Overview

Intel® Ethernet FCoE (Fibre Channel over Ethernet) is designed for the 82599 and X540-based 10 Gigabit family of PCI-Express server adapters. This guide covers hardware and software installation, setup procedures, known issues and troubleshooting tips for installing and booting the system using these adapters.

Fibre Channel over Ethernet (FCoE) is defined as the encapsulation of standard Fibre Channel (FC) protocol frames as data within standard Ethernet frames. This link-level encapsulation, teamed with an FCoE-aware Ethernet-to-FC gateway, acts to extend an FC fabric to include Ethernet-based host connectivity. The FCoE specification focuses on encapsulation of FC frames specific to storage class traffic, as defined by the Fibre Channel FC-4 FCP specification. FC is a market-leading technology used to create Storage Area Networks (SANs).

Data Center Bridging (DCB) is a collection of standards-based extensions to classical Ethernet. It provides a lossless data center transport layer that enables the convergence of LANs and SANs onto a single unified fabric. In addition to supporting Fibre Channel over Ethernet (FCoE) and iSCSI over DCB, it enhances the operation of other business-critical traffic.

Installation Overview

For information on system requirements see System Requirements.

1. Install FCoE-capable adapters in the system. For a list of supported adapters, see Supported Adapters.
2. After following the installation and configuration procedures, if you are having problems, refer to Known Issues.

FCoE Infrastructure - Installation and Configuration

The following is a typical FCoE setup flow:

1. Typical FCoE-Enabled Fabric Switch Configuration
2. If you want to Boot from an FCoE LUN
   - Configure Intel® Ethernet FCoE Boot Options from Intel® Windows® Device Manager
3. Install Operating System
   - Linux Installation and Configuration
   - Microsoft® Windows® Server 2008 Installation and Configuration
4. Configure Intel® Ethernet FCoE/DCBx
   - Configure DCBx
   - Configure FCoE
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   - Configure DCBx
   - Configure FCoE
System Requirements

Before installing Intel® Ethernet Server Adapters and Intel® Ethernet FCoE Protocol Drivers, check your system for the following minimum configuration requirements. If you are using an Intel® Ethernet FCoE-capable OEM server system, refer to the instructions provided from the OEM to enable Intel® FCoE Remote Boot.

System Hardware Compatibility for Network Adapters

- An FCoE-capable Intel® 82599 or X540-based Network Adapter. A list of FCoE/DCB-supported Intel® Ethernet Server Adapters can be found [here](#).
- One of the following slot types, depending on your adapter:
  - A PCI-Express slot (v1.0a or newer), 4x, 8x or 16x
- The latest BIOS for your system
- FCoE requires at least 4GB of RAM for optimum performance

Supported 32-bit Operating Systems

Intel® Ethernet FCoE Protocol Driver and Intel® FCoE Remote Boot are supported on the following IA-32 operating systems:

- Microsoft® Windows® Server 2008, (with latest service pack and Hyper-V role) - Standard, DataCenter or Enterprise
- Microsoft® Windows® Server 2008 Core
- Red Hat® Enterprise Linux 6
- Novell SUSE® Linux Enterprise 11, SP1

Supported Intel® 64 Architecture (Intel® 64) Operating Systems

Intel® Ethernet FCoE Protocol Driver and Intel FCoE Remote Boot are supported on the following Intel® 64 operating systems:

- Microsoft® Windows® Server 2008 (with latest service pack and Hyper-V role) - Standard, DataCenter or Enterprise
- Microsoft® Windows® Server 2008 R2 SP1 (with latest service pack and Hyper-V role) - Standard, DataCenter or Enterprise
- Microsoft® Windows® Server 2008 Core
- Microsoft® Windows® Server 2008 R2 Core
- Red Hat® Enterprise Linux 6
- Novell SUSE® Linux Enterprise 11, SP1

Platform Requirements for Intel® 64

A platform that supports Intel® 64 will run in either 64-bit mode or 32-bit compatibility mode. In order for it to run in 64-bit mode, the following requirements must be met:

- The Intel® 64 system must have a 64-bit BIOS that takes advantage of Intel Extended Memory 64 Technology
- One of the supported 64-bit operating systems must be installed

The installer for the adapter drivers will only list the drivers that are compatible with the currently running operating system.

- If the system is running in compatibility mode, only IA-32 drivers will be available
- If the system is running in 64-bit mode, only Intel® 64 drivers will be available

Jumbo Frames

The base driver supports FCoE mini-Jumbo Frames (2.5k bytes) independent of the LAN Jumbo Frames setting.
Supported Adapters

A list of Intel® FCoE-supported adapters can be found at http://www.intel.com/support/go/network/adapter/fcoefaq.htm
Switch Configuration for Intel® Ethernet FCoE Protocol Driver

Cisco Nexus* Switch Platform

Brocade* Switch Platform

NOTES:

- In the following examples, the assumption is made that the VLAN and VSAN configurations have already been performed.
- For more installation details check with your switch vendor's documentation:
  - Cisco Nexus
  - Brocade

Cisco Nexus* 5000 Series Switch Platform

For the Cisco/Nexus/switch platform, a virtual interface is needed to bind the Ethernet port to the FC forwarder or FCF. Assume port 1/3 in the following example.

Commands to enable trunk mode for a Ether port

```
Configure
Interface Ethernet 1/3
switchport mode trunk
spanning-tree port type edge trunk
exit
```

Commands to create a VFC:

```
configure
interface vfc 3
bind interface Ethernet 1/3
no shutdown
exit
```

Brocade* 8000 Series FCoE Switch

For the Brocade 8000 series FCoE switch, assuming port 1/3, vlan 101 for FCoE, use:

```
configure terminal
interface TenGigabitEthernet 1/3
switchport
switchport mode converged
vlan classifier activate group 1 vlan 101
no shutdown
cee default
exit
```

Note: The "cmsh" command must be issued before the "configure terminal" command will function properly.
Installation and Configuration

This section provides information on how to install and setup Intel® Ethernet FCoE components.

Follow the detailed instructions in Microsoft* Windows Installation or Linux Installation.

Enabling Intel® Ethernet FCoE Boot

In order to enable Intel® Ethernet FCoE Boot, the firmware should be loaded as Option ROM by the BIOS when the system boots. "Intel(R) FCoE Boot" followed by the firmware version number is displayed, if the firmware is installed correctly.

See instructions on Intel® Ethernet FCoE Boot.
**Intel® Ethernet FCoE Boot**

Intel® Ethernet FCoE Boot allows the user to install FCoE to boot an operating system from a remote target. The following information refers specifically to Intel® Ethernet FCoE Boot. To then configure the OS go to: Windows or Linux.

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**Upgrading an FCoE-Booted System**

**Intel® Ethernet FCoE Boot Option Rom Setup**

**Microsoft* Windows* Setup for Intel® FCoE Boot**

**Installing Windows Server With Local Disk**

**Crash Dump Support**

**BootUtility**

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**Upgrading an Intel® Ethernet FCoE-Booted System**

Upgrades for Release 16.2 or later are supported when Intel® Ethernet FCoE Boot is enabled or the Windows paging file is on an FCoE target. Upgrading an FCoE-booted system can only be done via the Intel® PROSet for Windows* Device Manager installer. A reboot is required to complete the upgrade.

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**Intel® Ethernet FCoE Boot Option ROM Setup**

**FCoE Port Selection Menu**

To configure Intel® Ethernet FCoE Boot, power-on or reset the system and input the Ctrl-D key combination when the message "Press <Ctrl-D> to run setup..." is displayed. After inputting the Ctrl-D key combination, you will be taken to the Intel® Ethernet FCoE Boot Port Selection Setup Menu.

![FCoE Port Selection Menu](image)

The first screen of the Intel® Ethernet FCoE Boot Setup Menu displays a list of Intel® FCoE Boot-capable adapters. For each adapter port, the associated SAN MAC address, PCI device ID, PCI bus/device/function location, and a field indicating FCoE Boot status is displayed. Up to 10 FCoE Boot-capable ports can be displayed within the Port Selection Menu. If there are more Intel® FCoE Boot-capable adapters, these are not listed in the setup menu.

Highlight the desired port and press Enter.

**FCoE Boot Targets Configuration Menu**
FCoE Boot Targets Configuration: Discover Targets is highlighted by default. If the Discover VLAN value displayed is not what you want, enter the correct value. Highlight Discover Targets and then press Enter to show targets associated with the Discover VLAN value. Under Target WWPN, if you know the desired WWPN you can manually enter it or press Enter to display a list of previously discovered targets.
Highlight the desired **Target** from the list and press **Enter**.

<table>
<thead>
<tr>
<th>WWPN</th>
<th>Fabric ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>20:16:00:A0:B8:42:13:8C</td>
<td>C20100</td>
</tr>
<tr>
<td>50:00:CC:A0:04:41:6B:2E</td>
<td>C205D6</td>
</tr>
</tbody>
</table>
Manually fill in the LUN and Boot Order values.

**Boot Order** valid values are 0-4, where 0 means no boot order or ignore the target. A 0 value also indicates that this port should not be used to connect to the target. Boot order values of 1-4 can only be assigned once to target(s) across all FCoE boot-enabled ports.

**VLAN** value is 0 by default. You may do a Discover Targets which will display a VLAN. If the VLAN displayed is not the one you require, enter the VLAN manually and then perform Discover Targets on that VLAN.

Hit Save.

**NOTE:** After the Discover Targets function is executed, the Option ROM will attempt to remain logged into the fabric until the FCoE Boot Targets Configuration Menu is exited.

- Keyboard Shortcuts: Up/Down, TAB and SHIFT-TAB to move between the controls. Left/Right/Home/End/Del/Backspace in the edit boxes.
- Press the Esc key to leave the screen.

**NOTE:** For more detailed instructions and description of a typical installation and setup go [here](#).

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**Intel® PROSet for Windows® Device Manager**

Many of the functions of the Intel® Ethernet FCoE Boot Port Selection Setup Menu can also be configured or revised using Intel® PROSet for Windows Device Manager. Click [here](#) for instructions on installing and using Intel® PROSet for Windows Device Manager.

- Intel® Ethernet FCoE Boot version is displayed on the Boot Options tab if the combo image supports FCoE Boot.
- Intel® Ethernet FCoE Boot is an Active Image option if FCoE Boot is supported by the combo image.
- The Active Image setting enables/disables Intel® Ethernet FCoE Boot in the EEPROM.
- Intel® Ethernet FCoE Boot settings are displayed if FCoE Boot is the active image.
Microsoft® Windows® Setup for Intel® Ethernet FCoE Boot

Requirements

1. Follow installation steps to install the Intel® Ethernet FCoE Boot-capable adapters with Intel® Ethernet FCoE Boot firmware support.
2. Create a disk target (LUN) on an available Fibre Channel target. Configure this LUN to be accessible to the WWPN address of the initiator of the host being booted.
3. Make sure the FCoE initiator of the host system starts the Intel® Ethernet FCoE Boot firmware. The firmware should be configured properly, be able to connect to Fibre Channel target, and detect the boot disk.
4. To setup Windows Server® boot system when a local disk is available, follow the steps in installing Windows Server with Local Disk.
5. Obtain information on Crash Dump Support.

