

**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<sup>™</sup> SC Series storage.

June 2019

# Revisions

Date	Description
October 2010	Initial release
October 2010	Corrected errors
November 2011	Additional content on Microsoft <sup>®</sup> Windows Server <sup>®</sup> 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
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February 2016	Removed Windows Server 2003 content and updated hotfix recommendations
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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
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# **Executive summary**

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

For your specific SC Series array and Storage Center OS (SCOS) version, refer to the primary reference material at <u>Dell.com/support</u> 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 <u>Dell EMC SC Series</u> and <u>Windows Server Best Practices Guide</u>.

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 <u>StorageSolutionsFeedback@dell.com</u>.

# 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 lesscostly, 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.

📥 Add Roles and Features Wizard		– 🗆 X
Select features		DESTINATION SERVER S1360.techsol.local
Before You Begin	Select one or more features to install on the selected server.	Description
Server Selection		Multipath I/O, along with the
Server Roles	Multipath (/O (Installed)     MultiPoint Connector	Microsoft Device Specific Module
Features	Network Load Balancing     Network Virtualization	provides support for using multiple
Confirmation	Peer Name Resolution Protocol	data paths to a storage device on
Results	Quality Windows Audio Video Experience RAS Connection Manager Administration Kit (CMA	Windows.

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<sup>™</sup> 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 <u>Dell EMC SC Series Storage and Microsoft Windows Server</u> 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 <u>Dell.com/support</u>.

#### 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 frontend 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.

Se	rver		
10G data switches	iSCSI FD1	iSCSI FD 2	
	Active	Active	
	SC Series array		

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 <u>Dell</u> <u>EMC Storage Compatibly Matrix</u> 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 <u>Dell EMC SC Series Storage with SAS Front-end Support for Microsoft</u> <u>Hyper-V</u> 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 <u>Dell EMC SC Series Storage</u> 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<sup>®</sup>.

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**.

MPIO Properties	×							
MPIO Devices Discover Multi-Paths	DSM Install Configuration Snapshot							
SPC-3 compliant								
Device Hardware Id								
	7							
Add support for ISCSI devices								
	Add							
Others								
Device Hardware Id								
	Add							
	OK Cancel							

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 <u>Dell EMC Storage Compatibly Matrix</u> 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 <u>Dell EMC SC Series</u> <u>Storage with SAS Front-end Support for Microsoft</u> configuration guide.





## 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<sup>™</sup> 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.

Lifecycle Con	ntroller			Help   About   Exit		
Select Update Repository	~	Firmware Update: Launch Firmwa	re Update			
Enter Access Details	~					
Select Updates		Step 3 of 3. Select Updates				
		Use the table to select available updates.				
		Catalog File: Catalog.xml.gz				
		Catalog Version: 19.01.01				
		Source: FTP (\\143.166.147.76\catalog)				
		Available System Updates				
		Component	Current	Available		
		C QLogic QLE2662 16Gb FC Adapter - 2001000E1EC2D998	14.07.05	14.07.05		
		QLogic QLE2662 16Gb FC Adapter -     2001000E1EC2D999	14.07.05	14.07.05		
		☐ Integrated Dell Remote Access Controller	2.61.60.60	2.61.60.60		

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.

QLogic F	QLogic Fibre Channel Adapter Properties X							
General	Driver	Details	Events	Resources				
\$	QLogic Fibre Channel Adapter							
Driver Provider: QLogic								
	Driver Date: 11/28/2017							
	Driver	Version:	9.2.6	22				
	Digital Signer: Microsoft Windows Hardware Compatibility Publisher							
Dri	Driver Details To view details about the driver files.							

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<sup>®</sup> 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**.

Adapter Type	Select Host Address	Adapter Slot	Bus	Device	Function -	
QLE2662	C820A000	04	82	00	Θ	
QLE2662	C8208000	04	82	00	1	

 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.

Adapter Settings					
Adapter S BIOS Address: BIOS Revision: Adapter Serial Number: Interrupt Level: Adapter Port Name: Host Adapter BIOS: Frame Size: Loop Reset Delay: Adapter Hard Loop ID: Hard Loop ID:	54000 3.45 BFE1338E07895 15 2001000E1E3039AA Enabled 2048 5 Disabled 0				
Spinup Delau:	Disabled				
Spinup Delay:	Disabled				
Fibre Channel Tane Sunnor	<u>1</u> t:Enabled				
Data Rate:	2				

- 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 <u>Dell EMC SC Series Storage with SAS Front-end Support for</u> <u>Microsoft Hyper-V</u> 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.



