Best Practices

Dell EMC SC Series: Microsoft Multipath I/O Best Practices

Abstract

This document provides best practices for configuring Microsoft® Multipath I/O (MPIO) to perform optimally with Dell EMC™ SC Series storage.

June 2019

Revisions

Date	Description
October 2010	Initial release
October 2010	Corrected errors
November 2011	Additional content on Microsoft® Windows Server® Core
October 2012	Updated to include Windows Server 2012 content
May 2013	Updated to include Windows Server 2008 R2/2012 iSCSI initiator setup and appendix listing recommended hotfixes and registry values
October 2013	Updated to include Windows Server 2012 R2 content
January 2014	Updated hotfix information
January 2015	Updated configuration recommendations
March 2015	Updated hotfix and configuration recommendations
April 2015	Added SAS front-end content
February 2016	Removed Windows Server 2003 content and updated hotfix recommendations
October 2016	Re-ordered document for clarity, added Windows Server 2016 and Nano Server content, and updated hotfix recommendations
January 2017	Updated configuration recommendations
June 2017	Updated hotfix info and configuration recommendations
January 2018	Re-ordered document for clarity, updated hotfix and configuration recommendations, updated guidance on Nano Server
July 2018	Updated configuration recommendations; added guidance on Live Volume ALUA support with SCOS 7.3
February 2019	Reordered contents for clarity; included support for Windows Server 2019 and SCOS 7.4

Acknowledgements

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Table of contents

Revisions....2
Acknowledgements....2
Table of contents....3
Executive summary....6
Audience....6
1 Introduction to Microsoft MPIO....7
1.1 Microsoft DSM....7
1.2 Windows Server support for other MPIO software....8
1.3 Supported Windows Server versions with SC Series....8
1.4 MPIO implementation overview....8
2 MPIO design, scale, and performance considerations....10
2.1 SC Series front-end connection options....10
2.2 Legacy port mode....10
2.3 Virtual port mode....11
2.4 SAS front-end support....12
3 Patch Windows Server OS and install MPIO....13
3.1 Apply OS patches and updates....13
3.2 Install MPIO....13
3.2.1 Windows Server 2008 R2....13
3.2.2 Windows Server 2012 or later....13
3.3 Enable support for iSCSI and SAS devices....13
4 Install and update an MPIO card....15
4.1 Verify the hardware is supported....15
4.2 Install MPIO card in the Windows Server....15
4.3 Update firmware and drivers....15
4.3.1 Firmware....16
4.3.2 Windows drivers....16
5 Configure MPIO card firmware....17
5.1 SAS-FE....17
5.2 FC....17
5.3 iSCSI....19
6 Install cabling and configure the storage network....20
6.1 SAS-FE....20
6.2 FC....20

6.3 iSCSI 21
6.3.1 Assign IP addresses and enable Jumbo Frames 22
7 Configure server object on SC Series 23
7.1 Automatic host configuration using the Dell Storage Manager client 23
7.2 Manual host configuration 26
7.2.1 SAS-FE manual configuration 27
7.2.2 FC manual configuration 27
7.2.3 iSCSI manual configuration 28
8 Present SC Series storage and apply the Microsoft DSM 34
8.1 A single volume instance is displayed in Disk Management 34
8.2 Duplicate volume instances are listed in Disk Management 36
8.2.1 Apply MS-DSM with the MPIO utility (GUI): 36
8.2.2 Apply the MS-DSM with PowerShell (Windows Server 2012 and later) 37
8.2.3 Apply the MS-DSM with MPCLAIM 37
8.2.4 Verify single instance of the disk 38
9 Multiple transports and volume mapping 39
9.1 Limited Windows Server support 39
9.2 Use cases for multiple transports 39
9.3 Configure a volume to use a single transport 39
10 Change the default load balance policy 40
10.1 MPCLAIM command 40
10.2 PowerShell (Windows Server 2012 or later) 41
10.3 Per-volume load-balancing settings 41
10.3.1 Disk Management GUI 41
10.3.2 MPCLAIM command 42
11 Boot-from-SAN 44
11.1 Boot-from-SAN advantages 44
11.2 Boot from local disk advantages 44
11.3 Boot-from-SAN configuration steps 44
11.3.1 FC boot-from-SAN 45
11.3.2 iSCSI boot-from-SAN 50
A Windows Server single-path and MPIO configuration recommendations for SC Series storage 51
A.1 Recommended updates and hotfixes for Windows Server 2008 R2 SP1 51
A.2 Recommended updates and hotfixes for Windows Server 2012 (non-R2 version) 52
A.3 Recommended updates and hotfixes for Windows Server 2012 R2/2016 52
A.4 Recommended registry settings for Windows Server 52

A.5 iSCSI initiator settings (single-path and MPIO) 55
B Additional resources 58
B.1 Technical support and resources 58
B.2 Related documentation 58

Executive summary

This document provides best practices for deploying Microsoft® Windows Server® Multipath IO (MPIO) with Dell EMC™ SC Series storage.

For your specific SC Series array and Storage Center OS (SCOS) version, refer to the primary reference material at Dell.com/support for optimal configuration of SC Series storage for Windows Server. Available resources (which may vary by SC Series model) include deployment guides, owner's manuals, administrator's guides, installation guides, and release notes. Readers should also be familiar with the Dell EMC SC Series and Windows Server Best Practices Guide.

Building upon the guidance provided in these resources, this document contains supplemental information to optimize Windows Server MPIO for SC Series storage.

Audience

This document is intended for Dell EMC customers, partners, and employees who desire to learn more about best practices when configuring Microsoft MPIO with SC Series storage. It is assumed that the reader has working knowledge of Windows Server and SC Series storage.

We welcome your feedback along with any recommendations for improving this document. Send comments to StorageSolutionsFeedback@dell.com.

1 Introduction to Microsoft MPIO

Microsoft MPIO is a framework that allows administrators to configure load balancing and failover processes using multiple data paths to external storage. Supported transports include Fibre Channel (FC) and iSCSI in a storage area network (SAN) configuration, and serial-attached SCSI (SAS) front-end connections in a direct-attach storage (DAS) configuration.

All SC Series models are SAN-configurable when equipped with FC or iSCSI front-end ports. This is the most common configuration with SC Series storage. Select SC Series models also support a DAS configuration when equipped from the factory with SAS front-end ports.

The main purpose of MPIO is to provide redundant paths for a server to access storage. With multiple paths, if one path goes down, another path provides connectivity to prevent a service outage. MPIO also allows for load-balancing to improve performance when there is more than one active optimized path available.

Configure all available front-end ports (targets) on an SC Series array to use your preferred transport to optimize throughput and maximize performance.

With Microsoft MPIO, load balancing can be configured to use up to 32 independent paths for each connected external storage device. Configuring two to four paths per external storage device is common with SC Series storage.

For test or development environments that can accommodate down time without business impact, a less-costly, less-resilient design that uses a single-path design for host server volumes may be acceptable to the business.

1.1 Microsoft DSM

The Microsoft MPIO framework uses a built-in device-specific module (DSM) which is software that allows the host server to recognize and intelligently manage multiple paths to the same volume (LUN) on an external SAN or DAS array. Without a DSM, the host is unable to manage multiple paths and as a result, Disk Management erroneously reports multiple instances of the same disk device — one disk for each FC, iSCSI, or SAS path.

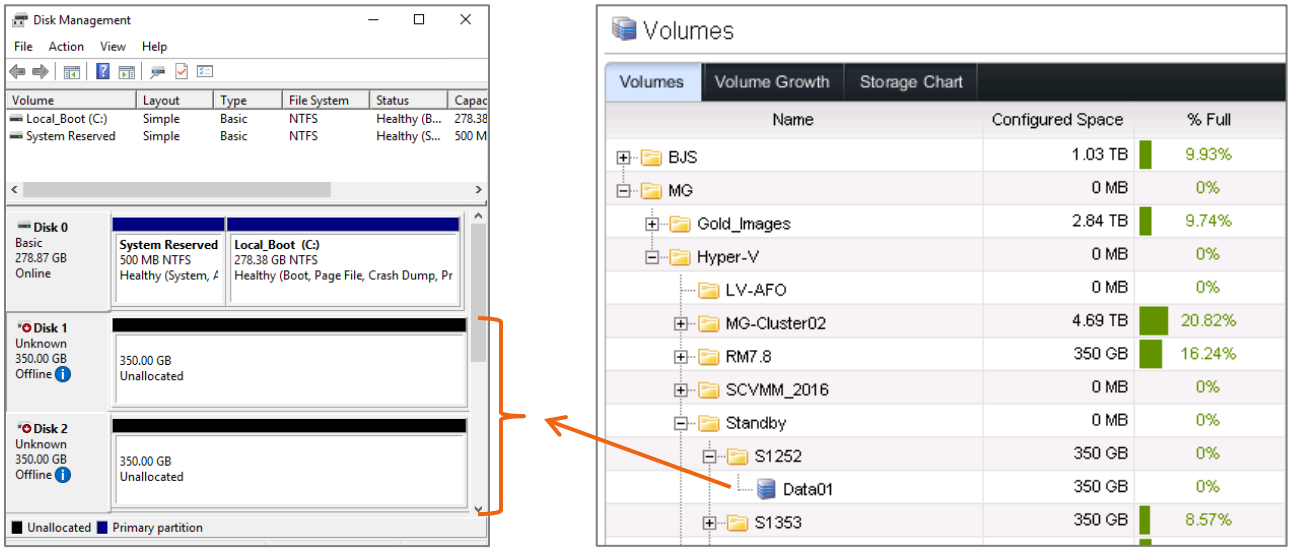


Figure 1 Multiple instances of a disk displayed in Disk Management before the Microsoft DSM is installed

Microsoft provides a built-in DSM for Windows Server 2008 R2 and above that is fully compatible with SC Series storage and is the focus of this paper. The built-in DSM is available after installing the **Multipath IO** feature. The MPIO feature is not installed on a Windows Server by default.

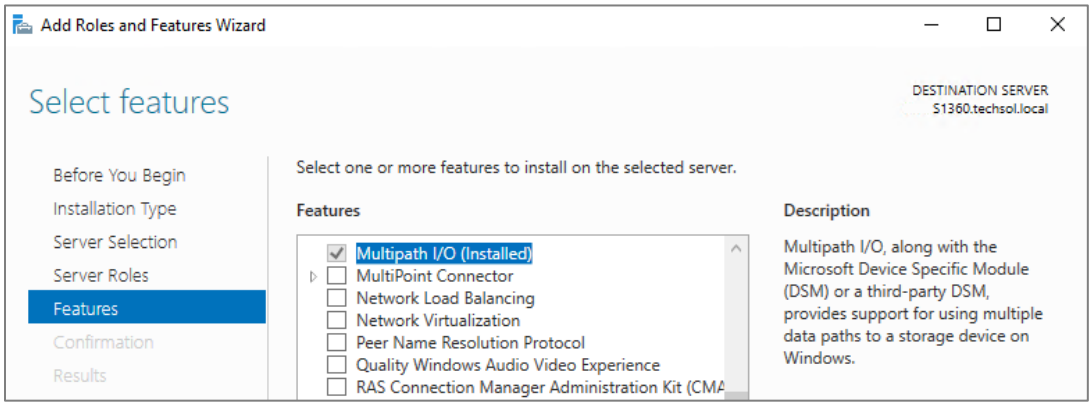


Figure 2 Install the Windows Server Multipath I/O feature to support MPIO with SC Series storage

1.2 Windows Server support for other MPIO software

This guide covers the built-in Microsoft DSM which is fully supported with SC Series arrays. If more advanced MPIO features are needed, third-party MPIO software may be used if supported. For example, see the Dell EMC PowerPath™ documentation for more information about PowerPath support for SC Series and Windows Server. Contact Dell Support for guidance with installing other MPIO software.

1.3 Supported Windows Server versions with SC Series

The best practice guidance in this document applies to versions of Windows Server that are currently supported by Microsoft (Windows Server 2008 R2 through Windows Server 2019) unless otherwise noted.

Note: Not all versions of Windows Server are supported with all versions of SCOS. To verify Windows Server version compatibility with your version of SCOS, consult the applicable SC Series documentation for your array. Windows Server 2019 is supported as of the SCOS 7.4 release.

1.4 MPIO implementation overview

This guide presents a logical process along with recommended best practices for successfully implementing Windows Server MPIO with SC Series storage. For best results, follow the sections in the order presented in this guide to avoid missing important configuration steps. This will help ensure a trouble-free installation.

Note: The installation steps for a boot-from-SAN configuration follow a different order. See section 11 for more information on boot-from-SAN.

The steps to implement MPIO are as follows:

- Plan for scale and performance with a right-sized SC Series array and storage network for the workload
- Make sure the Windows Server OS is fully patched with Microsoft updates
- Install the MPIO feature and enable support for iSCSI or SAS devices (as applicable)
- Verify that all MPIO hardware is supported

- Install a supported MPIO card in the host server
- Verify that current firmware is applied to all hardware (servers, MPIO cards, switches)
- Verify current OS drivers for the MPIO card
- Configure the MPIO card (HBA) firmware settings
- Configure cabling and the storage area network
- Create server object on the SC Series array
- Present an SC Series volume as a LUN to the host server
- Apply the Microsoft DSM and configure MPIO settings on the host server
- Adjust Windows Server registry setting (as applicable)
- Apply hot-fixes to the server OS (as applicable)

2 MPIO design, scale, and performance considerations

Plan for scale and performance. If the environment is new, ensure that the design will support the workload. See the Dell EMC SC Series Storage and Microsoft Windows Server best practice guide for information on right-sizing the SC Series storage array and storage fabric to maximize throughput and minimize latency.

2.1 SC Series front-end connection options

Several MPIO-capable front-end cabling options are supported with SC Series storage. Regardless of the option used, with MPIO the host server will see multiple paths to storage objects (LUNs) when presented to the host server.

For more front-end configuration guidance including detailed cabling examples, see the storage system configuration and deployment guide or owner's manual for your SC Series array at Dell.com/support.

2.2 Legacy port mode

In legacy port mode, front-end I/O ports are assigned to fault domains as either primary or reserve ports. I/O uses the primary ports only. Reserve ports stay in standby mode. If a primary port fails, I/O will fail over to the reserve port. Legacy port mode requires twice as many I/O ports as virtual port mode to enable multiple paths and therefore makes less efficient use of the available hardware.

SC Series offers legacy port mode as some workloads and operating systems may require it. Although Windows Server supports legacy port mode, the recommended configuration for Windows Server is virtual port mode.

Figure 3 shows an example cable configuration using legacy port mode. Each color represents a separate fault domain.

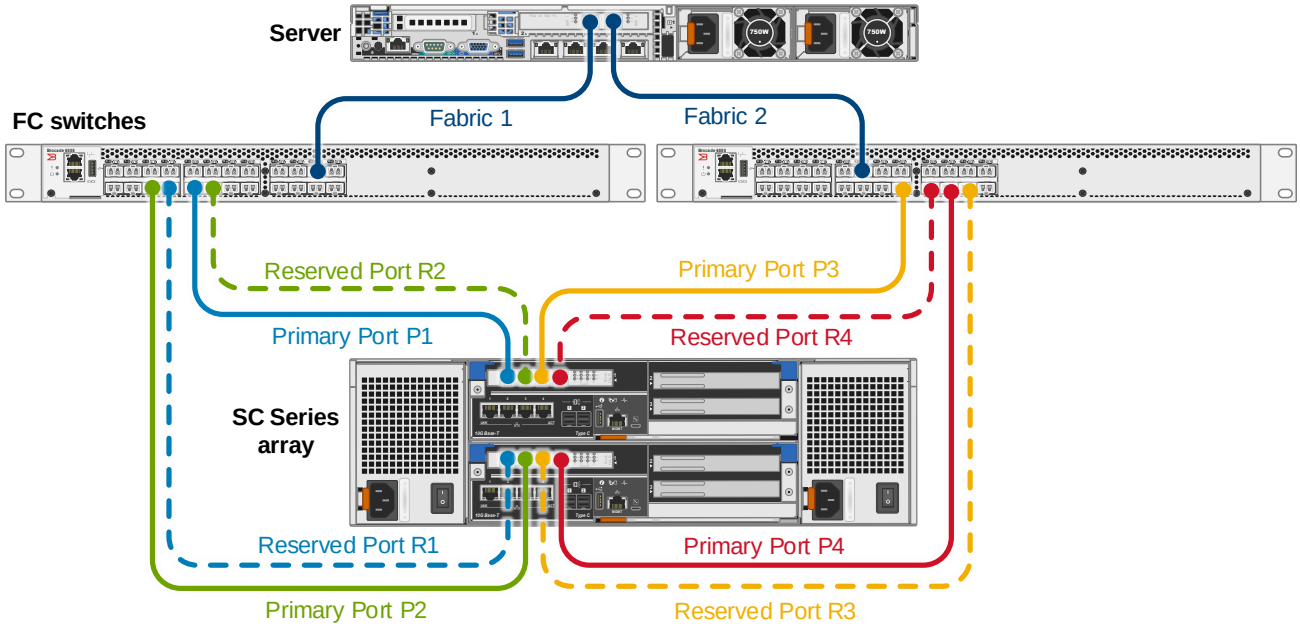


Figure 3 Legacy port mode cabling example with FC

2.3 Virtual port mode

Virtual port mode is the recommended configuration for Microsoft environments. In virtual port mode, all front-end I/O ports that are assigned to fault domains are configured as active ports. Because all ports are active, additional front-end bandwidth is available without sacrificing redundancy. The example in Figure 4 shows that virtual port mode provides the same MPIO functionally with half the number ports (four instead of eight) as the legacy port mode example shown in Figure 3.

