Emulex® Drivers for Windows for LightPulse® Adapters

User Guide

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Chapter 1: Introduction

This product supports the following Emulex® LightPulse® adapters:

- LPe12000-series adapters
- LPe16000-series adapters, including LPe16202/OCe15100 adapters
- LPe31000-series adapters
- LPe32000-series adapters

The Emulex drivers for Windows support the following protocols:

- Fibre Channel (FC)
- FC over Ethernet (FCoE) for LPe16202/OCe15100 adapters in NIC+FCoE mode
- Ethernet Network Interface Card (NIC) for LPe16202/OCe15100 adapters in NIC+FCoE mode

1.1 Driver Information

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

- FC and FCoE
  - Configuring the FC and FCoE driver parameters
  - Improving server performance with FC and FCoE drivers
- Ethernet
  - Configuring NIC driver options
  - Tuning network driver performance

1.2 Abbreviations

1GbE	1 Gigabit Ethernet
10GbE	10 Gigabit Ethernet
AL_PA	arbitrated loop physical address
ARM	Advanced RISC Machines
BIOS	basic input-output system
CPU	central processing unit
CRC	cyclic redundancy check
DCBX	Data Center Bridging Capabilities Exchange
DPC	deferred procedure call
DHCP	Dynamic Host Control Protocol
DID	device ID
DIMM	dual inline memory module
DMA	direct memory access
DNS	Domain Name Server
DOS	disk operating system

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
FSB	front-side bus
GB	gigabyte
Gb/s	gigabits per second
GUI	graphical user interface
HBA	host bus adapter
IEEE	Institution of Electrical and Electronics Engineers
iSCSI	Internet Small Computer Systems Interface
I/O	input/output
IOMMU	input/output memory management unit
IP	Internet Protocol
KB	Knowledge Base
LACP	Link Aggregation Control Protocol
LAN	local area network
LSO	large send offload
LUN	logical unit number
MAC	Media Access Control
MDS	Multilayer Director Switch
MSI	message signaled interrupts
MTU	maximum transmission unit
N/A	not applicable
NDIS	Network Driver Interface Specification
NIC	network interface card
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	Peripheral Component Interconnect
PCIe	PCI Express
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
QFE	Quick Fix Engineering
RAID	redundant array of independent disks
RCMD	Remote Command Service
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
SCSI	Small Computer System Interface
SFP	small form-factor pluggable
SLI	Service Level Interface
SR-IOV	Single Root I/O Virtualization
TCP	Transmission Control Protocol
TCP/IP	TCP over Internet Protocol
TX	transmit
UDP	User Datagram Protocol
ULP	unit of least precision
UEFI	Unified Extensible Firmware Interface
VF	virtual function
VHD	virtual hard disk
VLAN	virtual local area network
VLAN ID	VLAN identifier
VM	virtual machine
VMQ	virtual machine queue
WWN	World Wide Name
WWNN	World Wide Node Name
WWPN	World Wide Port Name
XRI	extensible resource indicator

Chapter 2: Installation

Install the Windows drivers for LightPulse adapters in one of two ways:

- OneInstall Installer contains the Emulex Storport Miniport driver, Emulex PLUS (ElxPlus) driver, and the OneCommand® Manager application for LightPulse® Adapters in a single download package.

  NOTE OneInstaller Installer does not include NIC and FCoE drivers for LPe16202/OCe15100 adapters in NIC+FCoE mode. To install these drivers, you must use the individual driver kits.

- 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 For LPe16202 adapters, OneInstall Installer, or NIC driver installations, 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, is required for Windows Server 2012, Windows 8, and Windows 10 client operating systems.

  NOTE If you are installing the NIC driver kit as an update to the Windows Server 2012 driver, Windows Server 2012 driver R2, or Windows Server 2016 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 patch 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 any or all of these conditions exist, install patch KB2846837 before installing the Emulex NIC driver.

  NOTE Windows 8 x64 and Windows 8.1 x64 drivers are Emulex signed. You must accept the Emulex 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 Emulex drivers.

2.1 OneInstall Installer

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

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

NOTE OneInstaller Installer does not include NIC and FCoE drivers for LPe16202/OCe15100 adapters in NIC+FCoE mode. To install these drivers, you must use the individual driver kits.

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

- FC drivers
- Emulex PLUS (ElxPlus) driver (supports the OneCommand Manager application, persistent binding, logical unit numbering (LUN) mapping and masking, and virtual port creation)
- OneCommand Manager application

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. Refer to the *Emulex OneCommand Manager Application for LightPulse Adapters User Guide* for installation instructions.

2.1.1 Loading OneInstall Installer Using Interactive Mode

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

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

   The **Welcome** screen is displayed.
4. Click **Next**.

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

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

2.1.2 Loading OneInstall Installer Using Silent Mode

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

If you run OneInstall Installer 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 OneInstall Installer 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 Installer 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 OneInstall Installer

<*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 theFC driver and the OneCommand Manager application (default).

NOTE On a Windows Server Core system, this installs all drivers and the OneCommand Manager Core Kit.

`ALLCORE=1` – Install the FC driver and the OneCommand Manager Core Kit.

`FC=1` – Install the FC driver only.

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

NOTE On a Windows Server Core system, this installs 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 OneInstall Installer from the Broadcom website.
2. Open a DOS window.
3. Change the directory to the folder containing your OneInstall package.

The following are examples of Silent mode commands:

```
Start /wait OneInstall-Setup-<version>.exe  /q2  ALL=1
Start /wait OneInstall-Setup-<version>.exe  /q2  FC=1
Start /wait OneInstall-Setup-<version>.exe  /q2  OCM=1
Start /wait OneInstall-Setup-<version>.exe  /q2  ALLCORE=1
Start /wait OneInstall-Setup-<version>.exe  /q2  OCMCORE=1
```

2.2 Driver Kit Installer

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

- FC driver package includes ElxPlus(`elxdrvr-fc-<version>.exe`)
- FCoE driver package includes ElxPlus(`elxdrvr-fcoe-<version>.exe`)

- NIC driver package (`elxdrvr-nic-<version>.exe`)

NOTE FCoE and NIC driver packages are used on LPe16202/OCe15100 adapters only.

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 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 is displayed.
3. Click **Next**.

   The **Installation Options** window is displayed.
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 is displayed.
5. To continue with the installation, ensure that **Start AutoPilot Installer** is selected.

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 requirement to manually install the same driver on all adapters in the system.

NOTE Refer to the *Emulex Software Kit Migration User Guide* for information about installing drivers on a system containing a mix of OneConnect® and LightPulse adapters.

- 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 Windows 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, which 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.

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. For command line invocation, always use the START command with the `/wait` option, which causes the command processor to wait for the installer to finish before the command processor continues.

For additional information on command line installation and configuration parameters, see Appendix C, 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 AutoPilot Installer, which completes the driver kit loading and installation with a few mouse clicks.

- Option 2 allows you to run AutoPilot Installer separately. This option is recommended when you are:
  - Changing installation settings for a limited number of systems
  - Familiarizing yourself with AutoPilot Installer configuration options

2.3.2.1 Option 1: Automatically Run AutoPilot Installer

Use this option unless you have specific configuration requirements.

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 (see Appendix C, AutoPilot Installer Command Line and Configuration File Parameters for additional 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** check box is automatically selected.
4. Click **Finish**.

   AutoPilot Installer runs automatically and completes one of the following installations:
   - Section 2.3.3, Hardware-First Installation or Driver Update
   - Section 2.3.4, Software-First Installation

2.3.2.2 Option 2: Run AutoPilot Installer Separately

To access these options, run AutoPilot Installer after the driver kit loading has been completed, which allows you to change the configuration options supplied to AutoPilot Installer.

1. Perform steps 1 through 3 in Option 1: Automatically Run 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** See Appendix C, AutoPilot Installer Command Line and Configuration File Parameters for additional information on either of these configuration methods.

After you have finished this step, you can run AutoPilot Installer at a later time.

4. Run AutoPilot Installer using the 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 is displayed multiple times. Click **Cancel** to exit the wizard each time it is displayed.

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 is displayed.

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

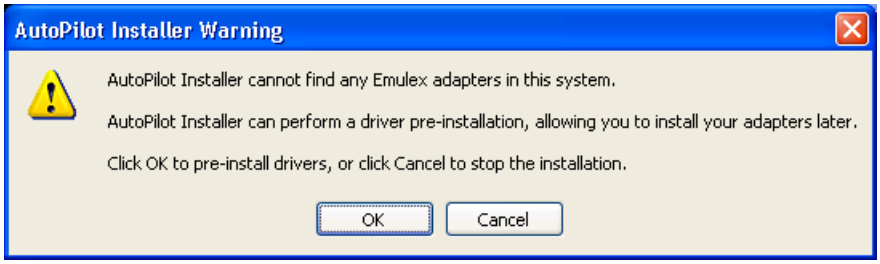
The driver kit must be downloaded from the Broadcom website and loaded.

