PowerEdge FX2 – FN I/O Module – VLT Deployment Guide

Configuring, testing and validating VLT on a pair of FN410S I/O Modules in a PowerEdge FX2 chassis (v2.0)
A Dell Deployment Guide

Dell Networking Solutions Engineering
September 2015

A Dell Deployment and Configuration Guide

Revisions

Date	Description	Authors
September 2015	V2.0 Added DNOS version 9.9 configuration information. Added FN IOM modes section	Neal Beard, Jim Slaughter, Mike Matthews, Kevin Locklear
July 2015	V1.2 Added additional SMUX configuration. Removed redundant sections.	Kevin Locklear, Curtis Bunch, Mike Matthews
May 2015	v1.1 Fixed Paragraph	Kevin Locklear
December 2014	Initial Document Release	Kevin Locklear, Curtis Bunch, Mike Matthews, Lindsay Coyle

Table of contents

Revisions 2

1 Introduction 5

2 The Dell FX2 and FN I/O Modules 7

2.1 FN I/O Modules Description 9

2.2 Networking Block FN Series Operational Modes 10

3 Initial "Out of Box" Connectivity Check and Default Settings 12

4 VLT and the Example Environments 13

4.1 The Benefits of VLT (Virtual Link Trunking) 14

4.2 Typographical Conventions and Common Abbreviations 16

5 FN IOM Dell Blade I/O Manager and Internal Port Mapping Features 16

5.1 FN IOM Dell Blade I/O Manager GUI 16

5.2 FN IOM Internal Port Mapping -- Detailed Overview 19

6 Environment One: Basic VLT Deployment with VLT Mode 23

6.1 Environment One: VLT Mode Configuration 24

6.2 Testing VLT Functionality 30

7 Environment Two: Dell Networking Switches with mVLT and IOM in Full Switch Mode 33

7.1 Environment Two: IOM Full Switch Mode Configuration 34

7.1.1 Configuring the IOM for Full Switch Mode 35

7.1.2 Configuring the VLTi Peer Link 36

7.2 Environment Two: Configuring the Dell Networking S4810 40

7.3 Verifying VLT Connectivity 43

8 Environment Three: Dell Networking Switches with mVLT and FN IOM in Programmable MUX Mode. 52

8.1 Environment Three: FN IOM Configuration 53

8.1.1 Configuring the FN IOM for Programmable MUX Mode 54

8.1.2 Configuring VLT on the FN IOM 55

8.2 Environment Three: Configuring the Dell Networking S4810 59

8.3 Environment Three: Verifying VLT Connectivity 62

9 Environment Four: VLT Interoperability with Cisco vPC 71

9.1 Environment Four: FN IOM Configuration 72

9.1.1 Configuring the FN IOM for Programmable MUX Mode 72

9.1.2 Configuring VLT on the FN IOM 73

9.2 Environment Four: Cisco Nexus 5000 Series vPC Configuration 77
9.3 Environment Four: Verify VLT Connectivity 85
9.4 Environment Four: Verify VPC Connectivity 86
A References 92
B Components 92
C Terminology 93
D Reset FN IOM to Default Factory Configuration 95
E FN IOM Initial Out of Box Configuration and Default Settings 101
E.1 Configure Interfaces and the Port Channel on the Upstream Switch 102
E.2 Verify the Configuration 106
F Support and Feedback 108

1 Introduction

Dell Networking provides customers with the most efficient use of current networking equipment at the lowest cost, while still providing today's great new technologies focused around the explosive data growth in the industry. The various application demands have driven the need for increased bandwidth, lower latency and converged infrastructure in today's networks. Dell's portfolio covers all these key areas to provide the best in service and customer experience.

Today's businesses find it difficult to keep pace with the changing networking and enterprise landscape. With limited resources, they must support a variety of devices that provide key business functions, deliver IT services that are reliable and flexible, and provide discernible cost savings.

