Emulex Drivers for Windows

User Manual

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Chapter 1: Introduction

This product supports Broadcom® converged network adapters (CNAs) and host bus adapters (HBAs) and CNAs.

NOTE For a list of adapters and firmware that are compatible with this driver, see the Broadcom website.

The Broadcom Emulex® drivers for Windows® support the following protocols:

- Fibre Channel (FC)
- FC over Ethernet (FCoE)
- Ethernet (NIC), which includes the TCP Offload Engine (TOE)
- Internet Small Computer System Interface (iSCSI)
- RDMA over Converged Internet (RoCE) for the OCe14000-series adapters
- Routable RoCE support for the OCe14000-series adapters

NOTE TOE is not supported on OCe14000-series and LPe16202 adapters.

1.1 Driver Information

This document explains how to install the Windows drivers on your system and configure the drivers' capabilities based on the supported networking protocols:

- FC and FCoE
  - Configuring the FC/FCoE driver parameters
  - Improving server performance with FC/FCoE drivers
- Ethernet and TOE
  - Configuring NIC driver options
  - Configuring SR-IOV
  - Configuring Network Virtualization using Generic Routing Encapsulation (NVGRE)
  - Configuring RoCE supporting Server Message Block (SMB) Direct
  - Configuring Universal Multi-channel (UMC)
  - Configuring NIC partitioning (NPar) for Dell adapters only
  - Tuning network driver performance
- iSCSI
  - Configuring iSCSI driver options
  - Creating non-bootable targets
  - Configuring Multipath Input/Output (I/O)

A NIC teaming package driver and manager are also available as a separate download. The *OneCommand NIC Teaming and VLAN Manager User Manual* is available for download as well. Refer to the Broadcom website for more information.

1.2 Operating System Requirements

One of the following operating systems must be installed:

- Windows Server 2008, Windows Server 2008 R2, Windows Server 2012, and Windows Server 2012 R2: x64 versions, Enterprise, and Server Core installation

  NOTE Microsoft patch KB2846340 must be installed on your system to successfully install the NIC driver. If the patch is not installed on your system, the installation stops and prompts you to install it. This patch, from Microsoft's Knowledge Base (KB), is required for Windows Server 2008, Windows Server 2008 R2, Windows Server 2012 and for Windows 8 client operating systems.

- Windows 8 and Window 8.1 and Windows 10 x64 base version, Professional and Enterprise

  NOTE Windows 8 x64, Windows 8.1 x64and Windows 10 drivers are Broadcom signed. You must accept the Broadcom certificate to install these kits. Support is provided by Broadcom, but not by Microsoft.

  NOTE Check the Broadcom website for required updates to the Windows operating system or the Broadcom Emulex drivers.

1.3 Abbreviations

AL_PA	arbitrated loop physical address
API	application programming interface
ARI	alternative routing-ID interpretation
BIOS	basic input-output system
CHAP	Challenge Handshake Authentication Protocol
CLI	command line interface
CNA	Converged Network Adapter
CNP	Congestion Notification Packet
CPU	central processing unit
CRC	cyclic redundancy check
CTCP	Compound TCP
DCB	Data Center Bridging
DCBX	Data Center Bridging Capabilities Exchange
DPC	deferred procedure call
DHCP	Dynamic Host Control Protocol
DID	device ID
DIMM	dual in-line memory module
DMA	direct memory access
DNS	Domain Name Server

DOS	disk operating system
DSM	Device Specific Module
ECN	Explicit Congestion Notification
ETO	extended timeout
ETS	Enhanced Transmission Selection
FC	Fibre Channel
FC-AL	Fibre Channel Arbitrated Loop
FCoE	Fibre Channel over Ethernet
FCP	Fibre Channel Protocol
FDMI	Fabric-Device Management Interface
FLOGI	fabric login
FW	firmware
FSB	front-side bus
GB	gigabyte
GbE	gigabit Ethernet
Gb/s	gigabits per second
GUI	graphical user interface
HBA	host bus adapter
iBFT	iSCSI Boot Firmware Table
ICMP	Internet Control Message Protocol
IEEE	Institution of Electrical and Electronics Engineers
IET	iSCSI Enterprise Target
I/O	input/output
IOCB	input/output control block
IOCTL	input/output control
IOMMU	input/output memory management unit
IOPs	I/O operations per second
IP	Internet Protocol
IPsec	Internet Protocol Security
IPL	initial program load
IPs	IP Security
iSCSI	internet Small Computer System Interface
IQN	iSCSI Qualified Name
KB	Knowledge Base
kb	kilobyte
LACP	Link Aggregation Control Protocol
LAN	local area network
LDTO	link down timeout
LRO	large receive offload
LSO	large send offload

LUN	logical unit number
MAC	Media Access Control
MPIO	multipath input/output
MSI	message signaled interrupts
MSS	maximum segment size
MTU	maximum transmission unit
N/A	not applicable
NAT	network address translation
NDIS	Network Driver Interface Specification
NIC	network interface card
NPar	NIC partitioning
NPIV	N_Port ID virtualization
NTFS	New Technology File System
NUMA	non-uniform memory access
NVGRE	network virtualization using generic routing encapsulation
OS	operating system
PCI®	PCI Express®
PCIe	Peripheral Component Interconnect express
PDU	protocol data unit
PF	PCI function
PFC	process flow control or priority flow control
PLOGI	port login
POST	power-on self-test
PT-PT	point-to-point
PXE	Preboot Execution Environment
QCN	Quantized Congestion Notification
QFE	Quick Fix Engineering
QoS	quality of service
RAID	redundant array of independent disks
RCMD	Remote Command Service
RDMA	remote direct memory access
RFC	Request for Comments
RoCE	RDMA over Converged Ethernet
ROM	read-only memory
RSC	receive segment coalescing
RSCN	registered state change notification
RSS	receive-side scaling
Rx	receive
SACK	selective acknowledgement

SAN	storage area network
SAS	serial attached SCSI
SCSI	Small Computer System Interface
SFP	small form factor pluggable
SLI	Service Level Interface
SMB	Server Message Block
SR-IOV	Single Root I/O Virtualization
SSH	Secure Shell network
TCP	Transmission Control Protocol
TCP/IP	TCP over Internet Protocol
TOE	TCP Offload Engine
TSO	TCP segmentation offload
Tx	transmit
UDP	User Datagram Protocol
UEFI	Unified Extensible Firmware Interface
UMC	Universal Multi-Channel
VF	virtual function
VLAN	virtual local area network
VLAN ID	VLAN identifier
VM	virtual machine
VMQ	virtual machine queue
VPN	virtual private network
vPort	virtual port
WMI	Window Management Instrumentation
WWN	World Wide Name
WWNN	World Wide Node Name
WWPN	World Wide Port Name
XRI	extensible resource indicator

Chapter 2: Installation

You can install the Windows drivers in two ways:

- OneInstall Installer contains all of the Emulex Windows drivers (Emulex Storport Miniport and NDIS Miniport drivers) and the OneCommand Manager application in a single download package.
- Driver kits and AutoPilot Installer provide installation options ranging from simple installations with a few mouse clicks to unattended installations that use predefined script files and text-only installations.

NOTE If you are installing the NIC driver kit as an update to the Windows Server 2012 driver, some parameter defaults are different from the inbox driver. After you install the Emulex out-of-box driver, select "reset to default" on the Advanced tab of the Device Manager property page. This action returns all adapter and driver settings to the default values listed in this manual.

NOTE Low performance might occur if the Emulex NIC driver is installed on a system meeting the following conditions before installing Microsoft KB2846837:

- A Windows 8, Windows 8.1, or Windows Server 2012 computer with multi-core processors is in use
- Three or more Ethernet ports are installed on the computer
- RSS is enabled and sets the RSS profile to use the "Closest" parameter for the Ethernet adapters

If these conditions exist, install KB2846837 before installing the Emulex NIC driver.

2.1 OneInstall Installer

The OneInstall Installer can be run in Interactive mode or Silent mode.

NOTE The OneInstall Installer does not allow you to perform preinstallation tasks or text-only installations. For these tasks, use the driver kits.

The OneInstall package is a self-extracting executable file that installs the following software on your system:

- All compatible protocol drivers:
  - FC
  - FCoE
  - iSCSI
  - NIC
  - NIC+RoCE
- Emulex PLUS (ElxPlus) driver (supports the OneCommand Manager application, persistent binding, and LUN mapping and masking)
- OneCommand Manager application for Emulex adapters

NOTE The Enterprise kit for the OneCommand Manager application does not operate locally on Windows Server Core. You must install the OneCommand Manager Core Kit (command line interface only) to the Windows Server Core.

2.1.1 Loading the OneInstall Package using Interactive Mode

To install the drivers using Interactive mode, perform these steps:

1. Download the OneInstall package from the Broadcom website.
2. Navigate to the OneInstall package in Windows Explorer.
3. Double-click the OneInstall package.

   The **Welcome** screen appears.
4. Click **Next**.

   The **Installation Options** screen appears.
5. Select the drivers and applications that you want to install and click **Next**.

   A progress screen appears while the OneInstall installer loads the selected drivers and applications. After the drivers and application software are loaded, an **Installation completed** screen appears.
6. Click **Finish**.

2.1.2 Loading the OneInstall Package using Silent Mode

Silent mode installation must be run from the from a batch file or from the command line.

If you run OneInstall from a batch file or from a command line prompt, the default Windows behavior starts OneInstall, then immediately continues with the next command. It does not wait until OneInstall has finished.

As a result, the value of %ERRORLEVEL% will always be 0, because Windows successfully started OneInstall. It does *not* reflect an accurate OneInstall exit code.

To remedy this, run setup as follows:

```
START /wait OneInstall-Setup-<version>.exe
echo %ERRORLEVEL%
```

The "start /wait" ensures that the command does not return until setup has exited. The value of %ERRORLEVEL% now accurately reflects the OneInstall exit code.

2.1.2.1 Command Format

The format of the command is:

`OneInstall-Setup-<version>.exe  <install-mode>  <options>`

Where:

`<version>` is the version number of the OneInstall package

`<install-mode>` is one of the following:

- `/q0` – (Interactive, non-silent install) This is the default.
- `/q1` – (non-Interactive install) This option displays status pages.
- `/q2` – (Silent install) This option is completely silent, no pages are displayed.
- `/q` – This is the same as `/q1`.

`<options>` specifies the kit, or kits, to install:

`ALL=1` – Install all drivers and the OneCommand Manager application (Default).

NOTE On a CORE system, this will install all drivers and the OneCommand Manager Core Kit.

`ALLCORE=1` – Install all drivers and the OneCommand Manager Core Kit.

`DRIVERS=1` – Install all drivers.

`FC=1` – Install the FC driver only.

`FCOE=1` – Install the FCoE driver only.

`NIC=1` – Install the NIC driver only.

`ISCSI=1` – Install the iSCSI driver only.

`OCM=1` – Install the OneCommand Manager Enterprise Kit only.

NOTE On a CORE system, this will install the OneCommand Manager Core Kit.

`OMCORE=1` – Install the OneCommand Manager Core Kit only.

To install the drivers using Silent mode, perform these steps:

1. Download the OneInstall package from the Broadcom website.
2. Open a DOS window.
3. Change directory to the folder containing your OneInstall package.

The following are examples of Silent mode commands:

```
Start /wait OneInstall-Setup-10.4.94.4.exe  /q2  ALL=1
Start /wait OneInstall-Setup-10.4.94.4.exe  /q2  DRIVERS=1
Start /wait OneInstall-Setup-10.4.94.4.exe  /q2  FCOE=1  NIC=1  OCM=1
Start /wait OneInstall-Setup-10.4.94.4.exe  /q2
Start /wait OneInstall-Setup-10.4.94.4.exe  /q2  ALLCORE=1
Start /wait OneInstall-Setup-10.4.94.4.exe  /q2  OCMCORE=1
```

2.2 Driver Kit Installer

Each driver kit contains and loads all the Windows drivers for a specific protocol, and includes ElxPlus.

- FC driver package (`elxdrvr-fc-<version>.exe`)
- FCoE driver package (`elxdrvr-fcoe-<version>.exe`)
- iSCSI driver package (`elxdrvr-iscsi-<version>.exe`)
- NIC + RoCE driver package (`elxdrvr-nic-<version>.exe`)

NOTE Updating the NIC protocol driver can temporarily disrupt operation of any NIC teams configured on the system.

2.2.1 Loading the Driver Kit

The driver kit copies the selected Emulex drivers and applications onto your computer.

NOTE This procedure does not install drivers, and no driver changes are made until you run the AutoPilot Installer.

To load the driver kit, perform these steps:

1. Download the driver kit from the Broadcom website to your system.
2. Double-click the driver kit to run it.

   The Emulex Kit Welcome page appears.
3. Click **Next**.

The **Installation Options** window appears.

4. Select one or both of the following options:
   - **Perform Installation of Software** – Copies the driver kit for your operating system to your computer.
   - **Unpack All Drivers** – Extracts all drivers to the current user's Documents folder. Select this option to perform boot from SAN installations.

   The **Operation in progress** window shows the kit file loading progress. After the kit files are loaded, the **Installation completed** window appears.
5. If you want to continue with the installation, ensure that Start AutoPilot Installer is checked.

2.3 AutoPilot Installer

AutoPilot Installer runs after the driver kit is loaded and the OneCommand Manager application is installed. AutoPilot Installer can be installed at these times:

- Immediately after the driver kit has been loaded
- At a later time using an interactive installation
- Through an unattended installation

AutoPilot Installer provides the following functions:

- Command line functionality – Initiates an installation from a command prompt or script. Configuration settings can be specified in the command line.
- Compatibility verification – Verifies that the driver to be installed is compatible with the operating system and platform.
- Driver installation and update – Installs and updates drivers.
- Multiple adapter installation capability – Installs drivers on multiple adapters, alleviating the need to manually install the same driver on all adapters in the system.
- Driver diagnostics – Determines whether the driver is operating properly.
- Silent installation mode – Suppresses all screen output (necessary for unattended installation).

NOTE AutoPilot Installer does not allow you to install the driver if the minimum Windows service pack or Microsoft Storport driver update is not installed.

You can install the driver by using any of the following methods:

NOTE These installation methods are not mutually exclusive.

- **Hardware-first installation**. At least one Emulex adapter must be installed before you can install the Emulex drivers and utilities.
- **Software-first installation**. You can install drivers and utilities using AutoPilot Installer prior to the installation of any adapters. You do not need to specify the adapter models to be installed later. The appropriate drivers and utilities automatically load when you install the adapters.
- **Utility-Only installation**. If the drivers in the driver kit share the same version with those already installed on the system, you can reinstall or update the previously installed utility without reinstalling the drivers.
- **Text-Only installation**. Text-based installation mode is used automatically when AutoPilot Installer is run on a Server Core system.
- **Network installation.** You can place the driver kit installers on a shared network drive and install them across your local area network (LAN). Network-based installation is often used with unattended installation and scripting. This allows you to configure and install the same driver and utility versions on all the hosts in a storage area network (SAN).

- **Unattended installation**. You can run the driver kit installers and AutoPilot Installer with no user interaction from a command line or script. Unattended installation works for both hardware-first and software-first installations and all driver kits. An unattended installation operates in Silent mode (also referred to as Quiet mode) and creates an extensive report file with installation status.

NOTE Complete driver and utilities documentation can be downloaded from the Broadcom website (www.broadcom.com).

2.3.1 Starting Installers from a Command Prompt or Script

If a driver kit or an AutoPilot Installer is run from a command prompt or command script (batch file), the Windows command processor does not wait for the installer to run to completion. As a result, you cannot check the exit code of the installer before the next command is executed. Emulex recommends that for command line invocation, always use the "start" command with the "/wait" option. This causes the command processor to wait for the installer to finish before it continues.

For more information on command line installation and configuration parameters, see Section D, AutoPilot Installer Command Line and Configuration File Parameters.

2.3.2 Running a Software Installation Interactively

Two options are available when performing an installation interactively. These options assume you have already downloaded the driver kit from the Broadcom website.

- Option 1 allows you to automatically run the AutoPilot Installer, which completes the driver kit loading and installation with a few mouse clicks.
- Option 2 allows you to run the AutoPilot Installer separately. This option is recommended when:
- Changing installation settings for a limited number of systems
- Familiarizing yourself with AutoPilot Installer configuration options

2.3.2.1 Option 1: Automatically Run the AutoPilot Installer

Use this option unless you have specific configuration needs.

1. Double-click the driver kit or run it from a command line. The command line parameter APargs allows you to specify arguments that are automatically passed to the AutoPilot Installer command.

   A **Welcome** window is displayed with driver kit version information and Emulex contact information (refer to the AutoPilot Installer Command Line and Configuration File Parameters topic in the *Emulex Driver for Windows User Manual* for more information on command line installations).
2. Click **Next** to proceed to the **Installation Options** window.

   For each installation option, the default installation location for that option is displayed. Browse to a different location, if desired.
3. Click **Install** to continue the installation.

   The **Progress** dialog is displayed.

   After all tasks complete, a **Finish** window is displayed. The Start AutoPilot Installer box is automatically selected.
4. Click **Finish**.

   AutoPilot Installer runs automatically and completes one of the following installations:

   — Hardware-First Installation or Driver and Utility Update (page 17).

   — Software-First Installation (page 18).

2.3.2.2 Option 2: Run the AutoPilot Installer Separately

To access these options, run AutoPilot Installer after the driver kit loading has been completed. This allows you to change the configuration options supplied to the AutoPilot Installer (see below).

1. Perform steps 1 through 3 for Option 1: Automatically Run the AutoPilot Installer.
2. Clear the **Run AutoPilot Installer** check box on the **Finish** dialog.
3. Click **Finish**.

   The driver kit installer exits.

After the driver kit loading is complete, change the configuration in one of two ways:

- Change the configuration file.
- Supply parameters on the command line.

> **NOTE** Refer to the AutoPilot Installer Command Line and Configuration File Parameters section in the *Emulex Drivers for Windows User Manual* for more information on either of these configuration methods.

After you have finished this step, you can run AutoPilot Installer at a later time, using either of the following methods:

> **NOTE** If you are supplying options using the command line, you must run AutoPilot Installer from the command line.

- Select **Programs>Emulex>AutoPilot Installer** in the Start menu.
- Run AutoPilot Installer from a command line by running theo following command:

```
C:\Program Files\Emulex\AutoPilot Installer\APInstall.exe
```

> **NOTE** The location of `APInstall.exe` might differ on your system, depending on your system's Program Files location. You can also specify a different location when you install the driver package.

2.3.3 Hardware-First Installation or Driver Update

The driver kit installer must be downloaded from the Broadcom website and installed before performing this installation.

> **NOTE** Updating the NIC protocol driver can temporarily disrupt operation of any NIC teams configured on the system.

> **NOTE** To update the Emulex protocol drivers, begin this procedure at step 2.

To perform a hardware-first installation, perform these steps:

1. Install a new Emulex adapter and power-on the system. If the Windows Found New Hardware wizard is displayed, click **Cancel** to exit; AutoPilot Installer performs this function.

   > **NOTE** If there are multiple adapters in the system, the Windows Found New Hardware wizard appears multiple times. Click **Cancel** to exit the wizard each time it appears.

2. Run AutoPilot Installer using one of the two options listed in Section 2.3.2, Running a Software Installation Interactively.

Consider the following:

- If you are updating the driver, the existing port settings are used, unless otherwise specified in the configuration file. These settings are pre-selected but can be changed. Set or change the settings, then click **Next**.

- If you are initially installing a vendor-specific version of the Emulex driver installation program, a **Driver Configuration** window may be displayed. This window includes one or more windows with questions that you must answer before continuing the installation process. In this case, answer each question and click **Next** on each window to continue.

3. Click **Next**. The installation is completed automatically.

   A dialog is displayed if Windows requires a reboot. After the installation is successful, a **Finish** window appears.

4. View or print a report, if desired.
   - View Installation Report – The installation report is a text file with current Emulex adapter inventory, configuration information, and task results.
   - Print Installation Report – The Windows print dialog is displayed to select options for printing the installation report.
5. Click **Finish** to exit AutoPilot Installer.
6. If the system must be rebooted, you are prompted to do so as indicated in step 3; you must reboot before using the drivers or utilities.

2.3.4 Software-First Installation

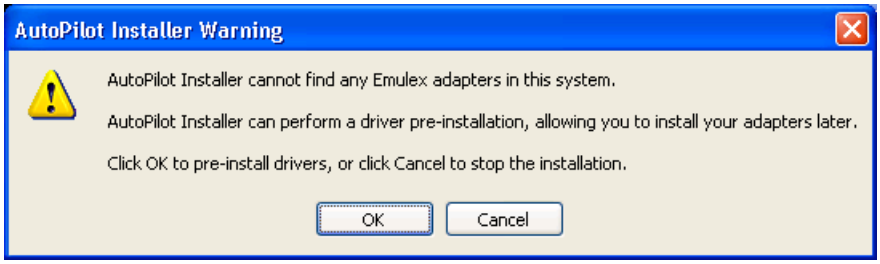
The driver kit must be downloaded from the Broadcom website and loaded. Either the full or core driver package can be installed; only one can be installed on a system.

To perform a software-first installation:

1. Run AutoPilot Installer using one of the two options listed in Section 2.3.2, Running a Software Installation Interactively.

   Figure 1 appears.

Figure 1 AutoPilot Installer Warning (Software-First Installation)



2. Click **OK**.

   A Welcome window appears.

3. Click **Next**. The installation automatically progresses.

   After the installation is successful, the **Finish** window appears.

4. View or print a report, if desired.
   - **View Installation Report** – The installation report is a text file with current Emulex adapter inventory, configuration information, and task results.
   - **Print Installation Report** – The Windows print dialog is displayed to select options for printing the installation report.
5. Click **Finish** to exit AutoPilot Installer.

2.3.5 Text-Only Driver Installation

Text-based Installation mode is used automatically when the driver kit installer runs on a server with the Server Core installation option of Windows Server. During text-based installations, AutoPilot Installer uses a command prompt window. The driver kit installer notifies you when the driver is installed and also gives you an opportunity to stop the installation.

Whether AutoPilot installer is launched from the command line or run as a program, Windows always starts AutoPilot Installer as a separate stand-alone task. This means that AutoPilot Installer has its own command prompt window and cannot access others.

2.3.6 Unattended Driver Installation

An unattended driver installation, sometimes referred to as a quiet or silent installation, requires no user input. This is useful for performing an installation remotely from a command script, or if you want to ensure that a custom configuration is not changed by a user during installation.

If in unattended installation mode, AutoPilot Installer does the following:

- Reads the configuration file
- Reads any options that might be specified on the command line, overriding the configuration file settings as appropriate
- Opens the installation report file
- Validates the operating system
- Discovers adapters and records the adapter inventory in the report file
- Verifies mandatory configuration file parameters
- Searches for drivers to install based on the LocalDriverLocation setting in the configuration file
- Verifies, if appropriate, that the selected driver is either a different type than the currently installed driver or a more recent version of the currently installed driver
- Copies the driver parameters from the configuration file into the registry for the driver's co-installer (FC and FCoE drivers only)
- Installs or updates the driver
- Rediscovers adapters and records the updated adapter inventory in the report file
- Records the final results and closes the report file

An unattended installation can be performed in two ways:

- Install the driver silently.
- Run the driver kit installer separately.

2.3.6.1 Option 1: Install the Driver Silently

Run the driver kit from a command prompt or script. Specify the `/q` (quiet) command line option. For example:

```
elxdrv-fc-fcoe<version>.exe /q
```

NOTE The name of the driver kit depends on the current version identifier. For other command line options, see AutoPilot Installer Command Line and Configuration File Parameters on page 148.

2.3.6.2 Option 2: Run the Driver Kit Installer Separately

1. Follow steps 1to3 from Section 2.3.2, Running a Software Installation Interactively.
2. Clear the **Run AutoPilot Installer** check box on the Finish dialog.

3. Choose one of the following options:
   - Run the AutoPilot Installer from a command prompt or script with the silent option:
     ```
     APInstall.exe /silent
     ```
   - Edit the AutoPilot Installer configuration file before running AutoPilot Installer. The configuration file is typically located in:
     ```
     C:\Program Files\Emulex\AutoPilot Installer\<driver type>\APInstall.cfg
     ```

   Uncomment the line that sets "SilentInstallEnable" to "True". You may also want to edit other settings in the same section of the configuration file related to unattended installations. See Software Configuration Parameters on page 150 for more information. After editing the file, you can run the AutoPilot Installer from the Start menu, a command prompt, or a script.

2.3.7 Installation Failure

If the installation fails, the Diagnostics window is displayed with the adapter that failed.

If the adapter fails, perform these steps:

1. Select the adapter to view the reason for the failure.

   The reason and suggested corrective action are displayed.
2. Perform the suggested corrective action and run AutoPilot Installer again.

NOTE You can run AutoPilot Installer again from the Start menu (**Programs>Emulex>AutoPilot Installer**) or you can run APInstall.exe from a command prompt.

2.4 Manually Installing or Updating the Emulex Protocol Drivers

You can install or update the Emulex protocol drivers and utilities manually without using AutoPilot Installer.

The ElxPlus driver supports the OneCommand Manager application, persistent binding, and LUN mapping and masking.

NOTE The ElxPlus driver must be installed before you install the Emulex protocol drivers.

2.5 Installing the Emulex PLUS (ElxPlus) Driver for the First Time

NOTE Only one instance of the ElxPlus driver must be installed, even if you have multiple adapter ports installed in your system.

To install the ElxPlus driver from the desktop, perform these steps:

1. Run the driver kit installer, but do not run AutoPilot Installer. See Section 2.3.2, Running a Software Installation Interactively for instructions.
2. Select **Start>Settings>Control Panel>Add Hardware**. The Add Hardware Wizard window appears. Click **Next**.
3. Select **Yes, I have already connected the hardware** and click **Next**.
4. Select **Add a new hardware device** and click **Next**.
5. Select **Install the hardware that I manually select from a list (Advanced)** and click **Next**.

6. Select **Show All Devices** and click **Next**.
7. Click **Have Disk** and direct the Device Wizard to the location of `elxplus.inf`. If you have installed the driver installer kit in the default folder and `C:\` is your Windows system drive, the path is:

   ```
   C:\Program Files\Emulex\AutoPilot Installer\Drivers\Storport\x64\HBA
   ```
8. Click **OK**.
9. Select **Emulex PLUS**. Click **Next** and click **Next** again to install the driver.
10. Click **Finish**.

    The initial ElxPlus driver installation has completed. Continue with manual installation of the Storport Miniport Driver. Refer to Section 2.5.2, Installing or Updating the FC/FCoE Storport Miniport Driver for this procedure.

2.5.1 Updating the Emulex PLUS (ElxPlus) Driver

NOTE Only one instance of the ElxPlus driver must be installed, even if you have multiple adapter ports installed in your system.

To update an existing ElxPlus driver from the desktop, perform these steps:

1. Run the driver kit installer, but do not run AutoPilot Installer. See Section 2.3.2, Running a Software Installation Interactively for instructions.
2. Select **Start>Settings>Control Panel>Administrative Tools>Computer Management**.
3. Click **Device Manager** (left pane).
4. Click the plus sign **(+)** next to the Emulex PLUS class (right pane) to show the ElxPlus driver entry.
5. Right-click the ElxPlus driver entry and select **Update Driver** from the menu.
6. Select **No, not this time**. Click **Next** on the Welcome to the Hardware Update Wizard window. Click **Next**.
7. Select **Install from a list or specific location (Advanced)** and click **Next**.
8. Select **Don't Search. I will choose the driver to install**.
9. Click **Have Disk** and direct the Device Wizard to the location of the driver's distribution kit. If you have installed the driver installer kit in the default folder, the path is:

   ```
   C:\Program Files\Emulex\AutoPilot Installer\Drivers\Storport\x64
   ```
10. Click **OK**. Select Emulex PLUS.
11. Click **Next** to install the driver.
12. Click **Finish**.

    The ElxPlus driver update is finished. Continue with the manual installation of the Storport Miniport Driver.

2.5.2 Installing or Updating the FC/FCoE Storport Miniport Driver

To update or install the FC/FCoE Storport Miniport driver from the desktop, perform these steps:

1. Select **Start>Settings>Control Panel>System**.
2. Select the Hardware tab.
3. Click **Device Manager**.
4. Open the SCSI and RAID Controllers item.
5. Double-click the desired Emulex adapter.

NOTE The driver affects only the selected adapter. If there are other adapters in the system, you must repeat this process for each adapter. All dual-channel adapter models are displayed in Device Manager as two adapters, and each adapter must be updated.

6. Select the Driver tab.
7. Click **Update Driver**. The Update Driver wizard starts.
8. Select **No, not this time**. Click **Next** on the Welcome to the Hardware Update Wizard window.
9. Select I**nstall from a list or specific location (Advanced)** and click **Next**.
10. Select **Don't search. I will choose the driver to install** and click **Next**.

NOTE Using the `OEMSETUP.INF` file to update Emulex's FC/FCoE Storport Miniport driver overwrites customized driver settings. If you are updating from a previous installation, write down the settings. Following the installation, use the OneCommand Manager application to restore the previous settings.

11. Click **Have Disk** and direct the Device Wizard to the location of `oemsetup.inf`. If you have installed the driver installer kit in the default folder, the path is:

```
C:\Program Files\Emulex\AutoPilot Installer\FC(or
FCoE)\Drivers\Storport\x64\HBA
```

12. Click **OK**. Select Emulex LightPulse LPX000, PCI Slot X, Storport Miniport Driver (your adapter model is displayed here).
13. Click **Next**.
14. Click **Finish**.

    The driver installation has completed. The driver will start automatically. If the adapter is connected to a SAN or data storage device, a blinking yellow light on the back of the adapter indicates a link up condition.

2.5.3 Installing or Updating the iSCSI Driver

To update or install the iSCSI driver from the desktop, perform these steps:

1. Select **Start>Settings>Control Panel>System**.
2. Select the Hardware tab.
3. Click **Device Manager**.
4. Open the “SCSI and RAID Controllers” item.
5. Double-click the desired Emulex adapter.
6. Select the Driver tab.
7. Click **Update Driver**. The Update Driver wizard starts.
8. Select **No, not this time**.
9. Click **Next** on the Welcome to the Hardware Update Wizard window.

NOTE The driver affects only the selected adapter. If there are other adapters in the system, you must repeat this process for each adapter. All dual-channel adapter models are displayed in Device Manager as two adapters; therefore, you must update each adapter.

10. Select I**nstall from a list or specific location (Advanced)** and click **Next**.
11. Select **Don't search. I will choose the driver to install** and click **Next**.
12. Click **Have Disk** and direct the Device Wizard to the location of `be2iscsi.inf`. If you have installed the driver installer kit in the default folder, the path is:

```
C:\Program Files\Emulex\AutoPilot
Installer\iSCSI\Drivers\Storport\x64\[Windows Version]
```

13. Click **OK**. Select Emulex OneConnect OCm<*your adapter model*>, iSCSI Initiator.
14. Click **Next**.

15. Click **Finish**.

    The driver installation has completed. The driver will start automatically.

2.5.4 Installing or Updating the NIC Driver

NOTE The Microsoft patch KB2846340 must be installed on your system. This patch, from Microsoft's Knowledge Base (KB), is available for Windows Server 2012, Windows Server 2008 R2, and Windows Server 2008 SP2 on the Microsoft website.

2.5.4.1 Installing or Updating the NIC Driver on Windows Server 2008

1. Select **Start>Settings>Control Panel>Device Manager**.
2. Open the Network Adapters item.
3. Double-click the desired Emulex adapter.
4. Select the Driver tab.
5. Click **Update Driver**.

   The Update Driver wizard starts.
6. Click **Browse my computer** for driver software.

   NOTE The driver affects only the selected adapter. If there are other adapters in the system, you must repeat this process for each adapter. All dual-channel adapter models are displayed in the Device Manager as two adapters, therefore, you must update each adapter.
7. Click **Let me pick from a list of device drivers on my computer** and click **Next**.
8. Select the network adapter that matches your hardware and click **Have Disk**.
9. Direct the Device Wizard to the location of `be2nd6x.inf`.

   If you have installed the driver installer kit in the default folder, the path is:

   ```
   C:\Program Files\Emulex\AutoPilot Installer\NIC\Drivers\NDIS\x64\Win2008
   ```
10. Click **OK**.

    The Windows Security dialog box opens.
11. Click **Install**.
12. After the device driver finishes installing, click **Close**.

    The driver installation is completed. The driver will start automatically.

2.5.4.2 Installing or Updating the NIC Driver on Windows Server 2012

1. Select **Server Manager>Dashboard>Tools>Computer Management>Device Manager**.

   NOTE Server Manager is set to open by default when booting Windows Server 2012. If it does not open automatically, you can open it with the Server Manager icon at the bottom left of the screen.
2. Open the Network Adapters item.
3. Double-click the desired Emulex adapter.
4. Select the Driver tab.
5. Click **Update Driver**.

   The Update Driver wizard starts.
6. Click **Browse my computer for driver software**.

The driver affects only the selected adapter. If there are other adapters in the system, you must repeat this process for each adapter. All dual-channel adapter models are displayed in the Device Manager as two adapters, therefore, you must update each adapter.

7. Click **Let me pick from a list of device drivers on my computer**.
8. Select the network adapter that matches your hardware and click **Have Disk**.
9. Direct the Device Wizard to the location of `ocnd63.inf`. Select the desired `oemsetup.inf` file and click **Open**.

   If you have installed the driver installer kit in the default folder, the path is:

   ```
   C:\Program Files\Emulex\AutoPilot Installer\Drivers\NDIS\x64\NIC\Win2012
   ```
10. Click **Next**.
11. After the device driver finishes installing, click **Close**.

    The driver installation has completed. The driver will start automatically.

2.5.4.3 The Emulex iSCSI Crash Dump Driver (OCe14000-Series Adapters Only)

When you install the Emulex NIC driver, you can choose to also install the Emulex iSCSI crash dump driver (also referred to as the iSCSI Boot Firmware Table (iBFT) crash dump driver). The Emulex iSCSI crash dump driver is intended only for crash dump/hibernation and is not loaded during a normal boot for regular network operations. The Emulex iSCSI crash dump driver is named `ocibftcd`.

Because the Emulex iSCSI crash dump driver is a special driver used only for dump, the driver cannot be installed using Windows Device Manager. The driver is provided as an installation option in all the Emulex driver installer utilities.

When running the NIC Driver Kit in silent mode, add the `crashdriver=1` parameter to enable the Emulex iSCSI Crash Dump Driver, (The default is 0.) For example:

```
start /wait elxdrvr-nic-<version>.exe /q2 crashdriver=1
```

When running OneInstall in silent mode, add the `ibft=1` parameter to enable the Emulex iSCSI Crash Dump Driver. (The default is 0.) For example:

```
start /wait OneInstall-Setup-<version>.exe /q2 ibft=1
```

NOTE The Emulex iSCSI crash dump driver is not supported on 32-bit, IA64, ARM systems and is not supported on Windows Server 2008 systems.

NOTE Supported only OCe14000-series adapters on systems that support booting into Windows using iBFT configuration.

2.5.4.3.1 Supported Configurations

The dump miniport driver does not support network configurations on its own. The driver works with any iBFT configuration setting used to successfully boot into Windows. The supported network configurations are listed in Table 1 on page 25.

Table 1 Supported Network Configurations

Network Configurations	Supported
Crash dump modes	Small Memory Dump Kernel Memory Dump Complete Memory Dump
Internet protocol options	IPv4 IPv6 Autoconfigure
IP configuration methods	Static IP DHCP
Port configuration	Supported on any physical port used to boot into the system.
MTU settings	1514 bytes. However, the actual iSCSI boot may have occurred over a connection that used jumbo MTUs.
MPIO configuration	Yes
Target discovery	Retrieved either through explicit configuration in iBFT menu or using DHCP.
iSCSI Login redirection	Supports targets that enable iSCSI Login redirection.
Boot LUN Id	Supports crash dump on any LUN ID.

2.6 Removing Emulex Driver Kits and Drivers

This section details procedures to uninstall the driver kits.

2.6.1 Uninstalling Emulex Driver Kits

NOTE If you uninstall the Emulex driver kit, AutoPilot Installer is automatically uninstalled.

2.6.1.1 Uninstalling an Emulex Driver Kit on Windows Server 2008

To uninstall a driver kit on a Windows Server 2008 system, perform these steps:

1. Open the **Programs and Features** control panel.
2. Select one of the following in the program list and click the **Uninstall** icon in the tool bar above the program list. If you have User Access Control enabled, click **Continue** when asked for permission.
   - `Emulex FC kit-2.xx.xxx`
   - `Emulex/FCoE kit-2.xx.xxx`
   - `Emulex/NIC 4.xx.xxx`
   - `Emulex/iSCSI kit-4.xx.xxx`
3. Click **Yes** when prompted to remove the kit. After the kit is removed from the system, click **OK**.

2.6.1.2 Uninstalling an Emulex Driver Kit on a Server Core System

To uninstall a driver kit on a Server Core system, perform these steps:

1. From the system prompt, navigate to the Program Files folder.
2. Navigate to Emulex\AutoPilot Installer.
3. Run the following batch files:
   - `Uninstall_fc_kit.bat`
   - `Uninstall_cna_kit.bat`
   - `Uninstall_nic_kit.bat`
   - `Uninstall_iscsi_kit.bat`

The driver files are removed from the system.

On all platforms, the reports folder in the "Emulex\AutoPilot Installer" folder is not removed, so you can still view installation history and the drivers that have been installed on the system. You can delete the reports folder at any time.

2.6.1.3 Uninstalling an Emulex Driver Kit on Windows Server 2012

To uninstall a driver kit on a Windows Server 2012 system, perform these steps:

1. Select **Start>Control Panel**.
2. From the Control Panel, select **Programs>Uninstall a Program**.
3. Select one of the following in the program list and click the **Uninstall** icon in the tool bar above the program list. If you have User Access Control enabled, click **Continue** when asked for permission.
   - `Emulex FC kit-2.xx.xxx`
   - `Emulex/FCoE kit-2.xx.xxx`
   - `Emulex/NIC 4.xx.xxx`
   - `Emulex/iSCSI kit-4.xx.xxx`
4. Click **Yes** when prompted to remove the kit. After the kit is removed from the system, click **OK**.

2.6.1.3.0.1 Uninstalling an Emulex Driver Kit on a Server Core System

To uninstall a driver kit on a Server Core system, perform the following steps:

1. From the system prompt, navigate to the Program Files folder.
2. Navigate to Emulex\AutoPilot Installer.
3. Run the following batch files:
   - `Uninstall_fc_kit.bat`
   - `Uninstall_cna_kit.bat`
   - `Uninstall_nic_kit.bat`
   - `Uninstall_iscsi_kit.bat`

The driver files are removed from the system.

On all platforms, the reports folder in the `Emulex\AutoPilot` Installer folder is not removed, so you can still view installation history and the drivers that have been installed on the system. You can delete the reports folder at any time.

2.6.2 Uninstalling the Emulex Drivers

The Emulex Storport Miniport and ElxPlus drivers are uninstalled using the Device Manager.

2.6.2.1 Uninstalling an Emulex Drivers on Windows Server 2008

NOTE On Windows 2008, after the message `Warning - you are about to uninstall this device from your system` is

displayed, you must select **Delete the software for this device** to uninstall the driver.

2.6.2.1.1 Uninstalling an Emulex Storport Miniport Driver

To uninstall the Emulex Storport Miniport driver, perform the following steps:

1. Select **Start>All Programs>Administrative Tools>Computer Management**.
2. Click **Device Manager**.
3. Double-click the adapter from which you want to remove the Storport Miniport driver. A device-specific console window is displayed. Select the Driver tab.
4. Click **Uninstall** and click **OK** to uninstall.

2.6.2.1.2 Uninstalling an ElxPlus Driver

NOTE Uninstall the ElxPlus driver only if all adapters and installations of Emulex miniport drivers are uninstalled.

To uninstall the ElxPlus driver, perform the following steps:

1. Select **Start>All Programs>Administrative Tools>Computer Management**.
2. Click **Device Manager**.
3. Click the plus sign **(+)** next to the Emulex PLUS driver class.
4. Right-click the Emulex driver and click **Uninstall**.
5. Click **OK** in the Confirm Device Removal window.

2.6.2.1.3 Uninstalling Older Versions of the Emulex Storport Miniport Driver

To uninstall or update an earlier version of the Storport Miniport driver (prior to version 1.20), you must remove the registry settings for the adjunct driver prior to manually installing a new driver.

CAUTION Use the registry editor at your own risk. Using the registry editor can cause serious issues that may require you to reinstall the computer's operating system. Emulex cannot guarantee that issues resulting from changes you make to the registry can be repaired. Make a backup of your registry before making any changes.

To remove the adjunct driver registry settings, perform the following steps:

1. Browse to the Storport Miniport driver version 1.20 (or later) driver kit that you downloaded and extracted.
2. Double-click on the `deladjct.reg` file. A Registry Editor window appears to confirm that you want to run `deladjct.reg`.
3. Click **Yes**. The elxadjct key is removed from the registry.

2.6.2.2 Uninstalling the Emulex Driver on Windows Server 2012

The Emulex Storport Miniport and ElxPlus drivers are uninstalled using the Device Manager.

NOTE On Windows 2012 and Windows 2012 R2, after the message `Warning - you are about to uninstall this device from your system` is displayed, you must select the checkbox **Delete the software for this device** to uninstall the driver.