To do a software-first installation, perform these steps:

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

   Figure 1 is displayed.

Figure 1 AutoPilot Installer Warning (Software-First Installation)



2. Click **OK**.

   A **Welcome** window is displayed.
3. Click **Next**. The installation automatically progresses.

   After the installation is successful, the **Finish** window is displayed.
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 other windows.

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:

`elxdrvr-fc<version>.exe /q`

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

2.3.6.2 Option 2: Run the Driver Kit Installer Separately

1. Follow steps 1 to 3 in 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 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 Appendix C.2.3, Software Configuration Parameters for additional information. After editing the file, run AutoPilot Installer from the **Start** menu, a command prompt, or a script.

2.3.7 Installation Failure

The two possible installation failures are described in this section.

2.3.7.1 AutoPilot Installer Failure

If AutoPilot Installer fails, the **Diagnostics** window shows that the adapter failed. If the adapter fails, perform these steps:

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 `APInstall.exe` from a command prompt.

2.3.7.2 OneInstall Installer Failure

OneInstall Installer might fail for any of the following reasons:

- The operating system prerequisites have not been met.

- The individual kit installation failed. To check the installation, 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. (OneInstall Installer does not provide this information because each package is installed silently.)

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.

2.4.1 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 is displayed. 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\FC\Drivers\Storport\x64\<OS>`
8. Click **OK**.
9. Select **elxplus**. 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. See Section 2.4.3, Installing or Updating the FC and FCoE Storport Miniport Drivers for this procedure.

2.4.2 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 **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\FC\Drivers\Storport\x64<OS>`
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.

2.4.3 Installing or Updating the FC and FCoE Storport Miniport Drivers

To update or install the FC and 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 **Storage 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 **Install 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**.
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\<OS>`
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.

2.4.4 Installing or Updating the NIC Driver

NOTE The Microsoft patch KB2846340 must be installed on your system. This patch, from Microsoft's KB, is available for Windows Server 2012 on the Microsoft website.

2.4.4.1 Installing or Updating the NIC Driver on Windows Server 2012, Windows Server 2012 R2, and Windows Server 2016

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 `lpnic.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\NIC\Drivers\NDIS\x64\<os>`
10. Click **Next**.
11. After the device driver finishes installing, click **Close**.

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

2.5 Removing the Emulex Driver Kits and Drivers

This section details procedures to uninstall the driver kits.

2.5.1 Uninstalling the Emulex Driver Kits

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

2.5.1.1 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 kit-4.xx.xxx`
4. Click **Yes** when prompted to remove the kit. After the kit is removed from the system, click **OK**.

2.5.1.2 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_cna_kit.bat`
   - `Uninstall_fc_kit.bat`
   - `Uninstall_nic_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.

2.5.2 Uninstalling the Emulex Drivers

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

2.5.2.0.1 Uninstalling an Emulex Storport Miniport Driver

To uninstall the Emulex Storport Miniport driver, perform these 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.

2.5.2.0.2 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 these steps:

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

2.5.2.1 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.

2.5.2.1.1 Uninstalling the Emulex Storport Miniport Driver

To uninstall the Emulex Storport Miniport driver in Windows Server 2012, perform these 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.

2.5.2.1.2 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 these steps.

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

3.1 FC and 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 *Emulex OneCommand Manager Application for LightPulse Adapters User Guide* for information on using this utility to configure the driver.

3.1.1 Configuring FC and FCoE Driver Parameters

Table 1, Storport Miniport Driver Parameters, provides information, such as the range of permissable values and the 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.

Most parameters default to a setting that optimizes adapter performance.

Table 1 Storport Miniport Driver Parameters

Parameter	Definitions	Activation Requirement	Notes
AutoMap	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	Class selects the class of service on FCP commands. ■ If set to 2, class of service is 2. ■ If set to 3, class of service is 3. Value: 2–3 Default = 3	Dynamic	Supported on FC only.
CoalesceMsCnt	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 nonzero value enables response coalescing at the specified interval in milliseconds. Value: 0–63 (decimal) or 0x0–0x3F (hexadecimal) Default = 0 (0x0)	Reset	Supported on FC only. Supported on LPe12000-series adapters only.
CoalesceRspCnt	CoalesceRspCnt specifies the number of response entries that trigger an interrupt response. Value: 0–255 (decimal) or 0x1–0xFF (hexadecimal) Default = 8 (0x8)	Reset	Supported on FC only. Supported on LPe12000-series adapters only.
ConfigScale	ConfigScale sets the memory footprint profile in accord with the anticipated use case on a per-port basis. ConfigScale is always set at 4. The maximum transfer size is set according to the value of the ExtTransferSize parameter. Default = 4	Reboot	Not supported on LPe12000-series adapters.
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 multiple levels of event logging. Values: 0, 1, 4, and 8. Default = 0.	Dynamic	

Table 1 Storport Miniport Driver Parameters (Continued)

Parameter	Definitions	Activation Requirement	Notes
EnableAck0	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	Supported on 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	Supported on LPe12000-series adapters only.
EnableFDMI	If set to 1, enables management server logon on fabric discovery, which 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. If set to 0, FDMI is disabled. Value: 0–2 (decimal) Default = 2	Reset	
EnableMDSD	If set to 1, Cisco Multilayer Director Switch (MDS) diagnostics are enabled. Value: 0–1 Default = 0 The parameter should be disabled (set to 0) after diagnostics are complete.	Reset	
EnableNPIV	If set to 1, enables NPIV. Requires NPIV-supported firmware for the adapter. Value: 0–1 Default = 1 (enabled) **NOTE** SLIMode=2 does not support NPIV mode on LPe12000 adapters.	Reboot	
EnableXLane	EnableXLane enables ExpressLane™ 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	Not supported on LPe12000-series adapters.
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 512 KB for all controller models. ■ If set to 1= The maximum transfer size is 1 MB. ■ If set to 2 = The maximum transfer size is 2 MB. ■ If set to 3 = The maximum transfer size is 4 MB. Value: 0–3 Default = 0 (disabled)		

Table 1 Storport Miniport Driver Parameters (Continued)

Parameter	Definitions	Activation Requirement	Notes
FrameSizeMSB	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	Determines the number of timeout seconds during driver initialization for the link to come up. If the link fails to come up by the InitTimeout, driver initialization exits but is still successful. If the link comes up before the value specified by 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 = 64 KB ■ 2 = 128 KB ■ 3 = 256 KB	Reboot	
LinkSpeed	LinkSpeed has significance only if the adapter supports speeds other than 1 Gb/s. Value: Auto-select, 2 Gb/s, 4 Gb/s, and 8 Gb/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	Supported on FC only. Supported on LPe12000-series adapters only.
LinkTimeOut	LinkTimeOut applies to a private loop only. A timer is started on all mapped targets using the LinkTimeOut value. If the timer expires before discovery is resolved, commands issued to timed-out devices return 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	

Table 1 Storport Miniport Driver Parameters (Continued)

Parameter	Definitions	Activation Requirement	Notes
LogErrors	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	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 the NodeTimeout interval expires, the timer is canceled and no notification is made. Value: 1–255 seconds or 0x0–0xFF (hexadecimal) Default = 30 (0x1E)	Dynamic	
QueueDepth	QueueDepth requests per LUN/target (see the QueueTarget parameter). If you expect the number of outstanding I/Os per device to exceed 32, 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	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	

Table 1 Storport Miniport Driver Parameters (Continued)

Parameter	Definitions	Activation Requirement	Notes
RmaDepth	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	■ 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 Default = 1 **NOTE** This option applies to private loop only in DID mode.	Reboot	Supported on FC only.
SLIMode	■ 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	Supported on LPe12000-series adapters only.
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 parameter 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		

Table 1 Storport Miniport Driver Parameters (Continued)

Parameter	Definitions	Activation Requirement	Notes
Topology	■ 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. **NOTE** 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. Value: 0–3 Default = 2 (0x2)	Reset	Supported on LPe12000-series and LPe16000-series adapters only. Not supported on LPe16202 adapters.
TraceBufSiz	TraceBufSiz sets the size in bytes for the internal driver trace buffer, which acts as an internal log of the driver's activity. Value: 250000–2000000 or 0x3D090–0x1E8480 (hexadecimal). Default = 250000 (0x3D090)	Reboot	
XLanePriority	XLanePriority sets the frame priority level for the LUN. Refer to the switch vendor administration guide to set the value. Value: 0–7F (hexadecimal) Default = 0	Dynamic	Not Supported on LPe12000-series adapters.

3.1.2 Server Performance with LPe12000-Series Adapters

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 setting 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 2 shows recommendations based upon the number of I/Os per adapter.

Table 2 Recommended Settings for I/O Coalescing

I/Os per Second	Suggested CoalesceMsCnt	Suggested CoalesceRspCnt
I/Os < 10,000	0	8
10,000 < I/Os < 18,000	1	8
18,000 < I/Os < 26,000	1	16
I/Os > 26,000	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.

NOTE A port reset is required to make changes to `CoalesceMsCnt` and `CoalesceRspCnt`.