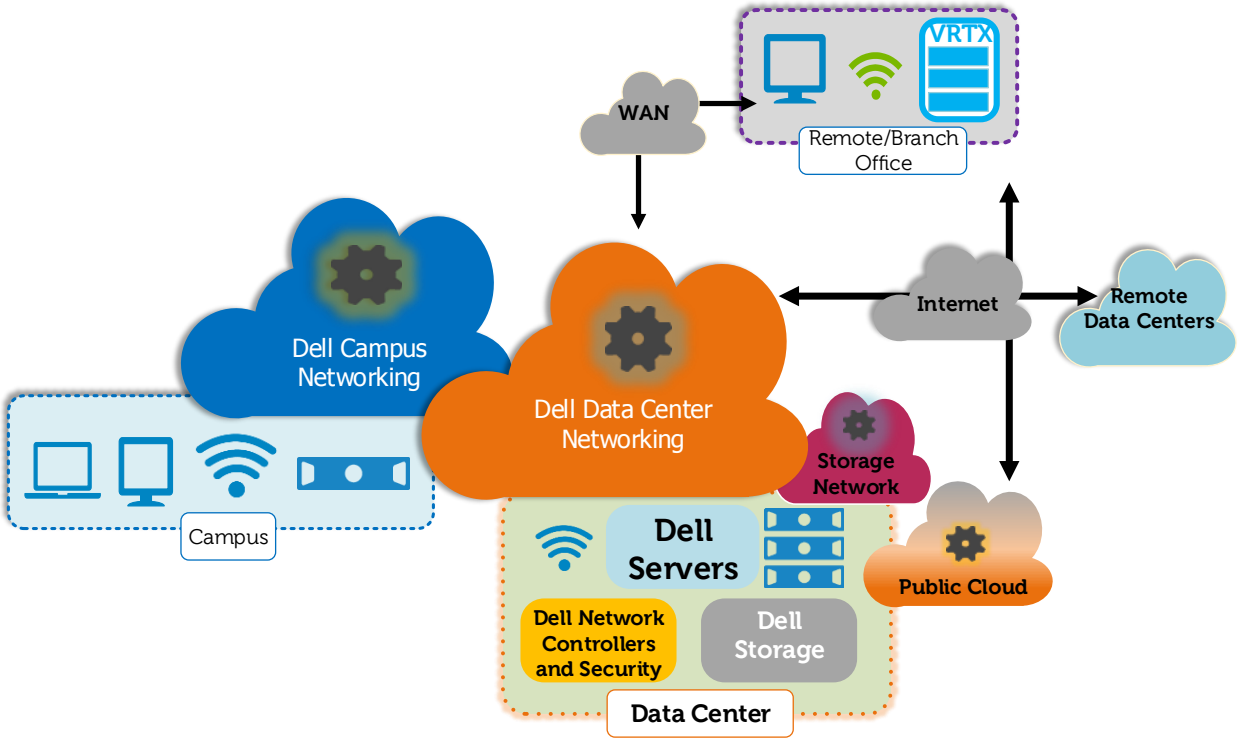


Figure 1 Networking Architecture Overview

The Dell PowerEdge FX architecture is a revolutionary approach to shared infrastructure for Enterprise Computing. It combines the density and innovative agility of hyper-scale computing with the ease of use and efficiency of advanced management technologies. The FX2 provides a straightforward, modular approach to infrastructure, and introduces a more practical way to manage the complex IT needs of businesses.

