



Marvell® QLogic® Fibre Channel Adapters

2600 Series

User's Guide

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Table of Contents

Preface

What Is in This Guide	x
Intended Audience	xi
Related Materials	xii
Documentation Conventions	xiii
Technical Support.	xv
Downloading Updates and Documentation	xv
Legal Notices	xvi
Laser Safety—FDA Notice.	xvi
Agency Certification.	xvi
EMI and EMC Requirements	xvi
Product Safety Compliance.	xviii

Quick Start

Installation Instructions.	xix
Step 1. Install the Adapter Hardware.	xix
Step 2. Install the Adapter Drivers.	xx
Step 3. Install an Adapter Management Tool.	xxi
Additional Resources	xxii

1 Product Overview

Functional Description	1
Features	1
Supported Operating Systems	3
Physical Characteristics	3
Standards Specifications	3

2 Software Installation and Initial Setup

Fibre Channel Adapter Installation with QLogic SuperInstallers	4
Multiboot Image for Fibre Channel Adapter Function Configuration Utility. .	5
Multiboot Package Contents	5
Fibre Channel Adapter Function Configuration Utility Package Contents.	5
Updating Multiboot Code and Firmware using QCC CLI.	5

	Updating Multiboot Code and Firmware using UEFI	7
	On-The-Fly Firmware Updates	7
	Fibre Channel Adapter Function Configuration Utility	8
	Using UEFI for Custom Configuration	8
3	Fibre Channel Configuration	
	Installing Fibre Channel	10
	Installing Fibre Channel in Linux	10
	Linux OS Support	10
	Supported Features	10
	Deploying the Driver	10
	Driver System Parameters	10
	Importing a Public Key for Secure Boot	11
	Boot from SAN	13
	Installing Fibre Channel Boot from SAN in Citrix Hypervisor Environments	13
	Installing Fibre Channel in VMware ESXi	15
	ESXi OS Support	15
	Using the Driver	15
	Installing Fibre Channel in Windows	16
	Windows OS Support	16
	Using the Driver	16
	Setting Fibre Channel Adapter Parameters	16
	Setting Fibre Channel Adapter Parameters with Interactive QConvergeConsole CLI	16
	Setting Fibre Channel Adapter Parameters with Noninteractive QConvergeConsole CLI	16
	Setting Fibre Channel Adapter Parameters with QConvergeConsole vSphere Client Plug-in	17
	Configuring Target Persistent Binding	17
	Configuring Persistent Binding with Interactive QConvergeConsole CLI	17
	Configuring Persistent Binding with Noninteractive QConvergeConsole CLI	17
	Configuring Boot Devices	18
	Configuring Boot Devices with Interactive QConvergeConsole CLI . .	18
	Configuring Boot Devices with Noninteractive QConvergeConsole CLI	18
	Configuring Boot Devices with QConvergeConsole vSphere Client Plug-in	19
	Configuring Virtual Ports (NPIV).	21

Configuring NPIV with Interactive QConvergeConsole CLI	21
Configuring NPIV with Noninteractive QConvergeConsole CLI	21
NPIV Quality of Service	22
Setting QoS by Priority	24
Setting QoS by Bandwidth	24
Configuring Driver Parameters	25
Configuring Fibre Channel Driver Parameters with Interactive QConvergeConsole CLI	25
Configuring Fibre Channel Driver Parameters with Noninteractive QConvergeConsole CLI	26
Configuring Fibre Channel Driver Parameters with QConvergeConsole vSphere Client Plug-in	26
Configuring Selective LUNs	27
Setting Queue Depth	30
Enabling Fabric-Assigned World Wide Port Name	30
Enabling FA-WWPN with Interactive QConvergeConsole CLI	30
Enabling FA-WWPN with Noninteractive QConvergeConsole CLI	31
Enabling FA-WWPN with QConvergeConsole Plug-in	31
Using Fabric-Assigned Boot LUN	32
Using a Fabric-Assigned Boot LUN with Interactive QConvergeConsole CLI	32
Using a Fabric-Assigned Boot LUN with Noninteractive QConvergeConsole CLI	33
Using a Fabric-Assigned Boot LUN with QConvergeConsole Plug-in	33
FDMI Enhancements Support	34
Configuring End-to-End (CS_CTL) QoS	37
Configuring CS_CTL QoS on the Switch	38
Configuring CS_CTL QoS on the Storage Device	38
Configuring QoS Priority Levels	38
Changing the Priority Levels on Windows	39
Enabling Forward Error Correction	39
FEC Process Overview	40
Enabling and Disabling FEC	40
Enabling and Disabling FEC on VMware ESXi	41
Enabling and Disabling FEC on Linux and Windows	41
Using Buffer-to-Buffer Credit Recovery	41
Resetting Driver and Firmware Counters	42
Configuring VM-ID	42
Universal SAN Congestion Mitigation (USCM)	43

Prerequisites	44
SAN Congestion Mitigation	45
USCM Profiles	45
USCM Virtual Lanes	46
FPIN Link Integrity Marginal Path Detection Support.	47
FC Transport daemon Installation for RHEL 8.4, 8.5, and 8.6.	47
Multipath Configuration File Changes for RHEL 8.7 and Later; RHEL9.0 and Later; SLES15 SP3 and Later	48
Using Fibre Channel Diagnostics	49
Device Ping Testing	49
Fibre Channel Ping Testing (Echo ELS)	49
CT Ping Testing	50
CT Fibre Channel Trace Route Testing	50
Link Cable Beacon Extended Link Service Command	50
Diagnostic Port Testing	51
Read Diagnostic Parameters Extended Link Service Command	51
Running RDP Test from a Brocade 16/32/64G Switch	52
Running RDP Test from a Cisco 16/32G Switch.	53

4 NVM Express over Fibre Channel

Hardware and Software Requirements	55
Adapters	56
Operating Systems	56
Host Setup	56
Installing the Drivers	56
Finding Host NQN	57
Linux	57
Windows	58
ESXi	58
Programming the Host NQN onto the NVMe Storage Array	58
Configuring System for NVMe Auto Discovery	58
Verifying the Availability of FC-NVMe Devices	59
Verifying in Linux	59
Verifying in Windows	61
Verifying in ESX	62
Unloading and Reloading the Linux Driver	63
Limitations and Known Issues.	63
Boot From SAN Setup	64
Additional Setup for NVME Boot-from-SAN Using ESX 7.0 and Later.	64

A	Adapter LEDs	
B	Troubleshooting	
	Troubleshooting with Fibre Channel Diagnostics	70
	Fibre Channel Diagnostics Using Interactive QConvergeConsole CLI	71
	Fibre Channel Diagnostics Using Noninteractive QConvergeConsole CLI	71
	Fibre Channel Troubleshooting Diagram	72
	Troubleshooting in Diagnostics Port Mode	73
	Configuring, Running, and Viewing Results of a Diagnostics Port on a Brocade Fibre Channel Switch	75
	Configuring, Running, and Viewing Results of a Diagnostics Port on a Cisco Fibre Channel Switch	78
C	Revision History	
	Glossary	

List of Figures

Figure	Page
i Server Motherboard and Slots	xxi
3-1 2600 Series Adapter Part Number Location—Physical	21
3-2 2600 Series Adapter Part Number Location—QConvergeConsole CLI	23
3-3 System Power-on Initialization	25
3-4 Fast!UTIL Select Host Adapter Menu	25
3-5 Fast!UTIL Options Menu	26
3-6 Selecting Personality Setting	26
3-7 Changing the Personality from FC	27
3-8 Changing the Adapter's Personality	27
3-9 Save Your Changes	28
3-10 Fast!UTIL Options Menu	28
3-11 Exit Fast!UTIL Menu	29
3-12 Personality Change Complete	29
3-13 UEFI Driver Control Page in UEFI Setup	30
3-14 Selecting Advanced Settings	30
3-15 Selecting the Personality	31
3-16 Changing Personality Type Using QConvergeConsole Plug-in for VMware vCenter Server	34
4-1 Unloading the qla2xxx driver	40
4-2 Confirm Driver Update	40
4-3 Loading the OOB driver	41
4-4 QConvergeConsole vSphere Client Plug-in Boot Options	46
4-5 FC/FCoE Boot dialog box	47
4-6 Priority- and Bandwidth-based QoS	49
4-7 Selective LUN, General View	54
4-8 Enabling FA-WWPN Using QConvergeConsole vSphere Client Plug-in	58
4-9 Fabric-Assigned Boot LUN in QConvergeConsole Plug-in for VMware vCenter Server	60
4-10 QConvergeConsole CLI Information Menu: FEC Status	67
5-1 FC-NVMe Devices in Windows Device Manager	88
5-2 Listed NVMe Controllers	89
5-3 NVMe Namespace List	89
A-1 QLE2670 and QLE2672, 16Gb Adapter LEDs	95
A-2 QLE2690, QLE2692, QLE2694, and QLE2694L, 16Gb Adapter LEDs	96
B-1 Fibre Channel Troubleshooting Diagram (Part 1 of 2)	100
B-2 Fibre Channel Troubleshooting Diagram (Part 2 of 2)	101

List of Tables

Table		Page
i	Supported Adapter Models	x
i	Adapter Management Tools	xxii
2-1	Adapter Settings	10
2-2	Selectable Boot Settings	11
2-3	Advanced Adapter Settings	13
2-4	NVRAM Parameters (Oracle SPARC)	16
2-5	Diagnostic Commands (Oracle SPARC)	18
3-1	2600 Series Adapters That Support Personality Change	21
A-1	QLE2670 and QLE2672 16Gb Adapter LED Scheme	96
A-2	QLE2690, QLE2692, QLE2694, and QLE2694L, 16Gb Adapter LED Scheme	97

Preface

This guide provides detailed instructions on installing, configuring, and troubleshooting the 2600 Series Adapters listed in [Table i](#). It also provides details on the use of adapter features to enhance the value of server virtualization. Such features include virtual adapter configuration using N_Port ID virtualization (NPIV) and boot-from-SAN configuration.

Table i. Supported Adapter Models

Model Number	Port Quantity	Speeds		
		4Gb	8Gb	16Gb
QLE2670	1	✓	✓	✓
QLE2672	2	✓	✓	✓
QLE2690	1	✓	✓	✓
QLE2692	2	✓	✓	✓
QLE2694	4	✓	✓	✓
QLE2694L	4	✓	✓	✓

NOTE

Forth code (FCode) does not support 4Gb speed.

The 2600 Series Adapters run on the following operating systems:

- Microsoft® Windows® (including Hyper-V)
- Linux®
- VMware® ESXi
- Citrix® XenServer®
- Oracle® Solaris®

NOTE

For a detailed list of the currently supported operating systems, refer to the 2600 Series Adapter's *Read Me* and *Release Notes* at www.marvell.com.

What Is in This Guide

This preface specifies the intended audience, lists related documents, explains the typographic conventions used in this guide, and provides technical support, and regulatory information.

The remainder of this guide is organized into the following chapters and appendices:

- [Quick Start](#) provides high-level hardware and software installation instructions for advanced users, as well as additional resources.
- [Chapter 1 Product Overview](#) provides a functional description of the 2600 Series Adapters and lists the features, supported operating systems, physical characteristics, and standards specifications.
- [Chapter 2 Software Installation and Initial Setup](#) provides information about the SuperInstaller and the multi-boot image (Fibre Channel Adapter Function Configuration Utility).
- [Chapter 3 Personality Configuration](#) provides information about configuring the interface type (personality configuration).
- [Chapter 4 Fibre Channel Configuration](#) describes installing the Fibre Channel driver and agent across OSs; setting 2600 Series Adapter parameters; persistent binding; configuring the boot device, NPIV, and driver parameters; enabling the fabric to assign a world-wide port name or boot LUN; enabling end-to-end quality of service (QoS), diagnostics, configuring VM-ID, and Universal SAN Congestion Mitigation.
- [Chapter 5 NVM Express over Fibre Channel](#) describes the installation and configuration of NVMe over Fibre Channel (FC-NVMe).
- [Appendix A Adapter LEDs](#) describes the 2600 Series Adapter LEDs and defines the LED behavior.
- [Appendix B Troubleshooting](#) helps solve issues by running Fibre Channel diagnostics using QConvergeConsole® to identify and isolate link failures. It also provides a flowchart that walks you through troubleshooting problems that may occur with devices and LUNs on the 2600 Series Adapter.
- [Appendix C Revision History](#) contains a list of changes made to this guide since the last revision.

Following the appendices are a glossary of terms and acronyms used.

Intended Audience

This guide is intended for those responsible for deploying 2600 Series Adapters on Windows, Linux, Solaris, VMware ESXi, VMware vCenter™ Server, and Citrix XenServer: from end users (such as data center managers and system administrators) to the test and development community.

Related Materials

For additional information, refer to following documents that are available from the Marvell Web site, www.marvell.com:

- *2600 Series Adapter's Read Me and Release Notes* documents contain information about installation, OS support, and known issues.
- *User's Guide—UEFI Human Interface Infrastructure, 2600 Series 16Gb Fibre Channel Adapters* (part number SN0054689-00) describes how to use the HII application to configure the adapter parameters and boot-from-SAN settings.
- *User's Guide—QConvergeConsole Plug-ins for VMware vSphere* (part number SN0054677-00) provides procedures for using the two plug-in utilities: QConvergeConsole vSphere Client Plug-in and QConvergeConsole Plug-in for VMware vSphere® Web Client.¹
- *User's Guide—QConvergeConsole CLI* (part number SN0054667-00) provides specific command line use in both interactive and noninteractive modes.¹
- *User's Guide—Marvell® QLogic® Fibre Channel QConvergeConsole Extension for Windows® Admin Center* (part number TD-001728) provides information on installing and using the Marvell QLogic Fibre Channel (FC) QConvergeConsole Extension for Windows Admin Center (WAC) to manage the Marvell QLogic 2600/2700/2800 Series Adapters.¹

¹ Describes how to configure and use Universal SAN Congestion Mitigation (USCM).

- *User's Guide—Marvell QLogic PowerKit: Windows PowerShell® cmdlets for 2600, 2700, 2800 Series Marvell QLogic Fibre Channel Adapters* (part number TD-001187) provides information on installing the Marvell QLogic Fibre Channel (MRVLFC) PowerKit (Windows PowerShell cmdlets) software to manage Marvell QLogic Fibre Channel (FC) adapters.¹
- *User's Guide—Marvell ESXCLI Plug-in for VMware vSphere* (part number BC0151101-00) provides information on installing and using the Marvell ESXCLI VMware® Plug-in. The ESXCLI plug-in extends the capabilities of the ESX® command line interface to manage the following adapters installed in VMware ESX/ESXi hosts.¹

For information about downloading documentation from the Marvell Web site, see [“Downloading Updates and Documentation” on page xv](#).

Documentation Conventions

This guide uses the following documentation conventions:

- The adapters described in this guide are collectively referred to as the 2600 Series Adapters.
- **NOTE** provides additional information.
- **CAUTION** without an alert symbol indicates the presence of a hazard that could cause damage to equipment or loss of data.
- Text in [blue](#) font indicates a hyperlink (jump) to a figure, table, or section in this guide, and links to Web sites are shown in [underlined blue](#). For example:
 - ❑ [Table 9-2](#) lists problems related to the user interface and remote agent.
 - ❑ See [“Installation Checklist” on page 3-6](#).
 - ❑ For more information, visit www.marvell.com.
- Text in **bold** font indicates user interface elements such as a menu items, buttons, check boxes, or column headings. For example:
 - ❑ Click **Start**, point to **Programs**, point to **Accessories**, and then click **Command Prompt**.
 - ❑ Under **Notification Options**, select the **Warning Alarms** check box.
- Text in `Courier` font indicates a file name, directory path, or screen output. For example:
 - ❑ To return to the root directory from anywhere in the file structure, type `cd /root`, and then press the ENTER key.

Text in **Courier** font indicates a command. For example:

- ☐ Issue the following command: `# sh ./install.bin`
- Key names and key strokes are indicated with UPPERCASE:
 - ☐ Press the CTRL+P keys.
 - ☐ Press the UP ARROW key
- Text in *italics* indicates terms, emphasis, variables, or document titles. For example:
 - ☐ For a complete listing of license agreements, refer to the applicable *Software End User License Agreement*.
 - ☐ What are *shortcut keys*?
 - ☐ To enter the date type *mm/dd/yyyy* (where *mm* is the month, *dd* is the day, and *yyyy* is the year).
- Topic titles between quotation marks identify related topics either within this manual or in the online help, which is also referred to as *QConvergeConsole Help* throughout this document.
- QConvergeConsole CLI non-interactive command syntax conventions include the following:
 - ☐ Plain text indicates items that you must type as shown. For example:
 - `qauccli -pr fc -ei`
 - ☐ `< >` (angle brackets) indicate a variable whose value you must specify. For example:
 - `<hba instance>`

NOTE

For CLI commands only, variable names are always indicated using angle brackets instead of *italics*.

- ☐ `[ ]` (square brackets) indicate an optional parameter. For example:
 - `[<file_name>]` means specify a file name, or omit it to select the default file name.
- ☐ `|` (vertical bar) indicates mutually exclusive options; select one option only. For example:
 - `on|off`
 - `1|2|3|4`
- ☐ `...` (ellipsis) indicates that the preceding item may be repeated. For example:
 - `x...` means *one* or more instances of `x`.

- `[x...]` means **zero** or more instances of `x`.
- `:` (vertical ellipses) within command example output indicate where portions of repetitious output data have been intentionally omitted.
- `( )` (parentheses) and `{ }` (braces) are used to avoid logical ambiguity. For example:
 - `a|b c` is ambiguous
 - `{(a|b) c}` means `a` or `b`, followed by `c`
 - `{a|(b c)}` means either `a`, or `b c`

Technical Support

Customers should contact their authorized maintenance provider for technical support of their Marvell QLogic and FastLinQ products.

Downloading Updates and Documentation

The Marvell Web site provides periodic updates to product firmware, software, and documentation.

To download firmware, software, and documentation:

1. Go to www.marvell.com.
2. Click **Support**, and then under **Tools & Resources**, click **Driver Downloads**.
3. In the Marvell Drivers window:
 - a. (MUST) Under CATEGORY, select either FIBRE CHANNEL ADAPTERS or CONVERGED NETWORK ADAPTERS.
 - b. (optional) Under PLATFORM/OS, select the platform/OS that matches your system.
 - c. (optional) Under PART NUMBER, select the part number for your adapter.
 - d. (optional) Under KEYWORDS, type a keyword describing what you are looking for.
4. Click **Apply**.

5. Locate the firmware (boot code), software (drivers, management tools), or document (documentation for user's guides) you need, and then do one of the following:
 - a. Click the [blue](#) text in the DESCRIPTION column.
 - b. Click the arrow in the DOWNLOAD column.

NOTE

Marvell recommends downloading the associated Read Me and Release Notes for more information. To find them, enter either **Read Me** or **Release Notes** in the KEYWORDS search box.

A message may appear asking you to review and accept the Marvell Limited Use License Agreement.

6. If applicable, read the agreement, select the check box, and then click **I ACCEPT** to accept the end license agreement and start the download.

Legal Notices

This section provides laser safety (FDA notice), agency certification, and product safety compliance for the following products:

- QLE2670 (part number HD8310405-01)
- QLE2672 (part number HD8310405-02)
- QLE2690 (part number BK3210407-06)
- QLE2692 (part number BK3210407-05)
- QLE2694 (part number BK3210408-01)
- QLE2694L (part number BK3210405-02)

Laser Safety—FDA Notice

This product complies with DHHS Rules 21CFR Chapter I, Subchapter J. This product has been designed and manufactured according to IEC60825-1 on the safety label of laser product.

CLASS I LASER

Class 1 Laser Product	Caution —Class 1 laser radiation when open Do not view directly with optical instruments
Appareil laser de classe 1	Attention —Radiation laser de classe 1 Ne pas regarder directement avec des instruments optiques
Produkt der Laser Klasse 1	Vorsicht —Laserstrahlung der Klasse 1 bei geöffneter Abdeckung Direktes Ansehen mit optischen Instrumenten vermeiden
Luokan 1 Laserlaite	Varoitus —Luokan 1 lasersäteilyä, kun laite on auki Älä katso suoraan laitteeseen käyttämällä optisia instrumenttejä

Agency Certification

The following sections contain a summary of EMC and EMI test specifications performed on models HD8310405-01, HD8310405-02, BK3210407-06, BK3210407-05, BK3210408-01, BK3210405-02, and BK3210403-12 to comply with radiated emission, radiated immunity, and product safety standards.

EMI and EMC Requirements

FCC Rules, CFR Title 47, Part 15, Subpart B: 2017 Class A

Compliance information statement: This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Industry Canada, ICES-003:2016: Class A

This Class A digital apparatus complies with Canadian ICES-003.
Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

CE Mark 2014/30/EU EMC Directive Compliance

EN55032:2012/CISPR 32:2015 Class A

EN55024:2010

EN61000-3-2:2006 A1+A2:2014

EN61000-3-3:2013

EN61000-4-2 : ESD

EN61000-4-3 : RF Electro Magnetic Field

EN61000-4-4 : Fast Transient/Burst

EN61000-4-5 : Fast Surge Common/Differential

EN61000-4-6 : RF Conducted Susceptibility

EN61000-4-8 : Power Frequency Magnetic Field

EN61000-4-11 : Voltage Dips and Interrupt

AS/NZS; CISPR 32:2015 Class A

CNS 13438:2006 Class A

KCC: Class A

KC-RRA KN32 KN35 (2011 for HD series, 2014 for BK series) Class A



Product Name/Model—HD8310405-01, HD8310405-02,
BK3210407-06, BK3210407-05, BK3210408-01, BK3210405-02, and
BK3210403-12 Adapters
Certification Holder—QLogic Corporation
Manufactured Date—Refer to date code listed on product
Manufacturer/Country of Origin—QLogic Corporation/USA

A class equipment
(Business purpose info/
telecommunications equipment)

As this equipment has undergone EMC registration
for business purpose, the seller and/or the buyer is
asked to beware of this point and in case a wrong-
ful sale or purchase has been made, it is asked that
a change to household use be made.

Korean Language Format—Class A

A급 기기 (업무용 정보통신기기)

이 기기는 업무용으로 전자파적합등록을 한 기기이오니
판매자 또는 사용자는 이 점을 주의하시기 바라며, 만약
잘못판매 또는 구입하였을 때에는 가정용으로 교환하시기
바랍니다.

VCCI: CISPR 32: 2015 Class A

This is a Class A product based on the standard of the Voluntary Control Council
for Interference (VCCI). If this equipment is used in a domestic environment, radio
interference may occur, in which case the user may be required to take corrective
actions.

この装置は、クラス A 機器です。この装置を住宅環境で使用すると電波妨害を引き
起こすことがあります。この場合には使用者が適切な対策を講ずるよう要求されるこ
とがあります。

VCCI-A

BSMI: Class A

BSMI CNS 13438:2006 Class A for the BK3210407

警告使用者:
這是甲類的資訊產品, 在居住的環境中使用時, 可能會造成射
頻干擾, 在這種情況下, 使用者會被要求採取某些適當的對策.

Product Safety Compliance

UL, cUL Product Safety

UL60950-1 (2nd Edition), A1 + A2 2014-10-14

CSA C22.2 60950-1-07 (2nd Edition) A1 +A2 2014-10

Use only with listed ITE or equivalent.

Complies with 21 CFR 1040.10 and 1040.11.

For use with UL Listed Servers or equivalent.

Power off the computer and all attached devices such as monitors, printers, and external components before installing the accessory card or equivalent.

2014/35/EU Low Voltage Directive

TUV EN60950-1:2006+A11+A1+A12 2nd Edition

TUV IEC 60950-1 :2005 2nd Edition Am 1 :2009 + Am2 :2013 CB

TUV IEC62368 2nd and 3rd Edition CB TUV EN62368-1 :2014+A11:2017

Quick Start

To help you quickly get started using the 2600 Series Adapters, this chapter provides installation steps and lists additional resources.

Installation Instructions

Install and configure your new 2600 Series Adapter in three simple steps:

- [Step 1. Install the Adapter Hardware](#)
- [Step 2. Install the Adapter Drivers](#)
- [Step 3. Install an Adapter Management Tool](#)

Step 1. Install the Adapter Hardware

CAUTION

Keep the adapter in the antistatic bag until installation. The Host Bus Adapter contains parts that can be damaged by electrostatic discharge (ESD). Before handling the Host Bus Adapter, use standard methods to discharge static electricity. Place the Host Bus Adapter on the bag when examining it. Retain the bag for future use.

To install the adapter hardware, you need to open the computer and locate the appropriate bus slot. If necessary, consult your computer system manual for instructions on how to remove the computer cover.

To install the adapter hardware:

1. Power off the computer and all attached devices, such as monitors, printers, and external components.
2. Disconnect the power cable.
3. Remove the computer cover and find an empty PCIe® x8 (or larger) bus slot.
4. Pull out the slot cover (if any) by removing the screw or releasing the lever.
5. Install the low-profile bracket (if required).

6. Grasp the adapter by the top edge and seat it firmly into the appropriate slot (see [Figure i](#)).

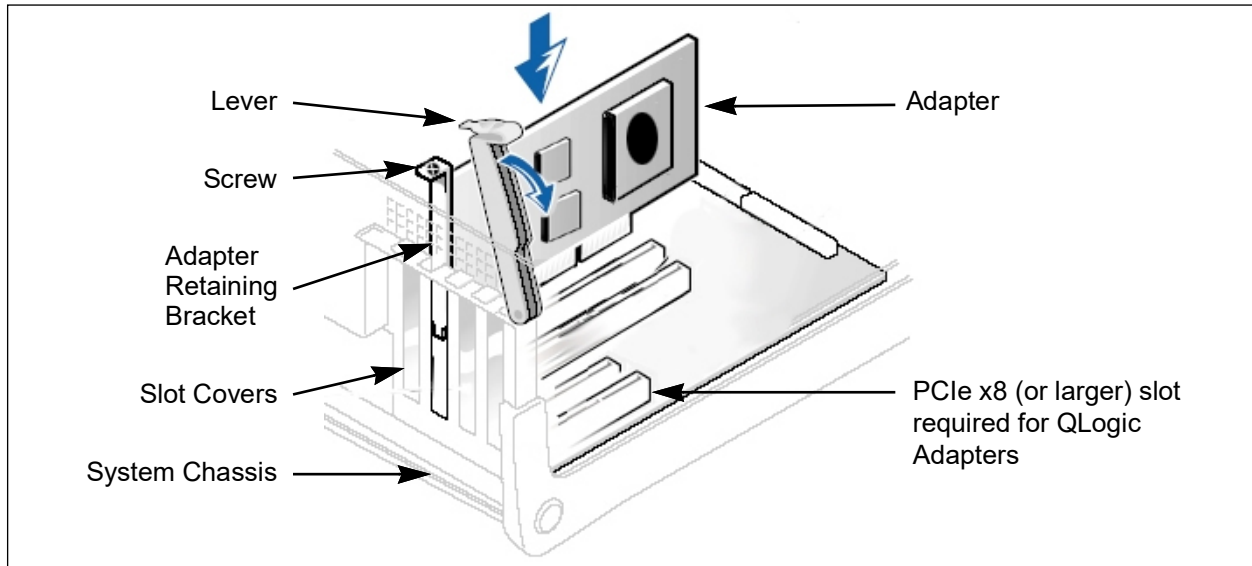


Figure i. Server Motherboard and Slots

7. Refasten the adapter's retaining bracket using the existing screw or lever.
8. Close the computer cover.
9. Plug the optical cable into the adapter.
10. Plug in the power cable and turn on the computer.

Step 2. Install the Adapter Drivers

Follow these steps to download and install adapter drivers.

To install the adapter drivers:

1. Go to www.marvell.com.
2. Click **Support**, and then under **Tools & Resources**, click **Driver Downloads**.
3. In the Marvell Drivers window:
 - a. (MUST) Under CATEGORY, select either FIBRE CHANNEL ADAPTERS.
 - b. (optional) Under PLATFORM/OS, select the platform/OS that matches your system.
 - c. (optional) Under PART NUMBER, select the part number for your adapter.

- d. (optional) Under KEYWORDS, type **drivers**.
4. Click **Apply**.
5. Locate the drivers you need, and then do one of the following:
 - a. Click the [blue](#) text in the DESCRIPTION column.
 - b. Click the arrow in the DOWNLOAD column.

NOTE

Marvell recommends downloading the associated Read Me and Release Notes for more information. To find them, enter either **Read Me** or **Release Notes** in the KEYWORDS search box.

A message may appear asking you to review and accept the Marvell Limited Use License Agreement.

6. If applicable, read the agreement, select the check box, and then click **I ACCEPT** to accept the end license agreement and start the download.

