com/cloudnative/virtualization/latest/en/installation-setup/requirements.html) ↗ and Trident: Requirements (https://docs.netapp.com/us-en/trident/trident-get-started/requirements.html) ↗ for more details.
This guide applies to SUSE Virtualization v1.6.0 and newer.

- **NetApp ONTAP storage**
  NetApp ONTAP (https://www.netapp.com/ontap-data-management-software/) ↗ intelligent data infrastructure must be available and accessible by the SUSE Virtualization cluster nodes over a network.
  This guide applies to ONTAP 9 and newer.

- **NetApp Trident CSI driver**
  Trident (https://docs.netapp.com/us-en/trident) ↗ is an open source storage provisioner and orchestrator maintained by NetApp that enables you to create storage volumes for containerized applications in Kubernetes.
  This guide applies to Trident 25.10.0 and newer.

- **Administrative access:** Ensure that you have administrative access to the SUSE Virtualization UI and the underlying Kubernetes cluster to apply configurations and manage resources.
  See SUSE Virtualization: Troubleshooting FAQ (https://documentation.suse.com/cloudnative/virtualization/latest/en/troubleshooting/faq.html) ↗.

2 Architecture

The diagram below illustrates the basic architecture for SUSE Virtualization integrated with NetApp ONTAP storage.

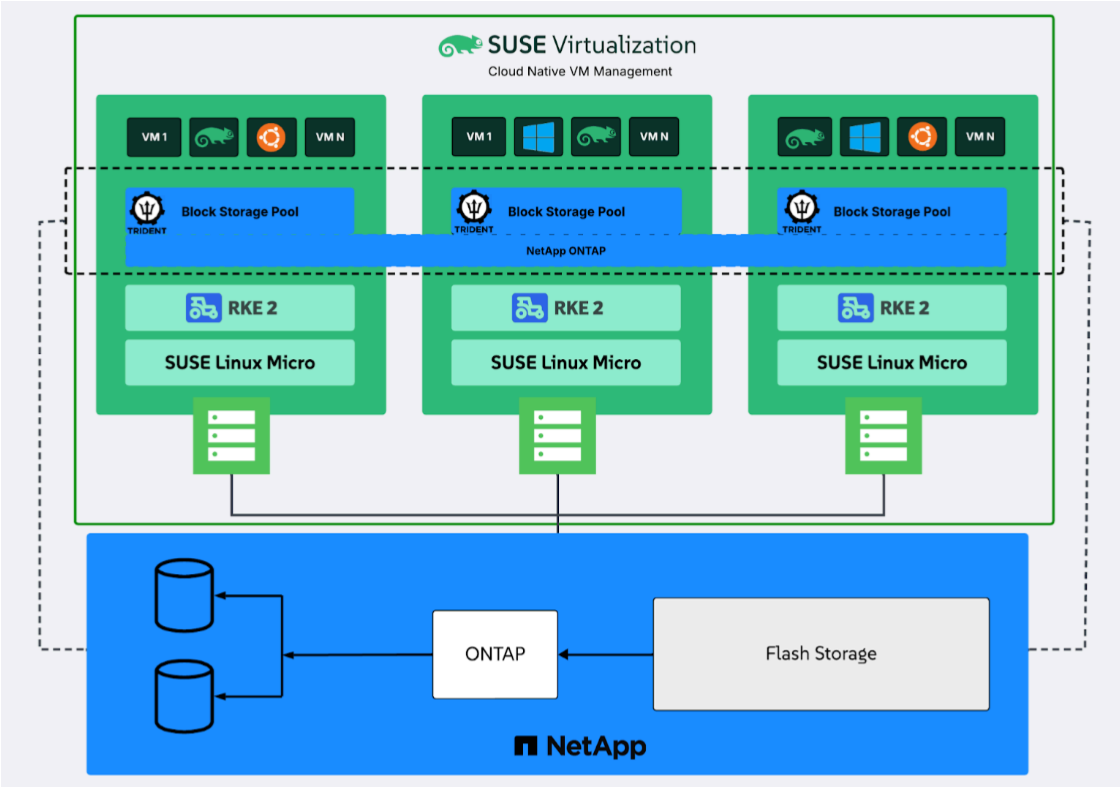

FIGURE 1: ARCHITECTURE: SUSE VIRTUALIZATION WITH NETAPP ONTAP AND TRIDENT

The key components of the solution are:

