NVMe provisioning

ONTAP 9

NetApp
May 23, 2023

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NVMe Overview

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.

Support for NVMe varies based on your version of ONTAP. See NVMe support and limitations for details.

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.

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.

About NVMe subsystems

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, by default it is not mapped to a subsystem. You can also choose to map it a new or existing subsystem.

Related information

- Provision NVMe storage for SUSE Linux
- Provisioin NVMe storage for other hosts
- Map an NVMe namespace to a subsystem

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
```

NVMe support and limitations

NVMe support and limitations varies based on your version of ONTAP, your platform and your configuration.

Protocol support

Protocol	Beginning with …	Allowed by…
TCP	ONTAP 9.10.1	Default

FC	ONTAP 9.4	Default

Platform and configuration support and limitations

Support for NVMe-oF protocol varies by platform and configuration. For details on your specific configuration, see the NetApp Interoperability Matrix Tool.

Beginning with ONTAP 9.12.1, 4-node MetroCluster IP configurations are supported on NVMe/FC. MetroCluster configurations are not supported for NVMe prior to 9.12.1.

Beginning with ONTAP…	Platforms
9.12.1	• FAS • All Flash FAS (AFF) • All SAN Array (ASA) platforms
9.9.1	• AFF • ASA
9.4	AFF platforms only

Namespace support and limitations

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. When working with NVMe namespaces you should be aware of the following:

- 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.
- 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.

- 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.
- Namespaces do not support the following:
  - Renaming

    You cannot rename a namespace.

  - Inter-volume move
  - Inter-volume copy

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. Select **Enable NVMe/FC** or **Enable NVMe/TCP** 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. Select **Enable NVMe/FC** or **Enable NVMe/TCP** 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.

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.

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.

System Manager

Using ONTAP System Manager (9.7 and later), create namespaces to provide storage using the NVMe protocol.

Steps

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

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

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

CLI

Using the ONTAP CLI, create namespaces to provide storage using the NVMe protocol.

This procedure creates an NVMe namespace and subsystem on an existing storage VM which has already been configured for the NVMe protocol, then maps the namespace to the subsystem to allow data access from your host system.

If you need to configure the storage VM for NVMe, see Configure an SVM 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>
   ```

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

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>
```

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`.

Map an NVMe namespace to a subsystem

This procedure maps an existing NVMe namespace to an existing NVMe subsystem using the ONTAP CLI.

Your namespace and subsystem should already be created. If you need to create a namespace and subsystem, see Provision NVMe storage.

Steps

1. Obtain the NQN from the host.
2. 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`*

3. 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.

4. 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`.

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