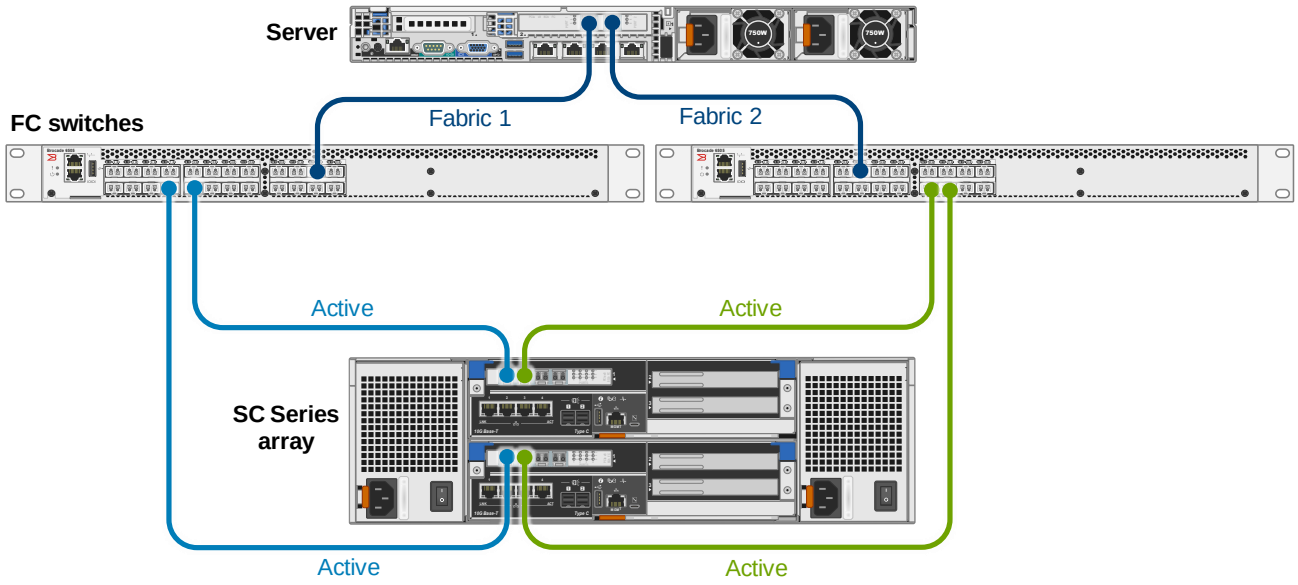


Figure 4 Virtual port mode cabling example with FC

A virtual front-end port configuration with iSCSI fault domains (FD 1 and FD 2) is similar to FC.

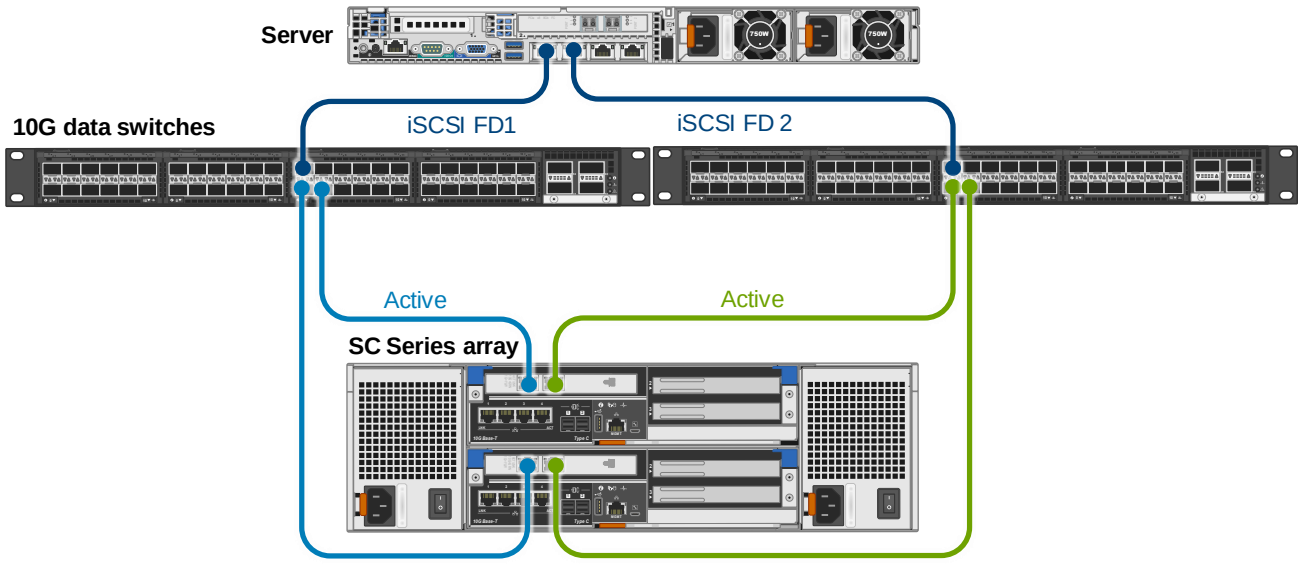


Figure 5 Virtual port mode cabling example with iSCSI

Note: To use virtual ports with FC, all FC switches and host bus adapters (HBAs) must support the N_Port ID Virtualization (NPIV) protocol.

Note: In virtual port mode, SC Series storage presents iSCSI control ports to host servers. Servers connect to control ports and the SC Series array redirects traffic automatically to the appropriate virtual port.

2.4 SAS front-end support

SAS front-end (SAS FE) is a simple, cost-effective transport option that is ideal for edge cases such as a small branch office or remote location with a few host servers. Up to four host servers per SC Series array are supported with SAS FE.

Select SC Series arrays support SAS FE ports for MPIO connectivity when the SC array is configured from the factory with SAS FE ports. With SAS FE, host servers are connected directly to SAS ports on the SC Series array as shown in Figure 6. No switch is required.

Host servers require a supported SAS PCIe card to connect directly to SC Series SAS FE ports. See the Dell EMC Storage Compatibly Matrix for a list of supported SAS FE cards.

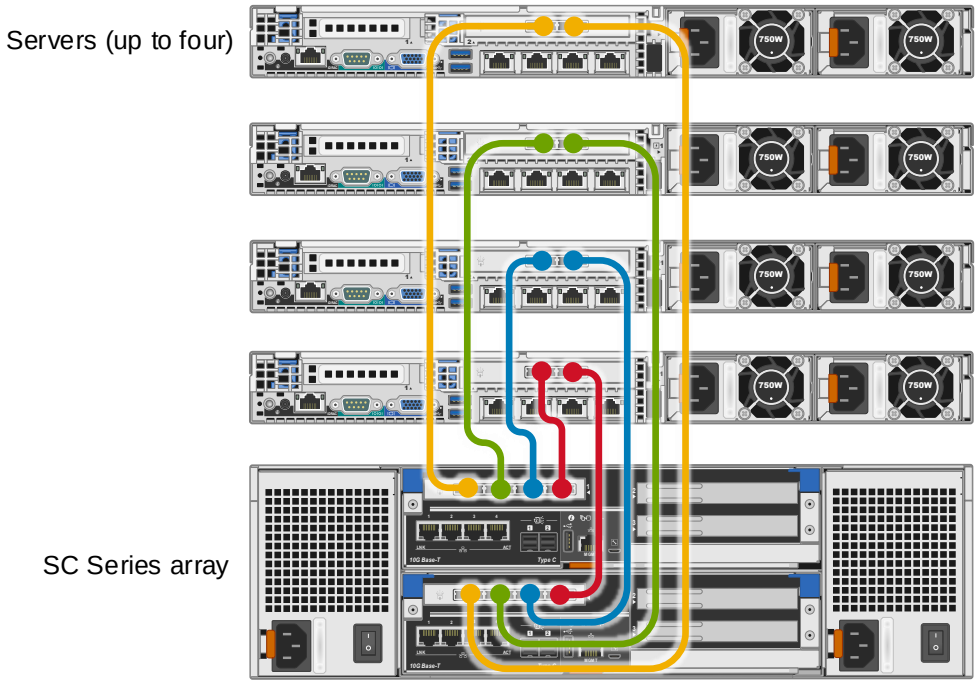


Figure 6 Cabling example with SAS FE

In addition to the general SAS FE cabling guidance found in the user configuration guide or owner's manual for your SC Series array, see the Dell EMC SC Series Storage with SAS Front-end Support for Microsoft Hyper-V configuration guide for detailed cabling examples and step-by-step configuration guidance for SAS FE in Microsoft environments.

Note: SAS FE is also supported with VMware. For more information, see the Dell EMC SC Series Storage with SAS Front-end Support for VMware vSphere configuration guide.

3 Patch Windows Server OS and install MPIO

Prepare the host server for MPIO by following the steps in this section.

3.1 Apply OS patches and updates

Leverage Microsoft Updates to fully patch the Windows Server OS.

Verify that Microsoft Updates do not downgrade the Windows Server drivers for any MPIO cards already installed in the host server.

3.2 Install MPIO

Install the **Multipath I/O** feature on the Windows Server host and reboot. For OS-specific guidance, see sections 3.2.1 and 3.2.2.

3.2.1 Windows Server 2008 R2

On Windows Server 2008 R2, the MPIO feature is installed using the Server Manager GUI or from the command line. To install MPIO using the CLI, open a command prompt with elevated (administrator) privileges and enter the following:

```
Servermanagercmd -install "Multipath-IO"
```

For Windows Server Core, open a command prompt and enter the following (commands are case sensitive):

```
DISM /online /enable-feature:MultipathIo
```

Reboot the server.

3.2.2 Windows Server 2012 or later

The MPIO feature is installed on Windows Server 2012 or later using the Server Manager GUI or through the MPIO module in Microsoft PowerShell®.

On Windows Server 2012 and newer Core installations, use PowerShell to install MPIO. The PowerShell command is as follows:

```
Enable-WindowsOptionalFeature –Online –FeatureName MultiPathIO
```

Reboot the server.

3.3 Enable support for iSCSI and SAS devices

After installing the MPIO feature and rebooting, if configuring MPIO for iSCSI or SAS, launch the MPIO configuration utility and under the **Discover Multi-Paths** tab, select **Add Support for iSCSI devices** or **SAS devices** as appropriate and click **Add**.

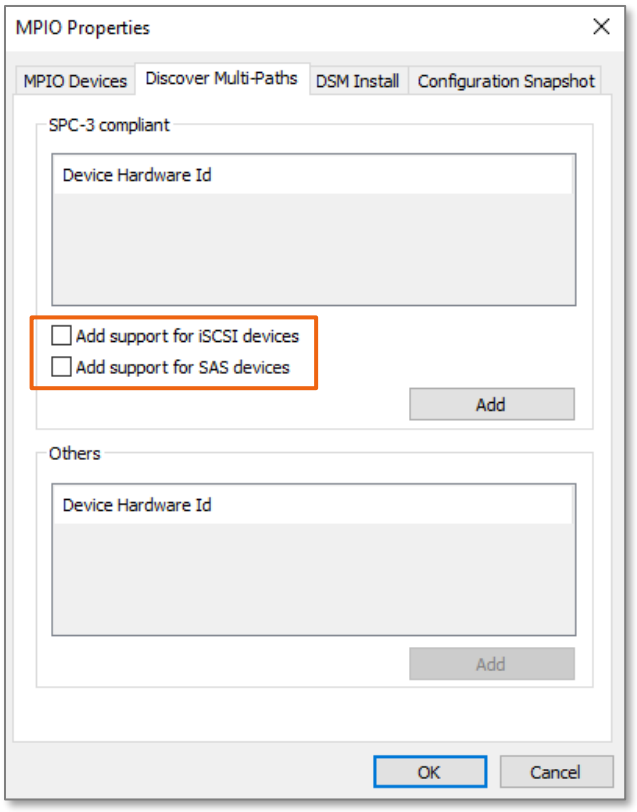


Figure 7 Enable support for iSCSI or SAS devices after installing the MPIO feature

After enabling support for iSCSI or SAS devices, reboot the Windows Server host.

4 Install and update an MPIO card

Follow the steps in this section to install and update a supported MPIO card in the Windows Server OS.

4.1 Verify the hardware is supported

Ensure that all hardware components in the storage data path are supported. This includes all FC, iSCSI, SAS cards, and FC/iSCSI switches. See the Dell EMC Storage Compatibly Matrix for a list of supported hardware.

Figure 8 QLogic 32Gb FC PCIe card with two host server ports (HBAs)

4.2 Install MPIO card in the Windows Server

Install a supported FC, iSCSI, or SAS-FE card in an available PCIe slot in the host server. Some cards may also be offered in a daughter card configuration depending on the server. If using iSCSI, the host server may already have built-in NICs that support iSCSI. For more information on SAS-FE, see the Dell EMC SC Series Storage with SAS Front-end Support for Microsoft configuration guide.

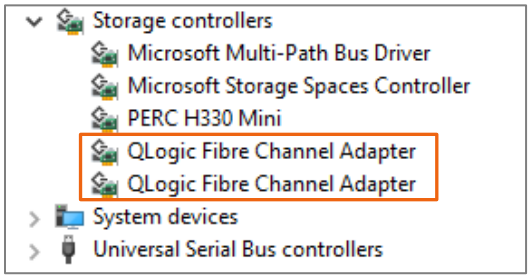


Figure 9 Access Windows Server Device Manager to view MPIO hardware and view driver versions

4.3 Update firmware and drivers

For all hardware components in the storage data path (FC, iSCSI, SAS cards and FC/iSCSI switches) install the latest firmware, BIOS, boot code, and Windows drivers as applicable to take advantage of the latest enhancements and bug fixes. Unnecessary troubleshooting can be avoided by making sure this step is not omitted.

4.3.1 Firmware

For Dell EMC PowerEdge™ servers, leverage the LifeCycle Controller (LC) or other options such as the latest Platform Specific Bootable ISO (PSBI) image to update server components. This will update the firmware for installed FC, iSCSI, and SAS cards that have Dell EMC drivers.

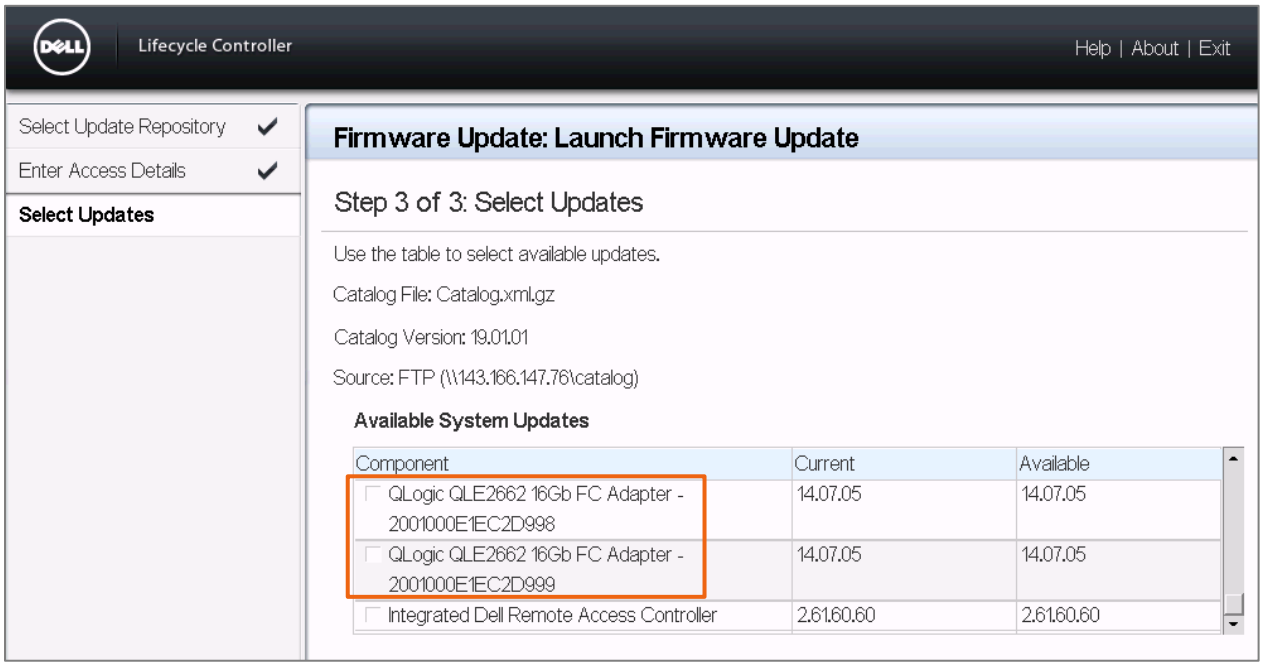


Figure 10 Use the Dell PowerEdge Server Lifecycle Controller to update MPIO card firmware

Update the firmware for FC, iSCSI, or SAS cards individually by following vendor documentation, if for some reason they are not updated to the latest version by the LC updates or PSBI.

4.3.2 Windows drivers

Use Device Manager to view the current driver version for the MPIO card.

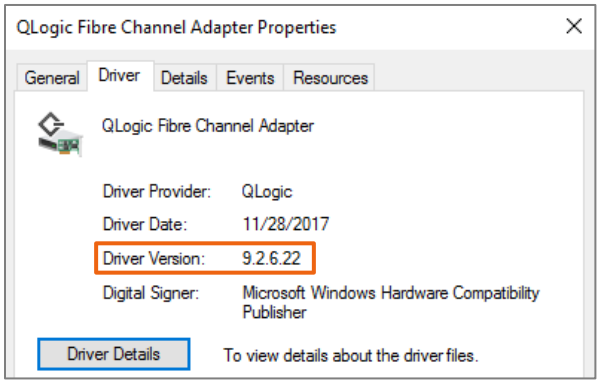


Figure 11 Use Device Manager to view the driver version for MPIO cards

See if newer drivers exist on the downloads and drivers page for your host server, or the vendor web site for the MPIO card. If newer drivers exist, download, install, and reboot the host. Verify that the updated drivers are listed in Device Manager.

5 Configure MPIO card firmware

Configure the firmware settings for the MPIO card, if required. Each card will typically contain one to four host ports (HBAs) each. The examples shown in this document show cards with two HBAs each.

5.1 SAS-FE

Supported SAS FE cards work out-of-the-box with the default firmware settings. No additional configuration is required.

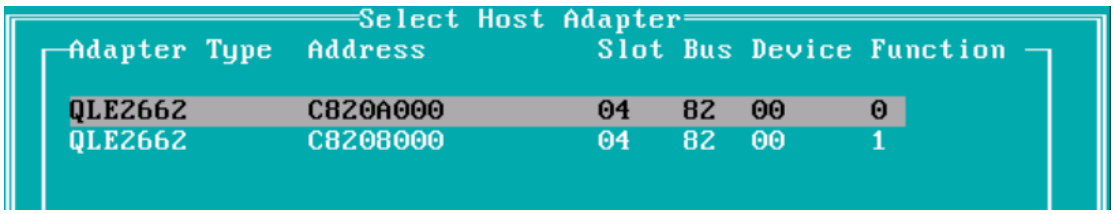
5.2 FC

FC cards may require firmware configuration to enable each port and to set parameters. In this example, the **Fast!UTIL** utility is used to configure a QLogic® card. Vendor tools such as QConverge (GUI or CLI) can also be used.

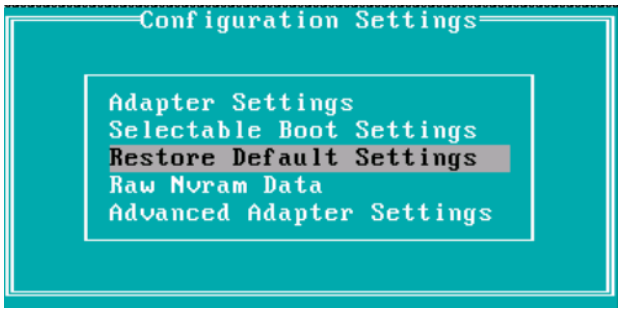
For FC card HBA firmware settings for commonly used FC cards, see the latest version of the Dell Storage Manager administrator's guide, version 2018 or newer. Contact Dell support if your MPIO card is supported but does not have recommended HBA firmware settings listed in the Dell Storage Manager administrator's guide.