Step 3. Install an Adapter Management Tool

Based on your system, download one of the Marvell tools in [Table i](#) to configure and manage your 2600 Series Adapter.

Table i. Adapter Management Tools

If you are using ...	Install
Windows, Linux, Solaris, Citrix Xen-Server	QConvergeConsole CLI
VMware ESXi including vCenter Server Appliance for VMware ESXi 7.0 and (8.0 for QLE269x only)	QConvergeConsole vSphere Client Plug-in
Windows, VMware ESXi, Linux	Marvell QLogic PowerKit
Windows	Marvell QLogic Fibre Channel QConvergeConsole Extension for Windows Admin Center

To download an application, follow the instructions in [“Downloading Updates and Documentation” on page xv](#).

For detailed information about using the adapter management tools, see the documents specified in [“Related Materials” on page xii](#).

Additional Resources

For more information on using the 2600 Series Adapter, Marvell provides these additional resources:

- To obtain the most current drivers, management tools, user instructions, and documentation, download the latest versions from the Downloads and Documentation page at www.marvell.com.
- For descriptions of the user instructions provided in this document, see [“What Is in This Guide” on page xi](#).
- For important product information, including warranty, laser safety, and agency certification, see the [“Legal Notices” on page xvi](#).

1

Product Overview

This chapter describes the function and features of the 2600 Series Adapter including:

- [Functional Description](#)
- [Features](#)
- [“Supported Operating Systems” on page 3](#)
- [“Physical Characteristics” on page 3](#)
- [“Standards Specifications” on page 3](#)

Functional Description

The 2600 Series Adapters are QLogic’s sixth generation Fibre Channel Adapters. They boast industry-leading native Fibre Channel (FC) performance—achieving quad-port (QLE2694 and QLE2694L) or dual-port (QLE2672 and QLE2692) line-rate, 16GFC throughput—at extremely low CPU usage with full hardware offloads.

Features

The 2600 Series Adapters provide the following features. For more information about these features, see the QConvergeConsole CLI online help.

- QLE2670, QLE2672, QLE2690, QLE2692, QLE2694, and QLE2694L offer connectivity to 16Gb, 8Gb, and 4Gb Fibre Channel networks
- Physical PCIe characteristics (with backward compatibility):
 - ❑ PCIe 3.0 x8 (QLE2670 and QLE2672, QLE2690, QLE2692)
 - ❑ PCIe 3.0 x16 (QLE2694, QLE2694L)
- Device management for SAN
- Full hardware offload for the Fibre Channel protocol
- Message-signaled interrupts (MSI-X) and legacy interrupts (INT-X)
- N_Port ID virtualization (NPIV)
- Buffer-to-buffer credit recovery (BB-CR) (QLE269x models only)

- Firmware and driver counter reset
- Boot from SAN
- Several advanced management features for the 2600 Series Adapter include:
 - ❑ The QConvergeConsole CLI management utility is available if you are running Windows, Linux, Solaris, or Citrix XenServer.
 - ❑ The QConvergeConsole vSphere Client Plug-in management utilities are available if you are running VMware ESXi.
- Diagnostics port
- FC-NVMe—QLE269x only
- Universal SAN Congestion Mitigation (USCM)—QLE269x only
 - ❑ FPIN Monitoring
 - ❑ Profiles
 - ❑ Marginal Paths (FPIN-LI/MPIO)
- Management Component Transport Protocol (MCTP)—QLE269x only
- Secure Firmware Update
- Link Cable Beaconsing (LCB)
- FDMI Registrations
- CS_CTL-based QoS
- Device ping
- Fibre Channel ping (Echo ELS)
- Common transport (CT) ping
- CT Fibre Channel trace route (FTR)
- Loop back testing
- Read buffer/write buffer testing
- Send read diagnostic parameters (RDP)
- 16G Forward error correction (FEC) (enable/disable, counter display, and reset)
- Principal/adjacent fabric WWN
- Fabric-assigned WWPN (FA-WWPN)
- Fabric-assigned boot LUN (FA-BLD)
- VM-ID support on VMware ESXi 7.0 and 8.0

- Conversion to 10-gigabit Ethernet (GbE) Converged Network Adapter—QLE2672 and QLE2670 only
- Support for long range 10km/5km optics

Supported Operating Systems

The 2600 Series Adapters support commonly used operating systems, including Windows, Linux, Solaris, VMware ESXi, and Citrix XenServer.

For a detailed list of the currently supported operating systems, refer to the adapter's *Read Me* and *Release Notes* available at www.marvell.com (see “Downloading Updates and Documentation” on page xv).

Physical Characteristics

Physical characteristics for the 2600 Series Adapters include the following:

- QLE2670, QLE2672, QLE2690, and QLE2692 Adapters are implemented as low-profile PCIe cards. The adapter ships with a standard-height bracket for use in a standard PCIe slot.
- The QLE2694 Adapter is implemented as a full-height PCIe card with a full-height bracket installed.
- The QLE2694L Adapter is implemented as a low-profile PCIe card. The adapter ships with soldered-down small form factor (SFF) fixed optical transceivers and a low profile bracket.

Standards Specifications

The 2600 Series Adapter supports the following standards specifications:

- SCSI Fibre Channel Protocol 4 (FCP-4)
- Fibre Channel Tape (FC-TAPE) Profile
- Fibre Channel Generic Services 8 (FC-GS-8)
- Fibre Channel-Physical Interface-5 (FC-PI-5)
- Fibre Channel-Physical Interface-6 (FC-PI-6)
- Fibre Channel Link Services 4 (FC-LS-4)
- Fibre Channel Framing and Signaling 5 (FC-FS-5)
- Fibre Channel NVMe (FC-NVMe)

For more information on these specifications, refer to the Technical Committee T11 Web site:

<http://www.t11.org>

2 Software Installation and Initial Setup

This chapter provides the following information about installing and setting up the software:

- [Fibre Channel Adapter Installation with QLogic SuperInstallers](#)
- [“Multiboot Image for Fibre Channel Adapter Function Configuration Utility” on page 5](#)

NOTE

If you are using VMware ESXi, see the *User's Guide—QConvergeConsole Plug-ins for VMware vSphere* (part number SN0054677-00) for details on installation and initial setup.

Fibre Channel Adapter Installation with QLogic SuperInstallers

The QLogic SuperInstallers are easy-to-use tools that install the following components:

- Fibre Channel, Fibre Channel over Ethernet (FCoE), iSCSI, and Ethernet networking drivers
- QConvergeConsole CLI management tool

For installation instructions for the QLogic Windows SuperInstaller, refer to the QLogic Windows SuperInstaller *Read Me* document.

Multiboot Image for Fibre Channel Adapter Function Configuration Utility

This section contains the following information:

- [Multiboot Package Contents](#)
- [Fibre Channel Adapter Function Configuration Utility Package Contents](#)
- [Updating Multiboot Code and Firmware using QCC CLI](#)
- [On-The-Fly Firmware Updates for QLE269x Adapters](#)
- [Using QLflash \(QLE267x Adapters Only\)](#)
- [Fibre Channel Adapter Function Configuration Utility](#)

Multiboot Package Contents

The multiboot package for the 2600 Series Adapter is a compressed file that contains the Host Bus Adapter BIOS, Unified Extensible Firmware Interface (UEFI) code, firmware, and the QLflash utility.

Fibre Channel Adapter Function Configuration Utility Package Contents

The following files are included in the boot code package:

- `update.bat`—DOS batch file that calls the executable files to update the adapter multiboot (supported on QLE267x Adapters only)
- `update.nsh`—UEFI batch file run from a UEFI shell that calls the executable files to update the adapter multiboot
- `QLflash.exe`—Utility to update the multiboot code and firmware (supported on QLE267x Adapters only)
- `ql2xxxx.drv`—UEFI driver
- `efxxxx.efi`—UEFI utility
- `Readme`—Boot Code folders contain Readme and Release notes
- `Read1st`—Component versions
- `DOS4GW.exe`—File required to use the `QLflash.exe`
- `bkxxxx.bin`—Combined binary file, which includes the binaries for the BIOS UEFI, FCode, and firmware for QLE269x Adapters
- `hldxxxxx.bin`—Combined binary file, which includes the BIOS, UEFI, FCode, and firmware for the QLE267x Adapters

NOTE

The files may be different for each respective OEM software release.

Updating Multiboot Code and Firmware using QCC CLI

To update the multiboot code and firmware using QCC CLI:

1. Boot to the OS with the latest driver and QConvergeConsole CLI installed.
2. Download the MBI kit for your 2600 Series Adapter from Marvell Support Website following the procedures in [“Step 2. Install the Adapter Drivers” on page xxi](#), and selecting the relevant package in the Boot Code section.
3. Unzip the following MBI kit to a directory: `q1_83xx_img3.35.03_b1_5.08.18_8.08.231.zip`
4. Navigate to the directory from step 3.
5. Update the firmware using QCC CLI by doing one of the following:
 - ☐ In noninteractive mode, enter the following command:
`# qauccli -b all bk010189.bin`
 - ☐ In interactive mode:
 - a. From the **Main** menu, select **Adapter Updates**.
The **FC Adapter Update** menu appears.
 - b. Select **1 Flash Update**.
 - c. From the **Flash Update** menu, select the adapter port, and then type the Flash update file name.

NOTE

The following steps apply when using Linux, other operating systems may vary or not allow this option.

6. Verify that the new firmware becomes active after the system reboots by doing one of the following using QCC CLI:
 - ☐ In noninteractive mode, enter the following command:
`# qauccli -i` (Firmware version = 8.08.204 or later)

Confirm that the **Running Firmware Version** matches the **Flash Firmware Version**.

- ❑ In interactive mode:
 - a. From the **Main** menu, select **Adapter Information**.
The **FC Adapter Information** menu appears.
 - b. Select **1 FC Adapter Information**.
 - c. From the **FC Adapter Information** menu, select the adapter for which to view adapter information.
Confirm that the **Running Firmware Version** matches the **Flash Firmware Version**.

Updating Multiboot Code and Firmware using UEFI

You can also update the MBI kit from the UEFI Shell.

1. Unzip MBI kit to a directory, for example:

```
ql268x_imgxx.xx.xx_risc_y.yy.yyy.zip
```

The prefix of the MBI zip file indicates whether the file is applicable to either a Marvell QLogic branded adapter or an OEM branded adapter.

2. Boot to the UEFI Shell.
3. Run `update.nsh` from the MBI folder.

On-The-Fly Firmware Updates for QLE269x Adapters

The following Marvell management tools perform additional checks to confirm that the new MBI image file to be flashed is consistent with the current running firmware on the adapter.

Marvell Management Tool	Supported Version
QConvergeConsole CLI	version 2.5 or later
Marvell QLogic QConvergeConsole Extension for Windows Admin Center	version 2.0.1 or later
QConvergeConsole vSphere Client Plug-in	version 2.0.37.02 or later
Marvell QLogic PowerKit	version 2.0.5.0 or later
Marvell ESXCLI Plug-in for VMware vSphere	version 1.1.10 or later

Consistent flash components can be activated and reset on-the-fly.

Components that are consistent with the running firmware:

- Limit changes between the running version and the version to be flashed to Fibre Channel firmware, board configuration, or boot code.

- Have the same firmware attributes in the running firmware and the new firmware.

Components that are not consistent with the running firmware:

- Have changes to components in the flash that need a PCIe reset (PE) or a power-on reset to start (for example, firmware other than Fibre Channel)

If the new MBI image file is consistent with the currently running flash components, the application issues a Fibre Channel firmware reset at the end of the flash update process to activate the new image.

If the new MBI image file is not consistent with the current running flash components, the application does not issue a Fibre Channel firmware reset at the end of the flash update process; instead, the user is prompted to reboot the system.

Using QLflash (QLE267x Adapters Only)

QLflash is a native DOS utility for QLE267x Adapters (it is not applicable to QLE269x Adapters). This section describes how to update the multiboot code and the QLflash command line options. Refer to the *Read Me* document for more information. To run this utility, boot to a DOS hard drive or a USB removable drive.

Utility version:

`/VER` = Display version of the QLflash utility

Help options:

`/?` = Display Help menu

QLflash Command Line Options

When you are running the `.exe`, type `/?` for help.

Fibre Channel Adapter Function Configuration Utility

This section provides detailed configuration information for advanced users who want to customize the configuration of the 2600 Series Adapter and the connected devices. You can configure the 2600 Series Adapter using *Fast!UTIL*, FCode, or UEFI:

- Use *Fast!UTIL* in a pre-OS environment (see [Using Fast!UTIL for Custom Configuration](#)).
- Use FCode for Oracle SPARC® systems (see [Using FCode for Custom Configuration \(Oracle SPARC\)](#)).
- Use UEFI for Cisco®, Dell®, HP®, IBM®, Lenovo®, and Oracle x64 OEM adapters where the platform supports UEFI (see [Using UEFI for Custom Configuration](#)).

Using *Fast!UTIL* for Custom Configuration

To use *Fast!UTIL* for custom configuration:

1. To access *Fast!UTIL*, press the ALT+Q or CTRL+Q keys during the Host Bus Adapter BIOS initialization (it may take a few seconds for the *Fast!UTIL* menu to appear).
2. In the Select Host Adapter window, select the adapter type.
3. In the Adapter Settings window, select the appropriate adapter settings.

CAUTION

If the configuration settings are incorrect, your 2600 Series Adapter may not function properly.

A message window indicates that the configuration settings have been modified.

4. To save the new settings, click **Save changes**. *Fast!UTIL* reboots your system to load the new parameters.

The *Fast!UTIL* **Options** menu provides the following options:

- [Configuration Settings](#)
- [Scan Fibre Devices](#)
- [Fibre Disk Utility](#)
- [Loopback Data Test](#)
- [Select Adapter](#)
- [Personality](#)
- [Exit Fast!UTIL](#)

Configuration Settings

The following sections show and describe the 2600 Series Adapter configuration settings:

- [Adapter Settings](#)
- [Selectable Boot Settings](#)
- [Restore Default Settings](#)
- [Raw NVRAM Data](#)
- [Advanced Adapter Settings](#)

Adapter Settings Table 2-1 describes the adapter settings.

Table 2-1. Adapter Settings

Setting	Values	Default	Description
Host Bus Adapter BIOS	Enabled, Disabled	Disabled	Disabling this setting disables the ROM BIOS on the 2600 Series Adapter, which frees space in upper memory. If you are booting from a Fibre Channel disk drive attached to the 2600 Series Adapter, you must enable this setting. See “ Selectable Boot Settings ” on page 11 for details on specifying the boot device.
Frame Size	512, 1024, 2048	2048	Specifies the maximum frame payload size supported by the 2600 Series Adapter
Loop Reset Delay	0–60 seconds	5 seconds	After resetting the loop, the firmware refrains from initiating any loop activity for the number of seconds specified in this setting.
Adapter Hard Loop ID	Enabled, Disabled	Disabled	When this setting is enabled, the adapter attempts to acquire its arbitrated loop physical address (AL_PA) during the loop initialization hard address (LIHA) phase using the <code>Hard Loop ID</code> value (see next row).
Hard Loop ID	0–125	0	If the <code>Adapter Hard Loop ID</code> setting (see previous row) is enabled, the adapter attempts to acquire the loop ID specified in this setting during the LIHA or loop initialization previous address (LIPA) phase.
Connection Options	0, 1, 2	2	Defines the type of connection: ■ 0—Loop only (for 4Gb and 8Gb data rates) ■ 1—Point-to-point only (for 4Gb, 8Gb, and 16Gb data rates) ■ 2—Loop preferred, then point-to-point for the 4Gb and 8Gb data rates. Because the standard for 16Gb data rates does not support loop, it uses point-to-point only, even if the connection options is set to 2.
Fibre Channel Tape Support	Enabled, Disabled	Enabled	Enables FCP-2 recovery.

Table 2-1. Adapter Settings (Continued)

Setting	Values	Default	Description
Data Rate	2, 3, 4, 5, 6	2	Determines the data rate: ■ 2—The adapter auto-negotiates and determines the data rate. ■ 3—The adapter runs at 4GFC. ■ 4—The adapter runs at 8GFC. ■ 5—The adapter runs at 16GFC. ■ 6—Not supported.

Selectable Boot Settings The **Configuration Settings** menu provides access to the **Selectable Boot Settings** option. If you enable the Host Bus Adapter BIOS in the adapter settings, you can select the boot device, as shown in [Table 2-2](#).

Table 2-2. Selectable Boot Settings

Enable Selectable Boot	Boot WWPN or LUN	Device Boot
No	—	The BIOS configures the first disk drive it finds as the boot device.
Yes	None specified	The BIOS configures the first disk drive it finds that is also LUN 0 as the boot device.
Yes	Specified	The BIOS scans through the specified boot worldwide port name (WWPN) or LUN list until it finds a disk drive. This drive is configured as the boot device.

The **Selectable Boot Settings** option allows you to specify up to four WWPNs or LUNs as boot devices.

To enable the Selectable Boot option and insert devices into boot device locations:

1. On the **Configuration Settings** menu, select **Host Adapter Settings**.
2. Enable the **Host Bus Adapter BIOS**, and then press the ESC key to return to the **Configuration Settings** menu.
3. On the **Configuration Settings** menu, select **Selectable Boot Settings**.

4. To enable or disable (toggle) the **Selectable Boot** option, press the ENTER key. To move to the Primary location of the **Selectable Boot List** menu, press the DOWN ARROW key.
5. To see a list of accessible devices (in the **Select Fibre Channel Device** menu), press ENTER.
6. To select a drive to put into the **Selectable Boot** list, press the UP ARROW and DOWN ARROW keys or the PAGE UP and PAGE DOWN keys to scroll to the device. To load the device into the **Selectable Boot** list, press ENTER.
7. To specify an alternate boot device (maximum of three) on the 2600 Series Adapter:
 - a. Move to the next available alternate entry by pressing the UP ARROW or DOWN ARROW.
 - b. Press ENTER.
 - c. Select the disk drive you want.
 - d. Press ENTER again.

NOTE

- **System BIOS compatibility:** To boot from a host 2600 Series Adapter in a computer system with a multiboot system BIOS, the 2600 Series Adapter must be included in the list of bootable devices in the system's **Boot** menu.
- **Solaris x86 boot-from-SAN:** To boot from a Fibre Channel drive connected to the host 2600 Series Adapter, reboot the system and enter *Fast!UTIL*. Before performing the OS (Solaris x86) installation, access the **Selectable Boot** menu, enable the selectable boot, and then insert the boot drive in the primary location of the **Selectable Boot** menu.
- For these boot-from-SAN configurations, the Solaris x86 QLogic Corporation (QLC) driver supports booting only from the Primary location. The driver does not attempt to boot from the Alternate 1, Alternate 2, and Alternate 3 entries.

Restore Default Settings The **Restore Defaults** option restores the NVRAM settings to the defaults.

Raw NVRAM Data The **Raw NVRAM Data** option shows the 2600 Series Adapter NVRAM contents in hexadecimal format. This option is a troubleshooting tool; you cannot modify the raw NVRAM data.

Advanced Adapter Settings

On the **Configuration Settings** menu in *Fast!UTIL*, select **Advanced Adapter Settings**.

[Table 2-3](#) describes the default settings for the 2600 Series Adapters.

Table 2-3. Advanced Adapter Settings

Setting	Values	Default	Description
LUNs per Target	0–256	128	Specifies the number of LUNs supported per target if the target does not support the Report LUN command. Multiple LUN support is typically for redundant array of independent disks (RAID) boxes that use LUNs to map drives.
Enable LIP Reset	Yes, No	No	Determines the type of LIP reset used when the OS initiates a bus reset routine as follows: ■ Yes—The driver initiates a global LIP reset to reset the target devices. ■ No—The driver initiates a global LIP reset with full login.
Enable LIP Full Login	Yes, No	Yes	When this setting is Yes , the 2600 Series Adapter' reduced instruction set computer (RISC) controller logs in to all ports after any LIP.
Enable Target Reset	Yes, No	Yes	When this setting is Yes , the drivers issue a Target Reset command to all devices on the loop when a SCSI Bus Reset command is issued.
Login Retry Count	0–65535	8	Specifies the number of times the software tries to log in to a device.
Port Down Retry Count	0–65535 seconds	30 seconds	Specifies the number of seconds the software waits before resending a command to a port whose status indicates that the port is down.
Link Down Timeout	0–65535 seconds	30 seconds	Specifies the number of seconds the software waits for a link that is down to come up.
Operation Mode	0, 5, 6	6	Specifies the reduced interrupt operation (RIO) modes if they are supported by the software driver. The RIO modes allow posting multiple command completions in a single interrupt. This setting supports the following modes: ■ 0—Interrupt for every I/O completion ■ 5—Interrupt when the interrupt delay timer expires ■ 6—Interrupt when the interrupt delay timer expires or when there are no active I/Os

Table 2-3. Advanced Adapter Settings (Continued)

Setting	Values	Default	Description
Interrupt Delay Timer	0–255 (100µs units)	2 (200µs)	Contains the value used by a timer to set the wait time before generating an interrupt.
Fabric Assigned WWPN	Enabled, Disabled	Enabled ^a	Fabric-assigned worldwide name (WWN) allows you to enable an adapter port to use a switch-assigned WWN rather than the physical adapter port WWN for communication.
Fabric Assigned Boot LUN	Enabled, Disabled	Enabled ^a	Fabric-based boot LUN discovery (F-BLD) allows you to eliminate the manual boot LUN configuration process of each adapter from individual servers. Instead, the adapters can query the SAN fabric at boot time to retrieve boot LUN configuration information. When the boot LUN configuration is available from the fabric, the server retrieves the information and boots from the SAN.
16G FEC Enable	Enabled, Disabled	Disabled ^{a b}	Forward error correction (FEC) improves performance and link integrity to support higher end-to-end data rates by automatically recovering from transmission errors.
BB_CR Enable	Enabled, Disabled	Enabled ^b	Buffer-to-buffer credit recovery (BB-CR) enables two FC peer ports (N_Port, F_Port, or E_Port) to periodically send and receive the quantity of receiver ready (R_RDY) signals transmitted. Enable the BB-CR feature to allow the peer port to recover from possible R_RDY signals lost over a lossy link.
BB_CR Count	0–15	8 ^b	Specifies the quantity of frame RX/TX counters maintained by the port to track R_RDYs and frames received.

^a This feature is enabled by default in adapters that are built with this release factory installed. Adapters upgraded from earlier releases retain the setting (enabled or disabled) that they had prior to upgrading to this release.

^b Applies to QLE269x adapters only. For field adapters, this feature is user defined and adapters settings are not restored to defaults when you select [Restore Default Settings](#). New 2016 adapters have default values.

Scan Fibre Devices

The **Scan Fibre Devices** option scans the Fibre Channel loop and lists all the connected devices by loop ID. For each device, it lists information such as the vendor name, product name, and revision. This information helps when configuring your 2600 Series Adapter and attached devices.

Fibre Disk Utility

The **Fibre Disk Utility** option scans the Fibre Channel loop and lists all the connected devices by loop ID. You can select a Fibre Channel hard disk and do one of the following tasks:

- Perform a low-level format
- Verify the disk media
- Verify the disk data (most targets do not support this feature)
- Select a disk device

CAUTION

Performing a low-level format destroys all data on the disk.

Loopback Data Test

The **Loopback Data Test** option allows you to perform both external and internal loopback data tests. During a loopback test, the adapter port LEDs will flash.

To perform an external loopback test, do one of the following:

- Insert a loopback connector into the 2600 Series Adapter port.
- Connect the 2600 Series Adapter port to a Fibre Channel switch.

Do not perform an internal loopback test at the OS if the target device is the SAN target from which the system boots.

Select Adapter

If you have a multiport or multiple 2600 Series Adapters in your system, use the **Select Adapter** option to select and then configure or view the settings of a specific 2600 Series Adapter or one of its ports.

Personality

The **Personality** option changes the interface type (personality) between Fibre Channel Adapter (QLE267x models only) and Converged Network Adapter. See the [Glossary](#) for a definition of *personality*.

For more information, see [“Changing the Personality with BIOS \(Fast!UTIL\)” on page 25](#).

Exit *Fast!UTIL*

Select the **Exit *Fast!UTIL*** option to exit the utility and reboot the system. After making changes to the 2600 Series Adapter in *Fast!UTIL*, make sure you save the changes before you reboot the system.

Using FCode for Custom Configuration (Oracle SPARC)

For additional information, see the *FCode for ORACLE_SPARC FC and FCoE Adapters* Read Me document.

You can use FCode to select the 2600 Series Adapter device (not applicable to 267x Series), set and view NVRAM parameters, and run diagnostic commands.

When booting using FCode within a logical domain's (LDOM's) environment, see the *Oracle VM Server for SPARC* documentation.

When booting a SPARC virtual function (VF) using FCode, the NVRAM parameters and diagnostics shown in the following sections are available only to the primary function (PF).

Setting and Viewing NVRAM Parameters

[Table 2-4](#) describes the NRAM parameters that you can set and view.

Table 2-4. NVRAM Parameters (Oracle SPARC)

Command	Values	Description
show-commands	N/A	Lists all NVRAM and diagnostic commands.
show-settings	N/A	Shows the current value of all of the NVRAM parameters, as well as the version, serial number, and adapter worldwide name.
set-connection-mode	0, 1, 2	Allows you to change or view the current host adapter Fibre Channel connection mode: ■ 0—Loop only ■ 1—Point-to-point only (do not select for 16G and above) ■ 2—Loop preferred; otherwise, point-to-point
set-data-rate	2, 3, 4, 5, 6, 7	Allows you to change or view the current host adapter Fibre Channel data rate: ■ 2—Auto-negotiated ■ 3—4GFC ■ 4—8GFC ■ 5—16GFC ■ 6—Not supported ■ 7—Not supported

Table 2-4. NVRAM Parameters (Oracle SPARC) (Continued)

Command	Values	Description
set-fapwwn-ena	N/A	The FCode supports the Fabric-Assigned Worldwide Port Name (FA-WWPN) feature in a Brocade® switch running Fabric OS (FOS) 7.3.0 or later. Issue the <code>set-fapwwn-ena</code> FCode command to enable and disable this feature on the adapter. (For details, refer to your switch documentation.) For example: <pre>{0} ok set-fapwwn-ena</pre> Current Fabric-Assign-WWPN: DISABLED Do you want to change it? (y/n) y Current Fabric-Assign-WWPN: ENABLED This feature must also be enabled on the switch using the following command sequence: <pre>portdisable # fapwwn -- enable - port # portenable #</pre> Where <code>#</code> is the switch port number that is attached to the adapter.
set-login-count	1h–FFh	Sets the Login Retry Count field in the initialize firmware control block (IFCB). This field specifies the number of login retries attempted by the firmware. The default value is 8h.
set-link-timeout	2h–FFh	Determines the number of seconds to wait for the link to come up. The default value is 30 seconds (1Eh).
set-port-down-count	1h–FFh	Determines the number of retries for the Start, Read, and Write SCSI commands. The default value is 30h.
set-max-frame-size	1, 2, 3	Sets the Maximum Payload Length field in the IFCB: ■ 1—512 ■ 2—1024 ■ 3—2048. This setting is the default.
set-boot-wait-time	8–65535	Adjusts the time to wait (in seconds) for the boot device to become online. The default value is DISABLED, which sets it to 8 seconds. The maximum value is 65,535 seconds (18 hours, 6 minutes). The minimum value is 8 seconds, same as when disabled. Because this wait time can be very long, the boot process can be aborted at any time by pressing the ESC key.

Table 2-4. NVRAM Parameters (Oracle SPARC) (Continued)

Command	Values	Description
restore-default-settings	N/A	Restores the default values of all NVRAM parameters used by the FCode, except the fc-mode (FCode operation mode) and the boot-wait-time.
set-personality	FC, CNA	Sets or clears bits in the feature configuration section of the Flash memory, which controls the 2600 Series Adapter's personality. A reboot is required for a change to take effect. ■ FC—Fibre Channel only ■ CNA—Converged Network Adapter

Running Diagnostic Commands

Table 2-5 describes the diagnostic commands.

Table 2-5. Diagnostic Commands (Oracle SPARC)

Command	Description
version	Lists the FCode version.
beacon	Flashes the 2600 Series Adapter's LED.
selftest	Tests the 2600 Series Adapter's memory and loopback.
selftest-loop	Tests the 2600 Series Adapter's memory and loopback; it runs continuously until the Break Key is sent.
ext-loopback-test	Tests the external loopback.
ext-loopback-test-loop	Tests the external loopback; it runs continuously until the Break Key is sent.
show-children	Lists all attached targets.
disk-test	Tests a selected target.
sel-dev	Selects a device for disk test.
sel-lun	Selects the LUN for disk test.

