

IBM Storage DS8000 (10th Generation)
10.0

Host Systems Attachment Guide



Note

Before using this information and the product it supports, read the information in [Safety and environmental notices](#) and [Notices](#).

This edition applies to version 9, release 1 of the *IBM DS8000 Host Systems Attachment Guide* and to all subsequent releases and modifications until otherwise indicated in new editions.

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About this guide

This book describes how to attach hosts to your DS8000 10th generation storage systems. It includes an overview of host attachment concepts and general guidelines for specific hosts.

Who should use this guide

This book is intended for system administrators or others who install and use the IBM® DS8000® series.

Publications and related information

Product guides, other IBM publications, and websites contain information that relates to the IBM DS8000 series.

To view a PDF file, you need Adobe Reader. You can download it at no charge from the [Adobe website \(get.adobe.com/reader/\)](http://get.adobe.com/reader/).

Online documentation

Go to IBM Documentation (www.ibm.com/docs) to find the most current information.

Publications

You can order or download individual publications (including previous versions) that have an order number from the IBM Publications Center website (www.ibm.com/resources/publications). Publications without an order number are available on the documentation CD or can be downloaded here.

Title	Description	Order number
IBM Storage DS8000 (10th Generation) Introduction and Planning Guide	This publication provides an overview of the new IBM Storage DS8000 (10th Generation), the most current storage system in the DS8000 series.	V10.0 sc2795609.pdf
<i>IBM DS8900F Introduction and Planning Guide</i>	This publication provides an overview of the new DS8900F, the most current storage system in the DS8000 series. The DS8900F provides two system types: DS8910F Flexibility Class models 993 and 994, DS8950F Agility Class models 996 and E96, and DS8980F Analytic Class models 998 and E96.	V9.4 SC27-9560-08 V9.3.2 SC27-9560-07 V9.3.0 SC27-9560-06 V9.2.0 SC27-9560-05 V9.1.0 SC27-9560-04 V9.0.2 SC27-9560-03 V9.0.0 SC27-9560-02
<i>IBM DS8882F Introduction and Planning Guide</i>	This publication provides an overview of the DS8882F, the most current storage system in the DS8000 series. The DS8882F provides the new model 983. This publication provides an overview of the product and technical concepts for DS8882F.	V8.5.3 GC27-9259-02 V8.5.1 GC27-9259-01 V8.5.0 GC27-9259-00

Table 1. DS8000 series product publications (continued)

Title	Description	Order number
<p><i>IBM DS8880 Introduction and Planning Guide</i></p>	<p>This publication provides an overview of the product and technical concepts for DS8880. It also describes the ordering features and how to plan for an installation and initial configuration of the storage system.</p>	<p>V8.5.3 GC27-8525-18 V8.5.1 GC27-8525-17 V8.5.0 GC27-8525-16 V8.4.0 GC27-8525-15 V8.3.3 GC27-8525-14 V8.3.1 GC27-8525-13 V8.3.0 GC27-8525-12 V8.2.3 GC27-8525-11 V8.2.1 GC27-8525-09 V8.2.0 GC27-8525-07 V8.1.1 GC27-8525-06 V8.1.0 GC27-8525-05 V8.0.1 GC27-8525-04 GC27-8525-03 V8.0.0 GC27-8525-02</p>
<p><i>IBM DS8870 Introduction and Planning Guide</i></p>	<p>This publication provides an overview of the product and technical concepts for DS8870. It also describes the ordering features and how to plan for an installation and initial configuration of the storage system.</p>	<p>V7.5.0 GC27-4209-11 V7.4.0 GC27-4209-10 V7.3.0 GC27-4209-09 V7.2.0 GC27-4209-08 V7.1.0 GC27-4209-05 V7.0.0 GC27-4209-02</p>
<p><i>IBM DS8000 Command-Line Interface User's Guide</i></p>	<p>This publication describes how to use the DS8000 command-line interface (DS CLI) to manage DS8000 configuration and Copy Services relationships, and write customized scripts for a host system. It also includes a complete list of CLI commands with descriptions and example usage.</p>	<p>V9.4 SC27-9562-07 V9.3.2 SC27-9562-06 V9.2.1 SC27-9562-05 V9.2.0 SC27-9562-04 V9.1.1 SC27-9562-03 V9.1.0 SC27-9562-02 V9.0.2 SC27-9562-01 V9.0.0 SC27-9562-00 V8.5.4 SC27-8526-11 V8.5.1 SC27-8526-10 V8.5.0 SC27-8526-09 V8.3.3 SC27-8526-08 V8.3.1 SC27-8526-07 V8.3.0 SC27-8526-06 V8.2.3 SC27-8526-05 V8.2.2 SC27-8526-04 V8.2.0 SC27-8526-03 V8.1.1 SC27-8526-02 V8.1.0 SC27-8526-01 V8.0.0 SC27-8526-00 V7.5.0 GC27-4212-06 V7.4.0 GC27-4212-04 V7.3.0 GC27-4212-03 V7.2.0 GC27-4212-02 V7.1.0 GC27-4212-01 V7.0.0 GC27-4212-00 V6.3.0 GC53-1127-07</p>

<i>Table 1. DS8000 series product publications (continued)</i>		
Title	Description	Order number
<i>IBM DS8000 Host Systems Attachment Guide</i>	This publication provides information about attaching hosts to the storage system. You can use various host attachments to consolidate storage capacity and workloads for open systems and IBM Z hosts.	V10.0 sc27956302.pdf V9.1.0 SC27-9563-01 V9.0.0 SC27-9563-00 V8.0.0 SC27-8527-00 V7.5.0 GC27-4210-04 V7.4.0 GC27-4210-03 V7.2.0 GC27-4210-02 V7.1.0 GC27-4210-01 V7.0.0 GC27-4210-00 V6.3.0 GC27-2298-02
<i>IBM DS8900F/DS8880 RESTful API Guide</i>	This publication provides an overview of the Representational State Transfer (RESTful) API, which provides a platform independent means by which to initiate create, read, update, and delete operations in the DS8000 and supporting storage devices.	V9.4.0 SC27-9823-10 V4.0 SC27-9823-00
<i>IBM DS8800/DS8700 RESTful API Guide</i>	This publication provides an overview of the Representational State Transfer (RESTful) API, which provides a platform independent means by which to initiate create, read, update, and delete operations in the DS8000 and supporting storage devices.	V1.3 SC27-9235-00 V1.2 SC27-8502-02 V1.1 SC27-8502-01 V1.0 SC27-8502-00

<i>Table 2. DS8000 series warranty, notices, and licensing publications</i>	
Title	Location
<i>IBM Warranty Information for DS8000 series</i>	IBM Support Portal website
<i>IBM Safety Notices</i>	IBM Systems Safety Notices
<i>IBM Systems Environmental Notices</i>	IBM Systems Safety Notices
<i>International Agreement for Acquisition of Software Maintenance (Not all software will offer Software Maintenance under this agreement.)</i>	IBM Support Portal website
<i>IBM License Agreement for Machine Code</i>	https://www.ibm.com/support/pages/node/631363

See the Agreements and License Information CD that was included with the DS8000 series for the following documents:

- License Information
- Notices and Information
- Supplemental Notices and Information

Related websites

View the websites in the following table to get more information about DS8000 series.

Title	Description
IBM Support Portal website	Find support-related information such as downloads, documentation, troubleshooting, and service requests and PMRs.
IBM Directory of Worldwide Contacts website (www.ibm.com/planetwide)	Find contact information for general inquiries, technical support, and hardware and software support by country.
IBM DS8000 series website (www.ibm.com/servers/storage/disk/ds8000)	Find product overviews, details, resources, and reviews for the DS8000 series.
IBM Redbooks® (www.redbooks.ibm.com/)	Find technical information developed and published by IBM International Technical Support Organization (ITSO).
IBM System Storage® Interoperation Center (SSIC) website(www-03.ibm.com/systems/support/storage/ssic/interoperability.was)	Find information about host system models, operating systems, adapters, and switches that are supported by the DS8000 series.
IBM Entitled Systems Support (ESS) website	Download licensed machine code (LMC) feature keys that you ordered for your DS8000 storage systems.
IBM Fix Central (www-933.ibm.com/support/fixcentral)	Download utilities such as the IBM Easy Tier® Heat Map Transfer utility.
IBM Java™ SE (JRE) (www.ibm.com/developerworks/java/jdk)	Download IBM versions of the Java SE Runtime Environment (JRE), which is often required for IBM products.
IBM Security Guardium Key Lifecycle Manager online product documentation (www.ibm.com/docs/en/sgklm)	This online documentation provides information about IBM Security Guardium Key Lifecycle Manager, which you can use to manage encryption keys and certificates.
IBM Spectrum Control online product documentation in IBM Documentation (www.ibm.com/docs/spectrum-control)	This online documentation provides information about IBM Spectrum Control, which you can use to centralize, automate, and simplify the management of complex and heterogeneous storage environments including DS8000 storage systems and other components of your data storage infrastructure.
DS8900F Code Bundle Information website (www.ibm.com/support/docview.wss?uid=ibm11072022)	Find information about code bundles for DS8900F. The version of the currently active installed code bundle displays with the DS CLI <code>ver</code> command when you specify the <code>-l</code> parameter.

IBM Publications Center

The IBM Publications Center is a worldwide central repository for IBM product publications and marketing material.

Procedure

- The IBM Publications Center website (www.ibm.com/resources/publications) offers customized search functions to help you find the publications that you need. You can view or download publications at no charge.

Sending comments

Your feedback is important in helping to provide the most accurate and highest quality information.

Procedure

To submit any comments about this publication or any other IBM storage product documentation:

- Send your comments by email to ibmdocs@us.ibm.com. Be sure to include the following information:
 - Exact publication title and version
 - Publication form number (for example, GA32-1234-00)
 - Page, table, or illustration numbers that you are commenting on
 - A detailed description of any information that should be changed

Summary of changes

IBM Storage DS8000® (10th Generation) Version 10, Release 0 introduces the following new features.

Version 10, Release 0

This table provides the current technical changes and enhancement to the IBM Storage DS8000® (10th Generation).

Function	Description
Improved Bandwidth with PCIe Gen4	<p>The DS8000 10th generation is designed with PCIe Gen4 enabled infrastructure. This is a significant upgrade over the PCIe Gen3 connectivity in the DS8900F, providing double the internal bandwidth across key components:</p> <ul style="list-style-type: none"> • New Power Servers with PCIe Gen4 support • New IO Bays with PCIe Gen4 • New zHyperlink and HPFE RAID adapters
Next Generation zHyperlink Adapter	<p>The zHyperlink adapter on the DS8000 G10 is built on PCIe Gen4 technology and will support connections at up to Gen4 speeds. The latency of the new adapter is reduced for reads and writes. The throughput of a single link on the new adapter is also improved.</p> <p>With the reduced latency provided by the new adapter it is also now possible to support larger read sizes. The default maximum read size supported is now 16 KB and z/OS provides the ability to increase this up to 32 KB if needed for specific workloads.</p>
Next Generation High Performance Flash Enclosure	<p>The next generation High Performance Flash Enclosure includes a new RAID Adapter with improved performance and uses NVMe Flash drives with RAID6 and RAID10 for data protection.</p> <p>The RAID functionality has been moved from the ASIC used in the HPFE Gen2 and now runs on dedicated processors within the RAID adapter. The HPFE Gen3 provides improved bandwidth and IOPS compared to the HPFE Gen2.</p>
Support for NVMe drives including IBM FlashCore Modules	<p>The new high-performance flash enclosure pairs are compatible with both industry-standard NVMe flash drive media and IBM FlashCore Modules (FCM), which feature built-in compression. Given the enhanced performance offered by the latest RAID adapters and NVMe drives, it's anticipated that users transitioning from earlier generation storage systems will have the option to upgrade to larger drive sizes compared to their current setup. To verify that a specific configuration will satisfy workload requirements, use the IBM Storage Modeller.</p>

Function	Description
Compression with IBM FlashCore Modules	<p>The DS8000 10th generation supports compression for both CKD and FB data when configured with IBM FlashCore Modules. Implemented completely in hardware with no processor intervention means that these added benefits do not slow down the rest of the storage system.</p>
Improved Capacity Scalability	<p>The DS8000 10th generation system provides double the capacity scalability compared to previous generation systems when configured with small extents. The maximum usable capacity of the A05 increases from 2 PiB to 4 PiB (1.15 PiB to 4.3 PiB for CKD) and for the A01 this increases from 512 TiB to 1 PiB (551 TiB to 1.08 PiB for CKD).</p> <p>The maximum provisioned capacity is also doubled enabling larger provisioned capacity for thin provisioning and Safeguarded Copy. The maximum provisioned capacity of the A05 increases from 4 PiB to 8 PiB (3.68 PiB to 7.18 PiB for CKD) and for the A01 this increases from 1 PiB to 2 PiB (971 TiB to 1.78 PiB for CKD).</p>
Security	<ul style="list-style-type: none"> • Improved Security for From Local Key Manager to PKS for Local DAR Key Manager <ul style="list-style-type: none"> – The DS8000 10th generation will exploit the IBM POWER PKS feature which creates an encrypted non-volatile store. • Data at Rest Encryption and FIPS 140-3 <ul style="list-style-type: none"> – All drives in the DS8000 G10 support Advanced Encryption Standard (AES), data-at-rest encryption, and are FIPS 140-3 compliant.
Simplification	<p>For the 10th generation of DS8000, the following changes will be made to simplify the configuration and operation of the system supported:</p> <ul style="list-style-type: none"> • Simplify Configuration in GUI/CLI • Remove duplicate options • Remove extended remote copy (XRC) support • Move code stack to SW with abstraction layer to HW • Removal of custom HW/FW and replace with standard HW/FW shown below: <ul style="list-style-type: none"> – POWER 9 based HMC – Rack Mounted Ethernet Switches

Chapter 1. Introduction

This chapter is an overview of host attachment for the DS8000 series.