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 port reset 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 0. 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 values 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 runs 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 runs 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).

3.1.3 Server Performance with FC Drivers

3.1.3.1 Performance Testing

The `QueueDepth` parameter must be considered (and perhaps changed from the default) for better performance testing.

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.

Test scenario:

- 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

NOTE This section applies to LPe16202/OCe15100 adapters in NIC+FCoE mode only.

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, see Section 3.2.2.1, Modifying Advanced Properties.

For additional information on NIC driver options, see Section 3.2.5, Network Driver Performance Tuning.

You can also set configurable driver options using Microsoft PowerShell on Windows Server 2012 and Windows Server 2016.

Use the `Get-NetAdapter` PowerShell command to list all available adapters in the system. The `Get-Help <cmdl> -full` command returns descriptions and help for the cmdlets.

Use the following PowerShell commands to get and set driver parameter values.

To get the driver parameter value, perform this step:

```
Get-NetAdapterAdvancedProperty –Name <adapter name> -AllProperties
-RegistryKeyword <registry keyword>
```

Example:

```
Get-NetAdapterAdvancedProperty –Name ""SLOT 6 Port 1"" -AllProperties
-RegistryKeyword *RSS
```

To set the driver parameter value, perform this step:

```
Set-NetAdapterAdvancedProperty –Name <adapter name> -AllProperties
-RegistryKeyword <registry keyword> -RegistryValue <valid registry value>
```

Example:

```
Set-NetAdapterAdvancedProperty –Name ""SLOT 6 Port 1"" -AllProperties
-RegistryKeyword *RSS -RegistryValue 1
```

NOTE Refer to the documentation that accompanies the Windows Server 2012 and Windows Server 2016 operating systems for additional information on using PowerShell.

Table 3 lists the NIC driver options.

Table 3 Windows Server 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 2012 Windows Server 2012 R2 Windows Server 2016	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.
Flow Control	Disabled RX and TX Enabled (default) RX Enable/TXDisable TX Enable/RX Disable	Windows Server 2012 Windows Server 2012 R2 Windows Server 2016	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. **NOTE** The network device can be configured to respond to pause frames (RX Enable) and also to send pause frames (TX Enable).
Interrupt Moderation	0 (None) 8 (Static 90k Int/s) 9 (Static 70k Int/s) 10 (Static 50k Int/s) 11 (Static 40k Int/s) 12 (Static 30k Int/s) 2 (Static 25k Int/s) 13 (Static 20k Int/s) 14 (Static 15k Int/s) 15 (Static 10k Int/s) 16 (Static 5k Int/s) 4 (Adaptive) (default)	Windows Server 2012 Windows Server 2012 R2 Windows Server 2016	The network device uses interrupt moderation algorithms to reduce the total amount of CPU cycles spent processing interrupts, which increases efficiency for the system. However, interrupt moderation increases the latency of each send and receive. It should only be disabled when short latencies are more important than efficient CPU utilization. The No Moderation setting disables all delays to minimize latency. The Static Moderation setting uses a constant interrupt delay to avoid any spikes in the interrupt rate. The Adaptive (default) setting causes the driver to dynamically maintain a target interrupt rate. The Adaptive setting value is controlled by a dynamic algorithm that scales well for various adapter link speeds.

Table 3 Windows Server NIC Driver Options (Continued)

Option Name	Acceptable Values	Supported Operating Systems	Definition
IP Checksum Offload (IPv4)	Disabled RX and TX Enabled (default) RX Enabled TX Enabled	Windows Server 2012 Windows Server 2012 R2 Windows Server 2016	This option offloads the transmit and the receive IPv4 checksum computation. Offloading checksums increases system efficiency.
Large Send Offload v1 (IPv4)	Disabled Enabled (default)	Windows Server 2012 Windows Server 2012 R2 Windows Server 2016	Large Send Offload allows the NIC hardware to segment large TCP packets (up to 64 KB) 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 2012 Windows Server 2012 R2 Windows Server 2016	Large Send Offload allows the NIC hardware to segment large TCP packets (up to 64 KB) 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 2012 Windows Server 2012 R2 Windows Server 2016	Large Send Offload allows the NIC hardware to segment large TCP packets (up to 64 KB) 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 Windows Version 2 LSO.
Maximum Number of RSS Processors	Min. 0 Max. The number of CPU cores installed on your system	Windows Server 2012 Windows Server 2012 R2 Windows Server 2016	This property sets the maximum number of processors that can be used for RSS.
Maximum Number of RSS Queues	Min. 1 Max. 16 Default: 8	Windows Server 2012 Windows Server 2012 R2 Windows Server 2016	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.
Maximum RSS Processor Number	Min. 1 Max. The number of CPU cores installed on your system	Windows Server 2012 Windows Server 2012 R2 Windows Server 2016	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.

Table 3 Windows Server NIC Driver Options (Continued)

Option Name	Acceptable Values	Supported Operating Systems	Definition
`Network Address`	Valid MAC address The default setting is `None`	Windows Server 2012 Windows Server 2012 R2 Windows Server 2016	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.

`Packet Size`	`1514` (default)
	`9014`
	`8222`
	`4088`
		Windows Server 2012
		Windows Server 2012 R2
		Windows Server 2016
			This option configures the packet size for OneConnect NIC adapters only.
			This option 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)
	`Statically balanced`
	`Dynamically balanced`
		Windows Server 2012
		Windows Server 2016
			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 this mode can maintain maximum performance if the system has resources available.

Table 3 Windows Server NIC Driver Options (Continued)

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 2012 Windows Server 2012 R2 Windows Server 2016	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 2012 Windows Server 2012 R2 Windows Server 2016	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 2012 Windows Server 2012 R2 Windows Server 2016	This option 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 2012 Windows Server 2012 R2 Windows Server 2016	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 additional PCI functions, RSS does not appear in the **Properties** list.
`Recv Segment Coalescing (IPv4)`	`Disabled` `Enabled` (default)	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 `0` if `TCP Connection Offload (IPv4)` is enabled.

Table 3 Windows Server NIC Driver Options (Continued)

Option Name	Acceptable Values	Supported Operating Systems	Definition
Recv Segment Coalescing (IPv6)	Disabled Enabled (default)	Windows Server 2012 Windows Server 2012 R2 Windows Server 2016	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 0 if TCP Connection Offload (IPv4) is enabled.
RSS Base Processor Group	Min.1 Max. 63	Windows Server 2012 Windows Server 2016 Windows Server 2016	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 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 Windows Server 2016	This option 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 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 Windows Server 2016	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 Windows Server 2016	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.

Table 3 Windows Server NIC Driver Options (Continued)

Option Name	Acceptable Values	Supported Operating Systems	Definition
SR-IOV	Disabled (default) Enabled	Windows Server 2012 Windows Server 2012 R2 Windows Server 2016	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 architecture 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.
TCP Checksum Offload (IPv4)	0 (Disabled) 1 (TX Enabled) 2 (RX Enabled) 3 (RX and TX Enabled) (default)	Windows Server 2012 Windows Server 2012 R2 Windows Server 2016	TCP Checksum Offload (IPv4) offloads the transmit or receive IPv4 TCP checksum computation. Offloading checksums increases system efficiency.
TCP Checksum Offload (IPv6)	0 (Disabled) 1 (TX Enabled) 2 (RX Enabled) 3 (RX and TX Enabled) (default)	Windows Server 2012 Windows Server 2012 R2 Windows Server 2016	TCP Checksum Offload (IPv6) offloads the transmit or receive IPv6 TCP checksum computation. Offloading checksums increases system efficiency.
Transmit Buffers	64–256, inclusive The default setting is 256.	Windows Server 2012 Windows Server 2012 R2 Windows Server 2016	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 2012 Windows Server 2012 R2 Windows Server 2016	This option 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 2012 Windows Server 2012 R2 Windows Server 2016	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.
UDP Checksum Offload (IPv4)	Disabled RX and TX Enabled (default) RX Enabled TX Enabled	Windows Server 2012 Windows Server 2012 R2 Windows Server 2016	UDP Checksum Offload settings offload the transmit or receive IPv4 UDP checksum computation. Offloading checksums increases system efficiency.

Table 3 Windows Server NIC Driver Options (Continued)

Option Name	Acceptable Values	Supported Operating Systems	Definition

`UDP Checksum Offload (IPv6)`	`Disabled`
	`RX and TX Enabled` (default)
	`RX Enabled`
	`TX Enabled`
		Windows Server 2012
		Windows Server 2012 R2
		Windows Server 2016
			`UDP Checksum Offload` settings offload the transmit or receive IPv6 UDP checksum computation.
			Offloading checksums increases system efficiency.

`Virtual Machine Queues`	`Enabled` (default) `Disabled`	VMQs require: Windows Server 2012 Windows Server 2012 R2 Windows Server 2016 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 option 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 Transmit`	`Enabled` (default) `Disabled`	Windows Server 2012 R2 Windows Server 2016	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) `1–4094`	Windows Server 2012 Windows Server 2012 R2 Windows Server 2016	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 Emulex Teaming Driver application. **NOTE** Do not use this property with Hyper-V. Use the Microsoft Hyper-V Manager to configure VLANs on each virtual machine.