- **SUSE Virtualization** is the cloud native solution that provides unified and streamlined orchestration for VMs and containers. Built on Kubernetes, SUSE Virtualization delivers a flexible, scalable, and resilient infrastructure platform for all of your workloads.
- **NetApp ONTAP** data management software powers ONTAP storage systems. With a global namespace that supports up to 24 hardware nodes of all types, ONTAP software supports unified storage (block and file), enabling significant workload consolidation that you can manage using the ONTAP System Manager GUI. In this solution, ONTAP is used to provision iSCSI LUNs on the ONTAP storage back-end.
- **NetApp Trident** is a Container Storage Interface (CSI) that delivers dynamic storage orchestration and natively integrates with Kubernetes. Trident enables consumption and management of storage resources across all popular NetApp storage platforms, in the public cloud or on-premises. Trident runs as a single controller pod and a node pod on each worker node in the cluster.

When deployed together in the illustrated configuration, SUSE Virtualization nodes connect over the iSCSI protocol to NetApp ONTAP storage using the Trident CSI. High availability storage access is available when the cluster environment is configured with multipath support.

3 Deployment

This section provides practical guidance for deploying a functional, proof-of-concept implementation of the solution with additional considerations for scaling to production.

For deployment purposes, the solution can be illustrated as a layered stack. The deployment process consists of installing and configuring each layer of this stack, typically from bottom (compute platform) to top (software applications). Guidance for deploying each layer of the solution are provided in the following sections.

3.1 Preparing the compute platform

1. Ensure each node meets minimum hardware requirements (https://documentation.suse.com/cloudnative/virtualization/latest/en/installation-setup/requirements.html).

   Note

   Be sure hardware virtualization (VT-x/AMD-V) is enabled on each node.

2. Deploy the nodes, storage, and network as illustrated in the architecture diagram.

3.2 Deploying SUSE Virtualization

1. Install a SUSE Virtualization high-availability cluster onto the compute platform.
   See official documentation (https://documentation.suse.com/cloudnative/virtualization/latest/en/introduction/overview.html) for detailed guidance.

2. After deployment, confirm you have access to the cluster through the SUSE Virtualization UI and CLI. For tips, see SUSE Virtualization: Authentication (https://documentation.suse.com/cloudnative/virtualization/latest/en/installation-setup/authentication.html) and SUSE Virtualization: Troubleshooting - FAQ (https://documentation.suse.com/cloudnative/virtualization/latest/en/troubleshooting/faq.html).

3.3 Configuring iSCSI

Use CloudInit to create a persistent configuration of the iSCSI initiator.

1. Define the configuration of the iSCSI initiator.

   a. Create the `01_iscsi_ip.yaml` CloudInit resource file listed below in the `/oem` directory on each cluster node.

```
apiVersion: node.harvesterhci.io/v1beta1
kind: CloudInit
metadata:
  name: iscsi-ip-config
spec:
  matchSelector: {}
    kubernetes.io/hostname: harvester-node-1 # Replace with actual hostname
  filename: 01_iscsi_ip.yaml
  contents: |
    stages:
      initramfs:
        - name: "Configure iSCSI network interfaces"
          files:
            - path: /etc/NetworkManager/system-connections/iscsi-
path1.nmconnection
              owner: 0
              group: 0
              permissions: 0600
              content: |
                [connection]
                id=iscsi-path1
                type=ethernet
                interface-name=eno3np0
                autoconnect=true
                [ipv4]
                method=manual
                addresses=192.168.100.87/24 # Replace the IP address
                never-default=true
            - path: /etc/NetworkManager/system-connections/iscsi-
path2.nmconnection
              owner: 0
              group: 0
              permissions: 0600
              content: |
                [connection]
                id=iscsi-path2
                type=ethernet
                interface-name=eno4np1
```

```
                autoconnect=true
                [ipv4]
                method=manual
                addresses=192.168.200.87/24 # Replace the IP address
                never-default=true
```

b. Apply the configuration on each node.

```
kubectl apply -f 01_iscsi_ip.yaml
```

c. Verify the iSCSI initiator is deployed.

```
kubectl get cloudinit
NAME               AGE
iscsi-ip-config    20s
```