1. Verify that a compatible FC card is installed in the server. A QLogic QLE2662 FC card is shown in this example.
2. Boot the server and press **Ctrl+Q** when prompted to access the **Fast!UTIL** utility.

3. On the main screen under **Select Host Adapter**, the first host adapter port (HBA) is selected. In this example, the FC card has two HBAs. Press **Enter**.

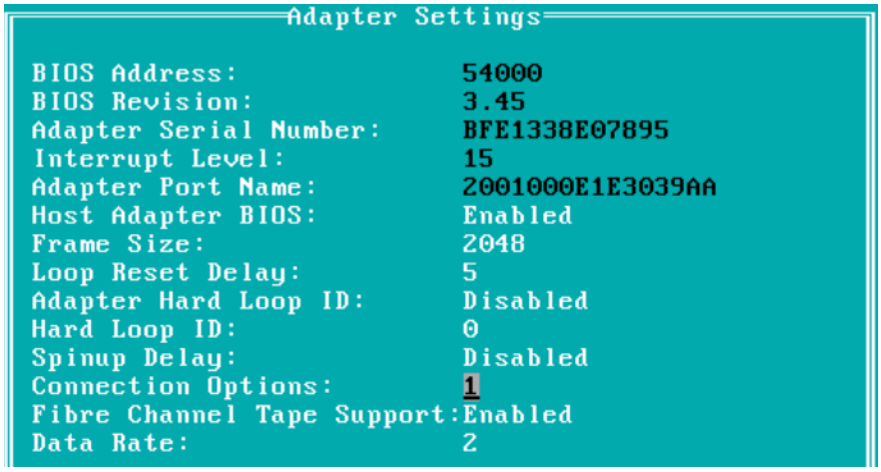


4. Reset the host adapter to factory defaults by selecting **Configuration Settings** > **Restore Default Settings**.

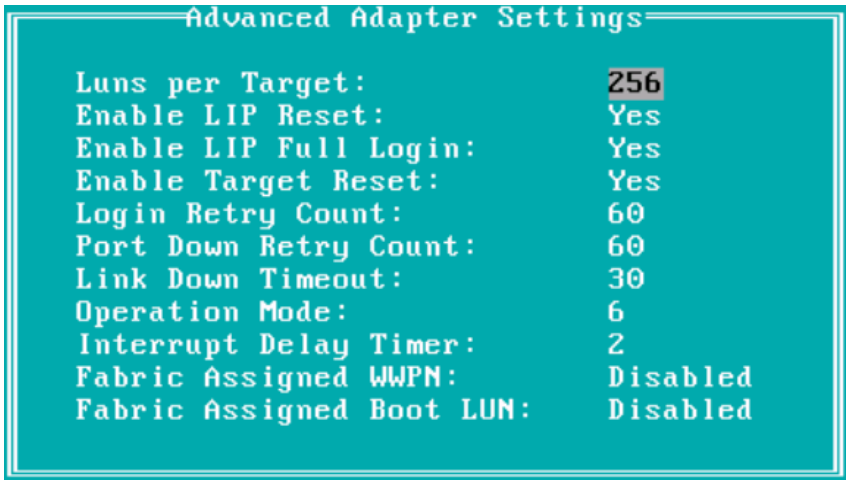


5. Return to the main screen and select any additional HBAs one at a time and reset them to factory defaults.
6. Reboot the host server and press **Ctrl+Q** when prompted to access **Fast!UTIL**.
7. Set the following parameters on the first HBA:

   a. Under **Configuration Settings** > **Adapter Settings**:
      i. Set **Host Adapter BIOS** to **Enabled**.
      ii. If this parameter is listed, set **Connection Options** to **1** (Point to Point only).
      iii. Leave all other settings at the defaults.
      iv. Press **Esc** and save the changes.



b. Under **Configuration Settings** > **Advanced Adapter Settings**:
   i. Set **Luns per Target** to **256**.
   ii. Set **Enable LIP Reset** to **Yes**.
   iii. Set **Enable LIP Full Login** to **Yes**.
   iv. Set **Login Retry Count** to **60**.
   v. Set **Port Down Retry Count** to **60**.
   vi. Set **Link Down Timeout** to **30**.
   vii. Leave all other settings at the defaults.
   viii. Press **Esc** twice and save the changes when prompted.



8. Repeat for each additional HBA listed on the main screen in **Fast!UTIL.**
9. Once finished and the settings are saved, reboot the host.

5.3 iSCSI

Consult the documentation for your iSCSI card to see if firmware configuration is required to enable ports. iSCSI cards typically do not require firmware configuration unless the iSCSI card will be used to boot-from SAN. See section 11 for more information on boot-from-SAN.

6 Install cabling and configure the storage network

Verify that cabling is connected between the host server MPIO card (the HBAs or NIC ports), switches, and the SC Series array, and then configure the storage network.

6.1 SAS-FE

For SAS-FE, switches are not used. Connect SAS cables from the SAS ports on the host server directly to SAS-FE ports on the SC Series array. See the Dell EMC SC Series Storage with SAS Front-end Support for Microsoft Hyper-V configuration guide for detailed cabling examples and step-by-step configuration guidance for SAS-FE.

6.2 FC

For FC, verify that FC cables (typically, LC style) are connected from the host adapter ports (HBAs) on the host server to FC switch ports, and from FC switch ports to front-end FC ports on the SC Series. SC Series does not support connecting FC cables from a host directly to the array. Use of an FC switch is required.

After connecting the cabling, use **Fast!UTIL** to rescan each port. This will broadcast the world-wide-name (WWN) of the HBA to the fabric so it is visible to the fabric for zoning, and to the SC Series for creating a server object. No devices should be found at this point.

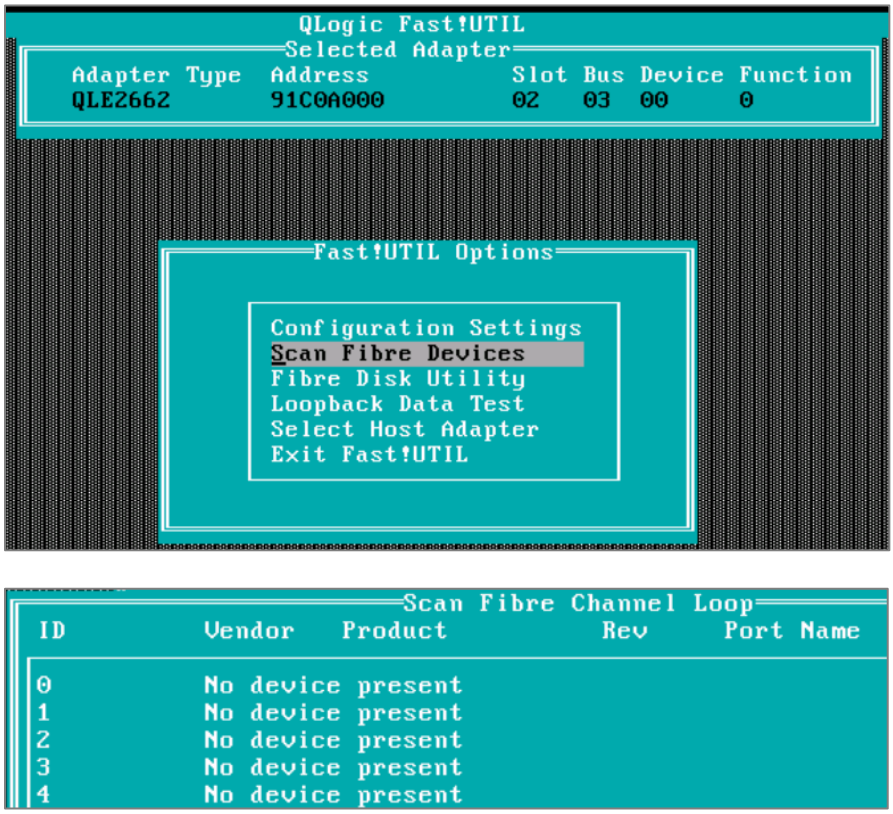


Figure 12 Scan Fibre Devices

Complete the necessary zoning steps on the FC switches to allow the host server FC HBA ports to see the SC Series front-end FC ports. This typically involves creating aliases, zones, and an active zone set for each

fabric. This guide assumes two separate virtual-port FC fault domains and fabrics are configured for redundancy (see Figure 4).

6.3 iSCSI

For iSCSI, verify that patch cables (typically RJ45 Cat5e/Cat6 or SFP-based) are connected from the NIC ports in the host server to switch ports, and from switch ports to the iSCSI ports on the SC Series array. SC Series storage does not support connecting iSCSI cables from a host directly to the array. Use of a data switch that supports iSCSI is required.

As a best practice, iSCSI (storage) traffic should be isolated from all other IP traffic such as LAN or management. The most resilient way to do this is to configure dedicated iSCSI ports in the host server and dedicated iSCSI switches for each iSCSI fault domain.

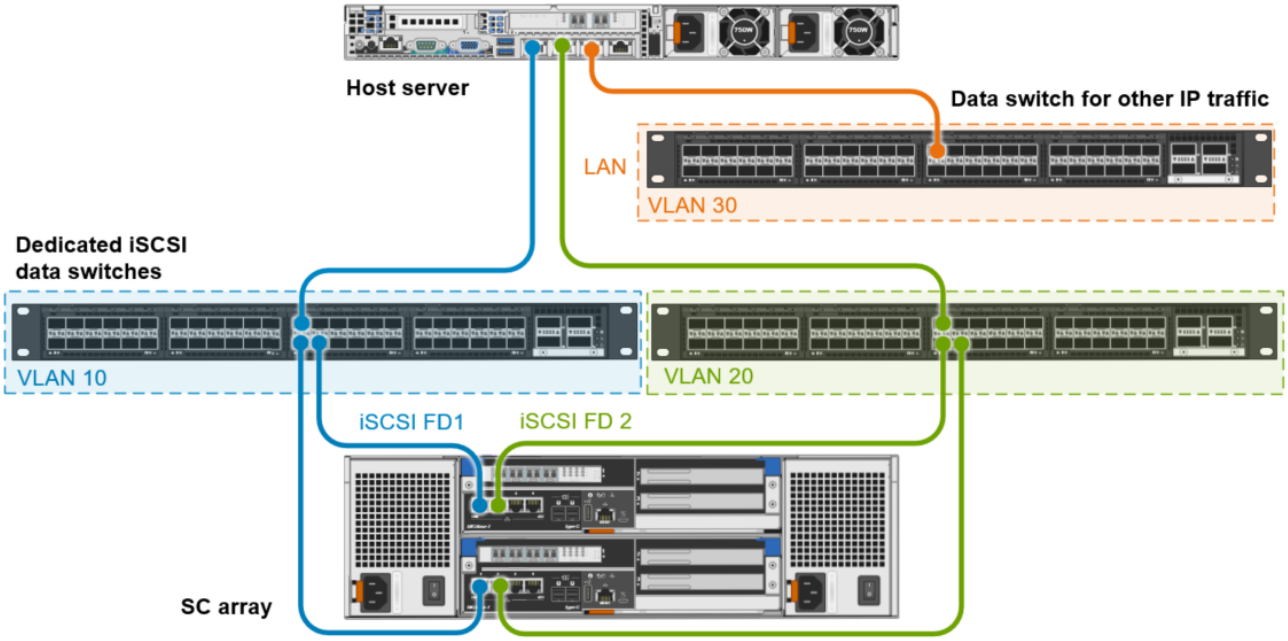


Figure 13 iSCSI configuration with dedicated iSCSI switches, host server NICs, and two fault domains

If using dedicated iSCSI switches is not possible, a less resilient design is to configure VLANs on a shared data switch to isolate iSCSI traffic from all other IP traffic. The use of separate dedicated iSCSI NICs in the host server for each iSCSI fault domain is recommended as a best practice.

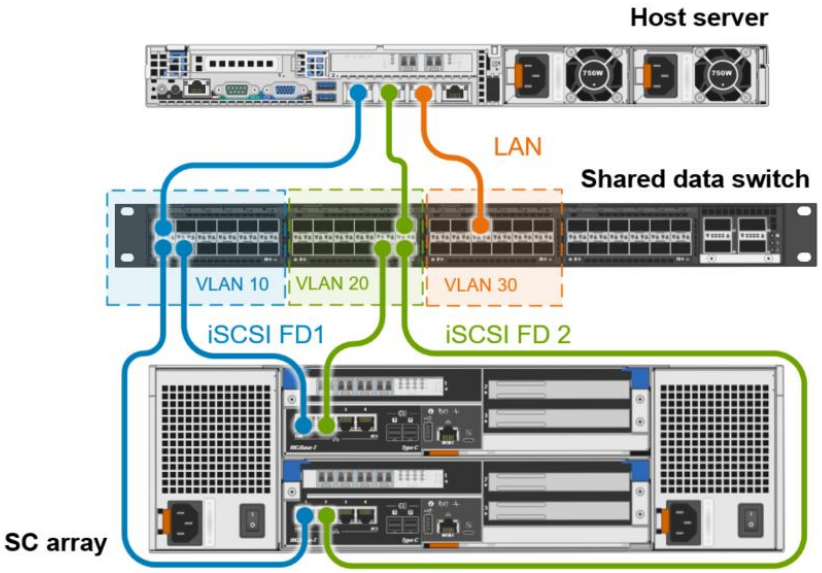


Figure 14 VLANs on a shared switch isolate iSCSI traffic and iSCSI fault domains

If a converged network adapter (CNA) is used on the host that combines iSCSI and other IP traffic over the same cable, configure VLANs to isolate the iSCSI traffic.

6.3.1 Assign IP addresses and enable Jumbo Frames

Once cabling is in place, assign IPs to each iSCSI port on the host and verify that the host can see the target iSCSI port IPs on the SC Series array. This is typically confirmed by pinging the iSCSI target (control port) IPs on the SC Series from the host. This guide assumes two separate virtual-port iSCSI fault domains are configured on the SC Series array for redundancy.

In addition, enable Jumbo Frames on every port in the iSCSI data path (SC Series ports, host server ports, and switch ports).

7 Configure server object on SC Series

A server object representing the Windows Server host and MPIO ports (SAS, FC, or iSCSI) or can now be created on the SC Series array.

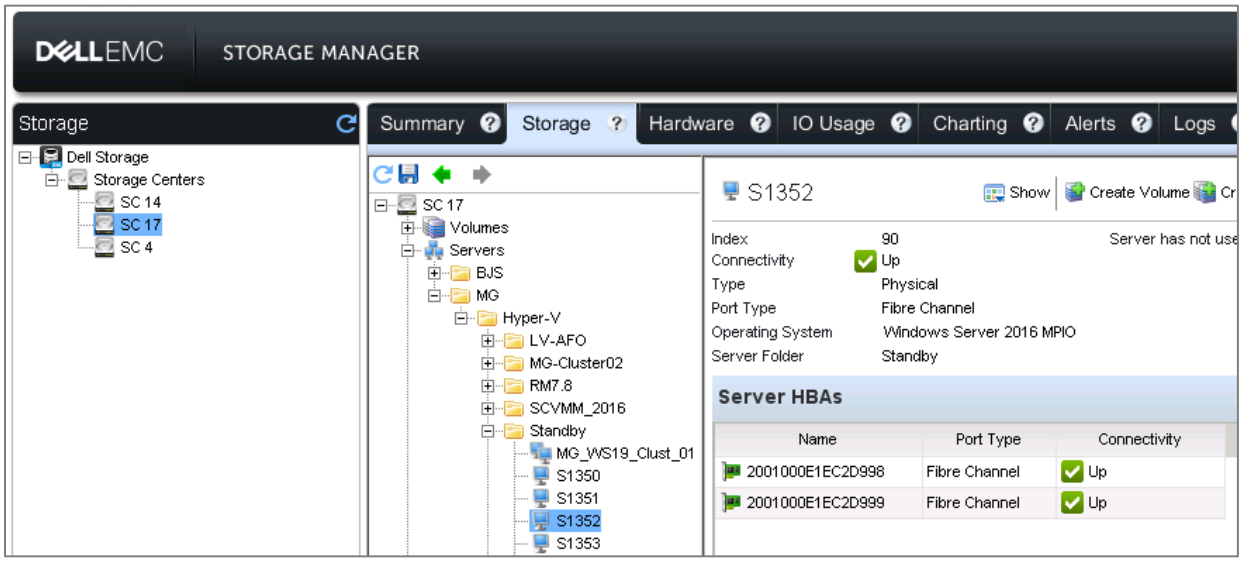


Figure 15 Server objects organized under subfolders on the SC Series array

There are two ways to create a new server object on SC Series: automatic or manual.

The automatic method is recommended where supported.

The manual method is required when a host is configured to boot-from-SAN with FC or iSCSI. See section 11 for more information on boot-from-SAN.

In cases where the automatic method is supported for SAS, FC, or iSCSI, users may still choose to create host server objects manually on the SC Series array.

Note: Before attempting to automatically or manually create a new server object on SC Series storage, verify that all the steps in the preceding sections of this document have been completed.

7.1 Automatic host configuration using the Dell Storage Manager client

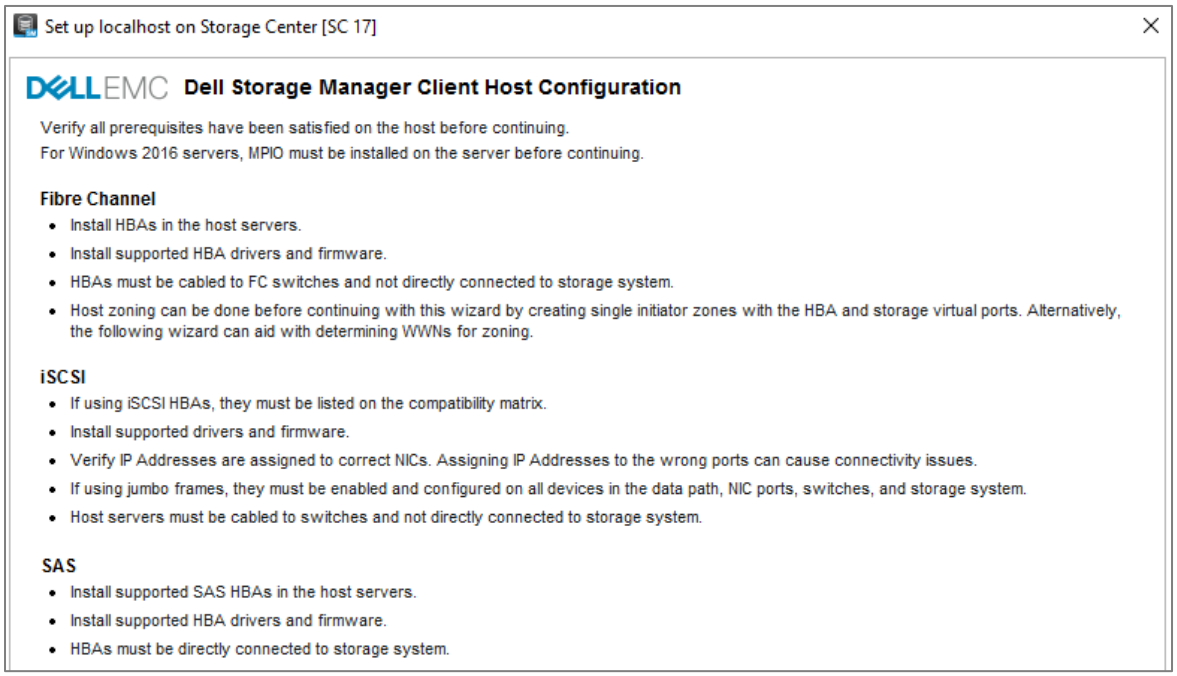
The preferred method to create a new server object on SC Series storage is to use the Dell Storage Manager client. The steps are similar for hosts with SAS, FC, or iSCSI cards.