3.2.1.1 Advisory: PowerShell Behavior

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

The default registry values for driver parameters 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, such as elxoccfg (for additional information on elxoccfg, see Section 3.2.3, Using ELXOCCFG for Windows NIC Driver Options).

Standard PowerShell (Get-NetAdapter) commands function 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.

For SR-IOV, check the output of `Get-NetAdapterSRIOV` and `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.

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.

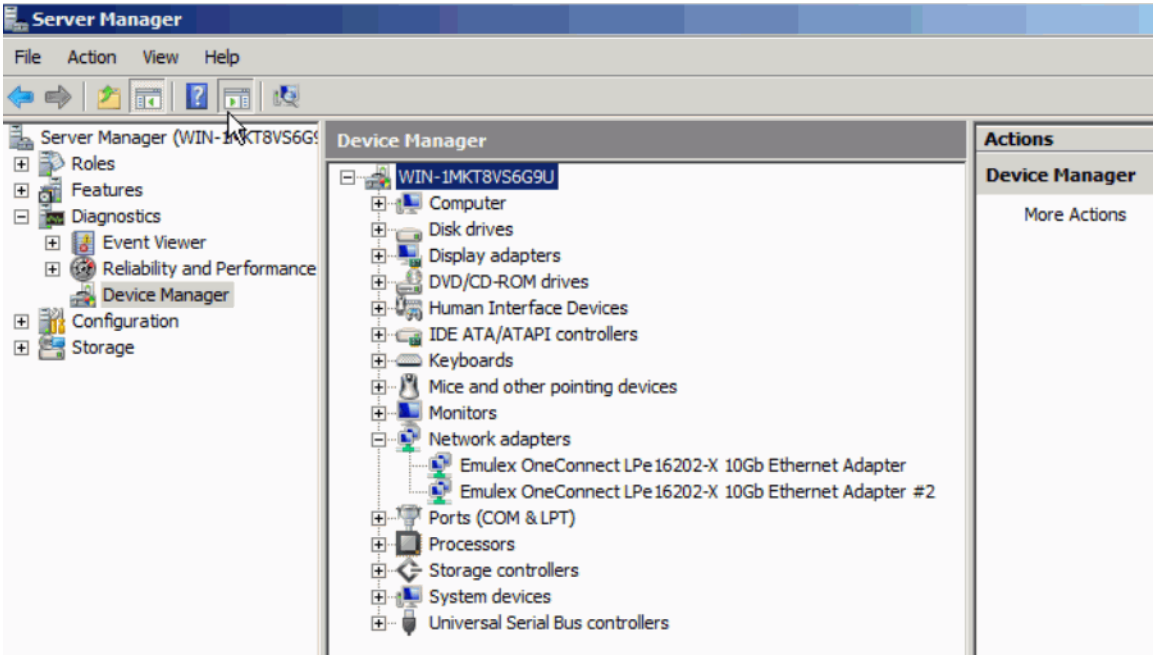
3.2.2.1 Modifying Advanced Properties

Modify the advanced properties for the driver for Windows with the Windows Device Manager. For additional information on advanced properties, see Section 3.2.5, 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 (Figure 2).

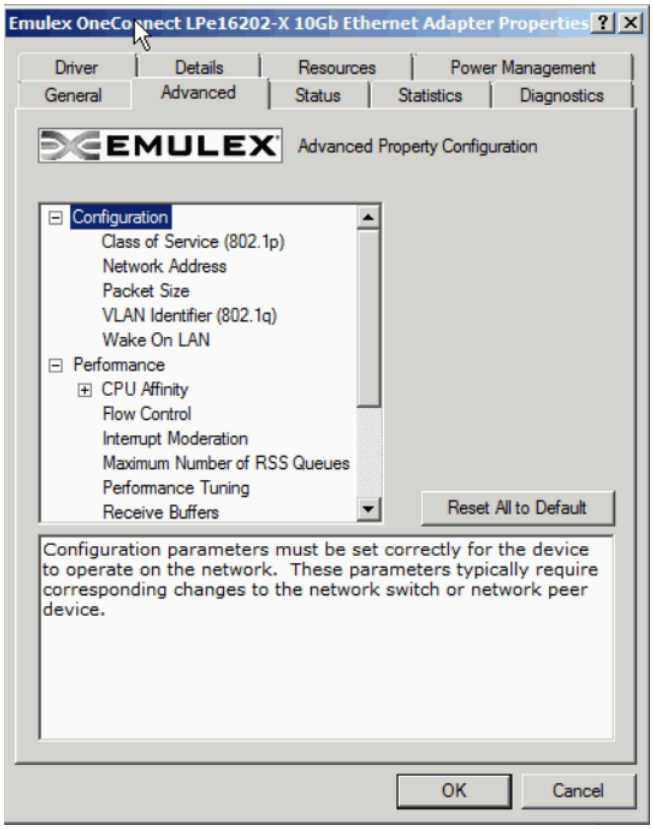
Figure 2 Partial View of Windows Device Manager



3. Right-click the network adapter for which you want to modify advanced properties.
4. Click **Properties**, and click the **Advanced** tab (Figure 3).
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 list under the property.
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



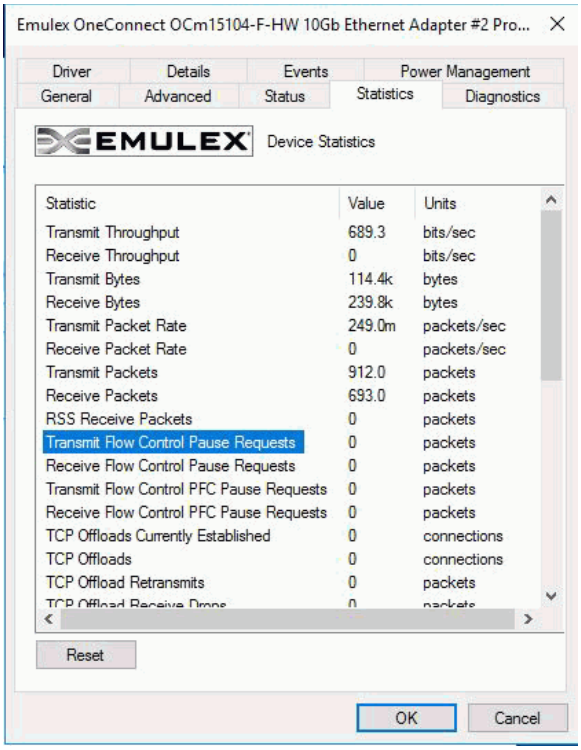
3.2.2.2 Statistics Property Page

Use the **Statistics** 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 (Figure 2).
3. Right-click the network adapter for which you want to view the statistics properties.
4. Click **Properties,** then click the **Statistics** tab (Figure 4).

Figure 4 NIC Statistics Properties in Windows Server 2016



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

Table 4 lists the NIC driver properties statistics.

Table 4 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 3 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 Bytes	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.
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.

Table 4 NIC Driver Properties Statistics (Continued)

Statistic Name	Description
Transmit Flow Control PFC Pause Requests	IEEE 802.1Qbb PFC extends an Ethernet PAUSE frame to each of the eight traffic classes. The PFC PAUSE frame is a link-level mechanism used by overwhelmed receiver nodes to halt the transmission from the peer node for a specified period of time.
Receive Flow Control PFC Pause Requests	IEEE 802.1Qbb PFC extends an Ethernet PAUSE frame to each of the eight traffic classes. The PFC PAUSE frame is a link-level mechanism used by overwhelmed receiver nodes to halt the transmission from the peer node for a specified period of time.
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.
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 configured 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 because 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.

Table 4 NIC Driver Properties Statistics (Continued)

Statistic Name	Description
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 ELXOCCFG for Windows NIC Driver Options

The `elxoccfg.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 `elxoccfg.exe` file 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 `elxoccfg.exe` program to configure the Windows device driver from the command line.

3.2.3.1 Using elxoccfg.exe Options

To display help, use the `-?` option by typing:

```
elxoccfg.exe -?
```

The following text is displayed:

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

Running the command with no arguments will display a menu to select the adapter and parameters to modify. Use the command line arguments to script this process.

Table 5 describes the available options.

Table 5 elxoccfg.exe Options

Option	Description
`-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 exits.
`-T filename`	Saves the tinylog to a binary file.
`-L filename`	Loads a binary file and replays the tinylog.
`-x`	Resets all parameters to the default values.
`-p`	Shows all registry parameter values.