2. Enable the iSCSI service daemon.

a. Create `99_iscsid.yaml` in the `/oem` directory any node.

```
apiVersion: node.harvesterhci.io/v1beta1
kind: CloudInit
metadata:
  name: iscsid-start
spec:
  matchSelector: {}
  filename: 99_iscsid.yaml
  contents: |
    stages:
      network:
        - name: "Enable and start iscsid"
          systemctl:
            enable:
              - iscsid
            start:
              - iscsid
```

b. Apply the configuration.

```
kubectl apply -f 99_iscsid.yaml
```

c. Verify the status of `iscsid` on each node.

```
systemctl status iscsid
```

```
● iscsid.service - Open-iSCSI
```

```
     Loaded: loaded (/usr/lib/systemd/system/iscsid.service; disabled;)
     Active: active (running) since Fri 2026-03-27 20:59:47 IST; 8s ago
TriggeredBy: ● iscsid.socket
       Docs: man:iscsid(8)
             man:iscsiuio(8)
             man:iscsiadm(8)
   Main PID: 27651 (iscsid)
     Status: "Ready to process requests"
      Tasks: 1
        CPU: 3ms
     CGroup: /system.slice/iscsid.service
             └─27651 /sbin/iscsid -f

Mar 27 20:59:47 docserver systemd[1]: Starting Open-iSCSI...
Mar 27 20:59:47 docserver systemd[1]: Started Open-iSCSI.
```

3.4 Enabling Multipath

1. Create a CloudInit resource to auto-start the multipath daemon (`multipathd`) as shown below.

```
apiVersion: node.harvesterhci.io/v1beta1
kind: CloudInit
metadata:
  name: multipathd-config
spec:
  matchSelector: {}
  filename: 99_multipathd.yaml
  contents: |
    stages:
      network:
        - name: "Configure multipath.conf"
          files:
            - path: /etc/multipath.conf
              permissions: 0644
              owner: 0
              group: 0
              content: |
                defaults {
                    find_multipaths no
                    user_friendly_names yes
                }
                blacklist {
                    device {
                        vendor ".*"
```

```
                        product ".*"
                    }
                }
                blacklist_exceptions {
                    device {
                        vendor "NETAPP"
                        product "LUN"
                    }
                }
        - name: "Enable and start multipathd"
          systemctl:
            enable:
              - multipathd
            start:
              - multipathd
```

2. Apply the configuration on any node.

```
kubectl apply -f 99_multipathd.yaml
```

3. Verify the status of `multipathd`.

```
systemctl status multipathd
```

```
● multipathd.service - Device-Mapper Multipath Device Controller
     Loaded: loaded (/usr/lib/systemd/system/multipathd.service; disabled;)
     Active: active (running) since Fri 2026-03-27 21:01:08 IST; 11s ago
TriggeredBy: ○ multipathd.socket
   Main PID: 28854 (multipathd)
     Status: "up"
      Tasks: 7
        CPU: 18ms
     CGroup: /system.slice/multipathd.service
             └─28854 /sbin/multipathd -d -s

Mar 27 21:01:08 docserver systemd[1]: Starting Device-Mapper Multipath Device
 Controller...
Mar 27 21:01:08 docserver multipathd[28854]: multipathd v0.10.2+122+suse.51e02cc:
 start up
```

3.5 Deploying the Trident CSI

1. Prepare the worker nodes.

Before installing NetApp Trident, ensure that each SUSE Virtualization node meets the prerequisites for Kubernetes storage integration. Follow the official NetApp documentation for Worker Node Preparation for Trident CSI (https://docs.netapp.com/us-en/trident/trident-use/worker-node-prep.html#iscsi-self-healing-capabilities).

2. Create a Kubernetes secret for your NetApp ONTAP storage controller credentials.

```
kubectl create secret generic ontap-secret -n trident \
  --from-literal=username=admin \
  --from-literal=password='YourPassword'
```

3. Install NetApp Trident.
The preferred installation method uses `tridentctl`, which is demonstrated in the following steps. Be sure to check the NetApp Trident Installation Guide (https://docs.netapp.com/us-en/trident/trident-get-started/kubernetes-deploy-tridentctl.html#install-trident-using-tridentctl) for the latest details about obtaining and using `tridentctl`.

a. Download the `trident-install` package.

```
wget https://github.com/NetApp/trident/releases/download/v25.10.0/trident-
installer-25.10.0.tar.gz
```

b. Extract the `trident-install` and associated files.

```
tar -xzf trident-installer-25.10.0.tar.gz
```

c. Change to the extracted directory.

```
cd trident-installer
```

d. Initiate the installation.

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

e. Verify that all Trident pods are in the `Running` state.