Using UEFI for Custom Configuration

For details on how to use UEFI to perform custom configuration, refer to the relevant server vendor documentation. For additional information, see the latest UEFI files under **Boot Code** on the Downloads and Documentation Web pages for 2600 Series Adapter models. See also the *User's Guide—UEFI Human Interface Infrastructure, 2600 Series 16Gb Fibre Channel Adapters* (part number SN0054689-00), which describes how to use the HII application to configure adapter parameters and boot-from-SAN settings. For download assistance, see [“Downloading Updates and Documentation” on page xv](#).

3 Personality Configuration

This chapter describes the personality configuration features of the QLE2670 and QLE2672 Adapters, including:

- [Preparing for a Personality Change](#)
- [“Changing the Adapter Personality” on page 24](#)

The QLE2670 and QLE2672 Adapters allow you to change the interface type (personality) from a Fibre Channel Adapter to a Converged Network Adapter. This chapter covers the information that you need to know prior to changing the adapter personality, as well as the steps for performing a personality change in various interfaces.

Preparing for a Personality Change

To ensure that your 2600 Series Adapter supports a personality change, confirm the part number and revision, update the firmware, and replace the optical transceivers.

NOTE

After the 2600 Series Adapter’s mode has been changed to Converged Network Adapter, remove the 16Gb optical transceivers. You can replace these transceivers with one of the following:

- Marvell QLogic-branded 10GbE optical transceivers. Contact Marvell’s approved suppliers for purchase.

For instructions on using the 2600 Series Adapter as a Converged Network Adapter, refer to the *User’s Guide—Converged Network Adapter 8300 Series* (part number HD8354601-00), available on the Marvell Web site. To access the guide, see [“Downloading Updates and Documentation” on page xv](#) and select one of the 8300 Series Converged Network Adapter model numbers on the Marvell Downloads and Documentation Web page.

Confirming the Part Number and Revision

Confirm that your 2600 Series Adapter supports the personality change feature by determining the model name, part number, and revision letter.

Supported Models

Table 3-1 lists the 2600 Series Adapter models that support personality change.

Table 3-1. 2600 Series Adapters That Support Personality Change

Model Name	Part Number
QLE2670	HD8310405-01
QLE2672	HD8310405-02

To determine if your 2600 Series Adapter supports personality change, use either of the following methods:

- Locate the physical label on the adapter that has the part number (see Figure 3-1), and then check to see if it is listed in Table 3-1.

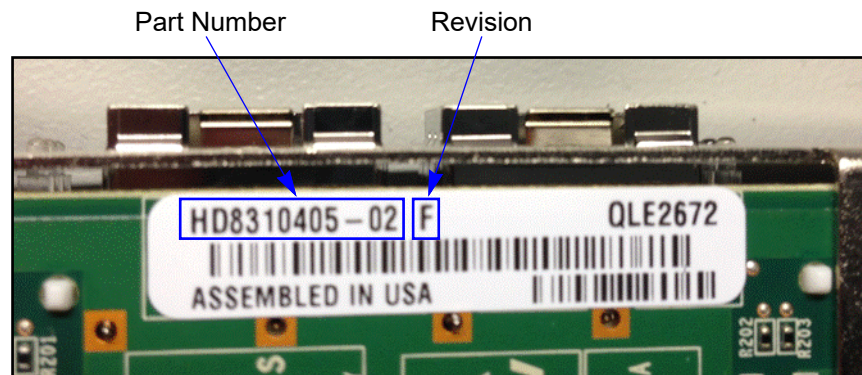


Figure 3-1. 2600 Series Adapter Part Number Location—Physical

- In QConvergeConsole CLI **Adapter VPD Information** menu, select a 2600 Series port in the **Adapter Port**. Navigate to **Port Vital Product Data (VPD)** (see Figure 3-1), view the **Engineering Date Code** for the part number, and then check to see if it is listed in Table 3-1.
QConvergeConsole CLI Command Line:

```
Display Adapter Port Vital Product Data (VPD)
#qauccli -I <hba instance> | <hba wwpn> /vpd
```

The following examples show output of the `gauccli -I` command.

```
QConvergeConsoleCLI
CLI - Version 3.0.x (Build xx)
FC Adapter Information
1: FC Adapter Information
2: FC Port Information
3: FC VPD Information
4: FC u provide me with Storage Device Information
5: FC Hyper-V VFC Information
6: FC Adapter FMB Information

(p or 0: Previous Menu; m or 98: Main Menu; ex or 99: Quit)
Please Enter Selection: 3
```

```
QConvergeConsoleCLI
CLI - Version 3.0.x (Build xx)
Adapter VPD Information
HBA Model QLE2742 SN: AFD1536Y03381
1: Port 1: WWPN: 21:00:00:24:ff:8f:d7:f4 Online (FEC)
2: Port 2: WWPN: 21:00:00:24:ff:8f:d7:f5 Link Down
HBA Model QLE2672 SN: AFE1225F05423
3: Port 1: WWPN: 20:01:00:0e:1e:05:64:de Online
4: Port 2: WWPN: 20:01:00:0e:1e:05:64:df Online
(p or 0: Previous Menu; m or 98: Main Menu; ex or 99: Quit)
Please Enter Selection: 3
```

```
-----
HBA Instance 0: QLE2672 Port 0 WWPN 20:01:00:0e:1e:05:64:de
PortID 02:0a:00
Link: Online
-----
```

```
Product Identifier : QLE2672 QLogic 2-ports 16Gb Fibre Channel
Adapter
Part Number : QLE2672
Serial Number : AFE1119C07636
Engineering Date Code : HD8310405-02
Flash Image Version : 033429
```

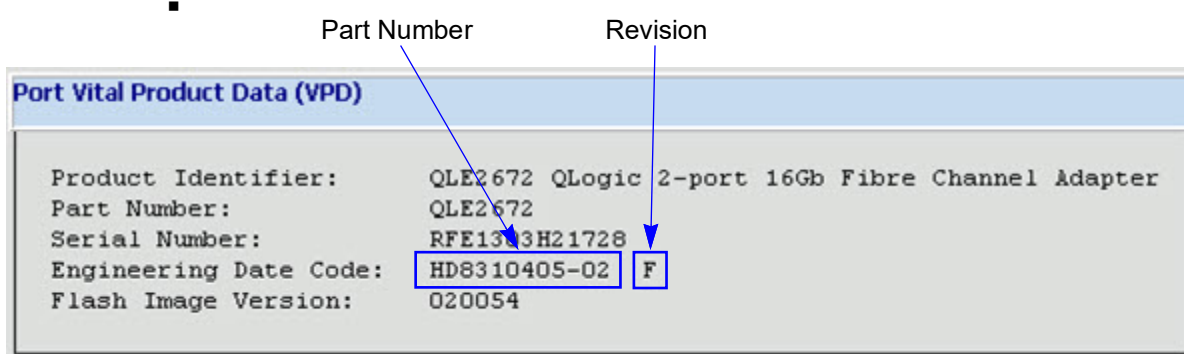


Figure 3-2. 2600 Series Adapter Part Number Location—QConvergeConsole CLI

Supported Revisions

Some 2600 Series Adapters that support personality change require an *enablement kit* (available on the QLogic Web site) for the change to work. For the adapters listed in [Table 3-1 on page 21](#), revisions A, B, C, D, E, F, and G require the enablement kit; revisions H and later do not. The adapter revision is printed on a label on the adapter (see [Figure 3-1 on page 21](#)).

If your adapter requires an enablement kit, refer to the knowledge base article, *Enabling CNA Functionality on QLogic 2600 Series Adapters*, available on the Marvell Downloads and Documentation page. To download documentation, follow the instructions in [“Downloading Updates and Documentation” on page xv](#).

Updating the Firmware

To enable a personality change, supported 2600 Series Adapters must have the latest firmware installed. To download the latest firmware, follow the instructions in [“Downloading Updates and Documentation” on page xv](#).

Replacing the Optical Transceivers

To operate the 2600 Series Adapter in Converged Network Adapter mode, replace the 16Gb optical transceivers with one of the following:

- QLogic-branded 10GbE optical transceivers. Contact QLogic’s approved suppliers for purchase.
- SFP+ direct-attach copper cables. For a list of supported cables, view the *Copper Cable Support Matrix* located here:

<https://www.marvell.com/documents/j1hg6lc3ixd5k4e2k89l/>

Be sure to have the new optics or copper cables available on-site before switching the 2600 Series Adapter's personality. Also, keep your 16Gb optical transceivers in a safe place in case you want to change the adapters back to Fibre Channel mode in the future.

NOTE

After the 2600 Series Adapters are converted to Converged Network Adapter mode, the adapters can no longer be connected to native Fibre Channel fabric or storage.

For instructions on converting the 2600 Series Adapter back to Fibre Channel mode, see the *User's Guide—Converged Network Adapter 8300 Series* (part number HD8354601-00), available on the Marvell Web site, Marvell Downloads and Documentation page.

Changing the Adapter Personality

NOTE

After changing the personality of a QLE267x Adapter, it is functionally equivalent to an 8300 Series Adapter.

You can configure the adapter personality in the following ways:

- [Changing the Personality with BIOS \(Fast!UTIL\)](#)
- [Changing the Personality with UEFI or EFI](#)
- [Changing the Personality with FCode](#)
- [Changing the Personality with Interactive QConvergeConsole CLI](#)
- [Changing the Personality with Noninteractive QConvergeConsole CLI](#)
- [Changing the Personality with QConvergeConsole Plug-in for VMware vCenter Server](#)

Changing the Personality with BIOS (*Fast!UTIL*)

To change the 2600 Series Adapter's personality mode using the BIOS *Fast!UTIL* utility on legacy x86 systems:

1. During system power-on initialization, press the CTRL+Q or ALT+Q keys. [Figure 3-3](#) shows an example.

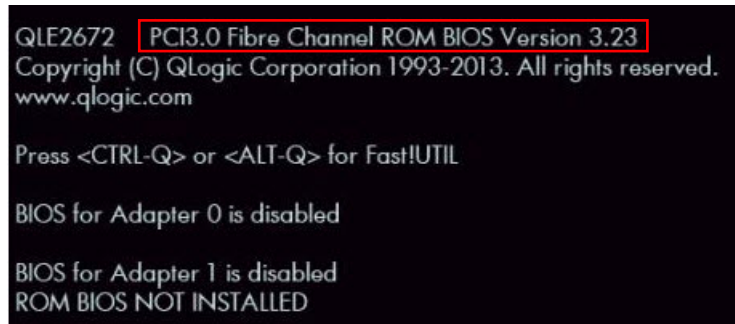


Figure 3-3. System Power-on Initialization

If you have more than one 2600 Series Adapter, the utility prompts you to select the adapter that you want to configure. [Figure 3-4](#) shows an example.

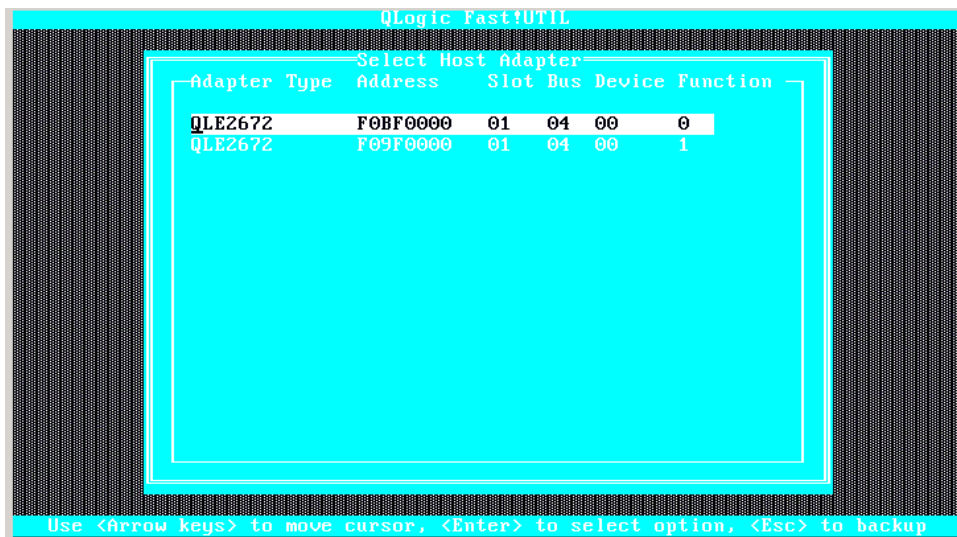


Figure 3-4. Fast!UTIL Select Host Adapter Menu

2. Select the 2600 Series Adapter that you want to configure, and then press the ENTER key.

The **Fast!UTIL Options** menu appears, as shown in [Figure 3-5](#).

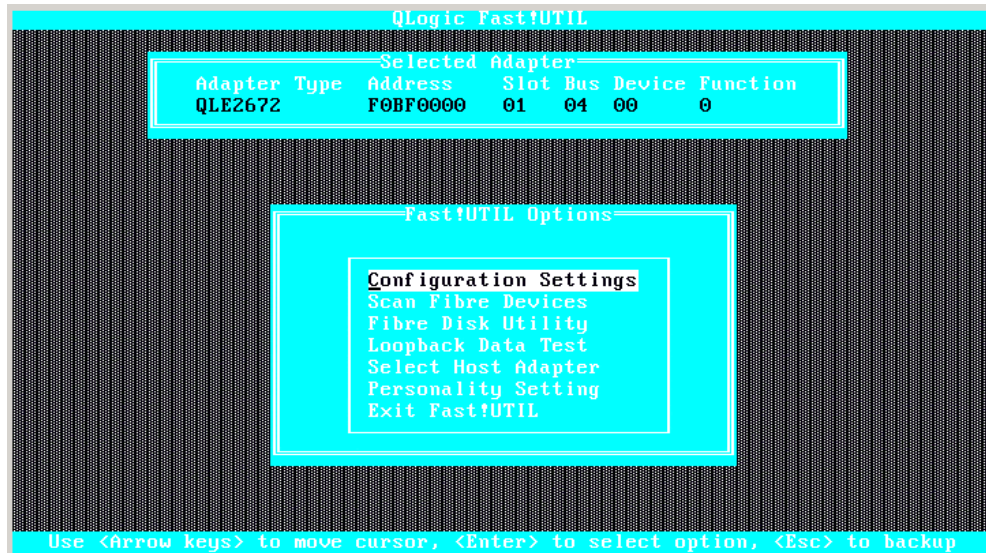


Figure 3-5. Fast!UTIL Options Menu

3. Press the arrow keys to select **Personality Setting**, and then press ENTER as shown in [Figure 3-6](#).



Figure 3-6. Selecting Personality Setting

The 2600 Series Adapter's current personality is displayed, as shown in [Figure 3-7](#).

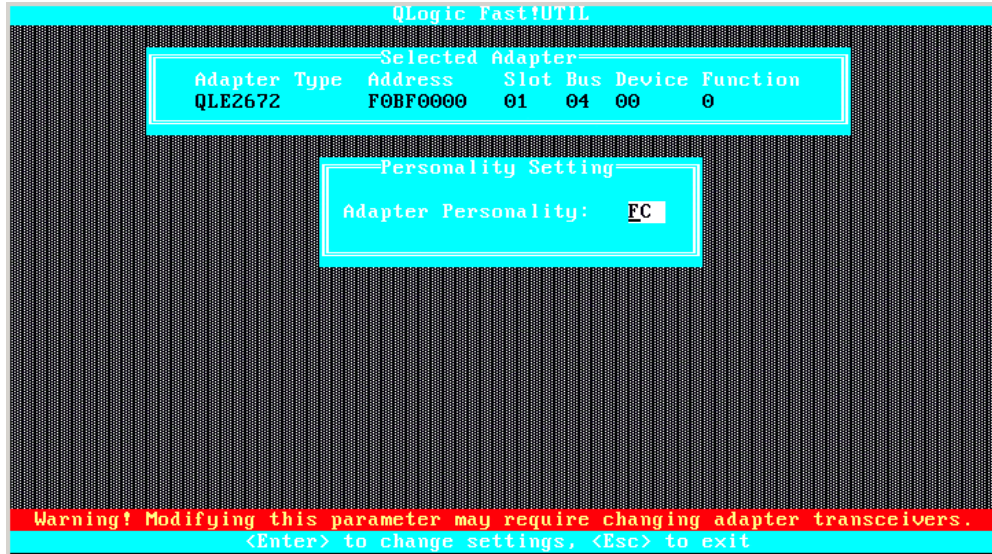


Figure 3-7. Changing the Personality from FC

4. To change the personality of the selected 2600 Series Adapter, press ENTER, and then press ESC to exit the menu. [Figure 3-8](#) shows an example.

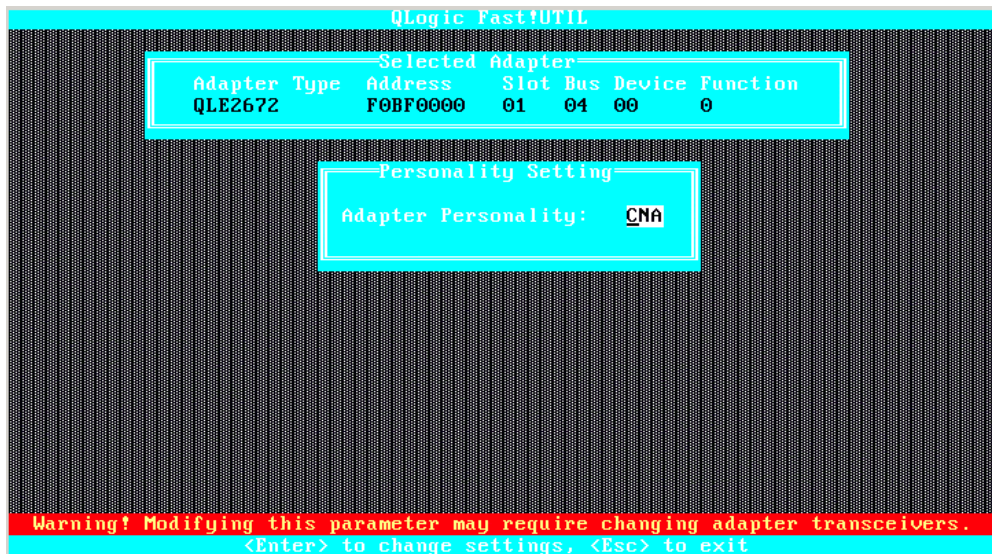


Figure 3-8. Changing the Adapter's Personality

5. Select **Save changes**, and then press ENTER, as shown in [Figure 3-9](#).

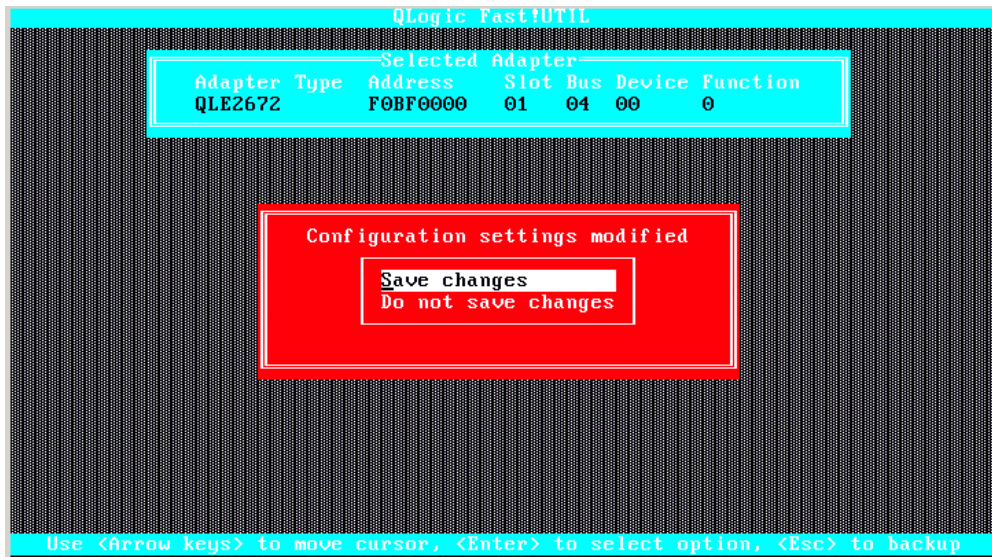


Figure 3-9. Save Your Changes

The **Fast!UTIL Options** menu appears. [Figure 3-10](#) shows an example.

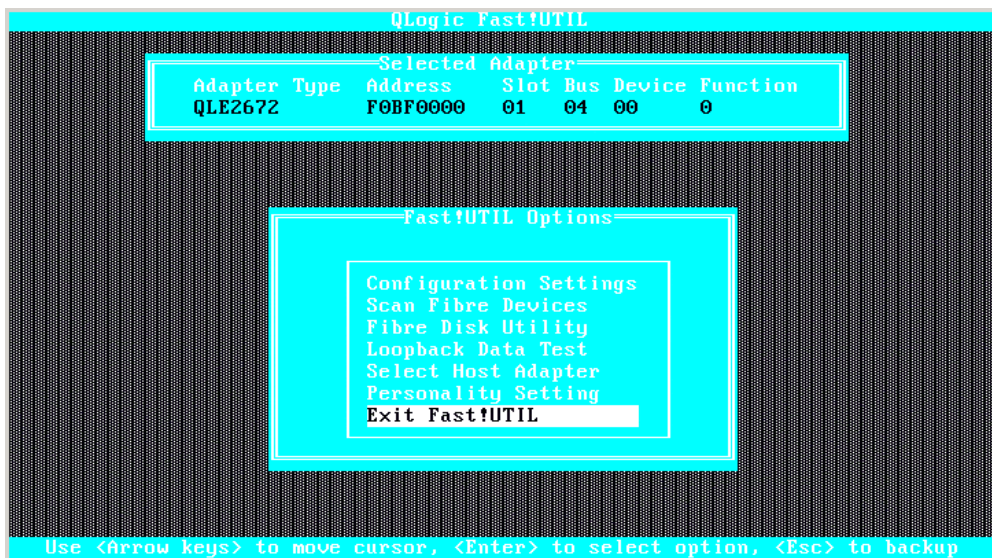


Figure 3-10. Fast!UTIL Options Menu

6. To exit the menu, do one of the following:
- ☐ Select **Exit Fast!UTIL**, and then press ENTER.
 - ☐ Press ESC.

The **Exit Fast!UTIL** menu appears, as shown in [Figure 3-11](#).

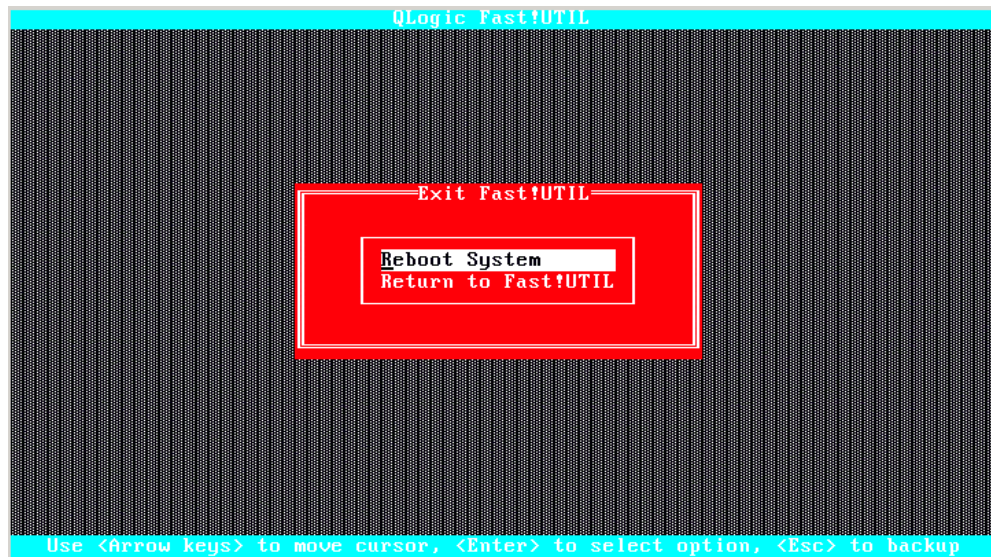


Figure 3-11. Exit Fast!UTIL Menu

7. To reboot the system, select **Reboot System**, and then press ENTER. After you reboot the system, the new personality takes effect, as shown in [Figure 3-12](#).

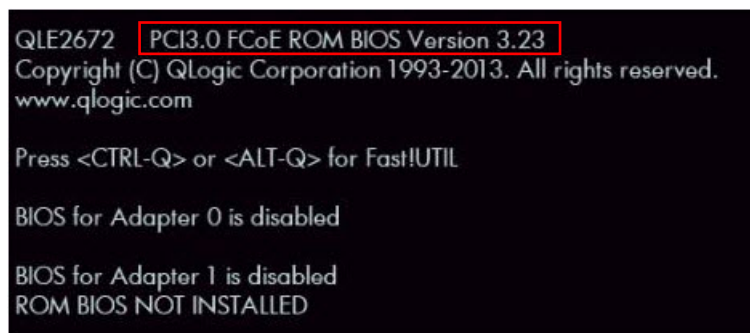


Figure 3-12. Personality Change Complete

Changing the Personality with UEFI or EFI

To change the 2600 Series Adapter's personality using the UEFI on x86 systems:

1. Enter the server's UEFI setup. (For instructions on how to enter the UEFI configuration menus, refer to your server manufacturer's documentation.)
2. To view the UEFI Driver Control page, select the **UEFI Driver Control** tab.

3. In the left pane, select a 2600 Series Adapter. [Figure 3-13](#) shows an example.

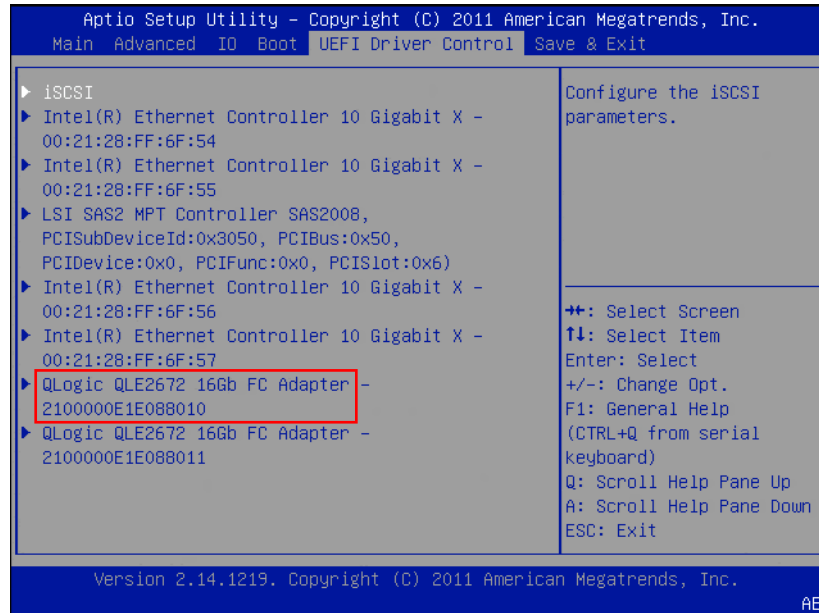


Figure 3-13. UEFI Driver Control Page in UEFI Setup

4. In the left pane, select **Advanced Settings**, as shown in [Figure 3-14](#).

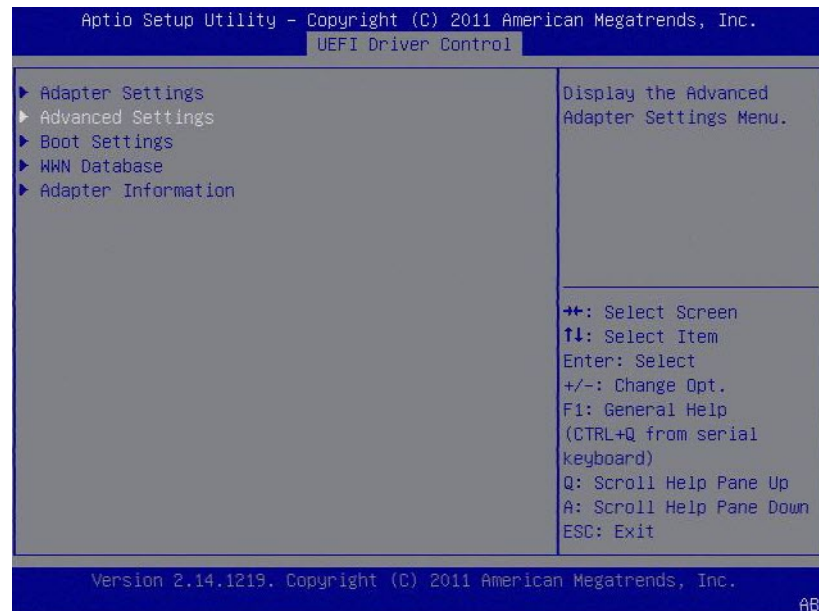


Figure 3-14. Selecting Advanced Settings

5. Select **Adapter Personality**, and then in the Adapter Personality box, select the mode, either **FC** or **CNA** (Fibre Channel or Converged Network Adapter) as required. Figure 3-15 shows an example.

