



Windows

ONTAP SAN Host Utilities

NetApp
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Windows

Configure Windows Server 2025 with NVMe/FC for ONTAP

You can configure NVMe over Fibre Channel (NVMe/FC) on hosts running Windows Server 2025 for operation with ONTAP LUNs.

About this task

You can use the following support with the NVMe/FC host configuration for Windows 2025. You should also review the known limitations before starting the configuration process.

- Support available:

Beginning with ONTAP 9.10.1, NVMe/FC is supported for Windows Server 2025.

For a list of supported FC adapters and controllers, see the [Hardware Universe](#). For the current list of supported configurations and versions, see the [Interoperability Matrix Tool](#).

- Known limitations:

Windows Failover Cluster isn't supported with NVMe/FC because ONTAP doesn't currently support persistent reservations with NVMe/FC.



Broadcom ships an external driver for Windows NVMe/FC that is a translational SCSI ☐ NVMe driver and not a true NVMe/FC driver. The translational overhead doesn't necessarily impact performance, but it does negate the performance benefits of NVMe/FC. As a result, NVMe/FC and FCP performance is the same on Windows servers, unlike other operating systems such as Linux, where NVMe/FC performance is significantly better than that of FCP.

Enable NVMe/FC

Enable FC/NVMe on the Windows initiator host.

Steps

1. Install the Emulex HBA Manager utility on the Windows host.
2. On each of the HBA initiator ports, set the following HBA driver parameters:
 - EnableNVMe = 1
 - NVMEMode = 0
3. Reboot the host.

Configure the Broadcom FC adapter

The Broadcom initiator can serve both NVMe/FC and FCP traffic through the same 32G FC adapter ports. For FCP and FC/NVMe, you should use the Microsoft device-specific module (DSM) as the Microsoft Multipath I/O (MPIO) option.

A `hostnqn` is associated with each host bus adapter (HBA) port for the Broadcom adapter with FC/NVMe in a Windows environment. The `hostnqn` is formatted as shown in the following example:

```
nqn.2017-01.com.broadcom:ecd:nvmf:fc:100000109b1b9765
nqn.2017-01.com.broadcom:ecd:nvmf:fc:100000109b1b9766
```

Enable MPIO for NVMe devices

You need to enable MPIO for NVMe devices to complete the NVMe configuration on the Windows host.

Steps

1. Install [Windows Host Utility Kit 7.1](#) to set the driver parameters that are common to both FC and NVMe.
2. Open the MPIO properties.
3. From the **Discover Multi-Paths** tab, add the device ID listed for NVMe.

MPIO becomes aware of the NVMe devices, which are visible under disk management.

4. Open **Disk Management** and go to **Disk Properties**.
5. From the **MPIO** tab, select **Details**.
6. Set the following Microsoft DSM settings:
 - PathVerifiedPeriod: **10**
 - PathVerifyEnabled: **Enable**
 - RetryCount: **6**
 - RetryInterval: **1**
 - PDORemovedPeriod: **130**
7. Select the MPIO Policy **Round Robin with Subset**.
8. Change the registry values:

```
HKLM\SYSTEM\CurrentControlSet\Services\mpio\Parameters\PathRecoveryInterval DWORD -> 30

HKLM\SYSTEM\CurrentControlSet\Services\mpio \Parameters\
UseCustomPathRecoveryInterval  DWORD-> 1
```

9. Reboot the host.

Validate the NVMe/FC configuration

Verify that the NVMe subsystems have been discovered and the ONTAP namespaces are correct for the NVMe-oF configuration.

Steps

1. Verify that "Port Type" is FC+NVMe:

```
listhba
```

Show example

```
Port WWN      : 10:00:00:10:9b:1b:97:65
Node WWN      : 20:00:00:10:9b:1b:97:65
Fabric Name   : 10:00:c4:f5:7c:a5:32:e0
Flags         : 8000e300
Host Name     : INTEROP-57-159
Mfg           : Emulex Corporation
Serial No.    : FC71367217
Port Number   : 0
Mode          : Initiator
PCI Bus Number : 94
PCI Function  : 0
Port Type    : FC+NVMe
Model         : LPe32002-M2
```

```
Port WWN      : 10:00:00:10:9b:1b:97:66
Node WWN      : 20:00:00:10:9b:1b:97:66
Fabric Name   : 10:00:c4:f5:7c:a5:32:e0
Flags         : 8000e300
Host Name     : INTEROP-57-159
Mfg           : Emulex Corporation
Serial No.    : FC71367217
Port Number   : 1
Mode          : Initiator
PCI Bus Number : 94
PCI Function  : 1
Port Type     : FC+NVMe
Model         : LPe32002-M2
```