Installing Windows Server with Local Disk

After the Option Rom is installed, if you wish to install Windows Server with local disk, do the following:

1. Follow the instructions for installing Windows Server and the FCoE stack.
2. Verify that the FCoE Boot disk is available in the Fabric View tab of Intel® PROSet for Windows Device Manager, and verify that you are online using Windows Disk Manager.
3. Open a command prompt, run the fcoeprep.bat batch file. To find the batch file, navigate to your architecture’s directory within the \APPS\FCOEBOOT directory.
4. Shut Windows down and capture the OS image to a local disk partition.
5. Transfer the image from the local hard drive to the FCoE target. This may be done from within the local Windows installation.
6. For Windows 2008 R2 SP1 only: Run bcdboot.exe from the local Windows installation to make the FCoE disk bootable.
   - If a System Reserved partition exists on the FCoE disk, type: `bcdboot F:\Windows /s E:`
     where E: is the FCoE System Reserved partition and F: is the FCoE partition with the Windows directory.
   - If a System Reserved partition does not exist, type: `bcdboot E:\Windows /s E:`
     where E: is the FCoE partition with the Windows directory.
7. Shut down and remove the local disk.
8. Configure the system BIOS to boot from the FCoE disk and boot.

NOTE: For more detailed instructions and description of a typical installation and setup go here.

Crash Dump Support

Crash dump file generation is supported in this release.
Microsoft* Windows* Installation and Configuration for Intel® Ethernet FCoE Protocol Driver

Software Requirements

Hardware Requirements

Upgrading from Software Release 15.4

Validation and Storage Certification

New Windows Server 2008 Installation

Intel® Ethernet FCoE Configuration Using Intel® PROSet for Windows* Device Manager

Storage Adapter Miniport Device’s Property Window Tabs

Network Adapter Miniport Device’s Property Window Tabs

Upgrading from Software Release 15.4

Upgrades for Software Release 16.2 or later are supported when Intel® Ethernet FCoE Boot is enabled or the Windows paging file is on an FCoE target. Upgrading an FCoE-booted system can only be done via the Intel® PROSet for Windows* Device Manager installer. A reboot is required to complete the upgrade.

**Warning:** Do not update X520 base driver via the Windows Update method. Doing so may render the system inoperable, generating a blue screen. The FCoE Stack and base driver need to be matched. The FCoE stack may get out of sync with X520, if the X520 base drive is updated via Windows Update.

The Windows FCoE stack has recently changed the way it creates the initiator WWPN. The first two bytes of the WWPN previously contained a 2 followed by the FCoE fabric VLAN ID. The VLAN ID is no longer added to the WWPN and the first two bytes will now always be 20:00. After upgrading from Release 15.4, you will need to zone the new WWPN for each initiator port.

Validation and Storage Certification

The software components for Intel® Ethernet FCoE are comprised of two major components: the Intel® Ethernet base driver and the Intel® Ethernet FCoE Driver. They are developed and validated as an ordered pair. Users are strongly encouraged to avoid scenarios, either through upgrades or Windows update, where the Intel® Ethernet driver version is not the version released with the corresponding Intel® Ethernet FCoE driver. Listed below is a table with the released versions and the associated base driver and the Intel® Ethernet FCoE Driver.

<table>
<thead>
<tr>
<th>Version</th>
<th>Qualified</th>
<th>NDIS Miniport Driver</th>
<th>Intel® Ethernet FCoE Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.4</td>
<td>No</td>
<td>2.5.52.0</td>
<td>1.0.2.0</td>
</tr>
<tr>
<td>15.4.1</td>
<td>Yes</td>
<td>2.5.52.0</td>
<td>1.0.2.1</td>
</tr>
<tr>
<td>15.4.2</td>
<td>Netapp</td>
<td>2.5.52.0</td>
<td>1.2.6.0</td>
</tr>
<tr>
<td>15.4.3</td>
<td>EMC</td>
<td>2.5.52.0</td>
<td>1.2.8.0</td>
</tr>
<tr>
<td>15.8</td>
<td>No</td>
<td>2.6.121.0</td>
<td>1.3.23.0</td>
</tr>
<tr>
<td>16.0</td>
<td>No</td>
<td>2.7.28.0</td>
<td>1.4.6.0</td>
</tr>
<tr>
<td>16.2</td>
<td>EMC, Netapp</td>
<td>2.8.32.0</td>
<td>1.5.9.0</td>
</tr>
<tr>
<td>16.4</td>
<td>No</td>
<td>2.9.66.0</td>
<td>1.6.5.0</td>
</tr>
</tbody>
</table>

Notes: Individually upgrading/downgrading the Intel® Ethernet FCoE driver will not work and may even cause a blue screen; the entire FCoE package must be the same version. Upgrade the entire FCoE package using Intel® Network Connections only.

If you uninstalled the Intel® Ethernet Virtual Storage Miniport Driver for FCoE component, just find the same version that you uninstalled and re-install it; or uninstall and then re-install the entire FCoE package.

Intel and the storage vendors spend considerable effort ensuring that their respective products operate with each other as expected for every version that we release. However, given the sheer number of releases and each respective organizations’ differing schedules, users are strongly encouraged to use their storage vendor’s support matrix to ensure that the versions that they are deploying for the Intel® Ethernet Protocol Driver, the switch and storage vendor have been tested as an integrated set.

New Windows* Server 2008 Installation

From the Intel CD: Click the FCoE/DCB checkbox to install Intel® Ethernet FCoE Protocol Driver and DCB. The MSI Installer installs all FCoE and DCB components including Base Driver.

Notes: FCoE is supported on 82599 and X540-based Intel® Network Connections.

We recommend installing using the latest Storage Qualified Image.

For current drivers and documentation, visit the Customer Support site.

Microsoft Hotfixes

The following Microsoft hotfixes have been found to be needed for specific use cases:

All Windows Server 2008 (R1 and R2)
Multipath I/O (MPIO)

Windows 2008 R1 SP2
- KB970525 - MPIO
- KB972797 - MS DSM
- KB974646 - NTFS
- KB976748 - MPIO - reboot fix
- KB979743 - MPIO - write errors
- KB981379 - MS DSM - target issues

Windows 2008 R2
- KB979743 - MPIO - write errors
- KB981379 - MS DSM - target issues

Windows 2008 R2 SP1
- KB2406705

Set the PathRecoveryInterval value to 60

iSCSI Over DCB - QOS binding

Windows 2008 R1 SP2
- KB2518021

Intel® Ethernet FCoE Configuration Using Intel® PROSet for Windows* Device Manager

Many FCoE functions can also be configured or revised using Intel PROSet for Windows Device Manager, accessed from the FCoE Properties button within the Data Center tab. You can use Intel PROSet to perform the following tasks:

- Configure FCoE initiator specific settings
- Go to the corresponding port driver
- Review FCoE initiator information
- Obtain general information
- Review statistics
- Obtain information about the initiator
- Obtain information about attached devices
- Obtain FIP discovered VLANs and status

Click here for instructions on installing and using Intel PROSet for Windows Device Manager.

Note: PROSetCL.EXE is used for DCB/FCoE configuration on Microsoft Windows Server 2008 Core and Microsoft Windows Server 2008 R2 Core operating systems.

From the Boot Options Tab, the user will see the Flash Information Button. Clicking on the Flash Information Button will open the Flash Information Dialog. From the Flash Information Dialog, clicking on the Update Flash button allows Intel® iSCSI Remote Boot, Intel® Boot Agent (IBA), Intel® Ethernet FCoE Boot, EFI, and CLP to be written. The update operation writes a new image to the adapter's Flash and modifies the EEPROM, which may temporarily disable the operation of the Windows* network device driver. You might need to reboot the computer following this operation.

You cannot update the flash image of a LOM; this button will be disabled.

Intel Ethernet Storage Miniport Driver for FCoE Properties Tabs

There are two ways to navigate to the FCoE properties. One using the X520 Network adapter properties Data Center tab and other through Intel® Ethernet Virtual Storage Miniport Driver for FCoE Storage Controllers properties from Windows Device Manager.

General Tab
Fabric View Tab

Intel(R) Ethernet Virtual Storage Miniport Driver for FCoE Properties

Fabric View Tab

Intel(R) Ethernet Storage Miniport Driver for FCoE

Device type: Storage controllers
Manufacturer: Intel
Location: Location 0 (Intel FCoE Virtual Bus 0)

Device status
This device is working properly.

Intel(R) Ethernet Server Adapter X520-2 Properties

VLANs

Device type: Network adapters
Manufacturer: Intel
Location: PCI bus 0, device 0, function 0

Device status
This device is working properly.
FabricView in connected mode

FabricView after completion of zoning and LUN masking
Fabric Mode with Target Selected

Selecting the target displays target information including: World Wide Node Name (WWNN), World Wide Port Name (WWPN), Serial Number, Fabric ID (FCID) and manufacturer name.

Fabric Mode with LUN Selected. Selecting a specific LUN from the list will display LUN information.
The Fabric View Tab displays information about Virtual Ports, Targets and LUNs connected to the host adapter. It also displays detailed information about the host, the target and LUNs, e.g., the host name, target name, LUN capacity, FCID, etc.

### Location

- **PortWWN**: PortWWN is an unique 8-byte address of the port within the Fibre Channel network or domain.
- **NodeWWN**: NodeWWN is a unique, 8-byte address of the node within the Fibre Channel network or domain.
- **FcId**: FcId is a 3-byte unique identifier that addresses a port within the fabric domain, usually assigned by the fabric.

### Link Status

- **Connected**
- Degraded (Class of Service not negotiated)
- Degraded (App mode disabled locally)
- Degraded (App mode disabled on peer)
- Connected (Class of Service unknown)
- Degraded (Data Center Bridging is disabled)
- Degraded (Data Center Bridging service not installed or started)
- Degraded (No Class Of Service negotiated)
- Degraded (PFC and APP setting mismatch)
- Degraded (Priority Flow Control is disabled)
- Degraded (Priority Flow Control not negotiated)
- Connected (Priority Flow Control state unknown)
- Not Connected (Fibre Channel link down)
- Not Connected
Advanced Tab

Port Properties

This button opens Intel® Proset for Windows® Device Manager for the selected adapter.