2.6.2.2.1 Uninstalling the Emulex Storport Miniport Driver

To uninstall the Emulex Storport Miniport driver in Windows Server 2012, perform the following steps:

1. Select **Server Manager>Dashboard>Tools>Computer Management>Device Manager**.
2. Double-click the adapter from which you want to remove the Storport Miniport driver. A device-specific console window is displayed.
3. Select the Driver tab.
4. Click **Uninstall** and click **OK** to uninstall.

2.6.2.2.2 Uninstalling the ElxPlus Driver

NOTE Uninstall the ElxPlus driver only if all adapters and installations of Emulex miniport drivers are uninstalled.

To uninstall the ElxPlus driver, perform the following steps.

1. Select **Server Manager>Dashboard>Tools>Computer Management>Device Manager**.
2. Click the plus sign (**+**) next to the Emulex PLUS driver class.
3. Right-click the Emulex driver and click **Uninstall**.
4. Click **OK** in the Confirm Device Removal window.

Chapter 3: Configuration

NOTE For information on configuring profile management, refer to the *OneCommand Manager Application User Manual* or the *OneCommand Manager Command Line Interface User Manual*.

3.1 FC/FCoE Driver Configuration

The Emulex Storport Miniport driver has many options that you can modify to provide different behavior. You can set Storport Miniport driver parameters using the OneCommand Manager application. Refer to the *OneCommand Manager Application User Manual* for information on using this utility to configure the driver.

3.1.1 Configuring FC Driver Parameters

Table 2, Storport Miniport Driver Parameters, provides information such as the allowable range of values and factory defaults. Parameters can be entered in decimal or hexadecimal format.

A parameter has one of the following activation requirements:

- Dynamic – The change takes effect while the system is running.
- Reset – An adapter reset from the utility is required before the change takes effect.
- Reboot – A reboot of the entire machine is required before the change takes effect. In this case, you are prompted to perform a reboot when you exit the utility.

NOTE If you are creating custom unattended installation scripts, any driver parameter can be modified and included in the script.

NOTE If the Adapter/Protocol column is blank, the parameter is supported on both LightPulse and OneConnect adapters. “LightPulse only” indicates that the parameters is supported only on LightPulse adapters. “FC only” indicates that the parameters is supported on LightPulse and non-LightPulse FC adapters.

NOTE The Windows driver enumerates 1024 targets across all physical and virtual ports with 8G Fibre Channel and 16G Fibre Channel adapters. However, setting ConfigScale to 0 changes the support to 128 targets. See “`ConfigScale`” in Table 2.

Most parameters default to a setting that optimizes adapter performance.

Table 2 Storport Miniport Driver Parameters

Parameter	Definitions	Activation Requirement	Adapter/Protocol
`AutoMap=n`	`AutoMap` controls the way targets are assigned SCSI IDs. Discovered targets are assigned persistent SCSI IDs according to the selected binding method. Persistent bindings do not take effect with the driver in stand-alone mode. ■ `0` = automap is disabled. The OneCommand Manager application persistently sets the SCSI address of a discovered FCP-capable FC node (target). ■ `1` = automap by WWNN. ■ `2` = automap by WWPN. ■ `3` = automap by DID. Value: 0–3 Default = 2	Reboot	
`Class=n`	`Class` selects the class of service on FCP commands. ■ If set to `2`, class = 2. ■ If set to `3`, class = 3. Value: 2–3 Default = 3	Dynamic	FC Only
`CoalesceMsCnt=n`	`CoalesceMsCnt` specifies wait time in milliseconds to generate an interrupt response if CoalesceRspCnt has not been satisfied. Zero specifies an immediate interrupt response notification. A non-zero value enables response coalescing at the specified interval in milliseconds. Value: 0–63 (decimal) or 0x0–0x3F (hexadecimal) Default = 0 (0x0)	Reset	LightPulse Only
`CoalesceRspCnt=n`	`CoalesceRspCnt` specifies the number of response entries that trigger an interrupt response. Value: 0–255 (decimal) or 0x1–0xFF (hexadecimal) Default = 8 (0x8)	Reset	LightPulse Only

Table 2 Storport Miniport Driver Parameters (Continued)

Parameter	Definitions	Activation Requirement	Adapter/Protocol
`ConfigScale`	`ConfigScale` sets the memory footprint profile in accord with the anticipated use case on a per port basis. While the default value is 4, a value of 1 is considered to be the typical use case. The ConfigScale parameter supersedes the ExtTransferSize parameter for OneConnect adapters. For OneConnect adapters: For all values except 0, up to 1024 targets can be discovered and mapped. If ConfigScale= 0, only 128 targets can be discovered and mapped. A value of 0 limits the maximum XRIs to 512. **NOTE** Use ConfigScale = 0 to minimize the driver's per-port memory foot print. If ConfigScale is set to ■ `0` – The maximum transfer size is limited to 500 KB. ■ `1` – The maximum transfer size is limited to 1012 KB. ■ `2` – The maximum transfer size is limited to 2036KB. ■ Use `ConfigScale = 2` if connecting to tape devices. ■ `3` – The maximum transfer size is limited to 2036KB, which is the best setting if you are running performance benchmarks in a non-production environment. ■ `4` – The maximum transfer size is limited to 512KB. Emulex 16GFC adapters: `ConfigScale` is always set at 4. The maximum transfer size is set according to the value of the 'ExtTransferSize' parameter. Values: 0, 1, 2, 3, and 4 Default = 4 **NOTE** For Emulex 16GFC adapters, only the value of 4 is valid.	Reboot	OneConnect and Emulex 16GFC adapters
`DiscoveryDelay=n`	`DiscoveryDelay` controls whether the driver waits for 'n' seconds to start port discovery after link up. ■ If set to `0` = immediate discovery after link up. ■ If set to `1` or `2` = the number of seconds to wait after link-up before starting port discovery. Value: 0–2 seconds (decimal) Default = 0.	Dynamic	

Table 2 Storport Miniport Driver Parameters (Continued)

Parameter	Definitions	Activation Requirement	Adapter/Protocol
DriverTraceMask	The DriverTraceMask parameter is only available on operating systems that support extended system event logging. ■ If set to 0 = the parameter is disabled. ■ If set to 1 = error events logging is enabled. ■ If set to 4 = warning events logging is enabled. ■ If set to 8 = informational events logging is enabled. The values can be masked to generate multi-levels of events logging. Values: 0, 1, 4, and 8. Default = 0.	Dynamic	
EnableAck0=n	Set to 1 to force sequence rather than frame level acknowledgement for class 2 traffic over an exchange. This applies to FCP data exchanges on IREAD and IWRITE commands. Value: 0–1 (decimal) Default = 1	Reset	FC only
EnableAUTH	EnableAUTH enables fabric authentication. This parameter requires the authentication to be supported by the fabric. Authentication is enabled if this value is set to 1. Value: 0–1 Default = 0	Reboot	FC only (up to and including 8 Gb)
EnableFDMI=n	If set to 1, enables management server login on fabric discovery. This allows FDMI to operate on switches that have FDMI-capable firmware. FDMI operates as FDMI-1. If set to 2, FDMI operates as FDMI-2. Value: 0–2 (decimal) Default = 0	Reset	
EnableNPIV=n	If set to 1, enables NPIV. Requires NPIV supported firmware for the adapter. Value: 0–1 Default = 0 (disabled) **NOTE** To run the driver using NPIV or SLI-3 optimization, the firmware version must be 2.72a0 or later. If an earlier version is used, the driver runs in SLI-2 mode and does not support NPIV. **NOTE** NPIV is not available on 1GFC and 2GFC adapters.	Reboot	
EnableXLane	EnableXLane enables Express Lane. If set to 1, enables the driver to set the CS_CTL priority according to the value of XLanePriority driver parameter. Value: 0-1 Default = 0	Reboot	16GFC and 32GFC adapters

Table 2 Storport Miniport Driver Parameters (Continued)

Parameter	Definitions	Activation Requirement	Adapter/Protocol
XLanePriority	Express Lane CS_CTL priority value. Refer to the switch vendor administration guide to set the value. Value: 0 - 7F (hexadecimal) Default = 0	Dynamic	
ExtTransferSize	ExtTransferSize is an initialization-time parameter that affects the maximum SGL that the driver can handle, which determines the maximum I/O size that a port will support. ■ If set to 0 = The maximum default transfer size is 512KB for all controller models. ■ If set to 1= The maximum transfer size is 1MB. ■ If set to 2 = The maximum transfer size is 2MB. ■ If set to 3 = The maximum transfer size is 4MB. Value: 0–3 Default = 0 (disabled)		LightPulse adapters only including LPe15000 and LPe16000 HBAs
FrameSizeMSB=n	FrameSizeMSB controls the upper byte of receive FrameSize if issued in PLOGI. This allows the FrameSize to be constrained on 256-byte increments from 256 (1) to 2048 (8). Value: 0–8 Default = 0	Reset	
InitTimeout=n	Determines the number of timeout seconds during driver initialization for the link to come up. If the link fails to come up by InitTimeout, driver initialization exits but is still successful. If the link comes up before InitTimeout, the driver sets double the amount for discovery to complete. Value: 5–30 seconds or 0x5–0x1E (hexadecimal) Default = 15 seconds (0xF)	Reboot	
LimTransferSize	Limits the maximum transfer size to selectable values if this parameter is nonzero. Values: ■ 0 = Port (default) ■ 1 = 64Kb ■ 2 = 128Kb ■ 3 = 256Kb	Reboot	

Table 2 Storport Miniport Driver Parameters (Continued)

Parameter	Definitions	Activation Requirement	Adapter/Protocol
LinkSpeed=n	LinkSpeed has significance only if the adapter supports speeds other than 1 Gb/s. Value: Auto-select, 1Gb/s, 2Gb/s, 4Gb/s, 8Gb/s, 16Gb/s, and 32Gb/s Default = Auto-select **NOTE** Setting this option incorrectly can cause the adapter to fail to initialize. **NOTE** If you configure the link speed in a BIOS utility, the link speed might be overridden by the Emulex driver for Windows according to its LinkSpeed setting. To avoid this issue, configure the link speed in both the Emulex driver for Windows and the Boot BIOS or UEFI driver.	Reset	FC Only
LinkTimeOut=n	LinkTimeOut applies to a private loop only. A timer is started on all mapped targets using the link timeout value. If the timer expires before discovery is resolved, commands issued to timed-out devices returns a SELECTION_TIMEOUT. The Storport driver is notified of a bus change event, which leads to the removal of all LUNs on the timed-out devices. Value: 1–500 seconds or 0x0–0xFE (hexadecimal) Default = 30 (0x1E)	Dynamic	
LogErrors=n	LogErrors determine the minimum severity level required to enable entry of a logged error into the system event log. Errors are classified as severe, malfunction, or command level. A severe error requires user intervention to correct a firmware or adapter issue. An invalid link speed selection is an example of a severe error. A malfunction error indicates a system problem, but user intervention is not required. An invalid fabric command type is an example of a malfunction error. An object allocation failure is an example of a command error. ■ If set to 0 = all errors are logged. ■ If set to 1 = command level errors are logged. ■ If set to 2 = malfunction errors are logged. ■ If set to 3 = severe errors are logged. Value: 0–3 Default = 3	Dynamic	
NodeTimeout=n	The node timer starts when a node (that is, a discovered target or adapter) becomes unavailable. If the node fails to become available before the NodeTimeout interval expires, the operating system is notified so that any associated devices (if the node is a target) can be removed. If the node becomes available before NodeTimeout expires, the timer is canceled and no notification is made. Value: 1–255 seconds or 0x0–0xFF (hexadecimal) Default = 30 (0x1E)	Dynamic	

Table 2 Storport Miniport Driver Parameters (Continued)

Parameter	Definitions	Activation Requirement	Adapter/Protocol
QueueDepth=n	QueueDepth requests per LUN/target (see the QueueTarget parameter). If you expect the number of outstanding I/Os per device to exceed 32, then you must increase to a value greater than the number of expected I/Os per device (up to a value of 254). If the QueueDepth value is set too low, a performance degradation can occur due to driver throttling of its device queue. QueueDepth supports more than 1000 outstanding commands per port. Value: 1–254 or 0x1–0xFE (hexadecimal) Default = 32 (0x20)	Dynamic	
QueueTarget=n	QueueTarget controls I/O depth limiting on a per-target or per LUN-basis. ■ If set to 0 = depth limitation is applied to individual LUNs. ■ If set to 1 = depth limitation is applied across the entire target. Value: 0–1 or 0x0–0x1 (hexadecimal) Default = 0 (0x0)	Dynamic	
RmaDepth=n	RmaDepth sets the remote management buffer queue depth. The greater the depth, the more concurrent management controls can be handled by the local node. Value: 8–64, or 0x8–0x40 (hexadecimal) Default = 16 (0x10) **NOTE** The RmaDepth driver parameter pertains to the functionality of the OneCommand Manager application.	Reboot	
ScanDown=n	■ If set to 0 (= lowest AL_PA) = lowest physical disk (ascending AL_PA order). ■ If set to 1 (= highest AL_PA) = lowest physical disk (ascending SEL_ID order). Value: 0–1 **NOTE** Default = 1 **NOTE** This option applies to private loop only in DID mode.	Reboot	FC Only
SLIMode=n	■ If set to 0 = autoselect firmware, use the latest firmware installed. ■ If set to 2 = implies running the adapter firmware in SLI-2 mode. ■ If set to 3 = implies running the adapter firmware in SLI-3 mode. Value: 0, 2, and 3 Default = 0	Reboot	LightPulse Only

Table 2 Storport Miniport Driver Parameters (Continued)

Parameter	Definitions	Activation Requirement	Adapter/Protocol
SrbTimeout	SrbTimeout limits the SCSI timeout value to 60 seconds if set to 1 or enabled. This parameter is a non-displayed parameter that must be set manually in the registry. This option alters the I/O timeout behavior, where an I/O will be returned in a maximum timeout of 60 seconds on long I/O timeouts. ■ If set to 1 = Enabled ■ If set to 0 = Disabled Values: 0, 1 Default = 0		
Topology=n	Topology values can be 0–3. ■ If set to 0 (0x0) = FC-AL. ■ If set to 1 (0x1) = PT-PT fabric. ■ If set to 2 (0x2) = *FC-AL first, then attempt PT-PT. ■ If set to 3 (0x3) = *PT-PT fabric first, then attempt FC-AL. * Topology fail-over requires firmware version v3.20 or higher. If the firmware does not support topology failover, options 0,2 and 1,3 are analogous.8 Value: 0–3 Default = 2 (0x2)	Reset	FC Only
TraceBufSiz=n	TraceBufSiz sets the size in bytes for the internal driver trace buffer. The internal driver trace buffer acts as an internal log of the driver's activity. Value: 250,000–2,000,000 or 0x3D090–0x1E8480 (hexadecimal). Default = 250,000 (0x3D090)	Reboot	
XLanePriority	Express Lane CS_CTL priority value. Refer to the switch vendor administration guide to set the value. Value: 0 - 7F (hexadecimal) Default = 0	Dynamic	

3.1.2 Server Performance with FC Drivers

3.1.2.1 I/O Coalescing

I/O Coalescing is enabled and controlled by two driver parameters: CoalesceMsCnt and CoalesceRspCnt. The effect of I/O Coalescing depends on the CPU resources available on the server. With I/O Coalescing turned on, interrupts are batched, which reduces the number of interrupts and maximizes the number of commands processed with each interrupt. For heavily loaded systems, this provides better throughput.

With I/O Coalescing turned off (the default setting), each I/O processes immediately, one CPU interrupt per I/O. For systems with light loads, the default setting provides better throughput. Table 3 shows recommendations based upon the number of I/Os per adapter.

Table 3 Recommended Settings for I/O Coalescing

I/Os per Second	Suggested CoalesceMsCnt	Suggested CoalesceRspCnt
I/Os < 10000	0	8
10000 < I/Os < 18000	1	8
18000 < I/Os < 26000	1	16
I/Os > 26000	1	24

3.1.2.1.1 CoalesceMsCnt

The `CoalesceMsCnt` parameter controls the maximum elapsed time in milliseconds that the adapter waits before it generates a CPU interrupt. The value range is 0–63 (decimal) or 0x0–0x3F (hexadecimal). The default is 0 and disables I/O Coalescing.

3.1.2.1.2 CoalesceRspCnt

The `CoalesceRspCnt` parameter controls the maximum number of responses to batch before an interrupt generates. If `CoalesceRspCnt` expires, an interrupt generates for all responses collected up to that point. With `CoalesceRspCnt` set to less than 2, response coalescing is disabled, and an interrupt triggers for each response. The value range for CoalesceRspCnt is 1–255 (decimal) or 0x1–0xFF (hexadecimal). The default value is 8.

NOTE A system restart is required to make changes to `CoalesceMsCnt` and `CoalesceRspCnt`.

3.1.2.2 Performance Testing

Three driver parameters must be considered (and perhaps changed from the default) for better performance testing: `QueueDepth`, `CoalesceMsCnt`, and `CoalesceRspCnt`.

3.1.2.2.1 QueueDepth

If the number of outstanding I/Os per device is expected to exceed 32, increase this parameter to a value greater than the number of expected I/Os per device, to a maximum of 254. The `QueueDepth` parameter defaults to 32. If the default setting is not a high enough value, performance degradation might occur due to Storport throttling its device queue.

3.1.2.2.2 CoalesceMsCnt

`CoalesceMsCnt` defaults to zero. If you are using a performance evaluation tool, such as IOMETER, and if you expect the I/O activity to be greater than 8000 I/Os per second, set `CoalesceMsCnt` to 1 and reset the adapter or reboot the system.

3.1.2.2.3 CoalesceRspCnt

`CoalesceRspCnt` defaults to 8. For all other values up to the maximum of 63, the adapter does not interrupt the host with a completion until either `CoalesceMsCnt` milliseconds has elapsed or `CoalesceRspCnt` responses are pending. The value of these two driver parameters reduces the number of interrupts per second, which improves overall CPU utilization. However, a point exists where the number of I/Os per second is small relative to `CoalesceMsCnt`, and this situation will slow down the completion process, causing performance degradation.

3.1.2.2.4 Examples

Test scenario 1:

- IOMETER is running with an I/O depth of 1 I/O per device in a small-scale configuration (16 devices). In this case, the test does not exceed the adapter's performance limits and the number of I/Os per second are in the low thousands.
- Recommendation: Set `CoalesceMsCnt` to 0 (or use the default value).

Test scenario 2:

- IOMETER is running with an I/O depth of 48 I/Os per device in a small-scale configuration (16 devices).
- Recommendation: Set `QueueDepth` to be greater than 48 (for example, 64).

3.2 NIC Driver Configuration

TOE is supported and enabled by default.

NOTE TOE is not supported on LPe16202 CNAs and OCe14000-series adapters.

3.2.1 Configuring NIC Driver Options

The Windows Server NIC driver supports configurable driver options through the Advanced Property page in the Windows Device Manager. For information on how to configure the options through the Advanced Property page, refer to Section 3.2.2.1, Modifying Advanced Properties.

For more information on NIC driver options, see Section 3.2.7, Network Driver Performance Tuning.

You can also set configurable driver options using Microsoft PowerShell on Windows Server 2012. Refer to the documentation that accompanies the Windows Server 2012 operating system for more information on using PowerShell.

Refer toTable 4 for a list of NIC driver options.

Table 4 Windows Server 2008, Windows Server 2008 R2, Windows Server 2012, and Windows Server 2012 R2 NIC Driver Options

Option Name	Acceptable Values	Supported Operating Systems	Definition
`Class of Service (802.1p)`	Automatic Priority (default) Filtered Priority User Priority Disable Priority	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	The following modes are supported for selecting 802.1p priority tags: ■ Automatic Priority – The DCBX standard allows the network adapter to negotiate priority class usage with DCBX aware endpoints such as switches or network cards. If the peer indicates that priority pause is supported for a nonzero priority, the NIC automatically inserts the default priority in all transmitted packets. This mode is the default mode, which allows priority pause to operate for both storage and network traffic. ■ Filtered Priority – This mode coerces the user priorities in each packet to avoid sending packets on the network function that might disrupt the adapter's storage traffic. The network device uses the next lower priority if a conflict exists. This mode is useful if multiple network priorities are necessary. Only a limited number of classes are supported for priority pause, so typically, it does not function optimally in this mode. ■ User Priority – This mode allows any user-specified priority value and must be limited to cases where storage functions are not used. ■ Disable Priority – The adapter always transmits either untagged packets, or VLAN ID (802.1q) tagged packets with a priority value (802.1p) of zero.
`Enhanced Transmission Selection (ETS)`	Disabled (default) Enabled	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2 **NOTE** For OCe11102 CNAs only. **NOTE** ETS is not supported with VMQ technology. ETS is not available if SR-IOV is enabled.	If ETS is enabled, the driver filters transmit packets based on the 802.1p priority tag into multiple separate transmit rings. The network switch must be configured for ETS to group priorities into a priority group (or traffic class). Each priority group can be assigned a QoS bandwidth limit. For example, one network priority can support priority flow control to achieve loss-less network traffic. Using separate hardware interfaces in the driver allows each priority to progress at a different rate, or pause temporarily without affecting the other priorities. If ETS is enabled, all configurations regarding bandwidth and priority flow control must be performed on the network switch. The adapter will learn the configuration using the DCBX protocol.
`Flow Control`	Disabled RX and TX Enabled (default) Rx Enable/Tx Disable Tx Enable/Rx Disable	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	Flow control is almost always advantageous to avoid packet drops on the network. The switch or network peer must also have flow control enabled. The IEEE 802.3x Ethernet specification defines a control frame between peers that can request a pause in packet transmissions. Flow control allows one system to request a temporary halt of all incoming traffic if receive buffer space is exhausted. The network device can be configured to respond to pause frames (Rx Enable) and also to send pause frames (Tx Enable). **NOTE** When NPar is enabled, flow control is set using UEFI.
`IP Checksum Offload (IPv4)`	Disabled RX and TX Enabled (default) RX Enabled TX Enabled	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	This option offloads the transmit and the receive IPv4 checksum computation. Offloading checksums increases system efficiency.

Table 4 Windows Server 2008, Windows Server 2008 R2, Windows Server 2012, and Windows Server 2012 R2 NIC Driver Options

Option Name	Acceptable Values	Supported Operating Systems	Definition
`Large Send Offload v1 (IPv4)`	Disabled Enabled (default)	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	Large Send Offload allows the NIC hardware to segment large TCP packets (up to 64kB) into smaller packets (<= "Packet Size") that can be transmitted. This segmentation increases transmit efficiency for TCP applications that send large buffers. During segmentation, the hardware computes the IPv4 and TCP checksums for each individual packet. The Windows Version 1 LSO supports only IPv4.
`Large Send Offload v2 (IPv4)`	Disabled Enabled (default)	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	Large Send Offload allows the NIC hardware to segment large TCP packets (up to 64kB) into smaller packets (<= "Packet Size") that can be transmitted. This segmentation increases transmit efficiency for TCP applications that send large buffers. During segmentation, the hardware computes the IPv4 and TCP checksums for each individual packet. The Windows Version 2 LSO supports larger offload sizes.
`Large Send Offload v2 (IPv6)`	Disabled Enabled (default)	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	Large Send Offload allows the NIC hardware to segment large TCP packets (up to 64kB) into smaller packets (less than the MTU) that can be transmitted. This segmentation increases transmit efficiency for TCP applications that send large buffers. During segmentation, the hardware computes the TCP checksums for each individual packet. IPv6 support requires LSO Version 2.
`Maximum Number of RSS Processors`	Min: 0 Max: The number of CPU cores installed on your system.	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	This property sets the maximum number of processors that can be used for RSS.
`Maximum Number of RSS Queues`	Windows Server 2012, Windows Server 2012 R2; ■ OCe11102, legacy: Min 1, Max 4, default 4 ■ OCe11102, advanced mode: Min 1, Max 8, default 8 ■ LPe16000: Min 1, Max 16, default 8 ■ OCe14000: Min 1, Max 16, default 8	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	If RSS is enabled, this parameter controls the number of receive queues. Typically, this option is left at the maximum value. Windows reduces the number of queues as necessary based on the number of installed CPU cores. This value can be reduced during performance tuning for a particular application. It is possible that system performance might improve by limiting the number of RSS queues. For OCe11102 adapters, greater than four RSS queues requires that Advanced Mode Support be enabled in the BIOS controller configuration.
`Maximum RSS Processor Number`	Min: 1 Max: The number of CPU cores installed on your system.	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	This parameter sets the maximum processor number for the RSS CPUs. This value is the highest processor number of any processors from the RSSMaxProcGroup parameter.
`Network Address`	Valid MAC address The default setting is None.	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	This option overrides the permanent MAC address for the interface. The MAC address must follow this format *XX:XX:XX:XX:XX:XX*, where *X* is a hexadecimal digit (0 – 9 or A – F). ■ The address cannot be a multicast address, which has the lowest bit in the first byte set. ■ The address cannot be all zeros. For example, 01:00:00:00:00:00 is not valid, while 02:00:00:00:00:00 is valid.

Table 4 Windows Server 2008, Windows Server 2008 R2, Windows Server 2012, and Windows Server 2012 R2 NIC Driver Options

Option Name	Acceptable Values	Supported Operating Systems	Definition
NetworkDirect	0: Disabled 1: Enabled (default)	Windows Server 2012 R2	The Network Direct feature enables an offloaded RDMA interface for SMB 3.0 network attached storage traffic using Microsoft's SMB Direct protocol. For best performance, PFC must be configured on the network switch. The Emulex driver defaults to priority (PFC) 5 for RoCE traffic, although it will still work without PFC enabled.
Network Direct MTU	256 512 1024 (default) 2048 4096	Windows Server 2012 R2	The MTU or frame size for RoCE traffic can be configured with this parameter.
NVGRE Task Offload (also known as Encapsulated Task Offload)	Disabled Enabled (default)	Windows Server 2012 Windows Server 2012 R2 **NOTE** For OCe14000-series adapters only.	NVGRE Task Offload enables the offloading of network virtualization using GRE tunneling on the NIC adapter. NVGRE offload works in conjunction with VMQ.
Packet Size	1514 (default) 9014 8222 4088	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	Configures packet size for OneConnect NIC adapters only. This parameter determines the maximum packet size transmitted and received on the interface. A 1514 byte frame size is standard, while larger packets are called jumbo frames. Using a higher frame size is generally more efficient, but it uses more system memory. A larger frame size also requires support on the network switch. Jumbo frames are IPv4-only frames; IPv6 packets will be fragmented by LSO. Switches and the peer must be configured to accept the specified packet size, or the size will be negotiated to the common smallest size.
Performance Tuning	■ Maximum performance (default) ■ Dynamically balanced ■ Statically balanced	Windows Server 2012	This parameter selects the driver algorithm for performance tuning, which allows you to balance raw networking throughput with overall system fairness among multiple devices and applications. ■ Maximum Performance – This mode maximizes the network performance for this adapter. This mode is the recommended mode. However, in systems with a large number of network or storage adapters, this mode can limit the performance of other devices. ■ Statically Balanced – This mode configures the network adapter to throttles CPU usage in all cases, allowing more balance among hardware devices and applications. If system responsiveness is poor, this mode can improve the overall system behavior. ■ Dynamically Balanced – Dynamic balancing adjusts the network adapter's performance based on system metrics, such as CPU usage. This mode can aggressively limit performance for the most stressful networking applications to ensure that all network adapters can share limited computer resources, yet it can maintain maximum performance if the system has resources available.

Table 4 Windows Server 2008, Windows Server 2008 R2, Windows Server 2012, and Windows Server 2012 R2 NIC Driver Options

Option Name	Acceptable Values	Supported Operating Systems	Definition
Preferred NUMA Node	Not present or a value from 0 – 65535. Optional. No default setting is set.	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	Most modern multi-socket servers have separate memory controllers for each CPU socket. These systems have NUMA latencies for a given CPU core to access the local versus remote memory node. By setting this property, the driver attempts to use both memory and CPU cores from the given NUMA node. If the Preferred NUMA node is not set, the driver uses the preferred NUMA node as specified by the computer's BIOS. For best performance, the network applications must use memory and CPU affinity from the same NUMA node. This level of tuning is primarily noticeable when multiple adapters are running.
Receive Buffers	64 – 32768, inclusive The default value is 896.	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	This option determines the number of Ethernet receive buffers allocated per receive queue. This number can be adjusted by the driver as needed.
Receive CPU	"Not Present" or a value from 0 through (number of CPUs on the system – 1). Optional. A default setting is not available.	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	Sets the logical CPU used for processing the non-RSS receive packets. By default, the driver intelligently chooses a CPU in the system, so this parameter must only be used for advanced performance tuning. RSS packets are processed by the set of RSS CPUs provided by the Windows operating system.
Receive Side Scaling	Disabled Enabled (default)	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	Support for multiple RSS queues if enabled. RSS scales receive processing over multiple CPUs in parallel. This scaling typically improves application performance; however, it tends to increase CPU usage on low end machines. For the OCe11102 adapter, RSS is only supported on two primary adapters per device (PF0 and PF1). For additional PCI functions, RSS does not appear in the Properties List.
Recv Segment Coalescing (IPv4)	Disabled Enabled (default)	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	RSC merges multiple TCP segments and identifies them as a single coalesced unit to the operating system's TCP/IP stack. This option reduces the per-packet receive processing overhead and CPU usage if standard 1514 byte sized frames are in use. **NOTE** If checksum offloads are disabled, RSC must also be disabled. RSC depends on checksum offloads for better performance. **NOTE** Both RSC (IPv4) and RSC (IPv6) are coerced to zero if TCP Connection Offload (IPv4) is enabled.
Recv Segment Coalescing (IPv6)	Disabled Enabled (default)	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	RSC merges multiple TCP segments and identifies them as a single coalesced unit to the operating system's TCP/IP stack. This reduces the per-packet receive processing overhead and CPU usage if standard 1514 byte sized frames are in use. **NOTE** If checksum offloads are disabled, RSC must also be disabled. RSC depends on checksum offloads for better performance. **NOTE** Both RSC (IPv4) and RSC (IPv6) are coerced to zero if TCP Connection Offload (IPv4) is enabled.
RoCE Mode	Acceptable values: 1, 2	Windows Server 2012 R2	Configures routeable RoCE. 2 (Default) is routable RoCE and 1 is native RoCE.

Table 4 Windows Server 2008, Windows Server 2008 R2, Windows Server 2012, and Windows Server 2012 R2 NIC Driver Options

Option Name	Acceptable Values	Supported Operating Systems	Definition
`RSS Base Processor Group`	Min: 1 Max: 63	Windows Server 2012	This option defines the base processor group for the RSS queues on the network adapter. A processor group contains 64 logical processors. This value can be modified with the "RSS Base Processor Number" to explicitly select the desired RSS processors for the adapter.
`RSS Base Processor Number`	Min: 1 Max: 63	Windows Server 2012	This defines the base processor number for the RSS queues on the network adapter within the given processor group. A processor group contains 64 logical processors, so this value ranges from 0 to 63. This value can be modified with the "RSS Base Processor Group" to explicitly select the desired RSS processors for the adapter.
`RSS Max Processor Group`	Min: 0 Max: The number of processor groups present on your system.	Windows Server 2012	RSS Max Processor Group allows you to set the maximum number of processor groups for the RSS CPUs.
`RSS Profile`	Closest processor (default) Closest processor static NUMA scaling NUMA scaling static Conservative scaling	Windows Server 2012	The RSS Profile setting determines the RSS load balancing profile implemented by Microsoft for this network adapter. The "Closest Processor" settings tend to localize the RSS CPUs to one NUMA node, allowing the device driver to allocate memory from the local node. The "NUMA Scaling" settings use all NUMA nodes on the system, and the memory allocation is not specific to a particular node. The driver ignores the Preferred NUMA node setting.
`SpeedDuplex`	AutoNeg (default) 10Gb/sFullDuplex 1Gb/sFullDuplex	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	SpeedDuplex is used for selecting link speed, mainly for 10GBASE-T adapters. If it is set to the default, it auto negotiates 100 Mbps/1 Gb/s/10 Gb/s with the switch/peer. Link speed can be forced to 1 Gb/s, if option 1Gb/sFullDuplex is selected. Link speed can be forced to 10 Gb/s, if option 10Gb/sFullDuplex is selected. 10 Gb/s is the maximum supported link speed.

Table 4 Windows Server 2008, Windows Server 2008 R2, Windows Server 2012, and Windows Server 2012 R2 NIC Driver Options

Option Name	Acceptable Values	Supported Operating Systems	Definition
SR-IOV	Disabled (default) Enabled	**NOTE** For OCe11102, LPe16202, and OCe14000-series adapters only. Windows Server 2012 Windows Server 2012 R2	SR-IOV enables the adapter to allocate virtual PCI functions for each virtual machine in Hyper-V. **NOTE** The virtual switch and virtual network adapter must have SR-IOV enabled in the Hyper-V Manager. SR-IOV requires a platform with IOMMU virtualization (VT-d, AMD-Vi). If using SR-IOV, the Emulex NIC driver must be installed on each virtual function within the virtual machine. SR-IOV provides a direct hardware interface from the virtual machine to the networking adapter, which reduces latency and improves performance. The Windows Server 2012 and Windows Server 2012 R2 SR-IOV architecture establishes each Emulex virtual NIC with a corresponding emulated NIC. This allows the virtual machine to seamlessly failover to the emulated NIC if SR-IOV is disabled. It also allows Live Migration to another system, regardless of the installed NIC hardware. **NOTE** The driver currently supports the following virtual functions for the following adapter families: ■ OCe11100-series adapters support a maximum of 24 virtual functions per port. ■ OCe14000-series adapters support a maximum ofthe following functions: — 2-port 10 Gb: 31 virtual functions/physical function. — 4-port 10 Gb: 31 virtual functions/physical function — 1-port 40 Gb: 63 virtual functions/physical function
TCP Checksum Offload (IPv4)	Disabled RX and TX Enabled (default) RX Enabled TX Enabled	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	TCP Checksum Offload (IPv4) offloads the transmit or receive IPv4 TCP checksum computation. Offloading checksums increases system efficiency.
TCP Checksum Offload (IPv6)	Disabled RX and TX Enabled (default) RX Enabled TX Enabled	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	TCP Checksum Offload (IPv6) offloads the transmit or receive IPv6 TCP checksum computation. Offloading checksums increases system efficiency.

Table 4 Windows Server 2008, Windows Server 2008 R2, Windows Server 2012, and Windows Server 2012 R2 NIC Driver Options

Option Name	Acceptable Values	Supported Operating Systems	Definition
`TCP Connection Offload (IPv4)`	Enabled Disabled (default)	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	**NOTE** `TCP Connection Offload` is not supported on 16GFC adapters. If TCP Connection Offload is enabled, the device offloads the entire TCP protocol, including acknowledgement processing, retransmits, and timers. Applications that prepost receive buffers (before the data arrives) might avoid data copies in the receive path, which substantially increases the system efficiency and data rates. Windows does not offload TCP connections if any of the following are enabled: ■ Network Load Balancing ■ IPsec ■ Network Address Translation ■ NDIS 5.1 Intermediate Drivers TCP offload must be enabled in the Windows operating system with the shell command: `netsh int tcp set global chimney=enabled` This parameter appears disabled if the firmware installed on your device does not support TCP connection offload. Upgrading the firmware might resolve this issue. View the "Statistics" property page to ensure that TCP connection offload is working. **NOTE** Both RSC (IPv4) and RSC (IPv6) are coerced to zero if TCP Connection Offload (IPv4) is enabled.
`TCP Offload Optimization`	Optimize Latency Optimize Throughput (default)	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	This parameter only applies to TCP connection offload, which must be enabled in the "Protocol Offloads" section. Most applications perform better with TCP Offload Optimization set to `Optimize Throughput`, which handles large data transfers with minimal CPU impact. Setting this parameter to "Optimize Latency" causes receive data to be delivered to the application without waiting for a TCP push flag. This causes additional receive indications that typically decrease total throughput.
`Transmit Buffers`	64 – 256, inclusive The default setting is 256.	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	`Transmit Buffers` sets the number of Ethernet transmits that might be posted to the hardware at any given time. The default value is sufficient to achieve maximum performance. Reducing this value conserves system memory.
`Transmit CPU`	"Not Present" or a value from 0 through (number of CPUs – 1). Optional. A default setting is not available.	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	Sets the CPU to be used to process transmit completions. By default, the driver intelligently chooses a CPU in the system, so this parameter must only be set for advanced performance tuning.
`Transmit Side Scaling (TSS)`	Enabled Disabled	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	`Transmit Side Scaling` distributes transmit completions to be processed on multiple CPUs in parallel. It uses the RSS CPU table for distribution, and therefore, requires RSS to be enabled.

Table 4 Windows Server 2008, Windows Server 2008 R2, Windows Server 2012, and Windows Server 2012 R2 NIC Driver Options

Option Name	Acceptable Values	Supported Operating Systems	Definition
`UDP Checksum Offload (IPv4)`	Disabled RX and TX Enabled (default) RX Enabled TX Enabled	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	`UDP Checksum Offload` settings offload the transmit or receive IPv4 UDP checksum computation. Offloading checksums increases system efficiency.
`UDP Checksum Offload (IPv6)`	Disabled RX and TX Enabled (default) RX Enabled TX Enabled	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	`UDP Checksum Offload` settings offload the transmit or receive IPv6 UDP checksum computation. Offloading checksums increases system efficiency.
`Virtual Machine Queues`	Enabled (default) Disabled	**NOTE** For OCe11102, LPe16202, and OCe14000 only. VMQs require WindowsServer 2008 R2 or later with Hyper-V	VMQs are dedicated hardware receive queues for virtual machines that filter receive packets based on the destination MAC address or VLAN. Receive buffers can be allocated for each queue from VM memory. This improves network throughput by distributing processing of network traffic for multiple VMs among multiple processors. It reduces CPU utilization by offloading receive packet filtering to NIC hardware. VMQs prove beneficial when four or more VMs are in use.
`Virtual Machine Queues Lookahead Split`	Enabled (default) Disabled	**NOTE** For OCe11102 CNAs only. Not applicable for LPe16202 and OCe14000-series adapters. Windows Server 2008 R2	VMQ enables direct DMA to VM memory. Lookahead improves packet steering performance by PCI prefetching an adjacent header buffer into a cache when examining a packet. Header buffers are continuous in physical memory because they belong to one pool. For OCe11102, Lookahead split requires Advanced Mode Support and is enabled in the BIOS controller configuration. **NOTE** Lookahead split is not supported for jumbo frames.
`Virtual Machine Queues Transmit`	Enabled (default) Disabled	**NOTE** For OCe11102, LPe16202, and OCe14000-series adapters only. Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	If this option is enabled with VMQs, separate transmit queues are created for each VM network interface. Send and receive interrupts for a VM network interface are processed on the same CPUs. Separate transmit queues increase system overall CPU utilization, but offer greater system scalability.
`VLAN Identifier (802.1q)`	Not Present (default) 1 to 4094	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	If selected, the adapter adds a VLAN tag to all transmitted packets, and only receives packets with the matching VLAN tag. **NOTE** Do not use this property if the Emulex Teaming Driver is enabled. In that case, perform VLAN configuration in the Teaming Driver application. **NOTE** Do not use this property with Hyper-V. In that case, use the Microsoft Hyper-V Manager to configure VLANs on each virtual machine.

Table 4 Windows Server 2008, Windows Server 2008 R2, Windows Server 2012, and Windows Server 2012 R2 NIC Driver Options

Option Name	Acceptable Values	Supported Operating Systems	Definition
`Wake on LAN`	Enabled (default) Disabled **NOTE** For Windows Server 2012 inbox drivers, "Wake on LAN" is disabled by default and not overwritten on driver updates.	Windows Server 2008	Enabling `Wake on LAN` allows the network device to wake up the computer if a magic packet is received during standby. In Blade server configurations, `Wake on LAN` is only supported on two primary adapters per device. Additional PCI functions appear disabled.
`Wake on Magic Packet`	0 – Disabled 1 (Default) – Enabled	Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	Defines if a network adapter is enabled to wake a computer on the magic packet.
`Wake on Pattern Match`	0 – Disabled 1 (Default) – Enabled	Windows Server 2008 Windows Server 2008 R2 Windows Server 2012 Windows Server 2012 R2	Defines if a network adapter is enabled to wake the computer on pattern matches.

3.2.1.1 Advisory: PowerShell Behavior

3.2.1.1.1 Issues with Capabilities Reported by Standard PowerShell Commands (Get-NetAdapter)

Driver parameter default registry values are initially populated from the driver installation INF file. Thereafter, the registry is written to only if the default settings are explicitly overridden. PowerShell uses these registry values to report capabilities with the result that the registry values might not always reflect what is supported in the current configuration.

The default settings can be modified through the Driver Properties page, standard PowerShell commands, and utilities like occfg (for more information on occfg, see Using OCCFG for Windows NIC Driver Options on page 53).

Standard PowerShell (Get-NetAdapter) commands behave in the following manner:

- If the feature is currently enabled, the driver reports its current capabilities. PowerShell reports all of the feature capabilities based on what the driver indicates. The feature capabilities are guaranteed to be what the NIC driver supports in the current configuration.
- If the feature is not enabled, the driver does not report any current capabilities. At that point, PowerShell searches the registry for keys related to the feature and reports their values. These values are either the default values (INF) or the last configured user values (if overwritten by the user). Default values are only intended as maximum upper bounds; they are not guaranteed resources supported in every configuration.

As a result, the driver can only report a feature's current capabilities (accurate for the present configuration), if the feature is currently enabled. However, standard PowerShell commands report whatever is present in the registry, if the feature is not enabled. This information can conflict with what the driver actually supports in the current configuration.