This chapter contains the following sections:

- [“General requirements for attaching a host” on page 1](#)
- [“Downloading and installing a host bus adapter driver” on page 1](#)
- [“Multipathing” on page 2](#)
- [“Host attachment path considerations for a storage system” on page 3](#)
- [“Attachment restrictions for Copy Services” on page 3](#)
- [“Fibre Channel host attachment” on page 3](#)
- [“Host configuration using the DS8000 interfaces” on page 8](#)

General requirements for attaching a host

Before you attach a host to the DS8000 storage system, review this list of general requirements for all hosts. The remaining chapters of this guide detail specific requirements for each host type.

Complete the following steps before you attach a DS8000 to any host system.

1. Go to the [IBM System Storage Interoperation Center \(SSIC\) website\(www-03.ibm.com/systems/support/storage/ssic/interoperability.was\)](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was) for the most current information on supported hosts, operating systems, adapters, and switches.
2. Obtain a list of supported host bus adapters (HBAs), firmware, and device driver information for your host system and host adapter on the [IBM System Storage Interoperation Center \(SSIC\) website\(www-03.ibm.com/systems/support/storage/ssic/interoperability.was\)](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was).
3. Ensure that you can access the most current DS8900 online product documentation. <https://www.ibm.com/support/knowledgecenter>
4. Have an IBM service support representative install the storage system.
5. Check the volume or logical unit number (LUN) limitations for your host system and verify that enough adapters are installed on the server to manage the total number of volumes or LUNs that you want to attach.
6. Review the "I/O adapter features" section of the *IBM DS8000 Introduction and Planning Guide* for detailed host adapter configuration rules and for information about host adapter and cable feature codes, host adapter balancing for optimal performance, and supported cabling distances. To find the appropriate *Introduction and Planning Guide* for your model, see the publications topic in the IBM DS8900 series online product documentation (<https://www.ibm.com/support/knowledgecenter>).
7. Use the DS8000 Storage Management GUI or the DS8000 command-line interface (DS CLI) to define the host and I/O port configurations.
8. Install the adapter driver with your host adapter or use the steps that are defined in [“Downloading and installing a host bus adapter driver” on page 1](#).
9. For further host attachment details, refer to the subsequent chapter dedicated to your host operating system.

Downloading and installing a host bus adapter driver

Download and install host adapter drivers to use with the DS8000.

About this task

Complete the following steps to download and install a host adapter driver.

Notes:

1. For Linux® hosts, use the HBA driver that is provided in the distribution.
2. You must download the relevant vendor documentation for the driver that you select to correctly install and configure the host adapter.

Procedure

1. Go to the [IBM System Storage Interoperation Center \(SSIC\) website\(www-03.ibm.com/systems/support/storage/ssic/interoperability.was\)](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was) and verify that the host adapter you want to use is compatible with the DS8000 series, your host, and your host operating system.
2. Obtain a list of supported host bus adapters (HBAs), firmware, and device driver information for your host system and host adapter on the [IBM System Storage Interoperation Center \(SSIC\) website\(www-03.ibm.com/systems/support/storage/ssic/interoperability.was\)](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was).
3. If required, download the adapter driver from the adapter vendor website. [Table 4 on page 2](#) provides vendor web addresses and specific download steps. For the most current steps, see the vendor website download page.

Host adapter vendor	Web address	Steps to locate download page
Broadcom Emulex	Broadcom Support Documents and Downloads (https://ibm.biz/BdqJsB)	<ol style="list-style-type: none">a. Select your operating system from the list.b. Select your adapter.c. Download the appropriate files for your adapter.
Hewlett Packard Enterprise	HPE website (https://www.hpe.com)	<ol style="list-style-type: none">a. Type the name of the host adapter in the Search field at the bottom of the Hewlett Packard Enterprise home page.b. In the search results, click the link for the driver for your operating system.c. Click Download to download the adapter driver.d. Return to the search results and review the links to documentation, such as installation requirements and release notes.
Marvell QLogic	Marvell QLogic Downloads and Documentation (http://driverdownloads.qlogic.com/QLogicDriverDownloads_UI/IBM_Search.aspx)	<ol style="list-style-type: none">a. Select your operating system from the list.b. Select your adapter.c. Download the appropriate files for your adapter.

4. Follow the installation instructions from the vendor to install the host adapter driver. Some installation instructions might be included in the readme files that are in the compressed download, but you might need to download some installation documentation separately. Return to the vendor web address that is listed in [Table 4 on page 2](#) to locate installation and configuration instructions.
5. Locate the chapter for your host system in the *IBM DS8000 Host Systems Attachment Guide*, and follow any additional driver configuration instructions.

Multipathing

Installing a multipathing driver on the host provides redundancy for failed paths and failed storage controllers. The DS8000 system supports various multipathing drivers, depending upon the operating system. Refer to the IBM Storage SSIC website at [IBM System Storage Interoperation Center \(SSIC\) website\(www-03.ibm.com/systems/support/storage/ssic/interoperability.was\)](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was) for the correct multipathing driver.

Table 5. Examples of supported multipathing drivers

Operating system	Description	Acronym
AIX®	AIX Path Control Module	AIXPCM
Windows	Microsoft Device Specific Module	MSDSM
ESXi	Native Multipathing Plug-In	NMP

Host attachment path considerations for a storage system

Path considerations affect the performance and availability of a storage system.

For optimal performance, use the following guidelines if you are attaching multiple paths from a single host system to I/O ports on a host adapter of a storage system:

- Use I/O ports on different host adapters, but make sure that the host adapters are of the same type, such as 16 Gb or 32 Gb.
- Use multiple physical adapters.
- Do not use all of the ports that are on a single host adapter, if it can be avoided.

The maximum number of host adapters and I/O ports depends on the model. A maximum of 16 ports per I/O enclosure and up to 128 ports per storage system is supported.

- DS8900 supports a maximum of four host adapters per I/O enclosure. Each I/O enclosure can include 32 Gb host adapters, 16 Gb host adapters, or a combination of all host adapter types.

Attachment restrictions for Copy Services

Certain attachment restrictions can apply to standard FlashCopy and Remote Mirror and Copy features with regard to the host system of the target and source volumes.

When you copy a source volume to a target volume with the FlashCopy or Remote Mirror and Copy feature, the source and target volumes must be on different host systems to enable concurrent read/write access of both volumes.

A copy operation with the source and target volume on the same host system creates a target volume with the same identification as the source volume. The result is that the host system sees two identical volumes. When the copy operation creates the same identification for the target volume as for the source volume, you are not able to distinguish one from the other. Therefore, you might not be able to access the original data.

There are several exceptions to these restrictions. Under the following conditions, the target volume and the source volume can be on the same host system for a FlashCopy or Remote Mirror and Copy operation:

- For AIX and Solaris, when the host system is not using a logical volume manager (LVM)
- For AIX, when the host system is using an LVM with `recreatevg` command support
- For HPE using a Fibre Channel connection, when an LVM accesses a host through the `vfchigid -f` command
- For any host system, when the host system can distinguish between a source and a target volume that have the same identification

Fibre Channel host attachment

The DS8000 series supports Fibre Channel (FC) attachment to a wide range of host systems.

Note: The DS8000 does not support direct attachment of Fibre Channel over Ethernet (FCoE); attachment must be made through a Fibre Channel over Ethernet switch or a Fibre Channel Forwarder (FCF).

Fibre Channel architecture

Fibre Channel architecture provides various communication protocols on the storage system. The storage systems that are interconnected are referred to as *nodes*. Each node has one or more *ports*.

A storage system is a node in a Fibre Channel network. Each port on a storage system Fibre Channel host adapter is a Fibre Channel port. A host is also a node in a Fibre Channel network. Each port attaches to a serial-transmission medium that provides duplex communication with the node at the other end of the medium.

The storage system architecture supports the following basic interconnection topologies or network structures:

- Point-to-point
- Switched-fabric

Point-to-point topology

With point-to-point topology, also known as direct connect, you can interconnect ports directly. Figure 1 on page 4 shows an illustration of a point-to-point topology configuration that includes one host system and one storage system.



Legend:

1 is the host system.

2 is the storage system.

Figure 1. Point-to-point topology example

The storage system supports direct point-to-point topology at the following maximum distances:

- 16 Gb shortwave adapters have a maximum distance of 125 meters (410 ft).
- 16 Gb longwave adapters have a maximum distance of 10 km (6.2 miles).
- 32 Gb adapters have a maximum distance of 10 km (6.2 miles).

The maximum distances also vary depending on the cable type as shown in Table 6 on page 4. There are three basic types of optical cable fiber. The orange cables are shortwave, multimode OM2 type cables. The aqua cables are multimode, laser-optimized OM3 and OM4 type. The yellow cables are longwave, single mode fiber. The connection speed in gigabits per second determines the distance that is allowed.

Cable type	Speed	Distance
OM2	16 Gbps	35 m (115 ft)
OM3	16 Gbps	100 m (328 ft)
OM4	16 Gbps	125 m (410 ft)
OM2	32 Gbps	20 m (65 ft)
OM3	32 Gbps	70 m (230 ft)

<i>Table 6. Connection speed and distance by cable type (continued)</i>		
Cable type	Speed	Distance
OM4	32 Gbps	100 m (328 ft)

The maximum distance for a longwave cable also varies depending on the speed and the type of optical transducer.

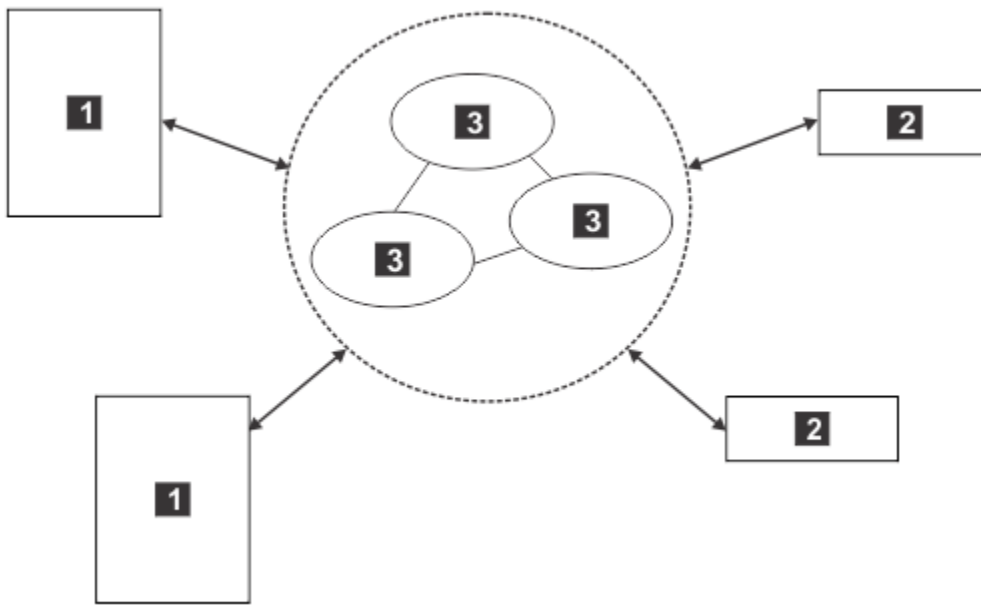
Switched-fabric topology

The switched-fabric topology provides the underlying structure that enables the interconnection of multiple nodes. The distance can be extended by thousands of miles by using routers and other storage area network components.

The storage system supports increased connectivity with the use of Fibre Channel (SCSI-FCP and FICON[®]) directors. Specific details on status, availability, and configuration options that are supported by the storage system are available at [IBM DS8000 series \(www.ibm.com/servers/storage/disk/ds8000\)](http://www.ibm.com/servers/storage/disk/ds8000).

The storage system supports the switched-fabric topology with point-to-point protocol. You must configure the storage system Fibre Channel adapter to operate in point-to-point mode when you connect it to a fabric topology.

Figure 2 on page 5 shows an illustration of a switched-fabric topology configuration that includes two host systems, two storage systems, and three switches.



Legend:

- 1** is the host system.
- 2** is the storage system.
- 3** is a switch.

Figure 2. Switched-fabric topology example

Fibre Channel overview

Each Fibre Channel adapter has either four or eight ports, and each port has a unique worldwide port name (WWPN). You can configure a port to operate with either the SCSI-FCP or the FICON (FC-SB-x) upper-layer protocol by using the DS8000 Storage Management GUI or the DS CLI. You can add both shortwave and longwave Fibre Channel adapters.

For details on the host systems that support Fibre Channel adapters, go to the [IBM System Storage Interoperation Center \(SSIC\) website\(www-03.ibm.com/systems/support/storage/ssic/interoperability.was\)](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was).

Fibre Channel adapters support the following configurations:

- Fibre Channel adapters support switched-fabric or point-to-point topologies, if 16 Gb adapters or 32 Gb adapters are used.
- A maximum of 509 logins per Fibre Channel port, which includes host ports and PPRC target and initiator ports
- Access to 63700 LUNs per target (one target per host adapter), depending on host type

Fibre Channel cables and adapter types

The Fibre Channel host adapters enable the DS8000 storage system to attach to Fibre Channel and FICON® servers. The adapters are installed in an I/O enclosure. A Fibre Channel cable is required to attach each Fibre Channel adapter port to a server port.