2. Verify that the NVMe/FC subsystems have been discovered:

- ° `nvme-list`

Show example

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n
vme_interop-57-159
Port WWN                  : 20:09:d0:39:ea:14:11:04
Node WWN                   : 20:05:d0:39:ea:14:11:04
Controller ID              : 0x0180
Model Number               : NetApp ONTAP Controller
Serial Number              : 81CGZBPU5T/uAAAAAAB
Firmware Version           : FFFFFFFF
Total Capacity             : Not Available
Unallocated Capacity       : Not Available

NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n
vme_interop-57-159
Port WWN                  : 20:06:d0:39:ea:14:11:04
Node WWN                   : 20:05:d0:39:ea:14:11:04
Controller ID              : 0x0181
Model Number               : NetApp ONTAP Controller
Serial Number              : 81CGZBPU5T/uAAAAAAB
Firmware Version           : FFFFFFFF
Total Capacity             : Not Available
Unallocated Capacity       : Not Available
Note: At present Namespace Management is not supported by NetApp
Arrays.
```

° nvme-list

Show example

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n
vme_interop-57-159
Port WWN                  : 20:07:d0:39:ea:14:11:04
Node WWN                   : 20:05:d0:39:ea:14:11:04
Controller ID              : 0x0140
Model Number               : NetApp ONTAP Controller
Serial Number              : 81CGZBPU5T/uAAAAAAB
Firmware Version           : FFFFFFFF
Total Capacity             : Not Available
Unallocated Capacity       : Not Available
```

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n
vme_interop-57-159
Port WWN                  : 20:08:d0:39:ea:14:11:04
Node WWN                   : 20:05:d0:39:ea:14:11:04
Controller ID              : 0x0141
Model Number               : NetApp ONTAP Controller
Serial Number              : 81CGZBPU5T/uAAAAAAB
Firmware Version           : FFFFFFFF
Total Capacity             : Not Available
Unallocated Capacity       : Not Available
```

Note: At present Namespace Management is not supported by NetApp Arrays.

3. Verify that the namespaces have been created:

```
nvme-list-ns
```

Show example

Active Namespaces (attached to controller 0x0141):

SCSI		SCSI	SCSI
NSID	DeviceName	Bus Number	Target Number
OS LUN			
-----	-----	-----	-----

0x00000001	\\.\PHYSICALDRIVE9	0	1
0			
0x00000002	\\.\PHYSICALDRIVE10	0	1
1			
0x00000003	\\.\PHYSICALDRIVE11	0	1
2			
0x00000004	\\.\PHYSICALDRIVE12	0	1
3			
0x00000005	\\.\PHYSICALDRIVE13	0	1
4			
0x00000006	\\.\PHYSICALDRIVE14	0	1
5			
0x00000007	\\.\PHYSICALDRIVE15	0	1
6			
0x00000008	\\.\PHYSICALDRIVE16	0	1
7			

Configure Windows Server 2022 with NVMe/FC for ONTAP

You can configure NVMe over Fibre Channel (NVMe/FC) on hosts running Windows Server 2022 for operation with ONTAP LUNs.

About this task

You can use the following support with the NVMe/FC host configuration for Windows 2022. You should also review the known limitations before starting the configuration process.

- Support available:

Beginning with ONTAP 9.7, NVMe/FC is supported for Windows Server 2022.

For a list of supported FC adapters and controllers, see the [Hardware Universe](#). For the current list of supported configurations and versions, see the [Interoperability Matrix Tool](#).

- Known limitations:

Windows Failover Cluster isn't supported with NVMe/FC because ONTAP doesn't currently support

persistent reservations with NVMe/FC.



Broadcom ships an external driver for Windows NVMe/FC that is a translational SCSI ☐ NVMe driver and not a true NVMe/FC driver. The translational overhead doesn't necessarily impact performance, but it does negate the performance benefits of NVMe/FC. As a result, NVMe/FC and FCP performance is the same on Windows servers, unlike other operating systems such as Linux, where NVMe/FC performance is significantly better than that of FCP.

Enable NVMe/FC

Enable FC/NVMe on the Windows initiator host.

Steps

1. Install the Emulex HBA Manager utility on the Windows host.
2. On each of the HBA initiator ports, set the following HBA driver parameters:
 - EnableNVMe = 1
 - NVMEMode = 0
3. Reboot the host.

Configure the Broadcom FC adapter

The Broadcom initiator can serve both NVMe/FC and FCP traffic through the same 32G FC adapter ports. For FCP and FC/NVMe, you should use the Microsoft device-specific module (DSM) as the Microsoft Multipath I/O (MPIO) option.

A `hostnqn` is associated with each host bus adapter (HBA) port for the Broadcom adapter with FC/NVMe in a Windows environment. The `hostnqn` is formatted as shown in the following example:

```
nqn.2017-01.com.broadcom:ecd:nvmf:fc:100000109b1b9765
nqn.2017-01.com.broadcom:ecd:nvmf:fc:100000109b1b9766
```

Enable MPIO for NVMe devices

You need to enable MPIO for NVMe devices to complete the NVMe configuration on the Windows host.

Steps

1. Install [Windows Host Utility Kit 7.1](#) to set the driver parameters that are common to both FC and NVMe.
2. Open the MPIO properties.
3. From the **Discover Multi-Paths** tab, add the device ID listed for NVMe.

MPIO becomes aware of the NVMe devices, which are visible under disk management.

4. Open **Disk Management** and go to **Disk Properties**.
5. From the **MPIO** tab, select **Details**.
6. Set the following Microsoft DSM settings:
 - PathVerifiedPeriod: **10**

- PathVerifyEnabled: **Enable**
- RetryCount: **6**
- RetryInterval: **1**
- PDORemovedPeriod: **130**

7. Select the MPIO Policy **Round Robin with Subset**.

8. Change the registry values:

```
HKLM\SYSTEM\CurrentControlSet\Services\mpio\Parameters\PathRecoveryInterval DWORD -> 30
```

```
HKLM\SYSTEM\CurrentControlSet\Services\mpio \Parameters\UseCustomPathRecoveryInterval DWORD-> 1
```

9. Reboot the host.

Validate NVMe/FC

Verify that the NVMe subsystems have been discovered and the ONTAP namespaces are correct for the NVMe-oF configuration.

Steps

1. Verify that "Port Type" is FC+NVMe:

```
listhba
```

Show example

```
Port WWN      : 10:00:00:10:9b:1b:97:65
Node WWN      : 20:00:00:10:9b:1b:97:65
Fabric Name   : 10:00:c4:f5:7c:a5:32:e0
Flags        : 8000e300
Host Name     : INTEROP-57-159
Mfg           : Emulex Corporation
Serial No.    : FC71367217
Port Number   : 0
Mode          : Initiator
PCI Bus Number : 94
PCI Function  : 0
Port Type    : FC+NVMe
Model         : LPe32002-M2
```

```
Port WWN      : 10:00:00:10:9b:1b:97:66
Node WWN      : 20:00:00:10:9b:1b:97:66
Fabric Name   : 10:00:c4:f5:7c:a5:32:e0
Flags        : 8000e300
Host Name     : INTEROP-57-159
Mfg           : Emulex Corporation
Serial No.    : FC71367217
Port Number   : 1
Mode          : Initiator
PCI Bus Number : 94
PCI Function  : 1
Port Type     : FC+NVMe
Model         : LPe32002-M2
```

2. Verify that the NVMe/FC subsystems have been discovered:

- `nvme-list`

Show example

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n
vme_interop-57-159
Port WWN                  : 20:09:d0:39:ea:14:11:04
Node WWN                   : 20:05:d0:39:ea:14:11:04
Controller ID              : 0x0180
Model Number               : NetApp ONTAP Controller
Serial Number              : 81CGZBPU5T/uAAAAAAB
Firmware Version           : FFFFFFFF
Total Capacity             : Not Available
Unallocated Capacity       : Not Available

NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n
vme_interop-57-159
Port WWN                  : 20:06:d0:39:ea:14:11:04
Node WWN                   : 20:05:d0:39:ea:14:11:04
Controller ID              : 0x0181
Model Number               : NetApp ONTAP Controller
Serial Number              : 81CGZBPU5T/uAAAAAAB
Firmware Version           : FFFFFFFF
Total Capacity             : Not Available
Unallocated Capacity       : Not Available
Note: At present Namespace Management is not supported by NetApp
Arrays.
```

° nvme-list

Show example

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n
vme_interop-57-159
Port WWN                 : 20:07:d0:39:ea:14:11:04
Node WWN                 : 20:05:d0:39:ea:14:11:04
Controller ID            : 0x0140
Model Number             : NetApp ONTAP Controller
Serial Number            : 81CGZBPU5T/uAAAAAAB
Firmware Version         : FFFFFFFF
Total Capacity           : Not Available
Unallocated Capacity     : Not Available
```

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n
vme_interop-57-159
Port WWN                 : 20:08:d0:39:ea:14:11:04
Node WWN                 : 20:05:d0:39:ea:14:11:04
Controller ID            : 0x0141
Model Number             : NetApp ONTAP Controller
Serial Number            : 81CGZBPU5T/uAAAAAAB
Firmware Version         : FFFFFFFF
Total Capacity           : Not Available
Unallocated Capacity     : Not Available
```

Note: At present Namespace Management is not supported by NetApp Arrays.