Ι	D	Vendor	Scan Product	Fibre	Channel Rev	Loop Port	Name
0	)	No device	e present				
1		No device	present				
2		No device	present				
3	1	No device	e present				
4	ł.	No device	present				

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.

<b>DØLL</b> EMC STORAGE MAN	AGER			
Storage Dell Storage Storage Centers Sc 14 Sc 17 Sc 4	Summary ? Storage ? Hardw C Sto	vare ? IO Usage ? S1352 Index 90 Connectivity ✓ Up Type Phys Port Type Fibre Operating System Win Server Folder Stan Server HBAS Name 20010000E1EC2D998	Charting ? Charting ? Show ical e Channel dowrs Server 2016 M dby Port Type Fibre Channel	Alerts <b>2</b> Logs (
	📮 S1351 <mark></mark>	) 2001000E1EC2D999	Fibre Channel	Vp Up

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**.

🗐 Set up localhost on Storage Center [SC 17]	×
DELLEMC Dell Storage Manager Client Host Configuration	
Verify all prerequisites have been satisfied on the host before continuing.	
For Windows 2016 servers, MPIO must be installed on the server before continuing.	
Fibre Channel	
Install HBAs in the host servers.	
Install supported HBA drivers and firmware.	
<ul> <li>HBAs must be cabled to FC switches and not directly connected to storage system.</li> </ul>	
<ul> <li>Host zoning can be done before continuing with this wizard by creating single initiator zones with the HBA and storage virtual ports. Alternatively, the following wizard can aid with determining WWNs for zoning.</li> </ul>	
iSCSI	
<ul> <li>If using iSCSI HBAs, they must be listed on the compatibility matrix.</li> </ul>	
Install supported drivers and firmware.	
<ul> <li>Verify IP Addresses are assigned to correct NICs. Assigning IP Addresses to the wrong ports can cause connectivity issues.</li> </ul>	
<ul> <li>If using jumbo frames, they must be enabled and configured on all devices in the data path, NIC ports, switches, and storage system.</li> </ul>	
<ul> <li>Host servers must be cabled to switches and not directly connected to storage system.</li> </ul>	
SAS	
<ul> <li>Install supported SAS HBAs in the host servers.</li> </ul>	

- Install supported HBA drivers and firmware.
- · HBAs must be directly connected to storage system.

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**.

erify localhost Informa	tion		
Clicking Next creates the ser	ver definition on the Storage	Center for the initiators that are Connected	or Partially Connected.
lost Operating System	Microsoft Windows Server	2016 Datacenter	
Name	S1352		
Host or IP Address	100.88.146.52		
Storage Center Connectivity	Fully Connected		
otorage center connectivity	r ally connected		
Host Initiators/HBAs			
Host Initiators/HBAs			C Refresh Connectivity Informat
Host Initiators/HBAs Port Name	Туре	Storage Center Connectivity	C Refresh Connectivity Informat Fault Domains
Host Initiators/HBAs Port Name	Type Fibre Channel	Storage Center Connectivity	C Refresh Connectivity Informat Fault Domains

	10001 6	50	
og in to Storage Center via	a ISCSI from nost S13	03	
To perform IO to the Storage Center	er, this host must log in to on	e or more of the iS	CSI target Fault Domains.
More information on fault dom	ains and server login		
insure the iSCSI hosts have been	configured correctly, includ	ing the correct IP A	ddress, before continuing.
More information about iSCSI I	lost Setup		, 2
More information about iSCSI I	Host Setup		
More information about ISCSI F Select Target Fault Domains	Host Setup		, ,
More information about iSCSI Select Target Fault Domains	Host Setup		C Refresh Reachable Statu
More information about iSCSI I Select Target Fault Domains Fault Domain	Host Setup Target IPv4 Address	Status	C Refresh Reachable Statu Adapters Used to Connect
More information about iSCSI I Select Target Fault Domains Fault Domain Fault Domain	Target IPv4 Address 10.10.17.10	Status	C Refresh Reachable Statu Adapters Used to Connect Mellanox ConnectX-4 Lx Ethernet Adapter #2 (10.10.134.53)

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.