One of the benefits of this method of server creation is that in addition to creating the server object on the SC Series array, the wizard will also modify MPIO registry settings on the host server to optimize performance and resiliency. The wizard will also apply the Microsoft DSM on the host server.

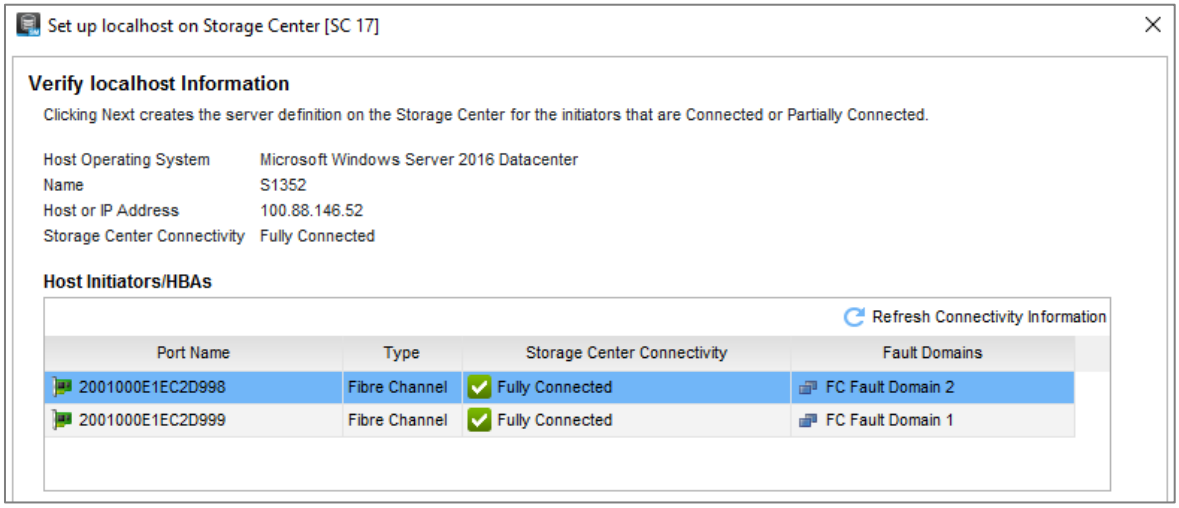
Note: The Dell Storage Manager client does not modify HBA firmware settings on the Windows host server. If HBA firmware settings are required to enable ports or set parameters, do this before running the configuration wizard (see section 5).

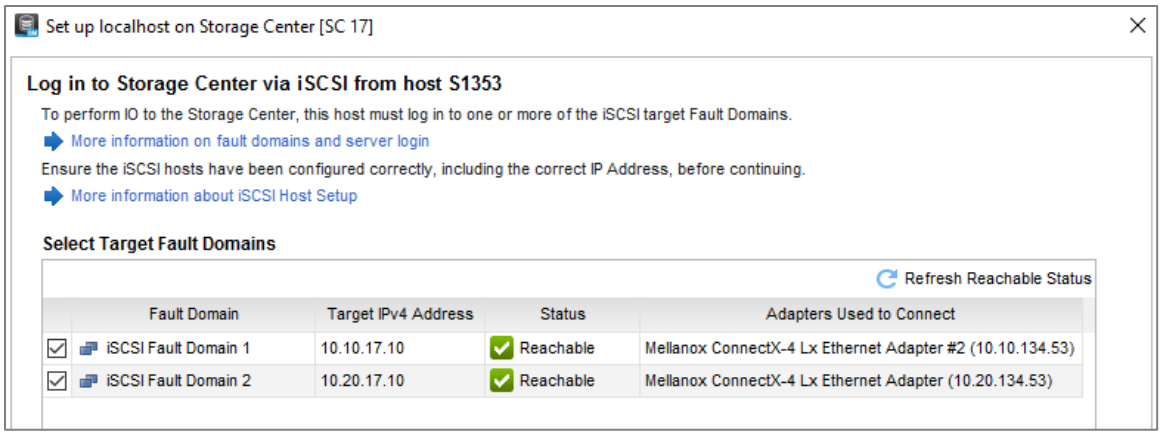
Follow these steps for automatic creation:

1. Install the latest Dell Storage Manager client version on the Windows Server host.
2. Right-click the Dell Storage Manager client icon and select **Run as administrator** to launch the client with administrator rights.
3. On the Dell Storage Manager client launch screen, select the **Configure this host to access a Storage Center** option.
4. Provide access information for the desired SC Series array.
5. Review the prerequisite steps screen. If the sections of this guide were followed in order, these steps should have all been completed previously. If any steps have not been completed, exit the wizard and complete them. Click **Next**.



6. Verify that the expected Windows Server host MPIO ports are listed. The two examples below show discovery from a Windows Server host named S1352 with a dual-HBA FC card, and a Windows Server host named S1353 with a dual-port NIC that supports iSCSI. In both examples, there are two separate fault domains on the SC Series array. Click **Next**.

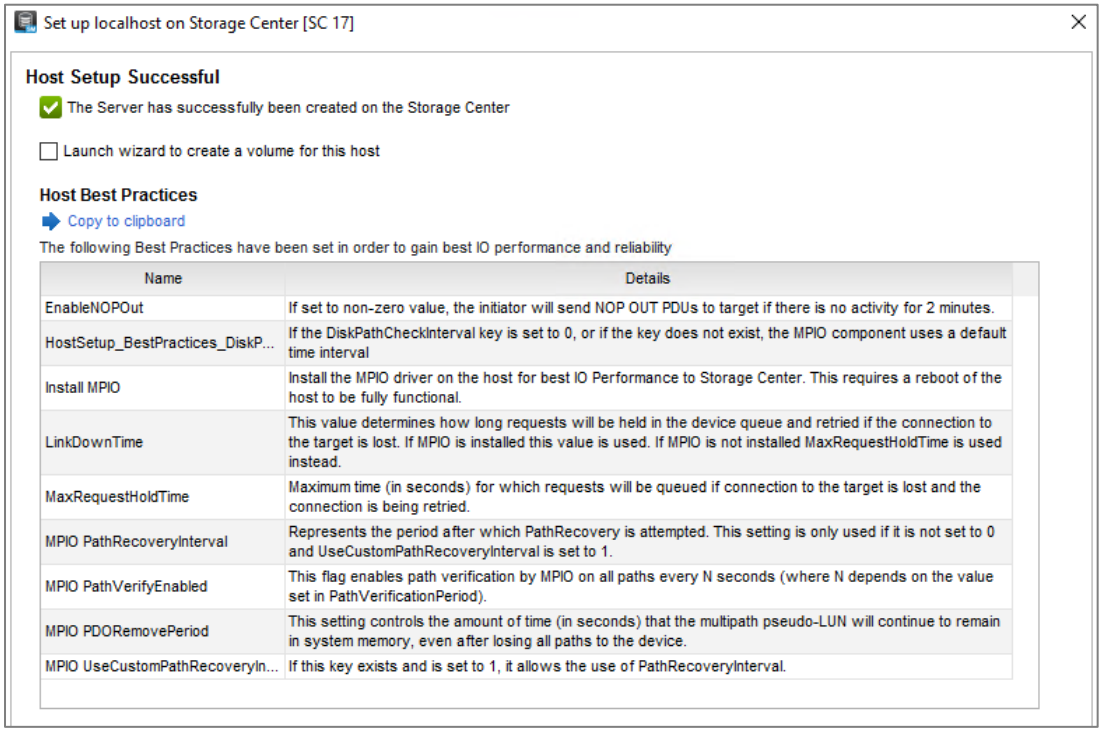




7. Allow the wizard to complete.

8. The wizard will display a list changes made to the Windows Server. These changes optimize the Windows Server for MPIO performance and resiliency.

Note: Additional registry changes may be required for your transport and OS version, as listed in appendix A. Use PowerShell or regedit to make additional adjustments as needed.



9. Optional: Check **Launch wizard to create a volume for this host** to create and add an SC Series volume to this host. Leave this option unchecked if a volume will be added later.
10. Click **Finish**.
11. The server object is placed at the root of the **Servers** folder on the SC Series array.
12. Optional: If desired, right click the server object and select **Move to Folder** to move the server object to a subfolder. Logically grouping server objects for ease of management is recommended but not required.
13. Because the wizard modified MPIO registry settings on the Windows Server host, a reboot is required. Reboot the server.
14. Next steps: If a volume was created and mapped to the server above, proceed to section 10 to review MPIO settings and load balance options. If a volume was not created above, proceed to section 8 to map a volume to the Windows Server host.

7.2 Manual host configuration

If possible, use the Dell Storage Manager client to automatically configure a new server object on the SC Series array, as detailed in section 7.1.

In cases where this is not possible or desired, create the server object manually by following the steps in this section.

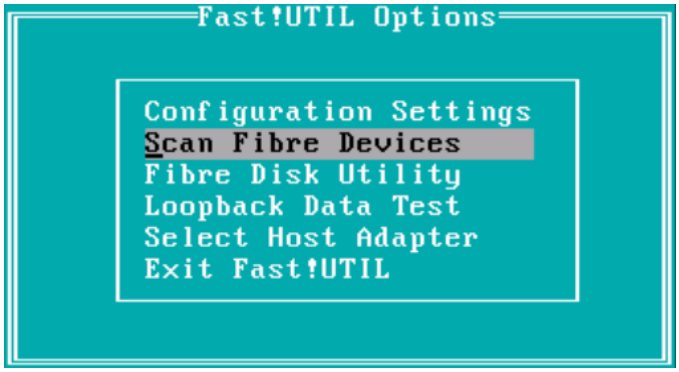
7.2.1 SAS-FE manual configuration

To create a server object manually when a host has SAS HBAs, refer to the Dell EMC SC Series Storage with SAS Front-end for Microsoft configuration guide.

7.2.2 FC manual configuration

To create a server object manually when a host has FC HBAs, follow these steps:

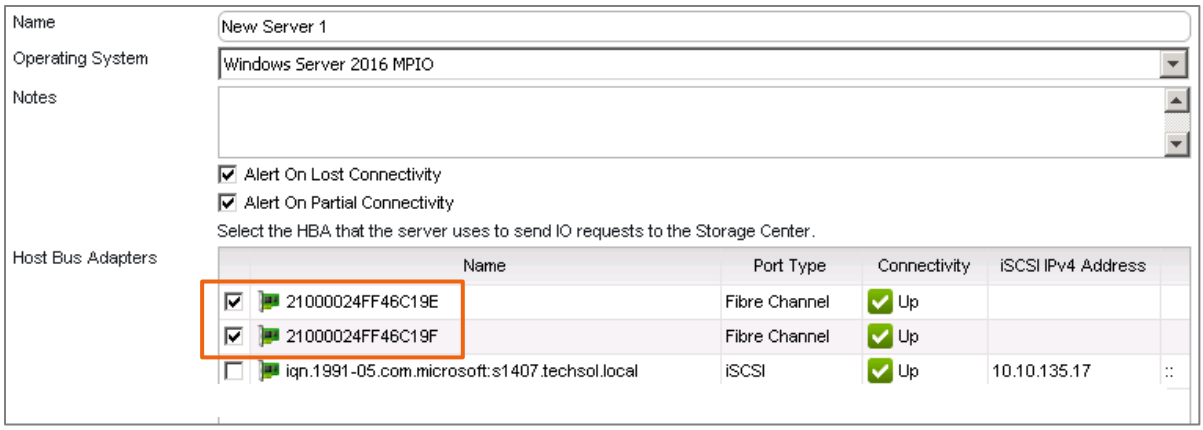
1. Verify that all the steps in the previous sections of this guide have been completed to prepare the Windows Server host for MPIO, and to prepare the storage network and fabric. The MPIO feature must be installed on the host server (see section 3).
2. Power on the Windows Server host.
3. Option 1: Enter the HBA firmware and perform a **Scan Fibre Devices** operation for each HBA. For QLogic HBAs, press **Ctrl + Q** at boot to enter the **Fast!UTIL** configuration utility. No devices should be found at this time.



4. Option 2: Allow the Windows Server host to boot to Windows. The FC HBAs should be visible to the fabric by simply booting the server if all perquisite steps in this guide have been completed. If not, re-attempt with option 1 and perform troubleshooting as necessary.
5. Connect to the desired SC Series array using the Dell Storage Manager client.
6. Under **Hardware**, expand the **Servers** folder to the desired location.
7. Right-click the desired folder and select **Create Server.**
8. The WWN for each unassigned HBA should be listed as available. If more HBAs are listed (HBAs that are installed in other hosts for example), only select the HBAs that are specific to this Windows Server host. In this example, the Windows Server host has a FC card with two HBAs, so two HBAs are listed as available in the wizard. Once available HBAs are assigned to a server object, the Dell Storage Manager client will no longer list the HBAs as available.

9. If the Windows Server host HBAs are not listed but should be, troubleshoot the issue. Once resolved, repeat the steps in this section.

Note: Although HBAs can added by manually typing in the WWN (if the server or HBA is off line for example), this is not advised. Mapping HBAs that are visible is highly recommended as a best practice because it helps to confirm correct configuration of the Windows Server host, HBAs, and the storage network.

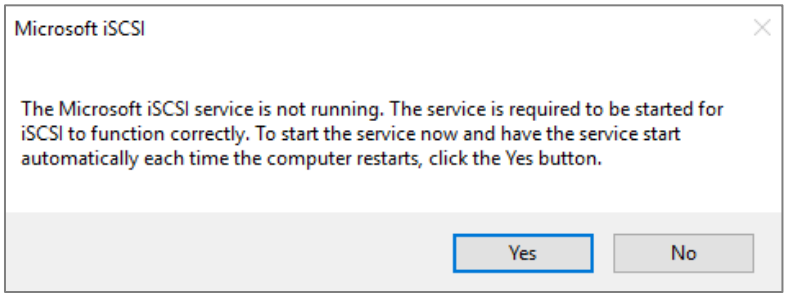


10. Once created, verify that the SC Series server object lists the HBAs with a status of **Up**.
11. Proceed to section 8 to map an SC Series volume to the Windows Server host.

7.2.3 iSCSI manual configuration

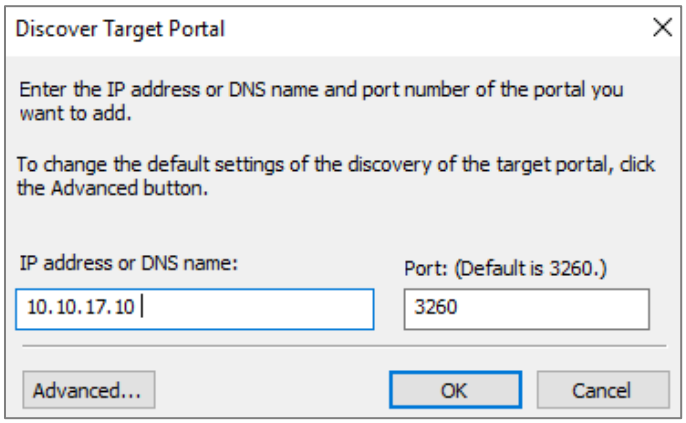
To create a server object manually when a Windows Server host has iSCSI NICs, follow these steps:

1. Verify that all the steps in the previous sections of this guide have been completed to prepare the Windows Server host for MPIO, and to prepare the storage network. The MPIO feature must be installed on the host server with support for iSCSI devices enabled (see sections 3 and 3.3)
2. Log in to Windows on the host server.
3. Click **Start** > **Administrative Tools** > **iSCSI Initiator**. Click **Yes** if prompted to start the iSCSI service.

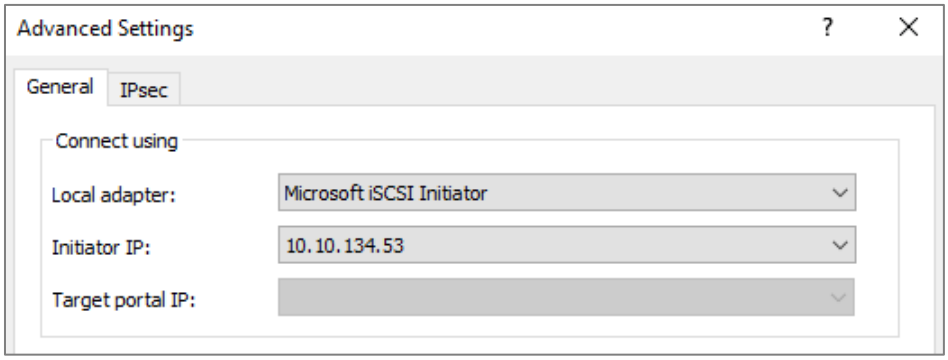


4. Select the **Discovery** tab and click **Discover Portal**.

5. Enter the target IP address for the control port for first iSCSI Fault Domain on the SC Series array. In this example, the target IP is 10.10.17.10. Click **Advanced**.