3. Verify that the namespaces have been created:

```
nvme-list-ns
```

Show example

Active Namespaces (attached to controller 0x0141):

SCSI		SCSI	SCSI
NSID	DeviceName	Bus Number	Target Number
OS LUN			
-----	-----	-----	-----

0x00000001	\\.\PHYSICALDRIVE9	0	1
0			
0x00000002	\\.\PHYSICALDRIVE10	0	1
1			
0x00000003	\\.\PHYSICALDRIVE11	0	1
2			
0x00000004	\\.\PHYSICALDRIVE12	0	1
3			
0x00000005	\\.\PHYSICALDRIVE13	0	1
4			
0x00000006	\\.\PHYSICALDRIVE14	0	1
5			
0x00000007	\\.\PHYSICALDRIVE15	0	1
6			
0x00000008	\\.\PHYSICALDRIVE16	0	1
7			

NVMe/FC Host Configuration for Windows Server 2019 with ONTAP

You can configure NVMe over Fibre Channel (NVMe/FC) on hosts running Windows Server 2019 for operation with ONTAP LUNs..

About this task

You can use the following support with the NVMe/FC host configuration for Windows 2019. You should also review the known limitations before starting the configuration process.



You can use the configuration settings provided in this procedure to configure cloud clients connected to [Cloud Volumes ONTAP](#) and [Amazon FSx for ONTAP](#).

- Support available:

Beginning with ONTAP 9.7, NVMe/FC is supported for Windows Server 2019.

For a list of supported FC adapters and controllers, see the [Hardware Universe](#). For the current list of

supported configurations and versions, see the [Interoperability Matrix Tool](#).

- Known limitations:

Windows Failover Cluster isn't supported with NVMe/FC because ONTAP doesn't currently support persistent reservations with NVMe/FC.



Broadcom ships an external driver for Windows NVMe/FC that is a translational SCSI ☐ NVMe driver and not a true NVMe/FC driver. The translational overhead doesn't necessarily impact performance, but it does negate the performance benefits of NVMe/FC. As a result, NVMe/FC and FCP performance is the same on Windows servers, unlike other operating systems such as Linux, where NVMe/FC performance is significantly better than that of FCP.

Enable NVMe/FC

Enable FC/NVMe on the Windows initiator host.

Steps

1. Install the Emulex HBA Manager utility on the Windows host.
2. On each of the HBA initiator ports, set the following HBA driver parameters:
 - EnableNVMe = 1
 - NVMEMode = 0
3. Reboot the host.

Configure the Broadcom FC adapter

The Broadcom initiator can serve both NVMe/FC and FCP traffic through the same 32G FC adapter ports. For FCP and FC/NVMe, you should use the Microsoft device-specific module (DSM) as the Microsoft Multipath I/O (MPIO) option.

A `hostnqn` is associated with each host bus adapter (HBA) port for the Broadcom adapter with FC/NVMe in a Windows environment. The `hostnqn` is formatted as shown in the following example:

```
nqn.2017-01.com.broadcom:ecd:nvmf:fc:100000109b1b9765
nqn.2017-01.com.broadcom:ecd:nvmf:fc:100000109b1b9766
```

Enable MPIO for NVMe devices

You need to enable MPIO for NVMe devices to complete the NVMe configuration on the Windows host.

Steps

1. Install [Windows Host Utility Kit 7.1](#) to set the driver parameters that are common to both FC and NVMe.
2. Open the MPIO properties.
3. From the **Discover Multi-Paths** tab, add the device ID listed for NVMe.

MPIO becomes aware of the NVMe devices, which are visible under disk management.

4. Open **Disk Management** and go to **Disk Properties**.

5. From the **MPIO** tab, select **Details**.
6. Set the following Microsoft DSM settings:
 - PathVerifiedPeriod: **10**
 - PathVerifyEnabled: **Enable**
 - RetryCount: **6**
 - RetryInterval: **1**
 - PDORemovedPeriod: **130**
7. Select the MPIO Policy **Round Robin with Subset**.
8. Change the registry values:

```
HKLM\SYSTEM\CurrentControlSet\Services\mpio\Parameters\PathRecoveryInterval DWORD -> 30
```

```
HKLM\SYSTEM\CurrentControlSet\Services\mpio \Parameters\UseCustomPathRecoveryInterval DWORD-> 1
```

9. Reboot the host.

Validate NVMe/FC

Verify that the NVMe subsystems have been discovered and the ONTAP namespaces are correct for the NVMe-oF configuration.