3.2.1.1.2 Determining what PowerShell is Reporting (Registry and Driver-Reported Capabilities)

You can usually tell whether PowerShell is using capabilities reported by the driver or is picking up registry values.

- SR-IOV

  Check the output of (Get-NetAdapterSRIOV). CurrentCapabilities for CurrentCapabilities.

  If CurrentCapabilities is empty, the driver is not currently enabled for SR-IOV. Any reported fields in Get-NetAdapterSriov | fl * are based on registry values. If CurrentCapabilities is not null, the driver is enabled for SR-IOV. Get-NetAdapterSriov fields are based on what the driver reports.

  NetAdapter*) commands behave in this manner.

- RDMA

  Check the output of (Get-NetAdapterRdma). RdmaAdapterInfo for RdmaAdapterInfo.

  If RdmaAdapterInfo is empty, any reported fields in Get-NetAdapterRdma | fl * are based on registry values. If RdmaAdapterInfo is not null, the driver is reporting RDMA capabilities. Get-NetAdapterRdma fields are based on what the driver reports.

3.2.1.2 Considerations for Using UMC and NIC

NOTE UMC is not supported on LPe16202 adapters.
64 VLAN IDs can be used with each UMC virtual channel.
SR-IOV must be disabled if UMC is enabled.

For additional information on UMC, refer to the *Emulex Universal Multi-Channel Reference Guide,* which is available for download from the Broadcom website.

3.2.1.3 ARI Considerations

NOTE RoCE is not supported with ARI.

The PCIe standard limits an adapter to a maximum of eight physical functions. This means that a 2-port adapter can only have four functions per port and a 4-port adapter can only have two functions per port. The following requirements must be met to fully support ARI and expose more than eight functions on an adapter:

- ARI must be available on the system to support up to 16 functions on an adapter. If these conditions are not met, although you can configure all 16 functions, only eight functions will be present and discovered by the OneCommand Manager application after a reboot.
- Only OCe14000-series adapters support ARI.
- The system hardware, such as the motherboard and BIOS, must support ARI.
- ARI must be enabled in the system BIOS.
- The operating system must support ARI, such as the Windows Server 2012 and later.
- Any management tools that you use must support ARI, such as the OneCommand Manager application version 11.0.

For Dell NPar support, refer to Section 3.2.6.13, NPar Configuration (Dell Only).

3.2.2 Configuring Windows Server NIC Driver Parameters

The Windows Server NIC drivers support driver options through the Advanced Property page in the Windows Device Manager.

NOTE Ensure that the OneCommand Manager application GUI is closed before opening the Windows Device Manager.

3.2.2.1 Modifying Advanced Properties

Modify the advanced properties for the driver for Windows with the Windows Device Manager. For more information on advanced properties, refer to Section 3.2.7, Network Driver Performance Tuning.

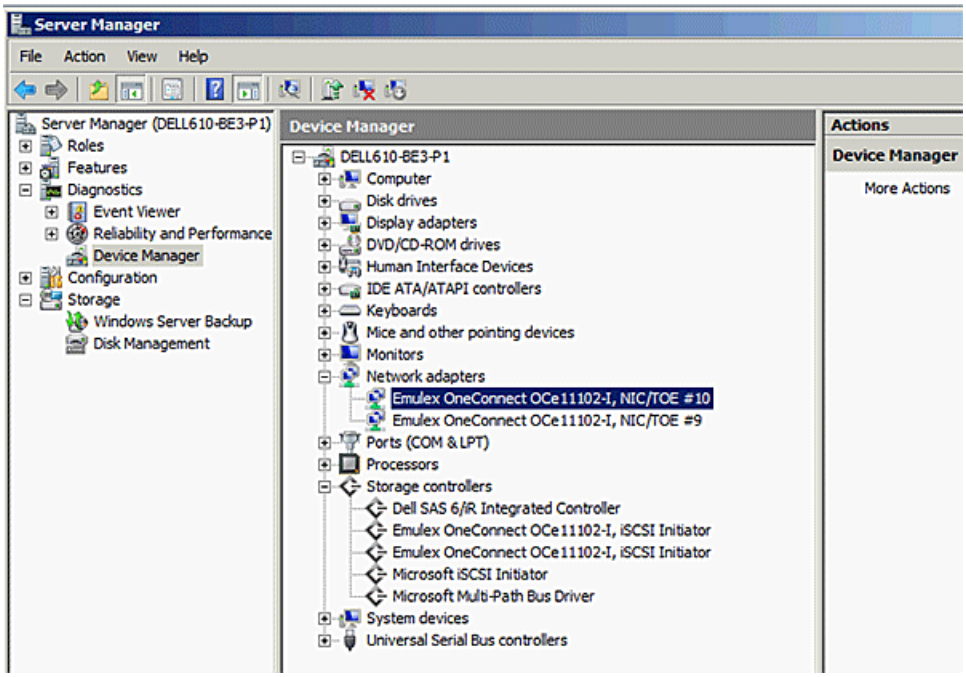
To modify the advanced properties, perform these steps:

1. Enter the Windows Device Manager using one of the following options:
   - Click **Start> Control Panel>System** and click the Device Manager hyperlink.
   - Click **Start>Run**, and type

     `devmgmt.msc`
2. Click **OK**.

The Windows Device Manager is displayed (refer to Figure 2).

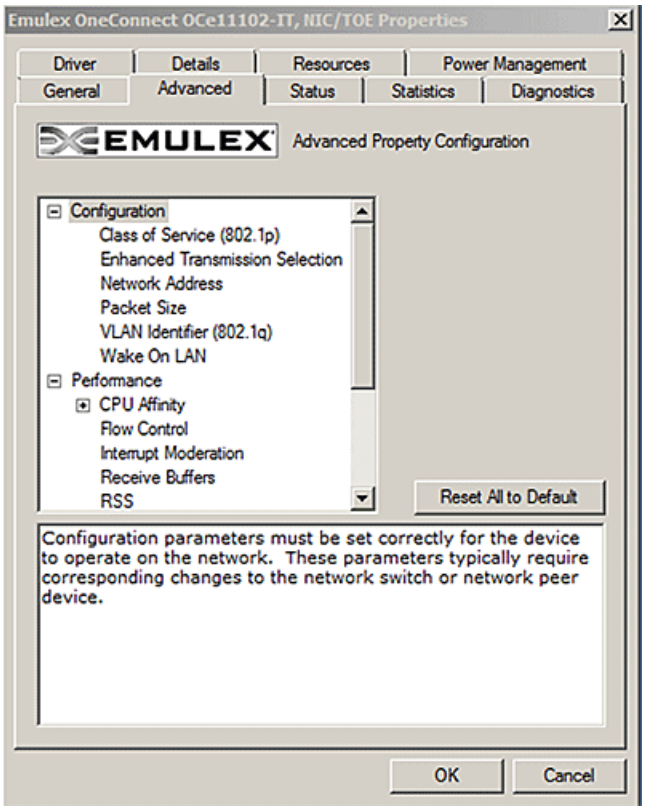
Figure 2 Partial View of Windows Device Manager



3. Right-click the network adapter for which you want to modify advanced properties.
4. Click **Properties**, and click the **Advanced** tab (refer to Figure 3 on page 50).
5. From the list of properties, click the property (parameter) you want to modify, then select the new value of the property by selecting it from the Value list.
6. Click **OK**.

NOTE Modifying properties causes the network driver to reload, and some TCP connections might be temporarily dropped.

Figure 3 NIC Advanced Properties in Windows Server 2008



3.2.2.2 Statistics Property Page

Use the Statistics Properties tab to view the performance of the device and network. By viewing the statistics properties, you can troubleshoot issues and performance tune the system; for example, you can assess how different device properties change the system performance.

To view the statistics properties, perform these steps:

1. Enter the Windows Device Manager using one of the following options:

- Click **Start> Control Panel>System** and click the Device Manager hyperlink.
- Click **Start>Run**, then type

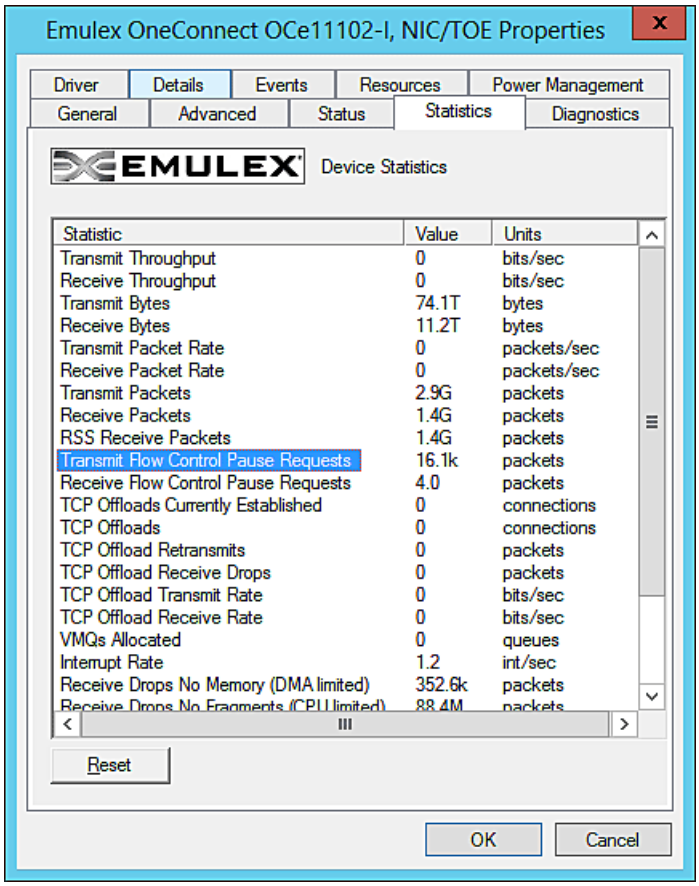
  ```
  devmgmt.msc
  ```

2. Click **OK**.

   The Windows Device Manager is displayed (refer to Figure 2 on page 49).

3. Right-click the network adapter for which you want to view the statistics properties.
4. Click **Properties,** then click the **Statistics** tab (refer to Figure 4 on page 51).

Figure 4 NIC Statistics Properties in Windows Server 2008



5. From the list of properties, select the property (parameter) you want to view.

Table 5 lists the NIC driver properties statistics.

Table 5 NIC Driver Properties Statistics

Statistic Name	Description
`Transmit Throughput`	The data rate for this adapter on the network, including all packet headers. It is expressed in terms of bits per second, where 1 byte = 8 bits. This range is computed as the average over approximately three seconds.
`Receive Throughput`	The receive rate for this adapter.
`Transmit Bytes`	The total number of bytes transmitted by this adapter, since the last statistics reset or the last driver reload.
`Receive Byte`	The total number of bytes received by this adapter.
`Transmit Packet Rate`	The rate of transmit packets for the adapter.
`Receive Packet Rate`	The rate of receive packets for the adapter.
`Transmit Packets`	The total number of packets transmitted by the adapter since the last statistics reset, or the driver was reloaded.
`Receive Packets`	The total number of packets received. This number includes both RSS and non-RSS packets.
`RSS Receive Packets`	The number of receive packets that were suitable for RSS.

Table 5 NIC Driver Properties Statistics (Continued)

Statistic Name	Description
Transmit Flow Control Pause Requests	The number of times the network adapter sent a PAUSE frame to request that the peer stop sending data temporarily. This number indicates a potential bottleneck in the system. Typically, this bottleneck is the result of the DMA of packets from the adapter to host memory.
Receive Flow Control Pause Requests	The number of times the network adapter received a PAUSE frame from the peer. This number indicates a potential bottleneck in the attached switch or network peer device. This statistic increments only if the switch is correctly configured for flow control.
TCP Offloads Current Established	The current number of TCP connections offloaded to the adapter's TOE.
TCP Offloads	The total number of TCP connections that have been offloaded since the last statistics reset or the driver was reloaded.
TCP Offload Retransmits	The number of packets retransmitted for TCP offloaded connections.
TCP Offload Receive Drops	The number of packets dropped by in the offloaded TCP stack. These drops might be the result of TCP protocol errors or bottlenecks in the system for consuming receive data.
TCP Offload Transmit Rate	The transmit data rate of the offloaded TCP connections. This value is the portion of the total "Transmit Throughput" contributed by offloaded TCP connections.
TCP Offload Receive Rate	The receive data rate of the offloaded TCP connections.
VMQs Allocated	The current number of Virtual Machine Queues allocated.
Interrupt Rate	The number of interrupts per second generated by the adapter. The interrupt rate can be tuned by modifying the Interrupt Moderation parameter.
Receive Drops No Memory (DMA Limited)	The number of packets dropped as a result of insufficient buffers posted by the driver. This value is generally the result of the CPU core used for any receive queue reaching 100%. The system might lack sufficient CPU cycles to post receive buffers at the necessary rate. Many small packets lead to this behavior on almost any CPU, because the processing time for small packets is very high in the networking stack. Using a teaming driver might also lead to this behavior, because it increases the CPU load during receive. Increasing the number of "Receive Buffers" in the advanced property page might alleviate some of these drops, in particular if the drops are the result of bursts of small receive packets on the network. However, if the CPU is the limit, increasing the buffer resources does not help because the driver cannot post them fast enough. Enabling RSS is another strategy to reduce drops because it allows the NIC driver to use additional CPU cores. The number of RSS queues can be increased to increase the total number of posted buffers available to the adapter. Enabling RSC can also reduce CPU consumption in the networking stack by combining multiple TCP packets into one larger packet. For best performance, the system BIOS must be set to "Maximum Performance" or manually disable C-states. The transitions to low power C-states might cause a steady trickle of drops due to increased latencies from packet reception until the driver's interrupt processing code is invoked.

Table 5 NIC Driver Properties Statistics (Continued)

Statistic Name	Description
`Receive Drops No Fragments (CPU Limited)`	The number of receive packets dropped because of a DMA bottleneck from the network adapter to host memory. This situation might be caused by bottlenecks in either the PCIe bus or main memory. In the Status tab of the Custom property page, the Emulex NIC reports the PCIe link parameters and the maximum supported parameters. For example, installing a 8x device in a 4x PCIe slot cuts the available PCIe bandwidth in half. The PCIe MTU and Read Request size are also reported, and these can be configurable in the system BIOS. The performance of the main memory is the other major concern for networking throughput. The ideal situation uses high speed memory with all memory channels populated per CPU; typically, three or four DIMMs per CPU socket. For the ideal performance, use the same DIMM size in each memory channel to allow perfect memory channel interleaving. Features, such as memory sparing or memory mirroring, dramatically decrease the memory bandwidth of the system and cause drops. TCP connection offload might lead to increased drops as a result of "no memory." If TCP connection offload is used, enabling flow control might reduce the drops. Alternatively, disabling TCP connection offload might improve performance.
`Receive CRC Errors`	The number of packets dropped as the result of CRC errors on the layer 2 Ethernet packet. In products that expose multiple PCIe functions per Ethernet port, this statistic is incremented only for the lowest PCI function per port since the packet cannot be further classified because of the error.
`Receive IP Checksum Errors`	The number of receive packets with an incorrect IPv4 checksum. These packets are provided to the TCP/IP stack for disposal in the operating system.
`Receive UDP Checksum Errors`	The number of receive packets with an incorrect UDP checksum. These packets are provided to the TCP/IP stack for disposal in the operating system.
`Receive TCP Errors`	The number of receive packets with an incorrect TCP checksum. These packets are provided to the TCP/IP stack for disposal in the operating system.
`Tunnels allocated`	The number of interfaces converted to tunnel interfaces. Used with NVGRE offload enabled and on.
`Tenants allocated`	The number of interfaces converted into tenant interfaces. Used with NVGRE offload enabled and on and VMQ.
`Virtual Functions allocated`	The number of PCIe virtual functions created by the SR-IOV supporting adapter.

3.2.3 Using OCCFG for Windows NIC Driver Options

The `occfg.exe` program supports configuring parameters for the network functions on Emulex Ethernet adapters either through interactive mode with a set of menus, or command line mode that is scriptable.

If you performed a standard driver installation, the `occfg.exe` is located in the following directory:

```
Directory of C:\Program Files\Emulex\AutoPilot
Installer\NIC\Drivers\NDIS\<platform>\<OS>
```

The following section describes how to use the occfg.exe program to configure the Windows device driver from the command line.

3.2.3.1 Displaying OCCFG Help

To display help, use the -? option by typing

```
occfg -?
```

The following text is displayed:

```
OneConnect Network Config (0.0.9999.0)
Copyright 2011 Emulex
Usage:   occfg.exe [-options]
```

```
Running with no arguments will display a menu to select the adapter and parameters
to modify. Using the command line arguments allow scripting this process.
Options:
```

`-a str[,str]`	Selects all adapters with any of the given strings in the connection or device name. If omitted, occfg prompts for an adapter from a list.
`-s name=v,[name=v]`	Sets the parameter's value and reloads the devices.
`-g name[,name]`	Gets parameter value.
`-r`	Skips reloading the driver when setting a parameter.
`-f`	Forces reloading the driver.
`--`	Forces disabling the driver.
`-+`	Forces enabling the driver.
`-l`	Lists available adapters and exit.
`-T filename`	Saves tinylog to a binary file.
`-L filename`	Loads a binary file and replays tinylog.
`-x`	Resets all parameters to the default values.
`-p`	Shows all registry parameter values.
`-q`	Shows all driver parameter values.
`-h`	Shows help text for all parameters.
`-?`	Shows this help.
`-M module=trace level [,module=trace level]`	Continously downloads ARM log into a file. Arguments set a specific trace level on listed modules. Default argument is `all=error`. Refer to ARM firmware for list of modules and debug trace levels. This is a special command argument.

3.2.3.1.1 Examples:

```
Run interactively with menus:                occcfg.exe
Set a parameter on all Emulex adapters:      occfg.exe -a Emulex -s
                                             rss=1
Set multiple parameters on one adapter adapter:
       occfg.exe -a "Local Area Connection 23" -s "Flow=3,rss=0"
```

3.2.3.2 Selecting an Adapter

In batch mode, the `-a` parameter must be followed by a substring that is contained within the adapter name. The name is a combination of the device manager name (for example, Emulex OneConnect OCe11102) and the network connection name (for example, Local Area Connection). The latter can be modified by using the Windows Network Connections applet `(ncpa.cpl)`.

The most typical scenario involves setting parameters to be the same for all ports of a network adapter by specifying `-a emulex`.

It is often convenient to rename the connections to have a common name to easily operate on a group. For example, naming the network connections “dot1, dot2, dot3” allows operating on all adapters using the substring “dot”, or on any individual adapter by specifying the exact name such as “dot1”.

3.2.3.3 Configuring Device Parameters

The `occfg` program is used to query and modify registry parameters for Emulex network devices. The registry keys are stored at:

```
HKLM/System/CurrentControlSet/Control/Class/{4D36E972-E325-11CE-BFC108002bE10318}
/####
```

where "####" is the device instance number.

The `occfg` program allows you to modify registry keys on a set of network devices. After the driver is modified, it must be restarted to apply these parameters. In batch mode, `occfg` automatically restarts the driver when changing a parameter, and, in interactive mode, you use a menu item to select to restart the driver.

In batch mode, the commands to modify parameters look like the following examples:

```
occfg -a emulex -s rss=0
occfg -a emulex -s "Interrupt Moderation=4,Flow Control=3"
```

The parameter name must uniquely specify one parameter to modify, but it might be only a substring on the full parameter name. For example, the following are all equivalent:

```
occfg -a emulex -s "Flow Control=3"
occfg -a emulex -s flow=3
occfg -a emulex -s control=3
```

Note that the parameter name is generally the text readable parameter description name, but you can specify the exact registry key name as well. Microsoft has defined many documented standard registry key names that start with a '*' character. The '*' is not a wildcard, it is part of the registry key name. The following examples are equivalent:

```
occfg -a emulex -s "Flow Control=3"
occfg -a emulex -s "*FlowControl=3"
```

NOTE Quotation marks are required if the parameter name contains a space character.

To modify a parameter without a driver reload, use `-r`. This setting is used to modify several parameters in sequence, without forcing a driver reload. To force a driver reload, use the `-f` parameter.

The following is an example of such a sequence:

```
occfg -a emulex -r -s rss=0
occfg -a emulex -r -s "interrupt moderation=0"
occfg -a emulex -f
```

Registry keys can be set to two special values:

- The "delete" value causes the key to be entirely deleted and the driver uses the default value. This value is appropriate for keys that are optional, such as the "Network Address".
- The "default" value sets the key to the driver's default value. If the key is optional, the default value might be equivalent to deleting the key.

For example:

```
occfg -a emulex -s vlan=delete
occfg -a emulex -s rss=default
```

3.2.3.4 Viewing Device Parameters

The `occfg.exe` program can query device parameters from either the registry or the device driver (if running driver version greater than or equal to 2.103.*x.x*).

The registry and driver values might differ until the driver is reloaded. If the driver reload fails for any reason (such as another application has an open handle to the device driver), it might be necessary to reboot the system to apply the registry changes.

NOTE If the driver has been disabled or if the driver failed to load due to any error, the driver query returns the error, "Failed to query driver for the parameter."

The following are batch mode examples:

```
occfg -a emulex -g "Interrupt Moderation"
occfg -a "(Local Area Connection)" -g interrupt,rss
Emulex OneConnect OCe11102-I, NIC/TOE (Local Area Connection):
   [Registry] Interrupt Moderation = 4 (Adaptive [Default])
   [Driver] Interrupt Moderation = 4 (Adaptive [Default])
Emulex OneConnect OCe11102-I, NIC/TOE (Local Area Connection):
   [Registry] RSS = 0 (Disable)
   [Driver] RSS = 0 (Disable)
```

3.2.3.5 Resetting All Parameters

Resetting all parameters restores the default values for each adapter. This is accomplished by using the command:

```
occfg -a emulex -x
```

3.2.3.6 Displaying All Parameters

To display the current value of all parameters, use either `-p` or `-q` command line options. This shows the registry value or driver value of the parameter, or both when using `-pq` together.

For example:

```
occfg.exe -a "SLOT 5 Port 1" -pq
OneConnect Network Config (10.4.164.0)
Copyright 2011 Emulex

Emulex OneConnect OCe14102-UX-D 2-port PCIe 10GbE CNA (SLOT 5 Port 1)
   Display all properties.

   [Registry] Class of Service (802.1p) = 1 (Auto Priority Pause)
   [Driver]   Class of Service (802.1p) = 1 (Auto Priority Pause)

   [Registry] Encapsulated Task Offload = 1 (Enabled)
   [Driver]   Encapsulated Task Offload = 1 (Enabled)

   [Registry] Enhanced Transmission Selection = 0 (Disabled)
   [Driver]   Enhanced Transmission Selection = 0 (Disabled)

   [Registry] Flow Control = 3 (Rx & Tx Enabled)
   [Driver]   Flow Control = 0 (Disabled)

   [Registry] IPv4 Checksum Offload = 3 (Rx & Tx Enabled)
   [Driver]   IPv4 Checksum Offload = 3 (Rx & Tx Enabled)

   [Registry] Interrupt Moderation = 4 (Adaptive (default))
   [Driver]   Interrupt Moderation = 4 (Adaptive (default))

   [Registry] Large Send Offload V1 (IPv4) = 1 (Enabled)
   [Driver]   Large Send Offload V1 (IPv4) = 1 (Enabled)

   [Registry] Large Send Offload V2 (IPv4) = 1 (Enabled)
```

```
[Driver]   Large Send Offload V2 (IPv4) = 1 (Enabled)

[Registry] Large Send Offload V2 (IPv6) = 1 (Enabled)
[Driver]   Large Send Offload V2 (IPv6) = 1 (Enabled)

[Registry] Maximum Number of RSS Processors = <not set>
[Driver]   Maximum Number of RSS Processors = <not set>

[Registry] Maximum Number of RSS Queues = 6
[Driver]   Maximum Number of RSS Queues = 6

[Registry] Maximum RSS Processor Number = <not set>
[Driver]   Maximum RSS Processor Number = <not set>

[Registry] Network Address = <not set>
[Driver]   Network Address = <not set>

[Registry] NetworkDirect = 1 (Enabled)
[Driver]   NetworkDirect = 1 (Enabled)

[Registry] NetworkDirect MTU = 1024 (1024)
[Driver]   NetworkDirect MTU = 1024 (0x400) (1024)

[Registry] Packet Size = 9014 (9014)
[Driver]   Packet Size = 9014 (0x2336) (9014)

[Registry] Performance Tuning = 0 (Maximum Performance)
[Driver]   Performance Tuning = 0 (Maximum Performance)

[Registry] Preferred NUMA Node = <not set>
[Driver]   Preferred NUMA Node = <not set>

[Registry] RSS Base Processor Group = <not set>
[Driver]   RSS Base Processor Group = <not set>

[Registry] RSS Base Processor Number = <not set>
[Driver]   RSS Base Processor Number = <not set>

[Registry] RSS Max Processor Group = <not set>
[Driver]   RSS Max Processor Group = <not set>

[Registry] RSS Profile = 1 (Closest Processor)
[Driver]   RSS Profile = 1 (Closest Processor)

[Registry] Receive Buffers = 896
[Driver]   Receive Buffers = 1280 (0x500)

[Registry] Receive CPU = <not set>
[Driver]   Receive CPU = <not set>

[Registry] Receive Side Scaling = 1 (Enabled)
[Driver]   Receive Side Scaling = 1 (Enabled)

[Registry] Recv Segment Coalescing (IPv4) = 1 (Enabled)
```

```
[Driver]   Recv Segment Coalescing (IPv4) = 1 (Enabled)

[Registry] Recv Segment Coalescing (IPv6) = 1 (Enabled)
[Driver]   Recv Segment Coalescing (IPv6) = 1 (Enabled)

[Registry] SR-IOV = 0 (Disabled)
[Driver]   SR-IOV = 0 (Disabled)

[Registry] TCP Checksum Offload (IPv4) = 3 (Rx & Tx Enabled)
[Driver]   TCP Checksum Offload (IPv4) = 3 (Rx & Tx Enabled)

[Registry] TCP Checksum Offload (IPv6) = 3 (Rx & Tx Enabled)
[Driver]   TCP Checksum Offload (IPv6) = 3 (Rx & Tx Enabled)

[Registry] Transmit = 1 (Enabled)
[Driver]   Transmit = 1 (Enabled)

[Registry] Transmit Buffers = 256 (256)
[Driver]   Transmit Buffers = 256 (0x100) (256)

[Registry] Transmit CPU = <not set>
[Driver]   Transmit CPU = <not set>

[Registry] Transmit Side Scaling = 1 (Enabled)
[Driver]   Transmit Side Scaling = 0 (Disabled)

[Registry] UDP Checksum Offload (IPv4) = 3 (Rx & Tx Enabled)
[Driver]   UDP Checksum Offload (IPv4) = 3 (Rx & Tx Enabled)

[Registry] UDP Checksum Offload (IPv6) = 3 (Rx & Tx Enabled)
[Driver]   UDP Checksum Offload (IPv6) = 3 (Rx & Tx Enabled)

[Registry] VLAN Identifier (802.1q) = 102
[Driver]   VLAN Identifier (802.1q) = 102 (0x66)

[Registry] Virtual Machine Queues = 1 (Enabled)
[Driver]   Virtual Machine Queues = 1 (Enabled)

[Registry] Wake On LAN = 1 (Enabled)
[Driver]   Wake On LAN = 0 (Disabled)
```

3.2.3.7 Using Interactive Mode

The `occfg.exe` program also supports the interactive mode with a set of menus. To start this utility in interactive mode, perform these steps:

1. Run `occfg.exe` from a command console.

   A list of adapters displays on which to operate.
2. Type either a number of the list or a substring from any part of the name (for more information, see Section 3.2.3.2, Selecting an Adapter).

   The program prompts for an operation, such as modifying or querying a parameter value.
3. Follow the prompt.

   The program provides a list of available registry parameters to modify or query.

4. Type either the number of the corresponding option or a substring in the parameter name. The substring must uniquely identify the parameter or occfg displays all potential options.
5. To apply the parameters, select the menu item to exit and reload the drivers. Pressing Ctrl+ C at any point might leave modifications in the registry, but the driver does not use the new parameters until it is reloaded.

3.2.3.8 Parameter Help

In interactive mode, setting a parameter displays help text and information regarding the legal values for each parameter. This information can be dumped for all parameters by specifying the `-h` option.

The following is an example help text for the RSS parameter:

```
RSS:
Receive Side Scaling (RSS) scales receive processing over multiple CPUs in
parallel. This scaling typically improves application performance; however, it
tends to increase CPU usage on low end machines.
RSS is only supported on two primary adapters per device. It will appear disabled
for additional PCI functions in blade server configurations.
RSS requires Windows 2008 and later.
Registry Key: *RSS
Default Value : 1 (Enable)
Valid Values :
   0 = Disable
   1 = Enable
```

3.2.4 Using SR-IOV with Emulex Devices

This section describes how to use SR-IOV with Emulex devices.

3.2.4.1 Advisory

OCe11100-series adapters might have problems recovering from the corrupted use of SR-IOV. Assigning an SR-IOV device to a virtual machine could leave the system vulnerable and lead to instability. Emulex recommends that you assign SR-IOV devices only to virtual machines that run trusted workloads, or consider disabling SR-IOV.

This advisory highlights a use case where a “rogue” (non-Emulex) digitally signed driver is installed by the system administrator on a virtual machine. It is then possible for that rogue driver to cause problems with an OCe11100-series networking adapter. While there are many benefits to using SR-IOV with virtualized workloads, these benefits must be weighed against the potential risks in doing so.

Notes

- The operating system comes with an Emulex inbox driver. Use the Emulex out-of-box driver.
- For a list of supported drivers and adapters, refer to the latest Windows Drivers release notes, which are available for download from the documents and downloads area of the Broadcom website.
- SR-IOV is not supported with RoCE configurations.
- SR-IOV is not supported with UMC.
- SR-IOV is not supported on 1Gb adapters
- SR-IOV is supported only on the following adapters in NIC-mode installed on Windows Server 2012 and Windows Server 2012 R2 with an installed Emulex NIC driver:
  - LPe16202 CNAs
  - OCe11000-series NIC adapters
  - OCe14000-series adapters
- The driver supports the following virtual functions for the following adapter families:

- OCe11100-series adapters support a maximum of 24 virtual functions per port.
- OCe14000-series adapters support a maximum of:
  - 2-port 10Gb Ethernet: 31 virtual functions per physical function
  - 4-port 10GbE: 31 virtual functions per physical function
  - 1-port 40GbE: 63 virtual functions per physical function
  - 2-port 40GbE: 63 virtual functions per physical function

3.2.4.2 Server BIOS Configuration

SR-IOV requires support in the server chipset beyond standard virtualization technologies, including operating system control of PCIe and interrupt remapping. The server might have BIOS options to control SR-IOV, and typically these are disabled by default. The following might need modification in your system BIOS during boot:

- Enable “Virtualization”, such as Intel VT-x or AMD-V. This is required for any virtual machine.
- Explicitly enable SR-IOV in the system BIOS. The specific name for this option varies between vendors. For instance, it might be called Intel VT-d (Virtualization Technology for Direct I/O), AMD-Vi (AMD I/O Virtualization Technology), or IOMMU.

3.2.4.3 Emulex PXESelect Configuration for SR-IOV

The Emulex OCe11000-series adapters require enabling firmware support for SR-IOV within the Emulex PXESelect BIOS. Refer to the *Boot for NIC, iSCSI, FCoE, and RoCE Protocols User Manual* for more information.

To enable firmware support in the PXESelect BIOS, perform these steps:

1. Press Ctrl+ P during the Emulex PXE Select splash screen as the server boots.

   A screen appears showing global options.
2. Set the following options to use SR-IOV:
   - Advanced mode = Enable
   - Universal Multichannel (UMC) = Disable
3. Save the settings and enable SR-IOV for each PCI function.

   The server reboots after this modification.

3.2.4.4 SR-IOV Server Validation

Use the following Microsoft PowerShell commands to determine if your server is capable of SR-IOV.

- Get-NetAdapterSriov
- Get-VmHost
- Get-VmNetworkAdapter
- Get-VmSwitch

Refer to the Microsoft documentation for more information.

NOTE Early SR-IOV-capable chipsets had errors that might prevent SR-IOV from operating in Windows Server 2012 and Windows Server 2012 R2. The PowerShell command `Get-VmHost | fl *` includes `IovSupportReasons` that indicates if the chipset suffers from this issue.

3.2.4.4.1 Enabling SR-IOV on Unqualified Servers

If Windows Server 2012 or Windows Server 2012 R2 detects a problem with the system I/O remapping hardware, you might still be able to use SR-IOV by explicitly enabling SR-IOV in the registry using `IovEnableOverride`.

NOTE Only use this procedure for trusted virtual machines.

CAUTION Use the registry editor at your own risk. Using the registry editor can cause serious issues that might require you to reinstall the computer's operating system. Emulex cannot guarantee that issues resulting from changes you make to the registry can be repaired. Make a backup of your registry before making any changes.

3.2.4.4.2 Backing Up and Editing the Registry

To back up and edit the registry, perform thee steps:

1. Create a system restore point.
2. Open the registry editor by running `regedit.exe` at the command prompt.
3. Select the hive (the top level key) and export it to a `.reg` file.
4. Save the `.reg` file to a location off of the server as a precaution.
5. Navigate to:

   `HKLM\Software\Microsoft\Windows NT\CurrentVersion\Virtualization`

6. Create a DWORD type entry named `IovEnableOverride`.
7. Set the value of `IovEnableOverride` to 1.
8. Reboot the system.

   If the system does not boot, press F8 and select **Previous Known Good**, or use the system restore function while booting from an operating system installation disc or recovery disk.
9. If the system boots but does not work properly, restore from a previous restore point, or import the saved `.reg` file and reboot.

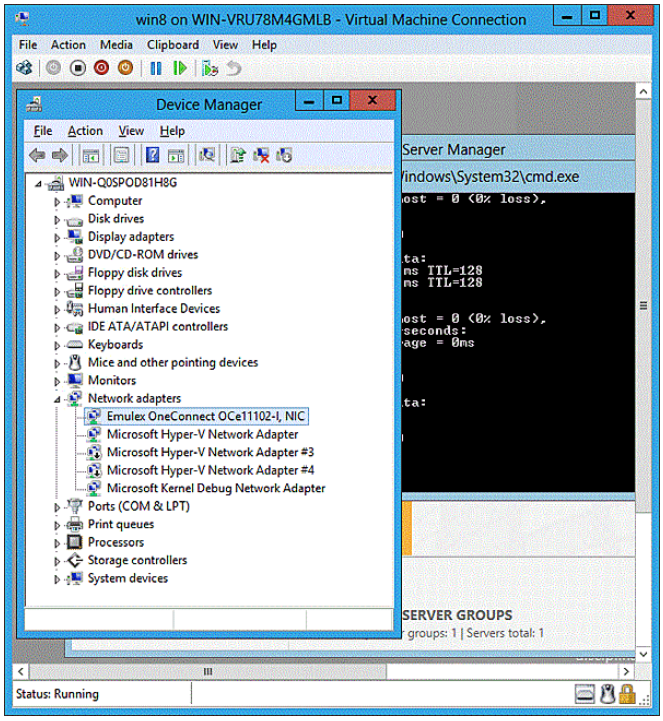
3.2.4.5 Verifying the Driver Version

To verify that the Emulex device driver meets the minimum requirements, perform these steps:

1. Select **Server Manager>Dashboard>Tools>Computer Management**.
2. Click **Device Manager**.

   The Device Manager opens (see Figure 5 on page 62.)

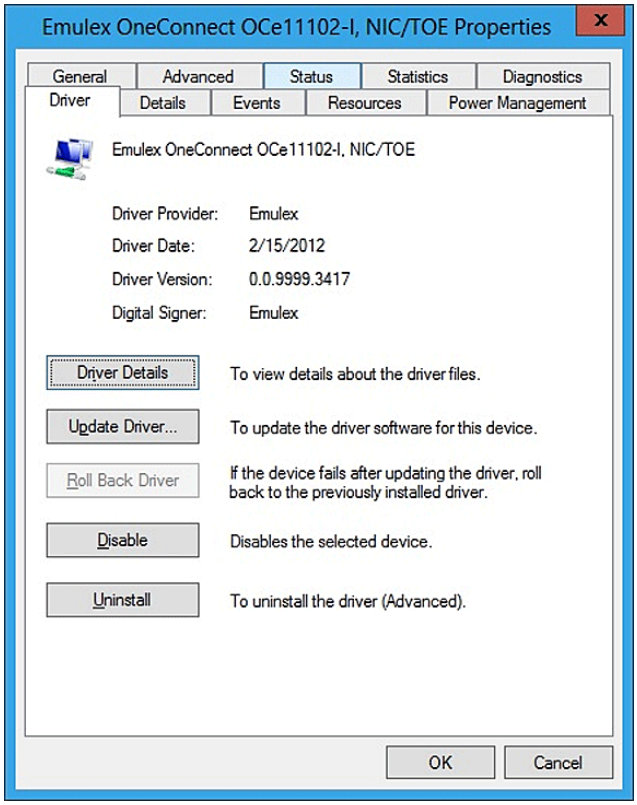
Figure 5 Device Manager for Windows Server 2012



3. Open the Network Adapters item, find the Emulex device and right-click it.
4. Select **Properties** from the context menu.

   The Properties dialog box opens showing the Driver page (see Figure 6 on page 63). The Driver page contains the driver version number.

Figure 6 Emulex NIC Driver Properties Page



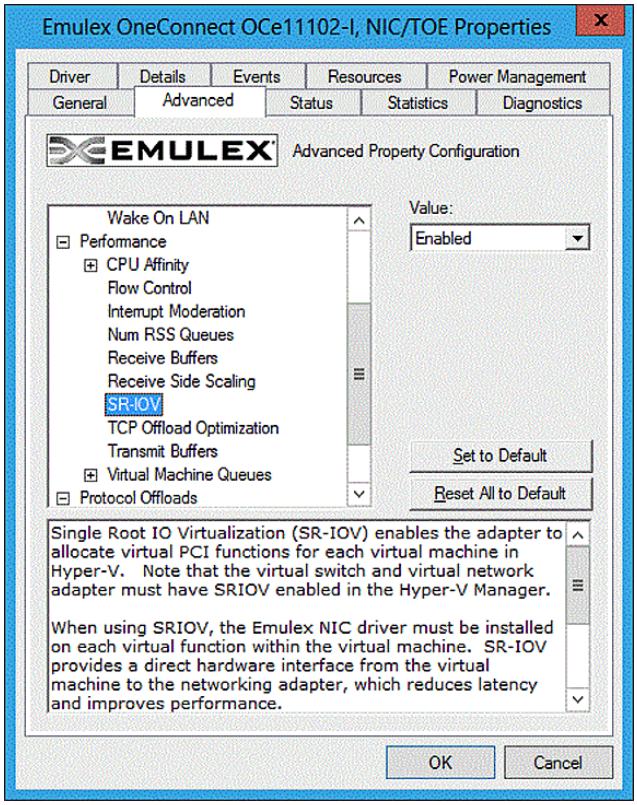
5. Click **Driver Details**.
   A window opens that displays the driver name.

3.2.4.6 Enabling SR-IOV in the Emulex Device

To enable SR-IOV in the Emulex device, perform these steps:

1. Select **Server Manager>Dashboard>Tools>Computer Management**.
2. Click **Device Manager**.
   The Device Manager opens (see Figure 5 on page 62).
3. Open the Network Adapters item, find the Emulex device and right-click it.
4. Select **Properties** from the context menu.
   The Properties dialog opens (see Figure 6 on page 63).
5. Click the **Advanced** tab.
   The Advanced Property Configuration page opens (see Figure 7 on page 64).

Figure 7 Emulex NIC Advanced Properties Page



6. Select **SR-IOV** from the list and select **Enabled** from the **Value** drop-down list.

NOTE You must configure Hyper-V to create an SR-IOV-enabled virtual machine. See the Microsoft Hyper-V documentation for more information.

3.2.4.7 Hyper-V

The Hyper-V role must be added using the Server Manager. After the Hyper-V role is added, you can enable SR-IOV in the Hyper-V Manager by doing one of the following:

- Creating the virtual switch
- Creating each virtual NIC

Refer to the Microsoft documentation for more information.

NOTE Ensure that SR-IOV is enabled on the server and on the Emulex adapter prior to configuring the Hyper-V virtual switch.

The Windows Server 2012 and Windows Server 2012 R2 servers treat SR-IOV as an offload; an active-active team with virtual function and an emulated adapter, which means each Emulex SR-IOV adapter is accompanied by a fully functional, emulated NIC. The emulated NIC is named “Microsoft Virtual Network Adapter,” and the TCP/IP stack is bound only to this device.

After the Emulex driver is loaded, the Emulex SR-IOV virtual function is used for all unicast receive and transmit traffic. The emulated NIC handles multicast and broadcast traffic. If SR-IOV is disabled, the Emulex adapter is removed from the virtual machine, and all traffic automatically uses the emulated NIC. This technology allows live migration of virtual machines if using SR-IOV.

NOTE If multiple adapters are added to the virtual machine, use MAC addresses to map the Emulex Network adapter to the corresponding Microsoft Virtual Network adapters.

3.2.4.8 Verifying SR-IOV

If SR-IOV is enabled, it can be verified by opening the Device Manager within the virtual machine and examining the information about the transmit and receive packets that are using the SR-IOV virtual function. This final verification shows that SR-IOV is working correctly. SR-IOV also can be verified from the host Hyper-V server.

