



NVMe provisioning

ONTAP 9

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NVMe provisioning

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
- NVMe 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

- Learn to [provision NVMe storage](#) on ASA, AFF, and FAS systems
- Learn to [map an NVMe namespace to a subsystem](#) on ASA AFF and FAS systems.
- [Configure SAN hosts and cloud clients](#)
- Learn to [provision SAN storage](#) on ASA r2 (ASA A1K, ASA A90, ASA A70, ASA A50, ASA A30, or ASA A20) storage systems.

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 configuration, support, and limitations

Beginning with ONTAP 9.4, the [non-volatile memory express \(NVMe\)](#) protocol is available for SAN environments. FC-NVMe uses the same physical setup and zoning practice as traditional FC networks but allows for greater bandwidth, increased IOPs and reduced latency than FC-SCSI.

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

details on your specific configuration, see the [NetApp Interoperability Matrix Tool](#). For supported limits, see [Hardware Universe](#).



The maximum nodes per cluster is available in Hardware Universe under **Supported Platform Mixing**.

Configuration

- You can set up your NVMe configuration using a single fabric or multifabric.
- You should configure one management LIF for every SVM supporting SAN.
- The use of heterogeneous FC switch fabrics is not supported, except in the case of embedded blade switches.

Specific exceptions are listed on the [NetApp Interoperability Matrix Tool](#).

- Cascade, partial mesh, full mesh, core-edge, and director fabrics are all industry-standard methods of connecting FC switches to a fabric, and all are supported.

A fabric can consist of one or multiple switches, and the storage controllers can be connected to multiple switches.

Features

The following NVMe features are supported based on your version of ONTAP.

Beginning with ONTAP...	NVMe supports
9.17.1	<ul style="list-style-type: none">• SnapMirror active sync NVMe/FC and NVMe/TCP host access for VMware workloads.
9.15.1	<ul style="list-style-type: none">• Four-node MetroCluster IP configurations on NVMe/TCP
9.14.1	<ul style="list-style-type: none">• Setting the host priority at the subsystem (host-level QoS)
9.12.1	<ul style="list-style-type: none">• Four-node MetroCluster IP configurations on NVMe/FC• MetroCluster configurations are not supported for front-end NVMe networks before ONTAP 9.12.1.• MetroCluster configurations are not supported on NVMe/TCP.
9.10.1	Resizing a namespace
9.9.1	<ul style="list-style-type: none">• Namespaces and LUNs coexistence on the same volume

9.8	<ul style="list-style-type: none"> • Protocol co-existence <p>SCSI, NAS and NVMe protocols can exist on the same storage virtual machine (SVM).</p> <p>Prior to ONTAP 9.8, NVMe can be the only protocol on the SVM.</p>
9.6	<ul style="list-style-type: none"> • 512 byte blocks and 4096 byte blocks for namespaces <p>4096 is the default value. 512 should only be used if the host operating system does not support 4096 byte blocks.</p> <ul style="list-style-type: none"> • Volume move with mapped namespaces
9.5	<ul style="list-style-type: none"> • Multipath HA pair failover/giveback

Protocols

The following NVMe protocols are supported.

Protocol	Beginning with ONTAP...	Allowed by...
TCP	9.10.1	Default
FC	9.4	Default

Beginning with ONTAP 9.8, you can configure SCSI, NAS and NVMe protocols on the same storage virtual machine (SVM). In ONTAP 9.7 and earlier, NVMe can be the only protocol on the SVM.

Namespaces

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

- For ONTAP 9.15.1 and earlier, ONTAP does not support the NVMe DataSet Management (deallocate) command with NVMe for space reclamation.
- You cannot use SnapRestore to restore a namespace from a LUN or vice-versa.
- The space guarantee for namespaces is the same as the space guarantee of the containing volume.
- You cannot create a namespace on a volume transition from Data ONTAP operating in 7-Mode.
- Namespaces do not support the following:
 - Renaming
 - Inter-volume move
 - Inter-volume copy
 - Copy on Demand

Additional limitations

The following ONTAP features are not supported by NVMe configurations:

- Virtual Storage Console
- Persistent reservations

The following applies only to nodes running ONTAP 9.4:

- NVMe LIFs and namespaces must be hosted on the same node.
- The NVMe service must be created before the NVMe LIF is created.

