NVMe provisioning

ONTAP 9

NetApp
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NVMe Overview

Beginning with ONTAP 9.4, NVMe/FC is supported on non-MetroCluster AFF configurations. Beginning with ONTAP 9.9.1 NVMe/FC is also supported on all non-MetroCluster AFF All SAN Array (ASA) configurations

You can use the non-volatile memory express (NVMe) protocol to provide storage in a SAN environment. The NVMe protocol is optimized for performance with solid state storage.

For NVMe, storage targets are called namespaces. An NVMe namespace is a quantity of non-volatile storage that can be formatted into logical blocks and presented to a host as a standard block device. You create namespaces and subsystems, and then map the namespaces to the subsystems, similar to the way LUNs are provisioned and mapped to igroups for FC and iSCSI.

NVMe targets are connected to the network through a standard FC infrastructure using FC switches or a standard TCP infrastructure using Ethernet switches and host-side adapters.

Unresolved directive in san-admin/manage-nvme-concept.adoc - include::_include/nvme-protocols.adoc[]

NVMe license requirements

Beginning with ONTAP 9.5 a license is required to support NVMe. If NVMe is enabled in ONTAP 9.4, a 90 day grace period is given to acquire the license after upgrading to ONTAP 9.5.

You can enable the license using the following command:

```
system license add -license-code NVMe_license_key
```

What NVMe is

The nonvolatile memory express (NVMe) protocol is a transport protocol used for accessing nonvolatile storage media.

NVMe over Fabrics (NVMeoF) is a specification-defined extension to NVMe that enables NVMe-based communication over connections other than PCIe. This interface allows for external storage enclosures to be connected to a server.

NVMe is designed to provide efficient access to storage devices built with non-volatile memory, from flash technology to higher performing, persistent memory technologies. As such, it does not have the same limitations as storage protocols designed for hard disk drives. Flash and solid state devices (SSDs) are a type of non-volatile memory (NVM). NVM is a type of memory that keeps its content during a power outage. NVMe is a way that you can access that memory.

The benefits of NVMe include increased speeds, productivity, throughput, and capacity for data transfer. Specific characteristics include the following:

- NVMe is designed to have up to 64 thousand queues.

  Each queue in turn can have up to 64 thousand concurrent commands.

- NVMe is supported by multiple hardware and software vendors
- NMVe is more productive with Flash technologies enabling faster response times
- NVMe allows for multiple data requests for each “request” sent to the SSD.

  NVMe takes less time to decode a “request” and does not require thread locking in a multithreaded program.

- NVMe supports functionality that prevents bottlenecking at the CPU level and enables massive scalability as systems expand

Related information

- Provision NVMe storage for SUSE Linux
- Configure a storage VM for NVMe

Configure a storage VM for NVMe

If you want to use the NVMe protocol on a node, you must configure your SVM specifically for NVMe.

What you’ll need

Your FC or Ethernet adapters must support NVMe. Supported adapters are listed in the NetApp Hardware Universe.

Example 1. Steps

System Manager

Configure an storage VM for NVMe with ONTAP System Manager (9.7 and later).

To configure NVMe on a new storage VM	To configure NVMe on an existing storage VM
1. In System Manager, click **Storage > Storage VMs** and then click **Add**. 2. Enter a name for the storage VM. 3. Select **NVMe** for the **Access Protocol**. 4. Click **Enable FC** and **Save**.	1. In System Manager, click **Storage > Storage VMs**. 2. Click on the storage VM you want to configure. 3. Click on the **Settings** tab, and then click ⚙ next to the NVMe protocol. 4. Click **Enable FC** and **Save**.

CLI

Configure an storage VM for NVMe with the ONTAP CLI.

1. If you do not want to use an existing SVM, create one:

   ```
   vserver create -vserver SVM_name
   ```

   a. Verify that the SVM is created:

      ```
      vserver show
      ```

2. Verify that you have NVMe or TCP capable adapters installed in your cluster:

   For NVMe: `network fcp adapter show -data-protocols-supported fc-nvme`

   For TCP: `network port show`

3. If you are running ONTAP 9.7 or earlier, remove all protocols from the SVM:

   ```
   vserver remove-protocols -vserver SVM_name -protocols
   iscsi,fcp,nfs,cifs,ndmp
   ```

   Beginning with ONTAP 9.8, it is not necessary to remove other protocols when adding NVMe.

4. Add the NVMe protocol to the SVM:

   ```
   vserver add-protocols -vserver SVM_name -protocols nvme
   ```

5. If you are running ONTAP 9.7 or earlier, verify that NVMe is the only protocol allowed on the SVM:

   ```
   vserver show -vserver SVM_name -fields allowed-protocols
   ```

   NVMe should be the only protocol displayed under the `allowed protocols` column.

6. Create the NVMe service:

   ```
   vserver nvme create -vserver SVM_name
   ```

7. Verify that the NVMe service was created:

   `vserver nvme show -vserver SVM_name`

   The `Administrative Status` of the SVM should be listed as `up`.