Storage system Fibre Channel adapters and FICON host adapters provide standard LC (Lucent) connectors for attachment to the host system or SAN.

See the *IBM DS8000 Introduction and Planning Guide* for detailed information about Fibre Channel cables and adapter types. This document also includes information about cable features and optional cables.

Node-to-node distances for Fibre Channel attachment

DS8000 supports Fibre Channel adapters for extended node-to-node distances.

See [Table 6 on page 4](#) for a list of longwave and shortwave adapter cables and their distances.

For Fibre Channel attachment, the maximum distance between the following items is 10 km (6.2 miles):

- Fabric switches
- Host Fibre Channel port
- Link extenders
- Storage system Fibre Channel port

The maximum distance might be greater than 10 km (6.2 mi) when a link extender provides target initiator functions or controller emulation functions.

Do not use link extenders with emulation functions on links over which Remote Mirror and Copy operations are performed. This is because of the additional path delay introduced by these units.

LUN considerations for Fibre Channel attachment

You can use a worldwide port name to associate a LUN for Fibre Channel attachment.

For Fibre Channel attachment, LUNs are associated with the Fibre Channel adapter through the worldwide port name (WWPN) for the host adapter.

In a switched fabric configuration, a single Fibre Channel host adapter can have physical access to multiple Fibre Channel ports on the storage system. In this case, you can configure the storage system to allow the host to use some or all of the physically accessible Fibre Channel ports on the storage system.

The maximum number of LUNs that can be assigned to a host is dependent on the host operating system type.

Table 7 on page 7 lists the maximum number of LUNs that are supported by some of the more common hosts. For more details, see your operating system documentation.

<i>Table 7. LUNs per host operating system</i>	
Host operating system type	Number of LUNs per host
AIX	64000
HP-UX	16000
Linux	Thousands
Solaris	Thousands ¹
IBM i	64000
Windows	Thousands
ESXi	1024 ²
¹ Previously for Solaris, all storage system ports shared a single volume group per host, which limited the maximum volumes per host to 256. Currently for Solaris, each storage system port can use a different volume group (256 volumes per port), allowing many thousands of volumes per host. This amount is limited only by the number of ports on the storage system that are assigned to the Solaris host.	
² 1024 is the configuration limit for ESXi 6.7 or later and 512 for ESXi 6.5.	

Access-restricted mode and profiles for Fibre Channel attachment

The access-restricted mode prevents all Fibre Channel attached host systems that do not have access profiles from accessing volumes that you defined in the storage system.

Access-restricted mode

The Fibre Channel architecture allows any Fibre Channel initiator to access any Fibre Channel device, without access restrictions. However, in some environments this flexibility can represent a security exposure. During initial configuration, IBM sets the access mode for the IBM DS8000 to the access-restricted mode.

Access profiles

Any Fibre Channel attached host system that has an access profile can access only those volumes that are defined in the profile. Depending on the capability of the particular host system, an access profile can contain either up to 256 or up to 4096 volumes.

The setup of an access profile is not apparent to you when you use the DS8000 Storage Management GUI to configure the hosts and volumes in the storage system. The following configuration actions can affect the access profile:

- When you define a new Fibre Channel attached host system in the DS8000 Storage Management GUI by specifying its worldwide port name (WWPN), the access profile for that host system is automatically created. Initially the profile is empty. That is, it contains no volumes. In this state, the host cannot access any volumes that are already defined in the storage system.
- When you add new volumes to the storage system, the new volumes are assigned to the host. The new volumes are created and are automatically added to the access profile.
- When you map volumes to Fibre Channel attached hosts, the volumes are added to the access profile.
- When you remove a Fibre Channel attached host system from the DS8000 Storage Management GUI, you delete the host and its access profile.

Fibre Channel storage area networks

A Fibre Channel storage area network (SAN) is a specialized, high-speed network that attaches servers and storage devices.

With a SAN, you can create an any-to-any connection across the network with interconnected elements such as routers, gateways, and switches. Using a SAN can eliminate the connection between a server, storage, and the concept that the server effectively owns and manages the storage devices.

The SAN also eliminates any restriction on the amount of data that a server can access. This restriction is limited by the number of storage devices that can be attached to the individual server. Instead, a SAN introduces the flexibility of networking to enable one server or many heterogeneous servers to share a common storage utility. This might comprise many storage devices, including disk, tape, and optical storage. You can also locate the storage utility far from the servers that use it.

Fibre Channel SANs provide the capability to interconnect open systems hosts and IBM Z hosts. You can map the protocols for attaching open systems hosts and IBM Z hosts to the FC-4 layer of the Fibre Channel architecture.

Fibre Channel worldwide port name identification

The DS8000 system uses a worldwide port name (WWPN) to uniquely identify a host port that is connected to a storage system. The WWPN consists of exactly 16 hexadecimal characters (0 - 9 and A - F).

The DS8000 system automatically assigns WWPNs to the ports on its host adapters when you attach your host system. You must identify the unique WWPN of each port on your host system that is attached to a DS8000 system. You use those WWPNs when you configure a host attachment either through the DS8000 Storage Management GUI or the DS CLI.

You can manually locate a unique WWPN for your host ports by completing the steps that are outlined in the chapter for your host.

N_Port ID Virtualization (NPIV) is a standardized method for virtualization of a Fibre Channel port. An NPIV-capable Fibre Channel HBA can have multiple N_Port IDs, each with a unique identity and WWPN. The DS8000 system supports configurations that use N_Port ID Virtualization (NPIV) on the host bus adapter or SAN switch.

Open-systems host attachment with Fibre Channel adapters

You can attach a storage system to an open-systems host with Fibre Channel adapters.

The storage system supports SAN speeds of up to 32 Gbps with the current 32 Gbps host adapters. The storage system detects and operates at the greatest available link speed that is shared by both sides of the system.

Fibre Channel technology transfers data between the sources and the users of the information. Fibre Channel connections are established between Fibre Channel ports that reside in I/O devices, host systems, and the network that interconnects them. The network consists of elements like switches, bridges, and repeaters that are used to interconnect the Fibre Channel ports.

Host configuration using the DS8000 interfaces

This section describes how to configure host connections using the following interfaces:

- DS8000 Storage Management GUI
- DS command line interface (DS CLI)
- IBM Copy Services Manager
- RESTful API

Host configuration using the DS8000 Storage Management GUI

You can use the DS8000 Storage Management GUI to add new hosts to the storage system, which includes assigning host ports, mapping volumes to hosts, and defining I/O ports.

For information about attaching and configuring hosts, see <https://www.ibm.com/support/knowledgecenter/SSHGBU> or refer to the DS8000 Storage Management GUI online help.

Host configuration using the DS CLI

You can use the DS CLI to create new host connections. This includes defining host ports, mapping host ports to volume groups and defining I/O ports; and to display connection information.

For the most current information about supported operating systems for the DS CLI and creating Fibre Channel host port connections, see the <https://www.ibm.com/support/knowledgecenter/SSHGBU> or the *IBM DS8000 Command-Line Interface User's Guide*.

Host configuration using IBM Copy Services Manager

You can use IBM Copy Services Manager to create and configure host connections.

For information about host configuration commands, see the IBM Copy Services Manager online product documentation in [IBM Knowledge Center website \(www.ibm.com/support/knowledgecenter/\)](http://www.ibm.com/support/knowledgecenter/).

Host configuration using the RESTful API

The RESTful (Representational State Transfer) API on your storage system HMC is used to start simple storage operations through the Web.

The RESTful API is a platform-independent application that you can use to initiate create, read, update, and delete operations in the storage system and supporting storage devices. These operations are started with the HTTP commands: POST, GET, PUT, and DELETE.

The RESTful API is for development, testing, and debugging of the client management infrastructures in your storage system. You can use the RESTful API with a CURL command or through standard Web browsers. For instance, you can use the storage system with the RESTClient add-on.

Chapter 2. HP-UX host attachment

If you have a Hewlett Packard Enterprise (HPE) server that is running the HP-UX operating system, refer to the following requirements and procedures for attaching DS8000 storage to your host using Fibre Channel.

This chapter contains the following sections:

- “[Locating the WWPN for an HP-UX host](#)” on page 11
- “[Setting the queue depth for an HP-UX host](#)” on page 12
- “[Configuring clustering on an HP-UX host](#)” on page 12

Before you attach a host, refer to the following information:

- For an overview of host attachment requirements, see “[General requirements for attaching a host](#)” on page 1.
- For the most current information on supported hosts, operating systems, adapters, and switches, go to the *System Storage Interoperation Center (SSIC) website*: [IBM System Storage Interoperation Center \(SSIC\) website\(www-03.ibm.com/systems/support/storage/ssic/interoperability.was\)](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was).

Note: Because of limitations in the host operating system, LUNs greater than x'3FFF' are not supported. When you create or assign LUNs and volumes, only LUN and volume IDs less than x'3FFF' are supported. This range limits the maximum number of volumes that are allowed for HP host types to 16384.

Locating the WWPN for an HP-UX host

To attach your DS8000 to a Hewlett Packard Enterprise (HPE) server that is running the HP-UX operating system, you must locate the worldwide port name (WWPN) for the host.

Procedure

To locate the WWPN, complete the following steps:

1. Go to the root directory of your HP-UX host.
2. Enter `ioscan -fnC fc | more` for information about the Fibre Channel adapters that are installed on the host.

The following example shows the output of the **ioscan** command:

```
fc 0 0/2/0/0 td CLAIMED INTERFACE HP Tachyon XL2 Fibre Channel Mass Storage Adapter /dev/td0
fc 1 0/4/0/0 td CLAIMED INTERFACE HP Tachyon XL2 Fibre Channel Mass Storage Adapter /dev/td1
fc 2 0/6/2/0 td CLAIMED INTERFACE HP Tachyon XL2 Fibre Channel Mass Storage Adapter /dev/td2
```

3. Look under the description for the Fibre Channel Mass Storage adapter.

For example, look for the device path name `/dev/td1`.

4. Enter `fcmsutil /dev/td1 | grep World` where `/dev/td1` is the path.

The following example shows the output of the **fcmsutil**:

```
(root@hpmain)/home/root# fcmsutil /dev/td1 | grep World
N_Port Node World Wide Name = 0x50060b000024b139
N_Port Port World Wide Name = 0x50060b000024b138
(root@hpmain)/home/root# fcmsutil /dev/td0 | grep World
N_Port Node World Wide Name = 0x50060b000023a521
N_Port Port World Wide Name = 0x50060b000023a520
(root@hpmain)/home/root# fcmsutil /dev/td2 | grep World
N_Port Node World Wide Name = 0x50060b0000253a8f
N_Port Port World Wide Name = 0x50060b0000253a8e
(root@hpmain)/home/root#
```

Setting the queue depth for an HP-UX host

After you attach your DS8000 to a Hewlett Packard Enterprise server that is running the HP-UX operating system, you can set the queue depth by device level or globally.

Before you begin

Before you set the queue depth, you must attach the host system to a DS8000.

Procedure

To set the queue depth for all classes of HP-UX, use the following formula:

```
256 ÷ maximum number of LUNs = queue depth
```

Note: For optimum performance, monitor configurations with greater than 256 LUNs and adjust the queue depth.

- To update and activate the queue depth by device immediately, complete the following steps:
 - a) Enter `scsimgr set_attr -D /dev/rdisk/$dsksf -a max_qdepth=21` where `/dev/rdisk/$dsksf` is the device node.
 - b) To locate the device node, enter the **ioscan** command.
- To save the update after rebooting, complete the following steps:
 - a) Enter `scsimgr save_attr -D /dev/rdisk/$dsksf -a max_qdepth=21` where `/dev/rdisk/$dsksf` is the device node.
 - b) To locate the device node, enter the **ioscan** command.
- To update or save the queue depth by driver level, complete the following steps:
 - a) Enter `scsimgr [set/save]_attr -N /escsi/$driver -a max_qdepth=21` where `/escsi/$driver` is the disk driver. For example, `/escsi/esdisk`.

Configuring clustering on an HP-UX host

After attaching to the DS8000, you can configure the storage system for clustering on a Hewlett Packard Enterprise host that uses the MC/ServiceGuard clustering software.

The steps to configure MC/ServiceGuard with the storage system are the same as the steps in the Hewlett Packard Enterprise high availability documentation. See the Hewlett Packard Enterprise website for information.

After you configure your host for normal operating system access, the storage system acts as a normal disk device in the MC/ServiceGuard configuration. You can create volume groups that contain the volumes by using the Hewlett Packard Enterprise logical volume manager. This method of disk management is more reliable, easier, and more flexible than whole-disk management techniques.

When you create volume groups, you can implement PV-Links, the Hewlett Packard Enterprise built-in multipathing software for high availability drives.

Note: The standard multipath support driver that comes with HP-UX 11iv3 is supported. For more information, see your Hewlett Packard Enterprise documentation.

Implementing PV-Links multipathing software

To use PV-Links multipathing software, complete the following steps:

1. Create the volume group, using the path to the volumes that you want as the primary path to the data. The following lines are an example that shows the commands that you use to create the volume group:

```
mkdir /dev/vg15
mkknod /dev/vg15/group c 64 0x030000
pvcreate /dev/rdisk/c1t0d0
```

```
pvcreate /dev/rdsk/c1t2d0
vgcreate /dev/vg15 /dev/dsk/c2t0d0
```

In this example, the new volume group is `/dev/vg15` and the primary path to the data is `/dev/dsk/c2t0d0`.