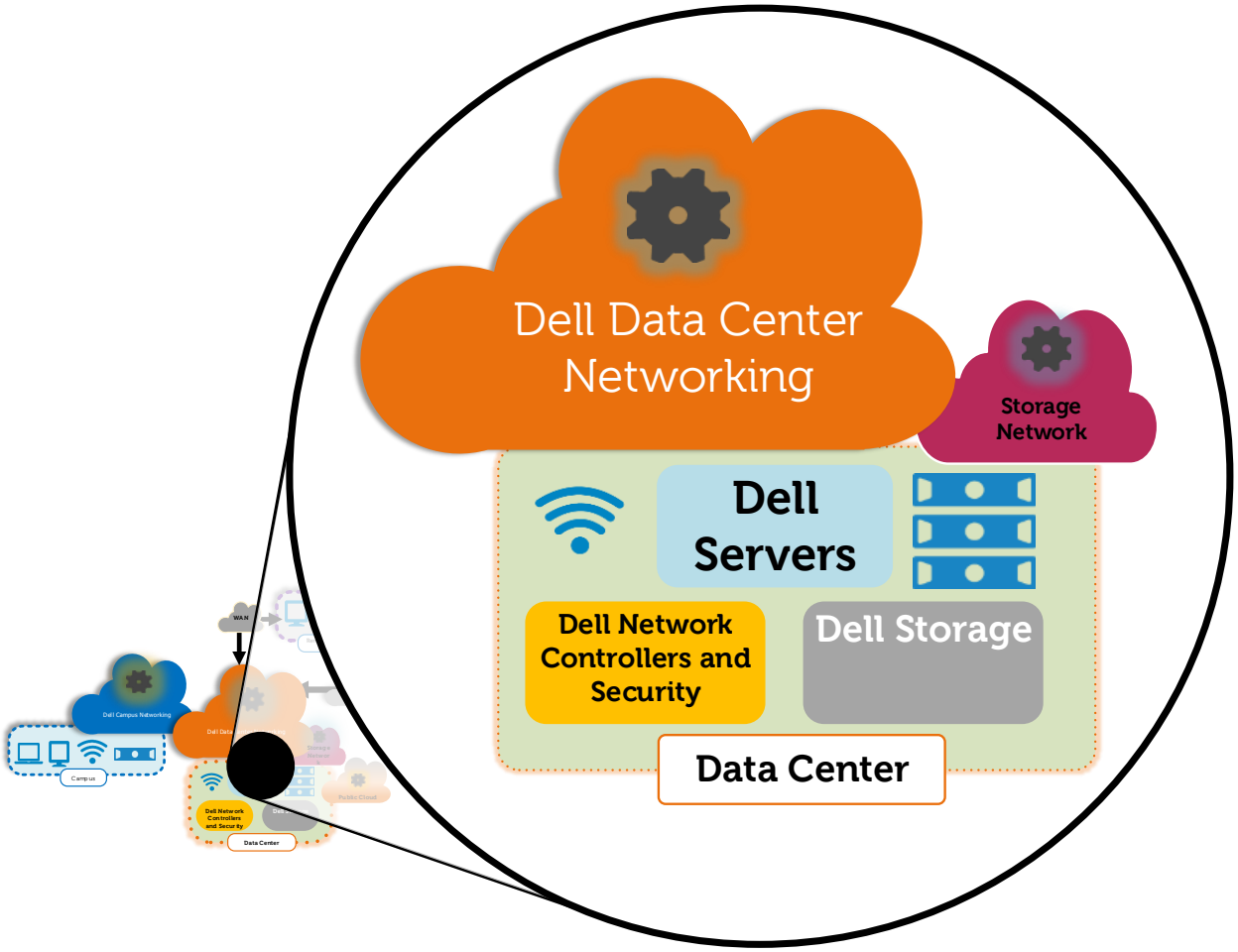


Figure 2 Zooming in to Focus on the Data Center and Storage Networking

This deployment guide will provide a step-by-step configuration in the data center utilizing the FN I/O Module, the PowerEdge FN410S. In this deployment guide, the two FN410S's installed in the rear of the FX2 chassis are configured as a VLT pair of switches. This provides the functionality for the pair of switches to perform as one logical switch

What is VLT (Virtual Link Trunk)?

VLT allows physical links between two switching devices to appear as a single virtual link to other networking devices. VLT reduces the role of spanning tree protocols (STPs) by allowing link aggregation group (LAG) terminations on two separate distribution or core switches, and by supporting a loop-free topology. VLT provides Layer 2 multipathing, creating redundancy through increased bandwidth, enabling multiple parallel paths between nodes and load-balancing traffic where alternative paths exist.

2 The Dell FX2 and FN I/O Modules

Introducing the Dell FX Architecture, a great way to bring optimized workloads, maximize efficiency and simplify complexity in today's data center.

Figure 3 Dell PowerEdge FX2

The Dell FX2 enclosure is unique in its modular capabilities that come in a compact 2U size. This innovative design combines the density and efficiency of blade servers with the simplicity and cost benefits of the smaller rack-based server systems.

Figure 4 FX2 Chassis with FN IOM (FN410S)