Set up localhost on Storage Cent	er [SC 17]	
ost Setup Successful		
The Server has successfully be	en created on the Storage Center	
Launch wizard to create a volum	e for this host	
Host Best Practices		
Copy to clipboard		
The following Best Practices have b	een set in order to gain best IO performance and reliability	
Name	Details	1
EnableNOPOut	If set to non-zero value, the initiator will send NOP OUT PDUs to target if there is no activity for 2 minutes.	
HostSetup_BestPractices_DiskP	If the DiskPathCheckInterval key is set to 0, or if the key does not exist, the MPIO component uses a default time interval	
Install MPIO	Install the MPIO driver on the host for best IO Performance to Storage Center. This requires a reboot of the host to be fully functional.	
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.	
MaxRequestHoldTime	Maximum time (in seconds) for which requests will be queued if connection to the target is lost and the connection is being retried.	
MPIO PathRecoveryInterval	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.	
MPIO PathVerifyEnabled	This flag enables path verification by MPIO on all paths every N seconds (where N depends on the value set in PathVerificationPeriod).	
MPIO PDORemovePeriod	This setting controls the amount of time (in seconds) that the multipath pseudo-LUN will continue to remain in system memory, even after losing all paths to the device.	
MPIO UseCustomPathRecoveryIn	If this key exists and is set to 1, it allows the use of PathRecoveryInterval.	

- 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 <u>Dell EMC SC Series Storage with</u> <u>SAS Front-end for Microsoft</u> 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.
- 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.

```
QLE2662 PCI3.0 Fibre Channel ROM BIOS Version 3.45
Copyright (C) QLogic Corporation 1993-2017. All rights reserved.
www.qlogic.com
Press <CTRL-Q> or <ALT-Q> for Fast!UTIL
<CTRL-Q> Detected, Initialization in progress, Please wait...
Firmware Version 8.07.11
```



- 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, reattempt 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.

Name	New Server 1							
Operating System	Windows Server 2016 MPIO	Vindows Server 2016 MPIO						
Notes								
	✓ Alert On Lost Connectivity				<b>T</b>			
	☑ Alert On Partial Connectivity							
	Select the HBA that the server uses to send IO requests to th	e Storage Center.						
Host Bus Adapters	Name	Port Type	Connectivity	iSCSI IPv4 Address				
	🗹 🍺 21000024FF46C19E	Fibre Channel	🔽 Up					
	🔽 🎾 21000024FF46C19F	Fibre Channel	🔽 Up					
	🔲 🏴 iqn.1991-05.com.microsoft:s1407.techsol.local	iSCSI	🔽 Up	10.10.135.17	::			

- 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.
- 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**.

Discover Target Portal	×						
Enter the IP address or DNS name and port number of the portal you want to add.							
To change the default settings of the disc the Advanced button.	covery of the target portal, dick						
IP address or DNS name:	Port: (Default is 3260.) 3260						
Advanced	OK Cancel						

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.

Ad	vanced Settings		?	×
Ge	eneral IPsec			
	Connect using			-
	Local adapter:	Microsoft iSCSI Initiator	$\sim$	
	Initiator IP:	10.10.134.53	$\sim$	
	Target portal IP:		$\sim$	

- 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.

	atorriopei				
rgets	Discovery	Favorite Targets	Volumes and Devices	RADIUS	Configuration
_					
Targe	t portals				
The s	ystem will lo	ok for Targets on fo	llowing portals:		Refresh
Addr	ess	Port	Adapter	I	P address
10.1	0.17.10	3260	Microsoft iSCSI Initiat	or 1	0.10.134.53
10.2	0.17.10	3260	Microsoft iSCSI Initiat	or 1	.0.20.134.53
To ad	ld a target p	ortal, click Discover	Portal.	Disco	ver Portal
To re	move a targ click Remove	et portal, select the	address above and	F	Remove

- 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**.