Table 5 elxoccfg.exe Options (Continued)

Option	Description
`-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 the ARM logon to a file. Arguments set a specific trace level on listed modules. Default argument is `all=error`. Refer to the 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:                elxoccfg.exe
Set a parameter on all Emulex adapters:      elxoccfg.exe -a Emulex -s
                                             rss=1
Set multiple parameters on one adapter adapter:
       elxoccfg.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 LightPulse LPe16202`) 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 `elxoccfg` program queries and modifies 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 `elxoccfg` 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, `elxoccfg` 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:

```
elxoccfg -a emulex -s rss=0
elxoccfg -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 examples are all equivalent:

```
elxoccfg -a emulex -s "Flow Control=3"
elxoccfg -a emulex -s flow=3
elxoccfg -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:

```
elxoccfg -a emulex -s "Flow Control=3"
elxoccfg -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:

```
elxoccfg -a emulex -r -s rss=0
elxoccfg -a emulex -r -s "interrupt moderation=0"
elxoccfg -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:

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

3.2.3.4 Viewing Device Parameters

The `elxoccfg.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:

```
elxoccfg -a emulex -g "Interrupt Moderation"
elxoccfg -a "(Local Area Connection)" -g interrupt,rss
Emulex LightPulse LPe16202, NIC (Local Area Connection):
   [Registry] Interrupt Moderation = 4 (Adaptive [Default])
   [Driver] Interrupt Moderation = 4 (Adaptive [Default])
Emulex LightPulse LPe16202, NIC (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. To reset all parameters, use the following command:

```
elxoccfg -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. These options display the registry value or driver value of the parameter, or both when using `-pq` together.