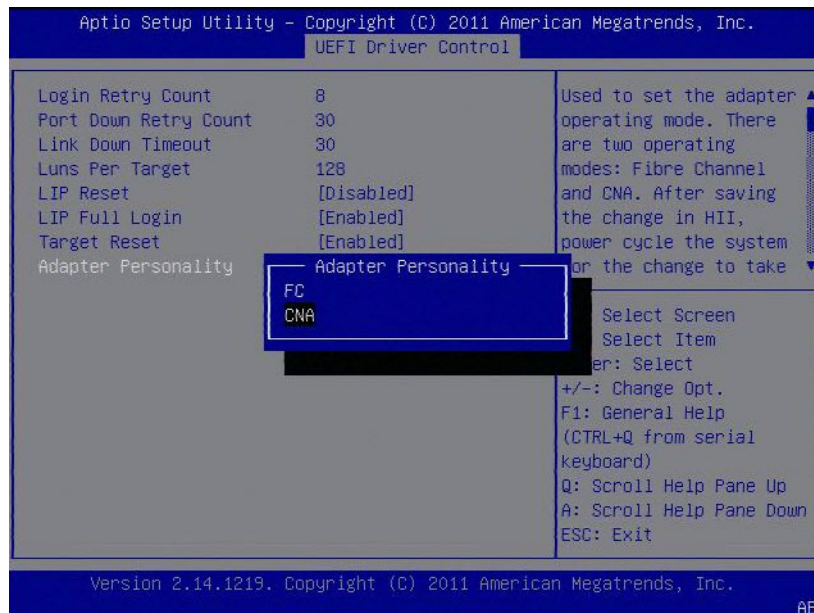


Figure 3-15. Selecting the Personality

6. Reboot the server.

Changing the Personality with FCode

NOTE

The path names shown in the examples might differ from the path names in your system. Look for the `QLGC,qlc@` section that identifies QLogic adapters.

The personality feature with FCode within the logical domain (LDOM) environment is available only to the primary function (PF).

To change the 2600 Series Adapter's personality using FCode on SPARC systems:

1. To list the QLogic Fibre Channel and FCoE device path, at the `ok` prompt, issue the `show-disks` command.

```
{0} ok show-disks
```

```
a) /pci@400/pci@1/pci@0/pci@c/LSI,sas@0/disk
```

```
b) /pci@400/pci@1/pci@0/pci@4/QLGC,qlc@0,1/fp@0,0/disk
```

```
c) /pci@400/pci@1/pci@0/pci@4/QLGC,qlc@0/fp@0,0/disk
```

```
d) /pci@400/pci@1/pci@0/pci@0/pci@0/usb@0,2/hub@3/storage@2/disk
e) /iscsi-hba/disk
q) NO SELECTION
Enter Selection, q to quit: q
{0} ok
```

2. At the **ok** prompt, issue the **select** command.

```
{0} ok select /pci@400/pci@1/pci@0/pci@4/QLGC,qlc@0
QLogic QLE2672 FC Host Adapter FCode (SPARC): x.xxxx yyyy-mm-dd
08:51
ISP Firmware version x.xx.xx
```

3. To change the 2600 Series Adapter's personality, at the **ok** prompt, issue the **set-personality** command.

The following example shows the mode being changed (in this case, from Fibre Channel to Converged Network Adapter):

```
{0} ok set-personality
Current Personality : FC
Do you want to change it? (y/n) y
Choose Personality :
0 - FC
1 - CNA
enter: 1
.
.
.
{0} ok reset-all
```

Changing the Personality with Interactive QConvergeConsole CLI

For information about downloading and installing QConvergeConsole CLI, see [“Step 3. Install an Adapter Management Tool” on page xxii](#).

To change the personality of a 2600 Series Adapter:

1. On the **Main Menu**, select **Adapter Configuration**.
2. On the **Adapter Type Selection** menu, select **Fibre Channel Adapter**.
3. On the **Fibre Channel Adapter Configuration** menu, select **Personality**.
4. On the adapter menu, select the 2600 Series Adapter whose personality is to be changed.
5. To change the personality, type **y**.

Example of changing a Fibre Channel Adapter to a Converged Network Adapter:

```
QConvergeConsole CLI
CLI - Version 2.7.x (Build xx)
Fibre Channel Adapter Configuration
1: HBA Model: QLE2672  SN: AFE1224F05259
   Port   1 WWPN: 21-00-00-0E-1E-08-F2-00 Link Down
   Port   2 WWPN: 21-00-00-0E-1E-08-F2-01 Online
(p or 0: Previous Menu; m or 98: Main Menu; ex or 99: Quit)
Please Enter Selection: 1
Change personality to CNA? (y/n): y
Personality type of HBA instance 1 (QLE2672) has been changed
successfully. Please reboot machine. Make sure to change the SFP
module to a compatible one (CNA) before reboot.
Hit <Enter> to continue:
```

Example of changing a Converged Network Adapter to Fibre Channel Adapter:

```
QConvergeConsole CLI
CLI - Version 2.7.x (Build xx)
Converged Network Adapter (CNA) FCoE Configuration
1: HBA Model: QLE2672  SN: AFE1224F05259
   Port   1 [Protocol(s): FCoE]
   Port   2 [Protocol(s): FCoE]
(p or 0: Previous Menu; m or 98: Main Menu; ex or 99: Quit)
Please Enter Selection: 1
Change personality to FC? (y/n): y
Personality type of HBA instance 1 (QLE2672) has been changed
successfully. Please reboot machine. Make sure to change the SFP
module to a compatible one (FC) before reboot.
Hit <Enter> to continue:
```

Changing the Personality with Noninteractive QConvergeConsole CLI

To display the current adapter personality type in the noninteractive mode of QConvergeConsole CLI, issue the following command:

```
gauccli -pr fc -pc <hba instance|hba wwpn|all> --info
```

To change the personality of a 2600 Series Adapter:

- Issue the following command:

```
gauccli -pr fc -pc <hba instance|hba wwpn|all> --type <mode>
```

Where:

`hba instance` = Fibre Channel Adapter instance number of a Fibre Channel Adapter port
(issue the `-g` command to find)

`hba wwpn` = Worldwide port name of a Fibre Channel Adapter port

`all` = All adapter ports

`mode` = Personality type:

`fc` or `0` = Change the adapter personality to Fibre Channel

`cna` or `1` = Change the adapter personality to Converged Network
Adapter

Changing the Personality with QConvergeConsole Plug-in for VMware vCenter Server

To change the personality of a 2600 Series Adapter:

1. In the tree pane on the left side of the QConvergeConsole pane, select a 2600 Series Adapter.
2. In the content pane under **Configuration**, select an **Adapter Personality Type** as shown in Figure 3-16.

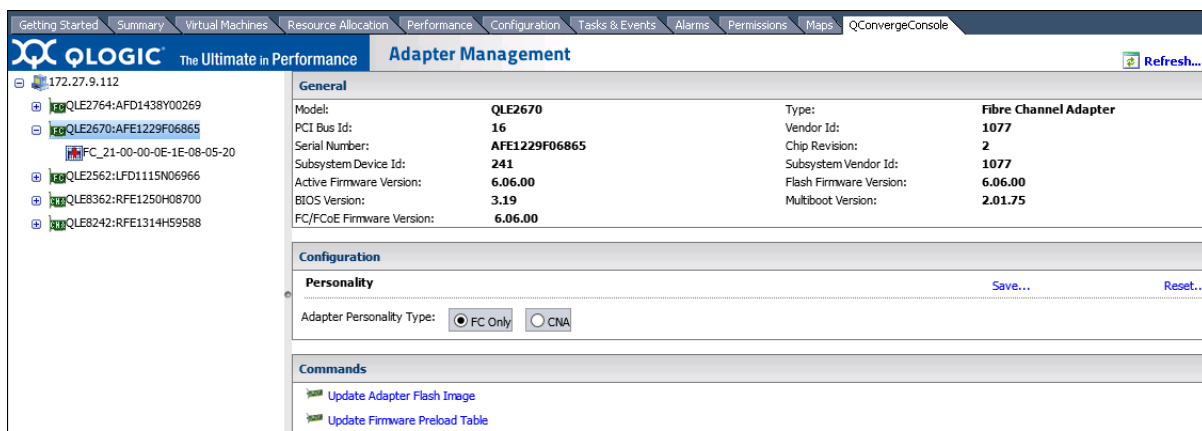


Figure 3-16. Changing Personality Type Using QConvergeConsole Plug-in for VMware vCenter Server

3. Click **Save**.

4 Fibre Channel Configuration

This chapter describes the driver and agent installation, configuration, operation, and troubleshooting of the Fibre Channel function of the 2600 Series Adapters, including:

- [“Installing Fibre Channel” on page 36](#)
- [“Setting Fibre Channel Adapter Parameters” on page 42](#)
- [“Configuring Target Persistent Binding” on page 43](#)
- [“Configuring Boot Devices” on page 44](#)
- [“Configuring Virtual Ports \(NPIV\)” on page 47](#)
- [“Configuring Driver Parameters” on page 52](#)
- [“Configuring Selective LUNs” on page 53](#)
- [“Setting Queue Depth” on page 56](#)
- [“Using Fabric-Assigned Boot LUN” on page 58](#)
- [“Configuring End-to-End \(CS_CTL\) QoS” on page 62](#)
- [“Enabling Forward Error Correction” on page 64](#)
- [“Using Buffer-to-Buffer Credit Recovery” on page 67](#)
- [“Resetting Driver and Firmware Counters” on page 68](#)
- [“Configuring VM-ID” on page 68](#)
- [“Universal SAN Congestion Mitigation \(USCM\)” on page 69](#)
- [“FPIN Link Integrity Marginal Path Detection Support” on page 72](#)
- [“Using Fibre Channel Diagnostics” on page 74](#)
- [“Management Component Transport Protocol Support” on page 80](#)

Installing Fibre Channel

This section provides information on installing Fibre Channel on the following platforms:

- [Installing Fibre Channel in Linux](#)
- [Installing Fibre Channel Boot from SAN in Citrix Hypervisor Environments](#)
- [Installing Fibre Channel in VMware ESXi](#)
- [Installing Fibre Channel in Windows](#)

Installing Fibre Channel in Linux

For more information, download the latest driver package and the associated *Read Me* and *Release Notes* documents, available at www.marvell.com (see “Downloading Updates and Documentation” on page xv).

Linux OS Support

To obtain the latest information about supported Linux operating systems, see the latest *Read Me* and *Release Notes*.

Supported Features

The Fibre Channel (inbox and/or out-of-box) Linux driver supports the following:

- Point-to-point, and fabric topologies
- Initiator mode only
- Fibre Channel tape
- MSI-X
- NPIV
- Device mapper
- Support for block SG (BSG) interface
- Support for sysfs interface
- Support for an adapter API

Deploying the Driver

For information on deploying the driver, see the latest *Read Me*.

Driver System Parameters

For information on setting driver system parameters, see the latest *Read Me*.

Importing a Public Key for Secure Boot

When loading drivers in a Secure Boot environment, Linux drivers require that you import and enroll the QLogic public key. Before you begin, ensure that your server supports Secure Boot.

This section is for use with one of the following packages:

■ SLES:

```
qlgc-qla2xxx-kmp-default-<driver version>_<kernel  
version>.<OSV-version>.<architecture-type>.rpm
```

For example:

```
qlgc-qla2xxx-kmp-default-10.02.08.01_k_k5.14.21_150400.22-1.  
sles15sp4.x86_64.rpm
```

■ RHEL:

```
kmod-qlgc-qla2xxx-<driver-version>.<OSV-version>.<architectu  
re-type>.rpm
```

For example:

```
kmod-qlgc-qla2xxx-10.02.08.01_k-1.rhel9u0.x86_64.rpm
```

Here, OSV means Operating System Vendor.

NOTE

A public key is required on a Linux physical system or virtual machine running on a hypervisor (if secure boot is enabled).

This section provides two methods for importing and enrolling the public key.

Method 1: To import and enroll the Marvell QLogic public key:

1. Download the `qlgc_module-202x.der` or `qlgc_module-202x.zip` public key file from the following web page:

<https://www.marvell.com/support/ldriver.html>

2. To install the `qlgc_module-202x.der` public key, issue the following command:

```
# mokutil --root-pw --import qlgc_module-202x.der
```

Where the `--root-pw` option enables direct use of the root user.

3. Review the list of certificates that are prepared to be enrolled:

```
# mokutil --list-new
```

4. Reboot the system.

5. When the shim launches MokManager, enter the root password to confirm the certificate importation to the Machine Owner Key (MOK) list.
6. To determine if the newly imported key was enrolled:

```
# mokutil --list-enrolled
```

Method 2: To launch MOK manually and enroll the Marvell QLogic public key:

1. Download the `qlgc_module-202x.der` or `qlgc_module-202x.zip` public key file from the following web page:
<https://www.marvell.com/support/ldriver.html>
2. Issue the following command:

```
# reboot
```
3. In the **GRUB 2** menu, press the C key.
4. Issue the following commands:

```
chainloader $efibootdir/MokManager.efi  
boot
```
5. Select **Enroll key from disk**.
6. Navigate to the `qlgc_module-202x.der` file and then press ENTER.
7. Follow the instructions to enroll the key. Generally, this includes pressing the 0 (zero) key and then pressing the Y key to confirm.

NOTE

The firmware menu may provide more methods to add a new key to the Signature Database.

For additional information about Secure Boot, refer to the following web page:

<https://documentation.suse.com/sles/15-SP4/html/SLES-all/cha-uefi.html#sec-uefi-secboot>

Boot from SAN

Booting from SAN means booting the OS from a Fibre Channel target device. You should use the QLogic inbox driver to install the OS to the Fibre Channel target device that is attached to a 2600 Series Adapter. If there is no QLogic inbox driver that supports the 2600 Series Adapter, you should use a DD-Kit¹ to boot from SAN.

NOTE

The following procedure is only for RHEL® 7.0 and later distributions.

To boot from SAN when installing to a LUN other than LUN 0 and LUN 0 is present:

1. On the Boot Loader Configuration window, select **Configure Advance Boot Loader**, and then click **Next**.
2. On the Advanced Boot Loader Configuration window, select **Change Drive Order**.
3. On the Edit Drive Order window, move the entry for the boot LUN.
4. To continue, click **OK**.
5. Continue with the OS installation as usual.

Installing Fibre Channel Boot from SAN in Citrix Hypervisor Environments

NOTE

The following procedure is only for Citrix Hypervisor 8.0 and later.

To Boot from SAN when installing to a LUN other than LUN ID 0, or LUN 0 follow the procedure below:

1. Insert the Citrix Hypervisor 8.0 installation CD and begin the installation in a root shell.
2. When the system is booted from XS8.0 install CD, choose the **Shell Mode Installation** option. This selection logs in the user with the required privileges.

¹ Marvell provides DD-Kits (driver update disks) for Linux platforms.

3. Once the system boots to shell, unload the inbox qla2xxx driver.

```
root@localhost /l# modprobe -rv qla2xxx  
rmmod qla2xxx  
rmmod scsi_transport_fc  
rmmod nune_fc  
rmmod nune_fabrics  
rmmod nune_core
```

Figure 4-1. Unloading the qla2xxx driver

4. Type “exit” to return to the GUI installer.
5. Insert the driver update disk (DUD) CD (ISO image) and load the driver using the “F9” option as shown in example below.

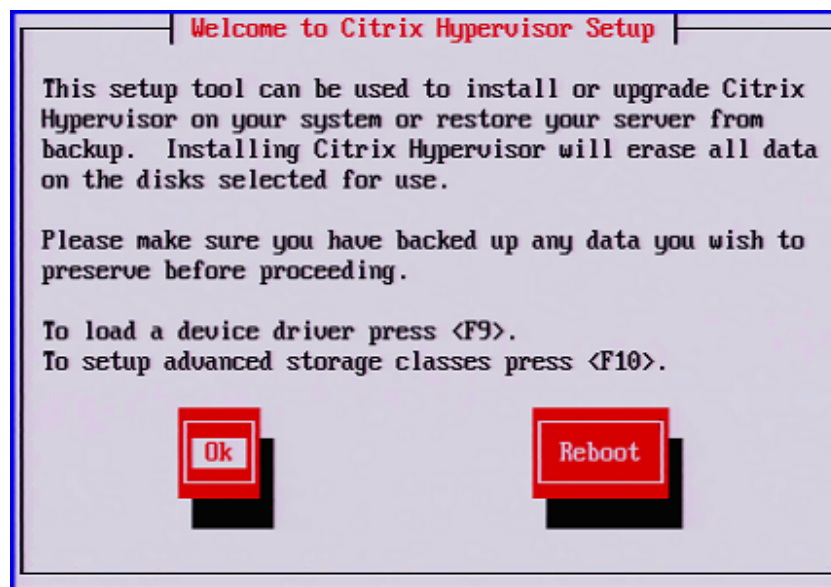


Figure 4-2. Confirm Driver Update

6. Go to the shell by pressing keys “ALT+F2” and load the OOB driver.

```
root@localhost ~]# modprobe -v qla2xxx  
insmod /lib/modules/4.19.0+1/kernel/drivers/scsi/scsi_transport_fc.ko  
insmod /lib/modules/4.19.0+1/kernel/drivers/nvme/host/nvme-core.ko  
insmod /lib/modules/4.19.0+1/kernel/drivers/nvme/host/nvme-fabrics.ko  
insmod /lib/modules/4.19.0+1/kernel/drivers/nvme/host/nvme-fc.ko  
insmod /lib/modules/4.19.0+1/updates/qla2xxx.ko
```

Figure 4-3. Loading the OOB driver

7. Return to the GUI installer by pressing “ALT+F1” and continue the OS installation without removing the Driver Update Disk CD.
8. Skip the supplemental package installation.
9. Reboot the system when prompted and remove the OS installer CD and driver update CD.
10. Hypervisor should boot with new driver installed.

NOTE

Both the OS install disk and driver update disk should be inserted during the installation process.

Installing Fibre Channel in VMware ESXi

For information on installing Fibre Channel in VMware ESXi, refer to the *Read Me* and *Release Notes* documents for VMware ESXi 7.0 and 8.0.

NOTE

For specific service packs (SPs) and OS updates, go to the Downloads and Documentation page at www.marvell.com (see “Downloading Updates and Documentation” on page xv).

ESXi OS Support

To obtain the latest information about supported ESXi operating systems, download the associated *Read Me* and *Release Notes* documents available at www.marvell.com (see “Downloading Updates and Documentation” on page xv).

Using the Driver

For information on how to install and remove the driver, refer to the *Read Me* document for VMware ESXi 7.0 and 8.0, available at www.marvell.com (see “Downloading Updates and Documentation” on page xv).

Installing Fibre Channel in Windows

For information on how to install Fibre Channel in Windows, refer to the *Fibre Channel Adapter STOR Miniport Driver Read Me* document.

Windows OS Support

To obtain the latest information about supported Windows operating systems, download the associated *Read Me* and *Release Notes* documents available at www.marvell.com (see “Downloading Updates and Documentation” on page xv).

Using the Driver

For information on how to create the driver disk, install the driver, and remove the driver, refer to the *Fibre Channel Adapter STOR Miniport Driver Read Me* document.

Installing Fibre Channel in Solaris

The Solaris drivers for this adapter are inbox in the Solaris OS. For additional Solaris-specific information, refer to the OS documentation.

NOTE

For a detailed list of the currently supported operating systems, refer to the adapter’s *Read Me* and *Release Notes* available at www.marvell.com (see “Downloading Updates and Documentation” on page xv).

Solaris OS Support

To obtain the latest information about supported Solaris operating systems, download the associated *Read Me* and *Release Notes* available at www.marvell.com (see “Downloading Updates and Documentation” on page xv).

Updating the Driver

Refer to the Solaris OS documentation for information on how to create the driver disk, install the driver, and remove the driver.

Setting Fibre Channel Adapter Parameters

You can set parameters for Fibre Channel using QConvergeConsole CLI or QConvergeConsole Plug-ins.

Setting Fibre Channel Adapter Parameters with Interactive QConvergeConsole CLI

To set Fibre Channel Adapter parameters with interactive QConvergeConsole CLI:

1. On the **Adapter Configuration** menu, select **HBA Parameters**.

2. On the port menu, select a port to open the **HBA Parameters** menu.
3. On the **HBA Parameters** menu, select the **Change Settings** option to open the Configure Parameters menu.

For more information, refer to the section about the Fibre Channel interactive commands in the *User's Guide—QConvergeConsole CLI* (part number SN0054667-00).

Setting Fibre Channel Adapter Parameters with Noninteractive QConvergeConsole CLI

For information on setting Fibre Channel Adapter parameters using the noninteractive mode of QConvergeConsole CLI, refer to the section about Fibre Channel noninteractive commands in the *User's Guide—QConvergeConsole CLI* (part number SN0054667-00).

Setting Fibre Channel Adapter Parameters with QConvergeConsole vSphere Client Plug-in

For information on setting Fibre Channel Adapter parameters using the QConvergeConsole vSphere Client Plug-in, refer to the section “Configure Fibre Channel Port Parameters” in the *User's Guide—QConvergeConsole Plug-ins for VMware vSphere* (part number SN0054677-00).

Configuring Target Persistent Binding

You can configure target persistent binding using either the QConvergeConsole CLI tool.

NOTE

Target persistent binding is supported only for Windows.

Configuring Persistent Binding with Interactive QConvergeConsole CLI

In the interactive mode of QConvergeConsole CLI, follow these steps to bind a selected target to a specific adapter.

To bind a target using interactive QConvergeConsole CLI:

1. On the **Adapter Configuration** menu, select **Bind Target(s)**.
2. On the port menu, select a port and then select **Bind Target(s)** to bind a target to a port.

3. Select a target and specify a target ID to open the **Target Persistent Binding – FC Port Configuration** menu with options to select more targets, save changes, or cancel the binding operation.

For more information, refer to the section about Fibre Channel interactive commands in the *User's Guide—QConvergeConsole CLI* (part number SN0054667-00).

Configuring Persistent Binding with Noninteractive QConvergeConsole CLI

In the noninteractive mode of QConvergeConsole CLI, bind a selected target to a specific adapter by issuing the following command:

```
# qauccli -pr fc -p (<hba instance> | <hba wwpn>) (<target wwnn>  
<target wwpn> <target port id> <target id>)
```

Where:

hba instance = Adapter number (issue the -g command to find)

hba wwpn = Worldwide port name of the adapter

target wwnn = Worldwide node name of the target

target wwpn = Worldwide port name of the target

target port id = Port ID of the target

target id = ID to which the target is bound

For more information, refer to the section about Fibre Channel noninteractive commands in the *User's Guide—QConvergeConsole CLI* (part number SN0054667-00).

Configuring Boot Devices

You can configure boot devices using QConvergeConsole CLI, QConvergeConsole Plug-in, or the BIOS utility.

Configuring Boot Devices with Interactive QConvergeConsole CLI

In the interactive mode of QConvergeConsole CLI, open the **Adapter Configuration** menu, and then select **Configure Boot Devices**. Depending on the selected adapter, you can configure the boot device with BIOS or UEFI, or only UEFI. For more information on configuring boot devices with the interactive mode of QConvergeConsole CLI, refer to the section about the Fibre Channel interactive commands in the QConvergeConsole.

Configuring Boot Devices with Noninteractive QConvergeConsole CLI

In the noninteractive mode of QConvergeConsole CLI, set a specific target as the boot device (BIOS boot mode) for a specific adapter by issuing the following command:

```
# qauccli -pr fc -e (<hba instance> | <hba wwpn>) <target wwnn>  
<target wwpn> <target id> <lun id>
```

Where:

hba instance = Adapter number (issue the `-g` command to find)
hba wwpn = Worldwide port name of the adapter
target wwnn = Worldwide node name of the target
target wwpn = Worldwide port name of the target
target id = ID to which the target is bound
lun id = ID of the LUN

In the noninteractive mode of QConvergeConsole CLI, set a specific target as the boot device (UEFI boot mode) for a specific adapter by issuing the following command:

```
qauccli -pr fc -e <hba instance>|<hba wwpn> <storage WWNN> <storage  
WWPN> <storage nsid> <storage flag> <boot entry> <boot mode>  
[<storage NQN>] [<storage ctrlid>]
```

For more information, refer to the section about the Fibre Channel noninteractive commands in the *User's Guide—QConvergeConsole CLI* (part number SN0054667-00).

Configuring Boot Devices with the BIOS

For information on configuring boot devices with BIOS, refer to [“Fibre Channel Adapter Installation with QLogic SuperInstallers” on page 4](#).

Configuring Boot Devices with QConvergeConsole vSphere Client Plug-in

Follow these steps to configure boot devices with QConvergeConsole vSphere Client Plug-in.

NOTE

The following instructions are not supported in VMware ESXi 8.0.

To configure boot devices:

1. In the tree pane on the left side of the VMware vSphere UI window, select a host.
2. In the content pane, click the **Configure** tab.
3. On the Configure page, bottom right side, click the **QConvergeConsole vSphere Client Plug-in** tab.

The QConvergeConsole vSphere Client Plug-in Adapter Management window appears in the VMware vSphere UI content pane. The **QConvergeConsole vSphere Client Plug-in** Adapter Management window also contains two panes: a tree pane on the left and a content pane on the right.

4. In the Adapter Management’s left pane, click a node corresponding to a 2600 Series Adapter, and then click a Fibre Channel port node to view general information pertaining to that port in the right pane.
5. On the General page, click the **Boot** tab.

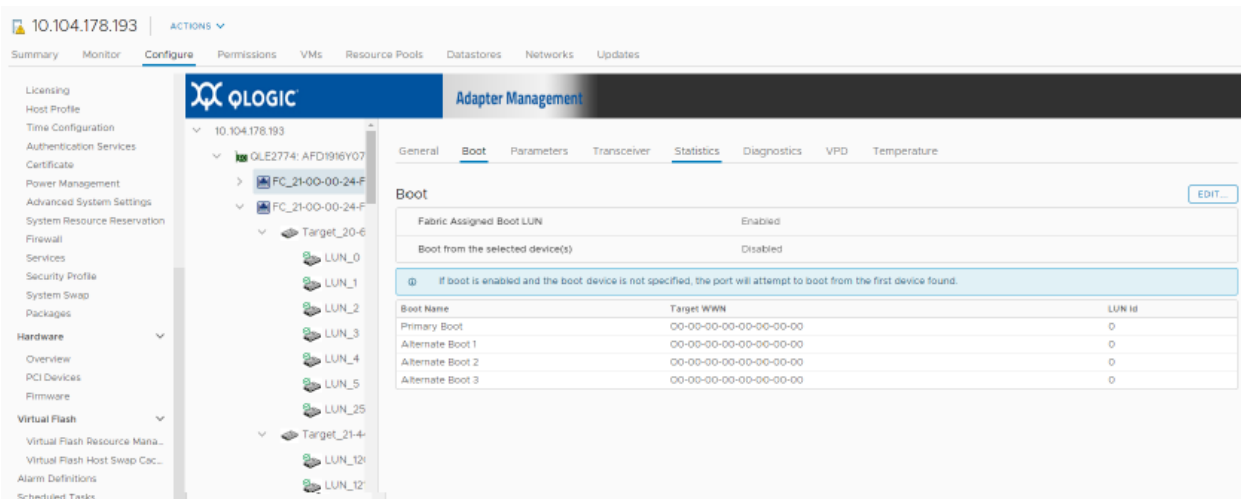


Figure 4-4. QConvergeConsole vSphere Client Plug-in Boot Options

6. On the Boot page under **Boot**, click **Edit**.

7. Complete the FC Boot dialog box to specify the primary and alternate boot Devices from the drop box, and then click **OK** to save your changes.