2. Extend the volume group with the path to the volumes that are intended as alternative paths. The logical volume manager reads the label on the disk and knows that it is an alternative path to one of the volumes in the group. The logical volume manager labels the volume.

The following command creates an alternative path using the volume group that you created in Step “1” on page 12 (`/dev/vg15`):

```
vgextend /dev/vg15 /dev/dsk/c3t0d0
```

In this example, `/dev/dsk/c3t0d0` is the alternative path to the data.

3. To display the alternative path that you created in step “2” on page 13, enter the following command:

```
vgdisplay -v /dev/vg15
```

For more information about these commands, see the online manpages `pvcreate(1M)`, `vgcreate(1M)`, and `vgdisplay(1M)`, or see the *HP-UX Reference (Manpages)* at <https://support.hpe.com/hpesc/public/home/productSelector?sp4ts.oid=4342294>.

Chapter 3. IBM Power Systems host attachment

If you have an IBM Power Systems server, refer to the following requirements and procedures for attaching DS8000 storage to your host using Fibre Channel.

This chapter contains the following sections:

- [“IBM Power Systems hosts running IBM i” on page 15](#)
- [“IBM Power Systems hosts running AIX host attachment” on page 19](#)
- [“IBM Power Systems hosts running Linux ” on page 23](#)

Before you attach a host, refer to the following information:

- For an overview of host attachment requirements, see [“General requirements for attaching a host” on page 1](#).
- For the most current information on supported hosts, operating systems, adapters, and switches, go to the *System Storage Interoperation Center (SSIC) website*: [IBM System Storage Interoperation Center \(SSIC\) website\(www-03.ibm.com/systems/support/storage/ssic/interoperability.was\)](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was).

IBM Power Systems hosts running IBM i

If you have an IBM i server, refer to the following requirements and procedures for attaching DS8000 storage to your host using Fibre Channel.

Notes:

1. You can assign storage system logical unit numbers (LUNs), also referred to as volumes, to multiple IBM i Fibre Channel adapters through switches, direct connection, or through a fabric. These multiple adapters must all be within the same IBM i operating system logical partition (LPAR).
2. For the latest IBM i documentation, go to the [IBM i online product documentation \(www.ibm.com/support/knowledgecenter/ssw_ibm_i/welcome\)](http://www.ibm.com/support/knowledgecenter/ssw_ibm_i/welcome).

Locating the WWPN for IBM Power Systems hosts running IBM i

To attach your DS8000 to an IBM i host that is running the IBM i operating system, you must locate the worldwide port name (WWPN) for the host.

Before you begin

You can find the 16-digit WWPN for an IBM i host using either of the following methods:

- Append the number 1000 to the beginning of the 12-digit IEEE address that is found on the tailstock label or the back side of the Fibre Channel input/output adapter (IOA).
- Display the details for the Fibre Channel Storage IOA through the Logical Hardware Resource information in the Hardware Service Manager in SST/DST.

If your IBM i host is attached to the DS8000 through a virtual Fibre Channel (vFC) N_port ID virtualization (NPIV) connection, you can find the WWPN in the Virtual Fibre Channel Properties in the Hardware Management Console.

Procedure

To locate the WWPN in System Service Tools (SST), complete the following steps:

1. On the IBM i **Main Menu** panel, type `strsst`.
2. On the **Start Service Tools (STRSST) Sign On** panel, type your service tools user ID and password.
3. On the **System Service Tools (SST)** panel, type 1 to select **Start a service tool**.
4. On the **Start a Service Tool** panel, type 7 to select **Hardware service manager**.

5. On the **Hardware Service Manager** panel, type 1 to select **Packaging hardware resources (systems, frames, cards)**.
6. On the **Packaging Hardware Resources** panel, type 9 to select the **System Expansion unit**.
7. On the **Packaging Hardware Resources** panel, type 8 to select **Storage IOA**.
8. On the **Logical Resources Associated with a Packaging Resource** panel, type 5 to select **Storage IOA**.
9. On the **Auxiliary Storage Hardware Resource Detail** panel, locate the field name for the worldwide port name. The number in the right column is the WWPN.

Note: If you exchanged a Fibre Channel IOA in the IBM i operating system partition, you must update the WWPN of the new IOA in the storage subsystem and any SAN fabric configurations that you need.

LUN considerations for IBM Power Systems hosts running IBM i

Learn about logical unit number (LUN) considerations for IBM i hosts that are running the IBM i operating system.

LUNs (also referred to as volumes) are represented in an IBM i environment by a nine-character serial number that is created by the storage system, for example, 75-1409194. In this example, 75 is the manufacturer code, 14 is the logical subsystem, 09 is the volume identifier, and 194 is the last three digits of the DS8000 worldwide node name (WWNN).

Notes:

1. Fibre Channel attached LUNs are identified as the storage system device type of 2107 on the IBM i host system.
2. You can specify 1-32 LUNs per port on IOP-based IBM i Fibre Channel adapters (features 2766, 2787, and 5760).
3. You can specify 1-64 LUNs per port on any IOPless Smart IOA Fibre Channel adapter.

The following example shows the hardware service manager output of the auxiliary storage hardware resource detail for the 5735/5273 adapter.

Auxiliary Storage Hardware Resource Detail

```

Description . . . . . : Storage IOA
Type-model . . . . . : 577D-001
Status . . . . . : Operational
Serial number . . . . . : YL12C80073DA
Part number . . . . . : 0000010N9824
Resource name . . . . . : DC13
Port . . . . . : 0
Worldwide port name . . . . . : 10000000C99CA072
Port . . . . . : 1
Worldwide port name . . . . . : 10000000C99CA073
PCI bus . . . . . :
  System bus . . . . . : 707
  System board . . . . . : 0
  System card . . . . . : 0
Storage . . . . . :
  I/O adapter . . . . . :
  I/O bus . . . . . : 127

```

Direct connect support for IBM Power Systems hosts running IBM i

The IBM i operating system supports direct connections to your DS8000 storage systems by using Fibre Channel adapters that are native to the IBM i partition.

IBM i Fibre Channel adapters that are capable of running 16 Gb or greater can be directly connected only to host adapter I/O ports on your DS8000 of the same capability, like-to-like. For example, 16Gb to 16Gb, or 32Gb to 32Gb. The host adapter I/O port must be configured as SCSI-FCP.

Switch support for IBM Power Systems hosts running IBM i

The IBM i operating system supports a homogeneous environment that contains IBM i operating system initiators only. You can establish a homogeneous environment by using the logical zoning of the switch. All hosts within the zone must be IBM i hosts.

For a list of supported switches for IBM i hosts, go to [IBM System Storage Interoperation Center \(SSIC\) website\(www-03.ibm.com/systems/support/storage/ssic/interoperability.was\)](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was).

Configurations for IBM Power Systems hosts running IBM i

To achieve an efficient connection with your DS8000, follow the configurations for IBM i hosts that are running the IBM i operating system.

The following example shows output of the logical hardware resources of the hardware service manager that are associated with the IOP:

Opt Description	Type-Model	Status	Resource Name
Combined Function IOP	2843-001	Operational	CMB04
Storage IOA	280E-001	Operational	DC18
Disk Unit	2107-A82	Operational	DD143
Disk Unit	2107-A81	Operational	DD140
Disk Unit	2107-A81	Operational	DD101

The following example shows output of the logical hardware resources of the hardware service manager that are associated with the Smart IOA Fibre Channel adapter:

Opt Description	Type-Model	Status	Resource Name
Virtual IOP	577F-001	Operational	CMB09
Storage IOA	577F-001	Operational	DC06
Disk Unit	2107-A04	Operational	DD017
Disk Unit	2107-A04	Operational	DD019
Disk Unit	2107-099	Operational	DD020
Disk Unit	2107-099	Operational	DD021

The following example shows output for the hardware service manager auxiliary storage hardware resource detail for the storage system:

```
Description.....: Disk unit
Type-Model.....: 2107-A04
Status.....: Operational
Serial number.....: 50-00413
Part number.....:
Resource name.....: DD017
licensed machine code.....: FFFFFFFF
Level.....: 0
PCI bus.....:
  System bus.....: 24
  System board.....: 0
  System card.....: 0
Storage.....:
  I/O adapter.....:
  I/O bus.....: 0
  Controller.....: 1
  Device.....: 1
```

You can define the storage system LUNs as either protected or unprotected. From a storage system, physical-configuration viewpoint all IBM i volumes are RAID-5, RAID-6, or RAID-10 volumes and are protected within the storage system. When you create IBM i volumes, you can create them as logically protected or unprotected, depending on the intended use of the LUNs in the IBM i configuration.

[Table 8 on page 18](#) shows the provisioned capacity for the protected and unprotected models. Logically unprotecting a storage LUN, allows the IBM i host to complete remote load source mirroring to that device. Because the load source is mirrored on an external LUN, the storage system can copy or transfer

this load source as a disaster recovery backup. When you use the IBM i toolkit, an IBM i host in a remote location, which uses a copy of the original load source, can recover this load source and start running as if this recovery box were the original source host.

Table 8. Capacity and models of volumes for IBM i hosts that are running IBM i operating system

Size	Type	Protected model	Unprotected model
8.0 GiB	2107	A01	A81
16.3 GiB	2107	A02	A82
32.7 GiB	2107	A05	A85
65.7 GiB	2107	A04	A84
131.4 GiB	2107	A06	A86
262.9 GiB	2107	A07	A87
1 GiB to 2000 GiB	2107	099	050

IBM i supports multipath attachment through Fibre Channel as part of the base IBM i operating system. Obtain a list of supported host adapters on the [IBM System Storage Interoperation Center \(SSIC\) website\(www-03.ibm.com/systems/support/storage/ssic/interoperability.was\)](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was)

Notes:

- A number of Fibre Channel and FCoE CNA adapters are not natively supported by IBM i. However, many of these adapters are supported when used in a Virtual I/O Server (VIOS) partition. Refer to the [IBM System Storage Interoperation Center \(SSIC\) website\(www-03.ibm.com/systems/support/storage/ssic/interoperability.was\)](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was) for a list of these adapters.
- DS8000 LUNs can be assigned to the IBM i partition as either natively attached (non-VIOS) or vFC (NPIV).

Multipath is important for the IBM i partitions because it provides greater resilience to storage area network (SAN) failures, which can be critical to IBM i due to the single-level storage architecture. Additionally, having multiple paths to a logical volume can improve the I/O performance of the partition.

Up to eight connections from multiple I/O adapters in an IBM i partition can be defined to a single logical volume in the DS8000. Each connection for a multipath disk unit functions independently. Several connections provide redundancy by allowing disk storage to be used even if a single path fails.

New paths are automatically detected, configured by the system, and immediately used. If a disk is initially set up as a single path and a second path is added, the resource name of the disk unit is modified from DDxxx to DMPxxx. This modification reflects that it now has more than one path to the disk unit. No user changes are required on the IBM i host to use the new path. Multipath connections can be directly connected or connected through a fabric. For more information, see [“Displaying Disk Multipath information and status”](#) on page 19.

To activate multipathing on the IBM i host, use the DS8000 Storage Management GUI.

With IBM i operating system, path information is available for the disk unit hardware configuration from the IBM i Navigator.

To improve the availability of Fibre Channel disks, use the following configuration guidelines to help you achieve optimum IBM i I/O performance:

- Use the Disk Magic Analysis tool to calculate the smallest LUN size possible to allow more IBM i-active I/O, without affecting device response times.
- Use High-Performance Flash drives or RAID-10 LUNs for performance-critical applications.

Displaying Disk Multipath information and status

You can display Disk Multipath information and status using System Service Tools (SST), Dedicated Service Tools (DST) and through IBM Navigator for IBM i.

System Service Tool (SST)

Procedure

To display disk multipath information and status using the System Service Tool (SST), complete the following steps:

1. On the **Main Menu** panel, type `strsst`
2. On the **Start Service Tools (STRSST) Sign On** panel, type your service tools user ID and password.
3. Select option 3 **Work with Disk Units**.
4. Select option 1 **Display disk configuration**.
5. Select option 9 **Display disk path status**.

Dedicated Service Tools

Procedure

Use the following procedure after starting the system using a manual IPL.

1. Start the system by running an initial program load (IPL) in **Manual** mode.
2. Select option 3 **Use Dedicated Service Tools (DST)**.
3. Log into DST with your Service Tools UserID.
4. Select option 1 **Work with disk unit**.
5. Select option 1 **Work with disk configuration**.
6. Select option 1 **Display disk configuration**.
7. Select option 9 **Display disk path status**.

IBM Navigator for i Procedure (port 2001)

Procedure

Use the following steps for the IBM Navigator for i procedure.

1. Expand **Configuration and Service**.
2. Click on **Disk Units**.
3. Right-mouse click on a disk unit and choose **Properties**.
4. Click on **Connections** on the left side of the window.

IBM Power Systems hosts running AIX host attachment

AIX supports the DS8000 system through the AIX multipath I/O (MPIO) framework, which is included in the base AIX operating system. You do not need to install additional software for AIX to recognize and configure the DS8000 system in supported MPIO configurations.

For information on selecting an MPIO solution, see *Guide to selecting a multipathing path control module for AIX or VIOS* at [Guide to selecting a multipathing path control module for AIX or VIOS \(www.ibm.com/developerworks/aix/library/au-multipathing/index.html\)](http://www.ibm.com/developerworks/aix/library/au-multipathing/index.html)

Using AIX MPIO

When using the AIX MPIO support for DS8000 that is included with the AIX base operating system, AIX detects and configures the DS8000 volumes as MPIO disks consistent with the AIX MPIO capability.

