



Windows

SAN hosts and cloud clients

NetApp
February 26, 2024

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Windows

NVMe/FC Host Configuration for Windows Server 2022 with ONTAP

You can configure NVMe over Fibre Channel (NVMe/FC) on hosts running Windows Server 2022 using ONTAP as the target.

NVMe/FC is supported on ONTAP 9.7 or later for Windows Server 2022.

Note that the Broadcom initiator can serve both NVMe/FC and FCP traffic through the same 32G FC adapter ports. For FCP and FC/NVMe, use MSDSM as the Microsoft Multipath I/O (MPIO) option.

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

Known limitations

Windows Failover Cluster (WFC) is not supported with ONTAP NVMe/FC because ONTAP does not currently support persistent reservations with NVMe/FC.



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

Enable NVMe/FC on a Windows initiator host

Follow these steps to enable FC/NVMe on the Windows initiator host:

Steps

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

Configure the Broadcom FC adapter in Windows for NVMe/FC

With the Broadcom adapter for FC/NVMe in a Windows environment, a `hostnqn` is associated with each host bus adapter (HBA) port. The `hostnqn` is formatted as follows.

Example

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

Enable MPIO for NVMe devices on the Windows host

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, click **Details**.
6. Set the following MSDSM 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  
val DWORD -> 30  
  
HKLM\SYSTEM\CurrentControlSet\Services\mpio \Parameters\  
UseCustomPathRecoveryInterval  DWORD-> 1
```

9. Reboot the host.

The NVMe configuration is now complete on the Windows host.

Validate NVMe/FC

1. Validate that the Port Type is FC+NVMe.

Now that NVMe is enabled, you should see the `Port Type` listed as FC+NVMe, as follows.

```
PS C:\Program Files\Emulex\Util\OCManager> .\hbaCmd listhba
```

Manageable HBA List

```
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. Validate that NVMe/FC subsystems have been discovered.

The `nvme-list` command lists the NVMe/FC discovered subsystems.

```
PS C:\Program Files\Emulex\Util\OCManager> .\hvacmd nvme-list
10:00:00:10:9b:1b:97:65
```

Discovered NVMe Subsystems for 10:00:00:10:9b:1b:97:65

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_int
erop-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_nvme_int
erop-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.
```

```
PS C:\Program Files\Emulex\Util\OCManager> .\hvacmd nvme-list
10:00:00:10:9b:1b:97:66
```

Discovered NVMe Subsystems for 10:00:00:10:9b:1b:97:66

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_int
erop-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_nvme_int
erop-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. Validate that namespaces have been created.

The `nvme-list-ns` command lists the namespaces for a specified NVMe target that lists the namespaces connected to the host.

```
PS C:\Program Files\Emulex\Util\OCManager> .\HbaCmd.exe nvme-list-ns
10:00:00:10:9b:1b:97:66 20:08:d0:39:ea:14:11:04 nq
.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_int
erop-57-159 0
```

Active Namespaces (attached to controller 0x0141):

SCSI		SCSI	SCSI	OS
NSID	DeviceName	Bus Number	Target Number	
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 using ONTAP as the target.

NVMe/FC is supported on ONTAP 9.7 or later for Windows Server 2019.

Note that the Broadcom initiator can serve both NVMe/FC and FCP traffic through the same 32G FC adapter ports. For FCP and FC/NVMe, use MSDSM as the Microsoft Multipath I/O (MPIO) option.

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



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

Known limitations

Windows Failover Cluster (WFC) is not supported with ONTAP NVMe/FC because ONTAP does not currently support persistent reservations with NVMe/FC.



The external driver shipped by Broadcom for Windows NVMe/FC is not a true NVMe/FC driver but a translational SCSI \square NVMe driver. This translational overhead does not necessarily impact performance, but it does negate the performance benefits of NVMe/FC. Thus, on Windows servers, NVMe/FC and FCP performance is the same, unlike on other operating systems such as Linux, where NVMe/FC performance is significantly better than that of FCP.

Enable NVMe/FC on a Windows initiator host

Follow these steps to enable FC/NVMe on the Windows initiator host:

Steps

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

Configure the Broadcom FC adapter in Windows for NVMe/FC

With the Broadcom adapter for FC/NVMe in a Windows environment, a `hostnqn` is associated with each host bus adapter (HBA) port. The `hostnqn` is formatted as follows.

Example

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

Enable MPIO for NVMe devices on the Windows host

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, click **Details**.
6. Set the following MSDSM 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  
val DWORD -> 30
```