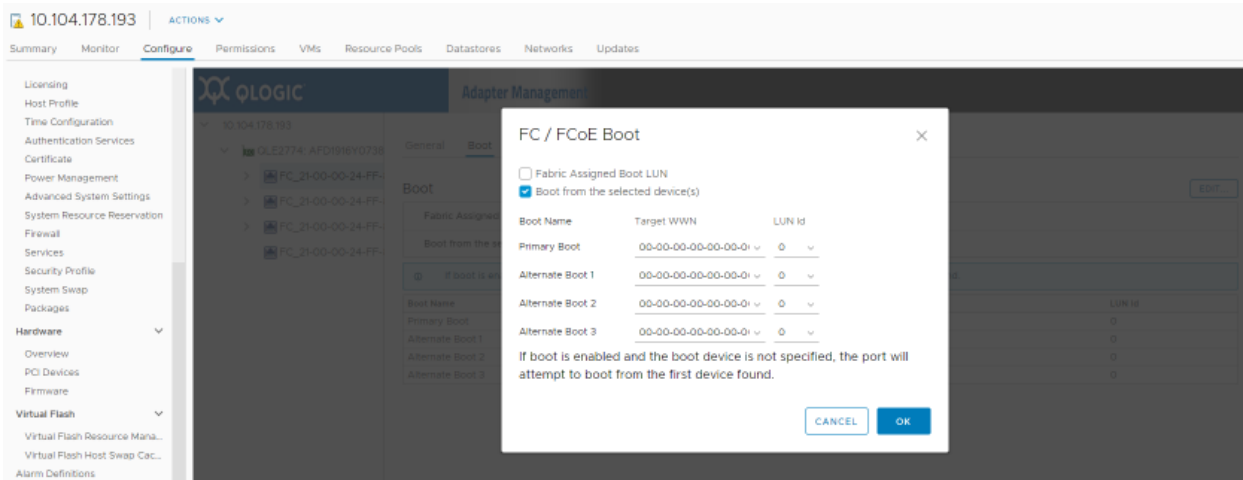


Figure 4-5. FC/FCoE Boot dialog box

8. Reboot the system for the new settings to take effect.

Configuring Virtual Ports (NPIV)

You can configure NPIV using the QConvergeConsole CLI tool. This section also covers NPIV quality of service (QoS).

NOTE

To configure NPIV on VMware ESXi, refer to the *User's Guide—Marvell Fibre Channel and Converged Network Adapters for VMware ESXi 7.0, and 8.0* (part number SN0154529-00), “Deploying NPIV for VMware ESXi 7.0 and 8.0” section, available at www.marvell.com (see “Downloading Updates and Documentation” on page xv).

Configuring NPIV with Interactive QConvergeConsole CLI

In the interactive menu of QConvergeConsole CLI, open the **Adapter Configuration** menu, and then select **N_Port ID Virtualization (NPIV)**. The **N_Port ID Virtualization (NPIV)** menu shows options for viewing and configuring virtual ports.

For more information about configuring NPIV with interactive QConvergeConsole CLI, refer to the *User's Guide—QConvergeConsole CLI* (part number SN0054667-00).

Configuring NPIV with Noninteractive QConvergeConsole CLI

You can configure a virtual port in the noninteractive mode of QConvergeConsole CLI with either an automatic or a specific WWPN.

To create a virtual port with an automatic WWPN:

- Issue the following command:

```
# qauccli -vp <hba instance>|<hba wwpn> create auto  
[<num_of_vport>]
```

Where:

<code>hba instance</code>	=	Adapter number (issue the <code>-g</code> command to find)
<code>hba wwpn</code>	=	Worldwide port name of the adapter
<code>num_of_vport</code>	=	Number of virtual ports to be created.

If the key word 'max' is specified, then maximum number of virtual ports will be automatically created.

To create a virtual port with a specific WWPN:

1. Issue the following command:

```
# qauccli -pr fc -vp (<hba instance> | <hba wwpn>) create  
<vport hex>
```

Where:

<code>hba instance</code>	=	Adapter number (issue the <code>-g</code> command to find)
<code>hba wwpn</code>	=	Worldwide port name of the adapter
<code>vport hex</code>	=	World wide port name of the virtual port with the two hexadecimal digits in byte three supplied by the user

2. When prompted, type two hexadecimal digits. The system checks these digits to ensure that they are unique and, if they are, puts them into byte 1 of the WWPN.

For more information, refer to the section about Fibre Channel noninteractive commands in the *User's Guide—QConvergeConsole CLI* (part number SN0054667-00).

NPIV Quality of Service

The 2600 Series Adapter solution provides for standards-based QoS, ensuring high-quality performance for applications that require preferential delivery. The QConvergeConsole QoS solution assigns QoS levels to virtual ports (NPIV ports) in contrast to end-to-end QoS, which assigns QoS levels from initiator to target across the fabric. For information about end-to-end (CS_CTL) QoS, see [“Configuring End-to-End \(CS_CTL\) QoS” on page 62](#).

You can configure the NPIV QoS using the **priority method** or the **bandwidth method**, as shown in [Figure 4-6](#).

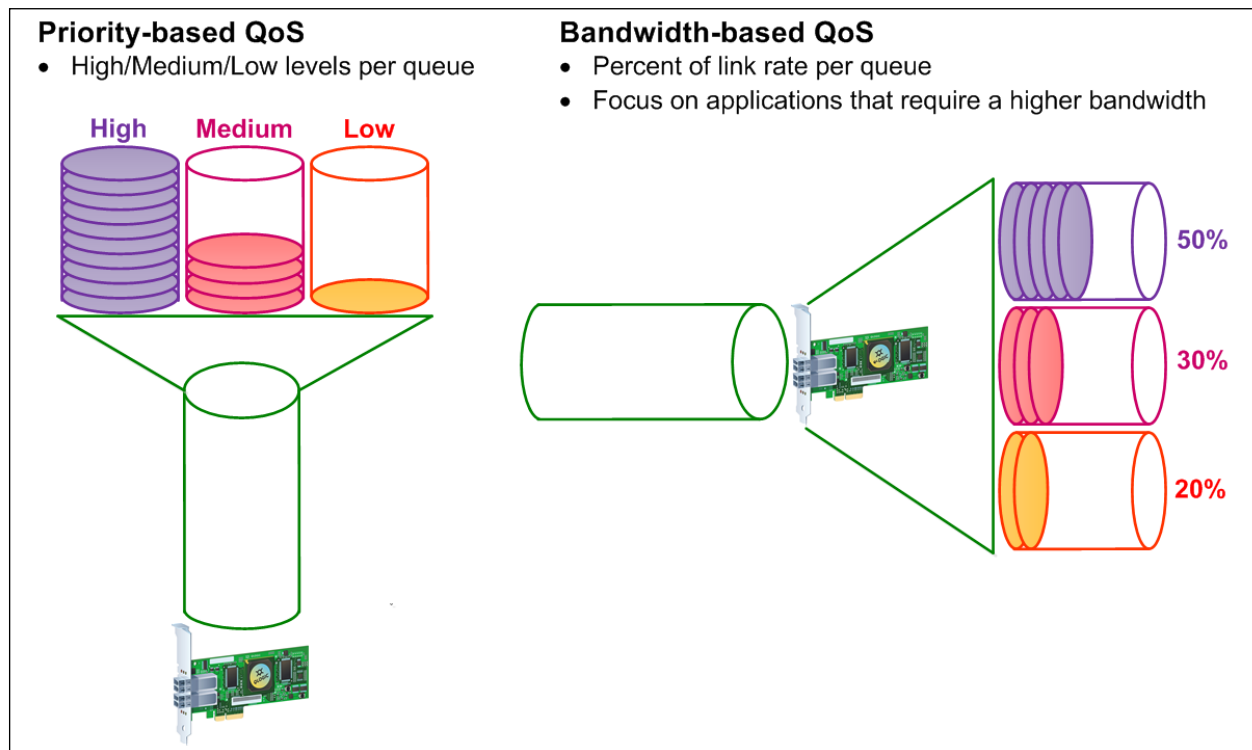


Figure 4-6. Priority- and Bandwidth-based QoS

On a single physical port, you can configure QoS using the priority method or the bandwidth method but not both.

- The **priority method** assigns priority levels (low, medium, or high) to virtual ports based on the QoS required for the applications or VMs using the virtual port. This method provides for various levels of latency requirements across virtual ports. See [“Setting QoS by Priority” on page 50](#).
- The **bandwidth method** assigns bandwidth to applications or VMs that are using virtual ports as a percentage of the total bandwidth available (16Gbps) or a specific value, such as 1Gbps. This method provides a minimum bandwidth guarantee. The bandwidth-based QoS configuration applies only when the total bandwidth requirement of the applications exceeds the available bandwidth. The bandwidth is not reserved for a specific virtual port, and unused bandwidth is shared among the other virtual ports. See [“Setting QoS by Bandwidth” on page 51](#).

The physical port or world-wide name (WWN) always has high priority, independent of the bandwidth or priority scheme chosen for created virtual ports. You need not assign a QoS level to every virtual port that you create. If a QoS level is not assigned to a virtual port, the default is low priority (best effort), independent of the bandwidth or priority scheme. This flexibility allows you to focus on critical applications to ensure that the highest service level is provided. You can modify QoS levels for virtual ports using QConvergeConsole CLI.

To modify QoS levels, the configuration must meet the following hardware and software requirements:

- Server operating system: Microsoft Windows Server® 2008 or later
- Server support for MSI-X
- A 2600 Series Adapter
- Latest version of the QLogic STOR miniport driver, available from the Downloads and Documentation page at www.marvell.com (see [“Downloading Updates and Documentation” on page xv](#)).
- Fibre Channel switch that supports NPIV
- Physical port attached in a point-to-point connection

Setting QoS by Priority

To set the QoS by priority with interactive QConvergeConsole CLI:

1. From the **Adapter Configuration** menu, select the **NPIV QoS** option.
2. From the port menu, select a port to open the **QoS Type Menu**. Select **1: QoS Priority** to set the priority.

Setting QoS by Bandwidth

Setting the QoS by bandwidth allocates up to 80 percent of the physical port's bandwidth to its virtual ports. The remaining 20 percent is reserved to handle non-QoS applications and virtual ports.

Setting QoS by bandwidth guarantees bandwidth for each virtual port and to the application or VM associated with that virtual port. The proper QoS setting can prevent bottlenecks that occur when VMs contend for port bandwidth.

Consider how much bandwidth is required to maximize application or VM performance and set the QoS level to 105 percent of that value. For example, if a mission-critical application on a VM requires 1Gb of bandwidth to transmit its data over the fabric, Marvell recommends a bandwidth setting of 1.05Gb for the virtual port.

Alternatively, the virtual port QoS values can be set as a percentage of the total available bandwidth.

NOTE

Setting QoS by bandwidth guarantees a minimum bandwidth to a virtual port but not a maximum limit. If the application/virtual port requires more bandwidth than the QoS bandwidth value allows and the physical port has available bandwidth, the application receives the additional bandwidth. The port allocates additional bandwidth on demand up to the port capacity or until there is contention for bandwidth among the virtual ports.

When the physical port is partitioned into four virtual ports, the port bandwidth is divided between the virtual ports according to traffic demands.

QConvergeConsole CLI lets you set QoS for each virtual port by setting minimum and maximum percentages of the physical port's bandwidth for each virtual port. Using this feature lets you guarantee a transmission rate for each port that requires a specific bandwidth to run mission-critical applications for business continuity using virtual ports. The setting for a specific QoS can resolve bottlenecks that exist when VMs contend for port bandwidth.

To set the QoS by bandwidth speed with interactive QConvergeConsole CLI:

1. On the **Fibre Channel Adapter Configuration** menu, select the **QoS** option.
2. From the port menu, select a port to open the **QoS Type Menu**. Select **2: QoS Bandwidth** to set the bandwidth speed.

Configuring Driver Parameters

You can configure driver parameters for Fibre Channel using either QConvergeConsole CLI or QConvergeConsole vSphere Client Plug-in.

Configuring Fibre Channel Driver Parameters with Interactive QConvergeConsole CLI

To configure Fibre Channel driver parameters using interactive QConvergeConsole CLI:

1. On the QConvergeConsole CLI **Adapter Configuration** menu, select **HBA Parameters**.
2. On the port menu, select a port to open the **HBA Parameters** menu.
3. Select options on the **Change Settings** menu to present persistently bound targets plus new targets with driver default, present persistently bound targets only, bind devices by WWPN, and bind devices by port ID.

For more information, refer to the section about the Fibre Channel interactive commands in the *User's Guide—QConvergeConsole CLI* (part number SN0054667-00).

Configuring Fibre Channel Driver Parameters with Noninteractive QConvergeConsole CLI

To configure the driver settings in the noninteractive mode of QConvergeConsole CLI, issue the following command:

```
# qauccli -pr fc -fs (<hba instance> | <hba wwpn>)  
{(<param name> | <param alias>) <param value>}
```

Where:

`hba instance` = Adapter port instance number (issue the `-g` command to find)

`hba wwpn` = Worldwide port name of the adapter

`param name` = Name of the parameter

`param alias` = Alias of the parameter, either:

PO Persistently bound targets only

PN Present persistently bound targets plus any new targets with driver default

NO Present targets with driver default

BW Bind devices by WWPN

BP Bind devices by port ID

`param value` = New value of the parameter

For more information, refer to the section about the Fibre Channel noninteractive commands in the *User's Guide—QConvergeConsole CLI* (part number SN0054667-00).

Configuring Fibre Channel Driver Parameters with QConvergeConsole vSphere Client Plug-in

For details on how to configure the Fibre Channel driver parameters with the VMware plug-in, see the *User's Guide—QConvergeConsole Plug-ins for VMware vSphere* (part number SN0054677-00).

Configuring Selective LUNs

You can configure selective LUNs using QConvergeConsole CLI on Windows. To enable selective LUNs of a target, the selected target must be currently persistently bound. See [“Configuring Target Persistent Binding” on page 43](#) for more additional information.

To configure selective LUNs with interactive QConvergeConsole CLI:

1. On the QConvergeConsole CLI **Adapter Configuration** menu, select **Selective LUN Mapping**.
2. On the port menu, select a port to open the **Selective LUN Mapping** menu.

The **Selective LUN Mapping** menu contains options for displaying LUN configuration, manually configuring LUNs, and auto-configuring LUNs.

Figure 4-7 shows the **Selective LUN Mapping (Display)** and the general view of selective LUNs.

```
Administrator: Command Prompt - qaucli -pr fc
QConvergeConsole
Version 1.1.3 <Build 49>
Selective LUN Menu <Display>
=====
HBA      : 0 Port: 1
SN       : RFE1305H32151
HBA Model : QLE8362
HBA Desc. : QLE8362 QLogic 2-port 16Gb Fibre Channel Adapter
FW Version : 132.00.00
WWPN     : 21-00-00-0E-1E-13-49-A0
WWNN     : 20-00-00-0E-1E-13-49-A0
Link     : Online
=====

1: Display LUN Configuration
2: Manual Configure LUNs
3: Auto Configure LUNs

<p or 0: Previous Menu; m or 98: Main Menu; ex or 99: Quit>
Please Enter Selection: 1

QConvergeConsole
Version 1.1.3 <Build 49>
Selective LUN Menu <Display>
=====
HBA      : 0 Port: 1
SN       : RFE1305H32151
HBA Model : QLE8362
HBA Desc. : QLE8362 QLogic 2-port 16Gb Fibre Channel Adapter
FW Version : 132.00.00
WWPN     : 21-00-00-0E-1E-13-49-A0
WWNN     : 20-00-00-0E-1E-13-49-A0
Link     : Online
=====

1: Details View
2: General View

<p or 0: Previous Menu; m or 98: Main Menu; ex or 99: Quit>
Please Enter Selection: 2
-----
HBA Instance 0: QLE8362 Port 1 WWPN 21-00-00-0E-1E-13-49-A0 PortID 01-07-00
Link: Online
-----
Enable Type      Target/LUN Info      Port Name      LUN ID
-----
Yes   Disk      ST336607FC      22-00-00-11-C6-2D-5A-3F 0
Yes   Disk      ST336607FC      22-00-00-0C-50-68-1E-9A 0
Yes   Disk      ST336607FC      22-00-00-0C-50-68-24-D9 0

Press <Enter> to continue:
```

Figure 4-7. Selective LUN, General View

For more information, refer to the section about the Fibre Channel interactive commands in the *User’s Guide—QConvergeConsole CLI* (part number SN0054667-00).

To configure selective LUNs with noninteractive QConvergeConsole CLI:

- To enable (select) or disable (deselect) a LUN for a specific target on a specific adapter, issue the following command:

```
# qauccli -pr fc -m (<hba instance> | <hba wwpn>) {<target  
wwnn> <target wwpn>} <lun id> (select | deselect)
```

Where:

hba instance = Adapter instance number (issue the `-g` command to find)
hba wwpn = Worldwide port name of the adapter
param name = Name of the parameter
target wwnn = Worldwide node name of the target
target wwpn = Worldwide port name of the parameter
lun id = ID of the LUN

- To enable (select) or disable (deselect) all LUNs for a specific target on a specific adapter, issue the following command:

```
# qauccli -pr fc -m (<hba instance> | <hba wwpn>) (select |  
deselect) {<target wwnn> <target wwpn>}
```

- To enable (select) or disable (deselect) all LUNs of all targets on a specific adapter, issue the following command:

```
# qauccli -pr fc -m (<hba instance> | <hba wwpn>) (select |  
deselect) all
```

For more information, refer to the section about the Fibre Channel noninteractive commands in the *User's Guide—QConvergeConsole CLI* (part number SN0054667-00).

Setting Queue Depth

For a detailed explanation of queue depth, including “Setting the Host Bus Adapter Queue Depth,” refer to the *Best Practices Guide—Fibre Channel Host Bus Adapters on Microsoft Windows 2012 and VMware ESXi 5.x, 2500 Series and 2600 Series* (part number SN0454502-00), available for download from the Marvell Web site. The default value for ESXi 7.0 and 8.0 is 64.

Enabling Fabric-Assigned World Wide Port Name

This section describes how to enable the fabric to assign the 2600 Series Adapters WWPN (FA-WWPN) on the following platforms:

- [Enabling FA-WWPN with Interactive QConvergeConsole CLI](#)
- [Enabling FA-WWPN with Noninteractive QConvergeConsole CLI](#)
- [Enabling FA-WWPN with QConvergeConsole Plug-in](#)

When using the FA-WWPN feature:

- FA-WWPN must be enabled on both the initiator (2600 Series Adapter) and the Brocade switch for the FA-WWPN to be assigned to the 2600 Series Adapter.
- If FA-WWPN is disabled on the 2600 Series Adapter and enabled on the Brocade switch, the FA-WWPN cannot be assigned to the 2600 Series Adapter.
- If FA-WWPN is enabled on the 2600 Series Adapter and disabled on the Brocade switch, the FA-WWPN cannot be assigned to the 2600 Series Adapter.

Enabling FA-WWPN with Interactive QConvergeConsole CLI

To enable FA-WWPN with interactive QConvergeConsole CLI:

1. From the main menu, select the adapter type (**Fibre Channel Adapter**).
2. On the **Adapter Configuration** menu, select **HBA Parameters**.
3. On the port menu, select a port to open the **HBA Parameters Menu**.
4. Select **Change Settings**.
5. Select **Fabric Assigned WWN**.
6. Under **Enable Fabric Assigned WWN Menu**:
 - ☐ Type 1 to enable FA-WWPN.
 - ☐ Type 2 to disable FA-WWPN.

Enabling FA-WWPN with Noninteractive QConvergeConsole CLI

To enable FA-WWPN with noninteractive QConvergeConsole CLI:

- Issue the following command:

```
# qauccli -pr fc -n <hba instance>|<hba WWPN>  
{<EnableFabricAssignWWN>|<FN> 1}
```

Where:

hba instance = Adapter number (issue the `-g` command to find)

hba wwpn = Worldwide port name of the adapter

EnableFabricAssignWWN = 1 enables the fabric to assign a WWN to this port
or FN 0 disables the fabric from assigning WWN to this port

To disable FA-WWPN with noninteractive QConvergeConsole CLI:

- Issue the following command:

```
# qauccli -pr fc -n <hba instance>|<hba WWPN>  
{<EnableFabricAssignWWN>|<FN> 0}
```

For more information, refer to the section about the Fibre Channel noninteractive commands in the *User's Guide—QConvergeConsole CLI* (part number SN0054667-00).

Enabling FA-WWPN with QConvergeConsole Plug-in

To enable FA-WWPN with QConvergeConsole Plug-in:

1. In the QConvergeConsole vSphere Client Plug-in, click the **QConvergeConsole** tab.
2. In the tree pane on the left, select a 2600 Series Adapter port.
3. In the content pane on the right, click the **Parameters** tab.

4. In QConvergeConsole vSphere Client Plug-in, the parameters appear and can be edited. [Figure 4-8](#) shows an example.



Figure 4-8. Enabling FA-WWPN Using QConvergeConsole vSphere Client Plug-in

- a. To enable FA-WWPN, select the **Enable Fabric Assigned WWN** check box.
- b. Click **Save Configuration**.

Using Fabric-Assigned Boot LUN

This section describes how to enable a fabric-assigned boot LUN on the following platforms:

- [Using a Fabric-Assigned Boot LUN with Interactive QConvergeConsole CLI](#)
- [Using a Fabric-Assigned Boot LUN with Noninteractive QConvergeConsole CLI](#)
- [Using a Fabric-Assigned Boot LUN with QConvergeConsole Plug-in](#)

Using a Fabric-Assigned Boot LUN with Interactive QConvergeConsole CLI

To use a fabric-assigned boot LUN with interactive QConvergeConsole CLI:

1. From the main menu, select the adapter type (**Fibre Channel Adapter**).
2. Select an adapter port.
3. On the **Adapter Configuration** menu, select **Configure Boot Devices**.

4. On the **Boot from SAN BIOS Configuration** menu, select **Boot-from-SAN Drive Mapping Parameters**, and then press ENTER.
5. Select **Configure BIOS Boot Parameters**, and then press ENTER.
6. On the **Boot from SAN BIOS Parameters** menu, select **Fabric Assign Boot LUN**, and then press ENTER.
7. To enable this feature, type 1.

Using a Fabric-Assigned Boot LUN with Noninteractive QConvergeConsole CLI

In noninteractive QConvergeConsole CLI, set a target as the fabric-assigned boot LUN for a specific adapter by issuing the following command:

```
# qauccli -pr fc -e <hba instance>|<hba wwpn> enable|disable  
FabricAssignBootLUN|fb
```

Where:

```
hba instance = Adapter number (issue the -g command to find)  
hba wwpn     = Worldwide port name of the adapter  
FabricAssignBootLUN or fb = Configure enable fabric assign boot LUN setting
```

Using a Fabric-Assigned Boot LUN with QConvergeConsole Plug-in

To configure the boot device with QConvergeConsole vSphere Client Plug-in:

1. In the QConvergeConsole vSphere Client Plug-in, click the **QConvergeConsole** tab.
2. In the tree pane on the left, select a 2600 Series Adapter port.
3. In the content pane on the right, click the **Boot** tab.

- On the Boot page, select the **Enable Fabric Assigned Boot LUN** check box. [Figure 4-9](#) shows an example.

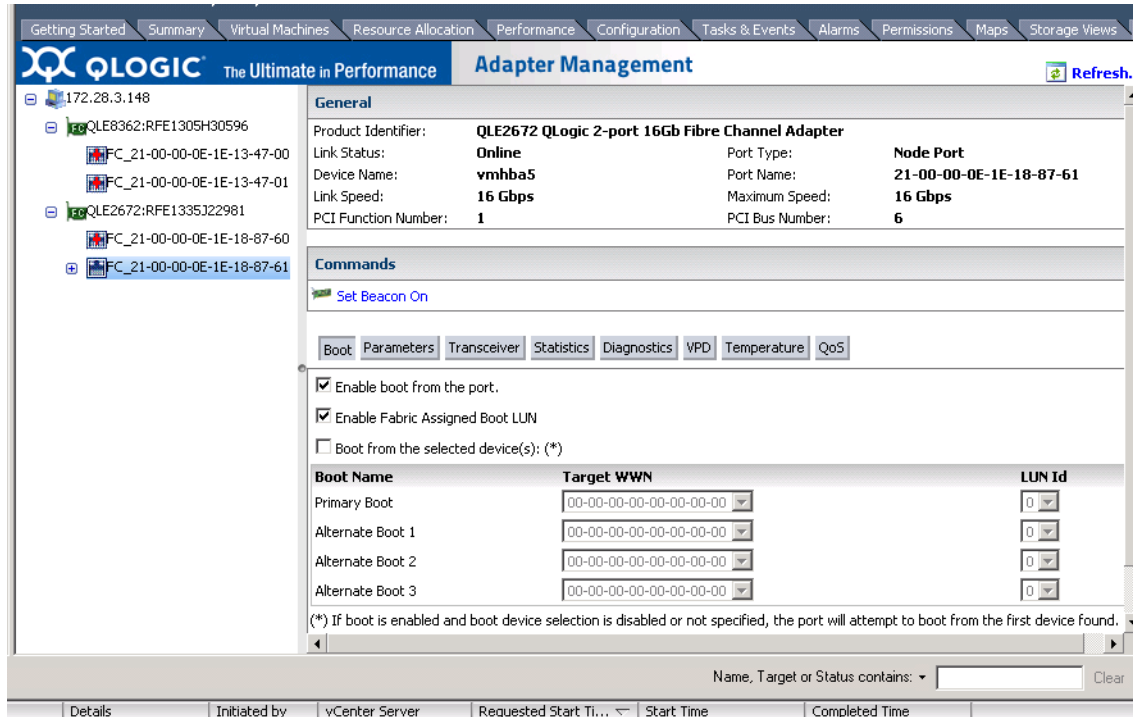


Figure 4-9. Fabric-Assigned Boot LUN in QConvergeConsole Plug-in for VMware vCenter Server

For details, refer to the “Boot Device Selection” topic in *QConvergeConsole Help*.

- Click **Save**.

Any previously saved configuration for the current 2600 Series Adapter is overwritten.

FDMI Enhancements Support

FDMI enables the management of devices such as host adapters. Enabling additional attributes using FDMI provides you with detailed information about the 2600 Series Adapter through a centralized management entity such as the Fibre Channel fabric switches.

To verify the additional 2600 Series Adapter attributes registered on the Brocade switch, issue the `fdmishow` command on Brocade Fibre Channel switches, and then confirm that all the requested attributes are displayed in the switch. For details, refer to your Brocade switch documentation.

The following examples show output of the `fdmishow` command.

Port attributes:

[illegible]

HBA attributes:

```
"OS Name and Version: Windows Server 2012 R2 Datacenter Evaluation for Intel64"
"Max CT Payload Length: 0x00000800"
"Symbolic Name: QLE8362 FW:v7.04.00 DVR:v9.1.12.20 Alpha 2"
"Number of Ports: 1"
"Fabric Name: 10:00:00:05:33:8f:1a:43"
"Bios Version: 3.26"
"Vendor Identifier: QLOGIC"
```

The following example shows how to verify FDMI from a Cisco switch. For more details, see the Cisco switch documentation.

```
Cisco# sh fdmi database detail
```

HBA-ID: 21:00:00:24:ff:8f:d8:88

```
Node Name      :20:00:00:24:ff:8f:d8:88
Manufacturer   :Marvell Semiconductor Inc.
Serial Num     :AFD1536Y03339
Model          :QLE2692
Model Description:QLogic 16Gb LR 2-port FC to PCIe Gen3 x8 Adapter
Hardware Ver    :BK3210407-05 01
Driver Ver     :8.08.00.04.07.0-k
ROM Ver        :3.62
Firmware Ver   :8.08.03 (d0d5)
```

```
Port-id: 21:00:00:24:ff:8f:d8:88
Supported FC4 types:scsi-fcp
Supported Speed      :4G 8G 16G
Current Speed       :16G
Maximum Frame Size  :2048
OS Device Name      :qla2xxx:host1
Host Name           :localhost.localdomain
```

Configuring End-to-End (CS_CTL) QoS

NOTE

End-to-end QoS requires the initiator, target and fabric to support CS_CTL QoS. QoS must also be supported by both the switch and target devices.

The class specific control (CS_CTL) QoS implementation is an end-to-end solution, encompassing the initiator (2600 Series Adapter), the switches, and the target (storage). The 2600 Series Adapter stamps the priority value (high, medium, low) in the CS_CTL field of the Fibre Channel frame. All three entities (initiator, switch, and target) honor this priority value at their respective levels.

This feature is enabled by default in the 2600 Series Adapter Windows and VMware drivers. Therefore, when all three entities support QoS (and it is enabled on the switch and the target), a default priority value is populated in all FCP_CMND, FCP_DATA, FCP_XFER_RDY, FCP_RSP, and FCP_CONFIRM frames.

The following sections describe how to configure CS_CTL QoS and change the default priority levels:

- [Configuring CS_CTL QoS on the Switch](#)
- [Configuring CS_CTL QoS on the Storage Device](#)
- [Configuring QoS Priority Levels](#)

Configuring CS_CTL QoS on the Switch

To enable CS_CTL QoS on the Brocade SW6510 switch:

1. From the switch, issue the following command:

```
root> configurechassis
Configure...
```

2. A list of attributes appear one at a time. After either accepting the default or entering a different value, the next attribute appears.
 - a. To accept the default for `cfgload` attributes, Custom attributes, and system attributes, press the ENTER key.
 - b. For `fos` attributes, type **y**.
 - c. For the `CSCTL QoS Mode` attribute, type **1**.