For information about AIX MPIO capabilities, see the [AIX online product documentation \(www.ibm.com/support/knowledgecenter/ssw_aix/welcome\)](http://www.ibm.com/support/knowledgecenter/ssw_aix/welcome).

The following example is the output that shows that DS8000 is recognized by the AIX MPIO:

```
[root@ocotillo1] / # lsdev -Cc disk
hdisk38 Available 06-09-02      MPIO IBM 2107 FC Disk
hdisk39 Available 06-09-02      MPIO IBM 2107 FC Disk
hdisk40 Available 06-09-02      MPIO IBM 2107 FC Disk
hdisk41 Available 06-09-02      MPIO IBM 2107 FC Disk
hdisk42 Available 06-09-02      MPIO IBM 2107 FC Disk
hdisk43 Available 06-09-02      MPIO IBM 2107 FC Disk
hdisk44 Available 06-09-02      MPIO IBM 2107 FC Disk
```

Using AIXPCM

All AIX deployments should use the default AIXPCM. This includes VIO servers providing storage resources to IBM i LPARs.

Prerequisite OS Levels

AIX 7.1 TL5

AIX 7.2 TL2, or higher

VIOS 2.2.6, 3.1, or higher

Reference

Refer to the following links for the complete list of path management commands for MPIO using the AIXPCM.

[Multiple Path I/O \(MPIO\)](#)

[lsmpio Command](#)

Locating the adapters installed on IBM Power Systems hosts running AIX

To attach your DS8000 to an IBM Power Systems host that is running the AIX operating system, you must locate the adapters that are installed on the host.

Procedure

To locate the installed adapters, complete the following steps:

1. Log in as root.
2. Enter `lsdev -Cc adapter`.

The following example output shows that Fibre Channel adapters `fcs0` and `fcs1` are installed on the host:

```
[root@ocotillo1] / # lsdev -Cc adapter
ent0      Available 02-08 2-Port 10/100/1000 Base-TX PCI-X Adapter (14108902)
ent1      Available 02-09 2-Port 10/100/1000 Base-TX PCI-X Adapter (14108902)
fcs0      Available 06-08 FC Adapter
fcs1      Available 06-09 FC Adapter
ics0      Available 08-09 iSCSI Adapter
ide0      Available 04-08 ATA/IDE Controller Device
sisscsia0 Available 05-08 PCI-X Dual Channel Ultra320 SCSI Adapter
usbhc0    Available 03-08 USB Host Controller (33103500)
usbhc1    Available 03-09 USB Host Controller (33103500)
usbhc2    Available 03-0a USB Enhanced Host Controller (3310e000)
vsa0      Available          LPAR Virtual Serial Adapter
```

Locating the WWPN for IBM Power Systems hosts running AIX

To attach your DS8000 to an AIX system, you must locate the worldwide port name (WWPN) for the host.

Procedure

To locate the WWPN, complete the following steps:

1. Log in as root.
2. Enter `lscfg -vl fcsx`, where `x` is the adapter number.

The network address is the Fibre Channel adapter port WWPN value.

Note: The `lscfg -vl fcsx` ROS level identifies the Fibre Channel adapter firmware level.

Attaching IBM Power Systems hosts running AIX

Learn the requirements and procedures for attaching an IBM Power Systems host that is running AIX to a storage system with Fibre Channel adapters. It is assumed that you properly connected and zoned the host, FC adapters, and SAN fabric with the storage.

Verifying the storage system configuration on IBM Power Systems hosts that are running AIX

Verify that the storage system is configured for Fibre Channel adapters so that you can attach it to an IBM Power Systems host that is running AIX.

Procedure

Enter the following command:

```
lsdev -Cc disk | grep 2107
```

Example

The following example shows the output for a successful configuration that uses the base AIX MPIO enablement:

```
hdisk3 Available 06-09-02      MPIO IBM 2107 FC Disk
hdisk4 Available 06-09-02      MPIO IBM 2107 FC Disk
hdisk5 Available 06-09-02      MPIO IBM 2107 FC Disk
hdisk6 Available 06-09-02      MPIO IBM 2107 FC Disk
...
...
```

For information about supported hardware and software configurations that use the DS8000, go to the *System Storage Interoperation Center (SSIC)* website at [IBM System Storage Interoperation Center \(SSIC\) website\(www-03.ibm.com/systems/support/storage/ssic/interoperability.was\)](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was).

Troubleshooting IBM Power Systems hosts that are running AIX

On a heavily loaded system, you might see lower-than-expected performance and errors that indicate that the host adapter is unable to activate an I/O request on the first attempt. The most likely cause of these errors is that the host is low on resources.

To reduce the incidence of these errors, complete the following steps to increase the resources by modifying the maximum transfer size attribute for the adapter:

1. To view the current setting, enter `lsattr -El adapter_name -a max_xfer_size`, where `adapter_name` is the name of the adapter that logs the error.

2. To increase the size of the setting, enter `chdev -l adapter_name -P -a max_xfer_size=0x1000000`.

Note: To view the range of allowable values for the attribute, enter `lsattr -Rl adapter_name -a max_xfer_size`.

3. Restart the host to use the updated setting.

Making SAN changes on IBM Power Systems hosts running AIX

You can change the storage area network (SAN) configuration on an IBM Power Systems host.

Before you begin

Before you make a SAN configuration change, ensure that AIX Dynamic Tracking is enabled for the Fibre Channel adapter. Dynamic Tracking enables AIX to detect changes in the Fibre Channel N_Port ID of the DS8000 and adjust I/O traffic as needed. Examples of SAN configuration changes are changing the switch port that is connected to the storage system or rebooting a switch.

To determine whether Dynamic Tracking is enabled on a Fibre Channel adapter:

1. Enter `lsattr -El fscsiX` where *fscsiX* is the FC SCSI I/O Controller Protocol Device that corresponds to the Fibre Channel adapter attached to the DS8000.
2. If the attribute **dyntrk** has a value of no, Dynamic Tracking of Fibre Channel devices is not enabled for this FC adapter. To enable Dynamic Tracking, enter `chdev -l fscsiX -a dyntrk=yes`

Notes:

1. You might need to unconfigure the Fibre Channel adapter to change the value of the **dyntrk** attribute. Complete the following procedure to unconfigure a Fibre Channel adapter. Alternatively, it is possible to use the **-P** option on the **chdev** command and then reboot the partition for the new **dyntrk** attribute value to take effect.
2. For a complete overview of AIX Dynamic Tracking of Fibre Channel device capabilities on IBM Power Systems see the https://www.ibm.com/support/knowledgecenter/ssw_aix.

About this task

You can modify the following steps, depending on the software stack on the AIX that is using the DS8000.

Procedure

To unconfigure the Fibre Channel adapter when used in a typical AIX configuration, complete the following steps.

1. Stop all I/O that is running to the affected disks.
2. For each host that is connected to the storage system, enter `umount filesystem_name` for all file systems to be unmounted.
3. Enter `varyoffvg VG_name` for each 2107/242x/533x volume group to be varied offline.
4. Enter `rmdev -d1 fcsadapter_number -R` to remove the Fibre Channel adapter.
The value of *adapter_number* is the number of the Fibre Channel adapter that you want to remove, for example, `rmdev -d1 fcs1 -R`.
5. Make all required SAN changes.
6. Enter `cfdgmgr` to reconfigure the adapter and rediscover the 2107/242x/533x hdisks.
7. Enter `varyonvg VG_name` for each 2107/242x/533x volume group to be varied online.
8. Enter `mount filesystem_name` to remount all file systems from all hosts that are connected to the storage system.
9. Resume I/O to the affected disks.

Support for Fibre Channel boot on IBM Power Systems hosts running AIX

IBM Power Systems hosts running AIX support both installation on and booting from DS8000 subsystem LUNs when you use AIX MPIO support.

For a complete overview of AIX installation capabilities on IBM Power Systems see the [AIX online product documentation \(www.ibm.com/support/knowledgecenter/ssw_aix/welcome\)](http://www.ibm.com/support/knowledgecenter/ssw_aix/welcome).

Note: When the **reserve_policy** attribute of the AIX root volume group disk or disks is set to a value of **no_reserve**, do not share the rootvg disks of your host with other hosts. This precautionary measure eliminates the potential for accidental modification of AIX rootvg data by other hosts.

IBM Power Systems hosts running Linux

If you have a Linux server, refer to the following requirements and procedures for attaching DS8000 storage to your Linux host with Fibre Channel.

Before you attach a host, refer to the following information:

For the most current information on supported hosts, operating systems, adapters, and switches, search the interoperability matrix at the [IBM System Storage Interoperation Center \(SSIC\) website\(www-03.ibm.com/systems/support/storage/ssic/interoperability.was\)](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was) website.

Linux host attachment overview

IBM supports the two largest commercial Linux distributions, Red Hat Enterprise Linux (RHEL) and SUSE Linux Enterprise Server (SLES). You can apply this information, in general, to other Linux distributions.

IBM supports various host bus adapters (HBAs) manufactured by Marvell QLogic and Broadcom Emulex. These guidelines assume that the HBA was previously installed. For all newer versions of RHEL and SLES, use the Linux multipathing driver, Device-Mapper Multipath (DM Multipath). This chapter assumes DM Multipath is used. Use the HBA driver that is included with the distribution.

The procedures for attaching DS8000 storage are similar to the procedures for attaching most storage systems to Linux. There might be more than one way to complete each procedure. For more information about configuring storage on your specific Linux distribution, see your distribution documentation. For example, detailed information for Red Hat is provided in the *Storage Administration Guide*, which is included in the Red Hat documentation.

Adding LUNs to a Linux host

To add DS8000 LUNs to a Linux host, complete the following steps.

1. Configure multipathing.
2. Scan for new LUNs.
3. Ensure that the LUNs are discovered and multipathed correctly.
4. Partition, format, and mount the multipathed devices, as needed.

For more information, see your Linux distribution documents.

Locating the WWPN for a Linux host

You can use several methods to locate the worldwide port names (WWPN) for a Linux host, however the simplest is the **sysstool** utility, which is included in the **sysfsutil** package.

To locate one or more WWPNs, enter the following command:

```
# sysstool -c fc_host -A "port_name"
```

Configuring Device-Mapper Multipath for a Linux host

Device-Mapper Multipath (DM Multipath) is the preferred multipathing method on Red Hat Enterprise Linux and SUSE Linux Enterprise Server.

For multipathing on Red Hat Enterprise Linux, use the defaults that are compiled into DM Multipath.

multipath.conf is a user-configurable file. The recommended settings are baseline recommendations and can be modified as needed.

Managing SCSI disk connectivity on a Linux host

To scan for new LUNs on RHEL/SLES, complete the following steps:

1. Upgrade the HBA driver to the latest stable version.
2. Install or upgrade **sg3_utils-* .rpm** to the latest version on RHEL/SLES.
3. Install or upgrade **scsi-* .rpm** to the latest version on SLES.
4. Ensure that the Device Mapper Multipath (DMMP) tool is enabled.
5. Enter `sh rescan-scsi-bus.sh -r`.
6. Enter `multipath`.
7. Enter `multipath -ll`.

Note: The format of the command string is lowercase "ll".

This adds any new LUNs to the configuration. No reboot is required.

To expand or shrink the LUN size on RHEL/SLES and above, complete the following steps:

1. Upgrade the HBA driver to the latest stable version.
2. Install or upgrade **sg3_utils-* .rpm** to the latest version on RHEL/SLES.
3. Install or upgrade **scsi-* .rpm** to the latest version on SLES.
4. Ensure that the Device Mapper Multipath (DMMP) tool is enabled.
5. Ensure that the LUNs that you want to expand or shrink are not mounted or in use by other applications.
6. Enter `sh rescan-scsi-bus.sh -r`.
7. Enter `multipath -F`.
8. Enter `multipath`.
9. Enter `multipath -ll`.

Note: The format of the command string is lowercase "ll".

This expands or shrinks the LUN size. No reboot is required.

For more information, see your Linux distribution documentation.

Configuring Linux hosts for SAN boot

You can configure various releases of Linux with DM Multipath for SAN boot.

Note: To complete these tasks, ensure that you have Fibre Channel FC switch zoning, HBA BIOS setting, and experience using the DS8000 command-line interface.

Configuring SUSE Linux Enterprise Server (SLES)

Complete the following steps:

1. Zone all the paths between server and the DS8000.
2. Create a host with either the DS8000 Storage Management GUI or the DS CLI.
3. If you are using the DS8000 Storage Management GUI, create a fixed block (FB) volume and map it to the host. If you are using the DS CLI, create an FB volume and map it to the host through a volume group. This FB volume is used to load the OS.
4. Enable HBA BIOS loading during boot, and select the newly mapped volume as a boot disk. For more information, see the HBA vendor BIOS setup guide.

Note: Disable the local hard disk through server BIOS.

5. Load SLES OS to the DS8000 volume.

6. On the disk selection page, use *custom partitioning*.
7. On the **Expert Partitioner** page, select **Hard Disks** > **Configure** > **Configure Multipath** > **Active Multipath**.
8. Partition the DM Multipath managed disk and install SLES on the local hard disk.
9. After installation, update `/etc/multipath.conf`:

```
defaults {
polling_interval 30
failback immediate
no_path_retry 5
rr_min_io 100
path_checker tur
user_friendly_names yes
}
devices {
# DS8000
device {
vendor "IBM"
product "2107900"
path_grouping_policy group_by_serial
}
}
```

Chapter 4. IBM SAN Volume Controller host attachment

If you have an IBM SAN Volume Controller server, refer to the following requirements and procedures for attaching DS8000 storage to your host using Fibre Channel.