argets	Discovery	Favorite Targets	Volumes and Devices	RADIUS	Configuration
Quick C	onnect	_			_
To disc DNS na	over and log ame of the ta	) on to a target usin arget and then dick	ng a basic connection, ty Quick Connect.	ype the IP	address or
Target	:			Qu	uick Connect
Discove	ered targets				
					Refresh
Name				Status	
ign.20	02-03.com.	compellent:5000d3	1001034f17	Inactive	
iqn.20	02-03.com.	compellent: 5000d3:	100 1034f2b	Inactive	
iqn.20	02-03.com.	compellent: 5000d3:	1001034f35	Inactive	
iqn.20	002-03.com.	compellent: 5000d3	1001034f36	Inactive	

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

Connect To Target	×
Target name:	
iqn.2002-03.com.compellent:5000d31001034f17	
Add this connection to the list of Favorite Targets. This will make the system automatically attempt to restore the connection every time this computer restarts.	
Enable multi-path	
Advanced OK	Cancel

- 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.

Ad	lvanced Settings		?	Х
G	eneral IPsec			
	Connect using			
	Local adapter:	Microsoft iSCSI Initiator	$\sim$	
	Initiator <u>I</u> P:	10.10.134.53	$\sim$	
	Target portal IP:	10.10.17.10 / 3260	) ~	

- 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.

CSI Initia	ator Proper	ties			
argets	Discovery	Favorite Targets	Volumes and Devices	RADIUS	Configuration
Quick Co	onnect				
To disco DNS nar	over and log me of the ta	on to a target usin arget and then click	g a basic connection, t Quick Connect.	ype the IP	address or
Target:				Qu	uick Connect
Discover	red targets				
		Virtua	WWNs		Refresh
Name				Status	
ign.200	02-03.com.	compellent:5000d3	1001034f17	Connecte	d
iqn.200	02-03.com.	compellent:5000d3	1001034f2b	Connecte	d
iqn.200 iqn.200	02-03.com. 02-03.com.	compellent:5000d3: compellent:5000d3:	100 1034f2b 100 1034f35	Connecte	d d



- 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.

🖳 Create Server [SC	17]							
Name	S1353							
Operating System	Windows Server 2016 MPIO							
Notes								
	Alert On Lost Connectivity							
	☑ Alert On Partial Connectivity							
	Select the HBA that the server uses to send IO requests to the Storage Center.							
Host Bus Adapters	Name	Port Type	Connectivity	iSCSI IPv4 Address	\$			
	🔽 🍺 iqn.1991-05.com.microsoft:s1353.techsol.local	iSCSI	🔽 Up	10.10.134.53	::			

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**.

Summary ? Storage ?	Hardware ?	IO Usage ? Charting ? Al	erts ? Log	s 🕜								
C II ← C II ← C II ← C Volumes C II ← Servers B → BJS C II ← MG C II ← SCSI C II ← C III ← C II ← C II ← C II ←	S1353	📰 Show 🔐 Creati 96 Server I 2 Up	e Volume 🌆 Crea nas not used any d	ate Multiple \ disk space (	/olumes	👤 Edit Settings 🌛 Ma age Center	ap Volume to Server	🝺 Add H				
	Type Port Type Operating System Server Folder	ee Physical rt Type iSCSI ereating System Windows Server 2016 MPIO rver Folder iSCSI										
⊞ 🔁 LV-AFO ⊞ 📴 MG-Cluster02	Server HBAs	Server HBAs										
		Name	P	Port Type		Connectivity	Connectivity					
	) iqn.1991-05.com.t	nicrosoft:s1353.techsol.local	iSCSI		<ul> <li></li> </ul>	Up						
Remote Storage Centers      Remote PS Groups      Fault Domains												
⊕ 🍣 Disks	Mappings Conne	ctivity Volumes Historical Usage										
B Storage Types B Storage Profiles B E Storage Profiles B E E Q QoS Profiles	iqn.1991-05. Port Type Connectivity iSCSI Name iSCSI IPv4 Address SCSI Fault Do iSCSI Fault Do	com.microsoft:s1353.techsol.ld iSCSI Up ign.1991-06.com.microsoft:s1363.techsol.local 10.10.134.63 pmain 2	ocal									
	Controller	Controller Port	Path Status	Slot	Slot Port	Fault D	omains					
	in 66383 🔅	🍺 5000D31001034F35 (10.20.17.11	) 🔽 Up	3	1	💣 iSCSI Fault Doma	in 2					
	🎲 SN 66384	) 5000D31001034F36 (10.20.17.12	) 🔽 Up	3	1	💣 iSCSI Fault Doma	ain 2					
	📲 iSCSI Fault De	omain 1										
	Controller	Controller Port	Path Status	Slot	Slot Port	Fault D	omains					
	SN 66383	) 5000D31001034F17 (10.10.17.11	) 🔽 Up	3	2	💣 iSCSI Fault Doma	ain 1					
	SN 66384	) 5000D31001034F2B (10.10.17.12	) 🔽 Up	3	2	💣 iSCSI Fault Doma	ain 1					