For example:

```
cfgload attributes (yes, y, no, n): [no]
Custom attributes (yes, y, no, n): [no]
system attributes (yes, y, no, n): [no]
fos attributes (yes, y, no, n): [no] y
CSCTL QoS Mode (0 = default; 1 = auto mode): (0..1) [0] 1
```

3. Reboot the switch.
4. To verify that CS_CTL QoS is enabled, issue the following command:

```
root> configshow -all | grep fos.csctlMode
```

This command should return the following response:

```
fos.csctlMode:1
```

5. To enable QoS on a switch-port basis, issue the following command:

```
portcfgqos --enable [slot/]port csctl_mode
```

Configuring CS_CTL QoS on the Storage Device

For QoS configuration instructions, see your device's user guide.

Configuring QoS Priority Levels

The QoS priority levels are set in the 2600 Series Adapter virtual ports (vPorts). The Windows and VMware adapter drivers assign default vPort priority levels. The following sections describe how to change the default vPort priority levels in Windows and VMware ESXi systems.

Changing the Priority Levels on Windows

To change the vPort priority levels in Windows, you must first assign the vPorts, and then change the priority levels. Both procedures can be accomplished using interactive QConvergeConsole CLI, as described in the following sections.

For more detailed information, see the *QConvergeConsole Help* and the *User's Guide—QConvergeConsole CLI* (part number SN0054667-00).

To create a vPort in interactive QConvergeConsole CLI:

1. On the **Main Menu**, select **Adapter Configuration**.
2. On the **Adapter Type Selection** menu, select **Virtual Ports (NPIV)**.
3. On the **Virtual Ports** menu, select **Adapter Port**.
4. On the **Adapter Port** menu, select **Create vPorts**.
5. On the **Create vPorts** menu, select **Generate**.
6. To create the vPorts, select the **Commit** option.

To change the vPort priority level using interactive QConvergeConsole CLI:

1. On the **Main Menu**, select **Adapter Configuration**.
2. On the **Adapter Type Selection** menu, select **QoS**.
3. On the **QoS** menu, select **Adapter Port**.
4. On the **Adapter Port** menu, select **QoS Priority**.
5. On the **QoS Priority** menu, select **Modify QoS Settings**.
6. Choose the priority value for the vPorts.
7. Select **Apply QoS**.

Enabling Forward Error Correction

QConvergeConsole supports forward error correction (FEC), which is a correction technique used for high-speed telecommunications devices to control errors in data transmission over unreliable or noisy communication channels.

NOTE

The FEC feature is supported only if the current adapter port is connected to a Fibre Channel switch with FEC support. For more information, refer to the section about setup tips in the *Application Note—Enabling Forward Error Correction* (part number 83830-514-03).

FEC Process Overview

The following highlights how the FEC process works between the transmitting and receiving device:

- The transmitting device:
 - a. Takes the incoming data stream.
 - b. Inserts a redundant amount of parity bits of information on the data stream.
 - c. Sends the data stream.
- The receiving device:
 - a. Receives the data stream.
 - b. Checks for missing or corrupt data:
 - If there are no corrupt or missing bits of information, proceeds with normal process.
 - If there are corrupt or missing bits of information, reconstructs the original data by using pieces of the original data stream (that are still intact) and combining those with the parity bits of information.

NOTE

Instead of having to request re-transmission of the entire data frame, the receiving device can recreate or reconstruct the data stream itself. This process prevents multiple CRC errors from being triggered and causing application performance issues.

Enabling and Disabling FEC

Use the appropriate procedure to enable or disable FEC:

- [Enabling and Disabling FEC on VMware ESXi](#)
- [Enabling and Disabling FEC on Linux and Windows](#)

Enabling and Disabling FEC on VMware ESXi

To enable or disable FEC using the QConvergeConsole vSphere Client Plug-in, see the *Marvell QLogic QConvergeConsole Plug-ins for vSphere*, (part number SN0054677-00).

To enable or disable FEC using the QConvergeConsole ESXCLI Plug-in for VMware vSphere (ESXi), see the *User's Guide—Marvell ESXCLI Plug-in for VMware vSphere* (part number BC0151101-00).

Enabling and Disabling FEC on Linux and Windows

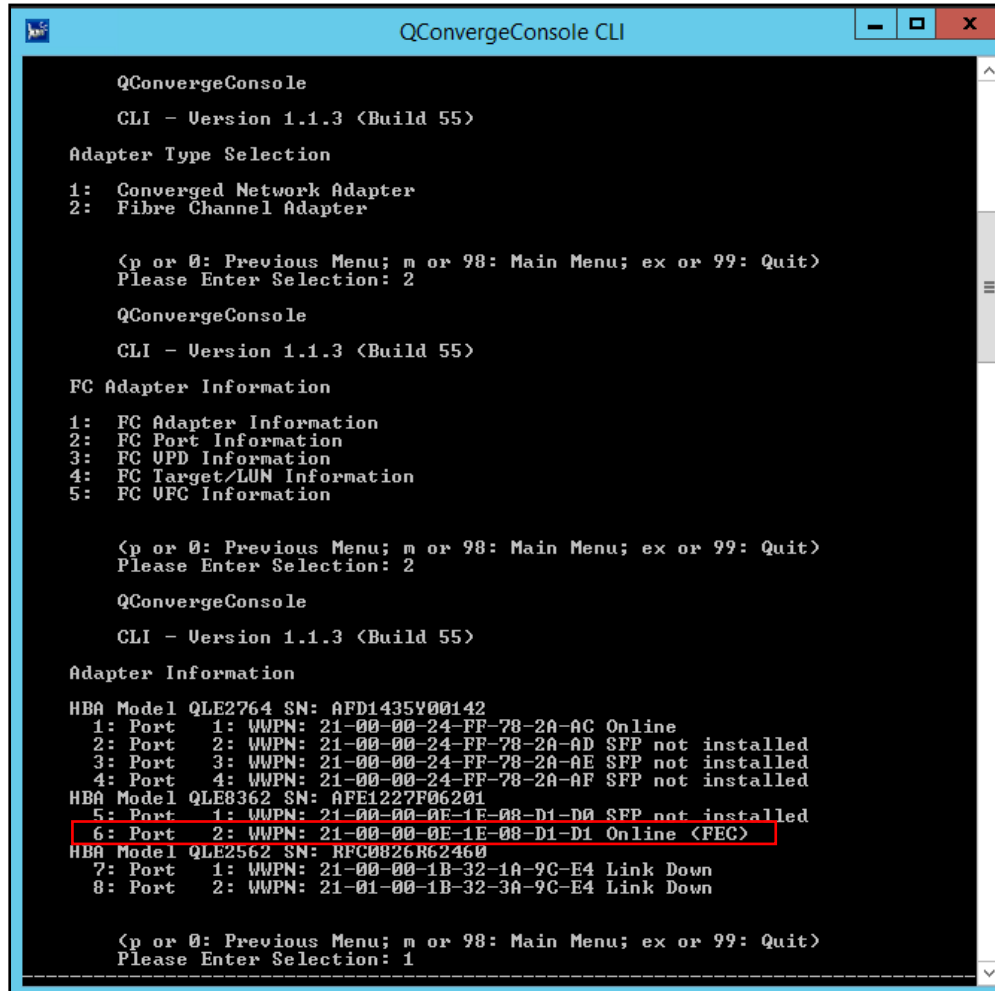
To enable FEC on Linux or Windows using QConvergeConsole CLI, follow the instructions in the *User's Guide—QConvergeConsole CLI* (part number SN0054667-00).

To enable FEC on Linux or Windows using Windows PowerShell cmdlets, follow the instructions in the *User's Guide—Marvell QLogic PowerKit* (part number TD-001187).

To enable FEC on Windows using the QConvergeConsole extension for Windows Admin Center, follow the instructions in *User's Guide—Marvell QLogic Fibre Channel QConvergeConsole Extension for Windows Admin Center* ((part number TD-001728).

All guides are available on the Support pages at www.marvell.com (see “[Downloading Updates and Documentation](#)” on page xv).

Figure 4-10 shows the FEC status on the QConvergeConsole CLI **Adapter Information** menu.



```
QConvergeConsole
CLI - Version 1.1.3 <Build 55>

Adapter Type Selection
1: Converged Network Adapter
2: Fibre Channel Adapter

<p or 0: Previous Menu; m or 98: Main Menu; ex or 99: Quit>
Please Enter Selection: 2

QConvergeConsole
CLI - Version 1.1.3 <Build 55>

FC Adapter Information
1: FC Adapter Information
2: FC Port Information
3: FC UPD Information
4: FC Target/LUN Information
5: FC UPC Information

<p or 0: Previous Menu; m or 98: Main Menu; ex or 99: Quit>
Please Enter Selection: 2

QConvergeConsole
CLI - Version 1.1.3 <Build 55>

Adapter Information
HBA Model QLE2764 SN: AFD1435Y00142
1: Port 1: WWPN: 21-00-00-24-FF-78-2A-AC Online
2: Port 2: WWPN: 21-00-00-24-FF-78-2A-AD SFP not installed
3: Port 3: WWPN: 21-00-00-24-FF-78-2A-AE SFP not installed
4: Port 4: WWPN: 21-00-00-24-FF-78-2A-AF SFP not installed
HBA Model QLE8362 SN: AFE1227F06201
5: Port 1: WWPN: 21-00-00-0E-1E-08-D1-D0 SFP not installed
6: Port 2: WWPN: 21-00-00-0E-1E-08-D1-D1 Online <FEC>
HBA Model QLE2562 SN: RFC0826R62460
7: Port 1: WWPN: 21-00-00-1B-32-1A-9C-E4 Link Down
8: Port 2: WWPN: 21-01-00-1B-32-3A-9C-E4 Link Down

<p or 0: Previous Menu; m or 98: Main Menu; ex or 99: Quit>
Please Enter Selection: 1
```

Figure 4-10. QConvergeConsole CLI Information Menu: FEC Status

Using Buffer-to-Buffer Credit Recovery

Buffer-to-buffer credit recovery (BB-CR) enables two FC peer ports (N_Port, F_Port, or E_Port) to periodically send and receive the quantity of receiver ready (R_RDY) signals transmitted. The BB-CR feature allows the peer port to recover from possible R_RDY signals lost over a lossy link. BB-CR enables two FC ports logged in with each other to recover lost buffer-to-buffer credits. These lost credits can impact throughput, cause link resets, and disrupt traffic flow.

NOTE

BB-CR takes effect only when the operational link speed is 16G or higher.

During the login process, the peer ports exchange a nonzero BB_SC_N value. During frame transmission/reception, one port maintains counters to track the R_RDY and frames received. Based on a periodic exchange of BB_SC_N values, the receiving port determines how many R_RDYs should have been received. BB-CR compares this value with the actual counters maintained at the receiving port, from which the receiver can compute the actual quantity of credits lost, and thus recover without incurring a link reset.

By default, BB-CR functionality is enabled on the 269x Series Adapters that are operating at 16Gbps or higher, and that integrate with Brocade Fabric OS Manager, Brocade Network Advisor. You can disable this feature using either the boot code (BIOS or UEFI) or QConvergeConsole CLI.

For details about how to recover buffer credits, see the Marvell management tool user guide for your system; the guides are listed in [“Related Materials” on page xii](#).

Resetting Driver and Firmware Counters

When 2600 Series Adapter are running I/Os, they collect and display many driver and firmware counters, which are an accumulation of normal traffic statistics or error conditions. These counters can help you assess the traffic flow, identify I/O bottlenecks, and isolate link issues that affect the SAN performance.

Some counters are accumulated in the adapter’s hardware and persist throughout the life of the adapter. Other counters are transient in memory and are reset after a reload or re-initialization. The 2600 Series Adapter software provides the ability to reset counters as needed. For example, you may want to see if counters or rates change as a result of taking corrective actions in response to issues or after changing configuration parameters.

For details about how to reset counters, see the management tools user guide for your system; the guides are listed in [“Related Materials” on page xii](#).

Configuring VM-ID

VM storage I/O activity automatically generates VM-ID tagging in FC frames. VM-ID tags I/O frames with an ID that identifies the virtual machine that sent or received them. This ID allows management tools to monitor traffic flows down to the virtual machine level. VM-ID is enabled by default and requires a Brocade or Cisco switch running a supported FOS or NX-OS version. For detailed VM-ID information, see the documentation for your switch.

- To enable VM-ID (and disable QoS), type the following command and then reboot the system:

```
$ esxcfg-module -s "ql2xvmidsupport=1,  
ql2xfabricpriorityqos=0" qlnativefc
```

- To disable VM-ID, type the following command, and then reboot the system:

```
$ esxcfg-module -s "ql2xvmidsupport=0" qlnativefc
```

For details about configuring VM-ID, see the *Marvell QLogic Fibre Channel and Converged Network Adapters for VMware ESXi 7.0, and 8.0 User's Guide* (SN0154529-00).

Universal SAN Congestion Mitigation (USCM)

NOTE

Universal SAN congestion mitigation (USCM) is supported on the QLE2690, QLE2692, QLE2694 and QLE2694L adapters. See [“Prerequisites” on page 70](#) for more information.

- SAN congestion management (SCM) is a common noun, and describes a standards-based Fibre Channel technology.
 - Universal SAN Congestion Mitigation (USCM) is Marvell's IP, and describes Marvell's SCM feature.
-

NOTE

Marvell USCM requires a Brocade or Cisco switch running FOS 9.0 or later, or NX-OS 9.2(1) or later, respectively.

The USCM feature tracks fabric performance impact notifications (FPINs) and prevents both potential or actual congestion occurrences in the FC SAN environment. An FC port can become congested because of events such as link instability, credit stall, and over-subscription. When this feature is supported and enabled, the drivers and the application track FPINs and maintain statistics about the health of local and remote FC ports in NVMe and FCP environments. For a subset of FPINs that indicate a congestion occurrence in the fabric, depending on the cause of the congestion, the driver uses either one or a combination of multiple actions to mitigate congestion. The mechanisms/actions are described in the following sections.

By default, USCM is enabled on all ports of the adapter. USCM support can be configured (enabled/disabled) per port on all Marvell management tools.

NOTE

In the following examples the “0” denotes the first port detected by QCC CLI on the system.

For example, to enable USCM in QConvergeConsole CLI:

```
# qauccli -scm|-uscm 0 --enable
```

For example, to disable USCM in QConvergeConsole CLI:

```
# qauccli -scm|-uscm 0 --disable
```

- USCM allows you to monitor the following FPIN statistics:
 - ☐ Congestion Notification (FPIN-CN)
 - ☐ Peer Congestion Notification (FPIN-PN)
 - ☐ Link Integrity Notification (FPIN-LI)
 - ☐ Delivery Notification (FPIN-DN)
- You can request the following USCM information at any time:
 - ☐ A list of slow-drain device(s)
 - ☐ A list of normal-drain device(s)

For more information about using USCM, see the appropriate documents in [“Related Materials” on page xii](#).

Prerequisites

USCM is supported only on the following Marvell QLogic adapters:

- QLE2690
- QLE2692
- QLE2694
- QLE2694L

NOTE

USCM is not supported on QLE2670 or QLE2672.

USCM is supported on the following drivers, which you can download from the Marvell Web site.

- Linux: 10.02.04.00 or later

- Windows: 9.4.4.20 or later
- ESX: 3.1.64.0/4.1.34.0/5.3.1

USCM is supported on the following Marvell management tools:

- QConvergeConsole CLI
- Marvell QLogic Fibre Channel QConvergeConsole Extension for Windows Admin Center
- QConvergeConsole vSphere Client Plug-in
- Marvell QLogic PowerKit
- Marvell ESXCLI Plug-in for VMware vSphere

To use these tools for USCM, see the associated user's guides in [“Related Materials” on page xii](#).

USCM Profiles

USCM utilizes Profiles to throttle bandwidth to and from the SAN, to mitigate congestion. This is described in the following sections.

USCM Profiles can be controlled:

- Through the Marvell QLogic applications listed in [“Prerequisites” on page 70](#)
- Using driver modules or registry parameters

USCM Profiles control the amount of *I/O throttling*, where the driver reduces the load on the fabric by *throttling down* outstanding requests to a target device. The Fabric Performance Impact Notifications (FPINs) provide details about the N_Port where the congestion originates (perpetrator port), along with the cause of the congestion (credit stall, over-subscription, and so on). Based on these details, the driver determines a throttling strategy.

Throttling appropriate requests reduces the load of the port at the congestion origin, which improves the performance of one or more *victim* ports that share downstream resources with the *perpetrator* port. However, reducing the load may reduce the performance of one or more sessions associated with the perpetrator port. While the main goal is improving the performance of victim ports, under certain circumstances, a performance drop at the perpetrator port may be undesirable.

The USCM Profiles feature provides controls by which an administrator can select an appropriate mitigation strategy using one of the Marvell applications listed in [“Prerequisites” on page 70](#) or using a driver module/registry parameter.

Using Driver Modules or Registry Parameters for USCM Profiles

You can control USCM Profiles through either a driver module (Linux, VMware ESXi) or registry parameter (Windows). This parameter applies to all adapter ports on the server.

scomrprofile	Windows/driver registry parameter	Requests are throttled based on defined driver profiles. The default profile is Monitor Only. USCM Profiles are: 0 = Monitor Only (default) 1 = Conservative 2 = Moderate 3 = Aggressive
ql2x_scomr_profile	Linux/driver module parameter	
ql2x_scomr_driver_profile	VMware ESXi/driver module parameter	

For more information, see the associated readme.txt file.

FPIN Link Integrity Marginal Path Detection Support

The Device Mapper (DM) Multipath FPIN link integrity (FPIN-LI) marginal path detection is currently supported only on RHEL8.4 and later, RHEL 9.0 and later, SLES15 SP3 and later, OSs with Brocade and Cisco fabrics. The Fibre Channel Transport Services daemon (`fcitxpd`) must be installed on the RHEL8.x OS for marginal path detection to work. The transport daemon improves DM Multipath functionality to take corrective actions when link integrity events are received from switch. The steps are provided in [“FC Transport daemon Installation for RHEL 8.4, 8.5, and 8.6” on page 72](#).

RHEL 8.7 and later; RHEL9.0 and later; SLES15 SP3 and later: all support marginal path detection natively. Therefore, you do not have to install the Fibre Channel transport services daemon on these OSs. However, changes are needed in the `multipath.config` file for marginal path detection to work correctly. The steps are provided in [“Multipath Configuration File Changes for RHEL 8.7 and Later; RHEL9.0 and Later; SLES15 SP3 and Later” on page 74](#).

See the Brocade FOS and Cisco NX-OS documentation for more information on the fabric notification functionality provided by the switch.

FC Transport daemon Installation for RHEL 8.4, 8.5, and 8.6

The current Red Hat offering requires an out-of-box solution that requires the installation of an Extra Packages for Enterprise Linux (EPEL) component of the distribution. Following are the steps to install the FC transport daemon on the system.

1. Install the EPEL package:
 - a. `dnf install https://dl.fedoraproject.org/pub/epel/epel-release-latest-8.noarch.rpm`
 - b. `dnf update`
 - c. `dnf install fctxpd.x86_64`

2. Start the FC Transport daemon.

- a. Run `systemctl status fctxpd`

Following is a sample output.

```
fctxpd.service - Fiber Channel Transport Daemon
Loaded: loaded (/usr/lib/systemd/system/fctxpd.service;
disabled; vendor preset: disabled)
Active: inactive (dead)
```

NOTE

The fctxpd daemon is not started by default when installed and needs to be started manually.

- b. Run `systemctl enable fctxpd`

NOTE

This step is to ensure that the daemon is loaded automatically upon system reboot.

- c. Run `systemctl start fctxpd` to start the daemon

3. Verify the FC Transport daemon status by running `systemctl status fctxpd`

Following is a sample output indicating that the daemon started successfully.

```
systemctl status fctxpd
â fctxpd.service - Fiber Channel Transport Daemon
Loaded: loaded (/usr/lib/systemd/system/fctxpd.service;
disabled; vendor preset: disabled)
Active: active (running) since Mon 2020-07-27 17:43:11 IST; 2s
ago
Main PID: 64691 (fctxpd)
Tasks: 2 (limit: 403798)
Memory: 688.0K
```

The marginal path detection package installation is complete.

Multipath Configuration File Changes for RHEL 8.7 and Later; RHEL9.0 and Later; SLES15 SP3 and Later

Edit the `multipath.conf` file as follows:

Enable the attribute `marginal_pathgroups` in the `/etc/multipath.conf` file. For example:

```
marginal_pathgroups fpinx3
```

If the `marginal_pathgroups` attribute is not enabled, marginal path detection will not work for the Fabric Notification event.

Using Fibre Channel Diagnostics

The following sections show and describe the 2600 Series Adapter Fibre Channel diagnostic functions:

- [Device Ping Testing](#)
- [Fibre Channel Ping Testing \(Echo ELS\)](#)
- [CT Ping Testing](#)
- [CT Fibre Channel Trace Route Testing](#)
- [Link Cable Beacon Extended Link Service Command](#)
- [Diagnostic Port Testing](#)
- [Read Diagnostic Parameters Extended Link Service Command](#)

Device Ping Testing

QConvergeConsole supports device ping testing. The device ping test sends a SCSI Inquiry command to each selected target, measuring the time it takes for the target to respond.

NOTE

Before and after each SCSI command, the link statistics are collected to verify that no counters are incremented during each pass.

For more information on performing general diagnostic tests and viewing the diagnostic test results, refer to the help system, *QConvergeConsole Help*.

Fibre Channel Ping Testing (Echo ELS)

QConvergeConsole supports Fibre Channel (FC) ping testing. The FC ping test sends an ECHO extended link service (ELS) from the adapter port to the selected switch, fabric, or target. For more information on performing general diagnostic tests and viewing the diagnostic test results, refer to the appropriate QConvergeConsole user guide in [“Related Materials” on page xii](#).

CT Ping Testing

QConvergeConsole supports common transport (CT) ping testing. The CT ping test pings each device attached to the adapter port. For more information on performing general diagnostic tests and viewing the diagnostic test results, refer to the appropriate QConvergeConsole user guide in [“Related Materials” on page xii](#).

NOTE

Run the CT Ping test only from a switch with either FOS version 6.4.x or later or NX-OS version 8.4.1 or later.

CT Fibre Channel Trace Route Testing

QConvergeConsole supports CT Fibre Channel trace route (FTR) testing. The CT FTR test traces the route from the adapter port to the target device.

NOTE

All inter-link switches between the initiator and the target must have the Brocade switch firmware 7.1.1 or later and must support CT FTR for the test to work end-to-end. To confirm that your target is supported, contact Technical Support.

For more information on performing general diagnostic tests and viewing the diagnostic test results, refer to the appropriate QConvergeConsole user guide in [“Related Materials” on page xii](#).

Link Cable Beacon Extended Link Service Command

NOTE

This feature is supported only on QLE2690, QLE2692, QLE2694, and QLE2694L Adapters. Run the LCB test only from a switch with FOS version 7.4.x or later or NX-OS 8.3.1 or later.

The link cable beacon (LCB) extended link service command locates the corresponding ends of a cable by flashing the specific LEDs (see [“Adapter LEDs” on page 95](#) for more information) on the corresponding ports of a link.

The LCB command can be sent through a Brocade switch using the following commands, which show examples of enabling, disabling, or verifying the LCB. For details, refer to your switch documentation.

```
SW6505:admin> portpeerbeacon --enable 12
SW6505:admin> portpeerbeacon --show -all
portPeerBeacon is enabled on port :12
SW6505:admin> portpeerbeacon --disable 12
```

To execute the LCB command through a Cisco switch, use the following commands to issue and stop beacon. For details, refer to your switch documentation.

```
# beacon interface fc1/1 peer
# no beacon interface fc1/1 peer
```

Diagnostic Port Testing

QConvergeConsole CLI supports diagnostics port testing to identify cable connection problems from a Brocade switch (FOS 7.4.x or later) or a Cisco switch (NX-OS 8.2.1 or later). For information about diagnostics port testing from the host server, see the *QConvergeConsole Help* or the *User's Guide—QConvergeConsole CLI* (part number SN0054667-00). For information about performing diagnostics port testing from the FC switch, see [“Troubleshooting in Diagnostics Port Mode” on page 101](#).

Read Diagnostic Parameters Extended Link Service Command

The read diagnostic parameters (RDP) extended link service (ELS) command is a powerful diagnostic tool that can be used while a link is up and passing traffic. When the adapter port receives an RDP command, it responds with a comprehensive diagnostic report containing several blocks of data useful for monitoring the fabric or trouble-shooting. The report includes:

- SFP Diagnostic Parameters: temperature, V_{CC} , and Tx and Rx power
- Port Speed Descriptor: speed capabilities and operating speed
- Link Error Status Block Descriptor
- Port Names Descriptor: WWNN and WWPNN
- FEC Status Descriptor: corrected and uncorrectable blocks

NOTE

This feature is supported only on QLE2690, QLE2692, QLE2694, and QLE2694L Adapters. You must run the RDP test from a switch with firmware as follows:

- Brocade switches: FOS 9.1.1 or later
- Cisco switches: NX-OS 8.2.1 or later

All of Marvell's management tools support running the RDP test. For information about running the RDP test from the host server, see the user's guide for your Marvell adapter's management tool in ["Related Materials" on page xii](#).

Running RDP Test from a Brocade 16/32G Switch

The following example shows the RDP ELS command output for Port 13 on a Brocade 16G switch (9.1.1 or later):

```
SW6505:admin> sfpshow 13 -link -force
Identifier: 3      SFP
Connector: 7      LC
Transceiver: 7004404000000000 4,8,16_Gbps M5 sw Short_dist
Encoding: 6      64B66B
Baud Rate: 140    (units 100 megabaud)
Length 9u: 0      (units km)
Length 9u: 0      (units 100 meters)
Length 50u (OM2): 3      (units 10 meters)
Length 50u (OM3): 0      (units 10 meters)
Length 62.5u:0    (units 10 meters)
Length Cu: 0      (units 1 meter)
Vendor Name: HP-F      BROCADE
Vendor OUI: 00:05:1e
Vendor PN: QK724A
Vendor Rev: A
Wavelength: 850    (units nm)
Options: 003a Loss_of_Sig,Tx_Fault,Tx_Disable
BR Max: 0
BR Min: 0
Serial No: HAF314370000B7F
Date Code: 140909
DD Type: 0x68
Enh Options: 0xfa
Status/Ctrl: 0x30
```

4–Fibre Channel Configuration

Using Fibre Channel Diagnostics

Pwr On Time: 0.30 years (2666 hours)

E-Wrap Control: 0

O-Wrap Control: 0

Alarm flags[0,1] = 0x0, 0x0

Warn Flags[0,1] = 0x0, 0x0

			Alarm		Warn	
			low	high	low	high
Temperature:	60	Centigrade	-5	85	0	75
Current:	8.430	mAmps	2.500	12.000	2.000	11.500
Voltage:	3322.2	mVolts	3000.0	3600.0	3100.0	3500.0
RX Power:	-3.1	dBm (495.3uW)	31.6 uW	1258.9 uW	31.6 uW	794.3 uW
TX Power:	-3.2	dBm (481.6 uW)	125.9 uW	1258.9 uW	251.2 uW	794.3 uW

State transitions: 5

Port Speed Capabilities 4Gbps 8Gbps 16Gbps

PEER Port Gbic Info

Laser Type: Short Wave Laser

SFP Type: Optical Port Type

Connector Type: Other

Following SFP Parameters are Valid

Temperature: 35 Centigrade [Range -128 - +128 C]

Current: 8.176 mAmps [Range 0 - 131 mAmps]

Voltage: 3463.2 mVolts [Range 0 - 3600 mVolts]

Rx Power: 460.4 uW [Range 0 - 6550 uW]

Tx Power: 504.7 uW [Range 0 - 6550 uW]

Signal Loss (Upstream) : -16.7 dBm (21.2 uW)

Signal Loss (Downstream): -20.3 dBm (9.4 uW)

Port Speed Capabilities 4Gbps 8Gbps 16Gbps Last poll time: 03-24-2015 UTC
Tue 18:03:14

Running RDP Test from a Cisco 16/32G Switch

The following command shows the RDP test results for port 10 from a Cisco 16/32G switch (NX-OS 8.2.1 or later).

```
Cisco# sh rdp fcid 0x590223 vsan 10
```

```
-----  
RDP frame details  
-----
```

```
Link Service Request Info:  
-----
```

```
Port Speed Descriptor Info:  
-----
```

```
Port speed capabilities : 16G 8G 4G
```

4–Fibre Channel Configuration

Using Fibre Channel Diagnostics

Port Oper speed : 16000 Mbps

Link Error Status:

VN PHY port type : FC
Link failure count : 1
Loss of sync count : 0
Loss of signal count : 0
Primitive sequence proto error : 0
Invalid Transmission word : 0
Invalid CRC count : 0

Port Name Descriptor:

Node WWN : 20:00:00:24:ff:8f:d8:88
Port WWN : 21:00:00:24:ff:8f:d8:88
Attached Node WWN : 20:0a:00:de:fb:83:80:81
Attached Port WWN : 20:01:00:de:fb:83:80:80

SFP Diag params:

SFP flags : Optical
SFP Tx Type : Long Wave LC

FEC Status:

Corrected blocks : 0
Uncorrected blocks : 0

Buffer Credit Descriptor:

Rx B2B credit : 186
Tx B2B credit : 32
Port RTT : 0 ns

Optical Product Data:

Vendor Name : FINISAR CORP.
Model No. : FTLF1432P3BCV-QL
Serial No. : UVE2AN5
Revision : A
Date : 171106

	Current	Alarms		Warnings	
	Measurement	High	Low	High	Low
Temperature	44.25 C	75.00 C	-5.00 C	70.00 C	0.00 C
Voltage	3.38 V	3.60 V	3.00 V	3.50 V	3.10 V
Current	37.92 mA	70.00 mA	1.00 mA	68.00 mA	2.00 mA
Tx Power	0.02 dBm	4.00 dBm	-10.00 dBm	3.00 dBm	-9.00 dBm
Rx Power	-4.16 dBm	3.00 dBm	-20.00 dBm	2.00 dBm	-18.01 dBm

Note: ++ high-alarm; + high-warning; -- low-alarm; - low-warning

Management Component Transport Protocol Support

Marvell offers a conversion kit to enable or disable Management Component Transport Protocol (MCTP) functionality with Marvell QLogic QLE2690 and QLE2692 adapters.