SETTINGS:

Timeout Value

Time in units of seconds before an SRB request initiated by the disk class driver will time out. For FCoE, valid values should range from 1 to 255 seconds.

Note: A restart is required to implement Timeout Value setting changes.

DeviceQDepth

Changes the Drive I/O Queue Depth value. This change may affect driver performance. Values for this setting are between 1-252 in increments of 1. Default value: 32.

Linkdown Timeout

Changes the time limit that I/O will be held on a link down. This value supersedes the Timeout Value setting. The values are 2, 5, 10, 15, 20, 30, 60, 90, and 120. Default value: 20.

Log Warning and Information Events

Allows user to enable/disable warnings in the event log if it is detected that the FCoE Interface Version returned from the base driver does not match the version that was validated.

Statistics Tab
The **Statistics Tab** displays FCoE Server Adapter Statistics and errors since the initialization of the FCoE stack.

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tx Frames</strong></td>
<td>Number of total Transmitted Fibre Channel frames across all protocols and classes.</td>
</tr>
<tr>
<td><strong>Rx Frames</strong></td>
<td>Number of total Received Fibre Channel frames across all protocols and classes.</td>
</tr>
<tr>
<td><strong>Tx Words</strong></td>
<td>Number of total Transmitted Fibre Channel words across all protocols and classes.</td>
</tr>
<tr>
<td><strong>Rx Words</strong></td>
<td>Number of total Received Fibre Channel words across all protocols and classes.</td>
</tr>
<tr>
<td><strong>LIP Count</strong></td>
<td>Number of LIP events that have occurred on a arbitrated loop.</td>
</tr>
<tr>
<td><strong>NOS Count</strong></td>
<td>Number of NOS events that have occurred on the switched Fabric.</td>
</tr>
<tr>
<td><strong>Error Frames</strong></td>
<td>Number of frames that have been received in error.</td>
</tr>
<tr>
<td><strong>Dumped Frames</strong></td>
<td>Number of frames that were lost due to a lack of host buffers available.</td>
</tr>
<tr>
<td><strong>Loss of Sync</strong></td>
<td>Number of times loss of sync has occurred.</td>
</tr>
<tr>
<td><strong>Loss of Signal</strong></td>
<td>Number of times loss of signal has occurred.</td>
</tr>
<tr>
<td><strong>Invalid Tx Word</strong></td>
<td>Number of invalid transmitted words.</td>
</tr>
<tr>
<td><strong>Invalid CRC</strong></td>
<td>Number of frames received with invalid CRC</td>
</tr>
</tbody>
</table>

**VLAN Tab**
VLAN IDs are obtained through FIP VLAN discovery. This is a read-only page.

Status Options: "In Use" and "Not In Use"

Virtual Ports Tab
Create Button
- Creates Virtual Ports with the specified WWPN.

Remove Button
- Deletes the selected Virtual Port.

Generate Button
- The WWPN is blank by default. The user can enter a WWPN manually or generate one automatically with the Generate Button.

A list of the Virtual Ports associated with the HBA has a column for the WWPN and FCID for each Virtual Port. Not Connected is displayed in the FCID column if it is not logged in to a target.

Network Adapter Miniport Device’s Properties Tabs

Boot Options Tab
From the Boot Options tab you can obtain Target information and Update the Flash.

Enabling FCoE boot will allow user to boot from FCOE LUN.
Selecting Boot Target in the above Window will allow user to select FCoE LUNs and their respective boot order.

**SETTINGS:**

**Active Image**

Enables/disables the boot options in the EEPROM. The update operation modifies the EEPROM to enable an option ROM, already contained within the flash. This may temporarily disable the operation of the Windows network device driver. You might need to reboot the computer following this operation.

**Boot Targets**

The server side system in an FCoE SAN configuration. The FCoE Boot Target system hosts the FCoE target drives which are accessed by an FCoE Boot initiator.

**Update Flash**

Click on the Flash Information Button to open the Flash Information Dialog.
Flash Information Dialog clicking on the Update Flash button allows Intel® Ethernet FCoE Boot, Intel® iSCSI Boot, Intel® Boot Agent (IBA), EFI, and CLP to be written. The update operation writes a new image to the adapter's Flash and modifies the EEPROM, which may temporarily disable the operation of the Windows® network device driver. You might need to reboot the computer following this operation.

Note: You cannot update the flash image of a LOM; this button will be disabled.

Properties Button Click on Properties button with Boot Targets selected to launch Target Properties Dialog.

Note: This button displays if you have either Intel® Ethernet iSCSI or Intel® Ethernet FCoE Boot enabled and a target selected in the Settings list.

Target Properties Dialog

Target: Each Target field contains WWPN numbers for the FCoE boot targets discovered on the network, and the network, and None Selected.

LUN: Each LUN field displays the LUNs on the selected target. If no target is selected, the LUN field is empty.

Boot Order: Boot Order field options are 1, 2, 3, 4, and Not Set.

LUN and Boot Order fields are disabled and cleared when target is set to None Selected.

Intel® Ethernet FCoE Boot cannot be enabled on an adapter that has a VLAN or is in a team. If the current adapter is in a team or has a VLAN, then all fields are disabled.

Data Center Tab

User must enable Use Data Center Bridging to be able to use Intel® Ethernet FCoE.

Changing FCoE priority allows the user to choose a different priority class for FCoE traffic on the converged Ethernet network. Adjusting Bandwidth percentage ensures FCoE traffic is allocated to specified minimum guaranteed bandwidth. All other traffic classes will share the remaining bandwidth. Bandwidth allocation rules are enforced when maximum available bandwidth is being utilized.
Use Switch Settings

From the Data Center tab you can, among other things: view operational status, select FCoE settings, and enable/disable Data Center Bridging (DCB).

- **Display Status** (operational or non-operational) by clicking on the icon.
  - Enhanced Transmission Selection
  - Priority Flow Control
  - FCoE Priority

**Non operational status:** If the Status indicator shows that DCB is non-operational, there may be a number of possible reasons.
1. DCB is not enabled - select the checkbox to enable DCB.
2. One or more of the DCB features is in a non-operational state. The features which contribute to the non-operational status are PFC and APP:FCoE.

A non-operational status is most likely to occur when Use Switch Settings is selected or Using Advanced Settings is active. This is generally a result of one or more of the DCB features not getting successfully exchanged with the switch. Possible problems include:
- One of the features is not supported by the switch.
- The switch is not advertising the feature.
- The switch or host has disabled the feature (this would be an advanced setting for the host).

When **Use Local Settings** is selected, the status should always be operational.

*Note:* In most circumstances, we recommend selecting **Use Switch Settings**, rather than **Use Local Settings**.

*Note:* Options on the Data Center tab are grayed out:
You cannot disable DCB or modify any DCB settings while the system is booted from an FCoE drive or if the system paging file is on an FCoE drive.

- Disable/enable
- Configuring host to use the settings provided by the switch or to use local settings
- Troubleshooting information

_Last modified on 9/09/11 10:34a Revision_
SUSE® Linux Enterprise Server 11 (SLES 11) FCoE Installation

Select FCoE during OS Installation

1. In Installation Settings, click the Software headline to go to Software Selection and System Tasks.
2. In Software Selection and System Tasks, click Details to enter a new window.
3. Enter Search tab
4. In Search box, type "fcoe" and click "Search"
5. Select open-fcoe package and click "Accept"
6. Click OK for questions to get back to "Installation Settings"

Using Yast to install after OS Installation

**NOTE:** If FCoE is installed during OS installation, then this is not required.

1. Select Software in the left pane
2. Select Software Management in the right pane
3. Type "fcoe" in the search box, then click Search button
4. "open-fcoe" package will show in right pane
5. Select "open-fcoe" package, then click Accept
6. Verify "Automatic Changes" and click OK
7. Click Install to install package

Red Hat® Enterprise Linux 6 (RHEL 6) FCoE Installation

Select FCoE during OS Installation

1. Select your desired installation profile (Basic Server, Database Server, Web Server, etc).
2. Set up your repositories as desired, and select the Customize now button before clicking Next to go to the software package selection screen.
3. Under Base System, select FCoE Storage Client. Make sure that the optional package Intel LLDP Agent is included under Optional packages.
4. Continue with OS installation.

Using YUM to install after OS Installation

**NOTE:** If FCoE is installed during OS installation, then these steps are not required.

1. Either configure the Red Hat Network (RHN) or mount the installation DVD. Please refer to the Red Hat documentation to learn how to register your repositories with YUM.
2. `root# yum -y install fcoe`
   a. You will notice several dependency packages being automatically installed.

Linux Intel® Ethernet FCoE Configuration

**NOTE:** The following examples assume that the network interface named "eth3" is the FCoE interface. Your interface name is likely to be different. Please substitute your interface name when "eth3" is used below.

Verifying the Network Interface
After the FCoE package has been installed, activate the interface. Then ensure that link is established and active at 10G link speed to the network switch.

```
root# ifconfig eth3 up
root# ethtool eth3

Settings for eth3:
Speed: 10000Mb/s
Link detected: yes
```

**NOTE:** If you do not see link detected, check cabling and correct before proceeding.

### Configuring Link Layer Discovery Protocol agent daemon (lldpad)

Lldpad is a utility used to initiate and configure the Link Layer Discovery Protocol (LLDP). LLDP enables the IEEE Data Center Bridging extensions (DCBX) so that FCoE VLAN discovery, parameter negotiations and session initiation can be accomplished.