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

```
NAME                                  READY   STATUS    RESTARTS   AGE
trident-controller-5dd5f9df49-xkp7t   6/6     Running   0          2m37s
trident-node-linux-7qmcw              2/2     Running   0          2m37s
trident-node-linux-9k4xr              2/2     Running   0          2m37s
```

```
trident-node-linux-zhx9n                          2/2     Running   0          2m37s
```

4. Configure the Trident back-end.

   a. Create a back-end configuration file, `ontap-backend.json` as below.

```
{
  "version": 1,
  "storageDriverName": "ontap-san",
  "managementLIF": "10.10.10.50",
  "dataLIF": "192.168.100.10",
  "svm": "harvester_svm",
  "username": "admin",
  "password": "YourPassword",
  "igroupName": "harvester_igroup"
}
```

   b. Apply the back-end.

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

   c. Validate the back-end.

```
./tridentctl get backend -n trident
```

```
+----------------+----------------+----------+--------+------------+---------+
| NAME           | STORAGE DRIVER | UUID     | STATE  | USER-STATE | VOLUMES |
+----------------+----------------+----------+--------+------------+---------+
| ontapsan_XXXXX | ontap-san      | xxxxxxxx | online | normal     |       0 |
+----------------+----------------+----------+--------+------------+---------+
```

3.6 Defining the NetApp StorageClass and SnapshotClass

1. Create the NetApp StorageClass.

   a. Create a file, named `netapp-storageclass.yaml`, as shown below.

```
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  name: netapp-storageclass
  annotations:
    storageclass.kubernetes.io/is-default-class: "true"
provisioner: csi.trident.netapp.io
```

```
parameters:
  fsType: ext4
  backendType: "ontap-san"
reclaimPolicy: Delete
volumeBindingMode: Immediate
allowVolumeExpansion: true
```

b. Apply the StorageClass.

```
kubectl apply -f netapp-storageclass.yaml
```

c. Verify that the StorageClass is available.

```
kubectl get storageclass
```

```
NAME            PROVISIONER           VOLUMEBINDINGMODE ALLOWVOLUMEEXPANSION
netapp-storage  csi.trident.netapp.io  Immediate         true
```

2. Create the NetApp SnapshotClass.

a. Create a file, named `netapp-snapshotclass.yaml`, with the content below.

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

b. Apply the SnapshotClass.

```
kubectl apply -f netapp-snapshotclass.yaml
```

c. Verify the that the SnapshotClass is deployed.

```
kubectl get volumesnapshotclass
```

```
NAME               DRIVER                  DELETIONPOLICY   AGE
netapp-snapclass   csi.trident.netapp.io   Delete           6s
```

3.7 Registering the NetApp CSI driver in SUSE Virtualization

1. Log in to the SUSE Virtualization UI.
2. Go to *Advanced* > *Settings* > *csi-driver-config*.
3. Click *Edit Setting*.
4. Set the provisioner to `csi.trident.netapp.io`.
5. Click *Save*.
6. Configure the NetApp CSI driver as the default StorageClass.
   a. Unset Longhorn as the default StorageClass.

   ```
   kubectl patch storageclass harvester-longhorn \
     -p '{"metadata":{"annotations":{"storageclass.kubernetes.io/is-default-
   class":"false"}}}'
   ```

   b. Set the NetApp CSI driver as the default StorageClass.

   ```
   kubectl patch storageclass netapp-storageclass \
     -p '{"metadata":{"annotations":{"storageclass.kubernetes.io/is-default-
   class":"true"}}}'
   ```

4 Validation

Verify that you can create a virtual machine configured with the NetApp StorageClass and which is backed by NetApp ONTAP iSCSI storage.

4.1 Creating a VM

1. Log in to the SUSE Virtualization UI.
2. Navigate to *Virtual Machines* and click *Create*.
3. Select a namespace for your VM.

> **Note**
>
> Only the `harvester-public` namespace is visible to all users by default.

4. Provide a name for your VM.
5. (Optional) Select a VM template (for example, `iso-image`, `raw-image`, `windows-iso-image`) to speed up provisioning.
6. On the *Basics* tab, configure the following settings:
   - *CPU*: 2
   - *Memory*: 4 GB
   - *SSHKey*: Select an existing key or upload a new one (required if you need SSH access).
   - (Optional) *Overcommit configuration*: Set CPU, memory, and storage overcommit ratios to allow scheduling of additional VMs even when physical resources are fully used.
   - (Optional) *Other advanced settings*: Run strategy, OS type, or custom cloud-init data.
7. On the *Volumes* tab, select or add disks.