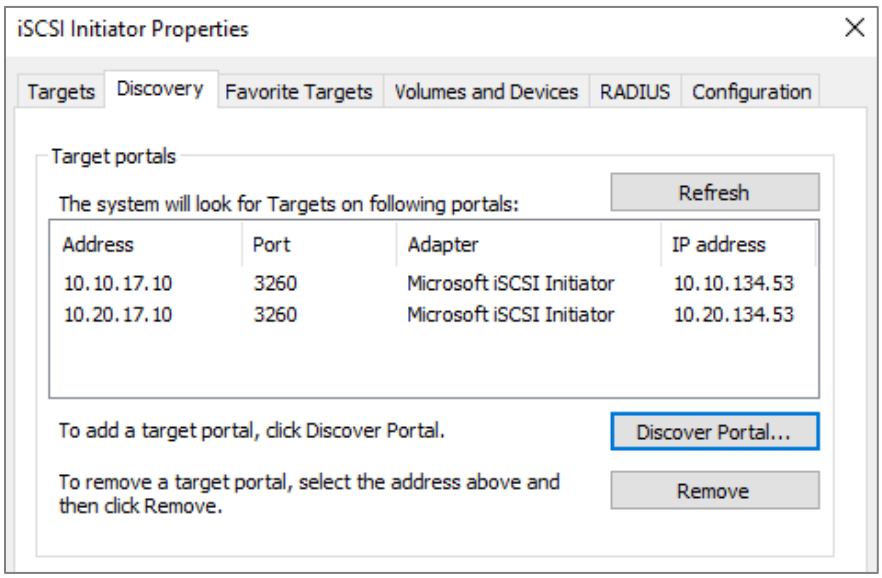


6. Set **Local adapter** to **Microsoft iSCSI Initiator**, and **Initiator IP** to the local IP address of the server NIC that is on the same subnet or VLAN as the target IP in step 5. The iSCSI initiator (host) IP in this example is 10.10.134.53.

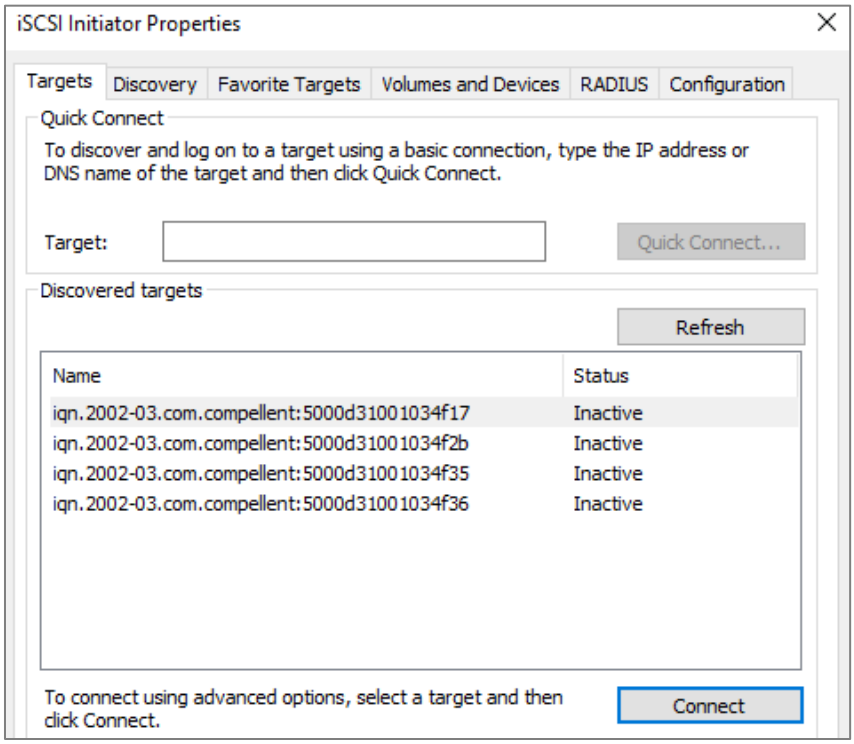


7. Click **OK** twice to return to the iSCSI Initiator properties window.
8. Verify that the target and initiator IPs are listed in the **Target portals** window.
9. Repeat steps 3–8 to configure the iSCSI target and initiator IPs for the second iSCSI fault domain.

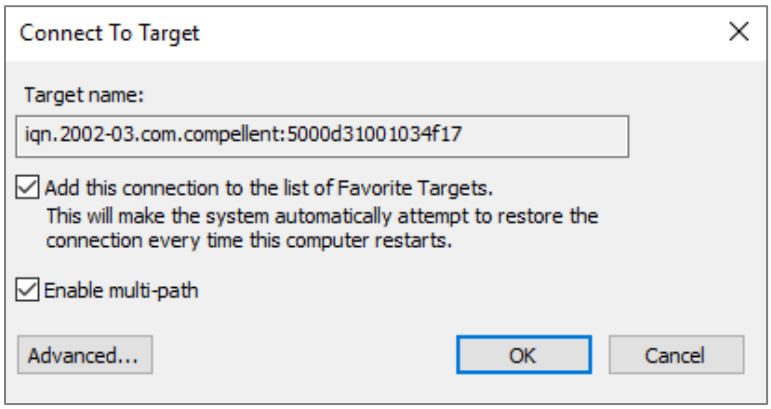
10. When completed, verify that both sets of iSCSI target IPs (left) and initiator IPs (right) are listed.



11. Select the **Targets** tab. This should be populated with the discovered iSCSI target ports on the SC array, with a status of **Inactive**.
12. Click the first target to select it and click **Connect**.

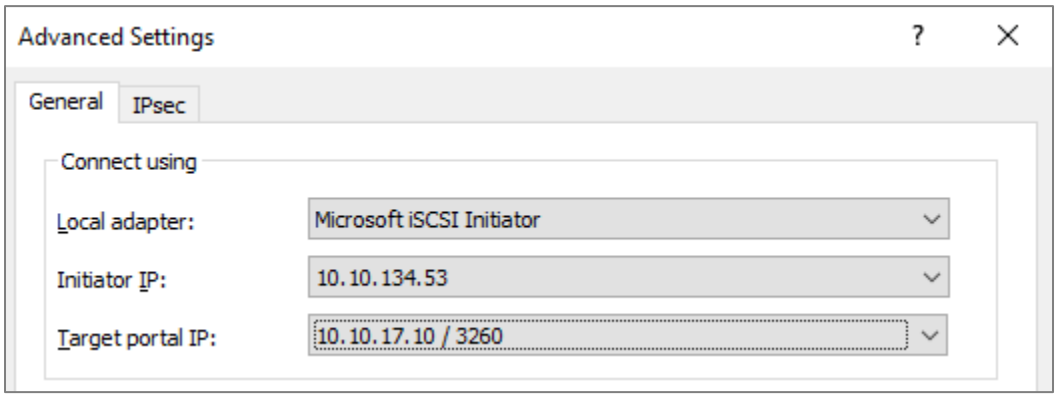


13. Check the box to **Enable multi-path.** The option **Add this connection…** should already be selected.
14. Click **Advanced**.



15. Using the drop-down lists, do the following:

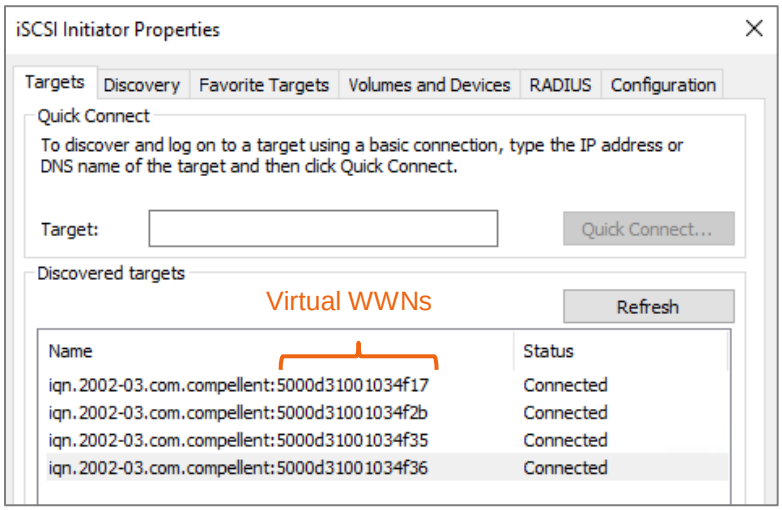
    a. Set **Local adapter** to **Microsoft iSCSI Initiator**.
    b. Select the **Target portal IP** address.
    c. Select the matching **Initiator IP** (host server iSCSI IP) address. Make sure the target and initiator IPs are in the same network or VLAN.

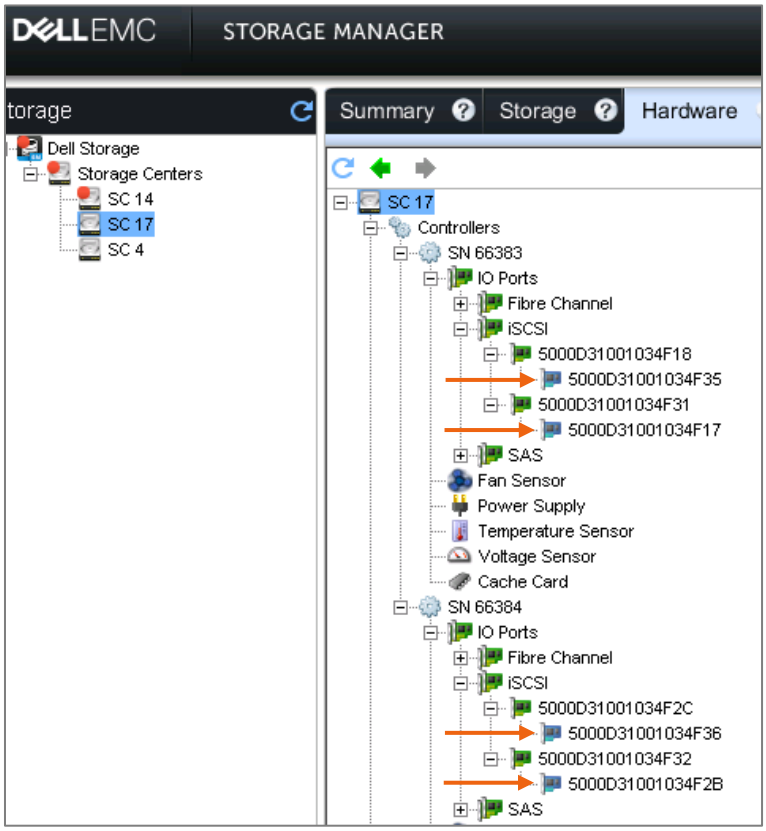


    d. Click **OK** twice to return to the iSCSI Initiator properties window.

16. Repeat steps 12–15 to connect each additional target.

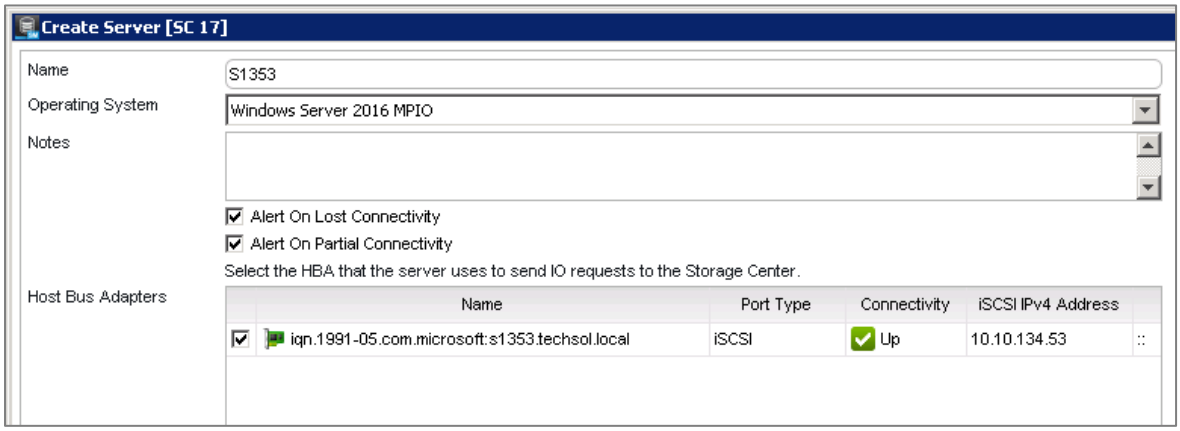
17. When finished, verify that all targets show with a status of **Connected**. Each target name includes a virtual WWN that corresponds with a matching virtual iSCSI port on the SC Series array.



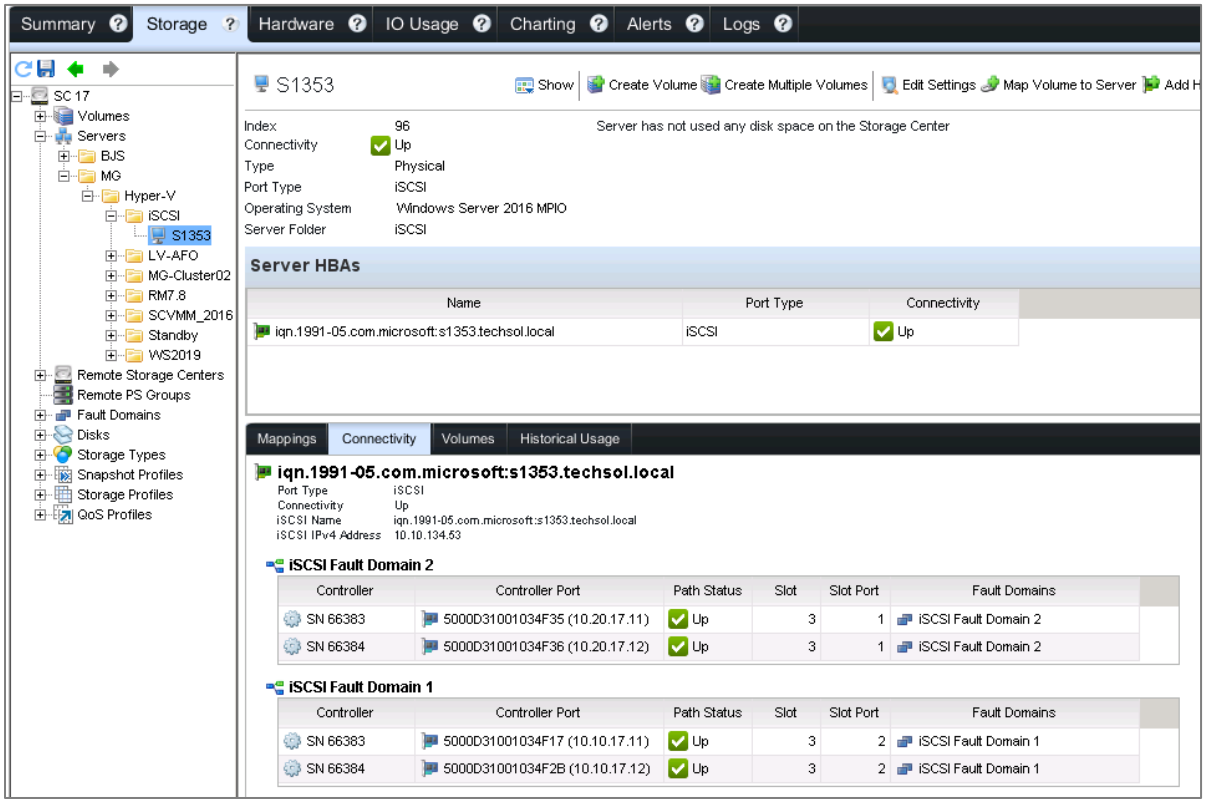


18. Click **OK** to exit the iSCSI Initiator Properties window.
19. Log in to the desired SC Series array using the Dell Storage Manager client.
20. Under the **Storage** tab, expand the **Servers** folder to the desired location.
21. Right-click the desired folder and select **Create Server.**

22. Under **Host Bus Adapter**, select the iSCSI control port for the host server. If the expected port is not listed, refresh the Dell Storage Manager client. With older versions of SCOS, the wizard may display two iSCSI HBAs for the host server. If so, select both.



23. Once created, verify that the server object lists the iSCSI HBA and the controller ports under each fault domain under the **Connectivity** tab with a status of **Up**.

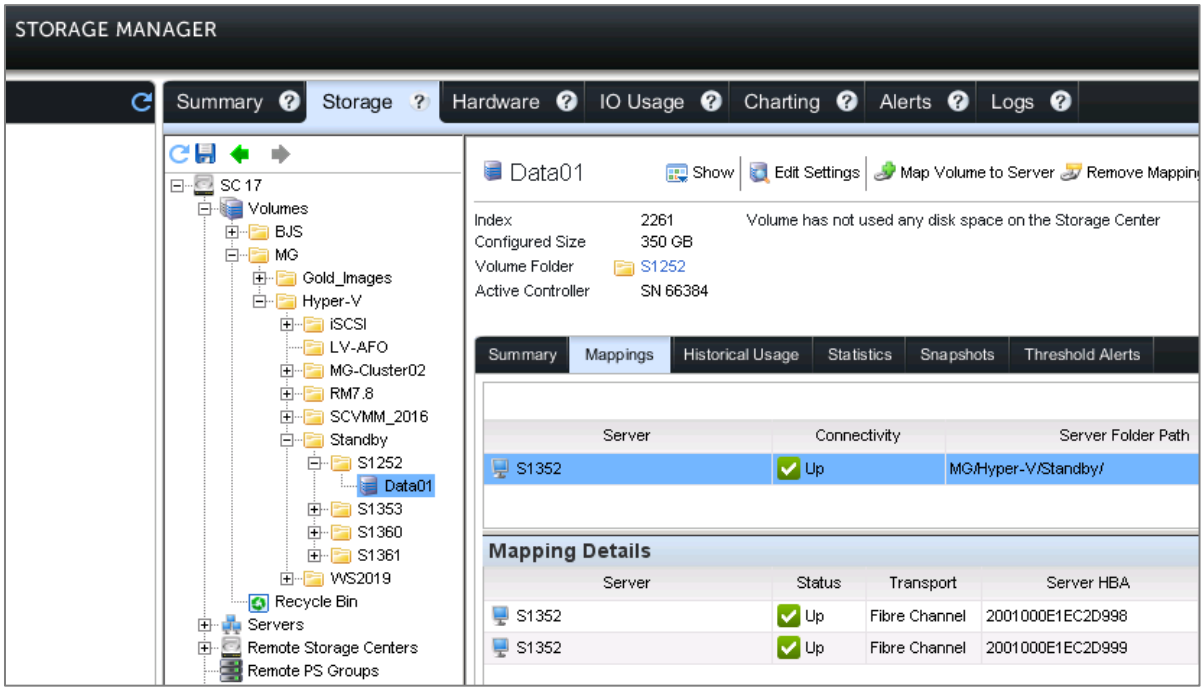


24. Go to section 8 to create and map storage from the SC Series to the server.

8 Present SC Series storage and apply the Microsoft DSM

Verify that all the steps in the previous sections of this guide have been completed before attempting to present SC Series storage to a Windows Server host that is configured for MPIO.

1. Use the Dell Storage Manager client to create a new volume on the SC Series array.
2. Map this SC Series volume to the Windows Server host as a new SAS-FE, FC, or iSCSI LUN. In the example below, a volume named **Data01** is mapped to host S1352 that has two FC HBAs.



Note: If a server is configured to use multiple transports (FC and iSCSI at the same time), see section 9 for additional guidance.

3. After the volume is mapped, launch **Disk Management** on the Windows Server and perform **Action > Rescan Disks.**
4. The host will detect the new LUN as offline and unallocated.