For example:

```
elxoccfg.exe -a "SLOT 4 2 Port 1" -pq
OneConnect Network Config (11.2.107.0)
Copyright 2009-2016 Broadcom. All rights reserved.

Emulex OneConnect LPe16202-X 10Gb Ethernet Adapter #4 (SLOT 4 2 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] Enhanced Transmission Selection = 0 (Disabled)
   [Driver]   Enhanced Transmission Selection = 0 (Disabled)

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

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

   [Registry] Interrupt Moderation = 4 (Adaptive 30k Int/sec (default))
   [Driver]   Interrupt Moderation = 4 (Adaptive 30k Int/sec (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 = 12
   [Driver]   Maximum Number of RSS Processors = 16 (0x10)

   [Registry] Maximum Number of RSS Queues = 8
   [Driver]   Maximum Number of RSS Queues = 8

   [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] Packet Size = 1514 (1514)
   [Driver]   Packet Size = 1514 (0x5ea) (1514)

   [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 = 1664 (0x680)

[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 = 1 (Enabled)
[Driver]   SR-IOV = 1 (Enabled)

[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 = 2048 (2048)
[Driver]   Transmit Buffers = 2048 (0x800) (2048)

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

[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) = 0
[Driver]   VLAN Identifier (802.1q) = 0

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

3.2.3.7 Using Interactive Mode

The `elxoccfg.exe` program also supports Interactive mode with a set of menus.

To start this utility in Interactive mode, perform these steps:

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

   A list of adapters is displayed on which to operate.
2. Type either a number of the list or a substring from any part of the name (for additional 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 typing `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 valid 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 Server 2012 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.

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.

- LPe16202 and OCe15100 adapters in NIC+FCoE mode support 63 virtual functions per physical function.

3.2.4.1 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 items might require modification in your system BIOS during boot:

- Enable "Virtualization", such as Intel VT-x or AMD-V. This setting is required for any virtual machine.
- Explicitly enable SR-IOV in the system BIOS. The specific name for this option varies among 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`.

3.2.4.2 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 additional 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 has this issue.

3.2.4.2.1 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. Broadcom 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.

3.2.4.2.2 Backing Up and Editing the Registry

To back up and edit the registry, perform these 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.

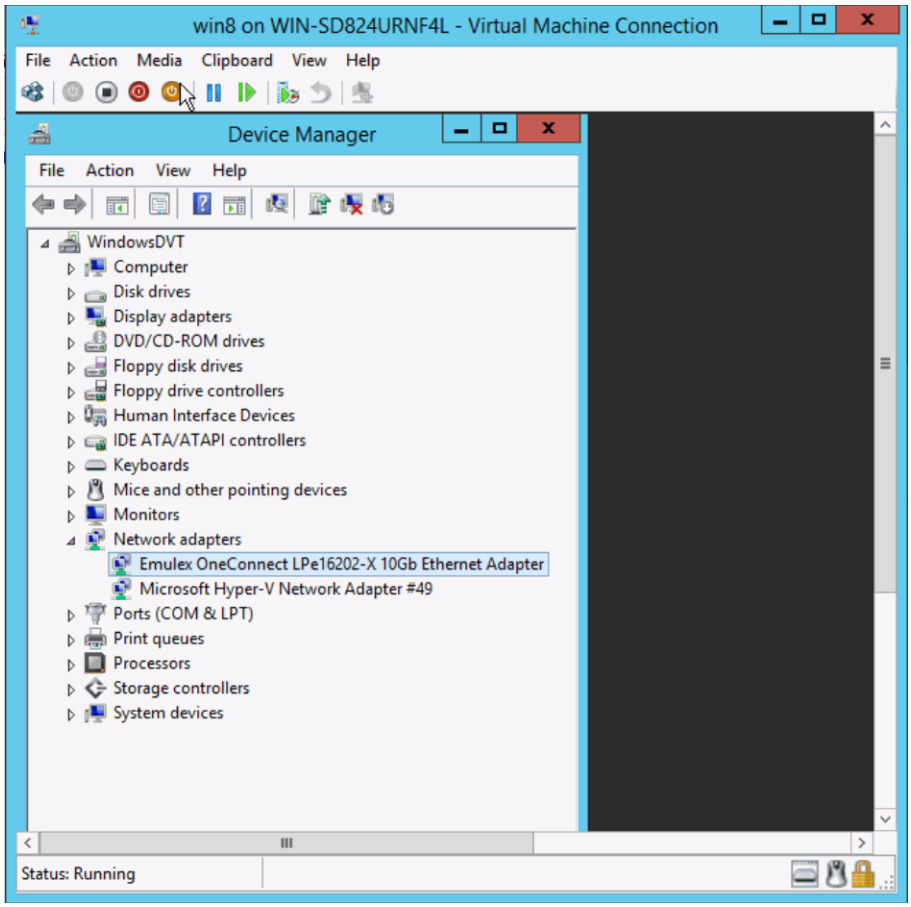
3.2.4.3 Verifying the Driver Version

To verify that the 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 (Figure 5).

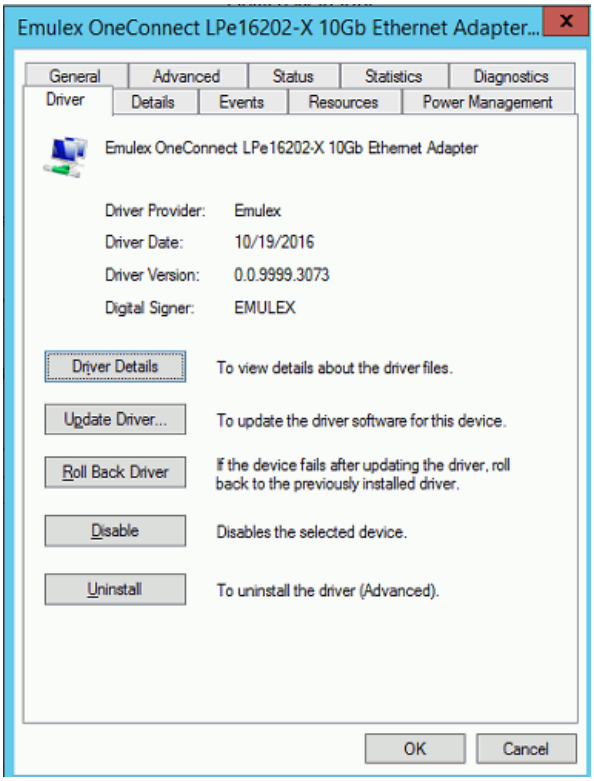
Figure 5 Device Manager for Windows Server 2012



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

   The **Properties** dialog opens and shows the **Driver** page (Figure 6). The **Driver** page contains the driver version number.

Figure 6 Emulex NIC Driver Page



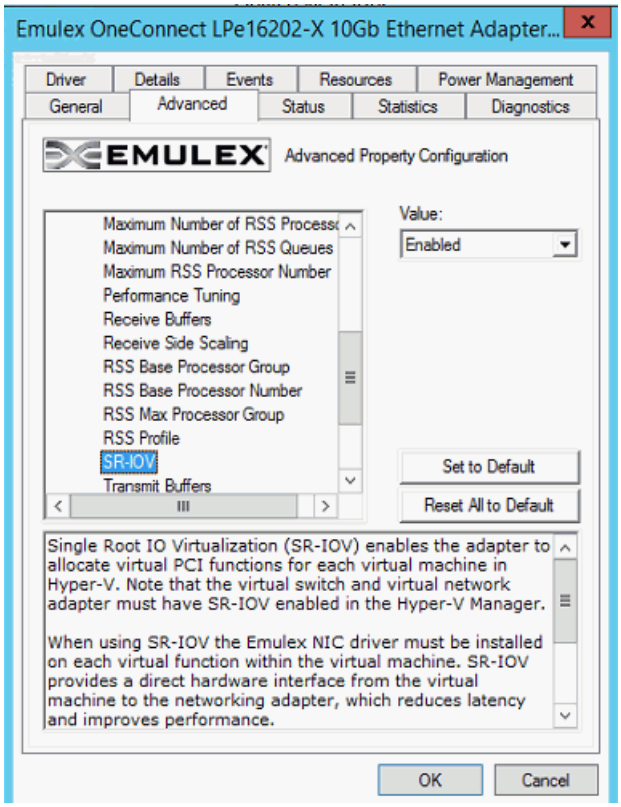
5. Click **Driver Details**.
   A window opens that displays the driver name.

3.2.4.4 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 (Figure 5).
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 (Figure 6).
5. Click the **Advanced** tab.
   The **Advanced Property Configuration** page opens (Figure 7).

Figure 7 Emulex NIC Advanced Configuration Page



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

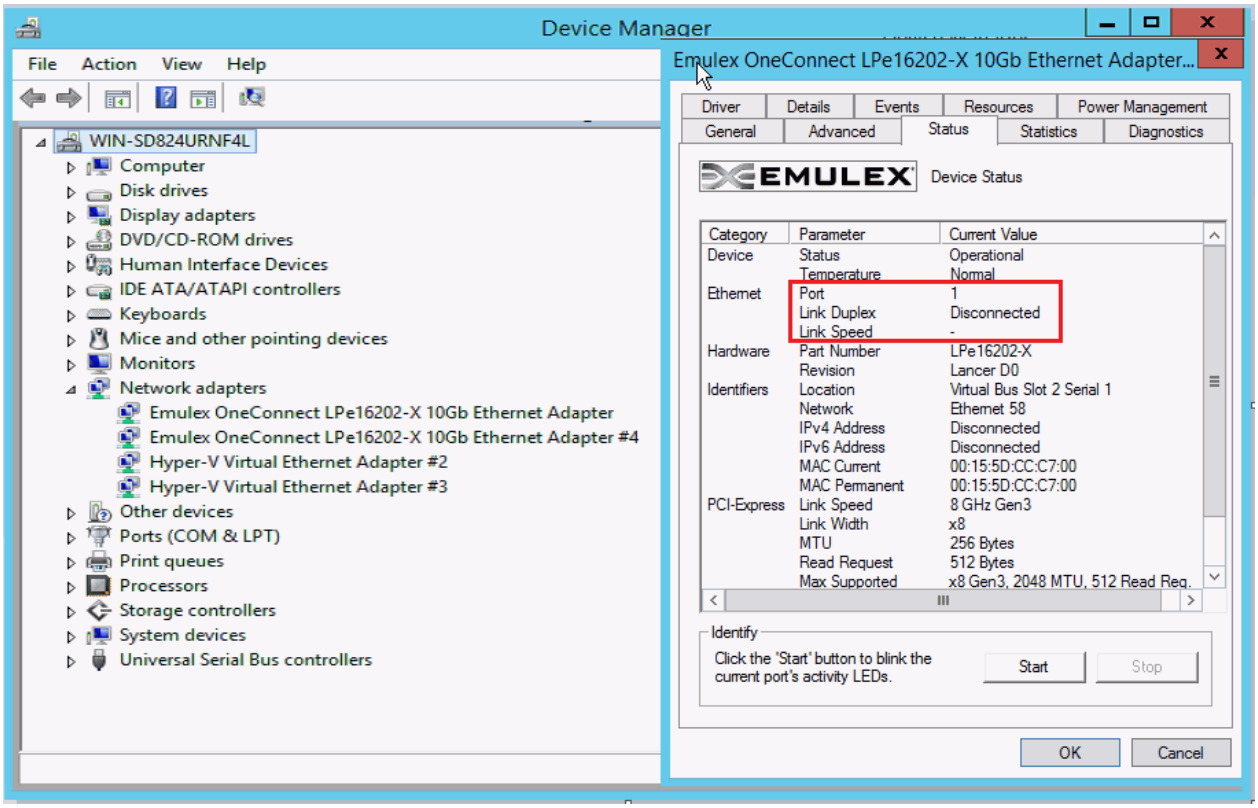
NOTE You must configure Hyper-V to create an SR-IOV-enabled virtual machine. Refer to the Microsoft Hyper-V documentation for additional information.

3.2.4.5 SR-IOV Link Behavior

Link status information for the virtual function (VF) is not available from the Network Connection Manager of the virtual machine. The link status of the VF adapter is displayed in the **Status** tab of the **Device Manager Advanced Property** page for the corresponding adapter.

If the link status of the VF is up, then it is shown as Connected along with the Link Speed. When PF link is disconnected, the VF adapter will be shown as Disconnected.

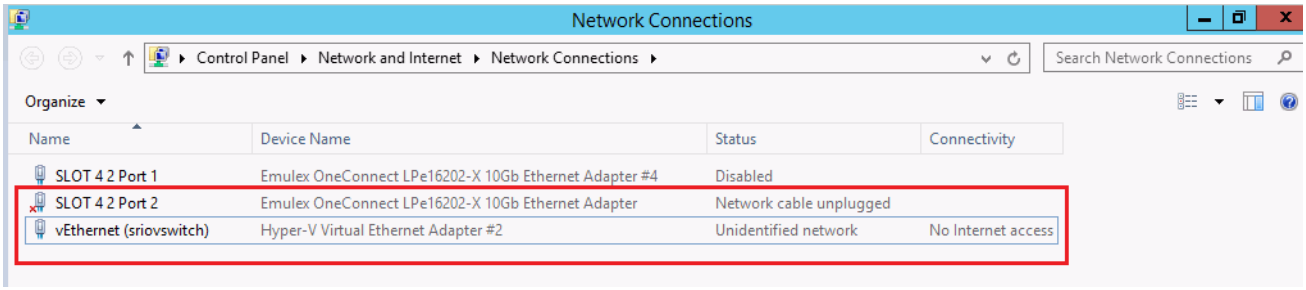
Figure 8 PF Link Disconnected, VF Adapter Disconnected



When a VF adapter link is down, the communication between the VF and its corresponding physical function (PF) adapter is still possible. The default synthetic data path provided by Hypervisor will be used instead of the VF data path of the adapter. In this case, statistics counters of the VF adapter are not incremented.

The virtual switch connected to the PF is always shown as link up regardless of the PF link status. The link status of the switch is controlled by the operating system and not the PF driver. Figure 9 depicts the **Network Connections** panel when the PF link is disconnected, but the SR-IOV enabled virtual switch link is shown as connected.

Figure 9 Network Connections Panel – PF Link Disconnected



3.2.4.6 Hyper-V

The Hyper-V role must be added using the Server Manager. After the Hyper-V role is added, 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 additional 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, Windows Server 2012 R2, and Windows Server 2016 servers treat SR-IOV as an offload. Each VM using SR-IOV gets its own VF with access to a subset of HW resources on the NIC, allowing for superior performance by bypassing the Hyper-V vSwitch reducing overhead.

After the Emulex driver is loaded, the Emulex SR-IOV virtual function is used for all unicast receive and transmit traffic. Live migration and multicast are supported while using SR-IOV. If SR-IOV is disabled, the Emulex adapter is removed from the virtual machine, and all traffic automatically uses the Hyper-V synthetic NIC.

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.

3.2.4.7 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.

3.2.4.7.1 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**.

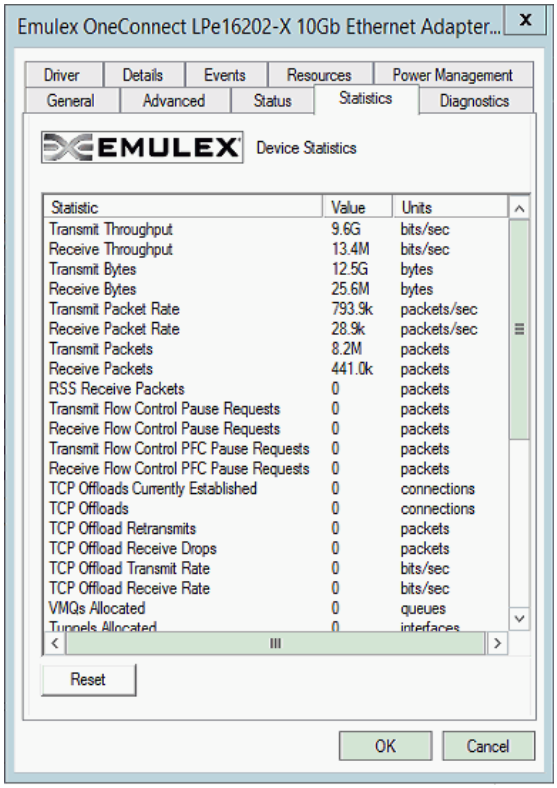
   The **Device Manager** opens (Figure 5).
3. Open the **Network adapters** item, select the Emulex device and right-click it.
4. Select **Properties** from the context-menu.

   The **Properties** dialog opens showing the **Driver** page (Figure 6).

   NOTE The Emulex adapter might initially appear as a “Network Adapter” before the driver is loaded.
5. Select the **Statistics** tab (Figure 10).

   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 10 Emulex NIC Statistics Page



3.2.4.7.2 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 opens and shows the **Driver** page.
3. Select the **Statistics** tab (Figure 10).
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 additional information.

3.2.5 Network Driver Performance Tuning

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

3.2.5.1 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 the **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.

3.2.5.2 Windows Server Network Driver

Table 6 describes ways to use various NIC driver properties and Microsoft Windows properties to performance-tune a system.

Table 6 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 and increase the number of RSS queues.
Large data transfers, such as to a backup server, exist.	Enable jumbo packets, and use TCP offload.
A small server is struggling to keep up with larger servers on the network.	Disable RSS, 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.	Enable RSS.

3.2.5.2.1 Analyzing Performance Issues

Use the Windows Performance Monitor (perfmon) to view statistics for each network device.

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

Table 7 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 7 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.

Table 7 Statistics and Fine Tuning (Continued)

Situation	Answer/Solution
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 3.2.5.2.2, 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 checksum offloads, and use jumbo packets.

3.2.5.2.2 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, which corresponds 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** page, see 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 require 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.

3.2.5.2.3 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.

3.2.5.2.4 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. The adapter 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 Section 3.2.1, Configuring NIC Driver Options.

3.2.5.2.5 NUMA Considerations for Windows Server 2012 R2 and Windows Server 2016

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 need to make an appropriate NUMA CPU selection. For example, in Windows Server 2012 R2, and Windows Server 2016, 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.

3.2.5.2.6 Checksum Offloading and Large Send Offloading (LSO)

The adapter supports IP and UDP checksum offloading. 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 data appear as giant packets in the packet sniffer, because the hardware has not yet segmented them.

NOTE On Windows Server 2012 and later, `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 Section 3.2.1, Configuring NIC Driver Options.

3.2.5.2.7 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.

3.2.5.2.8 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 DPCs can run, 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 Section 3.2.1, Configuring NIC Driver Options.

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, hyper-threaded CPU.

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 8 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, perform these steps: 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 OneInstall Installer fails, it may be because of one of the following reasons: ■ 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.
Port names might differ for adapter ports, although they are running the same driver binary.	This is a display issue that does not affect functionality. Run the AutoPilot Installer to correct this issue. Example: Run `elxdrvr-fc-11.x.xxx.xx.exe` and reinstall the driver kit. **NOTE** A reboot may be required after the installation to see the correct names in Device Manager.

4.2 Troubleshooting the NIC Drivers

The followng table provides troubleshooting information for the NIC drivers.

Table 9 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.
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 action 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, 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 bug check if a PCIe hot unplug or replace is attempted.	Hot unplug is not supported in this release.

The system crashes or appears to hang. In the case of a hang, there could be a message might indicate 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 on 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. Refer to the operating system documentation for details.

On Windows Server 2012 R2, the NIC driver will not load on a VM that is using passthrough in the host.	There is no workaround for this issue. PCI passthrough is not supported.

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 Emulex Storport Miniport will be Event ID 11 with source ELXFC/LPFC0E.

To view the error log:

1. Open the **Event Viewer** window by doing one of the following:
   - Click **Start > Programs > Administrative Tools > Event Viewer**.
   - Right-click **My Computer > Manage and Event Viewer** in Computer Management.

   The **Event Viewer** window is displayed.
2. Double-click any event with the source name ELXFC/LPFC0E.
3. Examine the entry at offset 0x10 and Event ID 11. The Emulex event code is found in byte 0x10, and supplementary data is in the byte offsets 0x11 through 0x13.

For example, in Figure 11:

byte 0x10 = 9b, byte 0x11 = 00, byte 0x12 = 29, and byte 0x13 = 00