NOTE Because current versions of Windows Server 2012 require that SR-IOV be enabled in different locations prior to creating the virtual switch, if SR-IOV is not working, delete the virtual switch and create it again. The SR-IOV option is always available during switch creation.

3.2.4.8.1 Verifying SR-IOV from the Virtual Machine

To verify SR-IOV from within the virtual machine perform these steps:

1. From within the virtual machine, select **Server Manager>Dashboard>Tools>Computer Management**.
2. Click **Device Manager**.

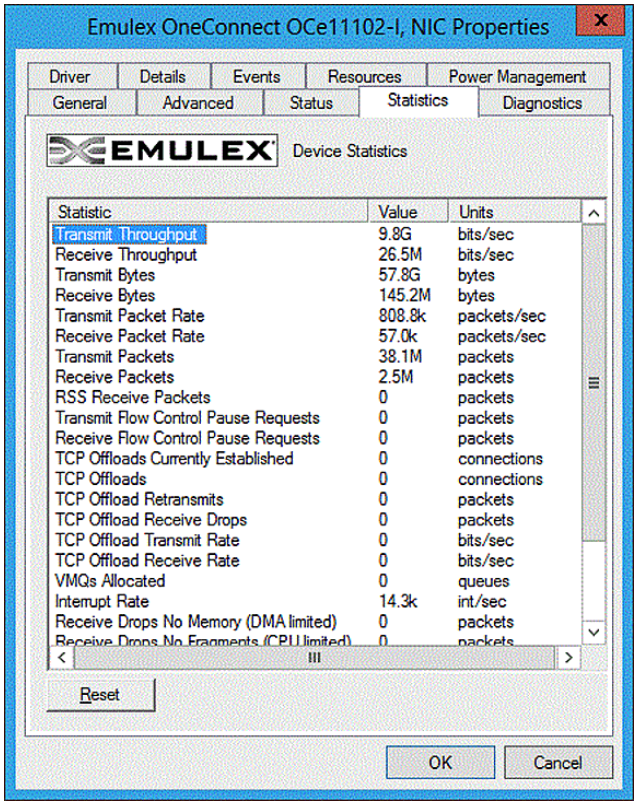
   The Device Manager opens (see Figure 5 on page 62).
3. Open the Network Adapters item, select the Emulex device and right-click.
4. Select **Properties** from the context-menu.

   The Properties dialog opens showing the Driver page (see Figure 6 on page 63).

   NOTE The Emulex adapter might initially appear as a “Network Adapter” before the driver is loaded.
5. Select the **Statistics** tab (see Figure 8 on page 66).

   Information about the transmit and receive packets that are using the SR-IOV virtual function are displayed; specifically, the number of “Transmit Bytes” and “Receive Bytes” that are transmitted directly to hardware from the virtual function. If this number is greater than zero, the device is successfully using the SR-IOV direct hardware access.

Figure 8 Emulex NIC Statistics Properties page



3.2.4.8.2 Verifying SR-IOV from the Host Hyper-V Server

To verify SR-IOV from the Host Hyper-V Server, perform these steps:

1. From the Device Manager, open the Network Adapters item, select the Microsoft Hyper-V Network adapter and right-click.
2. Select **Properties** from the context-menu.

   The Hyper-V Network adapter Properties dialog box opens showing the Driver page.
3. Select the **Statistics** tab (see Figure 8 on page 66).
4. From the Statistics tab, locate the “Virtual Functions Allocated” item.

   “Virtual Functions Allocated” shows the count of currently enabled virtual functions.

NOTE The Microsoft Powershell command “Get-NetAdapterSriovVf” lists each SR-IOV virtual function. Refer to the Microsoft documentation for more information.

3.2.5 Configuring NVGRE for the OCe14000-series Adapters

Network virtualization using NVGRE is a network virtualization method that uses encapsulation and tunneling to create large numbers of VLANs for subnets that can extend across dispersed data centers and layer 2 (the data link layer) and layer 3 (the network layer). The purpose is to enable multi-tenant and load-balanced networks that can be shared across on-premises and cloud environments.

NVGRE was designed to solve issues caused by the limited number of VLANs that the IEEE 802.1Q specification enables, which are inadequate for complex virtualized environments, and make it difficult to stretch network segments over the long distances required for dispersed data centers.

3.2.5.1 Setup

Hardware resources:

- Two host servers
- Virtual machines (two per Hyper-V host)
- One 10GbE or 40GbE Ethernet switch
- Two OCe14000-series adapters (one per host server)

Software resources:

- Windows Server 2012 with Hyper-V
- Windows Server 2012 on the Virtual Machines
- Add and Remove PowerShell Policy Scripts for each host server

To set up NVGRE, perform these steps:

1. On the Hyper-V hosts and peer, change the execution policy to allow PowerShell scripts to run:
   — Set-Execution Policy unrestricted –Force.
   — Run HostRegedit (run this once on the Hyper-V host only).

   This sets the registry key to use VMQs and allows remote PowerShell scripts to be run on the host.
2. Set up non-blank administrator passwords on the peer to run remote PowerShell scripts.
3. Copy the NIC driver to `C:\` driver on the Hyper-V Hosts.

3.2.5.2 Configuration

To create a VM, perform these steps:

1. Use a 10 GB disk image size and 1 GB RAM.
2. Install Windows Serer 2012 RTM.
3. Turn off automatic administrator login by using `control userpasswords2`.
4. Turn off the Windows Firewall.
5. Create a vswitch for NVGRE (for example, vport0).
6. Create a vswitch for non-NVGRE (normal traffic).
7. Expose a NIC interface into the VM for each of the vSwitches:
   — Make sure “Enable virtual machine queue” is selected under Network Adapter > Hardware Acceleration of the VMs.
   — Record the MAC addresses located under the Network Adapter > Advanced Features. These will be used in the add/remove policy scripts.
8. Rename the Network Connection name being used for NVGRE to WNVNIC (for example: **Control Panel>Network and Internet>Network Connections**, rename **Ethernet 3** to **WNVNIC**).
9. Set up an NVGRE script.

3.2.5.2.1 Setting up an NVGRE Script

The following sample script is required for network virtualization:

Example of a Script Adding the NVGRE Tunnel Between Two Hosts

```
# Add the locator records for Blue subnet
Get-NetVirtualizationLookupRecord | where {$_.VirtualSubnetID -eq "5001"} |
Remove-NetVirtualizationLookupRecord;
```

```
New-NetVirtualizationLookupRecord -VirtualSubnetID "5001" -CustomerAddress
"10.0.0.5" -ProviderAddress "192.x.x.x" -MACAddress "060600000005" -Rule
"TranslationMethodEncap"
New-NetVirtualizationLookupRecord -VirtualSubnetID "5001" -CustomerAddress
"10.0.0.7" -ProviderAddress "192.x.x.x" -MACAddress "060600000007" -Rule
"TranslationMethodEncap"

# Add the customer route records for Blue subnet
Get-NetVirtualizationCustomerRoute | where {$_.VirtualSubnetID -eq "5001"} |
Remove-NetVirtualizationCustomerRoute;
New-NetVirtualizationCustomerRoute -RoutingDomainID
"{11111111-2222-3333-4444-000000005001}" -VirtualSubnetID "5001"
-DestinationPrefix "10.0.0.0/24" -NextHop "0.0.0.0"  -Metric 255

##############################################################################
################################
# Red Virtual Network Information
#
# RoutingDomainID="{11111111-2222-3333-4444-000000006001}"
# VirtualSubnetID=6001
# (Both RDID and VSID are defined by administrators, MUST be unique in the
datacenter)
#
# [Customer Addresses]
# VM Name      Host    VSID  CA        PA             MAC                DefaultGW
#
-----------------------------------------------------------------------------
-----
# Red1         Host1   6001  10.0.0.5  192.x.x.x   08-08-00-00-00-05  10.0.0.1
# Red2         Host2   6001  10.0.0.7  192.x.x.x   08-08-00-00-00-07  10.0.0.1
#
# [Customer Routes]
# DestPrefix   NextHopGW  Note
#
-----------------------------------------------------------------------------
----
# 10.0.0.0/24  0.0.0.0    Onlink route for Red subnet

# Add the locator records for Red subnet
Get-NetVirtualizationLookupRecord | where {$_.VirtualSubnetID -eq "6001"} |
Remove-NetVirtualizationLookupRecord;

New-NetVirtualizationLookupRecord -VirtualSubnetID "6001" -CustomerAddress
"10.0.0.5" -ProviderAddress "192.x.x.x" -MACAddress "080800000005" -Rule
"TranslationMethodEncap"
New-NetVirtualizationLookupRecord -VirtualSubnetID "6001" -CustomerAddress
"10.0.0.7" -ProviderAddress "192.x.x.x" -MACAddress "080800000007" -Rule
"TranslationMethodEncap"

# Add the customer route records for Red subnet
Get-NetVirtualizationCustomerRoute | where {$_.VirtualSubnetID -eq "6001"} |
Remove-NetVirtualizationCustomerRoute;
```

```
New-NetVirtualizationCustomerRoute -RoutingDomainID
"{11111111-2222-3333-4444-000000006001}" -VirtualSubnetID "6001"
-DestinationPrefix "10.0.0.0/24" -NextHop "0.0.0.0"  -Metric 255

#
# [2] Configure the Host Provider Addresses and Routes required for this setup
#
# [Host PA Address & Route information required by the VM policy]
#
# Host    Hostname        {PA's}          {VM:VirtualSubnetID} ==> Set on the
VMNetworkAdapter on eash host
#
--------------------------------------------------------------------------------
-----
# Host1   example-host1  192.x.x.x    {Blue1:5001, Red1:6001}
# Host2   example-host2  192.x.x.x    {Blue2:5001, Red2:6001}

# [2-1] Host1
#
# (a) Configure Provider Address and Route:
#     Get the interface, assign the PA and the default route
Get-NetVirtualizationProviderAddress | where {$_.ProviderAddress -eq "192.x.x.x"}
| Remove-NetVirtualizationProviderAddress;

$iface = Get-NetAdapter $WNVNIC
New-NetVirtualizationProviderAddress -InterfaceIndex $iface.InterfaceIndex
-ProviderAddress "192.x.x.x" -PrefixLength 24

# (b) Set VirtualSubnetID on the VM network port
Get-VMNetworkAdapter "Blue1" | where {$_.MacAddress -eq "060600000005"} |
Set-VMNetworkAdapter -VirtualSubnetID 5001;
Get-VMNetworkAdapter "Red1"  | where {$_.MacAddress -eq "080800000005"} |
Set-VMNetworkAdapter -VirtualSubnetID 6001;
```

Example of a Script Removing the NVGRE Tunnel Between Two Hosts

```
################################################################################
################################
# Blue Virtual Network Information
#
# RoutingDomainID="{11111111-2222-3333-4444-000000005001}"
# VirtualSubnetID]=5001
# (Both RDID and VSID are defined by administrators, MUST be unique in the
datacenter)
#
# [Customer Addresses]
# VM Name      Host   VSID  CA        PA            MAC               DefaultGW
#
--------------------------------------------------------------------------------
# Blue1        Host1  5001  10.0.0.5  192.x.x.x   06-06-00-00-00-05  10.0.0.1
# Blue2        Host2  5001  10.0.0.7  192.x.x.x   06-06-00-00-00-07  10.0.0.1
#
# [Customer Routes]
# DestPrefix   NextHopGW  Note
```

```
#
-------------------------------------------------------------------------------
--
# 10.0.1.0/24  0.0.0.0    Onlink route for Blue subnet

# Remove the locator records for Blue subnet
Get-NetVirtualizationLookupRecord | where {$_.VirtualSubnetID -eq "5001"} |
Remove-NetVirtualizationLookupRecord;

# Remove the customer route records for Blue subnet
Get-NetVirtualizationCustomerRoute | where {$_.VirtualSubnetID -eq "5001"} |
Remove-NetVirtualizationCustomerRoute;

###############################################################################
################################
# Red Virtual Network Information
#
# RoutingDomainID="{11111111-2222-3333-4444-000000006001}"
# VirtualSubnetID=6001
# (Both RDID and VSID are defined by administrators, MUST be unique in the
datacenter)
#
# [Customer Addresses]
# VM Name      Host    VSID  CA        PA             MAC                DefaultGW
#
-------------------------------------------------------------------------------
-----
# Red1         Host1   6001  10.0.0.5  192.x.x.x   08-08-00-00-00-05  10.0.0.1
# Red2         Host2   6001  10.0.0.7  192.x.x.x   08-08-00-00-00-07  10.0.0.1
#
# [Customer Routes]
# DestPrefix   NextHopGW  Note
#
-------------------------------------------------------------------------------
-----
# 10.0.0.0/24  0.0.0.0    Onlink route for Red subnet

# Remove the locator records for Red subnet
Get-NetVirtualizationLookupRecord | where {$_.VirtualSubnetID -eq "6001"} |
Remove-NetVirtualizationLookupRecord;

# Remove the customer route records for Red subnet
Get-NetVirtualizationCustomerRoute | where {$_.VirtualSubnetID -eq "6001"} |
Remove-NetVirtualizationCustomerRoute;

#
# [2] Configure the Host Provider Addresses and Routes required for this setup
#
# [Host PA Address & Route information required by the VM policy]
#
# Host    Hostname        {PA's}          {VM:VirtualSubnetID} ==> Set on the
VMNetworkAdapter on eash host
```

```
#
--------------------------------------------------------------------------------
-----
# Host1   example-host1  192.x.x.x    {Blue1:5001, Red1:6001}
# Host2   example-host2  192.x.x.x    {Blue2:5001, Red2:6001}

# [2-1] Host1
#
# (a) Configure Provider Address and Route:
#     Get the interface, assign the PA and the default route
Get-NetVirtualizationProviderAddress | where {$_.ProviderAddress -eq "192.x.x.x"}
| Remove-NetVirtualizationProviderAddress;

# (b) Set VirtualSubnetID on the VM network port
Get-VMNetworkAdapter "Blue1" | where {$_.MacAddress -eq "060600000005"} |
Set-VMNetworkAdapter -VirtualSubnetID 0;
Get-VMNetworkAdapter "Red1"  | where {$_.MacAddress -eq "080800000005"} |
Set-VMNetworkAdapter -VirtualSubnetID 0;
```

3.2.5.2.2 Policy Script Information

Verify or modify the following list of components for your specific conditions:

- Network connection name of the NIC attached to the virtual switch
- Binding network connection to the Microsoft filter driver (ms_netwnv)

CAUTION Do not change the filter driver name.

- VM Names
- VM MAC Addresses
- VM SID (Virtual Machine Subnet ID)
- HOST IP Address (Provider Address = Physical NIC IP Address for NVGRE)
- VM IP Address (Customer Address = IP Address on each vNIC per VM)
- Subnet Masks

3.2.5.2.3 Verification and Troubleshooting

Verify that the host provider addresses can access each other. If a ping fails, perform these steps:

1. Shutdown all VMs on all of the hosts.
2. Remove the policies.
3. Remove the vport0 virtual switch.
4. Reboot the hosts.
5. Create a vport0 switch.
6. On each VM, add a new adapter, and use the vswitch name that you just created.

NOTE Do not share the NIC with the host operating system.

7. Apply the policies.
8. Power up the VMs.
9. Send a ping to the provider addresses.

`MS_NETWNV.sys` must only be bound to WNVNIC (physical NIC). If `ms_netwnv` is bound to a vswitch or Hyper-V adapter, unbind it from the host server. For example:

```
Disable-netadapterbinding vEthernet* -ComponentID ms_netwnv
```

Verify that all of the IP addresses and MAC addresses used in the add and remove policy scripts match the VM IP's/MACs using `ipconfig /all`.

Create firewall rules to allow ICMP (ping) packets:

1. New-NetFirewallRule –DisplayName "Allow ICMPv4-In"

```
 –Protocol ICMPv4
```

2. New-NetFirewallRule –DisplayName "Allow ICMPv4-Out"

```
 –Protocol ICMPv4 –Direction Outbound
```

PowerShell commands shown w/"WNVNIC" used as the network connection name:

```
Get-VM
Get-vmswitch
Get-vmnetworkadapter –VMName * | fl
vmname,switch*,macaddress,ipaddress*,virtualsub*
Get-netvirtualizationprovideraddress
Get-netvirtualizationlookuprecord
Get-netvirtualizationcustomerroute
Get-netadapter wnvnic
Get-netadapterbinding –componentID ms_netwnv
Get-netadapterencapsulatedpackettaskoffload wnvnic
Get-netadapteradvancedproperty wnvnic
Disable-netadatperSriov wnvnic
Disable-netadapterEncapsulationPacketTaskOffload wnvnic
Get-help *-NetVirtualization*
Get-netadapterstatistics wnvnic
```

Under the **Host Device Manage> – Network Adapters > Emulex Statistics** tab, check the following:

- VMQs Allocated
- Tunnels Allocated
- Tenants Allocated

To verify that all of the IP addresses and MAC addresses used in the add and remove policy scripts match the VM IP's/MACs, perform these steps:

1. Send a ping.
   a. Launch Policy Scripts on each host.
   b. Send a ping using the `–t` option.
      Pings will respond.
   c. Run the Remove Policy script on one host server.
      Pings will stop responding.
   d. Add policies.
      Pings will respond.
2. Change the VM IP Address.
   For example: change 10.0.0.5 on one host and 10.0.0.7 on the other.

Without NVGRE, you would not be able to use the same IP address as the other VM.

Ensure that you see the WNVNIC interface using the PowerShell command get-netadapter.

If you are unable to see the NVGRE Ethernet connection, make sure that the Hyper-V's control panel/network connections property and advanced property windows are all closed. The Control Panel renames the NDI/Params registry keys and causes the policy scripts to be inoperative.

3.2.5.2.4 Cleaning Up Outdated Network Adapter Data

To clean up outdated network adapter data, perform these steps:

1. Start a win32 console window (command prompt).
2. From the command prompt, type

   ```
   Set devmgr_show_nonpresent_devices=1
   ```
3. Start `devmgmt.msc`.
4. In the device manager console, go to the view menu and select **Show hidden devices**.
5. Open the network devices tree view.
6. Uninstall all Emulex entries.
7. Rescan for hardware changes.
8. Uninstall Emulex devices until they are not recognized.
9. Install the new driver.

3.2.6 Configuring RoCE for the OCe14000-Series Adapters

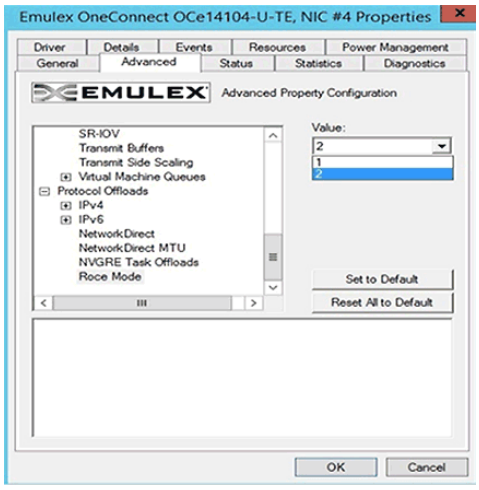
Both Windows SMB Direct and Windows NetworkDirect, which are included as part of the Windows operating system, are required for RoCE. Windows Server 2012 or Windows Server 2012 R2 is required to use the RoCE features on RoCE-capable adapters.

NOTE RoCE is not supported if UMC is enabled and RoCE configurations are not supported with SR-IOV.

3.2.6.1 Configuring Routable RoCE

Routable RoCE is enabled by default. A drop-down menu is added in property page. RoCE Mode 2 is Routable (default setting) and RoCE Mode 1 is Native RoCE.

Figure 9 Advanced tab RoCE Mode selected



To enable or disable routeable RoCE, perform these steps:

1. From the **Advanced** tab of the **Network Property** page, select **RoCE Mode** (Figure 9).
2. From the Value menu, choose **2** to enable routable RoCE, or choose **1** to select Native RoCE.

3.2.6.2 Enabling the RoCE Profile on the Client-Side

The RoCE profile can be enabled by using one of the following:

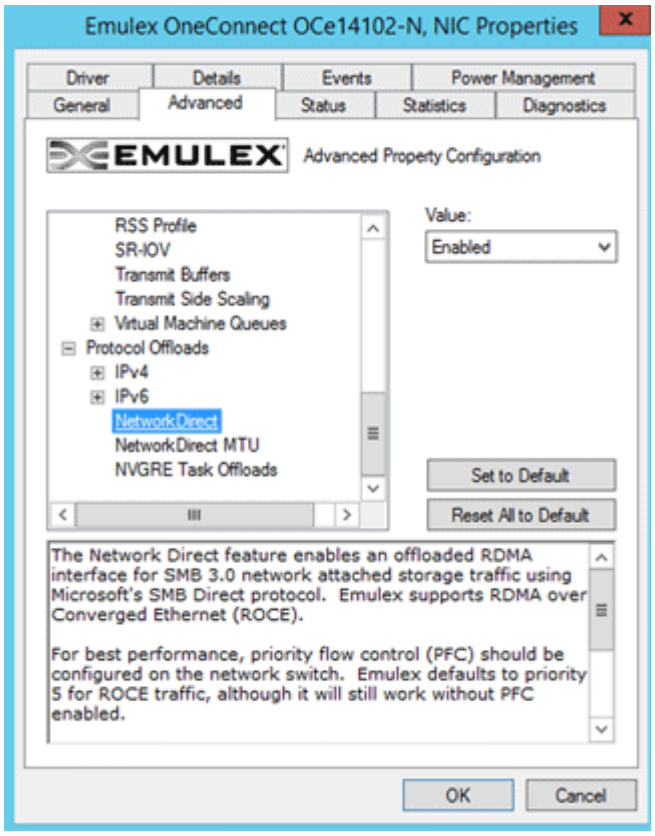
- PXESelect BIOS. Refer to the *Boot for NIC, iSCSI, FCoE, and RoCE Protocols User Manual* for details on the PXESelect BIOS utility.
- OneCommand Manager GUI. Refer to the *OneCommand Manager Application Version User Manual* for information about enabling the RoCE profile using the OneCommand Manager GUI.
- OneCommand Manager CLI. Refer to the *OneCommand Manager Command Line Interface Manual* for information about enabling the RoCE profile using the OneCommand Manager CLI.

3.2.6.3 Confirming That the RoCE Profile Is Enabled

To confirm that the RoCE profile is enabled, use one of the following methods:

- In the **Advanced** tab of the **Network Property** page, ensure that **NetworkDirect** is enabled (see Figure 10).

Figure 10 Advanced Property Configuration - RoCE - Enabled



- By using a PowerShell script:
  - Get-NetAdapterRDMA (Figure 11)

Figure 11 Get-NetAdapterRDMA - RoCE-Enabled)

```
PS C:\Users\Administrator> get-netadapterrdma

Name                      InterfaceDescription                    Enabled
----                      --------------------                    -------
SLOT 5 Port 2             Emulex OneConnect OCe14102B-U1-D 2-po... True
SLOT 5 Port 1             Emulex OneConnect OCe14102B-U1-D 2-po... True
```

— Get-NetOffloadGlobal (Figure 12)

Figure 12 Get-NetOffloadGlobal - RoCE-Enabled

```
Windows PowerShell
Copyright (C) 2013 Microsoft Corporation. All rights reserved.

PS F:\Users\Administrator> Get-NetOffloadGlobalSetting


ReceiveSideScaling           : Enabled
ReceiveSegmentCoalescing     : Enabled
Chimney                      : Disabled
TaskOffload                  : Enabled
NetworkDirect                : Enabled
NetworkDirectAcrossIPSubnets : Blocked
PacketCoalescingFilter       : Disabled
```

If the profile is correct and NetworkDirect is enabled, you will see active NetworkDirect listeners on IP addresses (port 445) assigned to the NICs using
`netstat -xan`.

3.2.6.4 Using SMB Direct with NetworkDirect

Because RoCE is supported in Windows using SMB Direct with NetworkDirect, it is important that SMB Direct and NetworkDirect be configured correctly.

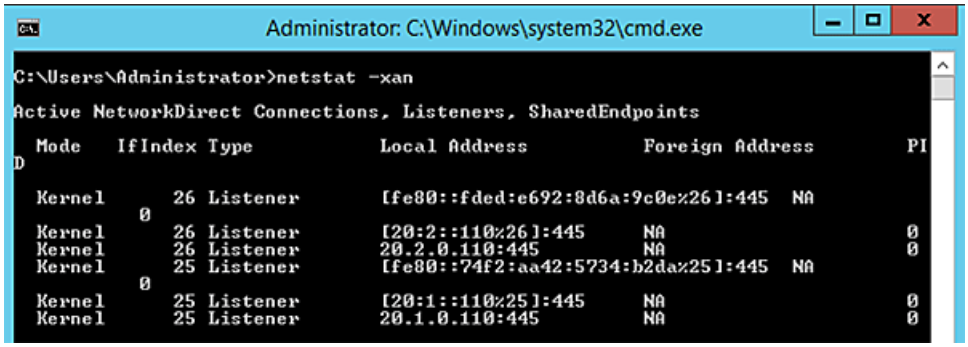
To use SMB Direct with NetworkDirect, perform the following steps:

1. From the **Advanced** tab of the **Network Interface Properties** page, enable the `NetworkDirect` parameter.
2. Set the NetworkDirect MTU. Use a NetworkDirect MTU of 4096 bytes for OCe14400-series adapters.

NOTE The NetworkDirect MTU affects only RoCE traffic, but the NIC traffic still uses the "Packet Size" MTU. An SMB Server accepts an incoming connection request from an SMB Client when the NetworkDirect MTU on the server is at least as large as the NetworkDirect MTU on the initiating client.

3. Use the `netstat -xan` command to enumerate the active NetworkDirect connections and listeners (Figure 13). A NetworkDirect enabled driver creates listeners on any configured IPv4 or IPv6 addresses, and the link-local IPv6 address. SMB Direct listeners listen on port 445.

Figure 13 Active NetworkDirect Connections and Listeners



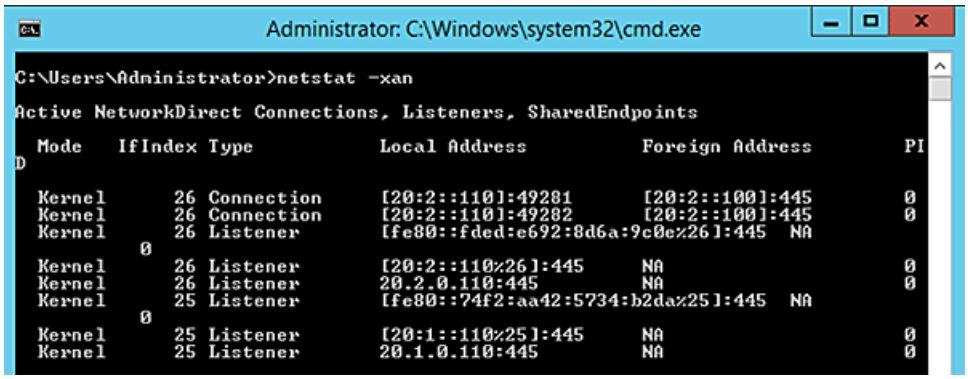
3.2.6.5 Mapping the RoCE-Enabled Client to the Server-Side Storage

Using an available network share with the proper permissions configured, open an SMB share from the Windows Run command or from the command prompt, by typing:

```
net use [devicename:*] [\\computername\sharename]
```

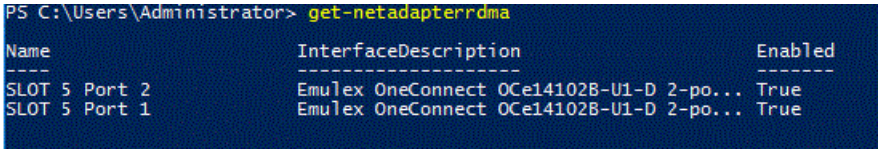
By default, this creates two RDMA connections per SMB Direct-enabled network interface on a particular server (see Figure 14 on page 76). Each SMB Direct connection maps to an RDMA queue pair. Both the client and server must negotiate support for SMB Direct. If available, each TCP connection is offloaded to an RDMA queue pair.

Figure 14 SMB Share - Two RDMA Connections Per RDMA-Enabled Network Interface



The PowerShell command, `Get-NetAdapterStatistics` (see Figure 15), shows the RDMA Statistics which indicate the number of failed connection attempts.

Figure 15 Get-NetAdapterStatistics

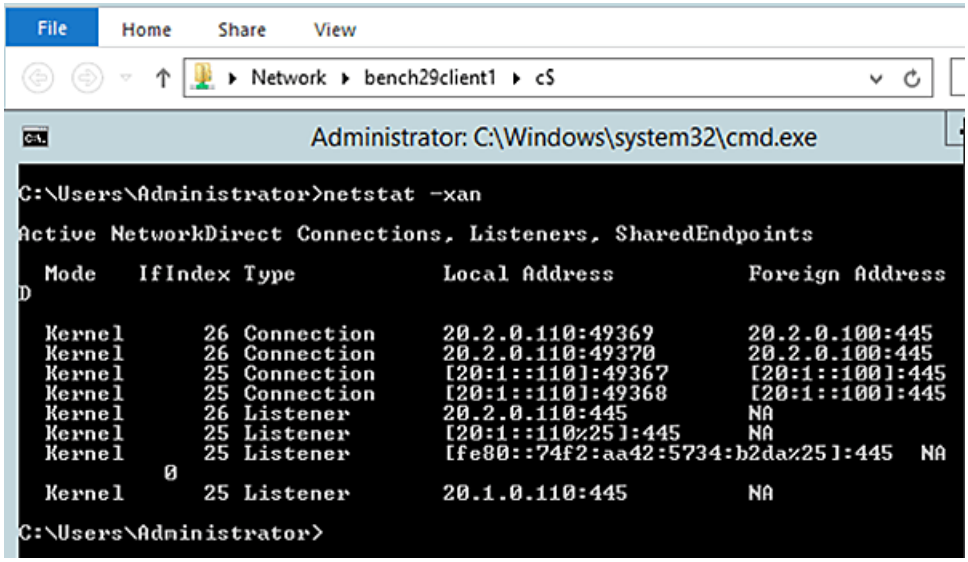


3.2.6.6 SMB Multichannel

For each SMB session, SMB multichannel establishes two SMB Direct connections to a particular server by default. It also makes use of multiple RDMA-capable NIC interfaces, if available.

Opening a file share from a 2-port OCe14000-series adapter (both ports are RDMA-enabled) connected back-to-back to another 2-port OCe14000-series adapter (both ports are also RDMA-enabled) creates two SMB Direct connections per interface (see Figure 16 on page 77).

Figure 16 Two SMB Direct Connections Per Interface



Use SMB multichannel constraints to limit an SMB connection to specific network interfaces. For example, if you have a 1GbE interface meant for a management path and one or more 10GbE interfaces meant for the RDMA traffic, you can restrict the RDMA traffic to the faster 10GbE interfaces by setting SMB multichannel constraints.

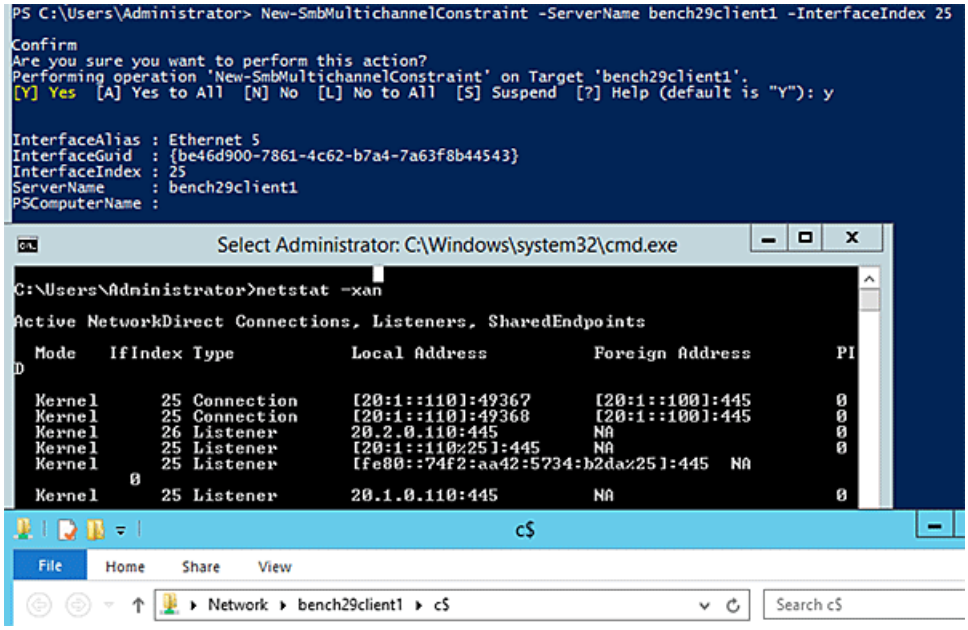
You can specify SMB multichannel constraints on the SMB client using certain RDMA network interfaces to access a particular server.

Figure 17 on page 78 shows that an SMB multichannel constraint has been added to specify that only InterfaceIndex 25 must be used to connect to the server `bench29client1`.

Two SMB Direct connections are established on the RDMA Network Interface with IfIndex: 25. None are established on the other OCe14000-series adapter ports; for example, the RDMA Network Interface with IfIndex: 26 (20.2.0.110).

NOTE On Windows Server 2012, depending on the path used to open the previous SMB sessions to the SMB server, you might notice multiple instances of connections being created while establishing a single SMB session to the server. When adding or removing adapters from your system, you must readjust the multichannel constraints for optimal performance.

Figure 17 SMB Multichannel Constraint



3.2.6.7 SMB Direct Resource Usage

This section describes how to use SMB Direct resources.

3.2.6.7.1 Active Connections

Active connections describe the connections that a client makes to a server. Passive connections describe the connections that a server allows the client to complete.

The maximum number of active connections per port for an adapter are required if setting the `ConnectionCountPerRdmaNetworkInterface` parameter. Use Table 6 on page 79 to determine the correct number of maximum active connections based on your OCe14000-series adapter and operating system.

NOTE Passive and active connection limits for OCe14000-series adapters followe following equation:
511 - (2 *:

- Active mode – See Table 6 on page 79.
- Passive mode – Maximum passive connections are calculated using the following equation:
  511 - (2 x number of ports)
- Passive and Active mode – Active and passive connection counts together must not exceed 511 - (2 x number of ports)

NOTE Passive and active connection limits for OCe14000B-series adapters follow:

- Active mode – See Table 6 on page 79.
- Passive mode
- 40Gb 1 port is 254 passive connections.
- 10Gb 2 port is 253 passive connections per port.
- 10Gb 4 port is 126 passive connections per port.

Table 6 shows the maximum number of SMB Direct active (client mode) connections that can be initiated on Windows Server 2012 and Windows Server 2012 R2 using the OCe14000-series adapters.

Table 6 SMB Direct Active Connections (Client Mode) Per Port for OCe14000-Series Adapters

Adapter Type	Windows Server 2012	Windows Server 2012 R2
1-port 40GbE adapter	31	15
2-port 10GbE adapter	15	7
4-port 10GbE adapter	7	3
1-port 40Gb adapter (OCe14000B-series adapters)	47	23
2-port 10Gb adapter (OCe14000B-series adapters)	31	11
4-port 10Gb adapter (OCe14000B-series adapters)	11	6

The Maximum Queue Pair counts on a 1-port, 2-port, and 4-port OCe14000-series adapter are shown in Figure 18 on page 79, Figure 19 on page 79, and Figure 20 on page 79.

Figure 18 Resource Counts on a 1-Port 10GbE or 40GbE OCe14000-Series Adapter

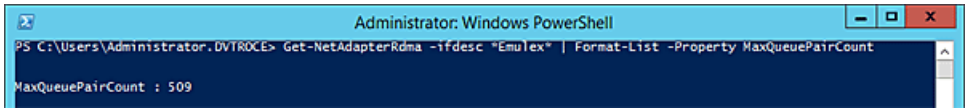


Figure 19 Resource Counts on a 2-Port 10GbE OCe14000-Series Adapter

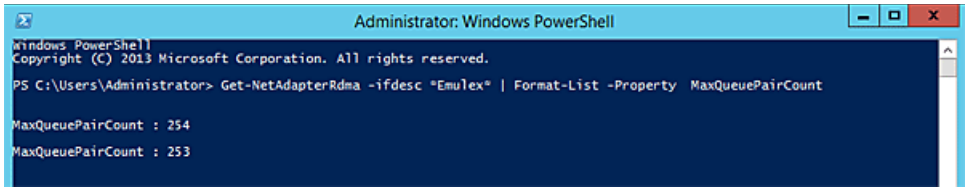
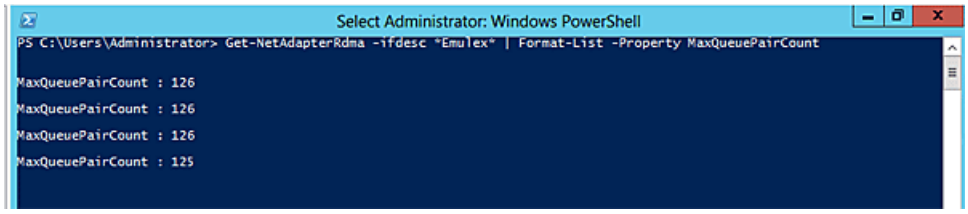


Figure 20 Resource Counts on a 4-Port 10GbE OCe14000-Series Adapter



SMB Direct does not take these adapter-reported limits into consideration when creating SMB Direct connections because the driver might still get a request to create more queue pairs or memory regions than are supported.

NOTE OCe14000-series adapters will fail to create a memory region or queue pair if they exceed the limits of what is supported. The per-port maximum active connections and the maximum passive connections cannot exceed the MaxQueuePairCount. See Table 6 on page 79, for more information.

For Windows Server 2012 and Windows Server 2012 R2, all existing RDMA connections between the particular client-server pair, on which the failure occurred, are torn down and re-created. After a certain number of unsuccessful retries, SMB traffic falls back to TCP/IP.

The following event warning message is placed in the Windows System Log under the source `be2net` which indicates the adapter is running out of resources:

```
"The Adapter ran out of resources while creating the requested number of SMB
Direct connections. Please reduce the connection count to a supported value."
```

3.2.6.7.1.1 Setting RoCE Parameters

You can set the RoCE adapter parameters using OneCommand Manager, PowerShell scripts, or by using the Network Interface Property page.

NOTE Refer to the *OneCommand Manager Application User Manual* for more information on using the OneCommand Manager GUI application to configure RoCE, or refer to the *OneCommand Manager Command Line Interface* for information on using the OneCommand Manager CLI to configure RoCE.

The parameters in Table 7 can be modified from the Network Interface Property page (see Figure 7 on page 64.

Table 7 Parameters for RoCE

Parameter	Description
`NetworkDirect`	This parameter enables an offloaded RDMA interface for SMB 3.0 network-attached storage traffic using Microsoft's SMB Direct protocol.
`NetworkDirect MTU`	This parameter configures the maximum transmission unit (frame size) for RoCE traffic. **NOTE** For optimal performance, Emulex recommends setting the MTU size to 4096.
`RoCE Mode`	This parameter controls the RoCE mode as native or routable. ■ 1= Native RoCE ■ 2 = Routable RoCE

The parameters in Table 8 on page 80 can be viewed using the Statistics Property Page (see Figure 8).

Table 8 RoCE Parameters Available for Viewing

Parameter	Description
`RoCE QP Allocated`	Indicates the number of established queue pairs for RoCE.
`RoCE Transmit Throughput`	The transmit data rate of RoCE traffic.
`RoCE Receive Throughput`	The receive data rate of RoCE traffic.

3.2.6.8 QoS Concepts Related to RoCE

This section describes QoS concepts and how to configure QoS for RoCE.

3.2.6.8.1 Priority Groups

It is advisable to split traffic into two or more priority groups; one priority group for RoCE and other groups for non-RoCE traffic. Many of the cluster applications use TCP and RoCE traffic simultaneously. Some of them use TCP for establishing connections and share connection-specific information. As a result, it is important to allocate enough bandwidth (greater than 1%) to non-RoCE (NIC traffic) to avoid a slow connection establishment rate and starvation of

NIC traffic. Work conserving behavior ensures that each priority group gets enough bandwidth. Based on this behavior, non-RoCE traffic must be given sufficient bandwidth; ideally 30 percent to 70 percent.

3.2.6.8.2 L2 Flow Control

If a port is operating in generic pause mode, RoCE latencies can be adversely affected. In this situation, configure RoCE to use PFC for better results.

For switches and adapters that do not support PFC, RoCE can continue to operate in generic pause mode. Bandwidth allocation can still be configured for RoCE versus NIC traffic. However, this allocation cannot be guaranteed, because all of the outgoing traffic can be paused in case of congestion.

3.2.6.9 Configuring QoS for RoCE

If configuring QoS for RoCE, consider the following points:

- A limited QoS configuration is available through the OneCommand Manager application.
- A single traffic class group for RoCE exists per port.
- A single RoCE priority exists in PFC mode.
- Bandwidth allocation for priority groups is supported.

NOTE

- The Windows NIC driver does not support the Microsoft DCB/QoS API.
- PowerShell commands cannot be used to configure QoS-related parameters for the RoCE profile.

3.2.6.9.1 RoCE Adapter Side

With DCBX enabled, the switch settings are used for PFC. Ensure that the switch settings match the adapter default Priority 5 used for RoCE and PFC.

NOTE PFC is enabled by default in OCe14000-series adapters.