8.1 A single volume instance is displayed in Disk Management

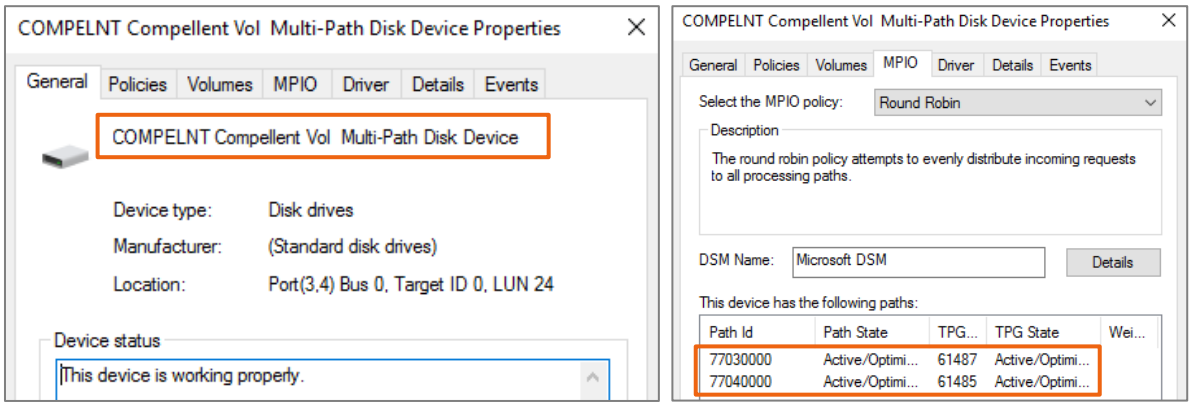
This section describes when a single-volume instance is displayed in Disk Management, which will be the case in one of the following scenarios:

- The server is intentionally limited to a single path (possible, but not recommended, unless for a temporary reason)
- The Microsoft DSM is already applied

In either case, perform the following steps.

1. Bring the disk online, initialize it, and format it.
2. Right-click the disk (not the volume) and select **Properties**.
3. The **General** tab should list the disk as a **COMPENLT Compellent Vol Multi-Path Disk Device**.

4. The **MPIO** tab will show the default MPIO policy for the transport, the DSM as **Microsoft DSM**, and two or more paths. If the server is configured to use single path, the **MPIO** tab is not present.



5. Configure MPIO timeout settings.

Note: The MPIO timeout settings and hotfixes are required with SC Series storage even if the server is configured to use single-path.

   a. If the Windows Server was configured automatically by using the Dell Storage Manager Client (see section 7.1), see appendix A for additional MPIO settings and hotfixes that may be needed for the Windows Server OS and transport.
   b. If the Windows Server was configured manually, apply the applicable MPIO timeout settings and hotfixes listed in appendix A manually.

6. Reboot the server after making registry changes or applying hotfixes.

8.2 Duplicate volume instances are listed in Disk Management

This section describes how to resolve duplicate volume instances by applying the Microsoft DSM to SC Series volumes to support MPIO. This is required when multiple instances of the same disk are listed in Disk Management.

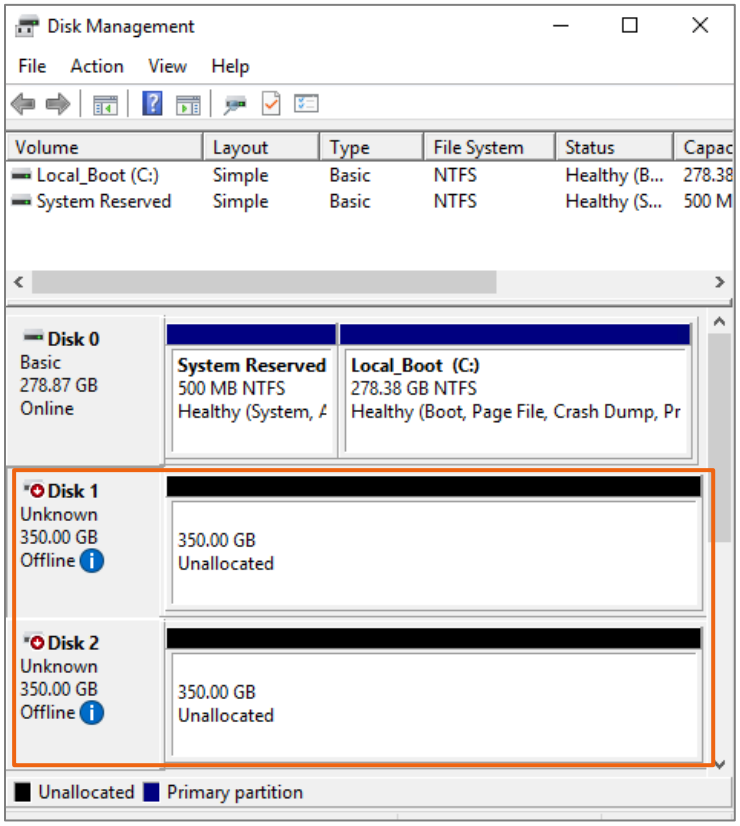


Figure 16 Multiple instances of the same disk requires the Micrsoft DSM to be applied on the host server

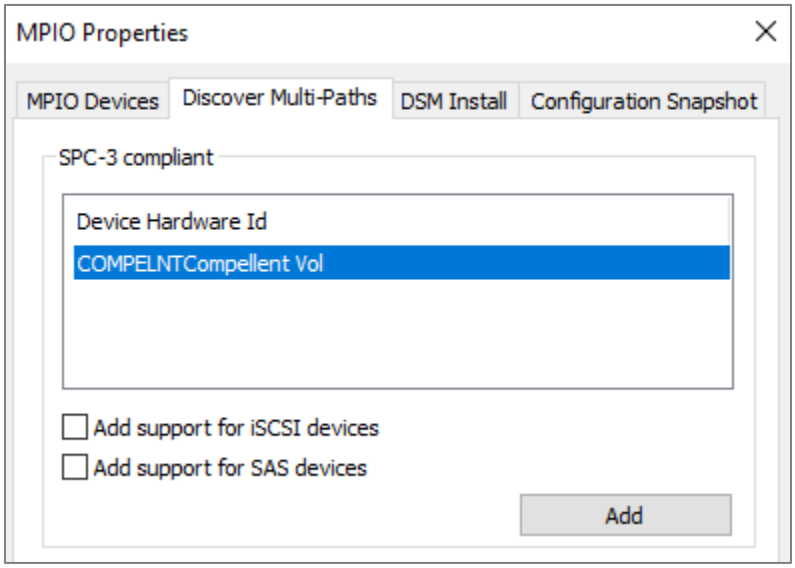
The Microsoft DSM can be applied using the MPIO utility (GUI), PowerShell, or MPCLAIM (cmd line).

8.2.1 Apply MS-DSM with the MPIO utility (GUI):

On the Windows Server OS, perform these steps:

1. Launch the **MPIO** management tool and click the **Discover Multi-Paths** tab.
2. For a SAS or iSCSI configuration, check either **Add support for SAS devices** or **Add support for SCSI devices** as appropriate and click **Add.** This step should have already been completed earlier (see section 3.3) assuming the steps in this guide were followed in order.

3. For a FC configuration, click **COMPELNTCompellent Vol** and click **Add**.



4. Reboot the server when prompted (required).

8.2.2 Apply the MS-DSM with PowerShell (Windows Server 2012 and later)

Windows Server 2012 or later includes the MPIO module in Windows PowerShell. Although the MPCLAIM command is included in Windows Server 2012 and above, Microsoft recommends using PowerShell.

To associate the SC Series volumes with the Microsoft DSM with PowerShell, follow these steps:

1. Open a PowerShell window with elevated (administrator) privileges.
2. On Windows Server Core installations, type **powershell** and press **Enter** at the command prompt.
3. At the PowerShell prompt, enter the following:

```
New-MSDSMSupportedHW –VendorID "COMPELNT" –ProductID "Compellent Vol"
```

4. SC Series storage is now supported through the Microsoft DSM. To claim all available SC Series volumes to be used by MPIO, enter the following command:

```
Update-MPIOClaimedHW –Confirm:$false
```

5. To reboot the server (required), enter the following command:

```
shutdown –r –t 0
```

8.2.3 Apply the MS-DSM with MPCLAIM

This command provides the same result as the MPIO configuration utility (GUI) or PowerShell. It associates SC Series volumes with the Microsoft DSM and then reboots the server.

1. Open a command prompt with elevated (administrator) privileges.
2. Enter the following command. If rebooting later is desired, substitute **-n** in place of **–r**.

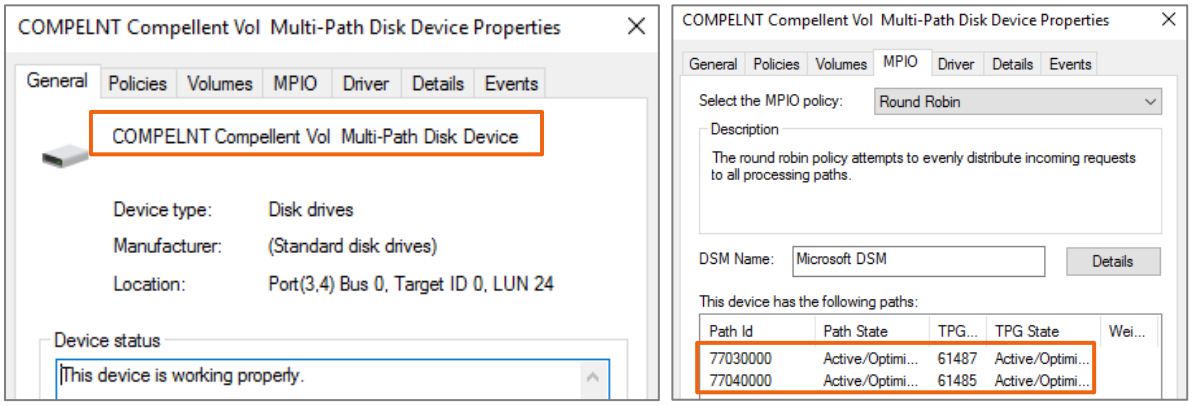
```
mpclaim.exe -r -i -d "COMPELNTCompellent Vol"
```

3. Once the server reboots, use Disk Management to verify that the configuration is correct. There should only be one instance of the SAN volume listed in Disk Management.

8.2.4 Verify single instance of the disk

To verify that there is now a single instance of the SC volume, complete these steps:

1. Log in to Windows and launch **Disk Management**.
2. Only one instance of the disk should now be listed.
3. Bring the disk online, initialize it, and format it.
4. Right-click the disk (not the volume) and select **Properties**.
5. The **General** tab should list the disk as a **COMPENLT Compellent Vol Multi-Path Disk Device**.
6. The **MPIO** tab will show the default MPIO policy for the given transport, the DSM as **Microsoft DSM**, and two or more paths. If the server is configured to use single path, the **MPIO** tab is not present.



7. Proceed to appendix A to configure MPIO timeout settings and apply hotfixes. This also applies to servers configured to run with a single path to SC Series storage.
8. Reboot the server after making registry changes or applying hotfixes.

9 Multiple transports and volume mapping

On an SC Series array that is configured to use multiple front-end transports concurrently, mapping volumes to host servers using multiple transports is supported, however, there is limited Windows Server support.

For example, if the SC Series array and a host server both support FC and iSCSI, when mapping a new volume to the host, all available FC and iSCSI paths will be mapped by default.

9.1 Limited Windows Server support

Using mixed transports concurrently on the same Windows volume has limited Microsoft support and should generally be avoided, unless there is a good reason (usually, temporary) to do so.

With Windows Server 2012 R2 and newer, when an SC Series volume is mapped to a host server using multiple transports (for example, FC and iSCSI concurrently) Windows Server will use an algorithm to arbitrarily choose a preferred transport (typically Fibre Channel wins) and the host will ignore the other transport. The problem with this default Windows behavior is the risk of service interruption. If all paths for the preferred transport go down, the host will not start using the alternate transport without a manual disk re-scan or server reboot.

9.2 Use cases for multiple transports

A common reason for using multiple front-end transports at the same time is when an environment is in the process of migrating from one transport to another.

Regardless of the use case, the best practice is to only use a single transport for any given volume. A host could have one volume mapped using FC, and another volume mapped with iSCSI. Windows treats each volume independently from the standpoint of the transport used.

9.3 Configure a volume to use a single transport

When multiple transports are available, limit volume mappings to a single transport by following these steps:

1. Log in to the Dell Storage Manager client.
2. On the SC Series array under the **Storage** tab, expand **Volumes** and locate the desired volume.
3. Right-click the volume and select **Map Volume to Server**. The **Map Volume to Server** window appears.
4. Select a server to map the volume to and click **Next**.
5. Click **Advanced Options**.
6. Under **Restrict Mapping Paths**, uncheck the box to **Map to All Available Server Ports**.
7. Select one of the following:

    a. **Map using specific server ports** (check the specific server ports desired).
    b. **Limit ports by transport type** (available only if the SC Series array is configured for multiple transports; select the desired transport from the drop-down menu).

10 Change the default load balance policy

Once SC Series volumes are associated with the Microsoft DSM on a Windows server, no further steps are necessary unless changing the Windows default MPIO load balance policy is necessary.

The best practice recommendation is to allow Windows Server to detect and use the appropriate load balance policy for SC Series volumes. Changing the default policy to an optional policy is discouraged. The default will be either round robin or round robin with subset depending on the use case. In cases where administrators need to change the default load balance policy on a Windows Server to an optional policy, this can be done on a system-wide or on a per-volume basis.

The supported Windows Server MPIO policies are as follows:

- SCOS 6.5 and earlier: round robin (default) and failover only
- SCOS 6.6 and later: round robin (default), failover only, and least queue depth
- Live Volume ALUA (with SCOS 7.3 and later): round robin with subset (default) and failover only (volumes not configured as Live Volumes default to round robin)
  - Windows Server 2016 with the March 2018 cumulative update and newer offers full support for Live Volume ALUA with SCOS 7.3 and later
  - Windows Server versions prior to 2016 with the March 2018 cumulative update offer limited support for Live Volume ALUA. For more information, see the document, Dell EMC SC Series Storage: Synchronous Replication and Live Volume
- SAS FE: round robin with subset (default), failover only, least queue depth, and weighted paths

Note: Some optional MPIO polices (such as least blocks) may not be listed supported because they were not subject to formal testing. If an optional policy is not listed as supported but there is a valid reason for using it, validate the behavior and performance of the policy in a test environment before using it in production.

A Windows Server host will default to either round robin or round robin with subset automatically based on the volume use case. To change the system-wide Windows default MPIO load balance policy to an optional policy such as failover only, use MPCLAIM or PowerShell.

10.1 MPCLAIM command

To use the MPCLAIM command to change the default load balance policy to an optional policy as the default, open a command prompt with elevated (administrator) privileges and enter the following:

```
mpclaim.exe -L -M <0-7> -d "COMPELNTCompellent Vol"
```

<0-7> refers to the desired load balance policy as shown in Table 1.

Table 1 MPCLAIM load balance options

Parameter	Definition
0	Clear the policy
1	Failover only
2	Round robin
3	Round robin with subset

Parameter	Definition
4	Least queue depth
5	Weighted paths
6	Least blocks
7	Vendor specific

For example, to change all SC Series volumes to a failover only policy, enter the following command:

```
mpclaim.exe -L -M 1 -d "COMPELNTCompellent Vol"
```

10.2 PowerShell (Windows Server 2012 or later)

Use the MPIO module in PowerShell to change the host server default load balance policy.

Open a PowerShell window with elevated (administrator) privilege. See the following examples.

Example 1: Change the default load balance policy from round robin (RR) to failover only (FOO):

```
Set-MSDSMGlobalDefaultLoadBalancePolicy –Policy "FOO"
```

Example 2: Change the default load balancing back to round robin:

```
Set-MSDSMGlobalDefaultLoadBalancePolicy –Policy "RR"
```

Verify the default load balance policy:

```
Get-MSDSMGlobalDefaultLoadBalancePolicy
```

- If the default policy is set to round robin, **RR** is returned.
- If the default policy is set to failover only, **FOO** is returned.

10.3 Per-volume load-balancing settings

The MPIO load balance policy can also be changed on a per-volume basis. This allows organizations with different workloads on different volumes with different load-balancing requirements to run on the same server. Use Disk Management or the MPCLAIM utility to change the per-volume policy.

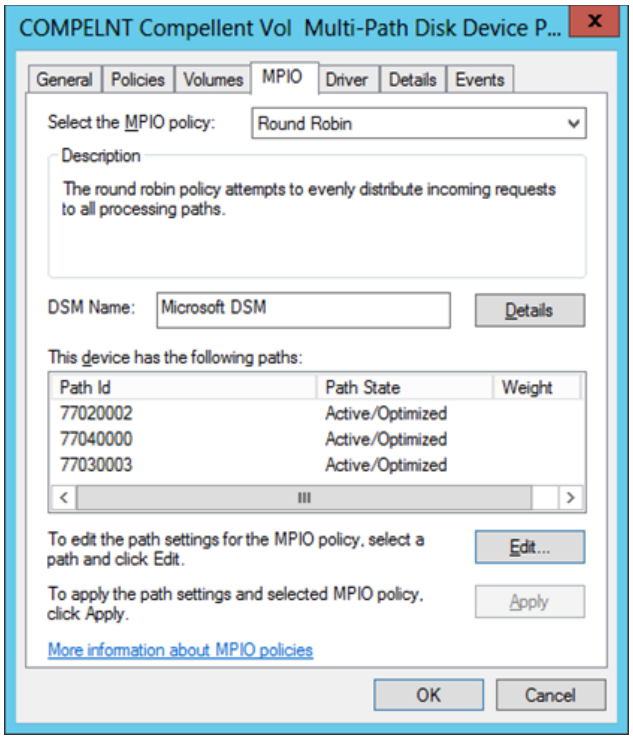
Note: The PowerShell MPIO module does not include cmdlets that can change the default load balance policy on a specific volume.

10.3.1 Disk Management GUI

1. Go to **Start > Administrative Tools > Computer Management**.
2. On the left, expand **Storage** and click **Disk Management**.
3. Right-click the desired disk number and select **Properties**.
4. Select the **MPIO** tab.

5. From the drop-down menu, select the desired MPIO policy for the volume.

Note: If a host server defaults to round robin for a volume use case, attempting to select round robin with subset will result in the policy reverting to back to round robin. The reverse is also true if a host server defaults to round robin with subset for a volume use case. Attempting to select round robin will result in the policy reverting back to round robin with subset.



10.3.2 MPCLAIM command

To change the default load balance policy on a single volume to an optional policy, open a command prompt or PowerShell window with elevated (administrator) privileges (commands will work in both).

Note: The load balance policy cannot be changed from round robin to failover only using the MPCLAIM command. MPCLAIM only supports switching from failover only to round robin.