Before you attach a host, refer to the following information:

- For an overview of host attachment requirements, see [“General requirements for attaching a host” on page 1](#).
- For the most current information on supported hosts, operating systems, adapters, and switches, go to the *System Storage Interoperation Center* (SSIC) website: [IBM System Storage Interoperation Center \(SSIC\) website\(www-03.ibm.com/systems/support/storage/ssic/interoperability.was\)](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was).

For more information, go to the SAN Volume Controller website <https://www.ibm.com/support/knowledgecenter/STPVGU>.

Note: You must create a host entry for every port on every SAN Volume Controller node in your cluster. For example, a four-node SAN Volume Controller requires 16 host entries.

Chapter 5. IBM Z host attachment

If you have an IBM Z host, refer to the following requirements and procedures for attaching DS8000 storage to your host by using a Fibre Channel or FICON adapter.

This chapter contains the following sections:

- [“FICON attached IBM Z hosts overview” on page 29](#)
- [“FICON considerations for IBM Z hosts” on page 31](#)
- [“FICON migration overview for IBM Z hosts” on page 31](#)
- [“Linux on IBM Z host attachment” on page 31](#)
- [“Registered state-change notifications on IBM Z hosts ” on page 36](#)
- [“Analyzing service information messages for IBM Z hosts” on page 36](#)

Before you attach a host, refer to the following information:

- For an overview of host attachment requirements, see [“General requirements for attaching a host” on page 1](#).
- For the most current information on supported hosts, operating systems, adapters, and switches, go to the *System Storage Interoperation Center (SSIC) website*: [IBM System Storage Interoperation Center \(SSIC\) website\(www-03.ibm.com/systems/support/storage/ssic/interoperability.was\)](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was).

FICON attached IBM Z hosts overview

The storage system can be attached to FICON attached IBM Z host operating systems under specified adapter configurations.

Each storage system Fibre Channel adapter has four ports. Each port has a unique worldwide port name (WWPN). You can configure the port to operate with the FICON upper-layer protocol.

With Fibre Channel adapters that are configured for FICON, the storage system provides the following configurations:

- Either fabric or point-to-point topologies
- A maximum of 32 ports on model 993, 64 ports on model 994, 996, or 998 (without expansion model E96), and 128 ports on model 996 or 998 with an expansion model E96.
- A maximum of 509 logins per Fibre Channel port
- A maximum of 8,192 logins per storage system
- A maximum of 1,280 logical paths on each Fibre Channel port
- Access to all 255 control-unit images (65,280 CKD devices) over each FICON port
- A maximum of 512 logical paths per control unit image

Note: IBM z13[®], IBM z14[®] and IBM z15 servers support 32,768 devices per FICON host channel, while IBM zEnterprise[®] EC12 and IBM zEnterprise BC12 servers support 24,576 devices per FICON host channel. Earlier IBM Z servers support 16,384 devices per FICON host channel. To fully access 65,280 devices, it is necessary to connect multiple FICON host channels to the storage system. You can access the devices through a Fibre Channel switch or FICON director to a single storage system FICON port.

The storage system supports the following operating systems for IBM Z hosts:

- Linux
- Transaction Processing Facility (TPF)
- Virtual Storage Extended/Enterprise Storage Architecture
- z/OS[®]
- z/VM[®]

- z/VSE®

For the most current information on supported hosts, operating systems, adapters, and switches, go to the IBM System Storage Interoperation Center (SSIC) website(www-03.ibm.com/systems/support/storage/ssic/interoperability.was).

Attaching an IBM Z host with FICON adapters

You can configure an IBM Z host for FICON attachment to a DS8000.

See the *IBM DS8000 Introduction and Planning Guide* for a list of the FICON host adapter feature codes. This guide also contains the number of FICON host adapters, cable group numbers, number of cables, and connector IDs to order for the cables.

FICON attachment overview for IBM Z hosts

You can attach the FICON channels directly to a storage unit or you can attach the FICON channels to a Fibre Channel switch.

You can use either longwave or shortwave adapters with IBM Z hosts. The adapter for the IBM Z has two or four channel ports.

Note: Depending on your DS8000 model, you might need to purchase a FICON license. See the *IBM DS8000 Introduction and Planning Guide* for more information.

When you attach the FICON channels directly to a storage system, the maximum number of FICON attachments is limited by the number of installed FICON I/O ports on the storage system. When you use a storage system host adapter to attach to FICON channels either directly or through a switch, the I/O port is dedicated to FICON attachment. It cannot be simultaneously attached to SCSI hosts.

Note: SCSI hosts include IBM Z hosts, which access storage through the SCSI-over-FC protocol (FCP).

When you attach a storage system to FICON channels through one or more switches, the maximum number of FICON attachments is 509 per storage system I/O port. The maximum number of logins per storage system through all I/O ports is 8,192.

Directors provide high availability with redundant components and no single points of failure or repair. You can use directors to attach Fibre Channel hosts and devices in addition to the FICON hosts and devices. For these configurations, the Fibre Channel hosts must communicate only with the Fibre Channel devices. The FICON hosts must communicate only with the FICON devices. Set up zones in the directors to guarantee that none of the Fibre Channel hosts or devices can affect the FICON traffic.

To support cascaded switches, the fabric must be what is called a high integrity fabric. A high integrity fabric ensures data integrity by detecting any incorrect cabling within a FICON cascaded switch fabric that could lead to I/O data being delivered to the wrong destination. A high integrity fabric is one that both supports and is configured to use fabric-binding and insistent domain IDs. Fabric-binding is the ability of the fabric to prevent another switch from being added operationally to the fabric without the new switch being properly planned for in the fabric and for the switch to be configured with the high integrity attributes. An insistent domain ID is a function of the fabric that does not allow the switch address to be automatically changed when a duplicate switch address is added to the fabric. Instead, fabrics that use insistent domain IDs require an operator's overt action to change a switch address. The customization of fabric-binding and the setting of an insistent domain ID are normally done only at switch installation time or reinstallation time.

Note: Switches that do not support high integrity fabrics can only be used in a single-switch FICON fabric.

With Fibre Channel and FICON-intermix mode, both Fibre Channel Protocol (FCP) and FICON upper-level protocols can be supported within the same director when deployed independently by port. (Director ports operate in either Fibre Channel or FICON mode).

For the most current information on supported hosts, operating systems, adapters, and switches, go to the IBM System Storage Interoperation Center (SSIC) website(www-03.ibm.com/systems/support/storage/ssic/interoperability.was).

FICON considerations for IBM Z hosts

Before you configure your system with FICON adapters for IBM Z hosts, review considerations regarding the number of links, multipathing, and channel-path groups.

Multipathing FICON

With multipath mode operation, reconnections can occur on any path in a path group. Increasing the number of paths allows reconnections to occur in a more timely basis. If you use eight paths in path groups, you can increase the overall throughput.

FICON allows a multiplex of requests for different devices concurrently. There is no problem with reconnections occurring concurrently with other I/O operations on a single path with FICON. The number of paths in the path group depends on the throughput requirement. If it takes x paths to satisfy the throughput requirement, where x is the number of paths, set the path group to x .

Note: x must be a minimum of two and cannot exceed a maximum of eight.

Attaching to a FICON channel or a FICON channel-path group

When you attach multiple controllers to a channel, you are connecting serially. You can use a switch (director) for each controller or FICON channel that has a direct connection to the controller. I/O activity does not flow through all the other controllers before you get to the target controller. I/O activity goes directly to the target controller. When multiple controllers are connected to a channel through a switch, you create the logical equivalent of the parallel interconnection.

FICON does not support a private connection. FICON performs frame (or packet) multiplexing. A configuration with the serially connected controllers communicates with the controllers simultaneously. It can multiplex I/O operations across all controllers simultaneously. No interface cycles are wasted because of a private connection. You can serially connect controllers with FICON without performance degradation.

You must also consider the implications of serially connecting disk drive control units with tape controllers. Tape performs much larger I/O operations at any instant in time. Therefore, even with FICON, when you run tape I/O, you can temporarily *lockout* some disk drive I/O operations. It is still better to connect tape and disk drives to different FICON channels.

FICON migration overview for IBM Z hosts

On an IBM Z host, you can migrate from a FICON bridge to a FICON adapter.

Notes:

1. FICON attachment is supported on all /242x/533x models.
2. FICON support consists of hardware enhancements for enterprise servers, host software upgrades, DS8000 LMC, and adapters.

Linux on IBM Z host attachment

If you have an IBM Z server that is running the Linux operating system, refer to the requirements and procedures for attaching your host to a DS8000 storage system.

Before you attach a storage system to any host, review the information in [“General requirements for attaching a host”](#) on page 1.

Running Linux on IBM Z hosts

You can run Linux on IBM Z host in a Logical Partition (LPAR) or as a z/VM guest.

z/VM provides virtualization of central processing units, I/O subsystems, and memory. You can have hundreds of Linux systems running on a single IBM Z host. For example, you can offer a complete Linux

server environment to each of the application developers and host production systems that are on the same IBM Z host.

IBM supports the following Linux distributions as servers on an IBM Z host for a storage system:

- Red Hat Enterprise Linux: versions 7.7 and higher / 8.1 and higher
- SUSE Linux Enterprise Server: versions SLES 12 SP5, SLES 15 SP1, and higher service packs
- Ubuntu: versions 20.04 LTS, 18.04.3 LTS and higher service packs

FICON and Fibre Channel Protocol (FCP) attached hosts are also supported.

For the most current information about supported Linux operating systems for IBM Z hosts, see [Linux on IBM Z tested platforms](https://www.ibm.com/it-infrastructure/z/os/linux-tested-platforms)(<https://www.ibm.com/it-infrastructure/z/os/linux-tested-platforms>).

For more information about interoperability with IBM Z hosts, see [IBM System Storage Interoperation Center \(SSIC\) website](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was)(www-03.ibm.com/systems/support/storage/ssic/interoperability.was).

Attachment requirements for IBM Z hosts running Linux

Before you begin attaching a IBM Z host running the Linux operating system to your DS8000, review the host and storage system requirements.

Complete the following tasks:

- Check the volume or LUN limitations for your host system.
- Ensure that you have the documentation for your host system and the DS8000: <https://www.ibm.com/support/knowledgecenter/SSHGBU>
- Ensure that you have installed the correct operating systems and are running a supported Linux kernel.
- Review the distribution-specific documentation for Linux on IBM Z on the [IBM developerWorks® Linux on IBM Z distribution hints webpage](http://www.ibm.com/developerworks/linux/linux390/distribution_hints.html) (www.ibm.com/developerworks/linux/linux390/distribution_hints.html). Check the following information for the Linux kernel that you are using:
 - Supported platforms and environments
 - Hardware and software requirements

HBAs for IBM Z hosts that are running Linux

Ensure that you use the correct Linux host bus adapter (HBA) and software on your IBM Z host.

Table 9 on page 32 lists the supported HBAs for IBM Z hosts that are running the Linux operating system.

For the most current interoperability information about supported HBAs and operating system levels, go to [IBM System Storage Interoperation Center \(SSIC\) website](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was)(www-03.ibm.com/systems/support/storage/ssic/interoperability.was).

<i>Table 9. Supported HBAs for Linux on IBM Z and IBM LinuxONE</i>		
Hosts	Operating systems	Supported HBAs¹
zEnterprise EC12	SUSE Linux Enterprise Server and Red Hat® Enterprise Linux AS	FICON Express4, FICON Express8, and FICON Express8S
IBM z13, LinuxONE Emperor, and LinuxONE Rockhopper	SUSE Linux Enterprise Server and Red Hat Enterprise Linux AS	FICON Express8 (supported only on z13), FICON Express8S, FICON Express16S

Table 9. Supported HBAs for Linux on IBM Z and IBM LinuxONE (continued)

Hosts	Operating systems	Supported HBAs ¹
IBM z14, LinuxONE Emperor II, and LinuxONE Rockhopper II	SUSE Linux Enterprise Server, Red Hat Enterprise Linux AS, and Ubuntu	FCP Express [®] 32S (supported only on LinuxONE Emperor II, and LinuxONE Rockhopper II), FICON Express8S (supported only on z14), FICON Express16S (supported only on z14), and FICON Express16S+
IBM z15 [®] and LinuxONE III	SUSE Linux Enterprise Server, Red Hat Enterprise Linux AS, and Ubuntu	FICON Express16SA ² , FCP Express 32S (supported only on LinuxONE III), FICON Express8S (supported only on z15), FICON Express16S (supported only on z15), and FICON Express16S+ ³
<p>Notes:</p> <ol style="list-style-type: none"> ¹IBM Z HBAs must be ordered as an additional feature for the host system. HBAs are either factory-installed on the host system or installed in an existing system by an IBM service representative. ²FICON Express 16SA is supported on LinuxONE III model LT1 and z15 model T01. ³FICON Express 16S+ is supported on z/15 models T01 and T02 and on LinuxONE III model LT2, but it is not supported on LinuxONE III model LT1. 		

Drivers and firmware for IBM Z hosts running Linux

Ensure that you use the correct kernel version and firmware levels for your IBM Z host.

For the most current interoperability information about supported device driver and firmware levels, go to [IBM System Storage Interoperation Center \(SSIC\) website\(www-03.ibm.com/systems/support/storage/ssic/interoperability.was\)](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was).

Installing and configuring HBAs on IBM Z hosts running Linux

Verify that the host bus adapters (HBAs) are properly installed on the IBM Z host that is running Linux, and configure the HBAs for attachment to your DS8000 system.