1. Start lldpad service and configure to start at boot time.

```
root# service lldpad start
Starting lldpad: [done] [ OK ]
root# chkconfig lldpad on

**NOTE:** There is no output from this command but it will enable lldpad to automatically start when the system is booted.
```

2. Adjust DCB settings on every physical interface to be used for FCoE with these commands:

```
**NOTE:** dcbtool makes change to /var/lib/lldpad/lldpad.conf.

root# dcbtool sc eth3 dcb on
root# dcbtool sc eth3 dcb on
Version: 2
Command: Set Config
Feature: DCB State
Port: eth3
Status: Successful

root# dcbtool sc eth3 app:fcoe e:1
root# dcbtool sc eth3 app:fcoe e:1
Version: 2
Command: Set Config
Feature: Application FCoE
Port: eth3
Status: Successful

root# dcbtool sc eth3 pfc e:1 a:1 w:1
(this optional command ensures pfc is configured in the default way (not necessary to do on a fresh system))

root# dcbtool sc eth3 pfc e:1 a:1 w:1
Version: 2
Command: Set Config
Feature: Priority Flow Control
Port: eth3
Status: Successful

root# dcbtool go eth3 pfc
(this optional command is used to verify that the settings are correct)

root# dcbtool go eth3 pfc
Version: 2
Command: Get Oper
Feature: Priority Flow Control
Port: eth3
```
Status: Successful  
Oper Version: 0  
Max Version: 0  
Errors: 0x00 - none  
Oper Mode: true  
Syncd: true  
pfcup: 0 0 0 1 0 0 0 0

root# dcbtool go eth3 app:fcoe

(this optional command is used to verify that the settings are correct)

root# dcbtool go eth3 app:fcoe

Version: 2  
Command: Get Oper  
Feature: Application FCoE  
Port: eth3  
Status: Successful  
Oper Version: 0  
Max Version: 0  
Errors: 0x00 - none  
Oper Mode: true  
Syncd: true  
appcfg: 08

Configuring Intel® Ethernet FCoE

1. Create a configuration file for the VLAN interface. To copy cfg file, run command:

   \textbf{NOTE:} The sample file is cfg-ethx. Copy it to a file which reflects your FCoE network interface name (eg. cfg-eth3).

   root# cp /etc/fcoe/cfg-ethx /etc/fcoe/cfg-eth3

2. Start fcoe service and configure to start at boot time.

   root# service fcoe start

   Starting FCoE initiator service: [ OK ]

   root# service fcoe status

   Created interfaces: eth3.100-fcoe

   \textbf{NOTE:} In the example above, an FCoE interface was created for eth3 using VLAN 100. "No interfaces added" indicates that the FIPVLAN protocol was not able to acquire a vlan and therefore an interface was not created. This must be corrected before continuing. This issue may be because you are not connected to a DCB enabled switch or DCB is disabled on this switch port. Contact your network administrator for further help.

   root# chkconfig fcoe on

   \textbf{NOTE:} There is no output from this command but it will enable FCoE to automatically start when the system is booted.

3. Verify that a vlan interface has been created.

   root# ifconfig -a

   eth3 Link encap:Ethernet HWaddr 00:1B:21:60:62:75
   ...  
   eth3.100-fcoe Link encap:Ethernet HWaddr 00:1B:21:60:62:75
   ...  

   \textbf{NOTE:} The interface name "eth3.100-fcoe" indicates that the FCoE Initialization Protocol (FIP) negotiated with the switch and established an FCoE session using VLAN 100. This process usually happens automatically for all DCBX enabled switches.

No FCoE ports configured
NOTE: This message indicates that the FIP VLAN Discovery failed. Please see your network administrator and ensure that this port is configured for DCBX and FCoE.

4. Check that vlan interface can obtain FC-ID. Run command

   root# fcoeadm -i

   Description: 82599EB 10-Gigabit Network Connection
   Revision: 01
   Manufacturer: Intel Corporation
   Serial Number: 001B21606274
   Driver: ixgbe 2.0.62-k2
   Number of Ports: 2
   Symbolic Name: fcoe v0.1 over eth3.100-fcoe
   OS Device Name: host3
   Node Name: 0x1000001B21606277
   Port Name: 0x2000001B21606277
   FabricName: 0x2064000DECA33A01
   Speed: 10 Gbit
   Supported Speed: 10 Gbit
   MaxFrameSize: 2112
   FC-ID (Port ID): 0x4A0064
   State: Online

   NOTE: The important values to note are that the state is "Online", the Port Name and the FC-ID. Your storage administrator may need the Port Name and the FC-ID in order to identify your connection when allocating zones for you.

   If you see the FCoE interface and an FCID from the switch, you are ready to zone and provision your storage. Please see your storage administrator. Once your storage administrator has properly provisioned your storage, you may continue to configure.

5. Verify that you have been assigned on a storage target.

   root# fcoeadm -t
   Interface: eth3.100-fcoe
   ...  
   FC-ID (Port ID): 0x4A06EF
   State: Online
   LUN ID Device Name Capacity Block Size Description
   ------- ----------- -------- ---------- -----------
   0 /dev/sdb 25.00 GB 512 DGC RAID 10 (rev 0429)

   NOTE: This example shows that a LUN has been provisioned and assigned to /dev/sdb. This may happen automatically but usually you must request a LUN from your storage administrator.

6. Verify that the file system has identified the SAN storage.

   root# lsscsi
   [0:0:0:0] cd/dvd TSSTcorp CDDVDW SH-S223L SB02 /dev/sr1
   [1:0:0:0] disk ATA ST3160811AS 3.AA /dev/sda
   [2:0:1:0] cd/dvd MATSHITA DVD-ROM SR-8178 P216 /dev/sr0
   [3:0:0:0] disk DGC RAID 10 0429 /dev/sdb

Basic Intel® Ethernet FCoE Commands

   show interface info: fcoeadm -i

   root# fcoeadm -i
   Description: 82599EB 10-Gigabit Network Connection
   Revision: 01
   Manufacturer: Intel Corporation
   Serial Number: 001B21606274
   Driver: ixgbe 2.0.62-k2
   Number of Ports: 2
   Symbolic Name: fcoe v0.1 over eth3.100-fcoe
   OS Device Name: host3
   Node Name: 0x1000001B21606277
   Port Name: 0x2000001B21606277
FabricName: 0x2064000DECA33A01
Speed: 10 Gbit
Supported Speed: 10 Gbit
MaxFrameSize: 2112
FC-ID (Port ID): 0x4A0064
State: Online

show LUNs: fcoeadm -l

root# fcoeadm -l
Interface: eth3.100-fcoe
Roles: FCP Target
Node Name: 0x50060160C46029CC
Port Name: 0x50060160446029CC
Target ID: 0
MaxFrameSize: 2048
OS Device Name: rport-3:0-1
FC-ID (Port ID): 0x4A06EF
State: Online

LUN #0 Information:
OS Device Name: /dev/sdb
Description: DGC RAID 10 (rev 0429)
Ethernet Port FCID: 0x4A0064
Target FCID: 0x4A06EF
Target ID: 0
LUN ID: 0
Capacity: 25.00 GB
Capacity in Blocks: 52428799
Block Size: 512 bytes
Status: Attached

show targets: fcoeadm -t

root# fcoeadm -t
Interface: eth3.100-fcoe
Roles: FCP Target
Node Name: 0x50060160C46029CC
Port Name: 0x50060160446029CC
Target ID: 0
MaxFrameSize: 2048
OS Device Name: rport-3:0-1
FC-ID (Port ID): 0x4A06EF
State: Online

LUN ID Device Name Capacity Block Size Description
------ ----------- -------- ---------- -----------
0 /dev/sdb 25.00 GB 512 DGC RAID 10 (rev 0429)

show statistics: fcoeadm -s

root# fcoeadm -s eth3.100-fcoe 1

eth3.100-fcoe interval: 1

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<th>TxBytes</th>
<th>RxFrames</th>
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</tr>
</tbody>
</table>
The Intel® Ethernet FCoE Linux Management Tools included in this package are:

- **fcoeadm** - program to create, reset, destroy, and display FCoE interfaces
- **fcoemon** - program to monitor the events from the DCB daemon

**Requirements:**
The user is not required to download and build from source if you're using a distribution (RHEL, SLES).

**If building from source:** The HBAAPI library and the HBAAPI vendor library source must be built and installed before you can build the management tools. The HBAAPI vendor library and libhbalinux may be downloaded from www.Open-FCoE.org. The instructions in the package describes how to download and build the libraries. See the man pages for other requirements.

---

### fcoeadm

The fcoeadm command is intended to be the FCoE management tool for the Linux systems. The -c, -d, and -r options are used to create, destroy, and reset an FCoE instance on a given network interface. The other options are used to query the information of the FCoE instance which includes the interface information, target information, LUN information, and port statistics. The fcoeadm command invokes the HBAAPI library routines to obtain this information. The HBAAPI library routines invoke the vendor-specific library and libhbalinux to grab the information from the /sys file system. In other words, the fcoeadm command requires the user to have libHBAAPI and libhbalinux installed on the system to work.

The libhbalinux is maintained at [http://www.Open-FCoE.org](http://www.Open-FCoE.org). The installation instructions of libhbalinux also instruct the user in how to download the HBAAPI source code, build and install with the libhbalinux. The last option -h is used to show a brief usage message of the supported command syntax.

**Options:**

- **-c, -create <ethX>**

  Creates an FCoE instance based on the given <ethX>.

- **-d, -destroy <ethX>**

  Destroys an FCoE instance based on the given <ethX>.

- **-r, -reset <ethX>**

  Resets the fc_host associated with the FCoE interface given by <ethX>.

- **-i, -interface <ethX>**
Shows the information of the FCoE instances created at <ethX>. If <ethX> is not specified the command will show the information of all the FCoE instances created on the system.

-t, -target <ethX>

Shows the information of all the discovered targets from the FCoE instances created at <ethX>. If <ethX> is not specified the command will show the information of all the discovered targets from all the FCoE instances created.

-l, -lun <target_port_id> <lun_id>

Shows the detailed information of a specific LUN with <lun_id> at the target with port id <target_port_id>. Port id is also known as FC-ID. If <lun_id> is not specified, all the LUNs associated with the target will be shown.

-s, -stats <ethX> <interval>

Show the statistics (including FC4 statistics) of the FCoE instances created at <ethX>. The information will be displayed in one line on the screen per given time interval. <interval> should be specified in whole integers greater than 0. It specifies the time interval in the unit of second. If <interval> is not specified, the default interval is one second.

-v, -version

Displays the version of the fcoeadm command.

-h, -help

Displays the usage message of the fcoeadm command where <ethX> is the network interface name, such as eth0, eth1, etc.

Examples:

Creates an FCoE instance on eth2
$ fcoeadm -c eth2
Destroys the FCoE instance on eth2

$ fcoeadm -d eth2
Resets the FCoE instance on eth2

$ fcoeadm -r eth2
Shows the information of all the adapters and their ports having FCoE instances created.

$ fcoeadm -i
Shows the information of a specific interface eth3. If eth3 has no FCoE instances created, the command will show the error "No fc_host found for eth3".

$ fcoeadm -i eth3
Shows the information of all the discovered targets from all the ports having FCoE instances created (they may be on different adapter cards). A brief listing of discovered LUNs are listed after the target they are associated with, if any.

$ fcoeadm -t
Shows the information of all the discovered targets from a given port (eth3) having FCoE instance created. A brief listing of discovered LUNs are listed after each target they are associated with, if any.

$ fcoeadm -t eth3
Shows the detailed information of all the LUNs associated with a specific target. The target is identified by its port id (aka -FC-ID) 0xD700EF.

    $ fcoeadm -l 0xD700EF
    $ fcoeadm -l D700EF
    $ fcoeadm -l 0xd700ef
    $ fcoeadm -l d700ef

Show the detailed information of a LUN associated with a specific target. The target is identified by its port id (aka FC-ID) 0xD700EF and the LUN is identified by its LUN id.

    $ fcoeadm -l 0xD700EF 1

Show the statistical information of a specific port eth3 having FCoE instances created. The statistics are displayed one line per time interval. The default interval is one second if -n option is not specified.