To list all MPIO volumes on the system, enter the following:

```
mpclaim -s -d
```

In this example, the load balance policy is set to round robin (RR) for disks 0 and 1; and to failover only (FOO) for disk 2.

```
PS C:\Windows\system32> mpclaim -s -d

For more information about a particular disk, use 'mpclaim -s -d #' where # is the MPIO disk number.

MPIO Disk     System Disk  LB Policy    DSM Name
-------------------------------------------------------------------------------
MPIO Disk2    Disk 2       FOO          Microsoft DSM
MPIO Disk1    Disk 1       RR           Microsoft DSM
MPIO Disk0    Disk 0       RR           Microsoft DSM
PS C:\Windows\system32> _
```

Figure 17 Use MPCLAIM to list MPIO volumes

The syntax to change the load balance policy on a specific volume is as follows:

```
mpclaim -l -d <disk #> <0-7>
```

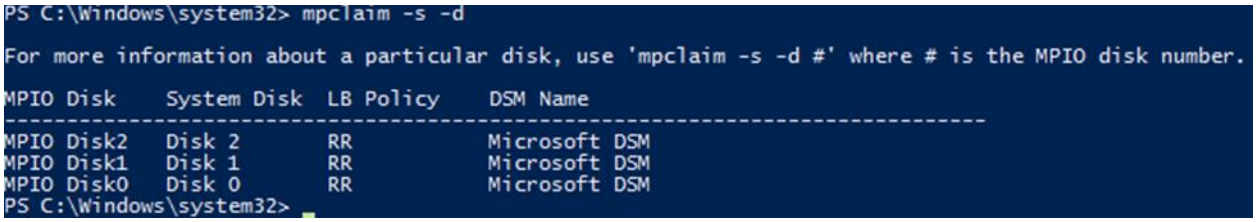
Refer to Table 1 for a list of load balance policies and the associated numbers for the MPCLAIM command.

To change the load balance policy of MPIO disk 2 from failover only to round robin, enter:

```
mpclaim -l -d 2 2
```

To verify the new settings, enter:

```
mpclaim -s -d
```



Visit the Microsoft Documentation Library for more information about using MPCLAIM.

11 Boot-from-SAN

SC Series storage supports boot-from-SAN when hosts are equipped with a supported FC or iSCSI MPIO card that supports a boot-from-SAN configuration.

Note: Booting from a DAS volume with SAS-FE is not supported with SC Series.

11.1 Boot-from-SAN advantages

- Use SC Series snapshots of boot volumes for quick recovery.
- Replicate boot volumes to another SC Series array at remote location to enhanced disaster recovery (DR) protection when both sites use similar hardware for server hosts.
- Leverage View Volumes created from a gold-image source volume on the SC Series to quickly provision new boot-from-SAN volumes for other Windows Server hosts.

11.2 Boot from local disk advantages

- Allow critical roles such as a domain controller to remain online during SAN or fabric maintenance or unplanned outages.
- Allow the Dell Storage Manager or Unisphere™ Central for SC Series Data Collector role to stay online (for troubleshooting purposes) regardless of the state of the SC Series array or fabric.

11.3 Boot-from-SAN configuration steps

Of necessity, a boot-from-SAN configuration requires modifying the logical order of some of the steps presented in this guide. The Windows Server OS is installed after a bootable LUN is presented from the SC Series array to the host server. The result will still be a resilient and optimized MPIO configuration, assuming no important configuration steps are omitted.

For a boot-from-SAN configuration, follow the sections of this guide in order, except for the following modifications:

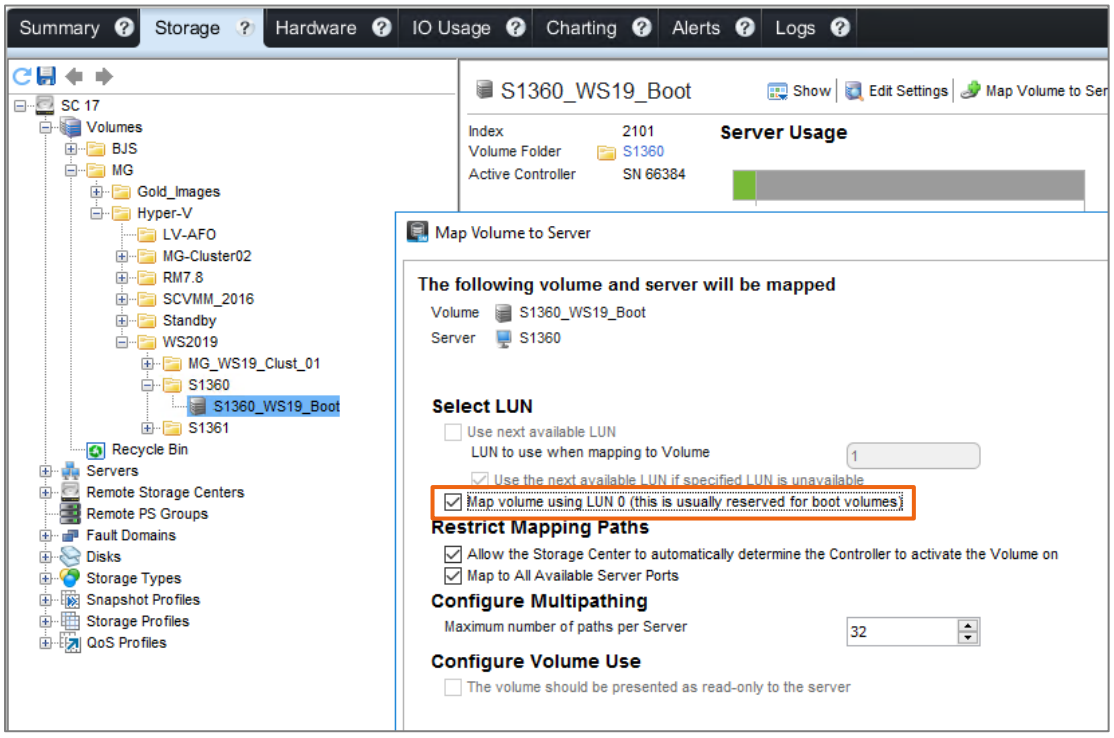
- Skip section 3 (the OS will be installed and patched after a boot volume is mapped as LUN 0).
- Skip section 4.3.2 (the latest Windows driver will be installed after the OS is installed).
- For section 7, manually configure a host server object on the SC Series array (automatic configuration is not possible when no OS installed on the host server).
- In place of section 8, follow the steps below to present SC Series storage as a boot volume as LUN 0.
- Stage the OS, install the MPIO feature, and apply the MS-DSM.
- Apply the OS patches and the latest OS drivers for the MPIO card.
- Manually adjust the MPIO timeouts and apply applicable hotfixes as listed in appendix A.

11.3.1 FC boot-from-SAN

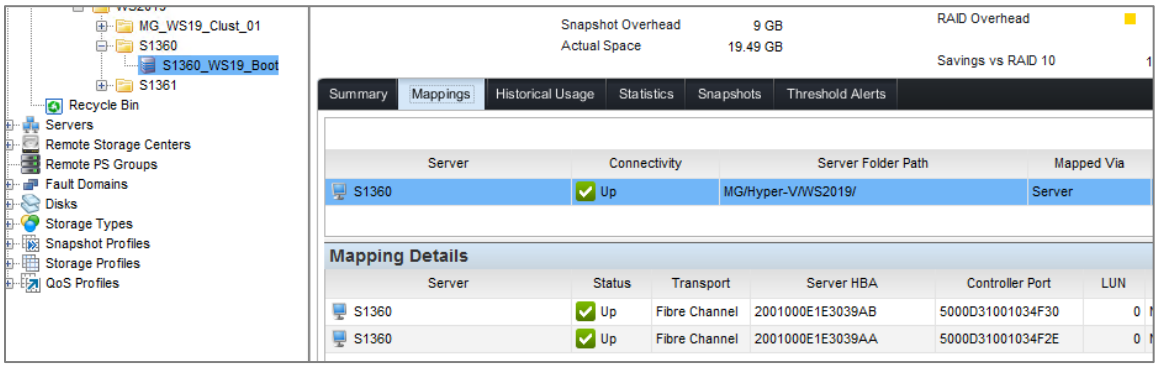
The example below will show how to configure a QLogic FC card to support boot from SAN. See the manufacturer documentation for how to configure boot-from-SAN for other supported FC or iSCSI MPIO cards.

1. Boot the server and press **Ctrl+Q** when prompted to access the **Fast!UTIL** utility.

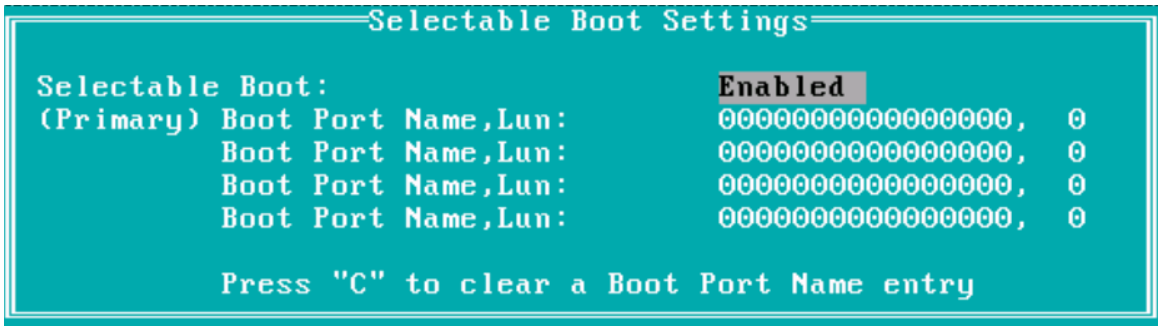
2. Verify correct firmware settings for each HBA (see section 5).
3. Verify that all fabric and zoning steps have been completed (see section 6).
4. Follow the steps in section 7 to manually configure an MPIO host server object on the SC Series array (section 7.2.2).
5. On the SC Series array, create a new LUN that will serve as the boot volume for the host, and map it to the host server object as LUN ID 0. No other SC Series volumes should be mapped to the host at this time.



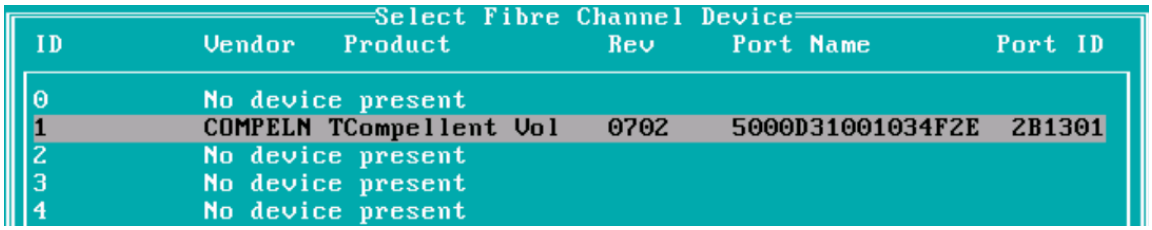
6. Once the boot volume is mapped as LUN 0, view the **Mappings** tab to verify the presence of all expected HBAs (two in this example) with a status of **Up**.



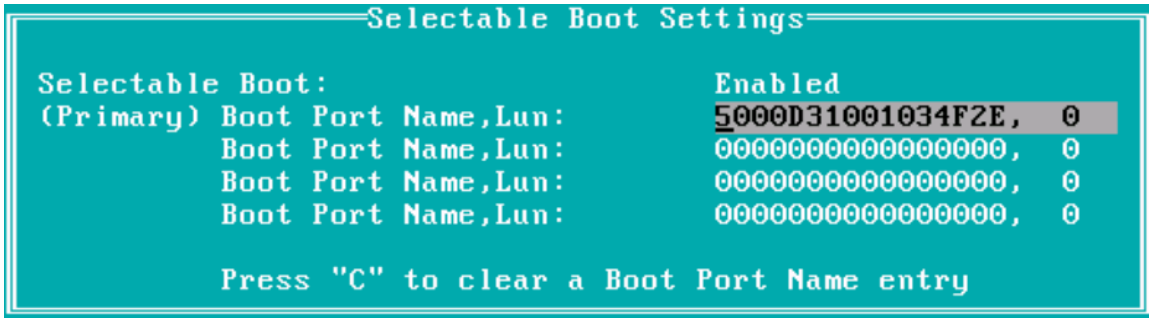
7. Using Fast!UTIL, go to **Selectable Boot Settings** for the first HBA and set **Selectable Boot** to **Enabled.**



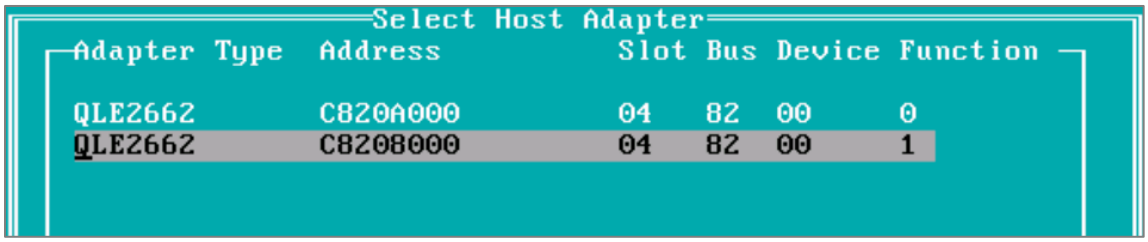
8. Arrow down to the first boot port and press **Enter**. One or more boot ports should be listed, depending on how many front-end ports are configured on your SC Series array. Arrow down to the first device until it is highlighted and press **Enter**.



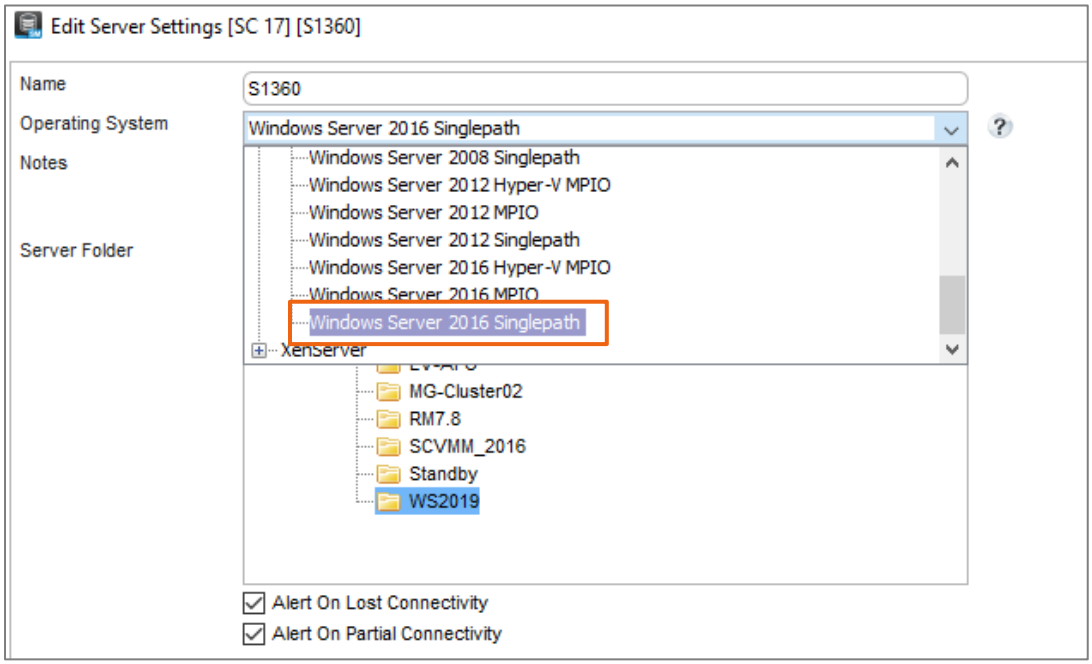
9. The first boot port should now be populated with a WWN.



10. If there is more than one boot port available, repeat this step until all boot ports for this adapter are added. In this example, there is one boot port for each HBA.
11. Save the changes.
12. On the **Fast!UTIL** main menu, select the next HBA port, repeat the above steps to add the boot ports, and save the changes. In this example, the FC card has two HBAs, each with a boot port defined.



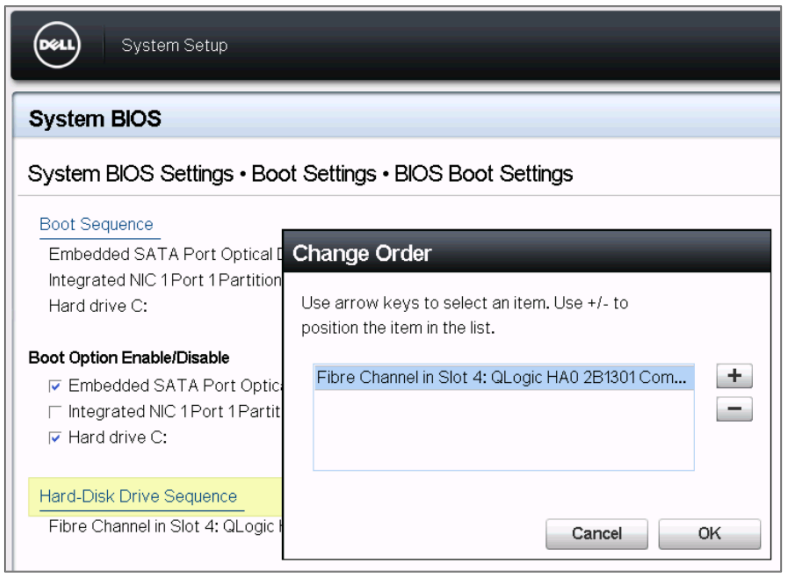
13. If the boot LUN was created from a gold image that has a sysprepped OS image that already has MPIO installed and configured (with MPIO timeouts and hotfixes applied), simply reboot the server and the host should boot from the LUN. No other steps are required for MPIO to work correctly.
14. If the LUN does not yet contain an OS, change the **Server Setting** on the SC Series from **MPIO** to **Single Path** temporarily until after the Windows Server OS is loaded and the MPIO feature is installed.



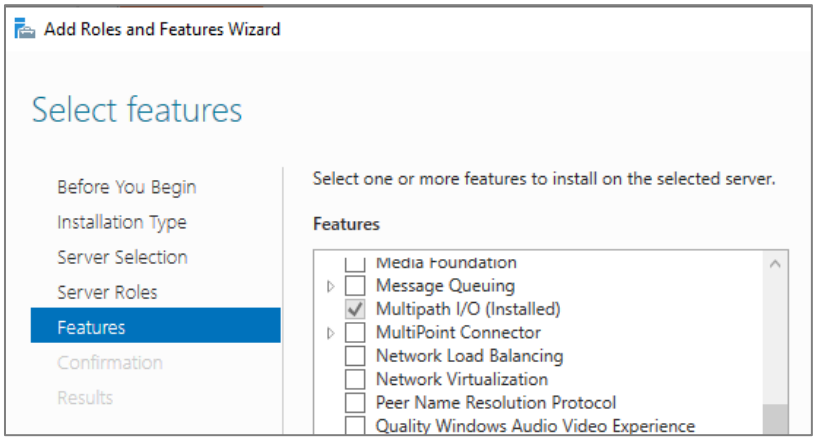
15. Modify the boot order in the host server BIOS or system setup (if required).