Related information

[Best practices for modern SAN](#)

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.

Before you begin

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
<ol style="list-style-type: none">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.	<ol style="list-style-type: none">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
```

Learn more about `network port show` in the [ONTAP command reference](#).

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`. Learn more about `up` in the [ONTAP command reference](#).

8. Create an NVMe/FC LIF:

- For 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>
```

- For ONTAP 9.10.1 or later, FC:

```
network interface create -vserver <SVM_name> -lif <lif_name>  
-service-policy <default-data-nvme-tcp | default-data-nvme-fc>  
-data-protocol <fc-nvme> -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
```

- For ONTAP 9.10.1 or later, TCP:

```
network interface create -vserver <SVM_name> -lif <lif_name>
-address <ip address> -netmask <netmask_value> -service-policy
<default-data-nvme-tcp> -data-protocol <nvme-tcp> -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:

- For 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>
```

- For ONTAP 9.10.1 or later, FC:

```
network interface create -vserver <SVM_name> -lif <lif_name>
-service-policy <default-data-nvme-fc> -data-protocol <fc-nvme>
-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
```

- For ONTAP 9.10.1 or later, TCP:

```
network interface create -vserver <SVM_name> -lif <lif_name>
-address <ip address> -netmask <netmask_value> -service-policy
<default-data-nvme-tcp> -data-protocol <nvme-tcp> -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

Use these steps to create namespaces and provision storage for any NVMe supported host on an existing storage VM.

About this task

This procedure applies to FAS, AFF, and ASA systems. If you have an ASA r2 system (ASA A1K, ASA A90, ASA A70, ASA A50, ASA A30, ASA A20, or ASA C30), follow [these steps](#) to provision your storage. ASA r2 systems provide a simplified ONTAP experience specific to SAN-only customers.

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.

Before you begin

Your storage VM must be configured for NVME, and your FC or TCP transport should already be set up.

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:



The volume you reference with the `-path` parameter must already exist or you will need to create one before running this command.

```
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

Mapping an NVMe namespace to a subsystem allows data access from your host. You can map an NVMe namespace to a subsystem when you provision storage or you can do it after your storage has been provisioned.

Beginning with ONTAP 9.17.1, if you are using a SnapMirror active sync configuration, you can add an SVM to a host as a proximal vserver while adding the host to an NVMe subsystem. Active-optimized paths for a namespace in an NVMe subsystem are published to a host only from the SVM that is configured as proximal vserver.

Beginning with ONTAP 9.14.1, you can prioritize resource allocation for specific hosts. By default, when a host is added to the NVMe subsystem, it is given regular priority. You can use the ONTAP command line interface (CLI) to manually change the default priority from regular to high. Hosts assigned a high priority are allocated larger I/O queue counts and queue-depths.



If you want to give a high priority to a host that was added to a subsystem in ONTAP 9.13.1 or earlier, you can [change the host priority](#).

Before you begin

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

Map an NVMe namespace

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>
```

If you want to change the default priority of the host from regular to high, use the `-priority high` option. This option is available beginning with ONTAP 9.14.1. Learn more about `vserver nvme subsystem host add` in the [ONTAP command reference](#).

If you want to add an SVM as a `proximal-vserver` to a host while adding the host to an NVMe subsystem in a SnapMirror active sync configuration, you can use the `-proximal-vservers` option. This option is available beginning with ONTAP 9.17.1. You can add the source or destination SVM, or both. The SVM in which you are running this command is the default.

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. Learn more about `vserver nvme subsystem map add` in the [ONTAP command reference](#).

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. Learn more about `vserver nvme namespace show` in the [ONTAP command reference](#).

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