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

9. Reboot the host.

The NVMe configuration is now complete on the Windows host.

Validate NVMe/FC

1. Validate that the Port Type is FC+NVMe.

Now that NVMe is enabled, you should see the Port Type listed as FC+NVMe, as follows.

```
PS C:\Program Files\Emulex\Util\OCManager> .\hbaCmd listhba
```

Manageable HBA List

```
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. Validate that NVMe/FC subsystems have been discovered.

The `nvme-list` command lists the NVMe/FC discovered subsystems.

```
PS C:\Program Files\Emulex\Util\OCManager> .\hvacmd nvme-list
10:00:00:10:9b:1b:97:65
```

Discovered NVMe Subsystems for 10:00:00:10:9b:1b:97:65

NVMe Qualified Name : nqn.1992-08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_int
erop-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_nvme_int
erop-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.

```
PS C:\Program Files\Emulex\Util\OCManager> .\hvacmd nvme-list
10:00:00:10:9b:1b:97:66
```

Discovered NVMe Subsystems for 10:00:00:10:9b:1b:97:66

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_int
erop-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_nvme_int
erop-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. Validate that namespaces have been created.

The `nvme-list-ns` command lists the namespaces for a specified NVMe target that lists the namespaces connected to the host.

```
PS C:\Program Files\Emulex\Util\OCManager> .\HbaCmd.exe nvme-list-ns
10:00:00:10:9b:1b:97:66 20:08:d0:39:ea:14:11:04 nq
.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_int
erop-57-159 0
```

Active Namespaces (attached to controller 0x0141):

SCSI		SCSI	SCSI	OS
NSID	DeviceName	Bus Number	Target Number	
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 2016 with ONTAP

You can configure NVMe over Fibre Channel (NVMe/FC) on hosts running Windows Server 2016 using ONTAP as the target.

NVMe/FC is supported on ONTAP 9.7 or later for Windows Server 2016.

Note that the Broadcom initiator can serve both NVMe/FC and FCP traffic through the same 32G FC adapter ports. For FCP and FC/NVMe, use MSDSM as the Microsoft Multipath I/O (MPIO) option.

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



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

Known limitations

Windows Failover Cluster (WFC) is not supported with ONTAP NVMe/FC because ONTAP does not currently support persistent reservations with NVMe/FC.



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

Enable NVMe/FC on a Windows initiator host

Follow these steps to enable FC/NVMe on the Windows initiator host:

Steps

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

Configure the Broadcom FC adapter in Windows for NVMe/FC

With the Broadcom adapter for FC/NVMe in a Windows environment, a `hostnqn` is associated with each host bus adapter (HBA) port. The `hostnqn` is formatted as follows.

Example

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

Enable MPIO for NVMe devices on the Windows host

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, click **Details**.
6. Set the following MSDSM 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  
val DWORD -> 30
```

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

9. Reboot the host.

The NVMe configuration is now complete on the Windows host.

Validate NVMe/FC

1. Validate that the Port Type is FC+NVMe.

Now that NVMe is enabled, you should see the `Port Type` listed as FC+NVMe, as follows.


```
PS C:\Program Files\Emulex\Util\OCManager> .\hbaCmd listhba
```

Manageable HBA List

```
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. Validate that NVMe/FC subsystems have been discovered.

The `nvme-list` command lists the NVMe/FC discovered subsystems.