    $ fcoeadm -s eth3
    $ fcoeadm -s eth3 \3
    $ fcoeadm -s eth3 \3

Reporting Bugs:

If you have identified a defect please either file a bug or engage the development mailing list at http://www.Open-FCoE.org.

Support:
Open-FCoE is maintained at http://www.Open-FCoE.org. There are resources available for both developers and users at that site.

**fcoemon**
The fcoemon command is a FCoE management tool provided by the Open-FCoE package.

fcoemon is the daemon of the fcoe system service. When fcoemon starts, it establishes a socket connection with the DCB daemon. It then sends commands to, and receives responses and events from the DCB daemon.

Since fcoemon depends on the existence of DCB service, there are settings required for DCB before fcoemon can be started. See the DCB Settings section below.

Notice that the fcoe system service does not depend on the lldpad service. However, the fcoemon daemon will be started by the fcoe service only if any one of the Ethernet ports requires DCB service. In this case, the fcoe service depends on the lldpad service. If none of the Ethernet ports requires DCB service, the fcoemon will not be started and, in this case, the fcoe service does not depend on the lldpad service.

**Options:**

- **-h | -v | --version**
  
  Shows the version of the fcoemon command.

- **-f | --foreground**
  
  Runs fcoemon in the foreground.

- **-d | --debug**
  
  PFC - The DCB Priority Flow Control feature.

App:FCoE - The DCB Fibre Channel over Ethernet feature.

LLINK - The DCB Logical Link TLV (or Logical Link) feature. Applicable to DCBX version 1.

multiq - See Documentation/networking/multiqueue.txt of linux kernel 2.6.28 or higher.

skbedit - See Documentation/networking/multiqueue.txt of linux kernel 2.6.28 or higher.

**Installation Requirements:**

The DCB and FCoE kernel configuration options must be enabled, these were introduced in v2.6.29. Both the Linux kernel and iproute2 must support multiq and skbedit. The DCB must be installed with version 0.9.4 and higher.

**Supported DCB Events:**

In response to each supported event from the DCB daemon, the fcoemon collects the current settings from the DCB daemon and
decides whether to delete and re-add the multiq queue discipline and skbedit filter. The fcoemon does not destroy, reset, or create FCoE interfaces during the DCB event processing.

FEATURE_APP

If an event message is received from lldpad and if the feature code in the event message is FEATURE_APP (5), and if the subtype field is APP_FCOE_STYPE (0), then this indicates a mode or configuration change event of the FCoE application. The fcoemon will then issue queries to the DCB daemon to collect the current mode and configuration information.

FEATURE_PFC

If an event message is received from lldpad and if the feature code in the event message is FEATURE_PFC (3), then this indicates a mode or configuration change event of the Priority Flow Control (PFC) feature. The fcoemon will then issue queries to the DCB daemon to collect the current mode and configuration information.

FEATURE_LLINK

If an event message is received from lldpad and if the feature code in the event message is FEATURE_LLINK (6), and if the subtype field is LLINK_FCOE_STYPE (0), then this indicates a mode or configuration change event of the Logical Link TLV feature. The fcoemon will then issue queries to the DCB daemon to collect the current mode and configuration information.

Criteria for Creating, Resetting and Destroying FCoE Interface

In this section the dcbtool is used to describe the conditions of the DCB feature status because the meaning is more understandable and precise. Although you may also issue the commands at run-time, the commands are intended only to be used for description purpose.

PFC and App:FCoE

DCB is configured correctly if

1) The command dcbtool gc ethX dcb shows DCB State: "on"
2) The command dcbtool gc ethX app:0 shows "Enable:true, Advertise:true, Willing:true."
3) The command dcbtool go ethX app:0 shows "OperMode:true."
4) The command dcbtool go ethX pfc shows "OperMode:true" and the values of pfcup.
5) The command dcbtool go ethX app:0 shows appcfg. The bits set to 1 are also set to 1 in pfcup found in (4).

Logical Link TLV (applicable in DCBX version 1)

The Logical Link TLV feature is configured correctly if

1) The command dcbtool gc ethX ll:0 shows "Enable:true, Advertise:true, Willing:true."
2) The command dcbtool go ethX ll:0 shows "OperMode:true."
3) The command dcbtool gp ethX ll:0 shows "Link Status:up."

Criteria to create FCoE interface
If DCB is required at the Ethernet port, an FCoE interface may be created only if the DCB and the Logical Link TLV feature are configured correctly. If DCB is not required at the Ethernet port, the FCoE interface may be created. FCoE interfaces are normally created by the fcoe system service.

**Criteria to Destroy FCoE Interface**

An FCoE interface will only be destroyed when the fcoe system service is stopped.

**Criteria to reset a FCoE interface**

The fcoe system service does not reset any FCoE interfaces.

**Changing DCB Configuration, Qdisc and Filters**

Changing the DCB configuration, qdisc, and filter are considered to be administrative actions. When the fcoe system service starts up, it sets up the default DCB configuration, qdisc, and filter for reliable FCoE operations. Administrators may alter the configuration while the service is running.

Changing the DCB parameters may cause the fcoemon daemon to delete the existing multiq queue discipline, skbedit filter and re-add, but the fcoe service will not touch (e.g. destroy or reset) the FCoE interface. Changing the DCB configuration, qdisc, and filter should be avoided while I/O traffic are in progress.

**Files:**

The Installation of the Open-FCoE management tools include the following files:

RHEL6.0/6.1

/usr/sbin/fcoemon
/usr/sbin/fcoeadm
/usr/sbin/lldpad
/usr/sbin/dcbtool

SLES11 SP1

/usr/sbin/fcoemon
/usr/sbin/fcoeadm
/sbin/lldpad
/sbin/dcbtool

/etc/fcoe/config

This is the common configuration file for the fcoe system service. The default options in this file are:

DEBUG="yes" and USE_SYSLOG="yes".

The former is used to enable (select yes) or disable (select no) debugging messages from fcoemon, and the fcoe service script. The latter is to indicate if the log messages of fcoemon, and the fcoe service script are to be output to the system log. Use editor to set the desired yes/no values.

/etc/fcoe/cfg-ethX

There is one of these file for each Ethernet interface ethX found in the output of cat /proc/net/dev at the time of installation. This file will be read by the /etc/init.d/fcoe script and the fcoemon daemon. The default options in this file are:

FCOE_ENABLE="no" and DCB_REQUIRED="yes". The former is used to enable (select yes) or disable (select no) the FCoE service at the ethX port. The latter is to indicate if the DCB service is required.
(select yes) or not required (select no) at the ethX port. If the former is set to no, the latter is ignored. The selection of the settings should match the settings of the FCoE switch port connected to the local Ethernet ethX port. Use editor to set the desired yes/no values for the ethX interfaces.

/etc/init.d/fcoe

This is the fcoe system service shell script. This script is invoked by the init process or by the service command.

/sbin/fcoemon

This is the fcoemon daemon only invoked by the fcoe system service script.

/sbin/fcoeadm

This is the program used by the fcoe system service to create or destroy FCoE interfaces.

Reporting Bugs:

If you have identified a defect please either file a bug or engage the development mailing list at http://www.Open-FCoE.org.

Support

Open-FCoE is maintained at http://www.Open-FCoE.org. There are resources available for both developers and users at that site.

Last modified on 8/24/11 10:47a Revision
Data Center Bridging (DCB) for Intel® Network Connections

Overview

Data Center Bridging is a collection of standards-based extensions to classical Ethernet. It provides a lossless data center transport layer that enables the convergence of LANs and SANs onto a single unified fabric. In addition to supporting Fibre Channel Over Ethernet (FCoE) and iSCSI Over DCB, it enhances the operation of other business-critical traffic.

Data Center Bridging is a flexible framework that defines the capabilities required for switches and end points to be part of a data center fabric. It includes the following capabilities:

- Priority-based flow control (PFC; IEEE 802.1Qbb)
- Enhanced transmission selection (ETS; IEEE 802.1Qaz)
- Congestion notification (CN)
- Extensions to the Link Layer Discovery Protocol standard (IEEE 802.1AB) that enable Data Center Bridging Capability Exchange Protocol (DCBX)

There are three supported versions of DCBX.

Version 1: The specification can be found at http://download.intel.com/technology/eedc/dcb_cep_spec.pdf

This version of DCBX is referenced in Annex F of the FC-BB-5 standard (FCoE) as the version of DCBX used with pre-FIP FCoE implementations.

Version 2: The specification can be found as a link within the following document: http://www.ieee802.org/1/files/public/docs2008/dcb-baseline-contributions-1108-v1.01.pdf

Version 3: The specification can be found as a link within the following document: https://standards.ieee.org/findstds/standard/802.1Qaz-2011.html

Note: The OS DCBX stack will default to CEE (Version 2) DCBX, and if a peer is transmitting IEEE TLVs, it will automatically transition to IEEE (Version 3) DCBX.


For system requirements go here.

DCB for Windows

Configuration:

Many DCB functions can be configured or revised using Intel® PROSet for Windows Device Manager, from the Data Center tab.

Click here for instructions on installing and using Intel® PROSet.

You can use the Intel® PROSet to perform the following tasks:

- Display Status (operational or non-operational) by clicking on the icon.
  - Enhanced Transmission Selection
  - Priority Flow Control
  - FCoE Priority

  Non operational status: If the Status indicator shows that DCB is non-operational, there may be a number of possible reasons.

  1. DCB is not enabled - select the checkbox to enable DCB.
  2. One or more of the DCB features is in a non-operational state. The features which contribute to the non-operational status are PFC and APP:FCoE.

A non-operational status is most likely to occur when Use Switch Settings is selected or Using Advanced Settings is active. This is generally a result of one or more of the DCB features not getting successfully exchanged with the switch. Possible problems include:

- One of the features is not supported by the switch.
- The switch is not advertising the feature.
- The switch or host has disabled the feature (this would be an advanced setting for the host).

When Use Local Settings is selected, the status should always be operational.

Note: In most circumstances, we recommend selecting Use Switch Settings, rather than Use Local Settings.

- Disable/enable
- Configuring host to use the settings provided by the switch or to use local settings
- Troubleshooting information

Hyper-V (DCB and VMQ)

Note: Configuring a device in the VMQ + DCB mode reduces the number of VMQs available for guest OSes.

DCB for Linux

- Background
- Requirements
- Functionality
Background

In the 2.4.x kernel, qdiscs were introduced. The rationale behind this effort was to provide QoS in software, as hardware did not provide the necessary interfaces to support it. In 2.6.23, Intel pushed the notion of multiqueue support into the qdisc layer. This provides a mechanism to map the software queues in the qdisc structure into multiple hardware queues in underlying devices. In the case of Intel adapters, this mechanism is leveraged to map qdisc queues onto the queues within our hardware controllers.