    Physical host servers with an internal RAID controller and local disks may be configured to boot locally or boot-from-SAN depending on the boot order. If a host server is configured to boot-from-SAN, it is a best practice to remove or disable the onboard RAID controller. This will prevent the host server from attempting to boot from a local disk if the SAN becomes unavailable. Some hosts will automatically detect available boot devices and will dynamically change the boot order from SAN to local disk if the SAN is temporarily unavailable. Manually changing the boot order in the host server BIOS from local disk back to SAN may be required after the SAN becomes available again. The

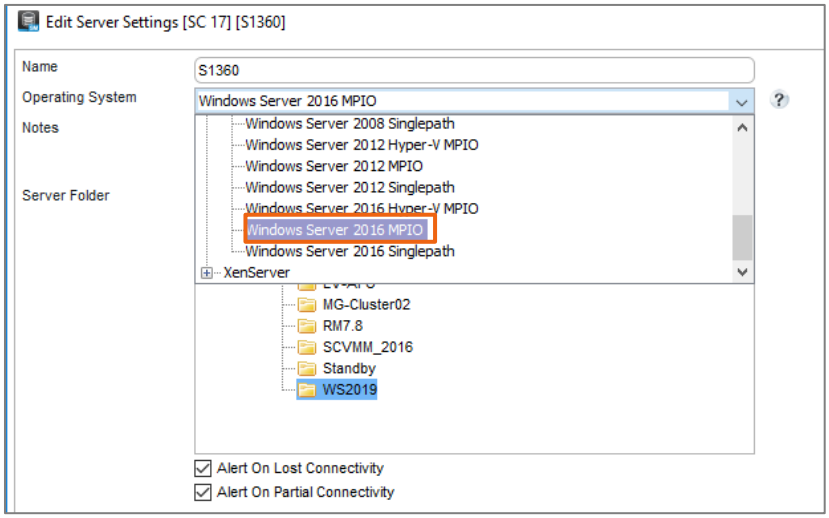
figure below shows the system setup of a Dell EMC PowerEdge server where a QLogic FC HBA is configured as the first boot device.



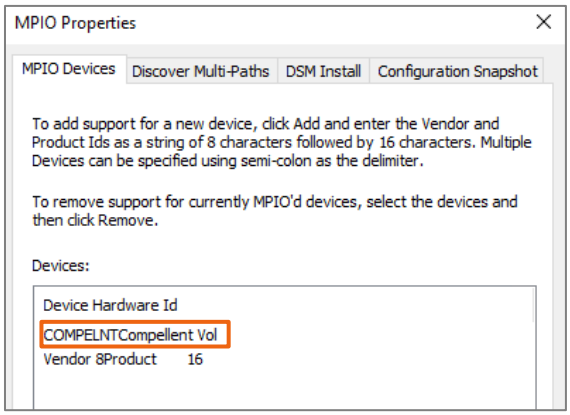
16. Stage an OS to LUN 0 following your preferred staging method. For PowerEdge servers, it is a best practice to leverage the LifeCycle controller to broker the OS install as this method will use the latest OS driver pack from Dell EMC.
17. Once the OS is installed and fully patched, install the Windows Server **MPIO** feature and reboot.



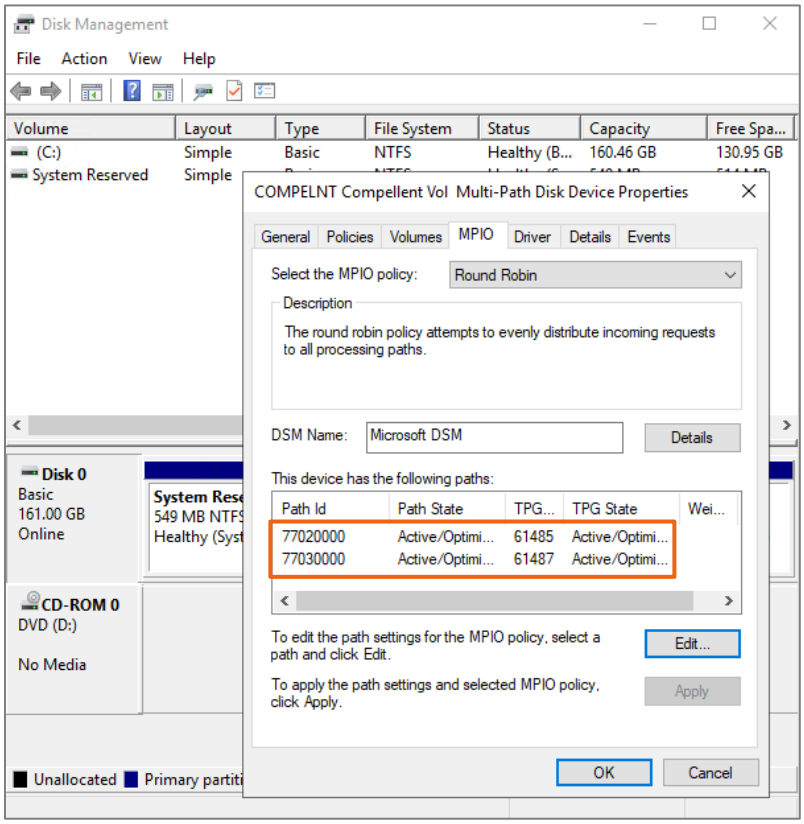
18. On the SC Series array, change the **Server Properties** for the host from **single path** back to **MPIO**.



19. Launch the **MPIO** feature on the host, and under **Discover Multi-Paths**, select and install the **COMPELNTCompellent Vol** item and reboot the host. It may be necessary to first perform a manual disk rescan using **Disk Management**, or a reboot of the host.
20. After rebooting, verify that this MPIO device is listed under the **MPIO Devices** tab on the host.



21. Verify that only one instance of the boot volume is listed in Disk Management, and that all expected paths are present. Where the default policy is round robin (typical), all paths will show as Active/Optimized.



22. Go to appendix A and adjust the MPIO timeout settings and apply hotfixes as applicable (even if the server is using single-path).

11.3.2 iSCSI boot-from-SAN

Consult the manufacturer documentation for your iSCSI card to configure boot-from-SAN.

A Windows Server single-path and MPIO configuration recommendations for SC Series storage

Observe the following guidelines before using this section.

- The recommended updates and hotfixes in this section list the names (msdsm.sys, mpio.sys, storport.sys, and msiscsi.sys) and modified dates of storage-specific files that are loaded when the associated update or hotfix is applied. If a newer version of the file listed is already loaded on the server, the recommended update or hotfix does not need to be loaded.
- In some cases, prerequisite updates must be installed on the server before the following hotfixes can be installed. Read the prerequisite information for each applicable hotfix before proceeding. Updates and hotfixes are listed in the order in which they should be installed.
- The following registry settings should be made on all Windows Server hosts that use the Microsoft DSM to access LUNs on SC Series arrays to ensure proper behavior and performance. This includes hosts configured to use single-path and MPIO.

A.1 Recommended updates and hotfixes for Windows Server 2008 R2 SP1

See the Microsoft Update Catalog to locate specific KB downloads.

Table 2 Recommended updates and hotfixes for Windows Server 2008 R2 SP1

KB number	Title	Link
KB3125574	Convenience rollup update for Windows 7 SP1 and Windows Server 2008 R2 SP1 (May 2016) **msdsm.sys** version 6.1.7601.23403 (3/25/16) **mpio.sys** version 6.1.7601.23403 (3/25/16) **msiscsi.sys** version 6.1.7601.23403 (3/25/16) **storport.sys** version 6.1.7601.23403 (3/25/16)	http://support.microsoft.com/kb/3125574

A.2 Recommended updates and hotfixes for Windows Server 2012 (non-R2 version)

See the Microsoft Update Catalog to locate specific KB downloads.

Table 3 Recommended updates and hotfixes for Windows Server 2012 (non-R2 version)

KB number	Title	Link
KB3018489	"No host bus adapter is present" error when querying SAS cable issues in Windows Server 2012 R2 or Windows Server 2012 **storport.sys** version 6.2.9200.17188 (11/19/14)	http://support.microsoft.com/kb/3018489
KB3046101	Server may freeze during startup when ALUA-capable storage is used in Windows Server 2012 R2 or Windows Server 2012 **mpio.sys** version 6.2.9200.17071 (8/5/14) **msdsm.sys** version 6.2.9200.17362 (5/6/15)	http://support.microsoft.com/kb/3046101
KB3102997	Data is corrupted after iSCSI sessions or paths recover in Windows Server 2012 R2 or Windows Server 2012 **msiscsi.sys** version 6.2.9200.21687 (11/8/15)	http://support.microsoft.com/kb/3102997

A.3 Recommended updates and hotfixes for Windows Server 2012 R2/2016

Microsoft publishes updates for Windows Server 2012 R2 and Windows Server 2016 cumulatively. Any updates for storage-related files are included in the monthly cumulative updates. Apply the latest monthly cumulative update from Microsoft to ensure that the storage-related files msdsm.sys, mpio.sys, msiscsi.sys and storport.sys stay current.

See the Microsoft Update Catalog at to locate specific KB downloads.

A.4 Recommended registry settings for Windows Server

The recommend registry settings listed in this section can be applied using the registry editor (regedit.exe) or through PowerShell. The registry editor can be used on all versions of Windows Server Desktop (Windows Server with a GUI).

Note: Recommended registry settings apply to all versions of Windows Server unless directly specified.

Table 4 Recommended registry settings location: HKLM\SYSTEM\CurrentControlSet\Services\mpio\Parameters

Setting name	Description	Default value	Recommended value
PDORemovePeriod	This setting controls the number of seconds that the multipath pseudo-LUN remains in system memory, even after losing all paths to the device. When this timer value is exceeded, pending I/O operations will be failed, and the failure is exposed to the application rather than attempting to continue to recover active paths. The maximum time allowed is MAXULONG (49,000 seconds).	20	120
PathRecoveryInterval	This represents the period after which PathRecovery is attempted. This setting is only used if it is not set to 0 and UseCustomPathRecoveryInterval is set to 1.	40	25
UseCustomPathRecoveryInterval	If this key exists and is set to 1, it allows the use of PathRecoveryInterval.	0	1
PathVerifyEnabled	This flag enables path verification by MPIO on all paths every N seconds (where N depends on the value set in PathVerificationPeriod). This Boolean function must be filled with either 0 (disable) or 1 (enable). By default, it is disabled.	0	1
PathVerificationPeriod	This setting is used to indicate the number of seconds with which MPIO has been requested to perform path verification. This field is only honored if PathVerifyEnabled is TRUE. This timer is specified in seconds. The default is 30 seconds. The maximum allowed is MAXULONG.	30	no change
RetryCount	This setting specifies the number of times a failed I/O if the DSM determines that a failing request must be retried. This is invoked when DsmInterpretError() returns Retry = TRUE. The default setting is 3.	3	no change (FC or iSCSI systems) 15 (front-end SAS systems only)

Setting name	Description	Default value	Recommended value
RetryInterval	This setting specifies the interval of time (in seconds) after which a failed request is retried (after the DSM has decided so, and assuming that the I/O has been retried a fewer number of times than RetryCount). This value is specified in seconds. The default is 1 second.	1	no change

Note: The registry settings in Table 5 need to be created on a Windows Server 2008 R2 server. Both settings should be created as DWORD (32-bit) values.

Table 5 Recommended disk registry settings location: HKLM\SYSTEM\CurrentControlSet\Services\mpio\Parameters

Setting name	Description	Default value	Recommended value
DiskPathCheckEnabled	If the DiskPathCheckEnabled key is set to a nonzero value, the MPIO component creates a path recovery worker.	-	1
DiskPathCheckInterval	If the DiskPathCheckInterval key is set to 0, or if the key does not exist, the MPIO component uses a default time interval. The default time interval is half of the time that is set in the PDORemovePeriod parameter.	-	25

Note: The registry settings in Table 6 only apply to Windows Server 2012 or later.

Table 6 Recommended disk registry settings location: HKLM\SYSTEM\CurrentControlSet\Services\mpio\Parameters

Setting name	Description	Default value	Recommended value
DiskPathCheckDisabled	If the DiskPathCheckDisabled key is set to zero, the MPIO component creates a path recovery worker.	0	no change
DiskPathCheckInterval	If the DiskPathCheckInterval key is set to 0, or if the key does not exist, the MPIO component uses a default time interval. The default time interval is half of the time that is set in the PDORemovePeriod parameter.	10	25

Table 7 Recommended disk registry settings location: HKLM\SYSTEM\CurrentControlSet\Services\disk

Setting name	Description	Default value	Recommended value
TimeoutValue	Disk time-out is a registry setting that defines the time that Windows will wait for a hard disk to respond to a command. Installing host bus adapters (HBA) or other storage controllers can cause this key to be created and configured.	60	no change

A.5 iSCSI initiator settings (single-path and MPIO)

This appendix contains recommended changes for iSCSI initiators. These changes apply to single-path and MPIO configurations that use iSCSI to connect to SC Series storage.

Table 8 Recommended iSCSI initiator registry settings location: HKLM\SYSTEM\CurrentControlSet\Control\Class\{4D36E97B-E325-11CE-BFC1-08002BE10318}\<Instance Number>\Parameters

Setting name	Description	Default value	Recommended value
MaxRequestHoldTime	This is the maximum number of seconds that requests are queued if connection to the target is lost and the connection is being retried. After this hold period, requests will be failed with **error no device** and device (disk) will be removed from the system.	60	90
LinkDownTime	This value determines how long requests will be held in the device queue and retried if the connection to the target is lost. If MPIO is installed this value is used. If MPIO is not installed MaxRequestHoldTime is used instead.	15	35
TCPConnectTime	Timeout given to TCP when a Connect request is sent.	15	no change
TCPDisconnectTime	Timeout given to TCP when a Disconnect request is sent.	15	no change
WMIRequestTimeout	Timeout value set for WMI requests such as LoginToTarget or LogoutFromTarget, SendTargets.	30	no change
DelayBetweenReconnect	If a connection is dropped while it is in FullFeature phase, the driver will attempt to re-login. This parameter sets the delay between each re-login attempts.	5	no change
MaxConnectionRetries	Maximum number of times a lost TCP connection will be retried.	4294967295 (indefinitely)	no change

Setting name	Description	Default value	Recommended value
MaxPendingRequests	This setting controls the maximum number of outstanding requests allowed by the initiator. At most this many requests will be sent to the target before receiving response for any of the requests.	255	no change
EnableNOPOut	If set to 1, the initiator will send NOP OUT PDUs to target if there is no activity for 2 minutes.	0	1
MaxTransferLength	This is maximum data size of an I/O request.	262144 (256KB)	no change
MaxBurstLength	This is the negotiated Max Burst Length.	262144 (256KB)	no change
FirstBurstLength	This is the negotiated First Burst Length.	65536 (64KB)	no change
MaxRecvDataSegmentLength	This is the negotiated MaxRecvDataSegmentLength.	65536 (64KB)	no change
IPSecConfigTimeout	This timeout value is used when the driver calls the discovery service to configure\release IPsec for an iSCSI connection.	60	no change
InitialR2T	If set to Non-Zero value, initiator will request InitialR2T (InitialR2T=Yes). Else initiator will not request InitialR2T (InitialR2T=No).	0	no change
ImmediateData	If set to Non-Zero value, initiator will request ImmediateData (ImmediateData=Yes). Else initiator will not request ImmediateData (ImmediateData=No).	1 (Yes)	no change
PortalRetryCount	This value is used to determine how many times a connect request to a target portal should be retried if the portal is down.	5	no change
NetworkReadyRetryCount	This value is used to determine how many times initiator should retry getting the IP address of NIC corresponding to the PortNumber specified in the login request.	10	no change
ErrorRecoveryLevel	Error recovery level that the initiator will request.	2	no change

Note the following additional guidelines:

Enable RFC1323 timestamps (TCP High Performance Extensions) to prevent sequence number wrap under high load, known as Prevention Against Wrapped Sequence (PAWS). High-load iSCSI connections are prone to this issue, particularly at 10GbE or higher. Run this command at elevated CMD prompt to add a registry key (set to value of 2 by default; this is the desired value):

```
netsh int tcp set global timestamps=enabled
```

HKLM\SYSTEM\CurrentControlSet\Services\TCPIP\Parameters\Tcp1323Opts

Values: 0 = Timestamps + windows scaling disabled
1 = Windows Scaling Enabled
2 = Timestamps enabled ✓
3 = both enabled

Disable Nagle's Algorithm: To disable delayed ACK and Nagle's algorithm, create the following **DWORD 32-bit** entries for each SAN interface subkey in the Windows Server registry:

```
HKLM\SYSTEM\CurrentControlSet\Services\Tcpip\Parameters\Interfaces\<SAN
interface GUID>
```

- Create or verify these DWORD 32-bit entries. Set them to a value of 1 (disabled)

  ```
  TcpAckFrequency
  TcpNoDelay
  ```

Disable NIC Interrupt Modulation:

1. Click **Adapter Settings**.
2. Right-click the adapter and select **Properties**.
3. Under the **Networking** tab, click **Configure**.
4. Under the **Advanced** tab, select **Interrupt Moderation** and choose **Disabled**.

Note: A reboot is required for any registry changes to take effect. Alternatively, unloading and reloading the initiator driver will also cause the change to take effect. In the Device Manager GUI, under **Storage controllers**, right-click **Microsoft iSCSI Initiator,** and select **Disable** to unload the driver. Then, select **Enable** to reload the driver.

B Additional resources

B.1 Technical support and resources

Dell.com/support is focused on meeting customer needs with proven services and support.

Storage technical documents and videos provides expertise that helps to ensure customer success on Dell EMC storage platforms.

B.2 Related documentation

Table 9 Referenced or recommended resources

Vendor	Resource
Dell EMC	Dell EMC Storage Compatibility Matrix (DSCM)
Dell EMC	Dell EMC SC Series Storage with SAS Front-end Support for Microsoft Hyper-V
Dell EMC	Dell EMC SC Series Storage and Microsoft Hyper-V
Dell EMC	Dell EMC SC Series Storage and Microsoft Windows Server
Dell EMC	Dell EMC SC Series Storage: Synchronous Replication and Live Volume
Dell EMC	Dell EMC Storage Products
Microsoft	Microsoft Documentation Library
Microsoft	Microsoft Update Catalog