Steps

1. Verify that "Port Type" is FC+NVMe:

```
listhba
```


Show example

```
Port WWN      : 10:00:00:10:9b:1b:97:65
Node WWN      : 20:00:00:10:9b:1b:97:65
Fabric Name   : 10:00:c4:f5:7c:a5:32:e0
Flags         : 8000e300
Host Name     : INTEROP-57-159
Mfg           : Emulex Corporation
Serial No.    : FC71367217
Port Number   : 0
Mode          : Initiator
PCI Bus Number : 94
PCI Function  : 0
Port Type    : FC+NVMe
Model         : LPe32002-M2
```

```
Port WWN      : 10:00:00:10:9b:1b:97:66
Node WWN      : 20:00:00:10:9b:1b:97:66
Fabric Name   : 10:00:c4:f5:7c:a5:32:e0
Flags         : 8000e300
Host Name     : INTEROP-57-159
Mfg           : Emulex Corporation
Serial No.    : FC71367217
Port Number   : 1
Mode          : Initiator
PCI Bus Number : 94
PCI Function  : 1
Port Type     : FC+NVMe
Model         : LPe32002-M2
```

2. Verify that the NVMe/FC subsystems have been discovered:

- ° `nvme-list`

Show example

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n
vme_interop-57-159
Port WWN                  : 20:09:d0:39:ea:14:11:04
Node WWN                   : 20:05:d0:39:ea:14:11:04
Controller ID              : 0x0180
Model Number               : NetApp ONTAP Controller
Serial Number              : 81CGZBPU5T/uAAAAAAB
Firmware Version           : FFFFFFFF
Total Capacity             : Not Available
Unallocated Capacity       : Not Available

NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n
vme_interop-57-159
Port WWN                  : 20:06:d0:39:ea:14:11:04
Node WWN                   : 20:05:d0:39:ea:14:11:04
Controller ID              : 0x0181
Model Number               : NetApp ONTAP Controller
Serial Number              : 81CGZBPU5T/uAAAAAAB
Firmware Version           : FFFFFFFF
Total Capacity             : Not Available
Unallocated Capacity       : Not Available
Note: At present Namespace Management is not supported by NetApp
Arrays.
```

° nvme-list

Show example

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n
vme_interop-57-159
Port WWN                  : 20:07:d0:39:ea:14:11:04
Node WWN                   : 20:05:d0:39:ea:14:11:04
Controller ID              : 0x0140
Model Number               : NetApp ONTAP Controller
Serial Number              : 81CGZBPU5T/uAAAAAAB
Firmware Version           : FFFFFFFF
Total Capacity             : Not Available
Unallocated Capacity       : Not Available
```

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n
vme_interop-57-159
Port WWN                  : 20:08:d0:39:ea:14:11:04
Node WWN                   : 20:05:d0:39:ea:14:11:04
Controller ID              : 0x0141
Model Number               : NetApp ONTAP Controller
Serial Number              : 81CGZBPU5T/uAAAAAAB
Firmware Version           : FFFFFFFF
Total Capacity             : Not Available
Unallocated Capacity       : Not Available
```

Note: At present Namespace Management is not supported by NetApp Arrays.

3. Verify that the namespaces have been created:

```
nvme-list-ns
```

Show example

Active Namespaces (attached to controller 0x0141):

SCSI		SCSI	SCSI
NSID	DeviceName	Bus Number	Target Number
OS LUN			
-----	-----	-----	-----

0x00000001	\\.\PHYSICALDRIVE9	0	1
0			
0x00000002	\\.\PHYSICALDRIVE10	0	1
1			
0x00000003	\\.\PHYSICALDRIVE11	0	1
2			
0x00000004	\\.\PHYSICALDRIVE12	0	1
3			
0x00000005	\\.\PHYSICALDRIVE13	0	1
4			
0x00000006	\\.\PHYSICALDRIVE14	0	1
5			
0x00000007	\\.\PHYSICALDRIVE15	0	1
6			
0x00000008	\\.\PHYSICALDRIVE16	0	1
7			

Configure Windows Server 2016 with NVMe/FC for ONTAP

You can configure NVMe over Fibre Channel (NVMe/FC) on hosts running Windows Server 2016 for operation with ONTAP LUNs.

About this task

You can use the following support with the NVMe/FC host configuration for Windows 2016. You should also review the known limitations before starting the configuration process.



You can use the configuration settings provided in this procedure to configure cloud clients connected to [Cloud Volumes ONTAP](#) and [Amazon FSx for ONTAP](#).

- Support available:

Beginning with ONTAP 9.7, NVMe/FC is supported for Windows Server 2016.

For a list of supported FC adapters and controllers, see the [Hardware Universe](#). For the current list of supported configurations and versions, see the [Interoperability Matrix Tool](#).

- Known limitations:

Windows Failover Cluster isn't supported with NVMe/FC because ONTAP doesn't currently support persistent reservations with NVMe/FC.



Broadcom ships an external driver for Windows NVMe/FC that is a translational SCSI ☐ NVMe driver and not a true NVMe/FC driver. The translational overhead doesn't necessarily impact performance, but it does negate the performance benefits of NVMe/FC. As a result, NVMe/FC and FCP performance is the same on Windows servers, unlike other operating systems such as Linux, where NVMe/FC performance is significantly better than that of FCP.

Enable NVMe/FC

Enable FC/NVMe on the Windows initiator host.

Steps

1. Install the Emulex HBA Manager utility on the Windows host.
2. On each of the HBA initiator ports, set the following HBA driver parameters:
 - EnableNVMe = 1
 - NVMEMode = 0
3. Reboot the host.

Configure the Broadcom FC adapter

The Broadcom initiator can serve both NVMe/FC and FCP traffic through the same 32G FC adapter ports. For FCP and FC/NVMe, you should use the Microsoft device-specific module (DSM) as the Microsoft Multipath I/O (MPIO) option.

A `hostnqn` is associated with each host bus adapter (HBA) port for the Broadcom adapter with FC/NVMe in a Windows environment. The `hostnqn` is formatted as shown in the following example:

```
nqn.2017-01.com.broadcom:ecd:nvmf:fc:100000109b1b9765  
nqn.2017-01.com.broadcom:ecd:nvmf:fc:100000109b1b9766
```

Enable MPIO for NVMe devices

You need to enable MPIO for NVMe devices to complete the NVMe configuration on the Windows host.

Steps

1. Install [Windows Host Utility Kit 7.1](#) to set the driver parameters that are common to both FC and NVMe.
2. Open the MPIO properties.
3. From the **Discover Multi-Paths** tab, add the device ID listed for NVMe.

MPIO becomes aware of the NVMe devices, which are visible under disk management.

4. Open **Disk Management** and go to **Disk Properties**.
5. From the **MPIO** tab, select **Details**.

6. Set the following Microsoft DSM settings:
 - PathVerifiedPeriod: **10**
 - PathVerifyEnabled: **Enable**
 - RetryCount: **6**
 - RetryInterval: **1**
 - PDORemovedPeriod: **130**
7. Select the MPIO Policy **Round Robin with Subset**.
8. Change the registry values:

```
HKLM\SYSTEM\CurrentControlSet\Services\mpio\Parameters\PathRecoveryInterval DWORD -> 30
```

```
HKLM\SYSTEM\CurrentControlSet\Services\mpio \Parameters\UseCustomPathRecoveryInterval DWORD-> 1
```

9. Reboot the host.

Validate NVMe/FC

Verify that the NVMe subsystems have been discovered and the ONTAP namespaces are correct for the NVMe-oF configuration.

Steps

1. Verify that "Port Type" is FC+NVMe:

```
listhba
```

Show example

```
Port WWN      : 10:00:00:10:9b:1b:97:65
Node WWN      : 20:00:00:10:9b:1b:97:65
Fabric Name   : 10:00:c4:f5:7c:a5:32:e0
Flags        : 8000e300
Host Name     : INTEROP-57-159
Mfg          : Emulex Corporation
Serial No.    : FC71367217
Port Number   : 0
Mode         : Initiator
PCI Bus Number : 94
PCI Function  : 0
Port Type    : FC+NVMe
Model        : LPe32002-M2
```

```
Port WWN      : 10:00:00:10:9b:1b:97:66
Node WWN      : 20:00:00:10:9b:1b:97:66
Fabric Name   : 10:00:c4:f5:7c:a5:32:e0
Flags        : 8000e300
Host Name     : INTEROP-57-159
Mfg          : Emulex Corporation
Serial No.    : FC71367217
Port Number   : 1
Mode         : Initiator
PCI Bus Number : 94
PCI Function  : 1
Port Type     : FC+NVMe
Model        : LPe32002-M2
```

2. Verify that the NVMe/FC subsystems have been discovered:

- ° `nvme-list`

Show example

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n
vme_interop-57-159
Port WWN                  : 20:09:d0:39:ea:14:11:04
Node WWN                  : 20:05:d0:39:ea:14:11:04
Controller ID             : 0x0180
Model Number              : NetApp ONTAP Controller
Serial Number             : 81CGZBPU5T/uAAAAAAB
Firmware Version          : FFFFFFFF
Total Capacity            : Not Available
Unallocated Capacity      : Not Available

NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n
vme_interop-57-159
Port WWN                  : 20:06:d0:39:ea:14:11:04
Node WWN                  : 20:05:d0:39:ea:14:11:04
Controller ID             : 0x0181
Model Number              : NetApp ONTAP Controller
Serial Number             : 81CGZBPU5T/uAAAAAAB
Firmware Version          : FFFFFFFF
Total Capacity            : Not Available
Unallocated Capacity      : Not Available
Note: At present Namespace Management is not supported by NetApp
Arrays.
```