3.2.6.9.2 Switch Side

For information on switch-side configurations, see Section E, RoCE Switch Support.

3.2.6.9.3 OCe14000-Series Adapter Defaults

If using the OCe14000-series adapters for RoCE functionality, the following defaults apply:

- Adapter boot time
  - PFC is disabled on all the ports in the NIC, and the RoCE profile is enabled.
  - Generic Pause is enabled on all the ports in the NIC and RoCE profiles.
- Back-to-back connection (OCe14000 to OCe14000)
  - PFC is disabled by default.
  - Generic Pause is enabled on the connected port.
- DCBX-enabled switch connection
  - If an OCe14000-series adapter is connected to a DCBX-enabled switch, it shifts the mode from Generic Pause to PFC.
  - An OCe14000-series adapter configures RoCE traffic for priority 5.
- Manually enable priority 5 on the switch under a different priority group other than the FCoE/iSCSI/NIC priority group.

NOTE If you do not enable priority 5 on the switch side, the OCe14000-series adapter maintains its configuration for PFC mode priority 5. This configuration can result in packet losses, unrecoverable errors, or infinite retries for RoCE traffic.

- DCBX-disabled switch connection
  - If an OCe14000-series adapter is connected to a DCBX-disabled switch, generic pause mode is enabled.

3.2.6.10 Congestion Management Options for RoCE

In addition to QoS settings, the OCe14000-series adapter supports congestion management protocols. The supported modes are Quantized Congestion Notification (QCN) for RoCE ports or Explicit Congestion Notification (ECN) for RoCE v2 ports.

NOTE For each RoCE port, the RoCE traffic must be limited to either RoCE or Routable RoCE (default).

If the port is configured for RoCE, it can support QCN. This feature must be enabled on both the RoCE port and the switch port. The port can be enabled using the OneCommand Management application. Refer to the *OneCommand Manager application User Manual* for details. The switch must also be enabled to generate QCN packets. QCN is active only if both the RoCE port and the switch port are enabled. The switch port must toggled after enabling QCN from the OneCommand Management application.

If the port is configured for Routable RoCE, it can support ECN. If this feature is enabled on the network switches, the Routable RoCE port will recognize ECN marked packets, send CNPs and react to CNPs. ECN is automatically detected by OCe14000B-series adapters.

3.2.6.11 Performance Considerations

The following recommended settings can improve SMB performance over TCP, including RDMA. However, the configuration must be tuned to provide line rate with TCP network traffic.

1. Disable TCP Autotuning.
2. Set the RDMA MTU size to 4096.
3. Set the NIC MTU size to 9014. The NIC MTU must be greater than the RDMA MTU.
4. On Windows Server 2012 R2, disable the bandwidth throttling option on the SMB client side to improve throughput (this parameter has no effect on Windows Server 2012):

```
Set-SmbClientConfiguration -EnableBandwidthThrottling 0
```

3.2.6.12 Configuring UMC

NOTE RoCE is not supported if UMC is enabled.

UMC allows you to divide a 10GbE port into multiple physical functions with flexible bandwidth capacity allocation. These functions appear to the operating system and network as separate physical devices.

UMC can be configured on OCe14000-series adapters through the adapter BIOS or the OneCommand Manager application.

- To configure UMC using the adapter BIOS, refer to the *Boot for NIC, iSCSI, FCoE, and RoCE Protocols User Manual*.
- To configure UMC using the OneCommand Manager application, refer to the *OneCommand Manager Application User Manual* or the *OneCommand Manager Command Line Interface User Manual*.

Refer to the Emulex *Universal Multi-Channel Reference Guide* for additional information on UMC.

3.2.6.13 NPar Configuration (Dell Only)

NOTE

- NPar is available only on Dell OCe14000-series adapters.
- If NPar is enabled, RoCE cannot be configured on any function.
- Each partition must have standard NIC properties for stateless offload.

NPar enables you to divide a 10GbE NIC port into multiple PCI functions with flexible bandwidth capacity allocation that appears to the operating system and network as separate NIC ports. For example, a single 10GbE port appears as multiple physical devices showing in PCI configuration space as multiple functions.

3.2.6.13.1 Adapter Configuration

NPar can be configured on OCe14000-series adapters in several ways, including the Emulex adapter driver properties, the adapter BIOS, or using the OneCommand Manager application.

Refer to the *Boot for NIC, iSCSI, FCoE, and RoCE Protocols User Manual* for information on configuring the adapter BIOS. If you are using the OneCommand Manager application, refer to the *OneCommand Manager Application User Manual*.

On the host operating system side, NPar provides up to 16 PCI functions per device using standard PCI configuration space if NParEP is enabled. Four PCI functions can be mapped to a physical port on a 4-port adapter. Eight PCI functions can be mapped to a physical port on an 2-port adapter. Each function or partition is assigned a unique MAC address.

Partitions are available for virtual function assignment and for application segmentation using VLAN or IP subnets. The partitions can be on separate subnets or VLANs.

3.2.6.13.2 NPar Partition Support

- Flexible bandwidth allocation with no changes required for the operating system or BIOS.
- The switch is independent; changes to the external switch are not required.
- NIC teaming is supported.
- The following items are supported on a per-partition basis:
  - Statistics
  - LSO, LRO, RSS, TSO, and MTU
  - Support for NetQueues

3.2.6.14 NPar Considerations

- NPar can use virtual adapters using VLAN tagging per partition.
- NPar can use RSS queuing support per partition.
- DCBX is supported while in NPar mode.
- If iSCSI or FCoE functions are not enabled, they are available as NIC functions.
- Only one iSCSI function is allowed per physical port.
- Only one FCoE function is allowed per physical port.
- The second to fourth functions on a particular port are available for storage protocols if desired, which allows you to configure up to two storage functions.
- If NParEP is disabled, a total of eight functions are available evenly distributed across the ports on the adapter. For example, a 2-port adapter can have four functions per port and a 4-port adapter can have two functions per port.

NOTE A system reboot is required if any of the NPar function mode settings are modified. A reboot is not required for bandwidth and MTU settings modifications.

3.2.7 Network Driver Performance Tuning

This section describes the tuning and configuration of the network drivers.

3.2.7.1 Optimizing Server Hardware and BIOS Configuration

Adapter performance can be improved by selecting a more efficient PCIe packet payload size. If the system BIOS allows selection of a larger PCIe packet size, selecting at least a 512-byte PCIe packet payload size provides the best efficiency for PCIe data transfers. This setting might be an option in the server's system BIOS. The current value is displayed in Device Manager on the Status property page for the adapter.

Most computers offer multiple distinct memory channels, which must be configured for channel interleaving for optimal performance. Optimal interleaving is achieved by using the exact same DIMM configuration for each memory channel. Check the manufacturer's documentation and BIOS parameters for details about optimizing memory bandwidth. Typically, all of the DIMM slots must be populated to make use of all memory channels. As a general rule, more DIMMs provide better performance by allowing a higher degree of memory-access interleaving to occur. However, some servers decrease the memory speed if using more than two DIMMs per memory channel, so it is important to consider the trade-off for a particular server platform.

Some servers might allow memory mirroring or memory sparing, where the total memory is divided in half and each location is stored twice. Memory mirroring and memory sparing provide fault recovery if one memory location detects an error, but they greatly reduce the perceived memory bandwidth of the system.

Nearly any desktop or low-end server has enough memory bandwidth for the adapter to support DMA at 20 Gb/s of data (10 Gb/s read, 10 Gb/s write). However, most of the memory demands come from the processor accessing the data for either packet copies in the non-offloaded networking stack or application. Increasing the clock speed of the memory interface to the processor can be critical for achieving the best networking performance. This interface might be the FSB, Intel QPI, or AMD HyperTransport.

3.2.7.2 Windows Server Network Driver

Table 9 describes ways to use various NIC driver properties and Microsoft Windows properties to performance-tune a system.

Table 9 Windows Server Performance Tuning Situations

Situation	Answer/Solution
A large number of short-lived TCP connections, such as web server or email server, exist.	Enable RSS, increase the number of RSS queues, and disable TCP offload.
Large data transfers, such as to a file server, web server with file downloads, or an FTP server, exist.	Use TCP connection offload.
Large data transfers, such as to a backup server, exist.	Enable jumbo packets, and use TCP offload.
TA small server is struggling to keep up with larger servers on the network.	Disable RSS, enable TCP offload, enable jumbo packets, and increase the interrupt moderation to allow fewer interrupts per second.
A general-purpose server, such as Active Directory server, DHCP server, or a DNS server, exists.	Use TCP offload, and enable RSS.

3.2.7.2.0.1 Analyzing Performance Issues

You can use the Windows Performance Monitor (perfmon) to view statistics for each network device.

1. Click **Start > Run > perfmon** to launch the Windows Performance Monitor.
2. Right-click and select **Add Counters** to add additional statistics.

Table 10 is a partial list of the statistics to use to troubleshoot performance issues. For network performance, all of the counters from the table are useful: Network Interface, TCPv4, IPv4, and Processor.

Table 10 Statistics and Fine Tuning

Situation	Answer/Solution
Network Interface > Packets Received Errors.	If this value is incrementing even a small amount, a physical problem might exist on the network, such as a loose connection or bad cable, which causes CRC errors in Ethernet packets. Find and eliminate the physical problem.
Network Interface > Packets Received Discarded.	If this value is incrementing dramatically, the computer system might be receiving a lot of unsolicited traffic using network resources.
IPv4 > Fragmented Datagrams / sec.	If this value is greater than 0, the computer system is sending or receiving IP fragments. This problem impacts performance. See Section 3.2.7.2.0.2, Jumbo Packet.
TCPv4 > Segments Retransmitted / sec.	TCP retransmits indicate that packets are being dropped by the receiving system (or in a network switch). Ideally, reduce retransmits to 0.
Processor >% Processor Time.	If CPU usage is high, try to enable all available offloads, such as TCP offload or checksum offloads, and use jumbo packets.

3.2.7.2.0.2 Jumbo Packet

The jumbo packet setting in the registry determines the maximum Ethernet packet size. It includes the Ethernet frame header (typically 14 bytes) but excludes the trailing CRC. The standard packet size is 1514 bytes plus a 4-byte trailing CRC.

Vendors use many terms that refer to this same quantity, such as packet size, frame size, or MTU. The MTU is the Ethernet packet payload size. The MTU does not include the Ethernet frame header or the trailing CRC. The standard MTU is 1500 bytes, corresponding to a 1514-byte packet size plus a 4-byte trailing CRC. Historically, any 1514-byte frame is a standard packet, while any frame larger than 1514 bytes is called a jumbo packet. Windows Server attempts to standardize the terminology across vendors so that the jumbo packet parameter refers to the byte size of the packet.

The Windows Server driver supports several jumbo packet values. The larger packet size provides better throughput and CPU usage. Typically, all devices on the network, including switches, must be configured for the larger size. The drawbacks of using jumbo packets are interoperability and increased memory usage on the server.

To set a jumbo packet value, go to the Advanced Properties page in Windows Device Manager. For information on how to configure the options through the Advanced Property page, Section 3.2.2.1, Modifying Advanced Properties.

The path MTU is the maximum MTU that can be used before IP fragmentation occurs, taking into account the MTU for the endpoints and all routers between the endpoints. To verify the path MTU, send a ping to a remote target with an increasing payload size. Eventually, the IP packet length exceeds the path MTU, and the packet fragments. This situation can be seen by using a packet sniffing application, such as Ethereal, Wireshark, or Microsoft Network Monitor.

IP fragmentation degrades performance dramatically, because all fragments must be received and reassembled before delivering the network packet to the upper layer protocol. In many cases, IP fragmentation can lead to a 10x performance degradation. The MTU parameter must be modified on all systems to avoid IP fragmentation for optimal network throughput.

Typical cases for using the MTU include the following:

- Server interconnects are typically deployed using jumbo frames. This configuration is the most efficient for high bandwidth server-to-server communication, such as Network Attached Storage, iSCSI, and database transactions.
- Servers connected to client systems that run desktop operating systems typically use standard 1500-byte frames. Most desktop systems do not support jumbo packets.

- Servers that need both high performance server-to-server communication and client access can be configured with jumbo frames with Path MTU Discovery enabled. Path MTU Discovery is enabled by default in the Windows Server, and it allows TCP connections to negotiate the optimal packet size that avoids IP fragmentation.

3.2.7.2.1 Flow Control

The adapter supports IEEE 802.3x standard flow control, which uses control packets to temporarily pause the transmission of packets between two endpoints. These control messages are point-to-point; they are not forwarded by switches or routers. You must configure both endpoints for flow control. The adapter can either respond to flow control packets (by temporarily pausing transmits) or send flow control PAUSE packets if the transmitter is overwhelming the system's receive bandwidth. For best performance, flow control must be enabled on the switches as well as on adapters. Receive and transmit flow control are enabled by default. Flow control is not available if using FCoE on a converged network adapter. In this situation, priority pause is negotiated with the network switch and used only for the FCoE protocol packets.

The NIC function can also use priority pause if it is supported by the switch. This process requires tagging packets in the operating system with the correct priority value, and enabling ETS in the driver properties.

Configurations that support multiple PCI functions per port generally configure flow control from the switch or blade configuration application. Because flow control is an Ethernet port property, it must be the same for all PCI functions using the same port.

If multiple PCI functions are exposed for a single 10GbE port, such as in a blade configuration, the flow control parameter must be set the same on all adapters for the port. The results are unpredictable if the setting differs among PCI functions, because this is a shared property of the 10GbE port.

3.2.7.2.1.1 Examples

Flow control greatly improves the following situations:

- The adapter is installed in a 4x PCIe slot or an underpowered server system.

  If the PCIe bus does not provide 10 Gb/s of throughput due to chipset limitations or the bus width, the adapter cannot maintain 10 Gb/s of incoming receive data. It starts dropping packets quickly. In this situation, it might be beneficial to enable receive flow control in the adapter, and enable flow control in the attached switch for all devices, which helps to slow down the transmitters.
- The adapter transmits to 1GbE devices, especially non-TCP protocol.

  If the adapter transmits to a 10GbE switch with attached 1GbE clients, the adapter can overwhelm the switch. The switch is then forced to start dropping packets because, although it might receive a 10 Gb/s stream, the client can only handle a 1 Gb/s stream. In this situation, it might be beneficial to enable transmit flow control in the adapter, and enable flow control for the 10GbE switch port.

NOTE If multiple PCI functions are exposed for a single 10GbE port, such as in a blade configuration, the flow control parameter must be set the same on all adapters for the port. The results are unpredictable if the setting differs among PCI functions, because this is a shared property of the 10GbE port.

For information on modifying the Flow Control parameter, see “Configuring NIC Driver Options” on page 38.

3.2.7.2.2 NUMA Considerations for Windows Server 2012 R2

NUMA assignments can affect network performance and CPU efficiency. If your application is not NUMA aware and network traffic is moderate to heavy, the CPU and memory access are managed by the operating system. As a result, the operating system can cross NUMA nodes or your application might be on the same NUMA node as other applications, decreasing your network efficiency. Regardless of whether your application is multi-threaded, and if data is not in parallel, consider the NUMA CPU defaults.

To improve network and CPU performance for heavy network loads under these conditions, you might have to make an appropriate NUMA CPU selection. For example, in Windows Server 2012 R2, you can use the Task Manager to adjust the `Set Affinity` property to bind the application to a specific NUMA node for maximum network performance and CPU efficiency.

3.2.7.2.3 Checksum Offloading and Large Send Offloading (LSO)

The adapter supports IP, TCP, and UDP checksum offloading. All these protocols are enabled by default. You can disable offloading through the Windows Device Manager Advanced Properties. Disabling checksum offloading is useful only for packet sniffing applications, such as Ethereal or Microsoft Network Monitor, on the local system where the adapter is installed and monitored. When packets are sniffed, transmit packets might appear to have incorrect checksums because the hardware has not yet calculated them.

The adapter supports transmit LSO, which allows the TCP stack to send one large block of data, and the hardware segments it into multiple TCP packets. Transmit LSO is recommended for performance, but it can be disabled for packet sniffing applications. LSO sends appear as giant packets in the packet sniffer, because the hardware has not yet segmented them.

NOTE On Windows Server 2012, Recv Segment Coalescing is enabled by default. You must disable Recv Segment Coalescing if you want to set the Checksum Offload setting to anything other than enabled.

For information on modifying the CheckSum Offload or Large Send Offload parameter, see “Configuring NIC Driver Options” on page 38.

3.2.7.2.4 Receive Side Scaling (RSS) for Non-Offloaded IP/TCP Network Traffic

The adapter can process TCP receive packets on multiple processors in parallel. This situation is ideal for applications that are CPU limited. Typically, these applications have numerous client TCP connections that might be short-lived. Web servers and database servers are prime examples. RSS typically increases the number of transactions per second for these applications.

3.2.7.2.5 Understanding RSS

To better understand RSS, it helps to understand the interrupt mechanism used in the network driver. Without RSS, a network driver receives an interrupt when a network packet arrives. This interrupt can occur on any CPU, or it might be limited to a set of CPUs for a given device, depending on the server architecture. The network driver launches one DPC that runs on the same CPU as the interrupt. Only one DPC ever runs at a time. In contrast, with RSS enabled, the network driver launches multiple parallel DPCs on different CPUs.

For example, on a four-processor server that interrupts all processors, without RSS the DPC jumps from CPU to CPU, but it only runs on one CPU at a time. Each processor is busy only 25 percent of the time. The total reported CPU usage of the system is about 25 percent (more if other applications are also using the CPU). This scenario is a sign that RSS might help performance. If the same four-processor server uses RSS, four parallel run DPCs, one on each processor. The total CPU usage that is available for networking processing is increased from 25 percent to 100 percent.

Some server machines and some network traffic profiles do not benefit from RSS. Because the non-offloaded TCP stack includes a data copy during receive processing, it is possible that memory bandwidth will limit performance before the CPU. In this situation, the CPU usage is very high while all processors wait for memory accesses. To overcome this issue, you can reduce the number of RSS CPUs, or disable RSS entirely.

Poor RSS behavior is typical only in network performance testing applications that receive data, but perform no other processing. For other applications, RSS allows the application to scale other processing tasks across all CPUs, thereby improving overall performance. RSS offers the most benefit for applications that create numerous, short-lived connections. These applications are typically CPU limited instead of network bandwidth limited.

For information on modifying the RSS Queues parameter, see “Configuring NIC Driver Options” on page 38.

NOTE Microsoft currently does not schedule RSS processing on all hyper-threaded CPUs. For example, only CPU 1 and CPU 3 have RSS queues on a dual-core, hyperthreaded CPU.

3.2.7.2.6 Enabling Windows to Use Up to Eight Processors

Windows Server 2008 uses only four processors by default. For the driver to use up to eight processors, the registry must be changed and the system restarted.

CAUTION Use the registry editor at your own risk. Using the registry editor can cause serious issues that might require you to reinstall the computer's operating system. Emulex cannot guarantee that issues resulting from changes you make to the registry can be repaired. Back up your registry before making any changes.

For Windows Server 2008, set the registry keyword MaxNumRssCpus (a DWORD type) to 8 at the following location:

```
HKEY_LOCAL_MACHINE\\SYSTEM\CurrentControlSet\Services\Ndis\Parameters
```

NOTE Do not set the registry keyword to a value greater than the number of processors in the system or 16, whichever is smaller.

For Windows Server 2008 R2 and Windows Server 2012, the operating system uses all available CPU cores for RSS without manual configuration.

3.2.7.3 TCP Offloading (TOE)

NOTE TCP Offloading (TOE) is not supported by OCe14000-series adapters.

Some Emulex adapters and drivers support TCP offload, which provides significant performance improvements. The performance improvements follow:

- A zero-copy receive data path exists. In contrast, all non-offloaded TCP packets are copied in the network stack. This copy dramatically increases the memory bandwidth and CPU requirements for receive data.
- Sending and receiving of acknowledgement packets is handled entirely in hardware, reducing PCIe bus usage and interrupts.
- TCP timers, including delayed acknowledgement, push, retransmit, and keep alive, are implemented in hardware, which reduces host CPU usage.
- Retransmits are handled entirely in hardware.
- Packetizing data, including segmenting, checksums, and CRC, is supported. The network driver must use send and receive buffers that are larger than 1 MB for maximum efficiency.
- The driver provides efficient parallel processing of multiple connections TCP on multiple CPU systems.

The adapter receive path is zero-copy for applications that prepost receive buffers or that issue a socket read before the data arrives. Ideal applications use Microsoft's Winsock2 Asynchronous Sockets API, which allows posting multiple receive buffers with asynchronous completions, and posting multiple send operations with asynchronous completions. Applications that do not prepost receive buffers might incur the penalty of the data copy, and the performance improvement is significantly less noticeable.

Applications that transmit large amounts of data show excellent CPU efficiency using TCP offload. TCP offload allows the network driver to accept large buffers of data to transmit. Each buffer is roughly the same amount of processing work as a single TCP packet for non-offloaded traffic. The entire process of packetizing the data, processing the incoming data acknowledgements, and potentially retransmitting any lost data is handled by the hardware.

3.2.7.3.0.1 TCP Offload Exclusions

Microsoft provides a method to exclude certain applications from being offloaded to the adapter. Certain types of applications do not benefit effectively from TCP offload. These applications include TCP connections that are short-lived, transfer small amounts of data at a time, exhibit fragmentation from end to end, or make use of IP options.

If an application sends less data than the MSS, the driver, like most TCP stacks, uses a Nagling algorithm. Nagling reduces the number of TCP packets on the network by combining small application sends into one larger TCP packet. Nagling typically reduces the performance of a single connection to allow greater overall performance for a large group of connections.

During Nagling, a single connection might have long pauses (200 ms) between sending subsequent packets, because the driver waits for more data from the application to append to the packet. An application can disable Nagling using the TCP_NO_DELAY parameter. TCP offload does not improve the performance for connections that Nagle, because the performance is intentionally limited by the Nagling algorithm. Telnet and SSH consoles are examples of connections that typically use Nagling.

Windows Server has not optimized the connection offload path. Some applications that use numerous short-lived TCP connections do not show a performance improvement using TCP offload.

Windows Server provides control over the applications and TCP ports that are eligible for TCP offload using the netsh tool. Refer to the Microsoft documentation for these netsh commands:

```
netsh interface tcp add chimneyapplication state=disabled application=<path>
netsh interface tcp add chimneyport state=disabled remoteport=23 localport=*
```

NOTE The netsh commands require the Windows firewall to be running. If the firewall is disabled, all applications and ports added with the netsh commands might fail to connect.

3.2.7.3.1 TCP Offload Optimization Settings

The adapter supports an option for optimizing TCP connection offload characteristics for throughput or latency. This option is available through the Advanced Property Page. See Section 3.2.1, Configuring NIC Driver Options for the TCP Offload Optimization settings.

The default option is Optimize Throughput, which produces the best throughput characteristics for certain types of traffic flows. This configuration setting has produced the best results on benchmarks, such as Chariot, ntttcp, and iperf.

The other available option, Optimize Latency, improves the latency characteristics for the class of traffic flows not ideally suited for offloading by sacrificing throughput. These applications typically do not pre-post receive buffers at a rate fast enough to keep up with the traffic flow, which cause the received data to be buffered until the application has pre-posted a receive buffer. Some applications intentionally are written this way to “peek” at incoming data to determine how large of a receive buffer to post. The timings of such a usage semantic in some cases (depending on factors, such as CPU-memory performance, line rates, the sizes of the receive buffers, and system loading at the time) will result in no observable performance improvement.

Use the Optimize Throughput (default) parameter setting.

3.2.7.3.2 Windows Networking and TOE

If certain Windows Server 2008 and Windows Server 2008 R2 networking features are enabled, TOE does not operate as expected, and connections are not offloaded.

Installing or activating firewall applications causes no connections to be offloaded by the Windows Server 2008 and Windows Server 2008 R2 network stack. By default, Windows Firewall Services are enabled at operating system

installation time, and they must be explicitly disabled to use TOE. Firewall services can be disabled through the Service Control panel, or the following commands at the command line prompt:

To set firewall services to load on demand:	`sc config MpsSvc start= demand`
To stop firewall services:	`Net stop MpsSvc`
To temporarily disable firewall services:	`netsh advfirewall set all state off`

Enabling certain Windows networking features, such as network bridging, VPN, and routing, can cause the operating system to enable IP NAT services and the IPSEC policy agent. These services, if enabled, disallow connections from being offloaded to the adapter. To disable these functions, use the Services Control panel, or the following commands at the command line prompt:

```
net stop accesspolicy
net stop sharedaccess
net stop ipnat
```

3.2.7.3.3 Windows TCP Parameters

Emulex does not recommend modifying the TCP registry parameters, such as `TcpAckFrequency`, provided by Microsoft. The default parameters are suitable for a wide variety of situations, with or without using TCP offloading.

3.2.7.4 Receive Window Auto Tuning and Compound TCP

Windows Server adds several features to the host TCP stack, such as receive window auto-tuning and CTCP. These features affect only non-offloaded TCP traffic.

Performance of some 10GbE stress applications can suffer with these features enabled. In particular, when receive window auto-tuning is enabled, some bi-directional data stream test performance degradation might occur. This situation is due to increased receive performance that adversely affects the same TCP connection's transmit performance.

To disable these features, type these commands at the command line prompt:

```
netsh interface tcp set global autotuning=disabled
netsh interface tcp set global congestionprovider=none
```

3.2.7.5 Interrupt Coalescing

The Windows Server network driver automatically performs adaptive interrupt coalescing. During periods of low network usage, the interrupt delay is set to a minimum for lower latency. As the interrupt rate increases, the delay is increased. This situation allows the driver to perform more work in a single interrupt, which reduces the amount of wasted cycles from additional interrupts.

The interrupt coalescing algorithm automatically tunes the system to maintain responsiveness and performance in a wide variety of situations, including RSS and TOE traffic.

On slower machines, excessive interrupts cause user input to become non-responsive, and they might not allow sufficient CPU cycles for higher level drivers (such as Microsoft iSCSI Initiator) and applications. This might result in timeouts in upper layer applications, because they are never scheduled to run. Increasing the level of interrupt coalescing can alleviate these issues. Increasing interrupt coalescing can improve total bandwidth for applications that transfer large data buffers. Additionally, servers running numerous parallel TCP connections can benefit from higher interrupt coalescing.

Some applications run slower with interrupt coalescing enabled, such as applications that depend on the completion of the current network transfer before they post additional work. If an application sends and receives one network message before posting the next message, it is considered latency bound. For latency bound applications, an interrupt is required to proceed to the next work item, so reducing the number of interrupts directly reduces the network throughput. The Microsoft iSCSI Initiator is generally considered a latency bound application unless the I/O sizes are very large.

When tuning the system, you must balance the extra CPU usage caused by interrupts with the potential decrease in total throughput for latency bound applications.

3.2.7.6 CPU Binding Considerations

Windows applications can set a processor affinity, which binds a program to a particular CPU in a multiple processor computer. Do not manually configure CPU affinity due to the recent additions to the Windows networking stack.

The advantage of application affinity for network applications is based on choosing the ideal relationship between the DPC and application affinity to reduce processor-cache coherency cycles. The ideal mapping might require that both the DPC and application run on the same processor, different processors, or different cores of a dual-core processor that share a common memory cache. Even when the best affinity relationship is determined, it is impossible to enforce this relationship because RSS or TCP offloading chooses the DPC processor.

The driver uses multiple parallel DPCs that are explicitly assigned to particular CPUs for processing both RSS and TCP offloading tasks. Each TCP connection is assigned to a particular CPU for processing. This situation provides the advantage of assigning CPU affinities by reducing CPU cache misses, without any user configuration.

Explicit processor affinity assignments are not necessary for the driver because the advantages of assigning processor affinities are realized by using RSS. The only reason to experiment with application and interrupt CPU affinity is when performing isolated networking benchmarks.

3.2.7.7 Single TCP Connection Performance Settings

One common benchmark is to run a single TCP connection between two computers as fast as possible. The following are a few suggestions to deliver the best possible performance:

- Use TCP window scaling with a 256 Kb or 512 Kb window. This setting can be controlled with show socket applications, such as ntttcp from Microsoft.
- Use send and receive buffers that are larger than 128 Kb with an efficient applications such as ntttcp.
- Disable RSS and use an interrupt filter driver. Experiment with all relative CPU affinities to find the best combination.
- Disable timestamps and SACK, because the test must run without dropping any packets.
- Unbind unused network protocols in the Network Connections property page.
- Disable any firewall services, IPSEC, or NAT.

3.2.8 iSCSI Driver Configuration

Table 11 lists the user-configurable iSCSI driver options available on Windows Server. It includes a description of the parameters, their default values, and their configuration limits.

NOTE If the value given for a parameter is outside the supported range, the driver logs an error in the Event Log and continues to load by using the parameter's default value.

3.2.8.1 Configuring iSCSI Driver Options

The OneConnect Windows iSCSI driver parameters can be configured using the Advanced tab of the Device Manager Property Page.

To modify a configuration parameter, perform these steps:

1. Select the Emulex OneConnect iSCSI adapter in the Windows Device Manager under Storage Controllers.
2. Right-click and select **Properties**.

   The Device Manager Property page opens.
3. Select the **Advanced** tab and make appropriate changes to the parameter as required.
4. Reboot the system for the changes to take effect.

NOTE

- The modifications to the driver parameters made using the Device Manager Property page are not immediately applied. They take effect during the next driver load sequence; either during the next reboot or a driver unload or load operation.
- Although the Advanced Tab of the Device Manager Property page can be accessed from any OneConnect iSCSI adapter, the parameter changes are uniformly applied to all the OneConnect iSCSI adapter PCIe functions on the system. Individual iSCSI PCIe functions cannot have their own set of parameters.

Table 11 provides descriptions of the different iSCSI driver options and their possible values.

Table 11 iSCSI Driver Options

Parameter	Default Value	Minimum Value	Maximum Value	Description
ETO	90 seconds	0 seconds	3600 seconds	ETO in seconds. This parameter determines the amount of time the driver waits for the target to be available after it has lost connection.
im_policy	2	0	4	The Interrupt Moderation policy parameter controls the rate of interrupts for the adapter. For more information, see Section 3.2.9, Interrupt Moderation Policy Settings.

Table 11 iSCSI Driver Options (Continued)

Parameter	Default Value	Minimum Value	Maximum Value	Description
large_io	64	64	512	Maximum transfer size in a single I/O request, in KB. By default, the iSCSI driver supports a maximum of 64 KB of data and 16 scatter/gather entries in a single I/O request. This option enables support for 512 KB of data in a single I/O request. If an application issues an I/O request that is larger than 64 KB or that needs more than 16 scatter/gather entries, the request is split into multiple requests by the Storport driver. **NOTE** If the large_io parameter is set to 512, the amount of physical memory consumed by the driver increases. Also, although intermediate values between 64 and 512 are accepted, the memory used by the driver is the same as is used if large_io is set to 512.
LDTO	20 seconds	0 seconds	3600 seconds	LDTO, in seconds. This parameter determines the amount of time the driver waits for the controller's physical link to be available before reporting that the LUNs are unavailable to the operating system.
lqd	128	1	255	The LUN queue depth parameter configures the number of concurrent commands to a logical unit via Storport API StorPortSetDeviceQueueDepth. The lqd parameter also sets the maximum number of concurrent commands allowed per LUN.

3.2.9 Interrupt Moderation Policy Settings

The Interrupt Moderation policy settings control the rate of interrupts for adapter hardware. By default, the driver implements an interrupt moderation scheme that is based on the I/O load and the interrupt rate. The default setting for im_policy tries to vary the interrupt rate between 3500 to 10000 interrupts per second. In addition, the iSCSI driver allows other configuration settings, as shown in Table 12.

Table 12 im_policy Settings

Parameter Value	Setting	Description
im_policy=0	Disabled	The interrupt rate algorithm is turned off in the driver.
im_policy=1	Aggressive	The highest interrupt rate.
im_policy=2	Moderate	The default value.
im_policy=3	Conservative	A lower interrupt rate than moderate.
im_policy=4	Very conservative	The lowest interrupt rate.

The default setting works for most configurations; however, there are instances when the setting might need to be altered. The im_policy parameter setting must be based on the adapter system configuration, the number of iSCSI targets to be connected, the I/O load, and the throughput and latency offered by these iSCSI targets.

On systems that are capable of sustaining a higher interrupt rate and on which the number of connected targets is low (eight or fewer), setting the im_policy to 1 results in lower latency and higher values of IOPs. However, this aggressive interrupt rate also can result in system stalls and freezes, especially if queue depth values are high and I/O requests are small.

In a configuration that involves a large number of iSCSI targets (more than 32 or 64) and higher values of queue depth, the default setting might prove to be too aggressive. In such a case, you might need to change the `im_policy` parameter setting to 3 or 4. Although this increases latency of an I/O request, the lower interrupt rate can allow the system to be functional under a high load.

3.2.10 Creating Non-Bootable Targets

To set up non-bootable targets, proceed with the driver and operating system installation, then download and use the Microsoft iSCSI Initiator Service to configure and manage the adapter.

3.2.10.1 Using the Microsoft iSCSI Initiator Service

Use the Microsoft iSCSI Initiator Service to configure and manage the adapter. The Microsoft Initiator Service is available as a free download from www.microsoft.com. Refer to the documentation that accompanies it for detailed information.

NOTE If you install the Microsoft iSCSI Initiator Service, you need to select only the **Initiator Service** check box and not the **Software Initiator** check box.

The Microsoft iSCSI Initiator Service sets its own initiator name. After you have installed it, you must replace this with a custom initiator name.

To assign a name, perform these steps:

1. In the Microsoft iSCSI Initiator Service, under the **General** tab, or the **Configuration** tab (Windows Server 2008 R2 systems and later), and click **Change**.
2. Type your initiator name and click **OK**.

3.2.10.2 Logging into a Target Using the Microsoft Software Initiator

If you install the Software Initiator, you must select the adapter initiator when logging into the target.

To select the initiator, perform these steps:

1. From the **Targets** tab, select the target and click **Logon**, or **Connect** (Windows Server 2008 R2 systems and later).
2. Click **Advanced**.

   Under the **General tab**, everything appears as default.
3. Select the adapter initiator as the local adapter, select your source IP, and click **OK**

3.2.10.3 Windows Multipath I/O Support

This section describes the installation and login processes for multipath I/O (MPIO) support on Windows Server operating systems.

3.2.10.4 Multipath Support

MPIO must be installed from the Server Manager. After installing the MPIO feature, you must launch and configure the MPIO GUI to enable multipath support for iSCSI devices.

The following steps describe the installation process for setting up Microsoft iSCSI DSM and enabling multipath I/O for all iSCSI devices irrespective of their vendor and device IDs. Use the MPIO GUI to configure DSMs other than Microsoft

iSCSI DSM. Also, use the GUI to enable multipath support for a specific vendor ID and device ID. For more information, refer to the Microsoft TechNet Library on the Microsoft website.

In a multipath configuration, the driver parameters LDTO and ETO can be configured to control the amount of time it takes for the failover operation to complete. The default value of LDTO is 20 seconds and the default value of ETO is 90 seconds.

For information on modifying the timeout parameters in a failover configuration, see Section 3.2.11.2.1, Error Handling Under MultiPath (MPIO) and Cluster Configurations.

If the ETO or LDTO value must be modified, perform these steps:

1. Select the Emulex OneConnect iSCSI adapter in the **Windows Device Manager** under **Storage Controllers**.
2. Right-click and select **Properties**.

   The Device Manager Property page opens.
3. Select the **Advanced** tab and set the desired value of ETO and LDTO; for example, ETO=120 and LDTO=60.
4. Reboot the system for the changes to take effect.
5. Log into the iSCSI target using WMI.

   For more information, see Section 3.2.10.4.1, Logging into Targets for Multipath Support.
6. Enable MPIO.
   a. Select **Start>Administrative Tools>Server Manager**.
   b. In the Server Manager tree, click **Features**.
   c. In the Features area, click **Add Features**.
   d. In the Add Features wizard on the Select Features page, select the **Multipath I/O** check box and click **Next**.
   e. On the Confirm Installation Selections page, click **Install**.
   f. After the installation is completed, click **Close** on the Installation Results page.
   g. When prompted to restart the computer, click **Yes**.
   h. Click **Close**.
7. Discover all possible paths to all devices on the system.
   a. Open the MPIO control pane and select **Start>Administrative Tools>MPIO**.
   b. On the User Account Control page, click **Continue**.

      The Properties dialog box is displayed.
   c. Select the **Discover Multi-Paths** tab.
   d. Select **Add support for iSCSI Devices** and click **Add**.
8. Reboot the system when prompted to do so.

After rebooting, the Microsoft iSCSI DSM claims all iSCSI discovered disks. The MPIO GUI shows device id MSFT2005iSCSIBusType_0x9 under the MPIO Devices tab. The Disk Manager does not show duplicate disks.

You can configure load balancing policies on the LUN from the Device Manager after you click the disk and select the **MPIO** tab.

3.2.10.4.1 Logging into Targets for Multipath Support

After you have successfully installed and enabled MPIO support on a Windows Server, you must log into the target. This section describes the steps to log into iSCSI targets through the WMI GUI. For information on using the iSCSISelect utility to log into an iSCSI target, refer to the *Emulex Boot for NIC, iSCSI, FCoE, and RoCE Protocols User Manual*.

To log into a target using WMI, perform these steps:

1. Select the Enable multi-path in the **Log On to Target** window.

This setting must be selected for every target to be logged in for MPIO. Use the Advanced tab to select the specific adapter port to use for login.

2. After the target login is complete, select the target and click the **Details** or **Properties** button (depending on the Windows operating system) to see the multiple sessions connected.

3.2.11 Maximum Transmission Unit (MTU) for iSCSI Connections

Because the Emulex OneConnect adapter is a multi-function adapter, the MTU settings for iSCSI functions are different than the ones for NIC functions.

For iSCSI, there is no explicit way to configure MTU from the OneCommand Manager application. Instead, this value is auto-negotiated by the firmware. Before establishing a TCP connection for an iSCSI Login, the iSCSI firmware issues an ICMP Echo with a large payload to the iSCSI target. If Jumbo Frames has been enabled on all the switches leading to the target as well as on the target interface, and if there is a successful ICMP Echo reply, the iSCSI firmware uses Jumbo Frames for that connection. The MTU used in this case is 8342 bytes.

If the large ping request is unsuccessful, the firmware defaults to non-jumbo mode and uses an MTU size of 1514 bytes.

The Max MTU value is displayed in the OneCommand Manager application for the iSCSI controller under the Port Information Tab on the Max MTU field. The TCP MSS used for an active iSCSI connection is displayed in the OneCommand Manager application on the `TargetSessions` window on the TCPMSS field.

3.2.11.1 iSCSI Error Handling

The goal of iSCSI error handling is to be tolerant of link level and target level failures up to configured timeout values, so that I/O errors are not seen by the application or operating system. The error handling is triggered under the following conditions:

- Loss of immediate link to the adapter (such as a cable disconnect or port failure). The adapter firmware detects the loss of link and notifies the driver. If this occurs, the driver queues the I/O requests internally, up to a configured timeout period, so that the operating system does not see I/O errors. This timeout period is known as LDTO.
- Loss of connection to the target because of target or network disconnection at the target. If the driver has I/O requests pending with the target and the target becomes unavailable (because the target is down, has failed over, or network issues are detected at the target), the driver queues the I/O request internally up to a configured timeout period. This timeout period is known as ETO.

If the configured threshold for LDTO and ETO is reached and the adapter is still unable to connect to the target, the driver fails all I/O requests. I/O errors are seen by the application and operating system.

NOTE Following a link up, switch ports can take a long time to initialize and go to a forwarding state. Because of this, add additional time to the ETO and LDTO settings to eliminate I/O disruption or target unavailability. If the switch port is connected to a single host, then PortFast mode can be enabled on the switch port to eliminate delays in transitioning to a forwarding state.

3.2.11.2 Configuring LDTO and ETO on the Windows Server

LDTO and ETO values are configured using the Advanced tab of the Device Manager Property page. Table 13 on page 97 lists the default values of LDTO and ETO on the Windows Server and the configuration limits.

NOTE If the ETO is set to a number between 0 and 19, the driver assumes the value of 20 seconds internally. The registry is not modified.

Table 13 LDTO and ETO Information on the Windows Server

Value	Default	Minimum	Maximum
LDTO	20 sec	0 sec	3600 sec
ETO	90 sec	0 sec	3600 sec

To modify LDTO and ETO values, edit the driver parameters for the iscsi service, perform these steps:

1. Select the Emulex OneConnect iSCSI adapter in the Windows Device Manager under Storage Controllers.
2. Right-click and select **Properties**.

   The Device Manager Property page opens.
3. Select the **Advanced** tab and make the following changes:
   - LDTO = 25
   - ETO = 50
4. Reboot the system for the changes to take effect.

This procedure sets the default value of LDTO to 25 seconds and the default value of ETO to 50 seconds. The settings are applied the next time the driver is loaded. You must reboot the system (boot drivers) or disable the iSCSI driver and enable it again (non-boot drivers) in Device Manager for the settings to take effect.

3.2.11.2.1 Error Handling Under MultiPath (MPIO) and Cluster Configurations

In an MPIO or a cluster configuration, fault tolerant software is present on the system in addition to the iSCSI driver's default error handling scheme. Depending on the type of failover configuration, the iSCSI driver's error handling parameter can be configured to modify the timing characteristics of a failover operation.

If the iSCSI target is in Active-Active failover mode, the iSCSI driver can be configured to report I/O errors as soon as they are detected by setting the iSCSI driver's LDTO and ETO parameters to 0. This mode allows the failover software to trigger a path failover to an active path or active node as quickly as possible.