NOTE

It is recommended that the update package should **not** be run in a Boot-from-SAN (BFS) environment.

A power cycle reboot is required after running the enable/disable process for the MCTP update to take effect.

On some servers, the upgrade may require a complete reset of the hardware and clears the system of its temporary memory. Therefore, powered-off booting is required.

Enabling/Disabling MCTP

Before attempting to enable MCTP support, verify that your adapter supports MCTP, using the Enablement Kit `-i all` switch to confirm the versions of the installed Flash components.

■ Minimum versions for QLE2690 Series Adapters:

- ☐ Flash Image: 1.06.03
- ☐ MPI Firmware: 3.02.01
- ☐ Preload Fw Area: 2.01.10
- ☐ FC Brd Cfg:2.00.06

An example using Windows is:

```
C:\>mctp-config-enablement-1.0.0-19_Windows_x64.exe -i all
```

NOTE

For QLE269x, do not use QCC CLI to downgrade an MBI that already has MCTP enabled to an MBI that has MCTP disabled. You must first use the MCTP disablement kit.

Refer to the following sections to enable or disable MCTP support using the conversion kit executables for the applicable operating system.

Windows

To enable MCTP support on a Windows system, issue the following command from the command prompt:

```
mctp-config-enablement-<version>-<build>_Windows_x64.exe
```

To disable MCTP support on a Windows system, issue the following command from the command prompt:

```
mctp-config-disablement-<version>-<build>_Windows_x64.exe
```

Linux

To enable MCTP support on a Linux system, issue the following command from the terminal prompt:

```
mctpconfig-enablement-<version>-<build>_Linux_x86_64.bin
```

To disable MCTP support on a Linux system, issue the following command from the terminal prompt:

```
mctpconfig-disablement-<version>-<build>_Linux_x86_64.bin
```

NOTE

For additional information on supported adapters and operating systems, see the MCTP conversion kit Readme file.

5 NVM Express over Fibre Channel

This chapter describes the installation and configuration of NVMe over Fibre Channel (FC-NVMe) on the Marvell QLogic adapters. It covers:

- [Hardware and Software Requirements](#)
- [“Host Setup” on page 83](#)
- [“Limitations and Known Issues” on page 90](#)
- [“Unloading and Reloading the Linux Driver” on page 90](#)

For assistance with the installation and configuration of FC-NVMe, contact Marvell Technical Support at this address:

https://www.marvell.com/support/contact/cust_support.do

Hardware and Software Requirements

The following sections list the required adapters, operating systems, and host software.

See the latest Readme and Release Notes for required versions of:

- Drivers
- Firmware
- QConvergeConsole CLI
- QConvergeConsole Plug-in for VMware vCenter Server
- Marvell QLogic Fibre Channel QConvergeConsole Extension for Windows Admin Center
- Marvell QLogic PowerKit
- Marvell ESXCLI Plug-in for VMware vSphere

Adapters

FC-NVMe requires one or more of the QLE2690, QLE2692, QLE2694, and QLE2694L adapters.

Operating Systems

The following x86_64 operating systems are supported for FC-NVMe.

- Operating systems with inbox drivers:
 - ☐ Windows Server 2019 or later
 - ☐ SLES12 SP5 or later
 - ☐ SLES15 SP2 or later
 - ☐ RHEL 7.8 or later
 - ☐ RHEL 8.0 or later
 - ☐ RHEL 9.0 or later
 - ☐ ESXi 7.0 U1 or later
 - ☐ ESXi 8.0 or later
- Operating systems with out-of-box drivers:
 - ☐ SLES12 SP4 or later
 - ☐ SLES15 SP2 or later
 - ☐ RHEL 7.8 or later
 - ☐ RHEL 8.3 or later
 - ☐ RHEL 9.0 or later
 - ☐ Windows Server 2019 or later
 - ☐ ESXi 7.0 or later
 - ☐ ESXi 8.0 or later

Host Setup

Procedures for setting up the initiator host include the following:

- [Installing the Drivers](#)
- [Finding Host NQN](#)
- [Programming the Host NQN onto the NVMe Storage Array](#)
- [Configuring System for NVMe Auto Discovery](#)
- [Verifying the Availability of FC-NVMe Devices](#)
- [Unloading and Reloading the Linux Driver](#)
- [Limitations and Known Issues](#)

Installing the Drivers

The following instructions are for configuring Linux, Windows, and ESX Host for FC-NVMe. Installation of the OS driver is a prerequisite for configuring FC-NVMe.

Finding Host NQN

The Host NQN string is needed to configure and connect to NVMe Storage. The default Host NQN is displayed at the HII UEFI driver level. For more information on configuring NVMe BFS see *User's Guide—UEFI Human Interface Infrastructure*, 2690 Series 16GFC, 2740/2760 32GFC, 2770 Series 32GFC Fibre Channel Adapters (part number BK3254602-00).

Additionally, the Host NQN can also be displayed at the OS level using the methods described in the following section. These methods use commands from either the operating system or QConvergeConsole CLI.

Linux

1. With the NVMe CLI already installed, issue the following command to verify that the `hostnqn` file exists:

```
# ls /etc/nvme/hostnqn
/etc/nvme/hostnqn
```

2. If the `hostnqn` file exists, issue the following command to view and note the `hostnqn` data to use when mapping the host initiator(s) to storage subsystems:

```
# cat /etc/nvme/hostnqn
nqn.2014-08.org.nvmexpress:uuid:1164eabb-e77f-4f15-ad16-c
efb43d1fc9
```

3. If the `hostnqn` file does not exist, issue the following command to create it using the NVMe CLI:

```
# nvme gen-hostnqn
nqn.2014-08.org.nvmexpress:uuid:a0baf242-85fd-41e5-a524-e
253d8531282
```

4. Take the output from the `nvme gen-hostnqn` command and save it to the `hostnqn` file. The edited file in the `/etc/nvme/hostnqn` directory should appear as follows.

```
nqn.2014-08.org.nvmexpress:uuid:a0baf242-85fd-41e5-a524-e
253d8531282
```

If steps 3 and 4 are performed, a new dynamic Host NQN is created that may not match the default Host NQN displayed in the HII UEFI. Ensure the newly created Host NQN is configured into the NVMe storage, or you can edit the `hostnqn` file to match the Host NQN displayed as the default Host NQN at the HII UEFI.

Windows

The driver automatically generates a host NVMe qualified name (NQN). To view the host NQN, issue the `qauccli -i` command.

The following shows an example Host NQN output:

```
-----  
Host Name : WIN-4KHVTBVO147  
Host NQN : nqn.2018-08.com.marvell:nvme.host.sys.wwpn:21000024ff784720  
HBA Instance : 2  
HBA Model : QLE2692
```

NOTE

Host NQN is read-only and is generated by the driver. There is no option to modify/configure Host NQN from QCC CLI.

ESXi

Issue the following command to list the current Host NQN:

```
# localcli nvme info get  
Host NQN: nqn.2014-08.org.qlogic:nvme:localhost
```

Programming the Host NQN onto the NVMe Storage Array

Refer to the instructions provided by the vendor of your NVMe Storage Array to configure and map the Initiator Host NQN to NVMe namespaces.

Configuring System for NVMe Auto Discovery

Auto discovery is natively supported for SLES15 SP2 or later, RHEL8.3 or later, Windows Server 2019 or later, and ESXi 7.0 or later. No additional configuration is needed.

The following procedure is for configuring auto discovery on RHEL7.8 or later only.

To set up a Linux host:

1. Verify that the FC-NVMe scripts are installed by issuing the following commands:

```
# ls -l /etc/udev/rules.d/99-nvme-fc.rules  
-rw-r--r--. 1 root root 310 Dec 31 15:14  
/etc/udev/rules.d/99-nvme-fc.rules  
# ls -l /usr/sbin/qla2xxx/qla2xxx_nvme_boot_connections.sh  
-rwxr-xr-x. 1 root root 859 Jan 31 10:56  
/usr/sbin/qla2xxx/qla2xxx_nvme_boot_connections.sh  
# ls -l  
/usr/lib/systemd/system/qla2xxx-nvmefc-connect@.service
```

```
-rwxr-xr-x. 1 root root 859 Jan 31 10:56
/usr/lib/systemd/system/qla2xxx-nvmefc-connect@.service
# ls -l
/usr/lib/systemd/system/qla2xxx-nvmefc-connect@.service
-rw-r--r--. 1 root root 279 Jan 31 10:54
/usr/lib/systemd/system/qla2xxx-nvmefc-connect@.service
```

2. If the Linux out-of-box driver does not discover NVMe targets after a system reboot, perform the following steps to ensure the service named `qla2xxx-nvmefc-boot-connection.service` is enabled.

- a. Open a Linux terminal window and issue the following command to check the state of the service.

```
# systemctl list-unit-files | grep nvmefc-boot-connection
qla2xxx-nvmefc-boot-connection.service disabled
```

- b. If the service is disabled, issue the following command to enable.

```
# systemctl enable qla2xxx-nvmefc-boot-connection.service
```

Following is an example response that should be seen:

```
Created symlink
/etc/systemd/system/default.target.wants/qla2xxx-nvmefc-b
oot-connection.service
→/usr/lib/systemd/system/qla2xxx-nvmefc-boot-connection.
service.
```

- c. Issue the following command to verify that the service is enabled:

```
# systemctl list-unit-files | grep nvmefc-boot-connection
qla2xxx-nvmefc-boot-connection.service enabled
```

3. Reboot the system and verify that the NVMe targets are discovered.

Verifying the Availability of FC-NVMe Devices

Follow the procedures in this section to confirm FC-NVMe device availability on Linux and Windows systems.

Verifying in Linux

In Linux, verify that the target devices are available by issuing either of the following commands:

```
# lsblk
```

or

```
# nvme list
```

Example: `lsblk` Command

The following example of a portion of the `lsblk` output shows the FC-NVMe attached targets. The system discovered three target controllers (nvme0, nvme1, and nvme2). Each of these controllers has one FC-NVMe LUN behind it (n1).

NAME	MAJ:MIN	RM	SIZE	RO	TYPE	MOUNTPOINT
nvme0n1	259:2	0	1G	0	disk	
nvme0n1p1	259:25	0	1023M	0	part	
nvme0n2	259:8	0	1G	0	disk	
nvme0n3	259:12	0	1G	0	disk	
nvme0n4	259:16	0	1G	0	disk	
nvme0n5	259:18	0	1G	0	disk	
nvme0n6	259:20	0	1G	0	disk	
nvme0n7	259:22	0	1G	0	disk	
nvme0n8	259:24	0	1G	0	disk	

Example: `nvme list` Command

The following example of a portion of the `nvme list` output shows the FC-NVMe attached targets.

Node	SN	Model	Namespace	Usage	Format	FW	Rev
nvme0n1	00-200100110dd89300	SANBlaze	VLUN P3T0	1 67.11 MB /	67.11 MB	512 B +	0 B V8.x-dev
nvme1n1	00-200000110dd89200	SANBlaze	VLUN P2T0	1 67.11 MB /	67.11 MB	512 B +	0 B V8.x-dev
nvme2n1	00-200000110d4d1300	SANBlaze	VLUN P0T0	1 67.11 MB /	67.11 MB	512 B +	0 B V8.x-dev

Verifying in Windows

In Windows, verify that the target devices are available by issuing the `gauccli -t` command. For example:

```
gauccli -t 0 (HBA instance 0)
Using config file: C:\Users\Administrator\gauccli.cfg
Installation directory: C:\Users\Administrator
Working dir: C:\Users\Administrator

-----
HBA Instance 0: QLE2692Port 1 WWPN 21:00:00:24:ff:8f:e3:9a PortID 01:21:00
Link: Online (FEC)
-----

Path                : 0
Target              : 0
Device ID           : 0x83
Product Vendor      : NVMe
Product ID          : SANBlaze VLUN P2
Product Revision    : -dev
Serial Number       : 6001_10d0_0247_2600_0302_0000_929d_14c6.
Node Name           : 20:02:00:11:0d:47:26:00
Port Name           : 20:02:00:11:0d:47:26:00
Port ID            : 01:1b:00
Product Type        : NVME Disk (Ensure that this shows as an FC-NVMe target.)
LUN Count(s)       : 51
Status              : Online
-----
```

Figure 5-1 shows the devices in Windows Device Manager.

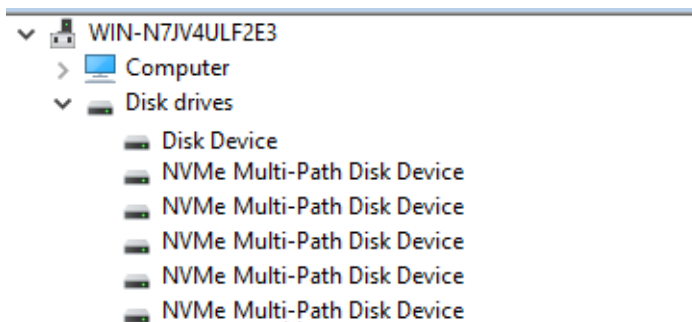


Figure 5-1. FC-NVMe Devices in Windows Device Manager

Verifying in ESX

To verify the controllers using ESX 7.0, issue the following command:

```
$ esxcli nvme controller list
```

Name	Controller Number	Adapter	Transport Type	Is Online
nqn.2014-08.org.sanblaze:virtualun.virtuallunnvme.2.0#vmhba67#200200110d27b200:200200110d27b200	260	vmhba67	FC	true
nqn.2014-08.com.sanblaze:virtualun.virtuallunnvme.2.2#vmhba67#200200110d27b202:200200110d27b202	267	vmhba67	FC	true
nqn.2014-08.com.sanblaze:virtualun.virtuallunnvme.2.4#vmhba67#200200110d27b204:200200110d27b204	268	vmhba67	FC	true
nqn.2014-08.com.sanblaze:virtualun.virtuallunnvme.2.6#vmhba67#200200110d27b206:200200110d27b206	269	vmhba67	FC	true
nqn.2014-08.org.sanblaze:virtualun.virtuallunnvme.2.0#vmhba68#200200110d27b200:200200110d27b200	274	vmhba68	FC	true
nqn.2014-08.com.sanblaze:virtualun.virtuallunnvme.2.2#vmhba68#200200110d27b202:200200110d27b202	281	vmhba68	FC	true
nqn.2014-08.com.sanblaze:virtualun.virtuallunnvme.2.4#vmhba68#200200110d27b204:200200110d27b204	282	vmhba68	FC	true
nqn.2014-08.com.sanblaze:virtualun.virtuallunnvme.2.6#vmhba68#200200110d27b206:200200110d27b206	283	vmhba68	FC	true

Figure 5-2. Listed NVMe Controllers

Display the NVMe namespace using the following command:

```
$ esxcli nvme namespace list
```

Name	Controller Number	Namespace ID	Block Size	Capacity in MB
eui.600110d00227b20003020000929d14c6	260	1	512	4096
eui.600110d00227b202030200022acfb0c	267	1	512	1
eui.600110d00227b20403020004b6297c9a	268	1	512	1
eui.600110d00227b2060302000641833f28	269	1	512	1
eui.600110d00227b20003020000929d14c6	274	1	512	4096
eui.600110d00227b202030200022acfb0c	281	1	512	1
eui.600110d00227b20403020004b6297c9a	282	1	512	1
eui.600110d00227b2060302000641833f28	283	1	512	1

Figure 5-3. NVMe Namespace List

NOTE

The ESX 7.0/8.0 `qlnativefc` driver may create and register two logical devices, one for NVMe and one for FCP. The `vmhbas` do not represent individual physical FC ports, but a logical device with which the operating system can interact. The `WWPN/WWNN` shows that it is the same physical FC port.

Unloading and Reloading the Linux Driver

This section applies to a locally booted Linux operating system.

Follow the instructions in this section to unload and reload the Linux driver after first disconnecting the NVMe devices.

To unload and reload the Linux driver:

1. List all the FC-NVMe connected target controllers by issuing the following command:

```
# ls /dev/nvme* | grep -E nvme[0-9]+$
```

The preceding command should list all connected `/dev/nvme[x]` devices. For example:

```
/dev/nvme0
```

```
/dev/nvme1
```

2. Disconnect all of the FC-NVMe target devices by issuing the following commands to each of the `/dev/nvme[x]` devices listed in [Step 1](#):

```
# nvme disconnect -d /dev/nvme0
```

```
# nvme disconnect -d /dev/nvme1
```

3. Unload the current driver by issuing the following command:

```
# modprobe -r qla2xxx
```

4. Reload the driver to auto-discover the FC-NVMe subsystems by issuing the following command:

```
# modprobe -v qla2xxx
```

Limitations and Known Issues

The following Linux and Windows limitations and known issues affect the installation and configuration of FC-NVMe.

Linux

For Linux operating systems, Marvell recommends that you disconnect all FC-NVMe devices prior to unloading the driver. Refer to the procedure in [Unloading and Reloading the Linux Driver](#).

Windows

Windows FC-NVMe does not support point-to-point (also called N2N) direct attach to target/LUN configuration. It does support fabric configuration through FC Switch fabric.

Boot From SAN Setup

NVMe BFS is supported through UEFI and not supported through legacy BIOS.

NOTE

NVMe BFS is only supported on QLE2690 Series adapters

NOTE

NVMe BFS is only supported on RHEL 9.2 (TP) and later, SLES15 SP3 and later, Windows Server 2019, Windows Server 2022, and ESXi 7.0 or later. For more information on configuring NVMe BFS see *User's Guide—UEFI Human Interface Infrastructure*, 2690 Series 16GFC, 2740/2760 32GFC, 2770 Series 32GFC Fibre Channel Adapters (part number BK3254602-00).

NOTE

Custom NQN configured in HII for NVMe BFS with SLES and Windows is not supported for SLES15 SP3, and Windows Server 2019 or 2022. The default Host NQN string is required for NVMe BFS installation to succeed using the above listed operating systems.

Once the UEFI driver is configured using HII, and the NVMe storage has been configured with the Initiator Host NQN, there are no additional NVMe BFS steps required to detect the NVMe storage in order to install SLES15 SP3, SLES15 SP4, Windows Server 2019, or Windows Server 2022.

For ESX 7.0 or later it is recommended to change the default Host NQN in HII to match the OS default Host NQN using the procedures in the following section.

Additional Setup for NVME Boot-from-SAN Using ESX 7.0 and Later

For VMware Host NQN is derived from the fully qualified domain name (FQDN) of the host. Following is the format for host NQN under VMware ESXi 7.0 and later:

```
nqn.2014-08.<reverse-domain>:nvme:<hostname>
```

For example, a host that has FQDN as R740-FRSCO.qlogic.org has the following NQN name:

```
nqn.2014-08.org.qlogic:nvme:R740-FRSCO
```

The UEFI driver assigns the host NQN based on a system UUID. The host NQN field can be changed on the NVME Settings page to match the format used by ESX. Marvell recommends that the UEFI and OS host NQN be the same, or configure the storage to accept both UEFI and OS NQN.

NOTE

To avoid FC-NVMe discovery related issues during the installation time, it's important to make sure that the Host NQN in UEFI, storage host definition and ESXi installer match up.

If the fully qualified domain name is not already pushed out by the DNS server, it can be set during the installation by performing the following steps prior to ESXi installation. Once the VMware installer is fully loaded, access the console by pressing Alt+F1.

1. Enter `root` for the username and leave password field blank.
2. Issue the following command to list the current NQN:

```
# localcli nvme info get  
Host NQN: nqn.2014-08.org.qlogic:nvme:localhost
```

Use the host NQN and assign that string into the NVME storage Controller namespace. If necessary, modify the UEFI driver fields to use the host NQN and the storage NQN.

Changing the host FQDN at a later time changes the NQN in the OS. To avoid this scenario, configure FQDN during the installation process using the following commands:

```
# localcli system hostname set --fqdn=R740-FRSCO.qlogic.org
```

3. Check the system FQDN using the following command:

```
# localcli system hostname get
```
4. Force a Host NQN change based on the FQDN that was just set using the following command:

```
#localcli nvme info set --hostnqn=default
```

5. Query the NQN name in the system using the following command:

```
# localcli nvme info get
```

6. Retrieve a list of vmhbas by issuing the following command:

```
localcli storage san fc list
```

Following is a partial sample output:

```
FcDevice:
  Adapter: vmhba65
  Port ID: 000000
  Node Name: 20:00:f4:c7:aa:0a:d7:27
  Port Name: 21:00:f4:c7:aa:0a:d7:27
  Speed: 0 Gbps
  Port Type: LPort
  Port State: LINK DOWN
  Model Description: QLogic QLE 2694 Dual Port 64/32/16GFC
                    PCIe Gen4 x8 Adapter

  Hardware Version:
  OptionROM Version: 0.00
  Firmware Version: 9.10.01 (d0d5)
  Driver Name: qlnativefc
Error getting field DriverVersion
```

7. Reset the HBA and rescan using the following command:

```
# localcli storage san fc reset -A vmhba65
# esxcfg-rescan vmhba65
```

A few attempts of reset and rescan may be required to force controller discovery.

8. List the namespaces using the following command:

```
# localcli nvme namespace list
```

9. List the NVME controllers using the following command:

```
# localcli nvme controller list
```

NVME namespaces should be available at this point to perform the installation. Press Alt+F2 to return to the installer GUI and continue with the installation process.

NOTE

For ESXi 8.0 and later, if the above steps do not list the NVMe namespaces then execute the following steps:

1. Fetch the Controller ID by executing the command:
`localcli nvme controller list`
 2. Clear all the existing connections/sessions with the older NQN
`localcli nvme fabrics disconnect -a <NVMe device> -n <target NVMe controller>`
 3. Reset the port by executing the command:
`localcli storage san fc reset -A <vmhbaX>`
 4. List the namespaces using the following command:
`# localcli nvme namespace list`
-

A Adapter LEDs

This appendix describes the LEDs on these 2600 Series Adapters:

- “QLE2670 and QLE2672 16Gb Adapter LEDs” on page 95
- “QLE2690, QLE2692, QLE2694, and QLE2694L, 16Gb Adapter LEDs” on page 96

QLE2670 and QLE2672 16Gb Adapter LEDs

The QLE2670 and QLE2672 16Gb Adapter ports have three LEDs (see [Figure A-1](#)):

- The amber LED on the left is 16Gb.
- The green LED in the middle is 8Gb.
- The amber LED on the right is 4Gb.

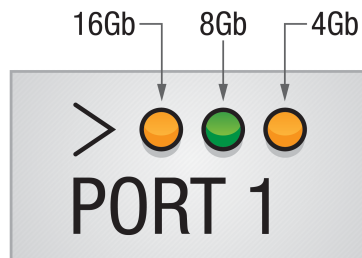


Figure A-1. QLE2670 and QLE2672, 16Gb Adapter LEDs

Table A-1 defines the LED behavior for the QLE2670 and QLE2672, 16Gb Adapters.

Table A-1. QLE2670 and QLE2672 16Gb Adapter LED Scheme

LED	Power Off	Power On (Before Firmware Initialization)	Power On (After Firmware Initialization)	Firmware Fault	4Gbps Link Up and Active	8Gbps Link Up and Active	16Gbps Link Up and Active	Beaconing
Amber LED (16Gbps)	Off	On	Flashing	Flashing in sequence	Off	Off	On or flashing	Flashing
Green LED (8Gbps)	Off	On	Flashing	Flashing in sequence	Off	On or flashing	Off	Off
Amber LED (4Gbps)	Off	On	Flashing	Flashing in sequence	On or flashing	Off	Off	Flashing

QLE2690, QLE2692, QLE2694, and QLE2694L, 16Gb Adapter LEDs

The QLE2690, QLE2692, QLE2694, and QLE2694L, 16Gb Adapter ports have three LEDs (see Figure A-2):

- The green LED on the left is 16Gb.
- The green LED in the middle is 8Gb.
- The green LED on the right is 4Gb.

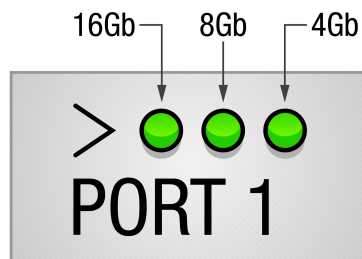


Figure A-2. QLE2690, QLE2692, QLE2694, and QLE2694L, 16Gb Adapter LEDs

Table A-2 defines the LED behavior for the QLE2690, QLE2692, QLE2694, and QLE2694L, 16Gb Adapters.

Table A-2. QLE2690, QLE2692, QLE2694, and QLE2694L, 16Gb Adapter LED Scheme

LED	Power Off	Power On (Before Firmware Initialization)	Power On (After Firmware Initialization)	Firmware Fault	4Gbps Link Up and Active	8Gbps Link Up and Active	16Gbps Link Up and Active	Beaconing
Green LED (16Gbps)	Off	On	Flashing	Flashing in sequence	Off	Off	On or flashing	Flashing
Green LED (8Gbps)	Off	On	Flashing	Flashing in sequence	Off	On or flashing	Off	Off
Green LED (4Gbps)	Off	On	Flashing	Flashing in sequence	On or flashing	Off	Off	Flashing

B Troubleshooting

This appendix provides procedures for solving issues by running Fibre Channel diagnostics using QConvergeConsole CLI. In addition, a two-part flowchart walks you through troubleshooting problems that may occur with devices and LUNs on the 2600 Series Adapter.

Troubleshooting with Fibre Channel Diagnostics

The following sections describe how to use QConvergeConsole CLI to perform diagnostics on the 2600 Series Adapter.

Either of following tests can be conducted only while the HBA port is connected to a Fibre Channel switch:

- Read Write Buffer Test
- Port Beacon Test.

Loopback test may be conducted while the HBA port is connected to a Fibre Channel switch by:

- Selecting the External Loopback type causes the HBA firmware to transmit the Extended Link Services (ELS) ECHO requests
- Selecting Internal Loopback type causes no transmission of any frame types,

Internal Loopback Test requires no SFP to be plugged into the HBA port.

Transceiver Diagnostics Monitoring Test requires an SFP to be plugged into the HBA port.

While a loopback connector is plugged into the HBA SFP, selecting Loopback Test with External Loopback type causes the HBA firmware to transmit data frames through the loopback connector.

NOTE

Do not perform an internal loopback test at the OS if the target device is the SAN target from which the system boots.

Fibre Channel Diagnostics Using Interactive QConvergeConsole CLI

To run the loopback test, read/write buffer test, or beacon test:

1. On the **Main Menu**, select **4: Adapter Diagnostics**.
2. On the **FC Diagnostics** menu, select the test type to run:
 - Select **1: Loopback Test** to run the loopback test.
 - Select **2: Read Write Buffer Test** to run the read/write buffer test.
 - Select **3: Transceiver Diagnostics Monitoring Interface (DMI)** to view the transceiver diagnostics information.
 - Select **4: Port Beacon** to run the beacon test.

For more information, refer to the section about Fibre Channel interactive commands in the *User's Guide—QConvergeConsole CLI* (part number SN0054667-00).

Fibre Channel Diagnostics Using Noninteractive QConvergeConsole CLI

For more information, refer to the section about the Fibre Channel noninteractive commands in the *User's Guide—QConvergeConsole CLI* (part number SN0054667-00).

Fibre Channel Troubleshooting Diagram

Figure B-1 and Figure B-2 provide a two-part troubleshooting flowchart.