° nvme-list

Show example

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n
vme_interop-57-159
Port WWN                  : 20:07:d0:39:ea:14:11:04
Node WWN                   : 20:05:d0:39:ea:14:11:04
Controller ID              : 0x0140
Model Number               : NetApp ONTAP Controller
Serial Number              : 81CGZBPU5T/uAAAAAAB
Firmware Version           : FFFFFFFF
Total Capacity             : Not Available
Unallocated Capacity       : Not Available
```

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n
vme_interop-57-159
Port WWN                  : 20:08:d0:39:ea:14:11:04
Node WWN                   : 20:05:d0:39:ea:14:11:04
Controller ID              : 0x0141
Model Number               : NetApp ONTAP Controller
Serial Number              : 81CGZBPU5T/uAAAAAAB
Firmware Version           : FFFFFFFF
Total Capacity             : Not Available
Unallocated Capacity       : Not Available
```

Note: At present Namespace Management is not supported by NetApp Arrays.

3. Verify that the namespaces have been created:

```
nvme-list-ns
```

Show example

Active Namespaces (attached to controller 0x0141):

SCSI		SCSI	SCSI
NSID	DeviceName	Bus Number	Target Number
OS LUN			
-----	-----	-----	-----

0x00000001	\\.\PHYSICALDRIVE9	0	1
0			
0x00000002	\\.\PHYSICALDRIVE10	0	1
1			
0x00000003	\\.\PHYSICALDRIVE11	0	1
2			
0x00000004	\\.\PHYSICALDRIVE12	0	1
3			
0x00000005	\\.\PHYSICALDRIVE13	0	1
4			
0x00000006	\\.\PHYSICALDRIVE14	0	1
5			
0x00000007	\\.\PHYSICALDRIVE15	0	1
6			
0x00000008	\\.\PHYSICALDRIVE16	0	1
7			

Configure Windows Server 2012 R2 with NVMe/FC for ONTAP

You can configure NVMe over Fibre Channel (NVMe/FC) on hosts running Windows Server 2012 R2 for operation with ONTAP LUNs.

About this task

You can use the following support with the NVMe/FC host configuration for Windows 2012 R2. You should also review the known limitations before starting the configuration process.



You can use the configuration settings provided in this procedure to configure cloud clients connected to [Cloud Volumes ONTAP](#) and [Amazon FSx for ONTAP](#).

- Support available:

Beginning with ONTAP 9.7, NVMe/FC is supported for Windows Server 2012 R2.

For a list of supported FC adapters and controllers, see the [Hardware Universe](#). For the current list of

supported configurations and versions, see the [Interoperability Matrix Tool](#).

- Known limitations:

Windows Failover Cluster isn't supported with NVMe/FC because ONTAP doesn't currently support persistent reservations with NVMe/FC.



Broadcom ships an external driver for Windows NVMe/FC that is a translational SCSI ☐ NVMe driver and not a true NVMe/FC driver. The translational overhead doesn't necessarily impact performance, but it does negate the performance benefits of NVMe/FC. As a result, NVMe/FC and FCP performance is the same on Windows servers, unlike other operating systems such as Linux, where NVMe/FC performance is significantly better than that of FCP.

Enable NVMe/FC

Enable FC/NVMe on the Windows initiator host.

Steps

1. Install the Emulex HBA Manager utility on the Windows host.
2. On each of the HBA initiator ports, set the following HBA driver parameters:
 - EnableNVMe = 1
 - NVMEMode = 0
3. Reboot the host.

Configure the Broadcom FC adapter

The Broadcom initiator can serve both NVMe/FC and FCP traffic through the same 32G FC adapter ports. For FCP and FC/NVMe, you should use the Microsoft device-specific module (DSM) as the Microsoft Multipath I/O (MPIO) option.

A `hostnqn` is associated with each host bus adapter (HBA) port for the Broadcom adapter with FC/NVMe in a Windows environment. The `hostnqn` is formatted as shown in the following example:

```
nqn.2017-01.com.broadcom:ecd:nvmf:fc:100000109b1b9765
nqn.2017-01.com.broadcom:ecd:nvmf:fc:100000109b1b9766
```

Enable MPIO for NVMe devices

You need to enable MPIO for NVMe devices to complete the NVMe configuration on the Windows host.

Steps

1. Install [Windows Host Utility Kit 7.1](#) to set the driver parameters that are common to both FC and NVMe.
2. Open the MPIO properties.
3. From the **Discover Multi-Paths** tab, add the device ID listed for NVMe.

MPIO becomes aware of the NVMe devices, which are visible under disk management.