Figure 5 FX2 Compute and Networking Modules

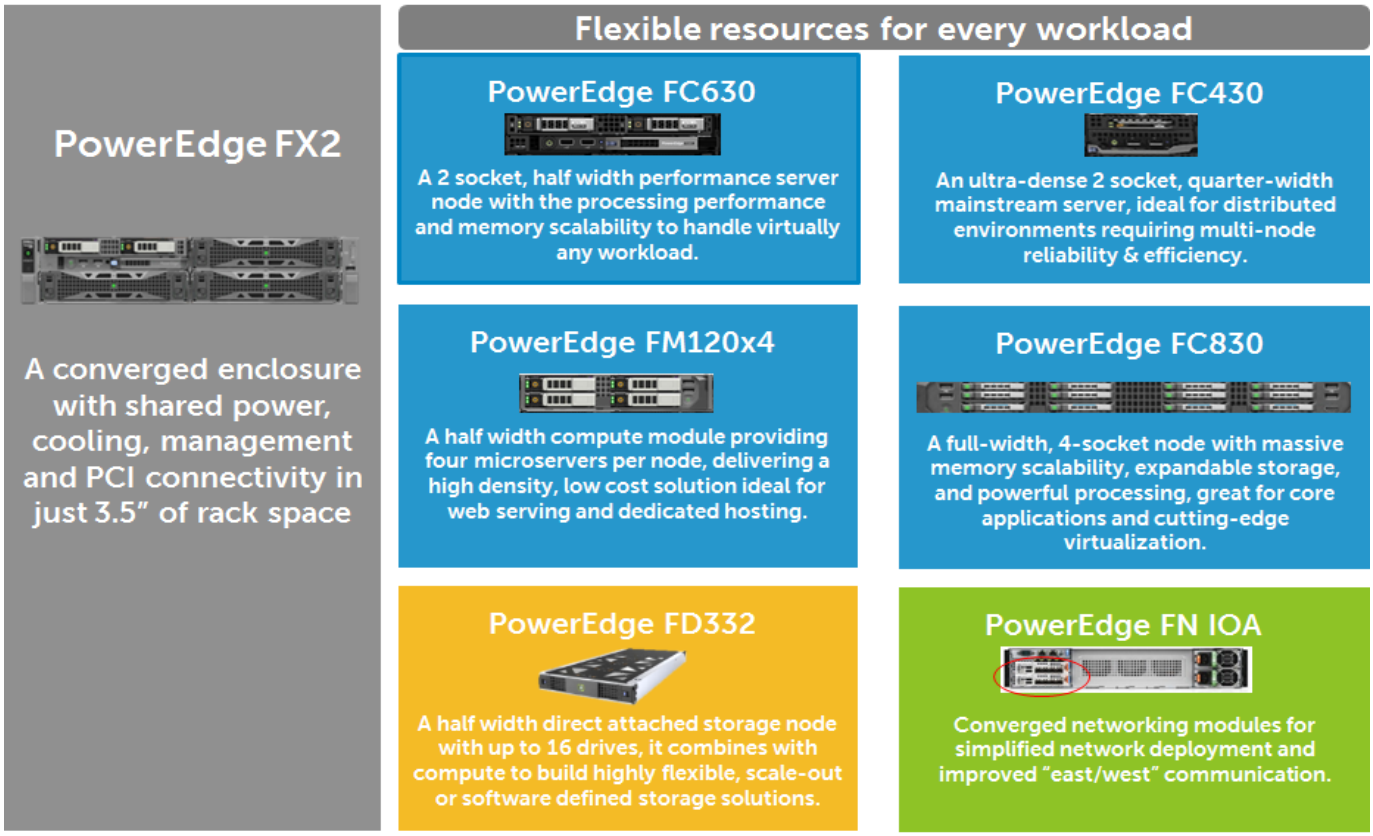
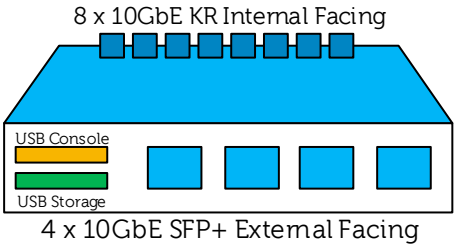


Figure 6 FX2 Module Descriptions

2.1 FN I/O Modules Description

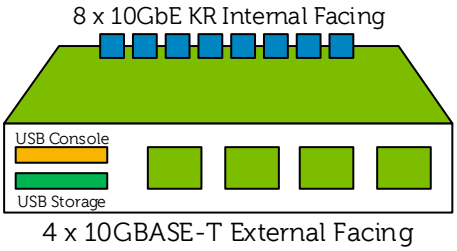
The PowerEdge FX2 is a chassis capable of housing compute, network and storage modules. The network modules, referred to as one of three FN I/O Modules (FN IOMs), behave as traditional network switches that are housed in the rear of the FX2 chassis. All three FN IOMs offer network services for both the Ethernet and storage fabrics in a data center. While the FN410S is used in this deployment guide, Dell offers three options of FN IOMs providing plug-and-play Ethernet as well as LAN/SAN convergence with iSCSI and FCoE. In addition to these features, the third model also offers native Fibre Channel traffic using NPIV Proxy Gateway mode (NPG mode).



FN410S

4-port SFP+ I/O Module

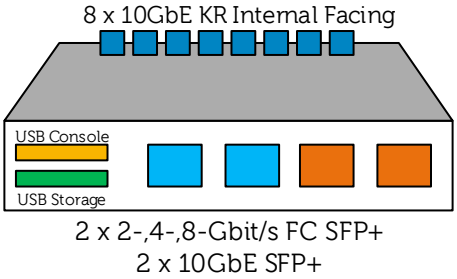
Provides 4 ports of SFP+ 10GbE connectivity. Supports optical and DAC cable media.



FN410T

4-port 10GBASE-T I/O Module

Provides 4 ports of 10GBASE-T connectivity. Supports cost effective copper media up to 100 meters.



FN2210S

4-port Combo FC/Ethernet I/O Module

Delivers up to 2 ports of 2, 4, or 8Gbit/s Fiber Channel in NPG mode. Ethernet is provided by 2 ports of SFP+ 10GbE connectivity. Supports optical and DAC cable media.

2.2 Networking Block FN Series Operational Modes

The FN IOM supports five operational modes: Standalone (SMUX), VLT, Stacking, Programmable MUX (PMUX) and Full-switch. See Table 1 for detailed descriptions of each mode. To enable a new operational mode the command **`stack-unit 0 iom-mode <IOM_Mode>`** is issued in configuration mode. After enabling a new operational mode, the switch must be reloaded.