8. Create an NVMe/FC LIF:

ONTAP version	Applicable protocols	Command
ONTAP 9.9.1 or earlier	FC	`network interface create -vserver SVM_name -lif lif_name -role data -data-protocol fc-nvme -home-node home_node -home-port home_port`
ONTAP 9.10.1	FC or TCP	`network interface create -vserver SVM_name -lif lif_name -service-policy {default-data-nvme-tcp | default-data-nvme-fc} -home-node home_node -home-port home_port -status admin up -failover-policy disabled -firewall -policy data -auto -revert false -failover -group failover_group -is-dns-update-enabled false`

9. Create an NVMe/FC LIF on the HA partner node:

ONTAP version	Applicable protocols	Command
ONTAP 9.9.1 or earlier	FC	`network interface create -vserver SVM_name -lif lif_name -role data -data-protocol fc-nvme -home-node home_node -home-port home_port`

ONTAP version	Applicable protocols	Command
ONTAP 9.10.1 or later	FC or TCP	`network interface create -vserver SVM_name -lif lif_name -service-policy {default-data-nvme-tcp | default-data-nvme-fc} -home-node home_node -home-port home_port -status admin up -failover-policy disabled -firewall -policy data -auto -revert false -failover -group failover_group -is-dns-update-enabled false`

10. Verify the NVMe/FC LIFs were created:

    `network interface show -vserver` *`SVM_name`*

11. Create volume on the same node as the LIF:

    `vol create -vserver` *`SVM_name`* `-volume` *`vol_name`* `-aggregate` *`aggregate_name`* `-size` *`volume_size`*

    If a warning message is displayed about the auto efficiency policy, it can be safely ignored.

NVMe namespaces considerations

To set up the NVMe protocol in your SAN environment, you must configure an SVM for NVMe, create namespaces and subsystems, configure an NVMe/FC LIF, and then map the namespaces to the subsystems. There are certain considerations you should be aware of when working with NVMe namespaces.

- If you lose data in a LUN, it cannot be restored from a namespace, or vice versa.
- The space guarantee for namespaces is the same as the space guarantee of the containing volume.
- Beginning with ONTAP 9.6, namespaces support 512 byte blocks and 4096 byte blocks.

  4096 is the default value. 512 should only be used if the host operating system does not support 4096 byte blocks.

- Namespaces do not support the following:
  - Renaming

    You cannot rename a namespace.

- Inter-volume move
- Inter-volume copy

Beginning with ONTAP 9.10.1, you can resize a namespace. Resizing a namespace is not supported in releases prior to ONTAP 9.10.1.

About NVMe namespaces

An NVMe namespace is a quantity of non-volatile memory (NVM) that can be formatted into logical blocks. Namespaces are used when a storage virtual machine is configured with the NVMe protocol and are the equivalent of LUNs for FC and iSCSI protocols.

One or more namespaces are provisioned and connected to an NVMe host. Each namespace can support various block sizes.

The NVMe protocol provides access to namespaces through multiple controllers. Using NVMe drivers, which are supported on most operating systems, solid state drive (SSD) namespaces appear as standard-block devices on which file systems and applications can be deployed without any modification.

A namespace ID (NSID) is an identifier used by a controller to provide access to a namespace. When setting the NSID for a host or host group, you also configure the accessibility to a volume by a host. A logical block can only be mapped to a single host group at a time, and a given host group does not have any duplicate NSIDs.

NVMe subsystem provisioning for NVMe namespaces

An NVMe subsystem includes one or more NVMe controllers, namespaces, NVM subsystem ports, an NVM storage medium, and an interface between the controller and the NVM storage medium. When you create an NVMe namespace, you can choose to map an NVMe subsystem to the namespace, as follows:

- **None (default)**

  No NVMe subsystems are mapped to the namespace.

- **Existing subsystem**

  You can select an existing NVMe subsystem to map to the namespace. NVMe subsystems are listed based on the host OS and SVM fields. When you hover the pointer over the NVMe subsystem name, more details are shown about the subsystem.

- **New subsystem**

  You can create a new NVMe subsystem and map it to the namespace. The subsystem is created on the host OS and SVM.

You provision a subsystem by providing the following details:

- **The NVMe subsystem name**

  The NVMe subsystem name is case sensitive. It must contain 1 to 96 characters, and special characters are allowed.

- **Host OS**

The host OS type that the subsystem is being created on.

- **Host NQN**

  The host NVMe qualification name attached to the controller. This column can contain comma-separated values because there can be from one to many hosts attached to a subsystem.

Provision NVMe storage for SUSE Linux

Create namespaces to provide storage for a SUSE Linux server using the NVMe protocol. Namespaces appear to Linux as SCSI disk devices.

This procedure creates new namespaces on an existing storage VM. Your storage VM must be configured for NVME, and your FC or TCP transport should already be set up.