If the iSCSI target is in Active-Standby failover mode, then the iSCSI driver must wait for the target side failover operation to complete before reporting device unavailability to the operating system. For such configurations, the driver's ETO must be set to the amount of time the iSCSI target needs to complete its failover operation.

Chapter 4: Troubleshooting

Your system may operate in an unexpected manner in certain circumstances. This section contains reference tables on event codes and error messages and provides information regarding unusual situations.

4.1 General Troubleshooting

The following table describes issues you may encounter and their solutions.

Table 14 General Troubleshooting

Issue	Answer/Solution
The operating system fails to install or does not successfully install the driver.	Verify that the operating system is supported by the driver.
The AutoPilot Installer fails.	If the AutoPilot Installer fails, the Diagnostics window shows that the adapter failed. If the adapter fails: 1. Select the adapter to view the reason why the adapter failed. The reason and suggested corrective action are displayed. 2. Perform the suggested corrective action and run AutoPilot Installer again. **NOTE** You can run AutoPilot Installer again from the Start menu (Programs>Emulex>AutoPilot Installer), or you can run APInstall.exe from a command prompt.
The OneInstall Installer fails.	If the OneInstall Installer fails, it may be because: ■ The operating system prerequisites have not been met. ■ The individual kit installation failed. To check, run the installation interactively. If you encounter error messages when you run the installation interactively, those issues would also apply to an unattended installation. ■ If an individual package failed to install properly, run that package's installer directly. This method displays status and error messages that can be used to diagnose the issue. (The OneInstall Installer does not provide these displays because each package is installed silently.)
Windows Device Manager shows a code 10 or code 39 with a yellow or red exclamation point on the device.	The firmware image does not match the installed device drivers, or the firmware is corrupt. Using the OneCommand Manager application or one of the Windows PE offline or online utilities, install a version of firmware that is compatible with the driver.
The firmware is corrupt or non-responsive.	Using the OneCommand Manager application or one of the Windows PE offline or online utilities, install a version of firmware that is compatible with the driver.
The Emulex iSCSI BIOS banner is not displayed during system POST.	Configure the motherboard BIOS to enable the Option ROM for the PCIe slot in which the adapter is installed.

4.2 Troubleshooting the FC/FCoE Driver

4.2.1 Troubleshooting the Cisco Nexus Switch Configuration

NOTE LACP cannot be used on an FCoE port.

Table 15 Cisco Nexus Switch Situations

Issue	Solution
1. Windows creates the NTFS partition, but then reports that "The hard disk containing the partition or free space you chose has a LUN greater than 0. Setup cannot continue". (Dell 1850 server). 2. Windows reboots successfully, but then gets stuck during the GUI portion of the installation right from the beginning. (HP DL385G2 server).	Set up the FCoE switch ports as follows: ■ no priority-flow-control mode on ■ untagged cos 0 ■ flowcontrol receive on ■ flowcontrol send on ■ spanning-tree port type edge
The system is showing an excessive number of I/O timeouts as a result of the switch routing frames to the incorrect port.	Ensure that LACP is not used on the FCoE port.

4.2.2 Event Trace Messages

4.2.2.1 ELS Log Messages (0100–0130)

4.2.2.1.1 lpfc_mes0100: FLOGI failure – ulpStatus: x%x, ulpWord[4]:x%x

Description	An ELS FLOGI command that was sent to the fabric failed.
Severity	Error
Log	LOG_ELS verbose
Action	Check the fabric connection.

4.2.2.1.2 lpfc_mes0101: FLOGI completes successfully – NPortId: x%x, RaTov: x%x, EdTov: x%x

Description	An ELS FLOGI command that was sent to the fabric succeeded.
Severity	Information
Log	LOG_ELS verbose
Action	No action needed, informational.

4.2.2.1.3 lpfc_mes0102: PLOGI completes to NPortId: x%x

Description	The adapter performed an N PLOGI into a remote NPort.
Severity	Information
Log	LOG_ELS verbose
Action	No action needed, informational.

4.2.2.1.4 lpfc_mes0103: PRLI completes to NPortId: x%x, TypeMask: x%x, Fcp2Recovery: x%x

Description	The adapter performed a PRLI into a remote NPort.
Severity	Information
Log	LOG_ELS verbose
Action	No action needed, informational.

4.2.2.1.5 lpfc_mes0104: ADISC completes to NPortId x%x

Description	The adapter performed an ADISC into the remote NPort.
Severity	Information
Log	LOG_ELS verbose
Action	No action needed, informational.

4.2.2.1.6 lpfc_mes0105: LOGO completes to NPortId: x%x

Description	The adapter performed a LOGO into a remote NPort.
Severity	Information
Log	LOG_ELS verbose
Action	No action needed, informational.

4.2.2.1.7 lpfc_mes0112: ELS command: x%x, received from NPortId: x%x

Description	Received the specific ELS command from a remote NPort.
Severity	Information
Log	LOG_ELS verbose
Action	No action needed, informational.
Remarks	lpfc_mes0114 and lpfc_mes0115 are also recorded for more details if the corresponding severity level is set. You can use the XRI to match the messages.

4.2.2.1.8 lpfc_mes0114: PLOGI chkparm OK

Description	Received a PLOGI from a remote NPORT and its FC service parameters match this adapter. Request can be accepted.
Severity	Information
Log	LOG_ELS verbose
Action	No action needed, informational.
See Also	lpfc_mes0112

4.2.2.1.9 lpfc_mes0115: Unknown ELS command: x%x, received from NPortId: x%x\n

Description	Received an unsupported ELS command from a remote NPORT.
Severity	Error
Log	LOG_ELS verbose
Action	Check remote NPORT for potential issue.
See Also	lpfc_mes0112

4.2.2.1.10 lpfc_mes0128: Accepted ELS command: OpCode: x%x

Description	Accepted an ELS command from a remote NPORT.
Severity	Information
Log	LOG_ELS verbose
Action	No action needed, informational.

4.2.2.1.11 lpfc_mes0129: Rejected ELS command: OpCode: x%x

Description	Rejected ELS command from a remote NPORT.
Severity	Information
Log	LOG_ELS verbose
Action	No action needed, informational.

4.2.2.1.12 lpfc_mes0130: ELS command error: ulpStatus: x%x, ulpWord[4]: x%x

Description	ELS command failure.
Severity	Error
Log	LOG_ELS verbose
Action	Check remote NPORT for potential issue.

4.2.2.2 Discovery Log Messages (0202–0262)

4.2.2.2.1 lpfc_mes0202: Start Discovery: Link Down Timeout: x%x, initial PLOGICount:%d

Description	Device discovery/rediscovery after FLOGI, FAN, or RSCN has started. TMO is the current value of the soft link time. It is used for link discovery against the LinkDownTime set in parameters. DISC CNT is the number of nodes being discovered for link discovery. RSCN CNT is the number of nodes being discovered for RSCN discovery. There will be a value in either DISC CNT or RSCN CNT, depending on which discovery is being performed.
Severity	Information
Log	LOG_DISCOVERY verbose
Action	No action needed, informational.

4.2.2.2.2 lpfc_mes0204: Discovered SCSI Target: WWN word 0: x%x, WWN word 1: x%x, DID: x%x:, RPI: x%x

Description	Device discovery found SCSI target.
Severity	Information
Log	LOG_DISCOVERY verbose
Action	No action needed, informational.

4.2.2.2.3 lpfc_mes0214: RSCN received: Word count:%d

Description	Received RSCN from fabric.
Severity	Information
Log	LOG_DISCOVERY verbose
Action	No action needed, informational.

4.2.2.2.4 lpfc_mes0215: RSCN processed: DID: x%x

Description	Processed RSCN from fabric.
Severity	Information
Log	LOG_DISCOVERY verbose
Action	No action needed, informational.

4.2.2.2.5 lpfc_mes0225: Device Discovery completes

Description	This indicates successful completion of device (re)discovery after a link up.
Severity	Information
Log	LOG_DISCOVERY verbose
Action	No action needed, informational.

4.2.2.2.6 lpfc_mes0229: Assign SCSIId x%x to WWN word 0: x%x, WWN word 1: x%x, NPortId x%x

Description	The driver assigned a SCSI ID to a discovered mapped FCP target. BindType - 0: DID 1:WWNN 2:WWPN
Severity	Information
Log	LOG_DISCOVERY verbose
Action	No action needed, informational.

4.2.2.2.7 lpfc_mes0230: Cannot assign SCSIId to WWN word 0: x%x, WWN word 1: x%x, NPortId x%x

Description	SCSI ID assignment failed for discovered target.
Severity	Warning
Log	LOG_ELS verbose
Action	Review system configuration.

4.2.2.2.8 lpfc_mes0232: Continue discovery at sequence number%d, PLOGIs remaining:%d

Description	NPort discovery sequence continuation.
Severity	Information
Log	LOG_ELS verbose
Action	No action needed, informational.

4.2.2.2.9 lpfc_mes0235: New RSCN being deferred due to RSCN in process

Description	An RSCN was received while processing a previous RSCN.
Severity	Information
Log	LOG_ELS verbose
Action	No action needed, informational.

4.2.2.2.10 lpfc_mes0236: Issuing command to name server" type: x%x

Description	The driver is issuing a nameserver request to the fabric. Also recorded if a GID_FT is sent.
Severity	Information
Log	LOG_DISCOVERY verbose

Action	No action needed, informational.
See Also	lpfc_mes0239 or lpfc_mes0240

4.2.2.2.11 lpfc_mes0238: NameServer response DID count:%d

Description	Received a response from fabric name server with N DIDs.
Severity	Information
Log	LOG_ELS verbose
Action	No action needed, informational.

4.2.2.2.12 lpfc_mes0239: NameServer Response: next DID value: x%x

Description	The driver received a nameserver response. And, this message is recorded for each DID included in the response data.
Severity	Information
Log	LOG_DISCOVERY verbose
Action	No action needed, informational.
See Also	lpfc_mes0236

4.2.2.2.13 lpfc_mes0240: NameServer Response Error – CmdRsp:x%x, ReasonCode: x%x, Explanation x%x

Description	The driver received a nameserver response containing a status error.
Severity	Error
Log	LOG_DISCOVERY verbose
Action	Check Fabric configuration. The driver recovers from this and continues with device discovery.
See Also	lpfc_mes0236

4.2.2.2.14 lpfc_mes0256: Start node timer on NPortId: x%x, timeout value:%d

Description	Starting timer for disconnected target with NPort ID and timeout value.
Severity	Information
Log	LOG_ELS verbose
Action	No action needed, informational.

4.2.2.2.15 lpfc_mes0260: Stop node timer on NPortId: x%x, SCSIId: x%x

Description	Discontinuing timer for reconnected target with NPort ID and SCSI ID.
Severity	Information
Log	LOG_ELS verbose
Action	No action needed, informational.

4.2.2.2.16 lpfc_mes0262: Node timeout on NPortId: x%x, SCSIId: x%x

Description	Disconnected NPort ID, SCSI ID has failed to reconnect within timeout limit.
Severity	Error
Log	LOG_ELS verbose
Action	Review system configuration.

4.2.2.3 Mailbox Log Messages (0310–0326)

4.2.2.3.1 lpfc_mes0310: Mailbox command timeout – HBA unresponsive

Description	A Mailbox command was posted to the adapter and did not complete within 30 seconds. sync - 0: asynchronous mailbox command is issued 1: synchronous mailbox command is issued.
Severity	Error
Log	LOG_MBOX verbose
Action	This error could indicate a software driver or firmware issue. If no I/O is going through the adapter, reboot the system. If these issues persist, report these errors to Broadcom technical support.

4.2.2.3.2 lpfc_mes0326: Reset HBA – HostStatus: x%x

Description	The adapter has been reset.
Severity	Information
Log	LOG_MBOX verbose
Action	No action needed, informational.

4.2.2.4 INIT Log Messages (0400–0463)

4.2.2.4.1 lpfc_mes0400: Initializing discovery module: OptionFlags: x%x

Description	Driver discovery process is being initialized with internal flags as shown.
Severity	Information
Log	LOG_ELS verbose
Action	No action needed, informational.

4.2.2.4.2 lpfc_mes0401: Initializing SLI module: DeviceId: x%x, NumMSI:%d

Description	PCI function with device id and MSI count as shown is being initialized for service level interface.
Severity	Information
Log	LOG_ELS verbose
Action	No action needed, informational.

4.2.2.4.3 lpfc_mes0405: Service Level Interface (SLI) 2 selected\n");

Description	Service Level Interface level 2 is selected.
Severity	Information
Log	LOG_ELS verbose

Action	No action needed, informational.

4.2.2.4.4 lpfc_mes0406: Service Level Interface (SLI) 3 selected\n");

Description	Service Level Interface level 3 is selected.
Severity	Information
Log	LOG_ELS verbose
Action	No action needed, informational.

4.2.2.4.5 lpfc_mes0436: Adapter not ready: hostStatus: x%x

Description	The adapter failed during powerup diagnostics after it was reset.
Severity	Error
Log	LOG_INIT verbose
Action	This error could indicate a hardware or firmware issue. If issues persist report these errors to Broadcom technical support.

4.2.2.4.6 lpfc_mes0442: Adapter failed to init, CONFIG_PORT, mbxStatus x%x

Description	Adapter initialization failed when issuing CONFIG_PORT mailbox command.
Severity	Error
Log	LOG_INIT verbose
Action	This error could indicate a hardware or firmware issue. If issues persist report these errors to Broadcom technical support.

4.2.2.4.7 lpfc_mes0446: Adapter failed to init, CONFIG_RING, mbxStatus x%x

Description	Adapter initialization failed when issuing CFG_RING mailbox command.
Severity	Error
Log	LOG_INIT verbose
Action	This error could indicate a hardware or firmware issue. If issues persist report these errors to Broadcom technical support.

4.2.2.4.8 lpfc_mes0454: Adapter failed to init, INIT_LINK, mbxStatus x%x

Description	Adapter initialization failed when issuing INIT_LINK mailbox command.
Severity	Error
Log	LOG_INIT verbose
Action	This error could indicate a hardware or firmware issue. If issues persist report these errors to Broadcom technical support.

4.2.2.4.9 lpfc_mes0458: Bring Adapter online

Description	The FC driver has received a request to bring the adapter online. This may occur when running HBAnyware.
Severity	Warning
Log	LOG_INIT verbose
Action	None required.

4.2.2.4.10 lpfc_mes0460: Bring Adapter offline

Description	The FC driver has received a request to bring the adapter offline. This may occur when running the OneCommand Manager application.
Severity	Warning
Log	LOG_INIT verbose
Action	None required.

4.2.2.4.11 lpfc_mes0463: Adapter firmware error: hostStatus: x%x, Info1(0xA8): x%x, Info2 (0xAC): x%x

Description	The firmware has interrupted the host with a firmware trap error.
Severity	Error
Log	LOG_INIT verbose
Action	Review OneCommand Manager application diagnostic dump information.

4.2.2.5 FCP Log Messages (0701–0749)

4.2.2.5.1 lpfc_mes0701: Issue Abort Task Set to PathId: x%x, TargetId: x%x, Lun: x%x

Description	The driver has issued a task management command for the indicated SCSI device address.
Severity	Warning
Log	LOG_INIT verbose
Action	Review system configuration.

4.2.2.5.2 lpfc_mes0703: Issue LUN reset to PathId: x%x, TargetId: x%x, Lun: x%x, Did: x%x

Description	Storport is requesting a reset of the indicated LUN.
Severity	Warning
Log	LOG_INIT verbose
Action	Review system configuration. Possible side-effect of cluster operations.

4.2.2.5.3 lpfc_mes0713: Issued Target Reset to PathId:%d, TargetId:%d, Did: x%x

Description	Storport detected that it needs to abort all I/O to a specific target. This results in login reset to the target in question.
Severity	Warning
Log	LOG_FCP verbose
Action	Review system configuration. Possible side-effect of cluster operations.
See Also	lpfc_mes0714

4.2.2.5.4 lpfc_mes0714: Issued Bus Reset for PathId:%d

Description	Storport is requesting the driver to reset all targets on this adapter.
Severity	Warning
Log	LOG_FCP verbose
Action	Review system configuration. Possible side-effect of cluster operations.
See Also	lpfc_mes0713

4.2.2.5.5 lpfc_mes0716: FCP Read Underrun, expected%d, residual%d

Description	FCP device provided less data than was requested.
Severity	Supplement Information
Log	LOG_FCP verbose
Action	No action needed, informational.
See Also	lpfc_mes0730

4.2.2.5.6 lpfc_mes0729: FCP command error: ulpStatus: x%x, ulpWord[4]: x%x, XRI: x%x, ulpWord[7]: x%x

Description	The specified device failed an I/O FCP command.
Severity	Warning
Log	LOG_FCP verbose
Action	Check the state of the target in question.
Remarks	lpfc_mes0730 is also recorded if it is a FCP Rsp error.

4.2.2.5.7 lpfc_mes0730: FCP response error: Flags: x%x, SCSI status: x%x, Residual:%d

Description	The FCP command failed with a response error.
Severity	Warning
Log	LOG_FCP verbose
Action	Check the state of the target in question.
Remark	lpfc_mes0716, lpfc_mes0734, lpfc_mes0736 or lpfc_mes0737 is also recorded for more details if the corresponding SEVERITY level is set.
See Also	lpfc_mes0729

4.2.2.5.8 lpfc_mes0734: Read Check: fcp_parm: x%x, Residual x%x

Description	The issued FCP command returned a Read Check Error.
Severity	Warning
Log	LOG_FCP verbose
Action	Check the state of the target in question.
See Also	lpfc_mes0730

4.2.2.5.9 lpfc_mes0737: SCSI check condition, SenseKey x%x, ASC x%x, ASCQ x%x, SrbStatus: x%x

Description	The issued FCP command resulted in a Check Condition.
Severity	Warning
Log	LOG_FCP verbose
Action	Review SCSI error code values.
See Also	lpfc_mes0730

4.2.2.5.10 lpfc_mes0747: Target reset complete: PathId: x%x, TargetId: x%x, Did: x%x

Description	A target reset operation has completed.
Severity	Warning
Log	LOG_FCP verbose
Action	Review system configuration. Possible side-effect of cluster operations.
Remark	See also Message 0713.

4.2.2.5.11 lpfc_mes0748: Lun reset complete: PathId: x%x, TargetId: x%x, Lun: x%x

Description	A LUN reset operation has completed.
Severity	Warning
Log	LOG_FCP verbose
Action	Review system configuration. Possible side-effect of cluster operations.
Remark	See also Message 0703.

4.2.2.5.12 lpfc_mes0749: Abort task set complete: Did: x%x, SCSIId: x%x

Description	A task management has completed.
Severity	Warning
Log	LOG_FCP verbose
Action	Review system configuration. Possible side-effect of cluster operations.
Remark	See also Message 0701.

4.2.2.6 Link Log Messages (1302–1306)

4.2.2.6.1 lpfc_mes1302: Invalid speed for this board:%d, forced link speed to auto

Description	The driver is re-initializing the link speed to auto-detect.
Severity	Warning
Log	`LOG_LINK_EVENT verbose`
Action	None required.

4.2.2.6.2 lpfc_mes1303: Link Up event: tag: x%x, link speed:%dG, topology (0 = Pt2Pt, 1 = AL):%d

Description	A link up event was received. It is also possible for multiple link events to be received together.
Severity	Error
Log	`LOG_LINK_EVENT verbose`
Action	If numerous link events are occurring, check physical connections to the FC network.
Remarks	lpfc_mes1304 is recorded if Map Entries > 0 and the corresponding mode and SEVERITY level is set.

4.2.2.6.3 lpfc_mes1305: Link down even: tag x%x

Description	A link down event was received.
Severity	Error
Log	`LOG_LINK_EVENT verbose`
Action	If numerous link events are occurring, check physical connections to the FC network.

4.2.2.6.4 lpfc_mes1306: Link Down timeout

Description	The link was down for greater than the configuration parameter (HLinkTimeOut) seconds. All I/O associated with the devices on this link will fail.
Severity	Warning
Log	`LOG_LINK_EVENT verbose`
Action	Check adapter cable/connection to SAN.

4.2.2.7 Tag Messages (1400–1401)

4.2.2.7.1 lpfc_mes1400: Tag out of range: ContextIndex: x%x, MaxIndex: x%x, ulpCommand: x%x

Description	Firmware has generated an invalid response.
Severity	Error
Log	`LOG_LINK_EVENT verbose`
Action	Review hardware configuration. Contact Broadcom technical support.

4.2.2.7.2 lpfc_mes1401: Invalid tag: ContextIndex: x%x, ulpCommand: x%x

Description	Firmware has generated an invalid response.
Severity	Error
Log	`LOG_LINK_EVENT verbose`
Action	Review hardware configuration. Contact Broadcom technical support.

4.2.2.8 NPIV Messages (1800–1899)

4.2.2.8.1 lpfc_mes1800: NPIV FDISC failure VPI: x%x Error x%x Reason x%x

Description	Virtual Port fails on a FDISC to the switch with the error and reason listed.
Severity	Error
Log	`LOG_NPIV verbose`
Action	Ensure that the switch supports NPIV.

4.2.2.8.2 lpfc_mes1801: Memory allocation failure for NPIV port: x%x

Description	Fails to allocated the block of memory for the Virtual Port.
Severity	Error
Log	`LOG_NPIV verbose`
Action	Ensure that the system has sufficient kernel memory.

4.2.2.8.3 lpfc_mes1802: Exceeded the MAX NPIV port: x%x

Description	Exceeded the number of Virtual Port allows on the adapter.
Severity	Error
Log	`LOG_NPIV verbose`
Action	Reduce the number of Virtual Ports.

4.2.2.8.4 lpfc_mes1803: Virtual Port: x%x VPI:x%x successfully created.

Description	Virtual Port ID is successfully created.
Severity	Information
Log	`LOG_NPIV verbose`
Action	No action needed, informational.

4.2.2.8.5 lpfc_mes1804: Removing Virtual Port: x%x VPI:x%x

Description	Removing Virtual Port ID.
Severity	Information
Log	`LOG_NPIV verbose`
Action	No action needed, informational.

4.2.2.9 ELS Messages (1900–1999)

4.2.2.9.1 lpfc_mes1900: x%x sends ELS_AUTH_CMD x%x with TID x%x

Description	An ELS_AUTH_CMD is sent.
Severity	Information
Log	`LOG_FCSP verbose`
Action	No action needed, informational.

4.2.2.9.2 lpfc_mes1901: x%x sends ELS_AUTH_REJECT x%x x%x to x%x

Description	An ELS_AUTH_REJECT is sent.
Severity	Information
Log	`LOG_FCSP verbose`
Action	No action needed, informational.

4.2.2.9.3 lpfc_mes1902: Receives x%x from x%x in state x%x

Description	Receives an ELS_AUTH_CMD.
Severity	Information
Log	`LOG_FCSP verbose`
Action	No action needed, informational.

4.2.2.9.4 lpfc_mes1903: Receives ELS_AUTH_RJT x%x x%x

Description: Receives an ELS_AUTH_REJECT.
Severity: Information
Log: `LOG_FCSP verbose`
Action: No action needed, informational.

4.2.2.9.5 lpfc_mes1904: Authentication ends for x%x with status x%x (%d %d)

Description: Authentication is done.
Severity: Information
Log: `LOG_FCSP verbose`
Action: No action needed, informational.

4.2.2.9.6 lpfc_mes1905: Authentication policy change for local x%08x x%08x remote x%08x%08x

Description: Authentication policy has been changed.
Severity: Information
Log: `LOG_FCSP verbose`
Action: No action needed, informational.

4.3 Troubleshooting the NIC Drivers

Table 16 provides troubleshooting information for the NIC drivers.

Table 16 Troubleshooting the NIC Drivers

Issue	Answer/Solution
Performance is not as expected.	The adapter may be installed in the wrong type of PCIe slot. Verify that the adapter has been properly installed. If TOE is enabled and performance is not as high as expected, the operating system may not offload TOE connections. For more information, see “TCP Offloading (TOE)” on page 88.
Frequent event log entries for link changes, or statistics that show more than expected CRC errors, occur.	Unload and reload the driver to reset available target IDs. Ensure that the SAN configuration is correct prior to reloading the driver. This clears the driver’s consistent binding table and frees target IDs for new target nodes.
The driver fails to load, and an event log entry states that the driver failed to load due to memory constraints.	There may not be enough memory installed in the system to provide sufficient memory for all devices installed in the system. Try installing more memory if possible.
Unpredictable results occur if the flow control setting differs among PCI functions.	If multiple PCI functions are exposed for a single 10GbE port, such as in blade configurations, the flow control parameter must be set the same on all adapters for the port. Results are unpredictable if the setting differs among PCI functions because this is a shared property of the 10GbE port.
On servers that support PCIe hot unplug, the system may hang or produce a bugcheck if a PCIe hot unplug or replace is attempted.	Hot unplug is not supported in this release.

Table 16 Troubleshooting the NIC Drivers (Continued)

Issue	Answer/Solution
If Wake on LAN is set through the advanced properties page, the system does not wake when receiving a magic packet or a packet that would normally wake the system.	The system may not support Wake on LAN on the PCIe slot in which the adapter is installed. Check the system documentation to determine whether the system is capable of Wake on LAN operation. A system BIOS setting may not be correct for Wake on LAN to work as expected. Check the system documentation to determine whether Wake on LAN must be enabled in the system BIOS. Wake on LAN may not be supported by the chipset as reported by the firmware. The driver reports the value that is reported by the firmware. The system may not go to a lower power state because another software component, device, or driver is preventing it. Microsoft provides several useful references for troubleshooting Wake on LAN configuration issues in the Microsoft TechNet Library on the Microsoft website.
When running Windows Server 2008,the computer restarts and shows various Stop error codes when performing one of the following operations: ■ Enabling or disabling TCP Chimney Offload ■ Changing the network adapter settings ■ Upgrading the NIC drivers	Apply the 979614 hotfix as described on the Microsoft website.
If an NDIS driver is being installed manually on a Windows Server 2008 system, the installer installs the first driver it finds, even if it is not the latest version of the driver.	Windows Server 2008 picks up the first available driver it finds if an NDIS driver is being installed manually. Therefore, an NDIS5 driver will be installed even if a Windows NDIS6 driver is available. An event log message advises you to update to the latest driver for best performance.
The system crashes or appears to hang. In the case of a hang, there could be a message indicating that the driver experienced a hardware malfunction.	Several possible causes for this issue exist. ■ Certain systems require an updated BIOS to properly manage the power states of newer Intel and AMD processors. Check with your vendor for information regarding BIOS and firmware updates that may be required to run well with the latest releases of the Windows operating systems. Also, certain BIOS settings may be required. For example, disable any low power processor states and low power settings for PCIe. ■ On certain AMD systems, it is possible the intelppm.sys driver is enabled, and should not be. To query this system driver's run state, log in as administrator and at the command line type sc query intelppm If the results indicate that the intelppm driver is running, you must disable it. At the command line type sc config intelppm start= disabled ■ On all systems, it may be necessary to set the power options to High Performance. See the operating system documentation for details.

4.3.1 Monitoring TCP Offloads

To monitor TCP offloads, in a command window type

```
netstat -t
```

This command indicates the offload state for each TCP connection of the system.

Windows Server 2008 (and later versions) allows TCP offloads in more scenarios than previous versions of Windows Server. In particular, TCP offloads can occur with the Windows firewall enabled.

4.3.2 TCP Offload Failure

Table 17 lists common reasons why TCP offloads do not occur and their potential solutions.

Table 17 Troubleshooting TCP Offload Failures

Reasons for No TCP Offload	Solutions
Chimney offload is disabled on the system.	For Windows Server 2008 and Windows Server 2008 R2 To determine whether Chimney offload is enabled or disabled, at the command line type netsh interface tcp show global To enable Chimney offload, at the command line type netsh interface tcp set global chimney=enabled To disable Chimney offload, at the command line type netsh interface tcp set global chimney=disabled To verify whether offloading is enabled type netstat -nt This command displays a list of connections and their offloading state.
Offloads are disabled for specific ports or applications.	To view any TCP ports or applications that can be configured to disable TCP offload, at the command line type netsh interface tcp show chimneyports netsh interface tcp show chimneyapplications
A third-party firewall is running.	The Windows firewall does not affect TCP offload, but third-party firewalls can prevent TCP offloads. Uninstall third-party firewall software to allow TCP offloads.
In the network properties, some intermediate drivers prevent offloading.	Go to **Network Connections > Properties** and clear the check boxes for unused drivers. In particular, Network Load Balancing and some third-party drivers prevent offloads.
IPSec is enabled.	Disable IPSec.
IP NAT is enabled.	Disable IP NAT.
The driver supports an Advanced Property to disable TCP offloading.	Make sure TCP offloading is enabled.
The TCP connection uses using IPv6.	The driver supports offloading TCP connections only with IPv4.

NOTE Packet sniffing applications such as Ethereal or Microsoft Network Monitor do not see TCP offloaded packets.

Troubleshooting the iSCSI Driver

This section provides troubleshooting information for the iSCSI driver.

4.3.2.1 Troubleshooting the Cisco Nexus Switch Configuration

NOTE LACP cannot be used on an iSCSI port.

Table 18 provides troubleshooting information for the Cisco switch.

Table 18 Cisco Nexus Switch Situations for iSCSI

Issue	Solution
The system is showing an excessive number of I/O timeouts as a result of the switch routing frames to the incorrect port.	Ensure that LACP is not used on the iSCSI port.

4.3.2.2 iSCSI Driver Troubleshooting

Table 19 provides troubleshooting information for the iSCSI driver.

Table 19 Troubleshooting the iSCSI Driver

Issue	Answer/Solution
Overall failure.	Use the iSCSISelect utility to clear the Adapter Configuration. See the *Emulex Boot for NIC, iSCSI, FCoE, and RoCE Protocols User Manual* for instructions.
The driver loads successfully, but there are event 11 entries in the event log for the iSCSI driver.	The most common cause is that the adapter link is down. See "Viewing the iSCSI Error and Event Log on Windows Server 2008" on page 133 and look for specific event codes to confirm.
Unable to create a memory dump file on a system booted over iSCSI.	Make sure the disk has enough free disk space to create the dump file. If a full memory dump is selected, the disk must have free space at least equivalent to the amount of physical memory in the system.
Unable to log in to target from WMI.	Ensure that the IP address on the adapter is valid and the network connection has been set up to reach the target. If login is attempted after discovering the target, ensure that the correct adapter port has been selected for the login.
The iSCSI WMI GUI shows the target state as connected, but LUNs are not seen from the disk manager.	Verify that the adapter name used to connect to the target matches the adapter name configured on the iSCSI target.
Multipath configuration shows duplicate LUNs on the disk manager.	Ensure that the MPIO software is installed and the login options have selected the MPIO flag. On Windows Server 2008 and Windows Server 2008 R2 Operating Systems, the server role must be set up for Multipath. See the *Emulex Boot for NIC, iSCSI, FCoE, and RoCE Protocols User Manual* for more information on MPIO.
Multipath configuration takes a long time to fail over or failover does not occur.	Ensure that LDTO settings and ETO settings have been configured for MPIO. These values must be set to 0. For more information, see "Configuring LDTO and ETO on the Windows Server" on page 96.
Sendtargets to a IET fails because it violates the iSCSI specification.	If you still want to add a IET, you must add the target manually. This issue affects Sendtargets only.

Table 19 Troubleshooting the iSCSI Driver (Continued)

Issue	Answer/Solution
The following POST error message appears: Initiator iSCSI Name mismatch, Please use iSCSISelect to set a single name for all controllers. Press <Ctrl><S> to enter iSCSISelect. (Reboot required)	In the iSCSI BIOS, the Emulex iSCSI initiator name may be different if more than one OneConnect adapters are in the system. This message appears if the iSCSI initiator name is different on multiple controllers. Enter the iSCSISelect utility and save a new initiator name on the first iSCSISelect utility menu window so that the iSCSI initiator name on all controllers match. All logins from the multiple controllers will use the new name. See the *Emulex Boot for NIC, iSCSI, FCoE, and RoCE Protocols User Manual* for more information.
If an iscsicli logouttarget command is issued back-to-back in a script, event 12 errors from the PlugPlayManager are seen in the Windows Event Viewer. The error message is similar to this string: The device 'SE ISCSI 00 SCSI Disk Device'(SCSI\Disk&Ven_SE_ISCSI&Prod_00&Rev_3.64\5&17659873&2&020000) disappeared from the system without first being prepared for removal.	This behavior is not specific to the OneConnect adapter.
On a system running Windows Server 2008, or Windows Server 2008 R2, the iSCSI driver fails to load after many iterations of enable/disable from Device Manager. Because the system failed to allocate contiguous uncached extension memory, the iSCSI driver failed to load, and an attention icon is displayed next to the OneConnect iSCSI device. The Device Status shows “This device cannot start. (Code 10)”, and an Event 11 error is logged in the Windows system event log for the iSCSI driver with 0x31840006 in the 5th DWORD.	No workaround exists for this issue.

Table 19 Troubleshooting the iSCSI Driver (Continued)

Issue	Answer/Solution
If an iSCSI adapter is used to login to an iSCSI target and the LUN configuration on the target is changed, neither the adapter nor the WMI GUI see the updated LUN configuration.	If an iSCSI target provides an asynchronous event notification to the adapter when its logical unit inventory has changed, the iSCSI driver initiates a bus rescan and the LUNs are updated dynamically. However, if an iSCSI target does not provide an asynchronous event notification, the LUN list is not updated dynamically. Perform a manual rescan in Disk Management.
A login to new target fails after Microsoft iSCSI Initiator Service is installed.	If Microsoft iSCSI software is installed, the service chooses a default IQN name for the adapter. The Microsoft iSCSI service issues the request to the iSCSI driver using the WMI interface to set this new IQN name. Therefore, any IQN name that was configured earlier (such as by using iSCSISelect) is overridden and the new IQN name will be in effect. Although this does not affect existing boot sessions and persistent sessions, new target logins could fail because the new IQN name does not match the incoming IQN name configured on the target. After the Microsoft iSCSI Initiator Service is installed, the initiator name must be renamed to the previous name configured from the WMI GUI.
If software-based iSCSI targets are logged into the adapter, Event ID 56 (Driver SCSI (000000)) appears in the Windows event viewer. This issue has been observed on Windows Server 2008 R2 under the following conditions: The iSCSI target is a software-based target (MSiSCSI, IET, StarWind) that uses a local hard drive or a RAM disk for its backend LUN. Different adapter ports are involved in the login. A SAS controller is present on the system.	This occurs caused because of an issue with the data reported by the iSCSI target in the Product Identification field in response to the standard inquiry from the adapter. This field should be unique among different targets' LUNs, but software-based targets report the same pre-formatted data for all the LUNs across all targets. If Windows encounters the same Product Identification field for different LUNs with the same Bus Target LUN field, it records error in the event log. No other effect has been found as a result of this behavior. The workaround for this error is to use non-overlapping LUN numbers for the various LUNs across the various iSCSI targets. On the iSCSI target system, LUNs can be numbered sequentially; they do not have to start at zero.

Appendix A: Error and Event Log Information

A.1 FC/FCoE Error and Event Logs

A.1.1 Viewing the FC/FCoE Error Log

The system event log is a standard feature of Windows Server software. All events logged by the Broadcom Emulex Storport Miniport will be Event ID 11 with source “elxfc/elxcna”.

To view the error log:

1. Open the Event Viewer window by doing one of the following:
2. Click Start>Programs>Administrative Tools>Event Viewer.
3. Right-click My Computer, Manage and Event Viewer in Computer Management.

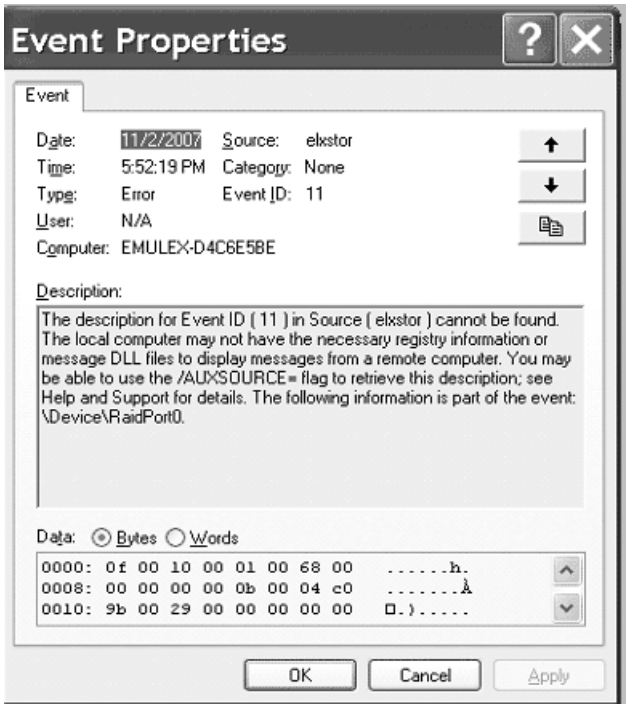
The Event Viewer window is displayed.

4. Double-click any event with the source name ELXFC/ELXCNA.
5. Examine the entry at offset 0x10 and Event ID 11. The Emulex event code is found in byte 0010 and supplementary data is in the byte offsets 0011 through 0013.

For example, in Figure 21 on page 119:

byte 0010 = 9b, byte 0011 = 00, byte 0012 = 29 and byte 0013 = 00

Figure 21 Event Properties



A.1.1.1 Severity Scheme

When the Event Viewer is launched, there are three branches: Application, Security, and System. All ELXFC/ELXCNA error log entries are found under the System branch, and all ELXFC/ELXCNA error log entries have the Event Viewer severity level of "error".

- A severe error code indicates that the driver, firmware, or adapter is behaving abnormally and your intervention is required to correct the issue.
- A malfunction error code indicates that there is an issue with the system, but your intervention is not required.
- A command error code indicates that an event has transpired, but does not require your intervention. An event may be issue-oriented, such as an invalid fabric command sub-type. An event may not be issue-oriented, such as exhausted retries on PLOGI or PDISC.

A.1.1.2 Related Driver Parameter: LogError

The LogError driver parameter determines the minimum severity level to enable entry of a logged error into the system. See the "Configuration" section for instructions on how to set driver parameters.

- If set to 0 = all errors regardless of severity are logged.
- If set to 1 = severe, malfunction, and command level errors are logged.
- If set to 2 = both severe and malfunction errors are logged.
- If set to 3 = only severe errors are logged.

NOTE Set LogError to 1 if you are troubleshooting SAN connectivity or device discovery issues.

A.1.1.3 Format of an Error Log Entry

An error log entry takes the form of an event. This event is described by:

- Date (date entry was logged)
- Source (elxfc/elxcna)
- Time (time entry was logged)
- Category (none)
- Type (error)
- Event id (0)
- User (N/A)
- Computer (name of computer)

A.1.1.4 Error Codes Tables

This section provides tables listing error codes and their descriptions.

A.1.1.4.1 Severe Errors

Table 20 lists severe errors and their codes.

Table 20 Severe Errors

Bits 0 – 7	Interpretation
0x00	Invalid link speed selection (SLI2-3 mode)
0x01	READ_REV failed (SLI2-3 mode)
0x02	Invalid adapter type (SLI2-3 mode)
0x03	Invalid adapter type (SLI2-3 mode)
0x04	CONFIG_PORT failed

Table 20 Severe Errors (Continued)

Bits 0 – 7	Interpretation
0x06	READ_CONFIG_failed
0x07	CONFIG_RING 0 failed
0x08	CONFIG_RING 2 failed
0x09	CONFIG_RING 1 failed
0x0A	CONFIG_RING 3 failed
0x0B	INIT_LINK failed (SLI2-3 mode)
0x0C	INIT_LINK failed (SLI2-3 mode)
0x0D	READ_REV failed (SLI2-3 mode)
0x0E	Invalid adapter type (SLI2-3 mode)
0x0F	Invalid adapter type (SLI2-3 mode)
0x10	CONFIG_PORT failed (reinitialization)
0x12	READ_CONFIG command failed (reinitialization)
0x13	CONFIG_RING 0 failed (reinitialization)
0x14	CONFIG_RING 1 failed (reinitialization)
0x15	CONFIG_RING 2 failed (reinitialization)
0x16	CONFIG_RING 3 failed (reinitialization)
0x17	Unresponsive adapter port (SLI2-3 mode)
0x1C	Firmware trap: info1 (SLI2-3 mode)
0x1D	Firmware trap: info2 (SLI2-3 mode)
0x1E	Over-temperature error condition (SLI2-3 mode)
0x1F	Firmware-initiated adapter port reset (SLI2-3 mode)
0x20	Adapter port error attention (SLI2-3 mode)
0x22	Over-temperature warning (SLI2-3 mode)
0x23	Returned to safe temperature (SLI2-3 mode)
0x24	Invalid response tag (SLI2-3 mode)
0x25	Invalid response tag (SLI2-3 mode)
0x26	Invalid response tag (SLI2-3 mode)
0x27	Invalid response sequence (SLI2-3 mode)
0x28	Failure on REG_LOGIN mailbox command
0x29	Unable to initiate fabric binding operation
0x42	Re-simulate FCF after exhausted retries on FLOGI
0x51	ABTS timeout on path and target (Bits 8-15: path id; Bits 16-23: target id)
0x2A	Attempted ADISC to non-existent node
0x2B	Failure on iocb context allocation
0x2C	Unable to initiate nport unbinding operation
0x2D	Unable to initiate nport binding operation
0x2E	Failed to allocate resources for Express Lane
0x30	Failure on mailbox context allocation
0x7C	Menlo initialization error
0x7D	Menlo initialization error

Table 20 Severe Errors (Continued)

Bits 0 – 7	Interpretation
0x7E	Menlo initialization error
0xA0	Failed to initialize adapter port (OneConnect)
0xA1	Failed to initialize adapter port (SLI2-3 mode)
0xCA	Invalid scatter gather list size
0xCB	Unsupported IFType (SLI4 mode)
0xC1	Failed to allocate miniport un-cached extension
0xC2	Insufficient un-cached extension space
0xC3	Port initialization failure (OneConnect)
0xC4	Port initialization failure (SLI2-3 mode)
0xC5	Utility mailbox command error
0xC6	SLI4 Pre-initialization failure
0xC7	UNREG_VPI failure requiring reset
0xC8	Invalid FLOGI response failure requiring reset
0xC9	REG_FCFI failure requiring resolicitation (SLI4 mode)
0xD3	NPIV memory allocation failure
0xE0	Unable to allocate exchange for unsolicited ELS command
0xE1	Misconfigured port event on indicated port, link effect and link state (SLI4 mode) Bits 31-24: Port Name; Bits 23-16: Link effect; Bits 15-8: Link state. Missing or unqualified SFP installed.
0xF0	Unresponsive adapter port (SLI4 mode)
0xF4	ULP Unrecoverable Error: low part (SLI4 mode)
0xF5	ULP Unrecoverable Error: high part (SLI4 mode)
0xF6	ARM Unrecoverable Error (SLI4 mode)
0xF7	READ_NV failed (SLI4 mode)
0xF8	READ_NV failed (SLI4 mode)
0xF9	READ_REV failed (SLI4 mode)
0xFA	READ_CONFIG failed (SLI4 mode)
0xFB	Failed to post header templates (SLI4 mode)
0xFC	Invalid Completion Queue Entry (SLI4 mode)
0xFD	Invalid Completion Queue Entry (SLI4 mode)
0xFE	Invalid Completion Queue Entry (SLI4 mode)

4.3.2.2.1 Malfunction Errors

Table 21 lists malfunction errors and their codes.