   > **Note**
   >
   > One writable root disk is created by default.

   a. Click *Add Disk* and select `cd-rom` as the disk type.

   b. Select the ISO image you uploaded and set its boot order to `1`.

   c. Choose the StorageClass named `netapp-storageclass`, which is provisioned by Trident.

   d. For the root disk, select the `netapp-storageclass` StorageClass and specify the desired size.
8. The management network is added by default.
   You can remove it if using VLAN networks. Optionally, you can add additional interfaces (`VLAN`, `bridge`, `masquerade`).
9. Review all settings and click *Create* to deploy the VM.

4.2 Verifying the VM Storage

You can use the SUSE Virtualization UI or CLI to verify that the VM is backed by NetApp CSI and the ONTAP iSCSI back-end.

4.2.1 Verifying with the SUSE Virtualization UI

1. Open *Virtual Machines* > *<Your VM>* > *Volumes*.
2. Confirm that the attached disk is using the `netapp-storageclass` StorageClass.

4.2.2 Verifying with the SUSE Virtualization CLI

1. Log in to the SUSE Virtualization management node CLI as `root`.
2. List the PersistentVolumeClaims (PVCs) in the VM's namespace.

```
kubectl get pvc -n <namespace>
```

3. Confirm that the **STORAGECLASS** column shows `netapp-storageclass`.

5 Summary

Organizations are accelerating their digital transformation by modernizing applications and infrastructure, transitioning from traditional, virtual machine environments to modern, cloud-native platforms powered by Kubernetes. SUSE Virtualization delivers a unified and flexible platform that allows organizations to seamlessly run both virtual machine (VM) and container workloads side-by-side on the same infrastructure.

NetApp Trident extends this capability by providing enterprise-grade, dynamic storage provisioning for Kubernetes and SUSE Virtualization clusters. Through its integration with NetApp ONTAP, Trident enables resilient, scalable, and efficient iSCSI-based storage for mission-critical workloads, ensuring consistent performance, automation, and data protection across hybrid environments.

This guide details the steps to configure and validate the integration of SUSE Virtualization with NetApp Trident and NetApp ONTAP, showcasing how enterprises can build a consistent, automated, and production-ready virtualization environment.

Dive into the product documentation to continue your learning journey:

- SUSE Virtualization documentation (https://documentation.suse.com/cloudnative/virtualization/)
- NetApp Trident documentation (https://docs.netapp.com/us-en/trident)
- NetApp ONTAP documentation (https://docs.netapp.com/us-en/ontap/)

For further guidance on how to modernize and optimize your IT infrastructure, contact your SUSE or NetApp representative or e-mail SUSE at isv-cosell@suse.com (mailto:isv-cosell@suse.com).

6 Frequently Asked Questions (FAQ)

1. **What is the role of Trident CSI in the SUSE Virtualization environment?**
   NetApp Trident acts as a Container Storage Interface (CSI) driver that integrates NetApp storage with Kubernetes-based platforms such as SUSE Virtualization.
   It enables dynamic provisioning of persistent storage volumes for virtual machines and containers using NetApp ONTAP storage systems.

2. **Why is multipath configuration required for NetApp iSCSI storage?**
   Multipath provides high availability and redundancy for storage connections.
   When multiple network paths exist between SUSE Virtualization nodes and the NetApp storage system, multipath ensures that:

   - Storage traffic can fail over automatically if a path becomes unavailable.
   - Performance is improved through path load balancing.
   - Storage access remains uninterrupted during network or interface failures.

3. **Why must the `netapp-storageclass` be configured as the default StorageClass?**
   Setting `netapp-storageclass` as the default ensures that newly created volumes automatically use NetApp-backed storage unless another StorageClass is explicitly selected.
   This simplifies VM provisioning and guarantees that persistent volumes are dynamically created through Trident using the NetApp ONTAP back-end.

4. **Can you deploy the Trident CSI using methods other than `tridentctl`?**

Yes. While using `tridentctl` is the recommended installation method, Trident can also be deployed using Helm charts.

Helm-based deployment is useful when you manage Kubernetes applications through a package management workflow.

5. **Can SUSE Virtualization run both virtual machines and container workloads?**

   Yes. SUSE Virtualization supports running virtual machines and Kubernetes workloads on the same infrastructure.

   This unified platform simplifies operations and allows organizations to modernize applications while maintaining existing VM-based workloads.

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