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.

📅 Disk Manageme	ent			- 0	×
File Action Vie	w Help				
🗢 🄿 🗔 🛛	🖬 🗩 🖌 🖾				
Volume	Layout	Туре	File System	Status	Capac
Local_Boot (C:)	Simple	Basic	NTFS	Healthy (B	278.38
System Reserved	Simple	Basic	NTFS	Healthy (S	500 M
<					>
Basic	Sustam Pasanua	d Local Bo	not (C)		
278.87 GB	500 MB NTFS	278.38 G	B NTFS		
Online	Healthy (System,	A Healthy	(Boot, Page File,	Crash Dump,	Pr
Disk 1					
Unknown					
350.00 GB	350.00 GB				
Offline 🕕	Unallocated				
ODisk 2					
Unknown					
350.00 GB	350.00 GB				
On the U	Unallocated				
Unallocated	Primary partition				

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.
- 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.

MPIO Properties		×
MPIO Devices Discover Multi-	Paths DSM Install	Configuration Snapshot
SPC-3 compliant		
Device Hardware Id		
COMPELNTCompellent Vo		
Add support for iSCSI d	evices	
Add support for SAS de	vices	
		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.

COMPELNT Compe	llent Vol Mul	ti-Path Disk	Device Propertie	s X	COMPE	LNT Con	npellent Vo	Multi-	Path Disl	Device P	ropertie	s	×
General Policies	Volumes MPI	O Driver Vol Multi-Par	Details Events th Disk Device		Genera Selec Des The to a	I Policies t the MPIC cription round rob	Volumes policy: in policy atte ng paths.	MPIO Round	Driver Robin evenly dis	Details I	Events ming req	Juests	•
Device ty Manufact Location:	pe: Disk urer: (Star Port(	drives ndard disk dri 3,4) Bus 0, T	ves) Target ID 0, LUN 24		DSM This o	Name: [	Microsoft DS	GM g paths:			D	etails	
Device status This device is w	orking properly.			^	Pati 770 770	n Id 30000 40000	Path St Active/ Active/	ate Optimi Optimi	TPG 61487 61485	TPG Stat Active/O Active/O	e ptimi ptimi	Wei	

- 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).

#### Change the default load balance policy 10

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.

#### 101 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.

COMPELNT Compellent	t Vol Multi-Path Disk	Device P X
General Policies Volumes	MPIO Driver Details I	Events
Select the <u>M</u> PIO policy:	Round Robin	~
The round robin policy atte to all processing paths.	empts to evenly distribute inco	ming requests
DSM Name: Microsoft DS	SM	Details
This device has the following	g paths:	
Path Id	Path State	Weight
77020002	Active/Optimized	
77040000	Active/Optimized	
77030003	Active/Optimized	
<	Ш	>
To edit the path settings for t path and click Edit.	the MPIO policy, select a	<u>E</u> dit
To apply the path settings an click Apply.	nd selected MPIO policy.	Apply
More information about MPIC	<u>D policies</u>	
	ОК	Cancel

#### 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:\Windo	ws\system32> m	pclaim -s -d							
For more in	formation abou	t a particula	r disk, use	'mpclaim	-s -d #'	where # i	is the MPIO	disk	number.
MPIO Disk	System Disk	LB Policy	DSM Name						
MPIO Disk2 MPIO Disk1 MPIO Disk0 PS C:\Windo	Disk 2 Disk 1 Disk 0 ws\system32>	FOO RR RR RR	Microsoft D Microsoft D Microsoft D	)SM )SM )SM					
Figure 17	Use MPCLAIN	I 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