Table 21 Malfunction Errors

Bits 0 – 7	Interpretation
0x05	SET_VAR command failed
0x11	SET_VAR command failed (reinitialization)
0x21	Spurious mailbox command interrupt
0x31	Unrecognized mailbox command completion
0x32	Duplicate link attention: event tag unchanged

Table 21 Malfunction Errors (Continued)

Bits 0 – 7	Interpretation
0x33	Invalid link attention: no link state indicated
0x34	Duplicate link attention: link state unchanged
0x35	Error reading common service parameters for port
0x36	Error reading common service parameters for fabric
0x37	Error reading common service parameters for nport
0xB1	Write check error
0x3B	Failed to create node object
0x3C	PRLI initiation failure
0x3D	Recoverable UNREG base VPI error (Bits 8-15: mailbox status)
0x3E	Recoverable UNREG VPI error (Bits 8-15: mailbox status)
0x42	Exhausted retries on FLOGI
0x45	ELS command rejected
0x49	Exhausted retries on PLOGI
0x4E	World Wide Port Name mismatch on ADISC
0x4F	World Wide Node Name mismatch on ADISC
0x50	ADISC response failure
0x55	LOGO response failure
0x57	PRLI to non-existent node
0x5A	PRLI response error
0x5F	CT command error
0x62	Name server response error
0x66	State Change Notification registration failure
0x6A	Unrecognized ELS command received
0x6F	Received PRLI from un-typed source
0x73	Failed to pend PRLI for authentication
0x77	Failed to allocate Node object
0x7A	REG_VPI failed
0xA3	Command context allocation failure
0xAB	SCSI command error
0xAC	Read check error
0xB0	Node timeout: device removal signaled to Storport
0xB2	FCP_RSP short frame received
0xE1	Misconfigured port event on indicated port, link effect and link state (SLI4 mode) Bits 31-24: Port Name; Bits 23-16: Link effect; Bits 15-8: Link state. Missing or unqualified SFP installed.

A.1.1.4.2 Command Errors

Table 22 lists command errors and their codes.

Table 22 Command Errors

Bits 0 – 7	Interpretation
0x43	Fabric login succeeded
0x46	ELS command failed
0x47	Exhausted retries on ELS command
0x4A	PLOGI accepted
0x56	LOGO accepted
0x59	PRLI accepted
0x63	Fabric name server response
0x6B	ELS RSCN processed
0x71	LOGO received from fabric
0x79	FDISC accepted
0xA2	SCSI address assigned to discovered target
0xA4	Report LUNs error (initial I/O to discovered target)
0xA5	Local error indication on FCP command
0xA6	FCP Command error
0xA8	Data overrun
0xA9	FCP command error
0xAA	SCSI check condition
0xAD	Local reject indication on FCP command
0xAE	Error on SCSI pass-through command
0xAF	Error on Menlo CT command
0xE1	Misconfigured ports event on indicated port, link effect and link state (SLI4 mode) Bits 31-24: Port Name; Bits 23-16: Link effect; Bits 15-8: Link state. Missing or unqualified SFP installed.

A.1.1.4.3 Event Indicators

Table 23 lists event indications and their codes.

Table 23 Event Indications

Bits 0 – 7	Interpretation
0x18	Port shutdown event (SLI2-3 mode)
0x19	Port in off-line state (SLI2-3 mode)
0x1A	Port in on-line state (SLI2-3 mode)
0x1B	Port in off-line state (SLI2-3 mode)
0xA7	Data underrun
0xD0	NPIV Virtual Port creation success (Virtual Port Did in bits 8-31)
0xD1	NPIV Virtual Port creation failed (Virtual Port index in bits 8-31)
0xD2	NPIV Virtual Port FDISC failed (Virtual Port index in bits 8-31)
0xD4	Exceeded max Virtual Port supported (Virtual Port index in bits 8-31)
0xD5	NPIV Virtual Port removal (Virtual Port Did in bits 8-31)

Table 23 Event Indications (Continued)

Bits 0 – 7	Interpretation
0xEE	Authenticated successfully (remote Did in bits 8-31)
0xEF	Failed to authenticate (remote Did in bits 8-31)
0xE2	Authentication not support (remote Did in bits 8-31)
0xE3	Authentication ELS command timeout (remote Did in bits 8-31)
0xE4	Authentication transaction timeout (remote Did in bits 8-31)
0xE5	LS_RJT other than Logical Busy received for Authentication transaction (remote Did in bits 8-31)
0xE6	LS_RJT Logical Busy received for Authentication Transaction (remote Did in bits 8-31)
0xE7	Received Authentication Reject other than Restart (remote Did in bits 8-31)
0xE8	Received Authentication Reject Restart (remote Did in bits 8-31)
0xE9	Received Authentication Negotiate (remote Did in bits 8-31)
0xEA	Authentication spurious traffic (remote Did in bits 8-31)
0xEB	Authentication policy has been changed (remote Did in bits 8-31)
0xED	Same passed were set for both local and remote entities (remote Did in bits 8-31)
0xF1	Port shutdown event (SLI4 mode)
0xF2	Port in off-line state (SLI4 mode)
0xF3	Port in on-line state (SLI4 mode)

A.1.2 Viewing the FC/FCoE Event Log

This section provides information on the FC/FCoE event logs.

A.1.2.1 Event Log Interpretation

- All events logged by Broadcom Emulex Storport Miniport are in Event ID 11 with source “elxfc/elxcna”.
- The Storport Miniport driver parameter LogErrors determines what type of events are logged by the driver; the default setting is “3”,which logs only events of a SEVERE nature; the optional setting of “2” logs events of both SEVERE and MALFUNCTION type; and the optional setting of “1” logs events of SEVERE, MALFUNCTION, and COMMAND type.

  NOTE For troubleshooting SAN connectivity or device discovery issues, set the LogErrors to 1.

- The Emulex event code is found in byte 0010 and supplementary data is in byte offsets 0011 through 0013.

A.1.2.2 Additional Event Log Information

The following tables are not comprehensive but do include the codes that are most likely to show up in SAN environments where issues occur.

A.1.2.2.1 ELS/FCP Command Error Status Codes

Table 24 lists the internal firmware codes posted by the adapter firmware that explain why a particular ELS or FCP command failed at the FC level.

Table 24 ELS/FCP Command Error Status Codes

Explanation	Code
Remote Stop – Remote port sent an ABTS	0x2
Local Reject – Local Reject error detail	0x3
LS_RJT Received – Remote port sent LS_RJT	0x9
A_RJT Received – Remote port sent BA_RJT	0xA

A.1.2.2.2 CT Command Response Codes

Table 25 lists the codes that indicate the response to a FC Common Transport protocol command.

Table 25 CT Command Response Codes

Explanation	Code
FC Common Transport Reject	0x8001
FC Common Transport Accept	0x8002

A.1.2.2.3 FC-CT Reject Reason Codes

Table 26 lists the codes that indicate the reason a CT command was rejected.

Table 26 FC-CT Reject Reason Codes

Explanation	Code
Invalid command code	0x01
Invalid version level	0x02
Logical busy	0x05
Protocol error	0x07

A.1.2.2.4 ELS Command Codes

Table 27 lists the FC protocol codes that describe the Extended Link Services commands that were sent.

Table 27 ELS Command Codes

Explanation	Code
Link Service Reject (LS_RJT)	0x01
Accept (ACC)	0x02
N_Port Login (PLOGI)	0x03
Fabric Login (FLOGI	0x04
N_Port Logout (LOGO)	0x05
Process Login (PRLI)	0x20
Process Logout (PRLO)	0x21
Discover F_Port Service Params (FDISC)	0x51
Discover Address (ADISC)	0x52
Register State Change Notify (RSCN)	0x61

A.1.2.2.5 SCSI Status Codes

Table 27 lists the SCSI status codes returned from a SCSI device which receives a SCSI command.

Table 28 SCSI Status Codes

Explanation	Code
GOOD	0x00
CHECK CONDITION	0x02
BUSY	0x08
RESERVATION CONFLICT	0x18
QUEUE FULL	0x28

A.1.2.2.6 Local Reject Status Codes

Table 29 list the codes supplied by the Emulex adapter firmware that indicate why a command was failed by the adapter.

Table 29 Local Reject Status Codes

Explanation	Code
SEQUENCE TIMEOUT – Possible bad cable/link noise	0x02
INVALID RPI – Occurs if the link goes down	0x04
NO XRI – Possible host or SAN problem	0x05
TX_DMA FAILED – Possible host system issue	0x0D
RX_DMA FAILED – Possible host system issue	0x0E
ILLEGAL FRAME – Possible bad cable/link noise	0x0F
NO RESOURCES – Port out of exchanges or logins	0x11
LOOP OPEN FAILURE – FC_AL port not responding	0x18
LINK DOWN – Queued cmds returned at link down	0x51A
OUT OF ORDER DATA – Possible bad cable or noise	0x1D

A.1.2.2.7 SRB Status Codes

Table 30 lists the SCSI Request Block status codes provided by the driver to the operating system based upon the response from a SCSI device in the SAN.

Table 30 SRB Status Codes

Explanation	Code
ERROR	0x04
BUSY	0x05
TIMEOUT	0x09
SELECTION TIMEOUT	0x0A
COMMAND TIMEOUT	0x0B
BUS RESET	0x0E
DATA OVERUN	0x12

A.1.2.3 ASC/ASCQ

Additional Sense Code/Additional Sense Code Qualifier information can be found in any SCSI specification document; these codes contain detailed information about the status or condition of the SCSI device in question.

A.1.2.4 Additional Notes on Selected Error Codes

These are error codes that may be seen more frequently than others, or that indicate conditions that you might be able to solve by investigation and correction of issues in the SAN configuration.

NOTE The nomenclature of "0x" is used as the prefix for the byte code fields because those byte codes are actually hexadecimal values.

A.1.2.4.1 Node Timeout (Code 0xAA)

This event code indicates that a particular device has not been found (if the message is logged during device discovery) or that a particular device has been removed from the fabric. If this message is seen, determine if there is something wrong with the connection of that device to the SAN (cables, switches or switch ports, or status of the target device itself).

A.1.2.4.2 SCSI Command Error (0x9A) and SCSI Check Condition (code 0x9B)

Code 0x9A indicates that the SCSI command to a particular device was responded to with an error condition (the target and LUN information, along with the SCSI status, are provided).

In the specific case of code 0x9B, this code indicates that the device responded with the specific status of Check Condition – the ASC/ASCQ information provided in bytes 0x12 and 0x13 allows you to find out the status being reported by the target and to determine if there is an action that can be performed to return the device to functional status.

A.1.2.4.3 Nameserver Response (Code 0x98)

This code is useful in determining if the expected number of targets in a SAN configuration are being presented by the nameserver to the requesting adapter. The number in byte 0x11 is the number of targets returned to the nameserver query made by the adapter. If the number of targets does not match expectations, examine the SAN configuration found in the switch tables and if that information shows targets or devices still missing, check connections between the switch ports and those devices.

A.1.2.4.4 Context Allocation Failures

A number of event codes for which the interpretation contains the phrase "context allocation failure" exist. These types of events are referring to the internal memory constructs of the Broadcom Emulex Storport Miniport driver and as such are intended for Broadcom design engineers' information. If you encounter this type of code, contact Broadcom technical support for assistance.

NOTE Context allocation failures are rare.

A.2 NIC Error and Event Logs

This section provides information on NIC error and event logs.

A.2.1 Viewing the NIC Error Log

For Windows Server operating systems, the network driver generates error codes in the system event log. These error codes can be viewed by using the Event Viewer application.

To view the error codes:

1. Click the Start tab on the bottom of the screen.
2. Click Run.
3. Type eventvwr and click OK.
4. Click Windows Log.
5. Click System.
6. Click the be2net error under System Events to show the event details.

A.2.2 RoCE Event Log

The Windows Device Manager generates error log codes if any errors occur during the installation of the NIC or RoCE driver. Each log contains a Message ID, Severity, and Symbolic Link. The Message ID is unique and tracks the error message if it is not displayed.

Table 31 shows the list of error codes, the severity of the error, the message displayed, the meaning of the error, and the recommended resolutions. When reporting an issue with the adapter to Broadcom, check the event log and report any of these entries that are displayed.

Table 31 RoCE Event Log Entries

Message ID Hexadecimal/ Decimal	Severity	Message	Recommended Resolution
0x3F/63	Warning	<adapter>: Incorrect RoCE profile selected, select the RoCE-2 profile.	Select the RoCE-2 profile.
0x3C/60	Warning	The adapter ran out of resources while creating the requested number of SMB Direct connections. Reduce the connection count to a supported value.	Reduce the connection count to a supported value.
0x3B/59	Warning	RoCE is not enabled. Update the firmware and ensure that the RoCE-2 profile is selected.	Update the firmware and ensure that the RoCE-2 profile is selected in the OneCommand Manager application, the OneCommand Manager CLI, or the PXESelect utility.
0x004B	Warning	Driver received an unexpected RoCE packet.	Ensure the same RoCE mode is enabled on both sides of the system.

A.2.3 NIC Event Log

Windows Device Manager generates error log codes if any errors occur during the installation of the NIC driver. Each log contains a Message ID, Severity, and Symbolic Link. The Message ID is unique and tracks the error message (if not displayed). Table 32 shows the list of error codes, the severity of the error, the message displayed, the meaning of the

error, and recommended resolutions. When reporting an issue with the adapter to Broadcom, check the event log and report any of these entries that are displayed.

Table 32 NIC Event Log Entries

Message ID Hexadecimal/ Decimal	Severity	Message	Recommended Resolution
0x80000039	Warning	Firmware does not support GRE encapsulation. Encapsulation disabled.	Issue configuring NVRE hardware offloads. Update firmware on the OCe14000 adapter.
0x4000003AL	Informational	N/A	N/A
0x0000038L/56	Warning	The device firmware does not support ETS functionality in SR-IOV or multichannel mode.	Revert to default mode for ETS support.
0x0049/73	Informational	%2 : Correct optics installed. (%2 is a place holder for the NIC controller name.)	This message is informational.
0x0046/70	Warning	Unqualified SFP+ module detected on %2, Port %3 from %4 part number %5. (%2 is a holder for the NIC controller name. %3, %4, %5 are placeholders for other arguments in the log message.)	Replace the SFP+ module.
0x0045/69	Informational	SFP+ module detected on %2, Port %3 from %4 part number %5. (%2 is a place holder for the NIC controller name. %3, %4, %5 are placeholders for other arguments in the log message.)	This message is informational.
0x00037/55	Warning	This adapter may have an issue recovering from corrupted use of SR-IOV. Assigning an SR-IOV device to a Virtual Machine could leave the system vulnerable, and lead to instability. Assign SR-IOV devices only to Virtual Machines that run trusted workloads, or consider disabling the use of SR-IOV.	This adapter exposes a vulnerability to the VM that may allow the VM to crash the entire physical computer. This is no different than running a physical adapter. SR-IOV should only be used if the VM has a trusted server administrator.
0x00036/54	Warning	Incompatible optics. Replace with compatible optics for card to function.	Replace the incompatible SFP transceivers with compatible ones for the adapter to function correctly.
0x00035/53	Warning	Optics of two types installed-Remove one optic or install matching pair of optics.	Remove one SFP transceiver or install a matching pair of SFP transceivers.
0x00034/52	Warning	Optics faulted/incorrectly installed/not installed. Reseat optics, if issue not resolved, replace.	Reseat the SFP transceiver. If the issue is not resolved, replace the transceiver.
0x00033/51	Warning	SR-IOV virtualization failed initialization. Check system BIOS settings, or disable SR-IOV for the adapter.	Check system BIOS settings, or disable SR-IOV for the adapter.
0x00032/50	Warning	The Ethernet link is down due to PHY over-temperature condition. Improve cooling for the device.	Improve the cooling conditions for the device.

Table 32 NIC Event Log Entries (Continued)

Message ID Hexadecimal/ Decimal	Severity	Message	Recommended Resolution
0x00031/49	Warning	RSS is limited to 4 queues. Enable Advanced Mode in the PXE BIOS to use up to 16 queues. This may require a firmware update.	Enable Advanced Mode in the PXESelect BIOS utility during boot to use up to 16 queues. This may require a firmware update. See the Broadcom website for compatible firmware.
0x00030/48	Warning	SR-IOV is not enabled. Update the firmware, enable SR-IOV in the server BIOS, and enable SR-IOV and Advanced Mode in the PXE BIOS.	Update the firmware, enable SR-IOV in the server BIOS, and enable SR-IOV and Advanced Mode in the PXESelect BIOS utility. See the Broadcom website for compatible firmware.
0x0002f/47	Warning	VMQ offload is disabled. Disable SR/IOV support in PXE BIOS to use VMQ.	Disable SR-IOV support in the PXESelectBIOS utility to use VMQ.
0x0002e/46	Error	Device is not supported on Windows 7 Operating System.	
0x0002d/45	Error	Error recovery failed. The device is no longer operational. Update all drivers and firmware.	See the Broadcom website for compatible firmware and drivers.
0x0002c/44	Warning	Error recovery is disabled on the system. The device is no longer operational.	This message is informational.
0x0002b/43	Informational	The driver successfully recovered from an error.	This message is informational.
0x0002a/42	Warning	Legacy driver loaded. Move to the NDIS 6.20 driver for Windows Server 2008 R2 for best performance.	
0x0029/41	Warning	Legacy driver loaded. Move to the NDIS 6.x driver for Windows Server 2008 for best performance.	
0x0028/40	Warning	The firmware is outdated and does not support TOE offloads for this driver. Update the firmware.	The firmware and the driver are not compatible versions. See the Broadcom website for compatible firmware and drivers.
0x0026/38	Warning	The device firmware does not support RSS functionality for this network adapter.	The firmware and the driver are not compatible versions. See the Broadcom website for compatible firmware and drivers.
0x0025/37	Warning	The device firmware does not support TCP offload functionality.	The firmware and the driver are not compatible versions. See the Broadcom website for compatible firmware and drivers.
0x0024/36	Error	The device firmware does not support network functionality.	The firmware and the driver are not compatible versions. See the Broadcom website for compatible firmware and drivers.
0x0023/35	Warning	The Ethernet link is down due to a remote fault.	The Ethernet link is down due to the remote partner signaling a fault. Check the peer device for errors.
0x0022/34	Warning	The Ethernet link is down due to a local fault.	The Ethernet link is down due to a link-down event detected at the driver.

Table 32 NIC Event Log Entries (Continued)

Message ID Hexadecimal/ Decimal	Severity	Message	Recommended Resolution
0x0021/33	Informational	Network device is operating in Gen2 mode and installed in a 4x PCIe slot.	For best performance, install the adapter in an 8x Gen2 PCIe slot. Note: A 16x slot does not provide any additional performance.
0x0020/32	Informational	The network device is operating in Gen2 mode and installed in a 1x PCIe slot.	For best performance, install the adapter in an 8x Gen2 PCIe slot. Note: A 16x slot does not provide any additional performance.
0x001f/31	Informational	The network device is operating in Gen1 mode and installed in a 8x PCIe slot.	For best performance, install the adapter in an 8x Gen2 PCIe slot. Note: A 16x slot does not provide any additional performance.
0x001e/30	Informational	The network device is operating in Gen1 mode and installed in a 4x PCIe slot.	For best performance, install the adapter in an 8x Gen1 PCIe slot. Note: A 16x slot does not provide any additional performance.
0x001d/29	Informational	The network device is operating in Gen1 mode and installed in a 1x PCIe slot.	For best performance, install the adapter in an 8x Gen1 PCIe slot. Note: A 16x slot will not provide any additional performance.
0x001c/28	Error	Vital product data is not initialized correctly.	Use the offline flash utility to reconfigure the device.
0x0015/21	Warning	Firmware version does not match driver version.	The firmware version and driver must match. This is a warning message, but Broadcom recommends that you reinstall matching versions of the firmware and driver.
0x0014/20	Error	Failed to read registry configuration.	The registry is corrupted. Reinstall the driver or the operating system.
0x0013/19	Error	Resource conflict.	The operating system failed to allocate resources for the device. Check low memory conditions and operating system hardware resource conflicts.
0x0012/18	Error	Failed to enable bus mastering.	Verify that the BIOS allows bus mastering and that no resource conflicts exist.
0x0011/17	Error	The driver is incompatible with the device.	The driver is loaded on the incorrect hardware device. Verify that the correct driver is installed.
0x0010/16	Warning	The network driver was reset.	This may indicate a system hang or hardware issue. Verify that other system devices are working properly.
0x000c/12	Informational	The Ethernet link is down.	This message is informational.
0x000b/11	Informational	The Ethernet link is up.	This message is informational.
0x000a/10	Error	The network device detected an error.	A hardware error occurred. Verify that the firmware flash image is not corrupted. Contact Broadcom technical support.
0x0009/9	Error	Failed to register interrupt service routine.	This is an NDIS error. Verify that hardware resource conflicts do not exist.

Table 32 NIC Event Log Entries (Continued)

Message ID Hexadecimal/ Decimal	Severity	Message	Recommended Resolution
0x0008/8	Error	Failed to get TCP offload handlers.	This is an NDIS error. Verify that the NDIS version is valid for the driver.
0x0007/7	Warning	A memory allocation failure occurred during driver load. Performance may be reduced.	This warning occurred due to a failed memory allocation. Check low memory conditions. Use a smaller MTU or disable TCP offload to reduce driver memory requirements.
0x0006/6	Error	Driver load failed due to memory allocation failure	This failure occurred due to a failed memory allocation in the driver. Check low memory conditions.
0x0005/5	Error	Failed to register scatter gather DMA.	This failure occurred due to a failed memory allocation in the operating system. Check low memory conditions.
0x0004/4	Error	Failed to map device registers.	This failure occurred due to a failed memory allocation in the operating system. Check low memory conditions.
0x0003/3	Error	Unsupported medium.	This is an internal NDIS error. Check the operating system installation.
0x0002/2	Error	The network driver initialization failed.	This may be a firmware driver mismatch or corrupt installation. Check the firmware version, reinstall the firmware and try again. This may also indicate a hardware issue.
0x0001/1	Informational	The driver successfully loaded.	This message is informational and indicates successful loading of the device driver.

A.3 iSCSI Error and Event Log

This section provides information on iSCSi error and event logs.

A.3.1 Viewing the iSCSI Error and Event Log on Windows Server 2008

The iSCSI driver generates error codes in the system event log in the form of Event ID 11 errors. These error codes can be viewed by using the Event Viewer application.

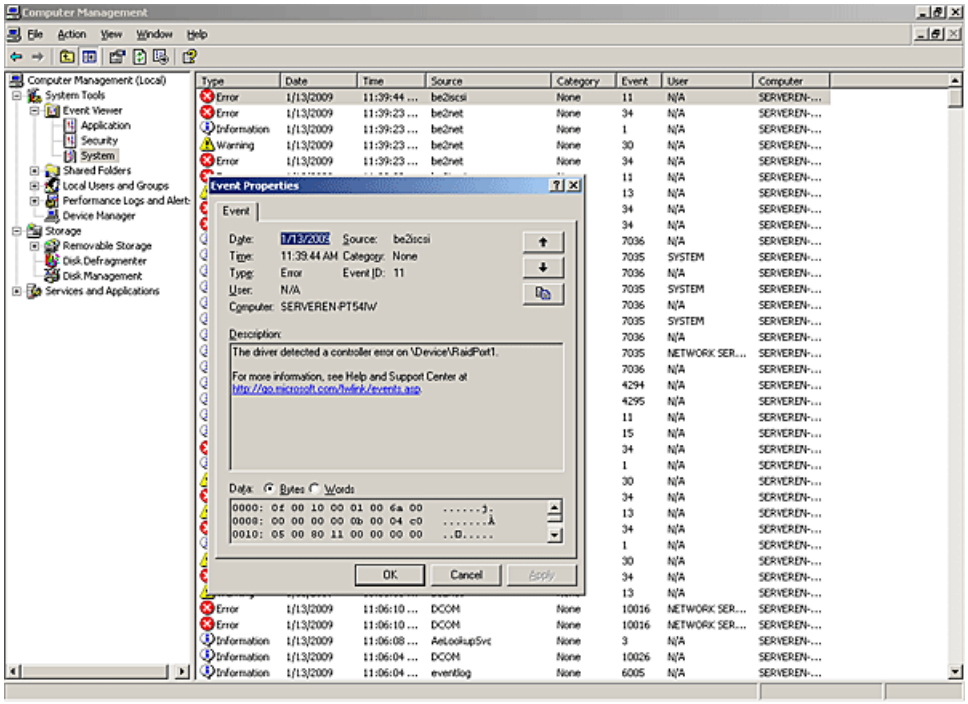
1. To view the error codes:
2. Click the Start tab on the bottom of the screen.
3. Click Run.
4. Type `eventvwr` and click OK.
5. Click Windows Log.
6. Click System.
7. Click the be2iscsi error under System Events to show the details of the event.

The iSCSI driver logs errors with the port driver error code of SP_INTERNAL_ADAPTER_ERROR, which translates to an Event ID 11 entry in the system event log.

The following is an example of the iSCSI driver error code 0x11800003 viewed with the Event Viewer application (see Figure on page 134). The window shows the driver-generated error code in the fifth DWORD (offset 0x10) of the word dump.

NOTE To improve the visibility of the error code in the Data field of the Event Properties window, select the Words option.

Figure 22 iSCSI Error



Because the adapters are dual PCI-function adapters, the “\Device\RaidPort<n>” value changes depending on the device that observed the error.

A.3.2 iSCSI Error Log on Windows Server 2008

Table 33 lists brief descriptions of the error log codes generated by the iSCSI driver for Windows Server 2008. It includes the error code, the message displayed, and the meaning of the message with the recommended resolution.

Table 33 iSCSI Error Log Entries on Windows Server 2008

Message ID	Message	Description/Recommended Resolution
0x348d0008	The iSCSI driver failed a WMI IOCTL request from the port driver because the request was failed by the ARM firmware. This error is immediately followed by another error code entry indicating the WMI request code in error.	This failure indicates that an operation attempted from the Microsoft WMI application resulted in an error. Check the operation being attempted for user or configuration errors.
0x348d0007	The iSCSI driver failed a WMI IOCTL request from the port driver. This error is immediately followed by another error code entry indicating the WMI request code in error.	This failure indicates that an operation attempted from the Microsoft WMI application resulted in an error. Check the operation being attempted for user or configuration errors.
0x33900002	The iSCSI driver failed an I/O request because it failed to retrieve a scatter gather list from the Storport driver.	This failure occurred due to a failed memory allocation in the operating system. Check low memory conditions.
0x31880001	The iSCSI driver failed to load because initialization failed during a power management bootup.	This failure may be due to the firmware not being present or currently running. This failure may also indicate a hardware issue.
0x3184000c	The iSCSI driver was unable to map one or more PCI Base Address Registers and failed to load.	This failure may indicate a low memory condition or a hardware error.
0x3184000b	The iSCSI driver ignored a configuration entry because the entry was invalid.	The invalid entry must be removed or corrected. Check the registry configuration for any new valid values added to the driver parameters. For more information on valid driver values, see Table 11, iSCSI Driver Options, on page 92.
0x31840009	The iSCSI driver failed to load a configuration value specified in the registry because the value was out of range. The driver will use the default value for this configuration parameter instead.	The range specified for a configuration parameter is too large or too small and must be corrected. Check the registry configuration for any new valid values added to the driver parameters. For more information on valid driver values, see Table 11, iSCSI Driver Options, on page 92.
0x31840006	The iSCSI driver failed to load due to memory allocation failure.	This failure occurred due to a failed memory allocation in the driver. Check low memory conditions.
0x31840001	The iSCSI driver failed to load because initialization failed during normal bootup.	This failure may be due to the firmware not being present or currently running. This failure may also indicate a hardware issue.
0x31640004	An internal API failed in the iSCSI driver during initialization.	This failure may indicate a low memory condition.
0x3164000D	The driver failed to allocate its complete memory requirement and will attempt to load with reduced capabilities. Total number of targets available will be reduced.	This message indicates a low memory condition.
0x14831000	There was an Unrecoverable Error detected by the iSCSI driver. Following this error log entry, the next 3 entries indicate the error codes.	This may be due to hardware errors or due to unhandled exceptions in the hardware or firmware.

Table 33 iSCSI Error Log Entries on Windows Server 2008 (Continued)

Message ID	Message	Description/Recommended Resolution
0x138e0103	The iSCSI driver failed an IOCTL request because the number of scatter gather elements required for the IOCTL buffer exceeded the firmware limit. Following this error log entry, the next entry will indicate the IOCTL opcode and the payload length requested.	This error may indicate an incorrect configuration option for the iSCSI driver. It may also indicate a low memory condition.
0x138d0101	The iSCSI driver detected an error offloading the iSCSI connection. The operation will be retried again. Following this error log entry, the next entry will indicate the session handle and the firmware error code.	This may indicate a target is in error or may point to transient network connectivity issues. It may also indicate a firmware error.
0x12990013	The iscsi driver did not receive an iSCSI command window update within 25 seconds during I/O operations. Following this error log entry, the next entry will indicate the session handle where this error occurred. The iSCSI driver will trigger a session recovery on the session and continue.	■ Verify that the iSCSI target is certified by Microsoft. Check for errors reported at the target. The Emulex iSCSI adapter is only supported with certified targets. ■ Check for software updates at the target vendor's website. If applicable, update the software. ■ Check for software updates at the Broadcom website. If applicable, update the software.
0x127b0012	The iSCSI driver received an invalid iSCSI Command Sequence Number update from the target. Following this error log entry, the next three entries will indicate the session handle and the iSCSI parameters – MaxCmdSN and ExpCmdSN respectively.	■ Verify that the iSCSI target is certified by Microsoft. Check for errors reported at the target. The Emulex iSCSI adapter is only supported with certified targets. ■ Check for software updates at the target vendor's website. If applicable, update the software. ■ Check for software updates at the Broadcom website. If applicable, update the software.
0x12790006	A connection to the target was lost for a period exceeding the ETO. The error log entry immediately following this entry will indicate the session ID of the target that lost the connection. There will be event log entries from the disk subsystem indicating that the drives were lost. If any I/Os were in progress, the system may see I/O errors or failures.	Check the connection to the target or the state of the target device. If the target is made available, any sessions that existed previously are re-established and the devices are available for I/O.
0x11990007	The iSCSI driver received a TMF that is not supported and rejected this request. The error log entry immediately following this entry will indicate the TMF function code that was rejected.	The operating system version is not supported.
0x11940008	The iSCSI driver received a TMF Abort request for an I/O request that is not present with the driver.	This may indicate a slow connection to the target. Check network connectivity to the target for any errors.
0x1184000B	Firmware returned invalid data in its configuration. iSCSI login and offload are disabled.	Reload the firmware.

Table 33 iSCSI Error Log Entries on Windows Server 2008 (Continued)

Message ID	Message	Description/Recommended Resolution
0x11840002	The iSCSI driver encountered a mismatched version of the firmware running on the board. This error may be followed by error codes 0x31840001 or 0x31880001 indicating that the iSCSI driver failed to load.	This failure indicates that the driver version running on the system does not match the firmware version on the board. Correct this by running the installer from the desired version.
0x11840001	The iSCSI driver detected a failure in the hardware during initialization. This error may be followed by error codes 0x31840001 or 0x31880001 indicating that the iSCSI driver failed to load.	This failure indicates that the hardware has not been initialized or is malfunctioning. This may also indicate that the firmware is not running correctly.
0x11800005	Both Port 0 and Port 1 links were down for a period exceeding the LDTO. If the adapter has a connection to the target, there will be event log entries from the disk subsystem indicating that the drives were lost. If any I/Os were in progress, the system may see I/O errors or failures.	Check the links to the adapter. If the link is re-established, any sessions that previously existed are re-established and the devices are available for I/O.
0x11800003	Both Port 0 and Port 1 links are down.	Check the links to the adapter.
0x31840005	Driver load failed because the PCI Vendor ID and Device ID are not supported.	Check the configuration on the adapter.
0x1180000A	The logical link on the OneConnect Port is down, traffic is disallowed on this function.	The iSCSI function may have been disabled in the PXESelect utility. If you disabled it intentionally, you can ignore this message.
0x13612000	A PHY event has been detected. Following this log entry, the next log entry indicates an additional dword with four fields: bits field 0-7 link state 8-15 link effect 16-23 port name 24-31 port number	The first byte of the additional dword (link state) indicates the type of the PHY event received. link state Event 00 Physical Link is functional 01 Optics faulted /incorrectly installed/not Installed - Reseat optics, if issue not resolved, replace. 02 Optics of two types installed - Remove one optic or install a matching pair of optics. 03 Incompatible optics - Replace with compatible optics. 04 Unqualified optics - Replace with Avago optics for warranty and technical support. 05 Uncertified optics - Replace with Avago certified optics to enable link operation. other values Unrecognized optics state

A.4 Viewing the iSCSI Error Log on Windows 7, Windows 8, Windows 8.1, Windows Server 2008 R2, Windows Server 2012, and Window Server 2012 R2

The iSCSI driver on the Windows 7, Windows 8, Windows 8.1, Windows Server 2008 R2, Windows Server 2012, and Windows Server 2012 R2 operating systems support the new event logging mechanism introduced by Storport. Custom event messages are logged for a variety of events with different severity, such as informational, warning, or error. The source of the events indicates the service name and every event includes a unique ID and a symbolic name. See Table 34 for a description of the error log codes.

Table 34 iSCSI Error Log Entries on Windows 7, Windows 8, Windows 8.1, Windows Server 2008 R2,Windows Server 2012, and Windows Server 2012 R2

Message ID	Severity	Message	Recommended Resolution
0x02	Info	Driver loaded successfully.	N/A
0x04	Error	Firmware version does not match with driver version.	The driver version that is running on the system does not match the version of the firmware on the adapter. Install a driver that is compatible with the firmware.
0x05	Warning	Port link is down, check connection to the adapter.	Check the links to the adapter.
0x06	Info	Port link is up.	N/A
0x07	Error	Link down timeout expired on the port, all targets are lost.	The link on the adapter is down for a period exceeding the LDTO value. If the adapter has a connection to the target, event log entries from the disk subsystem indicate that the drives were lost. If any I/O was in progress, the system may see I/O errors or failures. Check the links to the adapter. If the link is re-established, any sessions that previously existed are reestablished and the devices are available for I/O.
0x08	Error	Target with session id N failed to connect within the configured timeout.	A connection to the target was lost for a period exceeding the ETO. The error log entry includes the session ID of the target that lost the connection. Event log entries from the disk subsystem indicate that the drives were lost. If any I/O was in progress, the system may see I/O errors or failures. Check the connection to the target or the state of the target device. If the target is made available, any sessions that previously existed are re-established and the devices are available for I/O.
0x09	Error	Task Management request N was unhandled.	The iSCSI driver received a Task Management Function that is not supported, and it rejected this request. An application or service that is installed on the system may not be compatible with the driver.
0x0a	Warning	Task Management Function abort was received on a task that is not present.	The iSCSI driver received a Task Management Function Abort request for an I/O request that is not present with the driver. This may indicate a slow connection to the target. Check network connectivity to the target for any errors.

Table 34 iSCSI Error Log Entries on Windows 7, Windows 8, Windows 8.1, Windows Server 2008 R2,Windows Server 2012, and Windows Server 2012 R2 (Continued)

Message ID	Severity	Message	Recommended Resolution
0x0b	Error	Error in determining firmware configuration.	An error in determining the firmware configuration occurred. The firmware on the adapter may not be functioning properly. Check the adapter and reinstall the firmware if required.
0x0e	Warning	iSCSI error was detected on session A, ExpCmdSn B, MaxCmdSn C.	The iSCSI driver received an invalid iSCSI Command Sequence Number update from the target. The event log entry indicates the session handle, MaxCmdSN, and ExpCmdSN. ■ Verify that the iSCSI target is certified by Microsoft. Check for errors reported at the target. The Emulex iSCSI adapter is only supported with certified targets. ■ Check for software updates at the target vendor's website. If applicable, update the software. ■ Check for driver and firmware updates at the Broadcom website. If applicable, update the driver and firmware.
0x0f	Warning	The iSCSI target on session id N failed to open the command window within configured timeout.	The iSCSI driver did not receive an iSCSI command window update for up to 25 seconds during I/O operations. The event log entry indicates the session handle on which the error occurred. The iSCSI driver triggers a session recovery on the session and continues. ■ Verify that the iSCSI target is certified by Microsoft. Check for errors reported at the target. The Emulex iSCSI adapter is only supported with certified targets. ■ Check for software updates at the target vendor's website. If applicable, update the software. ■ Check for driver and firmware updates at the Broadcom website. If applicable, update the driver and firmware.
0x10	Warning	Encountered an error offloading an iSCSI connection, error code N.	The iSCSI driver detected an error while offloading the iSCSI connection. The operation is retried up to five times. The session handle and the adapter firmware error code are included in the event log message. This may indicate a target is in error or it may point to transient network connectivity issues. It may also indicate an adapter firmware error.
0x11	Warning	The IOCTL opcode A requires more scatter gather elements than allowed. Transfer length is B.	The iSCSI driver failed an IOCTL request because the number of scatter/gather elements required for the IOCTL buffer exceeded the adapter firmware limit. The IOCTL opcode and the payload length requested are included in the event log entry. This error may indicate an incorrect configuration option for the iSCSI driver. It may also indicate a low memory condition.
0x12	Error	Unrecoverable error detected. UE Low: A UE High: B FW Line: C.	An unrecoverable error was detected by the iSCSI driver. This may be caused by hardware errors or by unhandled exceptions in the hardware or firmware.