Figure 11 Event Properties

A.1.1.1 Severity Scheme

When the Event Viewer is launched, there are three branches: Application, Security, and System. All ELXFC/LPFCOE error log entries are found under the System branch, and all ELXFC/LPFCOE 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 Chapter 3: Configuration 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 the following items:

- 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 10 lists severe errors and their codes.

Table 10 Severe Errors

Byte 0x10	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 10 Severe Errors (Continued)

Byte 0x10	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 (0x11: path id; 0x12: 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 10 Severe Errors (Continued)

Byte 0x10	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. For LPE16000 and LPe32000 link effect and link state (SLI4 mode) 0x13: Port Name; 0x12: Link effect; 0x11: Link state. Link State Values - 0x11 0x0 “Physical Link is functional” 0x1 “Optics faulted/incorrectly installed/not installed – Reseat optics. If issue not resolved, replace.” 0x2 “Optics of two types installed – Remove one optic or install matching pair of optics.” 0x3 “Incompatible optics – Replace with compatible optics for card to function.” 0x4 “Unqualified optics – Replace with Avago optics for Warranty and Technical Support.“ See "Link Effect" 0x5 “Uncertified optics – Replace with Avago-certified optics to enable link operation.“ See "Link Effect" Link Effect 0x12 bit 0 set “Link is non-operational.” bit 0 clear “Link is operational.”
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)

A.1.1.4.2 Malfunction Errors

Table 11 lists malfunction errors and their codes.

Table 11 Malfunction Errors

Byte 0x10	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
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 (0x11: mailbox status)
0x3E	Recoverable UNREG VPI error (0x11: 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

Table 11 Malfunction Errors (Continued)

Byte 0x10	Interpretation
0xB0	Node timeout: device removal signaled to Storport
0xB2	FCP_RSP short frame received
0xE1	Misconfigured port event on indicated port. For LPE16000 and LPe32000 link effect and link state (SLI4 mode) 0x13: Port Name; 0x12: Link effect; 0x11: Link state. Link State Values - 0x11 0x0 "Physical Link is functional" 0x1 "Optics faulted/incorrectly installed/not installed – Reseat optics. If issue not resolved, replace." 0x2 "Optics of two types installed – Remove one optic or install matching pair of optics." 0x3 "Incompatible optics – Replace with compatible optics for card to function." 0x4 "Unqualified optics – Replace with Avago optics for Warranty and Technical Support." See "Link Effect" 0x5 "Uncertified optics – Replace with Avago-certified optics to enable link operation." See "Link Effect" Link Effect 0x12 bit 0 set "Link is non-operational." bit 0 clear "Link is operational."

A.1.1.4.3 Command Errors

Table 12 lists command errors and their codes.

Table 12 Command Errors

Byte 0x10	Interpretation
0x43	Fabric logon 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

Table 12 Command Errors (Continued)

Byte 0x10	Interpretation
0x43	Fabric logon succeeded
0xAE	Error on SCSI pass-through command
0xAF	Error on Menlo CT command
0xE1	Misconfigured port event on indicated port. For LPE16000 and LPe32000 link effect and link state (SLI4 mode) 0x13: Port Name; 0x12: Link effect; 0x11: Link state. Link State Values - 0x11 0x0 "Physical Link is functional" 0x1 "Optics faulted/incorrectly installed/not installed – Reseat optics. If issue not resolved, replace." 0x2 "Optics of two types installed – Remove one optic or install matching pair of optics." 0x3 "Incompatible optics – Replace with compatible optics for card to function." 0x4 "Unqualified optics – Replace with Avago optics for Warranty and Technical Support." See "Link Effect" 0x5 "Uncertified optics – Replace with Avago-certified optics to enable link operation." See "Link Effect" Link Effect 0x12 bit 0 set "Link is non-operational." bit 0 clear "Link is operational."

A.1.1.4.4 Event Indicators

Table 13 lists event indications and their codes.

Table 13 Event Indications

Byte 0x10	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 0x11–0x13)
0xD1	NPIV Virtual Port creation failed (Virtual Port index 0x11–0x13)
0xD2	NPIV Virtual Port FDISC failed (Virtual Port index 0x11–0x13)
0xD4	Exceeded max Virtual Port supported (Virtual Port index 0x11–0x13)
0xD5	NPIV Virtual Port removal (Virtual Port Did 0x11–0x13)
0xEE	Authenticated successfully (remote Did 0x11–0x13)
0xEF	Failed to authenticate (remote Did 0x11–0x13)
0xE2	Authentication not support (remote Did 0x11–0x13)
0xE3	Authentication ELS command timeout (remote Did 0x11–0x13)
0xE4	Authentication transaction timeout (remote Did 0x11–0x13)
0xE5	LS_RJT other than Logical Busy received for Authentication transaction (remote Did 0x11–0x13)
0xE6	LS_RJT Logical Busy received for Authentication Transaction (remote Did 0x11–0x13)
0xE7	Received Authentication Reject other than Restart (remote Did 0x11–0x13)
0xE8	Received Authentication Reject Restart (remote Did 0x11–0x13)
0xE9	Received Authentication Negotiate (remote Did 0x11–0x13)

Table 13 Event Indications (Continued)

Byte 0x10	Interpretation
0xEA	Authentication spurious traffic (remote Did 0x11–0x13)
0xEB	Authentication policy has been changed (remote Did 0x11–0x13)
0xED	Same passed were set for both local and remote entities (remote Did 0x11–0x13)
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 and FCoE Event Log

This section provides information on the FC and FCoE event logs.

A.1.2.1 Event Log Interpretation

- All events logged by Emulex Storport Miniport are in Event ID 11 with source "elxfc/lpfcoe".
- 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 appear in SAN environments where issues occur.

A.1.2.2.1 ELS/FCP Command Error Status Codes

Table 14 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 14 ELS/FCP Command Error Status Codes

Code	Explanation
0x2	Remote Stop – Remote port sent an ABTS
0x3	Local Reject – Local Reject error detail
0x9	LS_RJT Received – Remote port sent LS_RJT
0xA	A_RJT Received – Remote port sent BA_RJT

A.1.2.2.2 CT Command Response Codes

Table 15 lists the codes that indicate the response to a FC Common Transport protocol command.

Table 15 CT Command Response Codes

Code	Explanation
0x8001	FC Common Transport Reject
0x8002	FC Common Transport Accept

A.1.2.2.3 FC-CT Reject Reason Codes

Table 16 lists the codes that indicate the reason a CT command was rejected.

Table 16 FC-CT Reject Reason Codes

Code	Explanation
0x01	Invalid command code
0x02	Invalid version level
0x05	Logical busy
0x07	Protocol error

A.1.2.2.4 ELS Command Codes

Table 17 lists the FC protocol codes that describe the Extended Link Services commands that were sent.

Table 17 ELS Command Codes

Code	Explanation
0x01	Link Service Reject (LS_RJT)
0x02	Accept (ACC)
0x03	N_Port Login (PLOGI)
0x04	Fabric Login (FLOGI
0x05	N_Port Logout (LOGO)
0x20	Process Login (PRLI)
0x21	Process Logout (PRLO)
0x51	Discover F_Port Service Params (FDISC)
0x52	Discover Address (ADISC)
0x61	Register State Change Notify (RSCN)

A.1.2.2.5 SCSI Status Codes

Table 18 lists the SCSI status codes returned from a SCSI device that receives a SCSI command.

Table 18 SCSI Status Codes

Code	Explanation
0x00	GOOD
0x02	CHECK CONDITION
0x08	BUSY
0x18	RESERVATION CONFLICT
0x28	QUEUE FULL

A.1.2.2.6 Local Reject Status Codes

Table 19 list the codes supplied by the Emulex adapter firmware that indicate why a command was failed by the adapter.

Table 19 Local Reject Status Codes

Code	Explanation
0x02	SEQUENCE TIMEOUT – Possible bad cable/link noise
0x04	INVALID RPI – Occurs if the link goes down
0x05	NO XRI – Possible host or SAN problem
0x0D	TX_DMA FAILED – Possible host system issue
0x0E	RX_DMA FAILED – Possible host system issue
0x0F	ILLEGAL FRAME – Possible bad cable/link noise
0x11	NO RESOURCES – Port out of exchanges or logons
0x18	LOOP OPEN FAILURE – FC_AL port not responding
0x1A	LINK DOWN – Queued cmds returned at link down
0x1D	OUT OF ORDER DATA – Possible bad cable or noise

A.1.2.2.7 SRB Status Codes

Table 20 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 20 SRB Status Codes

Code	Explanation
0x04	ERROR
0x05	BUSY
0x09	TIMEOUT
0x0A	SELECTION TIMEOUT
0x0B	COMMAND TIMEOUT
0x0E	BUS RESET
0x12	DATA OVERUN

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 error codes might 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 appears, 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 (Code 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 Name Server Response (Code 0x98)

This code is useful in determining if the expected number of targets in a SAN configuration are being presented by the name server to the requesting adapter. The number in byte 0x11 is the number of targets returned to the name server 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 refer to the internal memory constructs of the 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, perform these steps:

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 NIC Event Log

The 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 21 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 if any of these entries that are displayed.

Table 21 NIC Event Log Entries

Message ID Hexadecimal/ Decimal	Severity	Message	Recommended Resolution
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 place holder for the NIC controller name. %3, %4, %5 are place holders 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 place holders 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 be used only 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.
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. Refer to the Broadcom website for compatible firmware.

Table 21 NIC Event Log Entries (Continued)

Message ID Hexadecimal/ Decimal	Severity	Message	Recommended Resolution
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. Refer to 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.	Refer to 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.
0x0026/38	Warning	The device firmware does not support RSS functionality for this network adapter.	The firmware and the driver are not compatible versions. Refer to 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. Refer to 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.
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 does not provide any additional performance.

Table 21 NIC Event Log Entries (Continued)

Message ID Hexadecimal/ Decimal	Severity	Message	Recommended Resolution
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 message 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 image is not corrupted. Contact Broadcom Technical Support.
0x0009/9	Error	Failed to register interrupt service routine.	This message indicates an NDIS error. Verify that hardware resource conflicts do not exist.
0x0008/8	Error	Failed to get TCP offload handlers.	This message indicates 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 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 message indicates an internal NDIS error. Check the operating system installation.
0x0002/2	Error	The network driver initialization failed.	This error may be a firmware driver mismatch or corrupt installation. Check the firmware version, reinstall the firmware and try again. This message 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.

Appendix B: Port Speed Specifications for LPe16202/OCe15100 Adapters

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 10 Gb 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 22 lists negotiated speed specifications per an adapter's port connection:.

Table 22 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	1 Gb/s	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	1 Gb/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

Appendix C: AutoPilot Installer Command Line and Configuration File Parameters

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 `APInstall.exe` with its `/silent` switch. See Section 2.3.6, Unattended Driver Installation, for additional information.

C.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-<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, type the following command on one line:

```
elxdrv-fc-<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 double quotation marks. To add such a setting to `APargs`, you must insert backslashes before the quotes around the value, and then add double quotation marks around the entire `APargs` expression. For example, the command line (all on one line):

```
elxdrv-fc-<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 Section 2.3.2.2, Option 2: Run AutoPilot Installer Separately and Section 2.3.6, Unattended Driver Installation.

You can specify a non-default directory for the driver kit by specifying an installation folder on the command line. For example:

```
elxdrv-fc-<version>.exe install:"C:\Emulex"
```

This option can be used in conjunction with the `APArgs` directive.

C.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 quotation marks 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 Section C.2.3, Software Configuration Parameters.

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
```

C.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"
```

C.2.2 Configuration File Location

The optional `ConfigFileLocation` setting 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
```

C.2.3 Software Configuration Parameters

C.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.

C.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).

C.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.

C.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 AutoPilot Installer.

C.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 shared drive. 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, and NIC driver. AutoPilot Installer automatically selects the most recent revisions that it finds.

C.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 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.

C.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\"`

C.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.

C.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 on as part of the Windows start up process. If there is no logon, the installation process would stop if the system is restarted. However, Windows can be configured to start up without requiring you to log on. You must ensure that it is safe to restart the system during unattended installations if you set this parameter to True.

C.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.

C.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 and 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 Configuration 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.

C.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 variable 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.

C.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 identifies the configuration that the file supports. This section may appear only once in the APInstall.cfg file.

C.3.3 Software Configuration [AUTOPILOT.CONFIG]

This section contains 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 Section C.2.3, Software Configuration Parameters, for information about settings that can be specified in this section.

C.3.4 Configuration Prompts and 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. These items are 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 displays below the question in a smaller font. If there is no explanatory text, empty quotation marks must be used in its place.
- *“answer0”* contains the first answer to be displayed in the drop-down list.
- *“answer1”* contains the second 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;"
```

C.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]
```

C.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 version 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.

For example:

```
[STORPORT.QFES]
qfe = "QFE 83896", "\system32\drivers\storport.sys", "5.2.1390.176","Win2012"
```

C.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 1, Storport Miniport Driver Parameters, for a listing of driver parameters, defaults, and valid values.

C.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.

C.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 23.

Table 23 Unattended Installation Error Codes

Error Code	Hex	Description
0	0x00000000	No errors are reported.
2399141889	0x8F000001	An unsupported operating system detected.
2399141890	0x8F000002	The AutoPilot configuration file is not found.
2399141891	0x8F000003	Disabled adapters are 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 canceled execution because you did not want to perform a software-first install.
2399141896	0x8F000008	No drivers are 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 configuration 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 canceled.
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 were disallowed.
2399141984	0x8F000060	You cancelled APInstaller before any driver or utility installation occurred.
2399142000	0x8F000070	You cancelled APInstaller after driver or utility installation occurred.
2399142032	0x8F000090	APInstaller encountered an error while parsing the command line (Report file contains details).

C.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 Installer 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.

C.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 network. 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 D: License Notices

D.1 Secure Hash Algorithm (SHA-1) Notice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