PS C:\Windows	s\system32> mp	pclaim -s -d		
For more info	ormation about	t a particula	r disk, use 'mpclaim -s -d #' where # is the MPIO disk numbe	r.
MPIO Disk	System Disk	LB Policy	DSM Name	
MPIO Disk2 MPIO Disk1 MPIO Disk0 PS C:\Windows	Disk 2 Disk 1 Disk 0 s\system32>	RR RR RR	Microsoft DSM Microsoft DSM Microsoft DSM	

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<sup>™</sup> 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.

```
QLE2662 PCI3.0 Fibre Channel ROM BIOS Version 3.45
Copyright (C) QLogic Corporation 1993-2017. All rights reserved.
www.qlogic.com
Press <CTRL-Q> or <ALT-Q> for Fast!UTIL
<CTRL-Q> Detected, Initialization in progress, Please wait...
Firmware Version 8.07.11
```

- 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).
- 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**.

⊕ 📴 MG_WS19_Clust_01			s	napshot Ove	erhead		9 GB	RAID Overhea	ad	-
⊖- 🔄 S1360 			A	ctual Space		19.4	9 GB	Savings vs R/	AID 10	1
⊞ 🔁 S1361 	Summary	Mappings	Historical Us	age Stat	istics	Snapsho	ts Threshold Alerts			
Remote PS Groups		Server		Conne	ectivity		Server Folde	er Path	Мар	ped Via
⊕	🖳 S1360			🔽 Up		MG/H	iyper-V/WS2019/		Server	
Storage Types										
Storage Profiles	Mapping	Details								_
E-EA QoS Profiles		Server		Status	Tra	nsport	Server HBA	Controlle	r Port	LUN
	🖳 S1360			Vp	Fibre (	Channel	2001000E1E3039AB	5000D310010	34F30	1 0
	🖳 S1360			V Up	Fibre (	Channel	2001000E1E3039AA	5000D310010	34F2E	1 0

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

Selectable Boo	t Settings	
Selectable Boot:	Enabled	
(Primary) Boot Port Name,Lun:	000000000000000000,	0
Boot Port Name,Lun:	00000000000000000,	0
Boot Port Name,Lun:	000000000000000000,	Θ
Boot Port Name,Lun:	00000000000000000,	Θ
Press "C" to clear a B	oot Port Name entry	

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**.

ID	Select Fibre Channel Device Jendor Product Rev Port Name Port ID
0	o device present
1	OMPELN TCompellent Vol 0702 5000D31001034F2E 2B1301
2	o device present
3	o device present
4	o device present

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

Selectable Boot	Settings	
Selectable Boot:	Enabled	
(Primary) Boot Port Name,Lun:	<u>5</u> 000D31001034F2E, 0	
Boot Port Name,Lun:	0000000000000000, 0	
Boot Port Name,Lun:	0000000000000000, 0	
Boot Port Name,Lun:	000000000000000000, 0	
Press "C" to clear a Boo	t Port Name entry	

- 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.

Name	S1360	)	
Operating System	Windows Server 2016 Singlepath	~	?
Notes Server Folder	Windows Server 2008 Singlepath Windows Server 2012 Hyper-V MPIO Windows Server 2012 Singlepath Windows Server 2016 Hyper-V MPIO Windows Server 2016 Singlepath Windows Server 2016 Singlepath MG-Cluster02 KMT.8 Standby WS2019 WS2019	~	
	Alert On Lost Connectivity		

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.

System Setup	
System BIOS	
System BIOS Settings • Boo	ot Settings • BIOS Boot Settings
Boot Sequence Embedded SATA Port Optical I Integrated NIC 1 Port 1 Partition Hard drive C: Boot Option Enable/Disable I Embedded SATA Port Optic. Integrated NIC 1 Port 1 Partit I Hard drive C:	Change Order Use arrow keys to select an item. Use +/- to position the item in the list. Fibre Channel in Slot 4: QLogic HA0 2B1301 Com
Hard-Disk Drive Sequence Fibre Channel in Slot 4: QLogic I	Cancel OK

- 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.