Beginning with ONTAP 9.8, when you provision storage, QoS is enabled by default. You can disable QoS or choose a custom QoS policy during the provisioning process or at a later time.

Example 2. Steps

System Manager

Create namespaces to provide storage using the NVMe protocol with ONTAP System Manager (9.7 and later).

1. In System Manager, click **Storage > NVMe Namespaces** and then click **Add**.
   a. If you need to create a new subsystem, click **More Options**.
   b. If you are running ONTAP 9.8 or later and you want to disable QoS or choose a custom QoS policy, click **More Options** and then, under **Storage and Optimization** select **Performance Service Level**.
2. Zone your FC switches by WWPN. Use one zone per initiator and include all target ports in each zone.
3. On your Linux server, discover the new namespaces.
4. Initialize the namespace and format it with a file system.
5. Verify the Linux server can write and read data on the namespace.

CLI

Create namespaces to provide storage using the NVMe protocol with the ONTAP CLI.

For systems using the NVMe protocol, you must create one or more NVMe namespaces and subsystems. Each namespace can then be mapped to an NVMe subsystem to allow data access from your host system.

What you'll need

The SVM must already be configured for NVMe.

Steps

1. Verify that the SVM is configured for NVMe:

   ```
   vserver show -vserver SVM_name -fields allowed-protocols
   ```

   `NVMe` should be displayed under the `allowed-protocols` column.

2. Create the NVMe namespace:

   ```
   vserver nvme namespace create -vserver SVM_name -path path -size
   size_of_namespace -ostype OS_type
   ```

3. Create the NVMe subsystem:

   ```
   vserver nvme subsystem create -vserver SVM_name -subsystem
   name_of_subsystem -ostype OS_type
   ```

4. Verify that the subsystem was created:

   ```
   vserver nvme subsystem show -vserver SVM_name
   ```

   The `nvme` subsystem should be displayed under the `Subsystem` column.

5. Obtain the NQN from the host.
6. Add the host NQN to the subsystem:

   ```
   vserver nvme subsystem host add -vserver SVM_name -subsystem subsystem_name
   -host-nqn Host_NQN:subsystem.subsystem_name
   ```

7. Map the namespace to the subsystem:

   ```
   vserver nvme subsystem map add -vserver SVM_name -subsystem subsystem_name
   -path path
   ```

   A namespace can only be mapped to a single subsystem.

8. Verify that the namespace is mapped to the subsystem:

   ```
   vserver nvme namespace show -vserver SVM_name -instance
   ```

   The subsystem should be listed as the `Attached subsystem`.

Provision NVMe storage

If a procedure for your specific host is not available, you can use these steps to create namespaces and provision storage for any NVMe supported host.

Namespaces appear to Linux as SCSI disk devices.

This procedure creates new namespaces on an existing storage VM. Your storage VM must be configured for NVME, and your FC or TCP transport should already be set up.

Unresolved directive in san-admin/create-nvme-namespace-subsystem-task.adoc - include::_include/98_qos_enabled_by_default.adoc[]

Example 3. Steps

System Manager

Create namespaces to provide storage using the NVMe protocol with ONTAP System Manager (9.7 and later).

1. In System Manager, click **Storage > NVMe Namespaces** and then click **Add**.

   If you need to create a new subsystem, click **More Options**.

   Unresolved directive in san-admin/create-nvme-namespace-subsystem-task.adoc - include::_include/98_qos_how_to_modify.adoc[]

2. Zone your FC switches by WWPN. Use one zone per initiator and include all target ports in each zone.
3. On your host, discover the new namespaces.
4. Initialize the namespace and format it with a file system.
5. Verify that your host can write and read data on the namespace.

CLI

Create namespaces to provide storage using the NVMe protocol with the ONTAP CLI.

Unresolved directive in san-admin/create-nvme-namespace-subsystem-task.adoc - include::_include/nvme-provisioning-cli.adoc[]

== About NVMe subsystems

An NVMe subsystem includes one or more controllers, one or more namespaces, one or more non-volatile memory (NVM) subsystem ports (FC-NVMe or RDMA transport ports), an NVM storage medium, and an interface between the controllers and the NVM storage medium. For controller mapping and management, an NVM subsystem maps to a vserver in ONTAP.

An NVMe over Fabric (NVMeoF) subsystem is a separate kernel object that resides in the FreeBSD kernel. The NVMeoF subsystem interfaces with the following components:

- SAN components, such as BCOMKA, FCT, and VDOM
- WAFL
- RAS components, such as CM, ASUP, and EMS

All interfaces with NVMeoF subsystems adhere to the current definitions and patterns found in ONTAP.

= Map an NVMe namespace to a subsystem
:icons: font
:relative_path: ./san-admin/
:imagesdir: /tmp/d20221002-16453-12dvbr0/source/./san-admin/../media/

Unresolved directive in san-admin/map-nvme-namespace-subsystem-task.adoc - include::_include/nvme-provisioning-cli.adoc[]