Table 34 iSCSI Error Log Entries on Windows 7, Windows 8, Windows 8.1, Windows Server 2008 R2,Windows Server 2012, and Windows Server 2012 R2 (Continued)

Message ID	Severity	Message	Recommended Resolution
0x13	Error	Hardware initialization failed, failing driver load	The iSCSI driver detected a failure in the hardware during initialization. This failure indicates that the hardware has not been initialized or is malfunctioning. This may also indicate that the firmware is not running correctly.
0x14	Warning	Failed to retrieve scatter gather list for a SCSI Request Block, an IO has failed.	The iSCSI driver failed an I/O request because it failed to retrieve a scatter/gather list from the Storport driver. This failure occurred because of a failed memory allocation in the operating system. Check low memory conditions.
0x15	Error	ACIT library table initialization failed.	An internal API failed in the iSCSI driver during initialization. This failure may indicate a low memory condition.
0x16	Error	An ACIT API failed.	An internal API failed in the iSCSI driver during initialization. This failure may indicate a low memory condition.
0x17	Error	Unsupported hardware, failing driver load.	Driver loading failed because the PCI Vendor ID and Device ID are not supported. Check the adapter configuration.
0x18	Error	Memory could not be allocated, failing driver load.	This failure occurred because of a failed memory allocation in the driver. This failure may indicate a low memory condition
0x19	Warning	WMI driver error, code A.	The iSCSI driver failed a WMI IOCTL request from the port driver. The event log entry includes the WMI request code in error. An operation attempted from the Microsoft WMI application resulted in an error. Check the operation being attempted for errors.
0x1a	Warning	WMI IOCTL error, code A.	The iSCSI driver failed a WMI IOCTL request from the port driver because the request was failed by the ARM firmware. The event log entry includes the request code in error. An operation attempted from the Microsoft WMI application resulted in an error. Check the operation being attempted for errors.
0x1b	Warning	A configuration parameter is out of range.	The iSCSI driver failed to load a configuration value specified in the registry because the value was out of range. The driver uses the default value for this configuration parameter. The range specified for a configuration parameter is either too large or too small, and it must be corrected. Check the registry configuration for new driver parameter entries. See Table 11, iSCSI Driver Options, on page 92 for the correct range of values

Table 34 iSCSI Error Log Entries on Windows 7, Windows 8, Windows 8.1, Windows Server 2008 R2,Windows Server 2012, and Windows Server 2012 R2 (Continued)

Message ID	Severity	Message	Recommended Resolution
0x1d	Warning	A configuration parameter is invalid.	The iSCSI driver ignored a configuration entry because the entry was invalid. Check the registry configuration for new driver parameter entries. The invalid entry must be removed or corrected. See Table 11, iSCSI Driver Options, on page 92 for the correct range of values.
0x1e	Error	Failed to map Base Address Register, failing driver load.	The iSCSI driver was unable to load because it was unable to map one or more PCI Base Address registers. This failure may indicate a low memory condition or a hardware error.
0x1f	Error	Hardware initialization has failed – error code A.	The hardware initialization has failed. This error causes the driver load to fail. The error code included in the event log entry identifies the specific point of failure. This failure indicates that the hardware has not been initialized or is malfunctioning. This may also indicate that the firmware is not running correctly.
0x20	Warning	Initial memory allocation failed, driver is running with reduced capabilities.	The driver failed to allocate its complete memory requirement and attempts to load with reduced capabilities. The total number of targets available is reduced. This message indicates a low memory condition.
0x21	Info	Target Reconnected for Session id N.	N/A
0x22	Info	Interrupt Redirection capability is enabled.	N/A
0x23	Warning	Interrupt Redirection capability is not supported by this firmware. Update your firmware.	Update the firmware to the latest version.
0x24	Error	Device is not supported on Windows 7 Operating System, failing driver load.	The iSCSI adapter family is not supported on the Windows 7 client operating systems.
0x25	Info	Interrupt Redirection capability is not supported by this hardware.	N/A
0x26	Warning	Logical link on the OneConnect Port is down, traffic is disallowed on this function.	The iSCSI function may have been disabled in the PXESelect utility. If you disabled it intentionally, you can ignore this message.
0x27	Error	Firmware returned invalid data in its configuration. iSCSI login and offload are disabled.	Reload the firmware.
0x28	Warning	Error Recovery is not being attempted. Adapter is no longer functional.	An unrecoverable error has occurred, but error recovery is not enabled. A system reboot is required to make the adapter operational again.
0x2b	Informational	The storage device is operating in Gen<xx> mode and installed in a <yy>x PCIe slot.	Informational message that provides the slot capabilities where the iSCSI adapter is installed.
0x2c	Error	The firmware appears unresponsive; Unrecoverable Error.	The adapter is no longer functional. A system reboot is required to make the adapter operational again.

Table 34 iSCSI Error Log Entries on Windows 7, Windows 8, Windows 8.1, Windows Server 2008 R2,Windows Server 2012, and Windows Server 2012 R2 (Continued)

Message ID	Severity	Message	Recommended Resolution
0x2d	Informational	Reporting X of the total Y sessions logged in by firmware.	Informational event to indicate that not all targets logged in by the firmware were reported as available to the operating system. If the total number of targets logged by the firmware is over the specified limits, this error can be ignored.
0x2f	Warning	Solicited command was invalidated internally due to a Data Digest error.	This condition is detected by the OneConnect firmware. If this message is unexpected, check the iSCSI configuration.
0x30	Warning	Connection was invalidated internally; the received PDU size was greater than the DSL.	This condition is detected by the OneConnect firmware. If this message is unexpected, check the iSCSI configuration.
0x31	Warning	Connection was invalidated internally; the received PDU sequence size was greater than the FBL/MBL.	This condition is detected by the OneConnect firmware. If this message is unexpected, check the iSCSI configuration.
0x32	Warning	Connection was invalidated internally; a received PDU HDR had AHS.	This condition is detected by the OneConnect firmware. If this message is unexpected, check the iSCSI configuration.
0x33	Warning	Connection was invalidated internally due to a Header Digest warning.	This condition is detected by the OneConnect firmware. If this message is unexpected, check the iSCSI configuration.
0x34	Warning	Connection was invalidated internally due to a bad opcode in the PDU header.	This condition is detected by the OneConnect firmware. If this message is unexpected, check the iSCSI configuration.
0x35	Warning	Connection was invalidated internally due to a received ITT/TTT that did not belong to this connection.	This condition is detected by the OneConnect firmware. If this message is unexpected, check the iSCSI configuration.
0x36	Warning	Connection was invalidated internally; the received ITT/TTT value was greater than the maximum supported ITTs/TTTs.	This condition is detected by the OneConnect firmware. If this message is unexpected, check the iSCSI configuration.
0x37	Warning	Connection was invalidated internally due to an incoming TCP RST.	This condition is detected by the OneConnect firmware. If this message is unexpected, check the iSCSI configuration.
0x38	Warning	Connection was invalidated internally due to TCP protocol warning (SYN received, maximum retransmits exceeded, urgent received, etc.).	This condition is detected by the OneConnect firmware. If this message is unexpected, check the iSCSI configuration.
0x39	Warning	Connection was invalidated internally due to TCP RST sent by the transmit side.	This condition is detected by the OneConnect firmware. If this message is unexpected, check the iSCSI configuration.
0x3a	Warning	Connection was invalidated internally due to an incoming TCP FIN.	This condition is detected by the OneConnect firmware. If this message is unexpected, check the iSCSI configuration.
0x3b	Warning	Connection was invalidated internally due to a bad unsolicited PDU (unsolicited PDUs are PDUs with ITT=0xffffffff).	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.

Table 34 iSCSI Error Log Entries on Windows 7, Windows 8, Windows 8.1, Windows Server 2008 R2,Windows Server 2012, and Windows Server 2012 R2 (Continued)

Message ID	Severity	Message	Recommended Resolution
0x3c	Warning	Connection was invalidated internally due to a bad WRB index.	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.
0x3d	Warning	Command was invalidated internally; the received command had residual overrun bytes.	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.
0x3e	Warning	Command was invalidated internally; the received command had residual underrun bytes.	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.
0x3f	Warning	Command was invalidated internally; a received PDU had an invalid StatusSN.	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.
0x40	Warning	Command was invalidated internally; a received R2T had invalid field(s).	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.
0x41	Warning	Command was invalidated internally; the received PDU had an invalid LUN.	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.
0x42	Warning	Command was invalidated internally; the corresponding ICD was not in a valid state.	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.
0x43	Warning	Command was invalidated; the received PDU had an invalid ITT.	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.
0x44	Warning	Command was invalidated; the received sequence buffer offset was out of order.	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.
0x45	Warning	Command was invalidated internally; a received PDU had an invalid DataSN.	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.
0x46	Warning	Connection invalidation completion notification.	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.
0x47	Warning	Connection invalidation completion with data PDU index.	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.
0x48	Warning	Command invalidation completion notification.	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.
0x49	Warning	Unsolicited header notification.	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.
0x4a	Warning	Unsolicited data notification.	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.
0x4b	Warning	Unsolicited data digest warning notification.	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.

Table 34 iSCSI Error Log Entries on Windows 7, Windows 8, Windows 8.1, Windows Server 2008 R2,Windows Server 2012, and Windows Server 2012 R2 (Continued)

Message ID	Severity	Message	Recommended Resolution
0x4c	Warning	TCP acknowledge based notification.	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.
0x4d	Warning	Connection was invalidated internally; the command and data were not on the same connection.	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.
0x4e	Warning	Solicited command was invalidated internally due to DIF warning.	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.
0x4f	Warning	Connection was invalidated internally due to an incoming unsolicited PDU that had immediate data on the connection that does not support it.	This condition is detected by the OneConnect firmware. If this message is unexpected, check your iSCSI configuration.
0x50	Informational	Physical Link is functional.	N/A
0x51	Error	Optics faulted/incorrectly installed/not installed - Reseat optics, if issue not resolved, replace.	The optics are not present.
0x52	Error	Optics of two types installed - Remove one optic or install matching pair of optics.	A mismatched pair of optics (for example:1 FC and 1 Ethernet) has been installed.
0x53	Error	Incompatible optics - Replace with compatible optics for adapter to function.	Incompatible optics (for example: FC optics in Ethernet adapter) have been used.
0x54	Warning	Unqualified optics - Replace with Avago optics for Warranty and Technical Support.	Replace with Avago optics for Warranty and Technical Support.
0x55	Error	Uncertified optics - Replace with Avago Certified optics to enable link operation.	Replace with Avago Certified optics to enable link operation.
0x56	Warning	Unrecognized optics state	This condition is reported if an unknown state for the optics is detected.

Appendix B: Configuring iSCSI through DHCP

B.1 Dynamic Host Configuration Protocol (DHCP) Recommendations

If you are using the DHCP server to obtain an IP address for the adapter, Broadcom recommends that you set up a reservation. A reservation assigns a specific IP address based on the MAC address of the adapter. If you do not reserve an IP address through DHCP, then you must set the lease length for the adapter IP address to unlimited. This prevents the IP address lease from expiring.

B.2 Vendor-Specific Option 43

This section describes the format for the data returned in DHCP vendor-specific option 43. The method and format for specifying the Vendor ID is outside of the scope of this document and is not included. The adapter offers this Vendor ID to the DHCP server to retrieve data in the format described in this section.

B.2.1 Format of Vendor-Specific Option 43

The following describes the format of option 43 and includes guidelines for creating the data string:

```
'iscsi:'<TargetIP>':'<TargetTCPPort>':'<LUN>':'<TargetName>':'
<InitiatorName>':'<HeaderDigest>':'<DataDigest>':' <AuthenticationType>
```

- Strings shown in quotes are part of the syntax and is therefore mandatory.
- Fields enclosed in angular brackets (including the angular brackets) should be replaced with their corresponding values. Some of these fields are optional and can be skipped.
- If an optional field is skipped, a colon must be used as a placeholder to indicate the default value for that field.
- If specified, the value of each parameter should be enclosed in double quotes. See “Examples” on page 146.
- All options are case-sensitive.

B.2.2 Description of Mandatory and Optional Parameters

Table 35 describes the parameters used in the data string for option 43.

Table 35 Data String Parameters for Option 43

Parameter	Description	Field Type
<TargetIP>	A valid IPv4 address in dotted decimal notation	Mandatory
<TargetTCPPort>	A decimal number ranging from 1 to 65535 (inclusive). The default TCP port is 3260.	Optional
<LUN>	A hexadecimal representation of the LUN of the boot device. By default, LUN 0 is assumed to be the boot LUN. It is an eight-byte number that should be specified as a hexadecimal number consisting of 16 digits, with an appropriate number of zeroes padded to the left, if required.	Optional
<TargetName>	A valid iSCSI name of up to 223 characters.	Mandatory

Table 35 Data String Parameters for Option 43 (Continued)

Parameter	Description	Field Type
<InitiatorName>	A valid iSCSI iqn name of up to 223 characters. If it is not provided, the default initiator name (generated by the adapter based on its MAC address) is used.	Optional
<HeaderDigest>	Either E (the header digest is enabled) or D (the header digest is disabled).	Optional
<DataDigest>	Either E (the data digest is enabled) or D (the data digest is disabled).	Optional
<AuthenticationType>	D (authentication is disabled), E (one-way CHAP is enabled; the user name and secret must be specified by non-DHCP means), or M (mutual-CHAP is enabled; the user name and passwords must be specified by non-DHCP means). D is the default setting.	Optional

B.2.2.1 Examples

The following is an example of default initiator name and data digest settings:

```
iscsi:"192.168.0.2":"3261":"000000000000000E":"iqn.2009-4.com:1234567890"::"E"::"
E"
```

- Target IP address: 192.168.0.2
- Target TCP port: 3261
- Target boot LUN: 0x0E
- Target iqn name: iqn.2009-04.com:1234567890
- Initiator name: not specified; use the initiator name that is already configured, or use the default name if no initiator name is already configured.
- Header digest: Enabled
- Data digest: not specified; assume disabled
- Authentication type: one-way CHAP

The following is an example of default TCP port and mutual-CHAP settings:

```
iscsi:"192.168.0.2"::"000000000000000E":"iqn.2009-4.com:1234567890"::"E":"D":"M"
```

- Target IP address: 192.168.0.2
- Target TCP port: Use default from RFC 3720 (3260)
- Target boot LUN: 0x0E
- Target iqn name: iqn.2009-04.com:1234567890
- Initiator name: not specified; use the initiator name that is already configured, or use the default name if no initiator name is already configured.
- Header digest: Enabled
- Data digest: Disabled
- Authentication type: Mutual-CHAP

Appendix C: Port Speed Specifications

An adapter can support only one Ethernet port speed at a time, and the preference is always for 10 Gb/s. The type of module used (copper or optical) does not make a difference. As soon as a 10Gb module is plugged into one of the ports, the adapter switches to 10 Gb/s no matter what speed the other port is running, or even if I/O is running on that port. This behavior is a per-adapter constraint; another adapter can be running on a different speed.

Table 36 lists negotiated speed specifications per an adapter's port connection:.

Table 36 Negotiated Speed Specification per Adapter Port Connection

Port 0	Port 1	Port Link	Status Speed
10 Gb/s	10 Gb/s	Both ports link up	10 Gb/s
10 Gb/s	1bpsG	Only Port 0 links up	10 Gb/s
1 Gb/s	10 Gb/s	Only Port 1 links up	10 Gb/s
1 Gb/s	1Gb/s	Both ports link up	1 Gb/s
1 Gb/s	-	Only Port 0 links up	1 Gb/s
-	1 Gb/s	Only Port 1 links up	1 Gb/s
10 Gb/s	-	Only Port 0 links up	10 Gb/s
-	10 Gb/s	Only Port 1 links up	10 Gb/s

C.1 Negotiating Speed on a Mezzanine Card

A mezzanine card retains the first negotiated speed. This could be either 10 Gb/s or 1 Gb/s, depending on the connected switch type. To change the speed on a mezzanine card:

1. Remove the switch from both ports.
2. Insert the switch on one port and wait for the link to come up.
3. After the link is up, insert the switch on the other port.

The mezzanine card retains the speed of the first link until both links are down.

Appendix D: AutoPilot Installer Command Line and Configuration File Parameters

The AutoPilot Installer can initiate an installation from a command prompt or script. You can run the AutoPilot Installer manually from the command line or a script, or you can run it automatically through the driver kit. When run manually from the command line or script, the command line parameters can be passed.

If you specify the "/q" switch with the driver kit installer command, the driver kit installer runs in unattended mode and automatically invokes the APInstall.exe with its "/silent" switch. See "Unattended Driver Installation" on page 19 for more information.

D.1 AParg Driver Kit Parameter and Appending to the APInstall.exe File

If you specify a value for the "APargs" driver kit parameter, this value is appended to the APInstall.exe command line. For example, if you execute this installer file as:

```
elxdrv-fc-fcoe<version>.exe /q APargs=SilentRebootEnable=True
```

After installing the AutoPilot Installer, the driver kit automatically executes it as:

```
APInstall.exe /silent SilentRebootEnable=True
```

To specify more than one parameter, separate the settings by one or more spaces and put quotes around the entire APargs expression. For example, the command line (all on one line):

```
elxdrv-fc-fcoe<version>.exe "APargs=SilentRebootEnable=True localDriverLocation =
"d:\drivers\new\Storport"
```

This results in the AutoPilot Installer being run as:

```
APInstall.exe SilentRebootEnable=True localDriverLocation =
"d:\drivers\new\Storport"
```

Parameter values that contain spaces, such as path names, must be enclosed in quotes. To add such a setting to APargs, you must insert backslashes before the quotes around the value, and then add quotes around the entire APargs expression. For example, the command line (all on one line):

```
elxdrv-fc-fcoe<version>.exe "APargs=ReportLocation=\"C:\Documents and
Settings\Administrator\My Documents\reports\""
```

This results in AutoPilot Installer being run as:

```
APInstall.exe ReportLocation="C:\Documents and Settings\Administrator\My
Documents\reports"
```

To pass multiple parameters to the AutoPilot Installer and minimize errors, you can run the utility kit installer interactively, delay AutoPilot Installer execution, and then run the AutoPilot Installer command. The procedure is described in "Option 2: Run the AutoPilot Installer Separately" on page 17 and "Unattended Driver Installation" on page 19.

You can specify a non-default directory for the driver kit by specifying an 'installation folder' on the command line. For example:

```
elxdrv-fc-fcoe<version>.exe install:"C:\Emulex"
```

This option can be used in conjunction with the "APArgs" directive.

D.2 AutoPilot Installer Syntax

The syntax used to run AutoPilot Installer silently from a command line or script is:

```
APInstall [/silent] [parameter setting][parameter setting...]
```

The "silent" switch and parameter settings can occur in any order. One or more spaces must separate the switch and each parameter setting.

The syntax of a parameter setting is:

```
parameter_name =["]value["]
```

Double quotes are required only around values that contain spaces. Spaces can separate parameters, equal signs, and values. Parameter names and values are not case-sensitive.

The APInstall command can contain the settings listed below. Each setting, except ConfigFileLocation, can also be specified in the AutoPilot Configuration file. For descriptions of each parameter, see "Software Configuration Parameters" on page 150.

Settings specified in the APInstall command override those specified in the configuration file.

```
ConfigFileLocation = path-specifier
NoSoftwareFirstInstalls = { TRUE | FALSE }
SilentRebootEnable = { TRUE | FALSE }
ForceDriverUpdate = { TRUE | FALSE }
ForceDriverTypeChange = { TRUE | FALSE }
SkipDriverInstall = { TRUE | FALSE }
InstallWithoutQFE = { TRUE | FALSE }
ForceRegUpdate = { TRUE | FALSE }
LocalDriverLocation = path-specifier
ReportLocation = path-specifier
```

D.2.1 Path Specifiers

Paths can be specified as

- an explicit path:

```
ReportLocation="C:\Program Files\Emulex\AutoPilot Installer\Reports"
```

- a relative path:

```
LocalDriverLocation="Drivers\Storport Miniport\"
```

(assuming installation into "C:\Program Files\Emulex\AutoPilot Installer\", this path would logically become "C:\Program Files\Emulex\AutoPilot Installer\Drivers\Storport Miniport\")

- with the %ProgramFiles% environment variable:

```
LocalDriverLocation = "%ProgramFiles%\Emulex\AutoPilot Installer\Driver"
```

D.2.2 Configuration File Location

The optional setting ConfigFileLocation contains the path to the configuration file that should be used. If this parameter is not specified, AutoPilot Installer uses the file named APInstall.cfg in the same folder as APInstall.exe.

The format is the same as that of the other path settings.

Example:

```
APInstall /silent SkipDriverInstall=True configFileLocation=MyConfiguration.cfg
```

D.2.3 Software Configuration Parameters

D.2.3.1 DiagEnable (Running Diagnostics)

NOTE The DiagEnable parameter cannot be specified on the command line; it must be specified within the configuration file.

Default: True

By default, AutoPilot Installer runs its diagnostics after all driver installation tasks have been completed. To disable this function, set this parameter to false.

D.2.3.2 ForceDriverTypeChange (Forcing a Driver Type Change)

Default: False

When installing a driver, set this parameter to true to cause silent mode installations to update or install the Storport Miniport driver on each adapter in the system, without regard for the currently installed driver type (replacing any installation of the SCSIport Miniport or FC Port driver).

D.2.3.3 ForceDriverUpdate (Forcing a Driver Version Update)

Default: False

By default, if the same version of the driver is already installed, an unattended installation proceeds with installing only the utilities. To force a driver update even if the same version of the driver is installed, set this parameter to true.

NOTE ForceDriverUpdate applies only to unattended installations; in interactive installations, this parameter is ignored and you are asked if the driver should be updated.

D.2.3.4 ForceRegUpdate (Forcing an Update of an Existing Driver Parameter Value)

Default: False

The ForceRegUpdate driver parameter setting determines whether existing driver parameters are retained or changed when you update the driver. By default, all existing driver parameter settings are retained. The ForceRegUpdate parameter does not affect any existing persistent bindings. To set up an installation to remove the existing driver parameters from the registry and replace them with parameters specified in the AutoPilot Configuration file, set this parameter to true.

NOTE You can use this setting for attended installations with the AutoPilot Installer wizard if you modify the AutoPilot Configuration file in an AutoPilot Installer Kit.

D.2.3.5 LocalDriverLocation (Specifying Location to Search for Drivers)

Default: Drivers (The default “Drivers” folder is located in the same folder as AutoPilot Installer.)

You can specify a local location that is to be searched for drivers during unattended installations. The location can be a local hard drive or a network share. Removable media are not searched.

Example:

```
LocalDriverLocation = "d:\drivers\new\Storport"
```

NOTE On x64 and 32-bit systems, the path specified by ‘LocalDriverLocation’ must contain at least one instance of an FC, FCoE, iSCSI, and NIC driver. AutoPilot Installer automatically selects the most recent revisions that it finds.

D.2.3.6 NoSoftwareFirstInstalls (Prohibiting Software First Installations)

Default: False

If this parameter is set to true, AutoPilot Installer prevents unattended installations from performing software-first installations. This way you can run an automated installation on multiple machines in your network, but only machines with Emulex adapters actually have Broadcom Emulex drivers updated or installed.

If this parameter is omitted from the configuration file or explicitly set to true, the page is not displayed. AutoPilot Installer uses configuration file parameters to determine the appropriate management mode.

D.2.3.7 ReportLocation (Setting Up an Installation Report Title and Location)

The automatically generated file name for this report is

```
"report_mm-dd-yy.txt"
```

where 'mm' is the month number, 'dd' is the day, and 'yy' indicates the year.

You can change only the installation report folder; the file name is auto-generated. In the following example x could be any available drive:

```
ReportLocation = "x:\autopilot\reports\installs\"
```

D.2.3.8 SilentInstallEnable (Enabling Unattended Installation)

NOTE Setting the SilentInstallEnable parameter to true in the configuration file is functionally equivalent to supplying the "/silent" switch on the command line. You cannot specify the SilentInstallEnable parameter on the command line.

Default: False

Setting this parameter to true causes AutoPilot Installer to operate with no user interaction.

D.2.3.9 SilentRebootEnable (Enabling Silent Reboot)

Default: False

AutoPilot Installer's default behavior in unattended installations does not restart the system. AutoPilot Installer continues with the installation. Restarts often require you to log in as part of the Windows start up process. If there is no login, the installation process would stop if the system is restarted. However, Windows can be configured to start up without requiring you to log in. You must ensure that it is safe to restart the system during unattended installations if you are going to set this parameter to true.

D.2.3.10 InstallWithoutQFE (Enabling Installation if a QFE Check Fails)

Default: False

AutoPilot Installer checks for Microsoft's QFEs, also known as KB updates, based on the checks you have specified in the [STORPORT.QFES] section. By default, the installation terminates if the QFE check fails. To enable a driver installation to proceed even if a check for QFEs fails, set this parameter to true.

D.3 AutoPilot Configuration File

The AutoPilot configuration file is organized into sections, grouped according to related commands. Six main sections exist:

- [AUTOPILOT.ID] – Configuration Identification
- [AUTOPILOT.CONFIG] – Software Configuration

- [STORPORT.CONFIGURATION] – Configuration Prompts/Vendor-Specific Questions
- [STORPORT.QFES] – QFE Checks
- [STORPORT.PARAMS] – Setting Up FC Driver Parameters
- [SYSTEM.PARAMS] – Setting Up System Parameters

Each section begins with a heading. The heading is required even if there are no settings in the section. The only section not required is the Installation Prompts section, which has the heading [STORPORT.CONFIGURATION]. That section cannot exist if AutoPilot Installer runs in silent mode. You must delete or comment-out that entire section for unattended installation.

Lines that begin with a semicolon are comments. Some of the comments are sample settings. To use the setting, remove the semicolon.

D.3.1 Using the Windows Environment Variable (%ProgramFiles%)

You can use the Windows ProgramFiles environment variable in the LocalDriverLocation and ReportLocation strings within the configuration file. This allows you to specify strings in a driver-independent manner, allowing the same configuration file to be used on different systems where Windows may have been installed on different drives. To use this option, "%ProgramFiles%" must be the first component specified in the string. The portion of the string that follows is appended to the contents of the ProgramFiles environment variable. For example:

```
ReportLocation = "%ProgramFiles%\my company\reports"
```

NOTE The contents of the ProgramFiles environment variable is not terminated with a slash, so you must provide one in the string. Windows environment variables are not case-sensitive.

D.3.2 Configuration Identification [AUTOPILOT.ID]

This section appears at the beginning of every AutoPilot configuration file and contains revision and label information. The revision entry identifies the file's version number and the date on which it was produced. The label entry is used to identify the configuration that the file supports. This section may appear only once in the APInstall.cfg file.

D.3.3 Software Configuration [AUTOPILOT.CONFIG]

This section can contain settings that control and configure AutoPilot Installer and the OneCommand Manager application operation. This section can appear only once in the AutoPilot configuration file. See "Software Configuration Parameters" on page 150 for information about settings that can be specified in this section.

D.3.4 Configuration Prompts/Vendor-Specific Questions [STORPORT.CONFIGURATION]

NOTE You must remove or comment out the entire [STORPORT.CONFIGURATION] section for an unattended installation.

A [STORPORT.CONFIGURATION] section can exist in the AutoPilot configuration file. The first items in this section are the driver parameters to be used regardless of how the questions are answered. This is followed by a subsection that contains questions (these may be vendor-specific questions). A line containing '[QUESTIONS]' marks the start of the subsection, and the end of it is marked by a line containing '[ENDQUESTIONS]'. Within the question subsection there can be as many questions as needed. Each question uses the format:

```
question= "question?", "explanation", "answer0", "answer1", "answer2",.... ,
"answern"
```

Where:

- "question?" contains the text of the question to be asked.
- "explanation" contains brief text to help explain the question. The explanation appears below the question in a smaller font. If there is no explanatory text, empty quotes must be used in its place.
- "answer0" contains the 1st answer to be displayed in the drop down list.
- "answer1" contains the 2nd answer to be displayed in the drop down list.
- "answern" contains the nth answer to be displayed in the drop down list.

For each question there can be as many answers as needed. For each answer there must be a corresponding "answer =" section with its corresponding driver parameters listed beneath it. The answer uses the format:

```
answer = 0
DriverParameter="Param1=value; Param2=value;"
answer = 1
DriverParameter="Param1=value; Param2=value;"
....
answer = n
DriverParameter="Param1=value; Param2=value;"
```

D.3.4.1 Example of [STORPORT.CONFIGURATION] section:

```
[STORPORT.CONFIGURATION]
;The first section contains the driver parameters common to all configurations, no
matter what answers are given.
DriverParameter="EmulexOption=0;"
[QUESTIONS]
question = "What is your link speed?", "Note: select 'Auto-detect' if you are
unsure about the answer.", "4GB", "2GB", "1GB", "Auto-detect"
ANSWER = 0
DriverParameter = "LinkSpeed=4;"  ;4 GB
ANSWER = 1
DriverParameter = "LinkSpeed=2;"  ;2 GB
ANSWER = 2
DriverParameter = "LinkSpeed=1;"  ;1 GB
ANSWER = 3
DriverParameter = "LinkSpeed=0;"  ;Auto-detect question = "Describe the topology
of your storage network.", "Note: Select 'Arbitrated Loop' when directly connected
to the array (no fibre switch). Select 'Point-to-Point' when connected to a SAN
(fibre switch).", "Arbitrated Loop", "Point-to-Point"
ANSWER = 0
DriverParameter = "Topology=2;"
ANSWER = 1
DriverParameter = "Topology=3;"
[ENDQUESTIONS]
[END.STORPORT.CONFIGURATION]
```

D.3.5 QFE Checks [STORPORT.QFES]

This section specifies an additional QFE check, also known as KB updates, during installation. To add a Windows QFE check to the configuration file, edit the [STORPORT.QFES] section in the AutoPilot configuration file. You can place this section anywhere within the file as long as it is not contained within another section. This section contains a single line for each QFE that is to be checked. Up to 10 lines are checked; more than that can exist but they are ignored. All parameters in each line must be specified. These lines have the format:

```
qfe = "qfe name", "path and file name", "file version", "applicable OS"
```

qfe name	The name of the item being checked. For example, QFE 2846340. The name should facilitate searching Microsoft's website for any required code updates.
path and file name	This string identifies the file to be checked and its location relative to the Windows home folder. In most cases, the file to check is the Microsoft Storport driver. For example: "\system32\drivers\storport.sys". This string is also used in dialogs and log file messages.
file version	This is the minimum version that the file to be checked must have for the QFE to be considered installed. It is specified as a text string using the same format as is used when displaying the files property sheet. For example: "5.2.1390.176".
applicable OS	This is used to determine if the QFE applies to the operating system platform present. The acceptable value is "Win2008".

For example:

```
[STORPORT.QFES]
qfe = "QFE 83896", "\system32\drivers\storport.sys", "5.2.1390.176","Win2008"
```

D.3.6 Setting Up FC Driver Parameters [STORPORT.PARAMS]

This section specifies driver parameters. Parameters are read exactly as they are entered and are written to the registry. To change driver parameters, modify this section of the AutoPilot configuration file. Locate the [STORPORT.PARAMS] section in the AutoPilot configuration file. This section follows Optional Configuration File Changes. Under the [STORPORT.PARAMS] heading, list the driver parameters and new values for the driver to use.

For example:

```
Driver Parameter = "LinkTimeout = 45"
```

See Table 2, Storport Miniport Driver Parameters, on page 30 for a listing of driver parameters, defaults, and valid values.

D.3.7 Setting Up System Parameters [SYSTEM.PARAMS]

To change the system parameters, create a [SYSTEM.PARAMS] section in the APInstall.cfg file. Create this section under the Optional Configuration File Changes heading in the [AUTOPILOT.CONFIG] section.

For example, you can adjust the operating system's global disk timeout. The timeout is stored in the registry under the key HKML\CurrentControlSet\Services\disk and is specified with the following string:

```
TimeOutValue = 0x3C (where the number is the timeout value in seconds.)
```

D.4 AutoPilot Installer Exit Codes

AutoPilot Installer sets an exit code to indicate whether an installation was successful or an error occurred. These exit codes allow AutoPilot Installer to be used in scripts with error handling. In unattended installations, AutoPilot Installer sets the following exit codes listed in Table 37.

Table 37 Unattended Installation Error Codes

Error Code	Hex	Description
0	0x00000000	No errors.
2399141889	0x8F000001	Unsupported operating system detected.
2399141890	0x8F000002	The AutoPilot Configuration file is not found.
2399141891	0x8F000003	Disabled adapters detected in the system.
2399141892	0x8F000004	The selected driver is 64-bit and this system is 32-bit.
2399141893	0x8F000005	The selected driver is 32-bit and this system is 64-bit.
2399141894	0x8F000006	Installation activity is pending. AutoPilot Installer cannot run until it is resolved.
2399141895	0x8F000007	(GUI Mode only) You cancelled execution because you did not wish to perform a software-first install.
2399141896	0x8F000008	No drivers found.
2399141897	0x8F000009	One or more adapters failed diagnostics.
2399141904	0x8F000010	(GUI Mode only) You chose to install drivers even though a recommended QFE or Service Pack was not installed.
2399141920	0x8F000020	(GUI Mode only) You chose to stop installation because a recommended QFE or Service Pack was not installed.
2399141899	0x8F00000B	Unattended installation did not find any drivers of the type specified in the config file.
2399141900	0x8F00000C	A silent reboot was attempted, but according to the operating system a reboot is not possible.
2399141901	0x8F00000D	(GUI Mode only) A driver package download was cancelled.
2399141902	0x8F00000E	(Non-Enterprise) No adapters were found in the system.
2399141903	0x8F00000F	A required QFE or Service Pack was not detected on the system.
2399141836	0x8F000030	AutoPilot Installer was not invoked from an account with Administrator-level privileges.
2391419952	0x8F000040	AutoPilot Installer has detected unsupported adapters on the system.
2399141968	0x8F000050	Unattended software-first installations are disallowed.
2399141984	0x8F000060	You cancelled APInstall before any driver/utility installation occurred.
2399142000	0x8F000070	You cancelled APInstall after driver/utility installation occurred.
2399142032	0x8F000090	APInstaller encountered an error while parsing the command line (Report file contains details).

D.5 AutoPilot Installer Installation Reports

During each installation, the AutoPilot Installer produces a report describing events that occurred during the installation. This report contains the following sections:

- The first section provides basic information including the time and date of the installation, the name of the machine on which the installation was performed, the version number of AutoPilot Installer, and the identification of the configuration file that was used.
- The second section provides an inventory of the Emulex adapters as they were before AutoPilot Installer performed any actions.
- The third section lists the tasks that AutoPilot performs in the order that they are completed.
- The fourth section records the results of each task. When all driver installation tasks are completed, an updated adapter inventory is recorded.

NOTE If you cancel AutoPilot Installer, that fact is recorded along with the time you cancelled the installation. The contents of any error dialogs that are displayed are also recorded.

D.6 Command Script Example

```
Modify the configuration file to script the installation of a system's driver. The
following example command script (batch file) assumes that you have made mandatory
changes to the AutoPilot configuration file, as well as any desired optional
changes. If your systems were set up with a service that supports remote
execution, then you can create a command script to remotely update drivers for all
of the systems on the storage net. If Microsoft's RCMD service was installed, a
script similar to the following would run remote execution:
rcmd \\server1 g:\emulex\autopilot installer\fc\apinstall.exe
if errorlevel 1 goto server1ok
echo AutoPilot reported an error upgrading Server 1.
if not errorlevel 2147483650 goto unsupported
  echo Configuration file missing.
goto server1ok
 :unsupported
if not errorlevel 2147483649 goto older
echo Unsupported operating system detected.
 :older
if not errorlevel 2001 goto none
   echo The driver found is the same or older than the existing driver.
   goto server1ok
:none
if not errorlevel 1248 goto noreport
   echo No Emulex adapter found.
goto server1ok
:noreport
 if not errorlevel 110 goto nocfg
   echo Could not open installation report file.
 goto server1ok
:nocfg
 if not errorlevel 87 goto badcfg
   echo Invalid configuration file parameters.
   goto server1ok
:badcfg
   if not errorlevel 2 goto server1ok
   echo No appropriate driver found.
server1ok
```

```
rcmd \\server2 g:\autopilot\ApInstall
ConfigFileLocation=g:\autopilot\mysetup\apinstall.cfg
if errorlevel 1 goto server2ok
echo AutoPilot reported an error upgrading Server 2.
if not errorlevel 2147483650 goto unsupported
   echo Configuration file missing.
goto server2ok
 :unsupported
 if not errorlevel 2147483649 goto older
   echo Unsupported operating system detected.
 :older2
 if not errorlevel 2001 goto none2
   echo The driver found is the same or older than the existing driver.
   goto server2ok
:none2
 if not errorlevel 1248 goto noreport2
   echo No adapter found.
goto server2ok
:noreport
 if not errorlevel 110 goto nocfg2
   echo Could not open installation report file.
 goto server2ok
:nocfg2
 if not errorlevel 87 goto badcfg2
   echo Invalid configuration file parameters.
   goto server2ok
:badcfg2
   if not errorlevel 2 goto server2ok
   echo No appropriate driver found.
server2ok
```

Appendix E: RoCE Switch Support

Some switches do not support DCBX, and most DCBX-enabled switches do not fully support RoCE as a protocol. At this time, none of the known switch vendors (Arista, Brocade, Cisco, and Juniper) allow configuring priority for RoCE-specific traffic. Additionally, most of the known switch vendors do not support APP TLV of 0x8915 for RoCE ETS bandwidth and PFC configuration.

In addition to QOS settings, OCe14000-series adapters support congestion management protocols. The supported modes are QCN for RoCE ports or ECN for Routable RoCE ports.

NOTE For each RoCE port, the RoCE traffic must be limited to either RoCE or Routable RoCE (Default).

E.1 DCBX-Enabled Switch Connection PFC Mode

Manually enable priority 5 on the switch under a different priority group other than FCOE/ISCSI/NIC priority group.

NOTE If an OCe14000-series adapter is connected to a DCBX-enabled switch, the mode shifts from generic pause to PFC mode.

NOTE If an OCe14000-series adapter is connected to a DCBX-disabled switch, generic pause mode is enabled.

NOTE In absence of priority 5 on the switch side, the OCe14000-series adapter maintains configuration for RoCE and PFC priority 5. This can result in packet losses, unrecoverable errors, or infinite retries for RoCE traffic.

E.1.1 Switch Configuration for PFC Priority 5

Using the documentation provided by your switch vendor, configure your switch for the following:

- Priority pause frames using Priority 5
- MTU size of 4200 or higher
- No-drop policy

To configure the switch:

1. Create PG 1 as Priority 5 with a no-drop policy for RoCE traffic.
2. Assign the appropriate bandwidth to PG 1; for example, 90%.
3. Create PG 2 (or something different from above, which is priority group 1) and assign NIC traffic to it.
4. Assign remaining bandwidth to PG 2.
5. Enable priority flow control on all ports participating in the cluster and at a global level in the switch.

   NOTE Some switches have global and port level settings for flow control and bandwidth allocation. Make sure the PFC flow control setting is performed on all the ports that participate in the cluster.
6. Configure a valid VLAN with an ID other than 0 or 1.
7. Ensure that Jumbo Frames is enabled, or at minimum set the MTU >= 4200.
8. Specify each switch port service policy rather than using the system QoS.

NOTE Some switches have jumbo frame size support disabled on the port and global level by default.

NOTE Some switches show the priority for FCoE on the switch itself. Use a policy with zero bandwidth for the FCoE priority.

E.1.2 Host—Client Configuration

For all host and clients participating in the network:

1. Create a VLAN using the VLAN ID you configured in step 6 above.
2. Assign an appropriate IP address to the VLAN interface.

NOTE Ensure that all the traffic is flowing through the VLAN interface.

E.1.2.1 DCBX-Disabled Switch Connection (Generic Pause Mode)

1. Host Configuration:
   a. On the host and peer systems, ensure that Tx pause flow control and Rx pause flow control are enabled on all the ports and interfaces that are RoCE enabled using operating system standard tools.
2. Switch Configuration:
   a. Enable Tx generic pause flow control and Rx generic pause flow control on each port participating in the cluster.
   b. Enable Jumbo Frames, or set the MTU to at least 4200 or greater.

NOTE Some switches have jumbo frame size support disabled on the port and global level by default.

E.1.2.2 Examples for Cisco Switch

This section provides information for configuring a Cisco switch.

E.1.2.3 Sample Class-maps for RoCE on a Cisco Switch

NOTE Not all switch settings are shown.

Cisco5548UP2(config)# show class-map

```
Type qos class-maps
===================
class-map type qos match-any class-fcoe
match cos 3
class-map type qos match-all class-roce
match cos 5
class-map type qos match-any class-default
match any

Type queuing class-maps
=======================
class-map type queuing class-fcoe
match qos-group 1
class-map type queuing class-roce
match qos-group 5
class-map type queuing class-default
match qos-group 0
```

```
Type network-qos class-maps
===========================
class-map type network-qos class-fcoe
match qos-group 1
class-map type network-qos class-roce
match qos-group 5
class-map type network-qos class-default
match qos-group 0
```

E.1.2.3.1 Sample Policy-maps for RoCE on a Cisco Switch

NOTE Not all switch settings are shown.

```
Type qos policy-maps
====================
policy-map type qos class-roce
class type qos class-roce
set qos-group 5
class type qos class-fcoe
set qos-group 1
class type qos class-default
set qos-group 0
policy-map type qos class-rocenofcoe
class type qos class-roce
set qos-group 5
class type qos class-default
set qos-group 0

Type queuing policy-map
=======================
policy-map type queuing class-roce90
class type queuing class-roce
bandwidth percent 90
class type queuing class-default
bandwidth percent 10

Type network-qos policy-maps
============================
policy-map type network-qos class-rocenofcoe
class type network-qos class-roce
pause no-drop
mtu 4200
class type network-qos class-default
mtu 9216
multicast-optimize
```

E.1.2.3.2 Sample Port Configuration for RoCE on a Cisco Switch

NOTE The Port flow control should be off and the Priority Flow Control should be on Auto. PFC flow is not explicitly displayed on this switch.

```
interface Ethernet1/15
description RoCE configuration
switchport mode trunk
switchport trunk allowed vlan 102
spanning-tree port type edge trunk
```

```
service-policy type qos input class-rocenofcoe
service-policy type queuing input class-roce90
service-policy type queuing output class-roce90
```

E.1.2.3.3 Sample Switch PFC Verification on a Cisco Switch

Ensure that the "Mode" is set to "Auto." and "Operational (Oper)" is "On".

```
Cisco5548UP2(config)# show int eth 1/11 priority-flow-control
================================================================
Port               Mode Oper(VL bmap)  RxPPP      TxPPP
================================================================

Ethernet1/11       Auto On  (28)      873        694950
```

E.1.2.4 Verifying Switch Configuration in OneCommand Manager

NOTE You do not need to configure the OCe14000-series adapter in the OneCommand Manager application to enable RoCE with PFC.

You can use the OneCommand Manager GUI application or the OneCommand Manager CLI application to verify the switch configuration.

See the *OneCommand Manager Application User Manual* for more information on using the OneCommand Manager GUI application to verify the switch configuration.

See the *OneCommand Manager Command Line Interface Manual* for more information on using the OneCommand Manager CLI application to verify the switch configuration.

Appendix F: License Notices

F.1 Secure Hash Algorithm (SHA-1) Notice


BROADCOM