Within the Data Center, the perception is that traditional Ethernet:

1. has high latency
2. is prone to losing frames, rendering it unacceptable for storage applications

In an effort to address these issues, Intel and a host of industry leaders have been working on addressing these problems. Specifically, within the IEEE 802.1 standards body there are a number of task forces working on enhancements to address these concerns. Listed below are the applicable standards bodies:

- **Enhanced Transmission Selection**
  - IEEE 802.1Qaz
- **Lossless Traffic Class**
  - Priority Flow Control: IEEE 802.1Qbb
  - Congestion Notification: IEEE 802.1Qau
- **DCB Capability exchange protocol**: IEEE 802.1Qaz

The software solution that is being released represents Intel's implementation of these efforts. It is worth noting that many of these standards have not been ratified - this is a pre-standards release, so users are advised to check open-fcoe.org or open-lldp.org often. While we have worked with some of the major ecosystem vendors in validating this release, there are many vendors which still have solutions in development. As these solutions become available and standards get ratified, we will work with ecosystem partners and the standards body to ensure that the Intel solution works as expected.

Requirements

- RHEL6 or later or SLES11 SP1 or later
- Linux ixgbe driver (for Intel® 82599 and X540-based adapters) from kernel 2.6.29 or later.
- 2.6.29 or newer version of the "iproute2" package should be downloaded and installed in order to obtain a multi-queue aware version of the 'tc' utility.
- Version 2.5.33 of Flex should be installed (to support iproute2), SLES10 is known to have an older version of Flex. The latest Flex source can be obtained from open-fcoe.org or open-lldp.org
  - An up-to-date netlink library needs to be installed in order to compile llqdpad.
  - Intel® 82599 or X540-based adapter.

Functionality

**lldpad**

- Executes the Link Layer Discovery Protocol (LLDP) over all supported interfaces.
- Executes the DCB capabilities exchange protocol to exchange DCBx configuration with the peer device using LLDP.
- Supports the versions of the DCB capabilities exchange protocol described here:
  - version 1
  - version 2
- Retrieves and stores LLDP and DCB configuration to a configuration file.
- Controls the DCB settings of the network driver based on the operation of the DCB capabilities exchange protocol. Interaction with a supporting network driver is achieved via DCB operations added to the rtnetlink interface in kernel 2.6.29.
- Supports the following DCB features: Enhanced Transmission Selection, Priority Flow Control, FCoE, and FCoE Logical Link Status.
- Provides an interface for client applications to query and configure DCB features. Generates client interface events when the operational configuration or state of a feature changes.

**lldttool**

- Interacts with lldpad via the client interface.
- Queries the state of the local, operational and peer configuration for the supported DCB features.
- Supports configuring the supported DCB features.
- Interactive mode allows multiple commands to be entered interactively, as well as displaying event messages.
- Enables or disables DCB for an interface.
Options
lldpad has the following command-line options:
- h show usage information
- f configfile: use the specified file as the config file instead of the default file - /etc/sysconfig/lldpad/lldpad.conf
- d run lldpad as a daemon
- v show lldpad version
- k terminate current running lldpad
- s remove lldpad state records

Setup
1. Load the ixgbe module.
2. Verify lldpad service is functional.
   If lldpad was installed, do "service lldpad status" to check, "service lldpad start" to start.
   Or, run "lldpad -d" from the command line to start.
3. Enable DCB on the selected ixgbe port: dcbtool sc ethX dcb on
4. The dcbtool command can be used to query and change the DCB configuration (i.e., various percentages to different queues). Use dcbtool -h to see a list of options.

DCBX Operation
lldpad and dcbtool can be used to configure a DCB-capable driver, such as the ixgbe driver, which supports the rtnetlink DCB interface. Once the DCB features are configured, the next step is to classify traffic to be identified with an 802.1p priority and the associated DCB features. This can be done by using the 'tc' command to setup the qdisc and filters to cause network traffic to be transmitted on different queues.

The skbedit action mechanism can be used in a tc filter to classify traffic patterns to a specific queue_mapping value from 0-7. The ixgbe driver will place traffic with a given queue_mapping value onto the corresponding hardware queue and tag the outgoing frames with the corresponding 802.1p priority value.

Set up the multi-queue qdisc for the selected interface:

# tc qdisc add dev ethX root handle 1: multiq

Setting the queue_mapping in a TC filter allows the ixgbe driver to classify a packet into a queue. Here are some examples of how to filter traffic into various queues using the flow ids:

# tc filter add dev ethX protocol ip parent 1: u32 match ip dport 80 0xffff action skbedit queue_mapping 0
# tc filter add dev ethX protocol ip parent 1: u32 match ip dport 53 0xffff action skbedit queue_mapping 1
# tc filter add dev ethX protocol ip parent 1: u32 match ip dport 5001 0xffff action skbedit queue_mapping 2
# tc filter add dev ethX protocol ip parent 1: u32 match ip dport 20 0xffff action skbedit queue_mapping 7
# tc filter add dev ethX protocol 802_3 parent 1: handle 0xfc0e basic match 'cmp(u8 at 12 layer 1 mask 0xffff eq 35078)' action skbedit queue_mapping 3

Testing
To test in a back-to-back setup, use the following tc commands to setup the qdisc and filters for TCP ports 5000 through 5007. Then use a tool, such as iperf, to generate UDP or TCP traffic on ports 5000-5007.

Statistics for each queue of the ixgbe driver can be checked using the ethtool utility: ethtool -S ethX

# tc qdisc add dev ethX root handle 1: multiq
# tc filter add dev ethX protocol ip parent 1: u32 match ip dport 5000 0xffff action skbedit queue_mapping 0
# tc filter add dev ethX protocol ip parent 1: u32 match ip dport 5001 0xffff action skbedit queue_mapping 1
# tc filter add dev ethX protocol ip parent 1: u32 match ip dport 5002 0xffff action skbedit queue_mapping 2
dcbtool Overview

dcbtool is used to query and set the DCB settings of a DCB-capable Ethernet interface. It connects to the client interface of lldpad to perform these operations. dcbtool will operate in interactive mode if it is executed without a command. In interactive mode, dcbtool also functions as an event listener and will print out events received from lldpad as they arrive.

Synopsis

dcbtool -h
dcbtool -v
dcbtool [-rR]
dcbtool [-rR] [command] [command arguments]

Options

- h shows the dcbtool usage message
- v shows dcbtool version information
- r displays the raw lldpad client interface messages as well as the readable output.
- R displays only the raw lldpad client interface messages

Commands

table

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>help</td>
<td>shows the dcbtool usage message</td>
</tr>
<tr>
<td>ping</td>
<td>test command. The lldpad daemon responds with &quot;PONG&quot; if the client interface is operational.</td>
</tr>
<tr>
<td>license</td>
<td>displays dcbtool license information</td>
</tr>
<tr>
<td>quit</td>
<td>exit from interactive mode</td>
</tr>
</tbody>
</table>

The following commands interact with the lldpad daemon to manage the daemon and DCB features on DCB-capable interfaces.

lldpad general
configuration commands:

<gc|go> dcbx sets the configured or operational version of the DCB capabilities exchange protocol. If different, the configured version will take effect (and become the operational version) after lldpad is restarted.

sc dcbx v[1|2] sets the version of the DCB capabilities exchange protocol which will be used the next time lldpad is started. Information about version 1 can be found at: 
Information about version 2 can be found at: 

DCB-per interface commands

gc <ifname> <feature> gets configuration of feature on interface ifname.
go <ifname> <feature> gets operational status of feature on interface ifname.
gp <ifname> <feature> gets peer configuration of feature on interface ifname.
sc <ifname> <feature> <args> sets the configuration of feature on interface ifname.

Feature may be one of the following:
dcb DCB state of the port
pg priority groups
pfc priority flow control
app:<subtype> application specific data
ll:<subtype> logical link status

Subtype can be:
0|fcoe Fiber Channel over Ethernet (FCoE)

Args can include:
e:<0|1> controls feature enable
a:<0|1> controls whether the feature is advertised via DCBX to the peer
w:<0|1> controls whether the feature is willing to change its operational configuration based on what is received from the peer
[feature-specific args] arguments specific to a DCB feature

Feature-specific arguments for dcb:
On/off enable or disable for the interface. The go and gp commands are not needed for the dcb feature. Also, the enable, advertise and willing parameters are not required.

Feature-specific arguments for pg:
pgid:xxxxxxxx Priority Group ID for the 8 priorities. From left to right (priorities 0-7), x is the corresponding Priority Group ID value, which can be 0-7 for Priority Groups with bandwidth allocations or f (Priority Group ID 15) for the unrestricted Priority Group.
pgpct:x,x,x,x,x,x,x Priority Group percentage of link bandwidth. From left to right (Priority Groups 0-7), x is the percentage of link bandwidth allocated to the corresponding Priority Group. The total bandwidth must equal 100%.
uppct:x,x,x,x,x,x,x Priority percentage of Priority Group bandwidth. From left to right (priorities 0-7), x is the percentage of Priority Group bandwidth allocated to the corresponding priority. The sum of percentages for priorities which belong to the same Priority Group must total 100% (except for Priority Group 15).
strict:xxxxxxxx Strict priority setting. From left to right (priorities 0-7), x is 0 or 1. 1 indicates that the priority may utilize all of the bandwidth allocated to its Priority Group.
up2tc:xxxxxxxx Priority to traffic class mapping. From left to right (priorities 0-7), x is the traffic class (0-7) to which the priority is mapped.

Feature-specific arguments for pfc:
pfcup:xxxxxxxx Enable/disable priority flow control. From left to right (priorities 0-7), x is 0 or 1. 1 indicates that the corresponding priority is configured to transmit priority pause.

Feature-specific arguments for app:< subtype>:
xx is a hexadecimal value representing an 8 bit bitmap where bits set to 1 indicate the priority which frames for the applications specified by subtype should use.
appcfg:xx The lowest order bit maps to priority 0.

Feature-specific arguments for ll:<subtype>:
status:[0|1] For testing purposes, the logical link status may be set to 0 or 1. This setting is not persisted in the configuration file.

Examples
Enable DCB on interface eth2
dcbtool sc eth2 dcb on
Assign priorities 0-3 to Priority Group 0, priorities 4-6 to Priority Group 1 and priority 7 to the unrestricted priority. Also, allocate 25% of link bandwidth to Priority Group 0 and 75% to group 1.
dcbtool sc eth2 pg pgid:0000111f pgpct:25,75,0,0,0,0,0,0
Enable transmit of Priority Flow Control for priority 3 and assign FCoE to priority 3.
dcbtool sc eth2 pfc pfcup:00001000
dcbtool sc eth2 app:0 appcfg:08

FAQ
How did Intel verify their DCB solution?