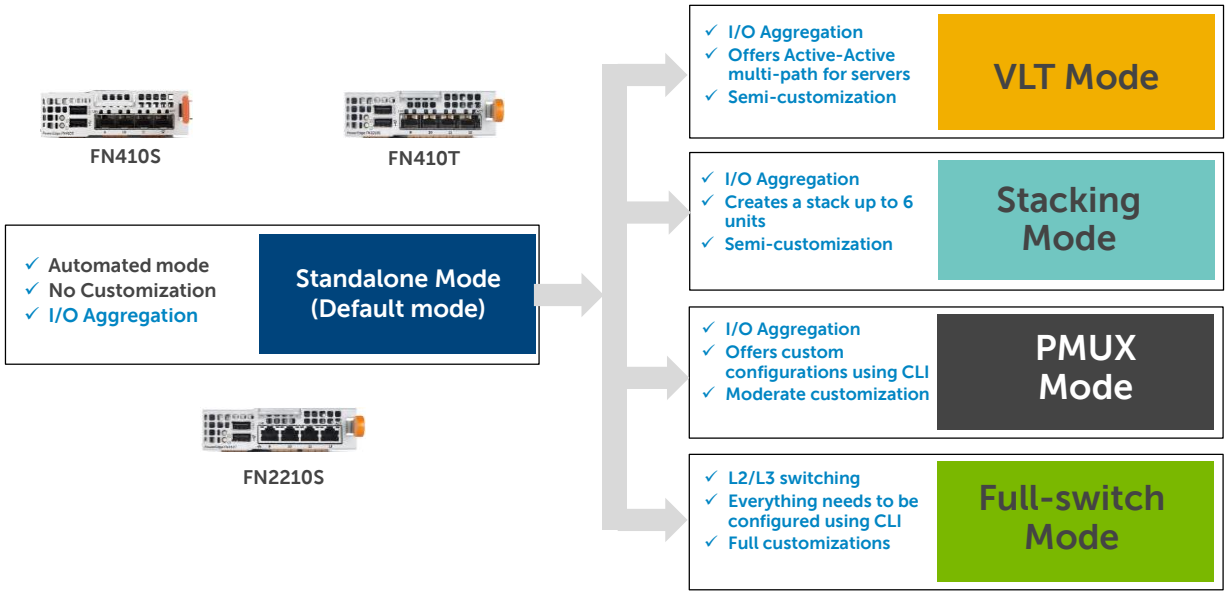


Figure 7 FN Series Operational Modes

Table 1 IOM modes and descriptions

IOM mode	Description
Standalone mode (SMUX)	This is the factory default mode for the IOM. SMUX is a fully automated, zero-touch mode that allows VLAN memberships to be defined on the server-facing ports while all upstream ports are configured in port channel 128 and cannot be modified.
VLT mode	In this low-touch mode, all configurations except VLAN membership are automated. Port 9 is dedicated to the VLT interconnect in this mode.
Programmable MUX mode (PMUX)	PMUX mode provides operational flexibility by allowing the administrator to create multiple LAGs, configure VLANs on uplinks and to configure DCB parameters on the server-facing ports.
Stacking mode	In Stacking mode, multiple switches can be combined to make a single logical switch, which is managed by a designated master unit in the stack. This mode can be useful because it simplifies management and redundant configurations.
Full Switch mode	In Full Switch mode, all switch features are made available. This mode requires the most configuration, but allows for the most flexibility and customization.

3 Initial "Out of Box" Connectivity Check and Default Settings

The environments documented within this guide cover configuring VLT (Virtual Link Trunking) in various topologies; however, many times there will be a need to simply bring up a single networking connection in the data center without VLT. This will be connecting a single link from the FN IOM to the ToR switch without configuration on the FN IOM side to show that basic network connections work.

Out of the box, the FN IOM will come in Standalone mode with the applicable default settings this mode has in place. This applies to FN 410S, FN 410T, and FN 2210S (applicable to ports in Ethernet mode only).

Three easy steps cover this process:

1. Ensure the FN IOM is in Standalone Mode
2. Create an LACP LAG on the upstream top-of-rack (ToR) switch
3. Verify the connection

More detail on these steps can be found in Appendix E.

Note: Default settings on the FN IOM will have the server facing network ports shut down until the uplink port channel is operational to the ToR (top of rack) switch. This is due to a feature called Uplink Failure Detection whereby, when upstream connectivity fails, the FN IOM disables the downstream links. This feature is essential for fail-over between two ports on the same CNA/NIC adapter.

For more information on Uplink Failure Detection and all other configuration settings, see the Dell PowerEdge FN I/O Module Configuration Guide.

4 VLT and the Example Environments

The rest of this guide illustrates configuring two FN410S FN I/O Modules in a PowerEdge FX2 chassis to use the VLT protocol for redundant, load-balanced connections. The initial configuration from the default Standalone mode to VLT, Full Switch and Programmable Mux mode can be performed either via the Dell Blade I/O Manager GUI or via standard CLI. This configuration works with the FN410S, FN410T and FN2210S (applicable to ports in Ethernet mode only).