```
PS C:\Program Files\Emulex\Util\OCManager> .\hvacmd nvme-list
10:00:00:10:9b:1b:97:65
```

Discovered NVMe Subsystems for 10:00:00:10:9b:1b:97:65

NVMe Qualified Name : nqn.1992-08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_int
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Port WWN : 20:09:d0:39:ea:14:11:04
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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_nvme_int
erop-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.

```
PS C:\Program Files\Emulex\Util\OCManager> .\hbacmd nvme-list
10:00:00:10:9b:1b:97:66
```

Discovered NVMe Subsystems for 10:00:00:10:9b:1b:97:66

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_int
erop-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
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```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_int
erop-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
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3. Validate that namespaces have been created.

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```
PS C:\Program Files\Emulex\Util\OCManager> .\HbaCmd.exe nvme-list-ns
10:00:00:10:9b:1b:97:66 20:08:d0:39:ea:14:11:04 nq
.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_int
erop-57-159 0
```

Active Namespaces (attached to controller 0x0141):

SCSI		SCSI	SCSI	OS
NSID	DeviceName	Bus Number	Target Number	
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 2012 R2 with ONTAP

You can configure NVMe over Fibre Channel (NVMe/FC) on hosts running Windows Server 2012 R2 using ONTAP as the target.

NVMe/FC is supported on ONTAP 9.7 or later for Windows Server 2012.

Note that the Broadcom initiator can serve both NVMe/FC and FCP traffic through the same 32G FC adapter ports. For FCP and FC/NVMe, use MSDSM as the Microsoft Multipath I/O (MPIO) option.

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



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

Known limitations

Windows Failover Cluster (WFC) is not supported with ONTAP NVMe/FC because ONTAP does not currently support persistent reservations with NVMe/FC.



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

Enable NVMe/FC on a Windows initiator host

Follow these steps to enable FC/NVMe on the Windows initiator host:

Steps

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

Configure the Broadcom FC adapter in Windows for NVMe/FC

With the Broadcom adapter for FC/NVMe in a Windows environment, a `hostnqn` is associated with each host bus adapter (HBA) port. The `hostnqn` is formatted as follows.

Example

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

Enable MPIO for NVMe devices on the Windows host

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, click **Details**.
6. Set the following MSDSM 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  
val DWORD -> 30
```

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

9. Reboot the host.

The NVMe configuration is now complete on the Windows host.

Validate NVMe/FC

1. Validate that the Port Type is FC+NVMe.

Now that NVMe is enabled, you should see the Port Type listed as FC+NVMe, as follows.

```
PS C:\Program Files\Emulex\Util\OCManager> .\hbaCmd listhba
```

Manageable HBA List

```
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. Validate that NVMe/FC subsystems have been discovered.

The `nvme-list` command lists the NVMe/FC discovered subsystems.

```
PS C:\Program Files\Emulex\Util\OCManager> .\hvacmd nvme-list
10:00:00:10:9b:1b:97:65
```

Discovered NVMe Subsystems for 10:00:00:10:9b:1b:97:65

NVMe Qualified Name : nqn.1992-08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_int
erop-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_nvme_int
erop-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.


```
PS C:\Program Files\Emulex\Util\OCManager> .\hbacmd nvme-list
10:00:00:10:9b:1b:97:66
```

Discovered NVMe Subsystems for 10:00:00:10:9b:1b:97:66

```
NVMe Qualified Name      : nqn.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_int
erop-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_nvme_int
erop-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. Validate that namespaces have been created.

The `nvme-list-ns` command lists the namespaces for a specified NVMe target that lists the namespaces connected to the host.

```
PS C:\Program Files\Emulex\Util\OCManager> .\HbaCmd.exe nvme-list-ns
10:00:00:10:9b:1b:97:66 20:08:d0:39:ea:14:11:04 nq
.1992-
08.com.netapp:sn.a3b74c32db2911eab229d039ea141105:subsystem.win_nvme_int
erop-57-159 0
```

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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