Procedure

To verify the installation of an HBA and to configure the HBA to work with the DS8000 system, complete the following steps:

1. Ensure that a supported HBA is installed on the IBM Z host. [Table 9 on page 32](#) lists the supported HBAs.
2. Configure the HBA to run in FICON or FCP mode.
3. When using an HBA in FCP mode, and multiple guest systems are sharing the HBA for access to the storage controller, enable the N-Port-ID Virtualization (NPIV) mode of the HBA.

Configuring IBM Z HBAs in FICON mode

You can attach the DS8000 system to Linux on IBM Z hosts with FICON attachment. Access to FICON attached storage devices is provided by the DASD device driver of the Linux operating system.

Before you begin

Review information about FICON attachment for IBM Z hosts.

About this task

For more information, see the latest edition of *Linux on IBM Z Device Drivers, Features, and Commands* for the Linux kernel that you are using. You can access this publication on the IBM developerWorks website at IBM Developerworks Linux on IBM Z website (www.ibm.com/developerworks/linux/linux390). This website has specific documentation for Red Hat Enterprise Linux and SUSE Linux Enterprise Server distributions, as well as generic information.

Configuring IBM Z HBAs in FCP mode

You can attach the DS8000 to Linux on IBM Z hosts with FCP attachment.

About this task

Access to FCP-attached storage devices is provided by the SCSI disk device driver and the zFCP HBA driver of the Linux operating system. For information about FCP connectivity, go to [IBM IBM Z I/O Connectivity website \(www.ibm.com/systems/z/connectivity\)](http://www.ibm.com/systems/z/connectivity).

Configuring IBM Z hosts with zFCP attachment

You can use the zFCP device driver to configure FCP connectivity between a Linux on IBM Z host and your DS8000 system.

Before you begin

You must configure the Linux operating system before you can use your IBM Z host with the DS8000 system.

Before you configure the host operating system, the following tasks must be completed:

- An IBM service representative must install the DS8000 system.
- You must install the appropriate HBAs.

Procedure

After the prerequisite tasks are finished, complete the following steps to configure your Linux on IBM Z hosts:

1. Zone the host system to the DS8000 system on the Fibre Channel SAN.
2. Create the host connection on the DS8000 system using the worldwide port names (WWPNs), and map the volumes to the host, as required.

For information on using the DS8000 Storage Management GUI or the DS CLI to create hosts and map volumes, see the <https://www.ibm.com/support/knowledgecenter> and search for DS8900.

3. Configure the Linux operating system for FCP attachment.

For more information, see the latest edition of *Device Drivers, Features, and Commands* for the Linux kernel that you are using. You can access this publication on the IBM developerWorks website at [IBM Developerworks Linux on IBM Z website \(www.ibm.com/developerworks/linux/linux390\)](http://www.ibm.com/developerworks/linux/linux390). For additional information, go to the publication [FC-attached SCSI devices with Linux on IBM Z](#).

4. Create either volumes or disks on your host with the logical volume manager. If you create disks, create file systems on the disks.

For more information, refer to your host system publications.

Installing multipath support for Linux on z Systems hosts with zFCP attachment

You can configure multipath support for a Linux on z Systems® host that is using the zFCP device driver or Parallel Access Volumes (PAV).

Before you begin

If you are using the FCP attachment, you must install multipath software on all IBM Z hosts that are attached to the DS8000.

About this task

On IBM Z hosts running the Linux operating system, the following software provides multipath support:

- Multipath-tools package

Recommended `/etc/multipath.conf` settings

```
defaults {
    user_friendly_names    no
    dev_loss_tmo           infinity
    fast_io_fail_tmo       5
    no_path_retry          queue
}
```

For more information about using the logical volume manager or the multipath-tools package, go to [IBM Developerworks Linux on z Systems website \(www.ibm.com/developerworks/linux/linux390\)](http://www.ibm.com/developerworks/linux/linux390).

SAN boot support on IBM Z hosts running Linux

You can perform an initial program load (IPL) from a SCSI LUN. However, be aware that the boot can fail if there is no multipath support during the boot process.

For more information about using IPL processes with IBM Z hosts, see the latest edition of *How to use FC-attached SCSI devices with Linux on Z*. You can access this publication on the IBM developerWorks website at [IBM Developerworks Linux on Z website \(www.ibm.com/developerworks/linux/linux390\)](http://www.ibm.com/developerworks/linux/linux390).

Defining the number of disks on IBM Z hosts running Linux

When you define the number of disks on IBM Z hosts that are running the Linux operating system, you allocate space for configured disks.

About this task

On the Linux operating system, disks are represented as device files. The maximum number of devices depends on your Linux configuration.

DS8000 storage configuration for IBM Z hosts running Linux

Each attached DS8000 LUN has a special device file in the Linux directory `/dev`. The maximum number of devices depends on your Linux configuration.

For more information, see the latest edition of *Device Drivers, Features, and Commands* for the Linux kernel that you are using. You can access this publication on the IBM developerWorks website at [IBM Developerworks Linux on Z website \(www.ibm.com/developerworks/linux/linux390\)](http://www.ibm.com/developerworks/linux/linux390).

Known issues and limitations for IBM Z hosts running Linux

There are several restrictions for IBM Z hosts running the Linux operating system.

For the most current information on restrictions, see the [IBM Developerworks Linux on Z website \(www.ibm.com/developerworks/linux/linux390\)](http://www.ibm.com/developerworks/linux/linux390).

For additional information, go to the following websites:

- Red Hat website at [Red Hat website \(www.redhat.com\)](http://www.redhat.com)
- SUSE website at [SUSE website \(www.suse.com\)](http://www.suse.com)

Registered state-change notifications on IBM Z hosts

Review information about registered state-change notifications (RSCNs) on IBM Z hosts.

This configuration enables all ports in the switch with a Fibre Channel connection to communicate with each other and to receive RSCNs about each other. You can set the zones.

Review the following recommendations:

- If you have FICON-only environments, do not disable the default zone.
- If you have FICON environments and plan to add (or already have) Fibre Channel intermix on the switch, ensure that all FICON host adapters and all FICON-capable device ports are in an explicitly defined common zone.
- If you have open-systems traffic with Fibre Channel Protocol, continue to create zones that include the host ports and storage ports. Multiple overlapping zones must be used in this case to support communication from multiple host ports to share device ports.

Analyzing service information messages for IBM Z hosts

Service information messages (SIMs) are generated by a storage system for IBM Z hosts. Use the customization worksheets before installation to record the SIM severity level and the maximum number of times the storage system sends the SIMs to the console (0-5 times). During installation, you (or the IBM service representative) must enter this information into the system.

SIM types

The following SIM types are generated by the storage system.

Direct access storage device (DASD) SIM

Tracks drive failures and problems.

Media SIM

Tracks data check problems on the media.

Storage unit SIM

Tracks storage system, power control, and other hardware problems.

SIM severity levels

1 acute

An unrecoverable error with possible loss of data. This severity level applies only to DASD SIMs.

2 serious

An unrecoverable error or a data check with loss of access to data.

3 moderate

A system path is not operational and performance might be degraded. This severity level does not apply to media SIMs.

4 service

A recoverable error, equipment checks, or data checks. You can defer repair.

Chapter 6. Microsoft Windows Server host attachment

If you have a Windows Server 2012, 2016, or 2019, refer to the following requirements and procedures for attaching DS8000 storage to your host with Fibre Channel.

This chapter contains the following sections:

- [“Installing Fibre Channel adapters and drivers on a Windows host” on page 37](#)
- [“Updating a Windows Server device driver” on page 38](#)
- [“Locating the WWPN for a Windows host” on page 38](#)
- [“Verifying that the Windows host is configured for storage” on page 39](#)
- [“Installing remote Fibre Channel boot support for a Windows host ” on page 39](#)

Before you attach a host, refer to the following information:

- For an overview of host attachment requirements, see [“General requirements for attaching a host” on page 1](#).
- For the most current information on supported hosts, operating systems, adapters, and switches, go to the *System Storage Interoperation Center* (SSIC) website: [IBM System Storage Interoperation Center \(SSIC\) website\(www-03.ibm.com/systems/support/storage/ssic/interoperability.was\)](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was).

LUN mapping: When you need access to the data on the target volume, map to the LUNs for the target volumes of the Windows host. This significantly reduces the time that it takes for the host system to restart. If you do not map the LUNs, the system can take up to 10 minutes per Remote Mirror and Copy target volume to map the LUNs. If you map the LUNs, complete the LUN mapping after the Remote Mirror and Copy operation and immediately before you access the data. You must restart the host system before you can access the data on the target volume. Map the LUNs when the target volume is mapped to the host through the DS8000 Storage Management GUI.

Installing Fibre Channel adapters and drivers on a Windows host

Install Fibre Channel adapters and drivers on your Windows Server 2012, 2016, or 2019 before you connect the host to your DS8000 system.

Installing a Broadcom Emulex adapter and driver on a Windows host

You can install and configure a Broadcom Emulex adapter and driver on Windows Server 2012, 2016, or 2019.

About this task

Single- and dual-port, Fibre Channel interfaces with a Broadcom Emulex adapter support the following public and private loop modes:

- Target
- Public initiator
- Private initiator
- Target and public initiator
- Target and private initiator

For the most current information about supported Emulex adapters, go to the *System Storage Interoperation Center* (SSIC) website at [IBM System Storage Interoperation Center \(SSIC\) website\(www-03.ibm.com/systems/support/storage/ssic/interoperability.was\)](http://www-03.ibm.com/systems/support/storage/ssic/interoperability.was).

Procedure

To install and configure a Broadcom Emulex adapter and driver, complete the following steps:

1. Record the IEEE number that is printed on the adapter. You can use the IEEE number to determine the WWPN.
2. Install and configure the adapter and driver on the host. See the installation instructions that are provided by your host adapter vendor for specific adapter and adapter driver instructions. Go to [Broadcom Support Documents and Downloads](#).
3. Connect the cable to the adapter and to the DS8000 or switch port that you configured for the host adapter. If you have not configured host adapter ports on your DS8000, see [“Host configuration using the DS8000 Storage Management GUI” on page 9](#).
4. Restart the host.

Installing a Marvell QLogic adapter and driver on a Windows host

You can install and configure a Marvell QLogic adapter and driver on Windows Server 2012, 2016, or 2019.

Procedure

To install and configure a Marvell QLogic adapter and driver, complete the following steps:

1. Install the Marvell QLogic adapter on the host system.
2. Connect the cable to the storage system port.
3. Install and configure the adapter driver. See the installation instructions that are provided by your host adapter vendor for specific adapter and adapter driver instructions. Go to [“Downloading and installing a host bus adapter driver” on page 1](#) or to [Marvell Drivers and Documentation \(http://driverdownloads.qlogic.com/QLogicDriverDownloads_UI/IBM_Search.aspx\)](http://driverdownloads.qlogic.com/QLogicDriverDownloads_UI/IBM_Search.aspx).
4. Restart the host.

Updating a Windows Server device driver

You can replace an existing Windows Server 2012, 2016, or 2019 device driver with an updated version.

Procedure

To update a Windows Server device driver, complete the following steps:

1. Right-click **My Computer** and select **Manage > Device Manager**.
2. Expand the menu for **Storage Controllers**.
3. Right-click the adapter that you want to update and select **Properties**.
4. Select the **Driver** tab.
5. Click **Update Driver** and follow the instructions that are displayed on the screen.

Locating the WWPN for a Windows host

To attach your DS8000 to a Windows Server 2012, 2016, or 2019 with an Emulex or QLogic adapter, you must locate the worldwide port name (WWPN) for the host.

About this task

To locate the WWPN, complete the steps for the adapter you are using.

• Emulex adapter with OC Manager

1. Use OneCommand Manager to locate the WWPN. You can download it from the [Broadcom website \(www.broadcom.com\)](http://www.broadcom.com).

2. After you install OneCommand Manager, start the application by selecting **Start > Programs > Emulex > OCManager**.
 3. In the left pane, double-click the host name. It expands to display the WWPN of the HBA that is installed on the host.
- **Emulex adapter with Emulex Lightpulse BIOS Utility**
 1. Restart the server.
 2. Press Alt+E or Ctrl+E to open the **Emulex Lightpulse BIOS Utility** menu. The 16-digit alphanumeric string is displayed on the screen.
 - **QLogic adapter with the SANsurfer tool and QConvergeConsole**

Note: You can use this tool to locate the WWPN without restarting the server.

 1. Go to the Marvell website at [Marvell website \(www.marvell.com\)](http://www.marvell.com) and click the **Downloads** tab.
 2. On the **Downloads** page, select your adapter type, model, and operating system, and then click **Go**.
 3. On the adapter page, go the tools list to download the SANsurfer tool and QConvergeConsole for Windows Server.
 - **QLogic adapter with the FAST!Util utility**
 1. Restart the server.
 2. Press Alt+Q to open the **FAST!Util** menu.

Note: If more than one Fibre Channel adapter is installed, all of the Fibre Channel adapters are displayed. Scroll down to the adapter you want and press Enter.
 3. From the **FAST!Util** menu:
 - a. Scroll down and select **Select Host Adapter**.
 - b. Scroll up and select **Configuration Settings**.
 - c. Press Enter.
 4. From the **Configuration Settings** menu, select **Host Adapter Settings**.
 5. Write down the 16-digit alphanumeric string that is displayed on the screen.

Verifying that the Windows host is configured for storage

Determine whether a Windows Server 2012, 2016, or 2019 is configured for storage.