This document describes four VLT environments in a step-by-step manner:

- Environment 1 - a basic VLT deployment using low-touch mode is presented.
- Environment 2 - an example of multi-Virtual Link Trunking using Full Switch mode configuration.
- Environment 3 - an example of multi-Virtual Link Trunking (mVLT) using Programmable MUX (PMUX) mode configuration.
- Environment 4 - the FN IOMs are incorporated into a Cisco Nexus environment utilizing virtual Port Channel (vPC) to create a fully redundant layer 2 topology.

Note: In order to utilize the new Dell Blade I/O Manager GUI, as well as the new Full Switch mode feature, the FN IOM Switching modules will need to be upgraded to Dell Networking Operating System (DNOS) 9.9 firmware. Please refer to the DNOS release notes included with the 9.9 firmware for the FN IOM upgrade procedure.

4.1 The Benefits of VLT (Virtual Link Trunking)

In a non-VLT environment (Figure 8), utilizing the spanning tree protocol, redundancy involves idle equipment and increased costs with no added value in the event of a device failure. On the other hand, in a VLT environment (Figure 9), all paths are active, utilizing all available links and switches to their fullest potential. This doubles the throughput, thus increasing performance and adding immediate value.

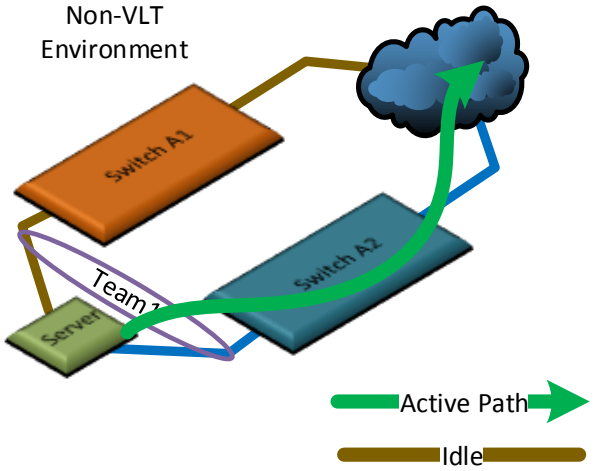


Figure 8 Non-VLT Environment with Active/Passive (Standby)

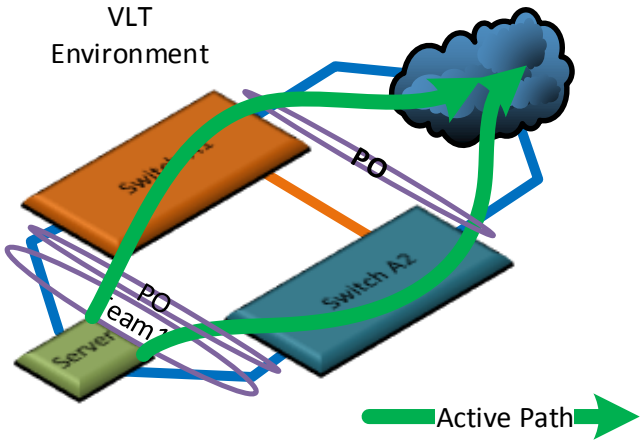


Figure 9 VLT Active-Active Environment

VLT also takes advantage of teamed Network Interface Cards (NICs) and switch pairs, causing them to appear as a single switch to devices outside the VLT domain. The physical versus logical connectivity, using a pair of FN IOMs in a PowerEdge FX2 chassis, is illustrated below in Figure 10 and Figure 11.