📥 Add Roles and Features Wizard	
Select features	
Before You Begin	Select one or more features to install on the selected server.
Installation Type	Features
Server Selection	Media Foundation
Server Roles	Message Queuing
Features	Multipath I/O (Installed)  MultiPoint Connector
Confirmation	Network Load Balancing
Populte	Network Virtualization
Results	Peer Name Resolution Protocol     Quality Windows Audio Video Experience

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

lame	S1360	)
Operating System	Windows Server 2016 MPIO	~
Notes Server Folder	Windows Server 2008 Singlepath Windows Server 2012 Hyper-V MPIO Windows Server 2012 Singlepath Windows Server 2016 Hyper-V MPIO Windows Server 2016 Hyper-V MPIO Windows Server 2016 Singlepath B-XenServer Windows Server 2016 Singlepath B-XenServer Windows Server 2016 Singlepath S-XenServer Windows Server 2016 Singlepath S-XenServer Windows Server 2016 Singlepath Windows Server 2016 Singlepath Server 2016 Singlepath Windows Server 2016 Singlepath Server 2016	~

- 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.

MPIO Propertie	25		>	×
MPIO Devices	Discover Multi-Paths	DSM Install	Configuration Snapshot	
To add support for a new device, click Add and enter the Vendor and Product Ids as a string of 8 characters followed by 16 characters. Multiple Devices can be specified using semi-colon as the delimiter. To remove support for currently MPIO'd devices, select the devices and then click Remove.				
Devices:				
Device Hardware Id				
COMPELNTCompellent Vol Vendor 8Product 16				

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.

File       Action       View       Help         Image: Status       Image: Status       Image: Status       Capacity       Free Space         Image: System Reserved       Simple       Basic       NTFS       Healthy (B       160.46 GB       130.95 G         Image: System Reserved       Simple       Basic       NTFS       Healthy (B       160.46 GB       130.95 G         Image: System Reserved       Simple       COMPELNT Compellent Vol Multi-Path Disk Device Properties       X         Image: General Policies       Volumes       MPIO       Driver       Details       Events
Volume       Layout       Type       File System       Status       Capacity       Free Space         Image: C:       Simple       Basic       NTFS       Healthy (B       160.46 GB       130.95 G         System Reserved       Simple       COMPELNT Compellent Vol Multi-Path Disk Device Properties       X         General       Policies       Volumes       MPIO       Driver       Details       Events
Volume         Layout         Type         File System         Status         Capacity         Free Spi <ul></ul>
COMPELNT Compellent Vol Multi-Path Disk Device Properties X General Policies Volumes MPIO Driver Details Events
Select the MPIO policy: Round Robin  V Description
The round robin policy attempts to evenly distribute incoming requests to all processing paths.
DSM Name: Microsoft DSM Details
Basic System Rese Path Id Date State TPC TPC State Wait
161.00 GB         549 MB NTF5         Pair Nu         Pair Sule         Proc.         Proc. <thproc.< th=""> <thproc.< th="">         Proc.</thproc.<></thproc.<>
CD-ROM 0 <
DVD (D:) To edit the path settings for the MPIO policy, select a Edit No Media
To apply the path settings and selected MPIO policy, Apply click Apply.
Unallocated Primary partiti

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.

KB number	Title		Link
KB3125574	Convenience rollup update for Windows 7 SP1 and Windows Server 2008 R2 SP1 (May 2016)		http://support.microsoft.com/kb/3125574
	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)	

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

# 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 update	s 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	http://support.microsoft.com/kb/3018489
	storport.sys version 6.2.9200.17188 (11/19/14)	
KB3046101	Server may freeze during startup when ALUA- capable storage is used in Windows Server 2012 R2 or Windows Server 2012	http://support.microsoft.com/kb/3046101
	<b>mpio.sys</b> version 6.2.9200.17071 (8/5/14)	
	msdsm.sys version 6.2.9200.17362 (5/6/15)	
KB3102997	Data is corrupted after iSCSI sessions or paths recover in Windows Server 2012 R2 or Windows Server 2012	http://support.microsoft.com/kb/3102997
	msiscsi.sys version 6.2.9200.21687 (11/8/15)	

## 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 4Recommended registry settings location:

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.

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

Table 5 Recommended disk registry settings location:

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

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

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

## 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 <b>error no</b> <b>device</b> 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  $\checkmark$
- 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.

<u>Storage technical documents and videos</u> 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