Procedure

To verify that the Windows host is configured for storage, complete the following steps:

1. Partition new drives with Disk Management.
2. From the Windows Server desktop, right-click **Start**.
3. Click **Explore** and verify that you can see the Fibre Channel drives.
4. Select a large file (for example, 9 MB file), and drag (copy) it to a Fibre Channel drive.
5. Verify that the file was copied to the selected drive.

Installing remote Fibre Channel boot support for a Windows host

You can install remote Fibre Channel boot support on a Windows Server 2012, 2016, or 2019.

Before you begin

You must obtain the following items for the Windows host before you can begin to install remote Fibre Channel boot support:

- The *IBM DS8000 Introduction and Planning Guide*.

- The Windows installation instructions.
- The supported Fibre Channel host adapter driver package.
- The supported Fibre Channel host adapter driver documentation.

Ensure that the host adapters are installed and cable connections of the host, switch, and storage system are complete and functional.

About this task

Remote Fibre Channel boot support is available for Windows Server with **MSDSM**.

Configure zoning and obtain storage

Complete this task to configure zoning and obtain storage.

Procedure

1. Obtain the WWPN for each host adapter.
For instructions, see [“Locating the WWPN for a Windows host” on page 38](#).
2. Zone only one path between the server and DS8000 I/O port.
3. Use the DS8000 Storage Management GUI to add the host to the list of host systems that are available for attachment to the storage system. For information about the DS8000 Storage Management GUI, see the IBM DS8000 series online product documentation (<https://www.ibm.com/support/knowledgecenter/SSHGBU>).
4. Use the DS8000 Storage Management GUI to allocate storage to the host system.

Check BIOS level

Because the host adapter BIOS is responsible for scanning the Fibre Channel bus to locate the remote boot device, ensure that the latest supported host adapter BIOS is loaded. If not, follow the host adapter documentation to update the BIOS of the host adapter.

Configure Marvell QLogic and Broadcom Emulex host adapters

Complete this task to configure the Marvell QLogic and Broadcom Emulex host adapters.

Procedure

1. Return to the host system and complete the following steps:
 - **Marvell QLogic host adapters**
 - a. When the BIOS banner is displayed press **Ctrl+Q** or **Alt+Q**. The Marvell QLogic Fast!UTIL menu is displayed. Depending on the host adapter BIOS version, the BIOS menu might be different in the following steps:
 - Select **Configuration Settings** → **Host Bus Adapter Settings**. Set **Host Adapters BIOS** for only one of the adapters to **Enabled** and set **Connection Options** appropriately. For example, set **Connection Options** to **Loop Preferred**; otherwise, **Point to Point**. Press **ESC** to return to the previous menu.
 - Select **Configuration Settings** → **Selectable Boot Settings**. Set **Selectable Boot** to **Enabled** and select the appropriate Boot Port Name and LUN that corresponds to the WWPN of the storage system.
 - **Broadcom Emulex host adapters:**
 - a. When the BIOS banner is displayed, press **Ctrl+E** or **Alt+E** as indicated, depending on the BIOS level. A list of adapters is displayed. Select an adapter by entering the appropriate number, and complete the following steps:

- Set only one host adapter to Enabled and set **Topology** appropriately. For example, set **Topology** to **Loop First** (default). Press ESC to return to the previous menu.
 - Select **Configure Boot Devices** and configure one boot device which includes the boot device, the boot entry WWPN, and the starting LUN.
2. Exit the BIOS utility and save the changes.

Complete the Windows installation

Complete this task to finish installing remote Fibre Channel boot support on Windows Server 2012, 2016, or 2019.

Procedure

Apply the Windows Server 2012, 2016, or 2019 installation instructions. These instructions include the following steps:

1. Reboot the host system and insert the Windows setup CD in the CD drive.
2. If prompted with the message, `Press any key to boot from CD`, press any key.
3. In the **Welcome to Setup** window, press **Enter**.
The message `Set up of Windows now` is displayed.
4. Answer appropriately in the **Windows Licensing Agreement** window.
5. Press ESC to reply to the `Continue installing a fresh copy of Windows` prompt.
6. When prompted, choose the drive on the storage system where you want to install the Windows operating system.

Complete Windows post-installation

Procedure

1. After the Windows Server installation is complete, configure the MSDSM. For information about configuring the MSDSM, see the [Microsoft Multipath I/O Step-by-Step Guide](#).
2. Update zoning on the switch to enable the availability of multiple paths.

Chapter 7. VMware ESXi/ESX host attachment

If you have a VMware ESXi/ESX server, learn the following requirements and procedures for attaching DS8000 storage to your host with Fibre Channel.

Notes:

- This information applies to VMware ESX/ESXi Server 6.5 and later.
- For information on how to boot ESX/ESXi from a Fibre Channel SAN, see <https://docs.vmware.com/en/VMware-vSphere/6.7/com.vmware.vsphere.storage.doc/GUID-9004389B-E2C0-4BE5-811C-E4886E3B7450.html> for information.

This chapter contains the following sections:

- [“Installing the Broadcom Emulex adapter for a VMware ESXi/ESX host” on page 44](#)
- [“Installing the Marvell QLogic adapter and driver for a VMware ESXi/ESX host” on page 44](#)
- [“Defining the number of disk devices on a VMware ESXi/ESX host” on page 45](#)
- [“SCSI disk considerations for a VMware ESXi/ESX host” on page 45](#)
- [“Configuring a VMware ESXi/ESX host” on page 45](#)
- [“Copy Services considerations for VMware ESXi/ESX hosts” on page 46](#)
- [“Selecting a multipath policy for a VMware ESXi/ESX host” on page 47](#)

Before you attach a host, refer to the following information:

- For an overview of host attachment requirements, see [“General requirements for attaching a host” on page 1](#).
- For the most current information on supported hosts, operating systems, adapters, and switches, go to the *System Storage Interoperation Center* (SSIC) website: [IBM System Storage Interoperation Center \(SSIC\) website\(www-03.ibm.com/systems/support/storage/ssic/interoperability.was\)](http://www.ibm.com/systems/support/storage/ssic/interoperability.was).

In addition, review the VMware product documentation for the version of VMware that you are using. You can access the VMware documentation at [VMware \(www.vmware.com\)](http://www.vmware.com).

LUN limitations: The calculated LUN limitations ([Table 10 on page 43](#)) includes a combination of the following VMware limitations:

- Maximum of 64 LUNs running I/Os concurrently
- Less than 2048 paths managed by multipathing

Number of paths	Maximum number of LUNs configured on storage system / HBA
1 through 16	64
32	31

VMware configuration maximums can be viewed at: <https://configmax.vmware.com/>.

Installing the Broadcom Emulex adapter for a VMware ESXi/ESX host

You can install a Broadcom Emulex adapter for a VMware ESXi/ESX Server host.

About this task

Single and dual-port Fibre Channel interfaces with an Emulex adapter support the following public and private loop modes:

- Target
- Public initiator
- Private initiator
- Target and public initiator
- Target and private initiator

Procedure

To install the Emulex adapter, complete the following steps:

1. Record the Institute of Electrical and Electronics Engineers (IEEE) number that is printed on the card. You can use the IEEE number to determine the WWPN.
2. For VMware ESXi server v5.5 and later, you can use `/usr/lib/vmware/vmkmgmt_keyval/vmkmgmt_keyval -a` to find the WWPN of the host adapter.
3. See the installation instructions provided by your host adapter vendor. For the latest information and firmware, see the [Broadcom website \(www.broadcom.com\)](http://www.broadcom.com).

Installing the Marvell QLogic adapter and driver for a VMware ESXi/ESX host

You can install a Marvell QLogic adapter and driver for a VMware ESXi/ESX host.

About this task

Single- and dual-port Fibre Channel interfaces with the Marvell QLogic adapters support the following public and private loop modes:

- Target
- Public initiator
- Private initiator
- Target and public initiator
- Target and private initiator

The following procedure is an example for a Marvell QLogic QLA23xx adapter. The configuration for your adapter might differ.

Procedure

1. Install the Marvell QLogic adapter in the host system.
2. Connect the cable to the adapter and to the DS8000 or switch port that you configured for the host adapter. If you have not configured host adapter ports on your DS8000, see [“Host configuration using the DS8000 Storage Management GUI” on page 9](#).
3. Restart the server.

4. Install the adapter driver on the host. See the installation instructions that are provided by your host adapter vendor for specific adapter and adapter driver instructions. Go to “[Downloading and installing a host bus adapter driver](#)” on page 1 or Marvell Support (www.marvell.com/support).
5. Restart the server.

Defining the number of disk devices on a VMware ESXi/ESX host

The maximum number of disk devices that are supported on a VMware ESXi/ESX server is 512 LUNs per host. The embedded multipathing capability of the VMkernel can manage up to 2048 paths.

The maximum number of LUNs that can be used must accommodate these two limitations.

VMware configuration maximums can be viewed at: <https://configmax.vmware.com/>.

SCSI disk considerations for a VMware ESXi/ESX host

You can identify specific LUNs or disk devices that are connected to the VMware ESXi/ESX server.

LUN identification for a VMware ESXi/ESX host

Each of the attached storage system LUNs has a special device file in the `/dev/disks` operating system directory. The maximum number of LUNs is 256 and the format is `/dev/disks/naa.xxxx`.

You can trace the storage system from the VMware ESXi/ESX server through the following layers:

- *Host adapter level* - The host adapter driver provides the list of LUNs that are detected for each Fibre Channel port.
- *Vmhba level* - VMware virtualizes the host adapter as a VMware host bus adapter from which you can retrieve the information that is related to the multipathing.

Host adapter level

The host adapter driver (`lpfxxx` for Emulex or `qla23xx` for QLogic) provides information about the port base. The content of the information varies according to the driver. The directory `/proc/scsi/driver_name/adapter_number` provides the information for a specific adapter/port.

Vmhba level

For information about how to identify a specific LUN connected to a VMware ESXi/ESX server, see the VMware Knowledge Base article at <https://kb.vmware.com/s/article/1014953>.

Disk device discovery on a VMware ESXi/ESX host

You can rescan storage for disk device discovery on a VMware ESXi/ESX server.

For information about how to rescan storage on a VMware ESXi/ESX server, see the VMware Knowledge Base article at <https://ibm.biz/Bdquv7>.

Configuring a VMware ESXi/ESX host

You can partition a server disk and create a file system on a VMware ESXi/ESX server.

The following requirement is necessary only when different host adapters are on the same VMware ESXi/ESX server, not when devices are shared between VMware ESXi/ESX servers. VMware ESXi/ESX multipathing requires that the storage system present the drive modules in the same LUN sequence for each Fibre Channel adapter on the host.

Partitioning storage and creating a file system for a VMware ESXi/ESX host

You can partition storage and create a file system for a VMware ESXi/ESX server.

As the preferred method, use the VMware Virtual Center (vSphere Client) product to partition LUNs and manage storage. For alternative methods, see the VMware Knowledge Base article at [VMware Knowledge Base Performing a rescan of the storage on an ESX/ESXi host \(http://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=1003988\)](http://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=1003988).

Copy Services considerations for VMware ESXi/ESX hosts

Review considerations for using the Copy Services functions with a VMware ESXi/ESX server.

Copy Services are only available for individual LUNs.

The DS8000 does not recognize Virtual Machine File Server (VMFS) volumes or extents so you must copy all LUNs that might be contained within a VMFS volume. To prevent LUN locking problems, no virtual machine can use a copy target volume during the copy process.

The source and target volumes must be on separate physical machines

The VMFS file system uses a label mechanism and if it encounters two volumes with the same label, only one remains accessible.

Remote Mirror and Copy read from secondary option is not supported

“Read from secondary” allows a target volume to be opened in read-only mode during a Remote Mirror and Copy operation. VMware ESX Server does not open volumes in read-only mode and therefore is not able to access a Remote Mirror and Copy target while a copy is in progress.

Rescan of LUNS might be required

VMFS is able to discover changes on a hard disk drive at the file system level. It can manage a copy if the system knows that there is a VMFS file system to discover:

- If the copy target volume was discovered at system start time without a VMFS file system, you must rescan for the changes.
- If there is a VMFS file system, the server can use the new information immediately without any intervention.

Additional considerations

Copy Services functions are supported for any DS8000 LUN that is attached to an ESX server, with the following important restrictions and recommendations:

- The copy relationship must not be persistent if the target LUNs are used with a VMware host. If you are using the Metro Mirror function, the complete relationship must be severed; if the suspend or read-only options are used, VMware cannot use the copied LUNs.
- If the target LUNs are used within the same VMware Datacenter as the source LUNs, a resignature operation is required (see the VMware SAN Configuration Manual, which is available at [VMware \(www.vmware.com\)](http://www.vmware.com)).
- Ensure that you create separate DS8000 volume groups for the set of source LUNs and the sets of target LUNs. The LUNs in the target volume group must have the same order and size as LUNs in the source volume group. Only one set of target LUNs can be presented to a single VMware host.
- Ensure that LUN names are distinctive for each type or set of copy operations. Distinctive names aid in postoperation identification of LUNs.
- Raw device mapping (RDM) LUNs might require reattachment to the OS image that was copied. The OS image must be edited so that the existing RDM LUNs are removed, and then add the appropriate LUNs. Data is preserved during this operation.
- If an OS image is running during a copy operation, there might be a loss of data that is caused by the timing of I/O buffer flushes. For absolute data integrity, shut down the guest OS image during the copy operation.

Selecting a multipath policy for a VMware ESXi/ESX host

For multipath configurations, the DS8000 system supports fixed, most recently used (MRU), and round-robin policies. For most configurations, use the round-robin policy so that the driver can balance the I/O load. For more information about multipath policies, see your VMware documentation.

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