4. Open **Disk Management** and go to **Disk Properties**.

5. From the **MPIO** tab, select **Details**.
6. Set the following Microsoft DSM settings:
 - PathVerifiedPeriod: **10**
 - PathVerifyEnabled: **Enable**
 - RetryCount: **6**
 - RetryInterval: **1**
 - PDORemovedPeriod: **130**
7. Select the MPIO Policy **Round Robin with Subset**.
8. Change the registry values:

```
HKLM\SYSTEM\CurrentControlSet\Services\mpio\Parameters\PathRecoveryInterval DWORD -> 30

HKLM\SYSTEM\CurrentControlSet\Services\mpio \Parameters\
UseCustomPathRecoveryInterval  DWORD-> 1
```

9. Reboot the host.

Validate NVMe/FC

Verify that the NVMe subsystems have been discovered and the ONTAP namespaces are correct for the NVMe-oF configuration.

Steps

1. Verify that "Port Type" is FC+NVMe:

```
listhba
```

Show example

```
Port WWN      : 10:00:00:10:9b:1b:97:65
Node WWN      : 20:00:00:10:9b:1b:97:65
Fabric Name   : 10:00:c4:f5:7c:a5:32:e0
Flags         : 8000e300
Host Name     : INTEROP-57-159
Mfg           : Emulex Corporation
Serial No.    : FC71367217
Port Number   : 0
Mode          : Initiator
PCI Bus Number : 94
PCI Function  : 0
Port Type    : FC+NVMe
Model         : LPe32002-M2
```

```
Port WWN      : 10:00:00:10:9b:1b:97:66
Node WWN      : 20:00:00:10:9b:1b:97:66
Fabric Name   : 10:00:c4:f5:7c:a5:32:e0
Flags         : 8000e300
Host Name     : INTEROP-57-159
Mfg           : Emulex Corporation
Serial No.    : FC71367217
Port Number   : 1
Mode          : Initiator
PCI Bus Number : 94
PCI Function  : 1
Port Type     : FC+NVMe
Model         : LPe32002-M2
```

2. Verify that the NVMe/FC subsystems have been discovered:

- `nvme-list`

Show example

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n
vme_interop-57-159
Port WWN                  : 20:09:d0:39:ea:14:11:04
Node WWN                   : 20:05:d0:39:ea:14:11:04
Controller ID              : 0x0180
Model Number               : NetApp ONTAP Controller
Serial Number              : 81CGZBPU5T/uAAAAAAB
Firmware Version           : FFFFFFFF
Total Capacity             : Not Available
Unallocated Capacity       : Not Available

NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n
vme_interop-57-159
Port WWN                  : 20:06:d0:39:ea:14:11:04
Node WWN                   : 20:05:d0:39:ea:14:11:04
Controller ID              : 0x0181
Model Number               : NetApp ONTAP Controller
Serial Number              : 81CGZBPU5T/uAAAAAAB
Firmware Version           : FFFFFFFF
Total Capacity             : Not Available
Unallocated Capacity       : Not Available
Note: At present Namespace Management is not supported by NetApp
Arrays.
```

° nvme-list

Show example

```
NVMe Qualified Name      : nqn.1992-  
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n  
vme_interop-57-159  
Port WWN                 : 20:07:d0:39:ea:14:11:04  
Node WWN                 : 20:05:d0:39:ea:14:11:04  
Controller ID            : 0x0140  
Model Number             : NetApp ONTAP Controller  
Serial Number            : 81CGZBPU5T/uAAAAAAB  
Firmware Version         : FFFFFFFF  
Total Capacity           : Not Available  
Unallocated Capacity     : Not Available
```

```
NVMe Qualified Name      : nqn.1992-  
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_n  
vme_interop-57-159  
Port WWN                 : 20:08:d0:39:ea:14:11:04  
Node WWN                 : 20:05:d0:39:ea:14:11:04  
Controller ID            : 0x0141  
Model Number             : NetApp ONTAP Controller  
Serial Number            : 81CGZBPU5T/uAAAAAAB  
Firmware Version         : FFFFFFFF  
Total Capacity           : Not Available  
Unallocated Capacity     : Not Available
```

Note: At present Namespace Management is not supported by NetApp Arrays.

3. Verify that the namespaces have been created:

```
nvme-list-ns
```

Show example

Active Namespaces (attached to controller 0x0141):

SCSI		SCSI	SCSI
NSID	DeviceName	Bus Number	Target Number
OS LUN			
-----	-----	-----	-----

0x00000001	\\.\PHYSICALDRIVE9	0	1
0			
0x00000002	\\.\PHYSICALDRIVE10	0	1
1			
0x00000003	\\.\PHYSICALDRIVE11	0	1
2			
0x00000004	\\.\PHYSICALDRIVE12	0	1
3			
0x00000005	\\.\PHYSICALDRIVE13	0	1
4			
0x00000006	\\.\PHYSICALDRIVE14	0	1
5			
0x00000007	\\.\PHYSICALDRIVE15	0	1
6			
0x00000008	\\.\PHYSICALDRIVE16	0	1
7			

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