Answer - The Intel solution is continually evolving as the relevant standards become solidified and more vendors introduce DCB-capable systems. That said, we initially used test automation to verify the DCB state machine. As the state machine became more robust and we had DCB-capable hardware, we began to test back to back with our adapters. Finally, we introduced DCB-capable switches in our test bed.

Known Issues

Prior to kernel 2.6.26, tso will be disabled when the driver is put into DCB mode.

A TX unit hang may be observed when link strict priority is set when a large amount of traffic is transmitted on the link strict priority.

License

lldpad and dcbtool - DCB daemon and command line utility DCB configuration
Copyright(c) 2007-2011 Intel Corporation.

Portions of lldpad and dcbtool (basically program framework) are based on:

    hostapd-0.5.7
    Copyright (c) 2004-2007, Jouni Malinen <j@w1.fi>

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Support

Contact Information:
open-lldp Mailing List lldp-devel@open-lldp.org

Last modified on 8/24/11 10:46a 5/05/05 8:51a
Known Issues

Intel® Ethernet FCoE Windows Issues

- **Windows® Server* 2008 with Hyper-V - storage miniport driver does not load when an adapter is added or removed as a VNIC**
  
  In Windows Server 2008 with Hyper-V, the storage miniport driver may not automatically load after adding or removing a DCB/FCoE adapter as a shared external virtual device. To load the storage miniport driver, reset the adapter.

- **When installing FCoE after installing ANS and creating AFT Team, Storports are not installed**
  
  If the user installs ANS and creates an AFT team and then installs FCoE/DCB, the result is that DCB is off by default. If the user then enables DCB on one port, the OS detects Storports and the user must manually click on the new hardware wizard prompts for each of them to install. If the user does not do that, DCB status is non-operational and the reason given is no peer.

- **Link Aggregation teams are not supported with existing FCoE Switches**

- **Intel® PROSet for Windows Device Manager (DMiX) is not synched with FCoE CTRL-D Utility**
  
  When the user disables FCoE via the Control-D menu, the Intel PROSet for Windows Device Manager User Interface states that the flash contains an FCoE image, but that the flash needs to be updated. Updating the flash with the FCoE image again, re-enables FCoE and returns the user to the state where all the FCoE settings are available.

  If the user uses the control-D menu to disable FCoE, then they should use the control-D menu to enable it because Intel PROSet for Windows Device Manager does not support enabling or disabling FCoE.

- **82599 and X540-based adapters don't display as SPC-3 compliant in Windows MPIO configuration**
  
  Because the FCoE initiator is a virtualized device it does not have its own unique hardware ID and thus is not displayed as a SPC-3 compliant device in Windows MPIO configuration.

- **When removing ALB teaming, all FCOE functions fail, all DMIX tabs are grayed out, and both adapter ports fail**
  
  For ANS teaming to work with Microsoft Network Load Balancer (NLB) in unicast mode, the team's LAA must be set to cluster node IP. For ALB mode, Receive Load Balancing must be disabled. For further configuration details, refer to http://support.microsoft.com/?id=278431

  ANS teaming will work when NLB is in multicast mode, as well. For proper configuration of the adapter in this mode, refer to http://technet.microsoft.com/en-ca/library/cc726473(WS.10).aspx

- **FCoE and TCP/IP traffic on the same VLAN may not work on some switches**
  
  This is a known switch design and configuration issue.

- **Intel® Ethernet Virtual Storage Miniport Driver for FCoE disappears from Device Manager after Virtual Network removal**
  
  The user may experience disappearance of the Intel® Ethernet Virtual Storage Miniport Driver for FCoE when the corresponding Intel adapter is virtualized to create a new Virtual Network, delete an existing Virtual Network, or modify an existing virtual network.

  As a workaround, the user should remove all the resource dependency of the Intel® Ethernet Virtual Storage Miniport Driver for FCoE that are currently being used by the system before making any changes to the Intel adapter for virtualization. For example, in one use case scenario, the user may have assigned the FCoE disk(s) from the FCoE storage driver to run one of its Virtual Machines, and at the same time the user wants to alter the configuration of the same Intel adapter for virtualization. In this scenario the user must remove the FCoE disks(s) from the Virtual Machine before altering the Intel adapter configuration.

Intel® Ethernet FCoE Boot Issues

Option ROM Known Issues

- **Discovery problems with multiple FCoE VLANs**
The FCoE Option ROM may not discover the desired VLAN when performing VLAN discovery from the Discover Targets function. If the Discover VLAN box is populated with the wrong VLAN, then enter the desired VLAN before executing Discover Targets.

**Windows Known Issues**

- **Brocade switch support in Release 16.4**
  
  Intel® Ethernet FCoE Boot does not support Brocade switches in Release 16.4. If necessary, please use Release 16.2.

- **Windows uses a paging file on the local disk**
  
  After imaging, if the local disk is not removed before booting from the FCoE disk then Windows may use the paging file from the local disk.

- **Crash dump to FCoE disks is only supported to the FCoE Boot LUN**
  
  The following scenarios are not supported:
  - Crash dump to an FCoE disk if the Windows directory is not on the FCoE Boot LUN.
  - Use of the DedicatedDumpFile registry value to direct crash dump to another FCoE LUN.

- **Stopping the InteIDCB service may cause the OS to hang or crash**

  When the FCoE Option ROM connects to an FCoE disk during boot, the Windows installer may be unable to determine if the system was booted from FCoE or not and will block the FCoE uninstall. To uninstall, configure the Option ROM so that it does not connect to an FCoE disk.

- **Unable to create VLAN interfaces with Intel® Ethernet FCoE Boot enabled**
  
  When booted with FCoE, a user cannot create VLANS and/or Teams for other traffic types. This prevents converged functionality for non-FCoE traffic.

- **Server adapter configured for FCoE Boot available as External-Shared vnic via Hyper-V**

  If a port is set as a boot port, when the user installs the Hyper V role in the system and then goes into the Hyper V Network Manager to select which port to externally virtualize, the boot port displays, which it should not.

  When setting the port to a boot port in Intel PROSet for Windows Device Manager (DMIX), a message shows that the user should restart the system for the changes to be effective but does not force a restart. As a result the user level applications are in boot mode (i.e., Data Center Tab is grayed out) but kernel level drivers haven’t been restarted to indicate to the OS that the port is a boot port. When the user then adds the Hyper V service to the system, the OS takes a snapshot of the ports available and this is the snapshot that it uses after the Hyper V role is added, system restarted and the user goes into the Hyper V Virtual Network Manager to virtualize the ports. As a result, the boot port also shows up.

  **Solutions:**

  Restart the system after setting a port to a boot port and before adding the Hyper V role. The port does not appear in the list of virtualizable ports in the Hyper V Virtual network manager.

  Disable/enable the port in Device Manager after setting it to boot and before adding the Hyper V role. The port does not appear in the list of virtualizable ports in the Hyper V Virtual network manager.

- **FCoE Linkdown Timeout fails prematurely when Remote Booted**

  If an FCoE-booted port loses link for longer than the time specified in the **Linkdown Timeout** advanced setting in the Intel® Ethernet Virtual Storage Miniport Driver for FCoE, the system will crash. **Linkdown Timeout** values greater than 30 seconds may not provide extra time before a system crash.
Glossary
This glossary defines terms, abbreviations, and acronyms that apply directly to Intel® Ethernet FCoE.

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<th>DEFINITIONS</th>
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<tbody>
<tr>
<td>ARP</td>
<td>Address Resolution Protocol</td>
</tr>
<tr>
<td>Boot Targets</td>
<td>The server-side system in an FCoE SAN configuration. The FCoE Boot Target system hosts the FCoE target drives which are accessed by an FCoE Boot initiator.</td>
</tr>
<tr>
<td>CEE</td>
<td>Converged Enhanced Ethernet</td>
</tr>
<tr>
<td>Data Link Interface</td>
<td>Interface to the chip at the MAC layer.</td>
</tr>
<tr>
<td>DCB</td>
<td>Data Center Bridging</td>
</tr>
<tr>
<td>DCBX</td>
<td>DCB Exchange Protocol</td>
</tr>
<tr>
<td>DDP</td>
<td>Direct Data Placement</td>
</tr>
<tr>
<td>Descriptor Queues</td>
<td>Descriptor queues are used by software to submit work requests like send and receive and get completion status.</td>
</tr>
<tr>
<td>DLL</td>
<td>Dynamic Linked Libraries</td>
</tr>
<tr>
<td>DPT</td>
<td>Diamond Peak Technology</td>
</tr>
<tr>
<td>ETS</td>
<td>Enhanced Transmission Selection</td>
</tr>
<tr>
<td>FC</td>
<td>Fibre Channel</td>
</tr>
<tr>
<td>FCF</td>
<td>Fibre Channel Forwarder</td>
</tr>
<tr>
<td>FCoE</td>
<td>Fibre Channel over Ethernet</td>
</tr>
<tr>
<td>HBA</td>
<td>Host Bus Adapter</td>
</tr>
<tr>
<td>IPC</td>
<td>Inter Process Communication</td>
</tr>
<tr>
<td>IRP</td>
<td>IO Request Packet</td>
</tr>
<tr>
<td>iSCSI</td>
<td>Internet SCSI</td>
</tr>
<tr>
<td>LLDP</td>
<td>Link Layer Discovery Protocol, IEEE802.1AB</td>
</tr>
<tr>
<td>LUN</td>
<td>Logical Unit Number (LUN) is the identifier of a device which is being addressed by protocols such as Fibre Channel and iSCSI.</td>
</tr>
<tr>
<td>MPA</td>
<td>Marker Based PDU Alignment. This protocol runs on top of TCP and provides framing and data integrity.</td>
</tr>
<tr>
<td>Native OS Stack</td>
<td>OS stack that represents a particular function implemented purely in software (e.g., native OS TCP/IP stack, native OS iSCSI stack).</td>
</tr>
<tr>
<td>Native TCP/IP Stack</td>
<td>TCP/IP stack implemented in software and provided as part of the operating system.</td>
</tr>
<tr>
<td>NFS</td>
<td>Network File System</td>
</tr>
<tr>
<td>NIC</td>
<td>Network Interface Controller</td>
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<tr>
<td>ODM</td>
<td>Offload Device Manager</td>
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<tr>
<td>Offload Stack</td>
<td>Components that make up the offload stack</td>
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<tr>
<td>OPS</td>
<td>Offload Protocol Switch</td>
</tr>
<tr>
<td>Packet Buffers</td>
<td>Packet buffers are hardware FIFOs that either receive or transmit packets. Each packet buffer can be associated with one or more traffic classes</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
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<tr>
<td>PCI</td>
<td>Peripheral Components Interface</td>
</tr>
<tr>
<td>PDU</td>
<td>Protocol Data Unit</td>
</tr>
<tr>
<td>PFC</td>
<td>Priority Flow Control</td>
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<tr>
<td>Raw Packet Driver</td>
<td>Standard Ethernet MAC driver.</td>
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<tr>
<td>RDMA</td>
<td>Remote Direct Memory Access</td>
</tr>
<tr>
<td>RDMAC</td>
<td>RDMA Consortium</td>
</tr>
<tr>
<td>RSS</td>
<td>Receive Side Scaling is a mechanism for hardware to distribute receive packets to queues that are associated with a specific processor core and thereby distributing the processing load.</td>
</tr>
<tr>
<td>RX</td>
<td>Receive</td>
</tr>
<tr>
<td>SAN</td>
<td>Storage Area Network</td>
</tr>
<tr>
<td>SCSI</td>
<td>Small Computer System Interface</td>
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<tr>
<td>SNMP</td>
<td>Simple Network Management Protocol</td>
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<td>TLV</td>
<td>Type Length Value</td>
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<td>Transport Interface</td>
<td>Interface to the chip at the transport layer.</td>
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<td>TX</td>
<td>Transmit</td>
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<tr>
<td>ULP</td>
<td>Upper Layer Protocol</td>
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<tr>
<td>VBD</td>
<td>Virtual Bus Driver. Driver that exposes two virtual physical Devices on a single physical device and enables sharing of LAN and SAN traffic on a common Ethernet port.</td>
</tr>
<tr>
<td>VFT</td>
<td>Virtual Fabric Tagging is a Fibre Channel defined extended frame header.</td>
</tr>
<tr>
<td>VMDq</td>
<td>Virtual Machine Device Queues</td>
</tr>
<tr>
<td>VLAN</td>
<td>Virtual LAN (VLAN) is a group of hosts with a common set of requirements that communicate as if they were attached to the same broadcast domain, regardless of their physical location.</td>
</tr>
<tr>
<td>VT</td>
<td>Vanderpool Technology, also known as Virtualization. VT is an Intel-wide effort to support multiple virtual platforms on a single physical platform. This requires both software and hardware support to implement efficiently.</td>
</tr>
</tbody>
</table>
Limited Lifetime Hardware Warranty