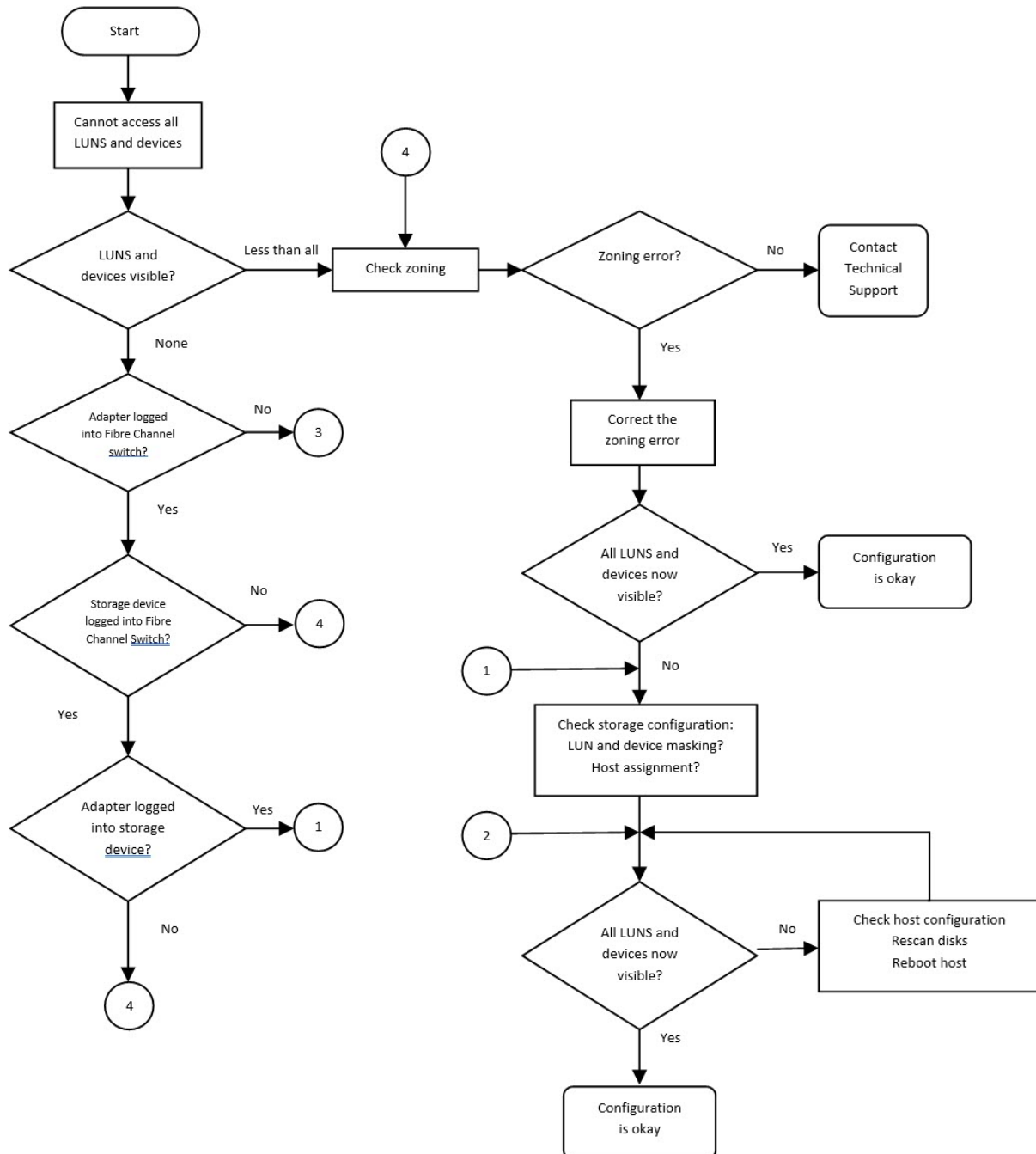


Figure B-1. Fibre Channel Troubleshooting Diagram (Part 1 of 2)

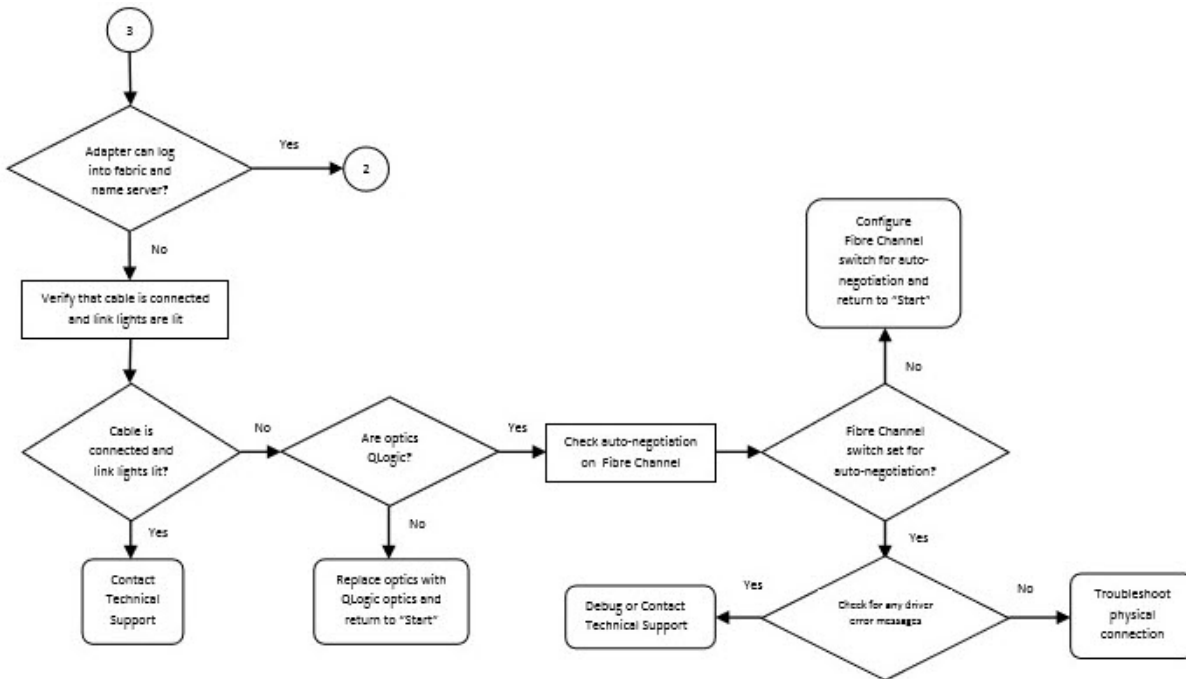


Figure B-2. Fibre Channel Troubleshooting Diagram (Part 2 of 2)

Troubleshooting in Diagnostics Port Mode

Use the diagnostics port feature on the 2600 Series Adapter to identify and isolate link failures resulting from faulty modules (link, cable, or SFP) by running diagnostics over a Fibre Channel link.

- The D_Port feature is supported on Windows, Linux, and ESXi.
- D_Port requires a Fibre Channel Adapter that is linked to a Brocade or Cisco Fibre Channel 16G, 32G, or 64G switch, and the supported Brocade or Cisco 16G, 32G, or 64G Fibre Channel switch firmware.

NOTE

All QLogic-branded 16Gbps, 32Gbps, 64GBps SFP+ transceivers support diagnostics port tests. If you have a supported non-QLogic branded transceiver, ensure that it supports the optical wrap (OWrap) and electrical wrap (EWrap) capability that is required for diagnostics port.

Before running diagnostics, verify that the FC switch supports Diagnostic Port mode, and then enable the HBA port Diagnostic Port mode. The following example enables and shows the Diagnostic Port mode on HBA port instance 0, where 0 specifies the HBA port instance number.

Execute this Non-Interactive QCC CLI command to enable D_Port on the HBA:

```
[root@evt70 ~]# qauccli -dport 0 --enable
Using config file:
/opt/QLogic_Corporation/QConvergeConsoleCLI/qauccli.cfg
Installation directory:
/opt/QLogic_Corporation/QConvergeConsoleCLI
Working dir: /root
HBA Parameters update complete. Changes have been saved to HBA
instance 0 and a reboot is required.
```

Execute this Non-Interactive QCC CLI command to verify D_Port is enabled on the HBA:

```
[root@evt70 ~]# qauccli -dport 0 --info
Using config file:
/opt/QLogic_Corporation/QConvergeConsoleCLI/qauccli.cfg
Installation directory:
/opt/QLogic_Corporation/QConvergeConsoleCLI
Working dir: /root

-----
QLE2692 (SN AFD1529Y02603)
-----

=====
Port 1:
=====
DPort   : Enable
```

While D_Port is enabled on both the switch port and 2600 Series Adapter port, the HBA port responds to diagnostic test commands received from the switch port. The switch runs the following tests:

- Electric loopback test
- Optical loopback test

NOTE

When running Diagnostic Port in a Boot from SAN environment, you should run diagnostics port tests on multipath configured boot from a SAN or fabric-assigned boot LUN. Running diagnostics port tests on a single path boot from SAN or fabric-assigned boot LUN may cause issues with OS stability in true boot from SAN environments.

For more information about verifying diagnostics port mode using QConvergeConsole CLI, refer to the section about the Fibre Channel noninteractive commands in the *User's Guide—QConvergeConsole CLI* (part number SN0054667-00). For information about running diagnostics port from the host server adapter, see the *User's Guide—QConvergeConsole CLI*.

For information about verifying diagnostics port mode using QConvergeConsole vSphere Client Plug-in and QConvergeConsole Plug-in for VMware vSphere Web Client, see the “Fibre Channel Adapter Management” section in the *User's Guide—QConvergeConsole Plug-ins for VMware vSphere* (part number SN0054677-00).

The following sections describe how to configure, run, and view diagnostics port mode from Fibre Channel switches:

- [Configuring, Running, and Viewing Results of a Diagnostics Port on a Brocade Fibre Channel Switch](#)
- [Configuring, Running, and Viewing Results of a Diagnostics Port on a Cisco Fibre Channel Switch](#)

Configuring, Running, and Viewing Results of a Diagnostics Port on a Brocade Fibre Channel Switch

Follow the steps given below to configure and run the test, then view results. For more detail about the switch, see the Brocade switch documentation.

To enable diagnostics port mode:

From the Fibre Channel switch, issue the following commands:

```
# portdisable <port#>
# portcfgdport --enable <port#>
# portenable <port#>
```

The diagnostics port test starts automatically.

The following example configures and starts a diagnostic test on port 17 of a Brocade Fibre Channel switch.

```
# portdisable 17
```

```
# portcfgdport --enable 17
# portenable 17
```

To view the diagnostics port test results from the Fibre Channel switch:

- Issue the `portdporttest` command as follows:

```
# portdporttest --show <port#>
```

For example:

```
# portdporttest --show 17
```

This command can be issued multiple times to monitor the status and to view the results of the test.

Following is an example output for this command after the test completes (for FOS versions prior to 9.2.0):

D-Port Information:

=====

```
Port: 17
Remote WWPN: 21:00:00:0e:1e:11:4a:31
Mode: Automatic
No. of test frames: 1 Million
Test frame size: 1024 Bytes
FEC (enabled/option/active): Yes/No/No
CR (enabled/option/active): Yes/No/No
Start time: Thu Aug 14 01:45:37 2014
End time: Thu Aug 14 01:47:40 2014
Status: PASSED
```

=====

Test Comments	Start time	Result	EST (HH:MM:SS)
------------------	------------	--------	----------------

=====

Electrical loopback -----	01:46:08	PASSED	-----
Optical loopback -----	01:46:54	PASSED	-----
Link traffic test -----	-----	SKIPPED	-----

=====

```
Roundtrip link latency: 157 nano-seconds
Estimated cable distance: 3 meters
Buffers required: 1 (for 2112 byte frames at 16Gbps speed)
```

Following example shows the result of Diagnostic Port test on port 16 (beginning with FOS version 9.2.0):

NOTE

Brocade FOS 9.2.0 and later omit both Electrical and Optical loopback phases. The result is the Brocade switch reports listed below.

```
GAD23826_EF5_G720:FID128:admin> portdporttest --show 16
D-Port Information:
=====
Port: 16
Remote WWPN: 21:00:34:80:0d:65:c4:4c
Mode: Automatic
No. of test frames: 1 Million
Test frame size: 1024 Bytes
Pattern: jCRPAT
FEC (enabled/option/active): Yes/No/Yes
CR (enabled/option/active): Yes/No/No
Start time: Fri Sep 29 01:25:01 2023
End time: Fri Sep 29 01:26:57 2023
Status: SKIPPED
=====
Test Start time Result EST(HH:MM:SS) Comments
=====
Link traffic test ----- SKIPPED ----- No remote port support
or
Skipped
```

To disable diagnostics port mode:

From the Fibre Channel switch, issue the following commands:

```
# portdisable <port#>
# portcfgdport --disable <port#>
# portenable <port#>
```

NOTE

After the diagnostics port is disabled on the switch port, the adapter port automatically resumes normal operation as an N_Port.

Configuring, Running, and Viewing Results of a Diagnostics Port on a Cisco Fibre Channel Switch

Follow the steps given below to configure and run the test, then view results. For more detail about the switch, see the Cisco switch documentation.

To enable diagnostics port mode:

The following example configures and starts a diagnostic test on port 2 of a Cisco Fibre Channel switch:

```
Cisco# config t
Cisco# int fc 1/2
Cisco(config-if)# shut
Cisco(config-if)# switchport link-dia
Cisco(config-if)# no shut
Cisco(config-if)# diagnostic start interface fc 1/2 test link-dia
```

To view the diagnostic test status, type the following command:

```
CISCO32G1# show diagnostic result interface fc1/2 test link-dia
```

Following is an example output for this command after the test completes:

```
PWWN of peer port: 21:00:34:80:0d:73:05:83
Status: Supported (Reflector)
Reflector loopback capabilities: Xcvr-optical Electrical
Time of Test: Wed Aug 24 15:17:00 2022
Total time taken: 42 seconds
```

```
=====|=====|=====|=====|=====|=====|=====|=====|=====|
|          |          | Discards |          | Latency (ns) |          |          |          |          |
Loopback Level | Tx Frames | Rx Frames | IN | OUT | BAD WORDS | In-Switch | External | Status
=====|=====|=====|=====|=====|=====|=====|=====|=====|
Remote-Switched(R) |          0 |          0 | 0 | 0 | 0 | 0 | 0 | 0 | -NA-
Mac(R) |          0 |          0 | 0 | 0 | 0 | 0 | 0 | 0 | -NA-
Xcvr-optical(R) | 48122705 | 48122705 | 0 | 0 | 0 | 3644 | 2684 | Success
Electrical(R) | 20000 | 20000 | -NA- | -NA- | -NA- | -NA- | -NA- | Success
=====|=====|=====|=====|=====|=====|=====|=====|=====|

Overall Status : Success
Cable Length (approx. +/- 5 metres) : 10.5 metres
```

To disable the diagnostic port, type the following commands:

```
Cisco#int fc 1/2
Cisco(config-if)# shut
Cisco(config-if)# no switchport link-dia
Cisco(config-if)# no shut
```

NOTE

After the diagnostics port is disabled on the switch port, the adapter port automatically resumes normal operation as an N_Port.

C Revision History

Document Revision History
Revision A, May 18, 2012
Revision B, September 7, 2012
Revision C, April 1, 2013
Revision D, October 10, 2013
Revision E, May 16, 2014
Revision F, October 28, 2014
Revision G, March 24, 2015
Revision H, August 24, 2015
Revision J, October 12, 2015
Revision K, February 25, 2016
Revision L, March 15, 2016
Revision M, June 27, 2016
Revision N, September 27, 2016
Revision P, January 13, 2017
Revision R, September 20, 2017
Revision T, May 7, 2018
Revision W, January 23, 2019
Revision X, April 3, 2019
Revision Y, May 17, 2019
Revision Z, November 22, 2019
Revision ZA, January 15, 2020
Revision ZB, May 14, 2020
Revision ZC, August 25, 2020
Revision ZD, February 8, 2021
Revision ZE, August 16, 2021
Revision ZF, March 22, 2022
Revision ZG, October 6, 2022
Revision ZH, March 24, 2023

Revision ZI, November 17, 2023	
Changes	Sections Affected
Replaced references of QConvergeConsole Plug-in for VMware vCenter Server with QConvergeConsole vSphere Client Plug-in.	All sections.
Added 'QLE269x only' for VMware ESXi (including vCenter Server Appliance for VMware ESXi 8.0).	“Adapter Management Tools” on page xxii
Modified steps for importing a Public Key for Secure Boot: Removed step 3. “Reboot the system”, and removed word “again” from step 5, in Method 1.	“Importing a Public Key for Secure Boot” on page 37
Removed section “Configuring Boot Devices with QConvergeConsole Plug-in for VMware vCenter Server”.	“Configuring Boot Devices” on page 44
Replaced vSphere HTML 5 with vSphere UI.	“Configuring Boot Devices with QConvergeConsole vSphere Client Plug-in” on page 45
Changed QConvergeConsoleCLI Version from 2.7.x (Build x) to 3.0.x (Build xx).	“Configuring Selective LUNs” on page 53
Removed section ‘To change the priority levels using the QConvergeConsole Plug-in for VMware vCenter Server’.	“Configuring QoS Priority Levels” on page 63
Added a note for For ESXi 8.0 and update.	“Additional Setup for NVME Boot-from-SAN Using ESX 7.0 and Later” on page 91
Organized and added example of Diagnostic Port result for Brocade FOS v9.02.00.	“Troubleshooting in Diagnostics Port Mode” on page 101

Glossary

adapter

The board that interfaces between the host system and the target devices. Adapter is synonymous with *Host Bus Adapter*, *Host Channel Adapter*, *host adapter*, and *adapter board*.

adapter port

A port on the adapter board.

adapter port beacon

An LED on the adapter. Flashing it enables you to locate the adapter.

AL_PA

Arbitrated loop physical address. A unique one-byte value assigned during loop initialization to each node loop port (NL_Port) on a loop.

alias

A user-defined name for an adapter, adapter port, logical disk, or subsystem.

arbitrated loop physical address

See [AL_PA](#).

bandwidth

A measure of the volume of data that can be transmitted at a specific transmission rate. A 1Gbps or 2Gbps Fibre Channel port can transmit or receive at nominal rates of 1 or 2Gbps, depending on the device to which it is connected. This corresponds to actual bandwidth values of 106MB and 212MB, respectively.

basic input output system

See [BIOS](#).

BIOS

Basic input output system. Typically in Flash PROM, the program (or utility) that serves as an interface between the hardware and the operating system and allows booting from the adapter at startup.

boot code

The program that initializes a system or an adapter. Boot code is the first program to run when a system or a device within a system, such as an adapter, is powered on. [FCode](#), [BIOS](#), and extensible firmware interface (EFI) are all forms of boot code for specific hardware/operating system environments.

Boot code for QLogic Fibre Channel Adapters is required if the computer system is booting from a storage device (disk drive) attached to the adapter. The primary function of the boot code is communication with the external boot device before the operating system is up and running. Boot code can also perform secondary functions, including managing the setup for the adapter and initializing and testing the adapter's ISP.

boot device

The device, usually the hard disk, that contains the operating system the BIOS uses to boot from when the computer is started.

boot from SAN

The ability for each server on a network to boot their operating system from a Fibre Channel [RAID](#) unit located on the SAN, rather than from a local disk or direct-attached storage (DAS). This enables easier SAN management because you can replace a server and boot it from the Fibre Channel RAID unit.

CRC

Cyclic redundancy check. A scheme to check data that have been transmitted or stored and to detect errors. A CRC cannot correct errors.

cyclic redundancy check

See [CRC](#).

device

A computer subsystem, such as an adapter card, that mediates data in a computer network. The term “device” is used interchangeably with “target” and “target device.”

driver

The software that interfaces between the file system and a physical data storage device or network media.

EFI

Extensible firmware interface. A specification that defines a software interface between an operating system and platform firmware. EFI is a replacement for the older BIOS firmware interface present in all IBM PC-compatible personal computers.

Ethernet

The most widely used LAN technology that transmits information between computer, typically at speeds of 10 and 100 million bits per second (Mbps).

extensible firmware interface

See [EFI](#).

fabric device management interface

See [FDMI](#).

Fast!UTIL

Fast!UTIL Fibre Channel Adapter BIOS utility.

FCode

Forth code. A type of boot code designed for use on Sun® SPARC® or Macintosh® hardware platforms. See also [Flash](#).

FCoE

Fibre Channel over Ethernet. A technology defined by the T11 standards body that allows traditional Fibre Channel storage networking traffic to travel over an Ethernet link by encapsulating Fibre Channel frames inside Layer 2 Ethernet frames. For more information, visit www.fcoe.com.

FDMI

Fabric device management interface. A standard enabling the management of devices such as adapters through the fabric.

FEC

Forward error correction. Automatically detects and recovers from bit errors. FEC enhances transmission reliability and performance.

Fibre Channel

High-speed serial interface technology that supports other higher layer protocols such as SCSI and IP, and is primarily used in SANs. Standardized under ANSI in 1994.

Fibre Channel over Ethernet

See [FCoE](#).

firmware

Low-level software typically loaded into read-only memory and used to boot and operate an intelligent device.

Flash

Non-volatile memory where the boot code is saved. At times, Flash and boot code are used interchangeably.

Forth code

See [FCode](#).

forward error correction

See [FEC](#).

Host Bus Adapter

An adapter that connects a host system (the computer) to other network and storage devices.

Internet small computer system interface

See [iSCSI](#).

iSCSI

Internet small computer system interface. Protocol that encapsulates data into IP packets to send over Ethernet connections.

LED

Light-emitting diode. Status indicator on a switch, router, adapter, or other device.

light-emitting diode

See [LED](#).

logical unit number

See [LUN](#).

loopback

A diagnostic tool that routes transmit data through a loopback connector back to the same adapter.

LUN

Logical unit number. A subdivision of a SCSI target. It is the small integer handle that differentiates an individual disk drive or partition (volume) within a common SCSI target device such as a disk array.

message signaled interrupts

See [MSI](#), [MSI-X](#).

MSI, MSI-X

Message signaled interrupts. One of two PCI-defined extensions to support message signaled interrupts (MSIs), in PCI 2.2 and later and PCI Express. MSIs are an alternative way of generating an interrupt through special messages that allow emulation of a pin assertion or deassertion.

MSI-X (defined in PCI 3.0) allows a device to allocate any number of interrupts between 1 and 2,048 and gives each interrupt separate data and address registers. Optional features in MSI (64-bit addressing and interrupt masking) are mandatory with MSI-X.

multiboot

The act of installing multiple operating systems on a computer, and being able to choose which one to boot when starting the computer. Multibooting may require a custom boot loader.

N_Port

Node port. A port that connects by a point-to-point link to either a single N_Port or a single F_Port. N_Ports handle creation, detection, and flow of message units to and from the connected systems. N_Ports are end ports in virtual point-to-point links through a fabric, for example, N_Port to F_Port to F_Port to N_Port using a single Fibre Channel fabric switch.

node port

See [N_Port](#).

N_Port ID virtualization

See [NPIV](#).

non-volatile random access memory

See [NVRAM](#).

NPIV

N_Port ID virtualization. The ability for a single physical Fibre Channel end point (N_Port) to support multiple, uniquely addressable, logical end points. With NPIV, a host Fibre Channel Adapter is shared in such a way that each virtual adapter is assigned to a virtual server and is separately identifiable within the fabric. Connectivity and access privileges within the fabric are controlled by identification of each virtual adapter and hence, the virtual server using each virtual adapter.

NVRAM

Non-volatile random access memory. A type of memory that retains data (configuration settings) even when power is removed. You can manually configure NVRAM settings or restore them from a file.

path

A path to a device is a combination of an adapter [port instance](#) and a target port as distinct from internal paths in the fabric network. A fabric network appears to the operating system as an opaque network between the adapter (initiator) and the target.

Because a path is a combination of an adapter and a target port, it is distinct from another path if it is accessed through a different adapter or it is accessing a different target port. Consequently, when switching from one path to another, the driver might be selecting a different adapter (initiator), a different target port, or both.

This is important to the driver when selecting the proper method of failover notification. It can make a difference to the target device, which might have to take different actions when receiving retries of the request from another initiator or on a different port.

PCI Express (PCIe)

A third-generation I/O standard that allows increased network throughput beyond that of the older peripheral component interconnect (PCI) and PCI extended (PCI-x) desktop and server slots.

personality

When used in the context of an adapter, the term *personality* refers to the entire adapter. It includes all the I/O ports and the functions on that adapter. For example, a QLogic adapter can have dual personality, converting from Fibre Channel to Converged Network Adapter or vice versa. Therefore, all the I/O functions and all the I/O physical ports on the adapter changes from Fibre Channel Adapter to Converged Network Adapter.

port

Access points in a device where a link attaches. The most common port types are:

- **N_Port**—a Fibre Channel port that supports point-to-point topology.
- **NL_Port**—a Fibre Channel port that supports loop topology.
- **F_Port**—a port in a fabric where an N_Port can attach.
- **FL_Port**—a port in a fabric where an NL_Port can attach.

port instance

The number of the port in the system. Each adapter may have one or multiple ports, identified with regard to the adapter as port 0, port 1 and so forth. To avoid confusion when dealing with a system containing numerous ports, each port is assigned a port instance number when the system boots up. So port 0 on an adapter might have a port instance number of 8, for example, if it is the eighth port discovered by the system.

QLflash

The executable file `QLflash.exe` is used by the `UPDATE.BAT` file to update the adapter [multiboot](#) code. The application `QLflash.exe` may be used to read, write, or verify either the multiboot image or the [NVRAM](#) on the adapter.

QoS

Quality of service. Refers to the methods used to prevent bottlenecks and ensure business continuity when transmitting data over virtual ports by setting priorities and allocating bandwidth.

quality of service

See [QoS](#).

RAID

Redundant array of independent disks. Fault-tolerant disks that look like either single or multiple volumes to the server.

RDP

Read diagnostic parameters. A function that provides diagnostic information about a fiber optic cable and its connection.

Read diagnostic parameters

See [RDP](#).

redundant array of independent disks

See [RAID](#).

SAN

Storage area network. Multiple storage units (disk drives) and servers connected by networking topology.

SCSI

Small computer systems interface. The original SCSI specification was a hardware bus specification and a packet-oriented protocol specification for communicating on that bus. SCSI over Fibre Channel uses the packet-oriented protocol to communicate with storage devices on the Fibre Channel.

small computer systems interface

See [SCSI](#).

storage area network

See [SAN](#).

target

The storage-device endpoint of a SCSI session. Initiators request data from targets (usually disk drives, tape drives, or other media devices). Typically, a SCSI peripheral device is the target but an adapter may, in some cases, be a target. A target can contain many LUNs.

target binding

The process in which the adapter driver binds a target ID using a target's world-wide port name ([WWPN](#)) or port ID. This binding enables the target ID to always connect to the WWPN or port ID across reboots regardless of [SAN](#) reconfiguration.

UEFI

Unified extensible firmware interface. A specification detailing an interface that helps hand off control of the system for the pre-boot environment (that is, after the system is powered on, but before the operating system starts) to an operating system, such as Windows or Linux. UEFI provides a clean interface between operating systems and platform firmware at boot time, and supports an architecture-independent mechanism for initializing add-in cards.

unified extensible firmware interface

See [UEFI](#).

USCM

SAN congestion management (SCM) is a common noun, and describes a standards-based Fibre Channel technology. Universal SAN Congestion Mitigation (USCM) is Cavium's IP, and describes Cavium's SCM feature set.

USCM Profiles

Settings to control the level of I/O throttling undertaken by the FC HBA in response to SAN congestion between a server and a target.

virtual machine

See [VM](#).

virtual port

See [vPort](#).

VM

Virtual machine. A software implementation of a machine (computer) that executes programs like a real machine.

vPort

Virtual port. A port number or service name associated with one or more virtual servers. A virtual port number should be the same TCP or UDP port number to which client programs expect to connect.

worldwide node name

See [WWNN](#).

worldwide port name

See [WWPN](#).

WWNN

Worldwide node name. A unique 64-bit address assigned to a device.

WWPN

Worldwide port name. A unique 64-bit address assigned to each port on a device. One WWNN may contain multiple WWPN addresses.



Marvell first revolutionized the digital storage industry by moving information at speeds never thought possible. Today, that same breakthrough innovation remains at the heart of the company's storage, networking and connectivity solutions. With leading intellectual property and deep system-level knowledge, Marvell semiconductor solutions continue to transform the enterprise, cloud, automotive, industrial, and consumer markets. For more information, visit www.marvell.com.

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Doc. No. FC0054609-00 Rev. ZI Revised: November 17, 2023