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Web and Internet Sites

Support: [http://www.intel.com/support](http://www.intel.com/support)


To learn more about Intel® Ethernet, visit: [http://communities.intel.com/community/wired](http://communities.intel.com/community/wired)

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Intel® Ethernet FCoE Boot Installation - Detailed Instructions

Requirements

Detailed Instructions for Installing Windows Server with Local Disk

Appendix 1
Appendix 2
Appendix 3

Requirements:

Microsoft ImageX

Microsoft WinPE v2.1 or later

Detailed Instructions for Installing Windows Server with Local Disk

The following steps describe one method to install Intel® Ethernet FCoE Boot for Windows. Other methods, using different tools, may also work.

**NOTE:** Please be sure to read the Appendix information when directed; they contain important details.

Prepare for partition imaging

1. On the test server set up the local disk drives. These instructions will cover imaging with a partition imaging tool, so at a minimum a second partition will be needed to store the captured image. If the entire Windows disk will be captured, then a second local disk will be required.

Prepare the Adapter for FCoE Booting

**NOTE:** If the FCoE Option ROM doesn’t find the FCoE LUN, perform steps 2-4. Otherwise, skip to step 5.

2. Flash adapter with FCoE Option ROM.
   a. Intel® Ethernet drivers CD: \Apps\BootUtil\DOS\Bootutil /?

3. Configure the Option ROM to boot from an FCoE LUN:
   a. Input Ctrl+D during boot message.
   b. Select the boot port.
   c. Select Discover Targets.
   d. Choose a target, enter its LUN and set its boot order to 1.

**NOTE:** Once Intel® Ethernet FCoE drivers are installed, in order to uninstall them the Option ROM must not be allowed to connect to an FCoE LUN. Either disable the boot port in the Option ROM or set all boot orders to 0.

4. During POST ensure that the FCoE Option ROM loads and finds the LUN.

5. Ensure local disk is set as first boot option in system BIOS boot menu.

Install the OS and drivers

6. Install Windows Server on the first local drive.
7. Boot to the OS on the local disk. Install Intel® Ethernet drivers via CD, selecting **FCoE Using Data Center Bridging**. Windows 2008 may ask to install an update and request a reboot. Click **OK** and reboot at the prompt. After rebooting, re-run Intel® Ethernet driver FCoE/DCB installation.
8. Using Disk Management, verify that FCoE LUNs are mounted.
9. Reboot.
Prepare Windows for imaging

10. As administrator: Open a command window. Navigate to Intel® Ethernet drivers CD “APPS\FCOEBOOT\Win32” or “APPS\FCOEBOOT\Winx64” depending on installed OS. Run fcoeprep.bat and verify no error messages.

The following steps capture the image that was created on drive C: to the secondary partition.

11. Reboot and ensure the server boots to a copy of WinPE. See Appendix 1 for WinPE information.

   \NOTE: This step is performed right after running fcoeprep. If the server boots back into Windows, fcoeprep must be run again. This is because Windows resets the settings every time it boots.

12. From the WinPE command line, capture the local Windows installation with ImageX. See Appendix 2 for ImageX information. Assuming WinPE mounts the Windows disk as C: and the secondary partition or disk as D:, use the following command line:

   `imagex /capture /check /compress fast c: d:\fcoeboot.wim "FCoE Boot Image"`

13. For Windows Server 2008 R2 only. Windows 2008 R2 may be installed onto two partitions: the normal Windows partition and a smaller partition called System Reserved. System Reserved contains files necessary to boot Windows. Assuming WinPE mounts the System Reserved partition as C: and the secondary partition as D:, use the following command line to capture the System Reserved partition:

   `imagex /capture /check /compress fast c: d:\fcoesr.wim "FCoE Boot System Reserved"

   Note that in this case WinPE should mount the System Reserved partition as C:, and the Windows partition may be mounted as D or E.


The following steps write the image to the FCoE LUN.

15. Open Disk Management and verify that the boot LUN on the FCoE Target is online. Note the drive letter assigned to the FCoE LUN.

16. Open a command prompt. Use DiskPart to create the necessary partition(s) on the FCoE LUN. If a System Reserved partition was captured, then one should be created on the FCoE LUN. See Appendix 3 for DiskPart information.

17. Assuming the image was saved to drive D: and the FCoE LUN was mounted as drive E:, use the following command line:

   `imagex /apply d:\fcoeboot.wim 1 e:\`

18. For Windows Server 2008 R2 only: If the System Reserved partition was captured above, it should be applied. In this case, you may need to use Disk Management to assign a drive letter to this partition on the FCoE LUN. Assuming the FCoE LUN’s System Reserved partition is mounted as drive F:, use the following command line:

   `imagex /apply d:\fcoesr.wim 1 f:\`

19. For Windows 2008 R2 only: Run bcdboot.exe from the local Windows installation to make the FCoE disk bootable.

   a. Open Disk Management
   b. If a System Reserved partition exists on the FCoE LUN, type: `bcdboot F:\Windows /s E:`, where E: is the FCoE System Reserved partition and F: is the FCoE partition with the Windows directory.
   c. If a System Reserved partition does not exist, type: `bcdboot E:\Windows /s E:`, where E: is the FCoE partition with the Windows directory.

Boot the system from the FCoE LUN

20. Shutdown the system.

21. Use the BIOS settings to configure the server to boot from the FCoE LUN.

   \NOTE: If the server still boots from the local drive, then remove the local drives.

22. Boot to the OS on the FCoE LUN.

Appendix 1: WinPE

WinPE is used to run ImageX to capture the local Windows partitions. WinPE versions 2.1 or later is required.

The simplest way to boot WinPE is with a Windows Server 2008 or 2008 R2 install DVD. A bootable WinPE USB flash drive may
also be created and used.

**For install DVD installation only:** After booting, proceed to perform a “Custom” installation. When Windows setup displays the drive selection screen, input SHIFT-F10 to open a command prompt.

**Important:** At the command prompt, cycle through the drive letters and use the dir command to identify which disk partitions are mounted with which driver letters. WinPE may use different drive letters than Windows, so no assumptions can be made.

Once the partitions are identified, ImageX can be used to capture the image.

### Appendix 2: ImageX

ImageX is available as part of the Microsoft Windows Automated Install Kit (WAIK). Download and install the kit, then locate ImageX and copy it so it may be accessed from WinPE and the local Windows. Microsoft TechNet contains a section covering ImageX.

### Appendix 3: DiskPart

If a partition image tool is used to copy Windows to the FCoE LUN, then **DiskPart** must be used to create partitions on the FCoE LUN. There are two sets of instructions below. The first covers creating one partition, while the second covers the case where a System Reserved partition is captured in addition to the Windows partition.

To identify the FCoE LUN disk number within DiskPart, use the LIST DISK command. Alternatively, Disk Management also shows the disk numbers.

**Windows Server 2008 and Windows Server 2008 R2 with no System Reserved partition**

The following sequence of commands in **DiskPart** will create a Windows partition on an FCoE LUN, suitable for imaging Windows Server 2008 and Windows Server 2008 R2 when no System Reserved partition is used (assumes FCoE LUN is disk 1, and only C: and D: are already used by Windows):

1. SELECT DISK 1
2. CLEAN
   
   ![NOTE: This will destroy everything on the disk, so be sure the correct disk is selected!]

3. CREATE PARTITION PRIMARY
   
   ![NOTE: Add SIZE=nnn to the end of the line to create a partition of size nnn in MB.]

4. SELECT PARTITION 1
5. ACTIVE
6. FORMAT FS=NTFS QUICK
7. ASSIGN LETTER=E
8. EXIT

**Windows Server 2008 R2 with a System Reserved partition**

The following sequence of commands in **DiskPart** will create a System Reserved and Windows partition on an FCoE LUN, suitable for imaging Windows 2008 R2 (assumes FCoE LUN is disk 1, and only C: and D: are already used by Windows):

1. SELECT DISK 1
2. CLEAN
   
   ![NOTE: This will destroy everything on the disk, so be sure the correct disk is selected!]

3. CREATE PARTITION PRIMARY SIZE=100
4. SELECT PARTITION 1
5. ACTIVE
6. FORMAT FS=NTFS QUICK
7. ASSIGN LETTER=E
8. CREATE PARTITION PRIMARY
NOTE: Add SIZE=nmm to the end of the line to create a partition of size nmm in MB.

9. SELECT PARTITION 2
10. FORMAT FS=NTFS QUICK
11. ASSIGN LETTER=F
12. EXIT