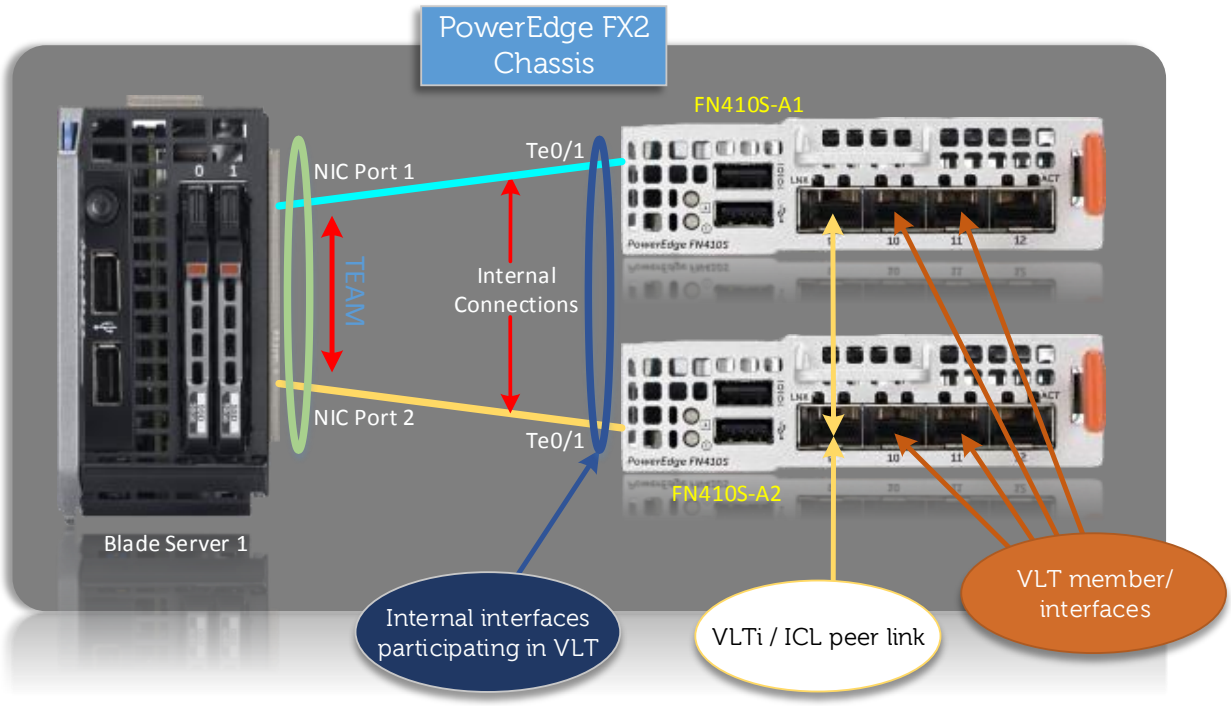


Figure 10 Physical Connectivity in a PowerEdge FX2 Chassis Using IOMs

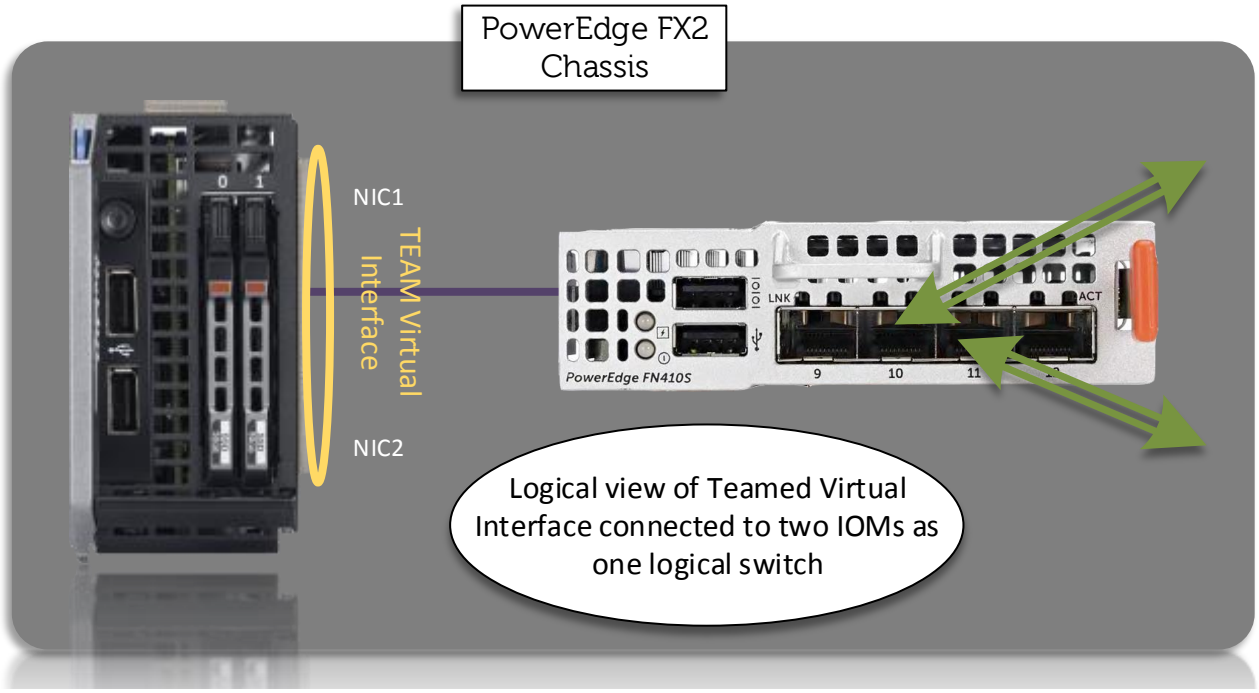


Figure 11 Logical Connectivity in a PowerEdge FX2 Chassis Using IOMs

4.2 Typographical Conventions and Common Abbreviations

The following conventions are used in the command line examples in this document:

`Monospace Text`	CLI (Command Line Interface) examples
`Italic Monospace Text`	Variables in CLI examples
`Bold monospace Text`	Commands entered at the CLI prompt

5 FN IOM Dell Blade I/O Manager and Internal Port Mapping Features

5.1 FN IOM Dell Blade I/O Manager GUI

In previous versions of the Dell Networking Operation System (DNOS) 9.x, the FN410S, FN410T and FN2210S FX2 switching modules were only configurable via CLI. Now, with DNOS 9.9 these FX2 switching modules can be configured for most common deployments with an easy to use GUI application. The new "Dell Blade I/O Manager" GUI application allows IT administrators to configure features such as:

- Configuring modes, combo ports, account credentials, SNMP parameters, uplink failure detection and NTP through the Initial Setup Wizard
- Viewing logs and alerts and configuring settings for viewing logs and alerts
- Viewing port settings and configuring port settings, uplink ports, uplink failure detection, and combo port settings
- Assigning VLANs, Configuring LAGs, IGMP, Port Mirroring, Fibre Channel, iSCSI, and DCB
- Configuring TACACS+, RADIUS, AAA
- Configuring FN IOM users and passwords
- Configuring Broadcast Storm Control
- Configuring Auto LAG
- Configuring the default VLAN
- Configuring NTP servers
- Rebooting the FN IOM

The features listed above allow IT administrators to quickly deploy the FX2 FN IOMs in most data center environments. The Dell Blade I/O Manager is typically launched from the **FX2 CMC** > **I/O Module Overview section**, but it can also be launched by typing the management IP address of the FN IOM into a browser with a port number of 8081, i.e. 172.25.189.209:8081

The FX2 CMC I/O Module Overview page (Figure 12) is the preferred method to launch the FN IOM Dell Blade I/O Manager GUI. When the **Launch I/O Module GUI** button is clicked the login page (Figure 13) will allow authorized users access to this feature-rich application.

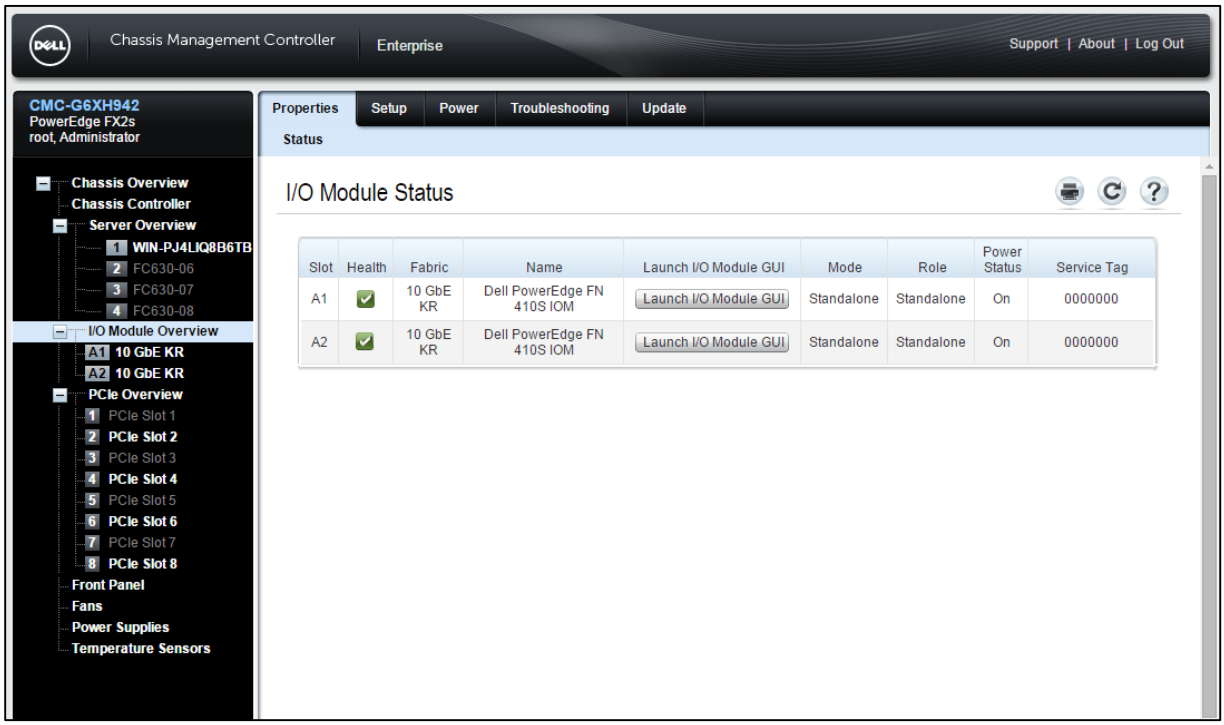


Figure 12 FX2 CMC I/O Module Overview

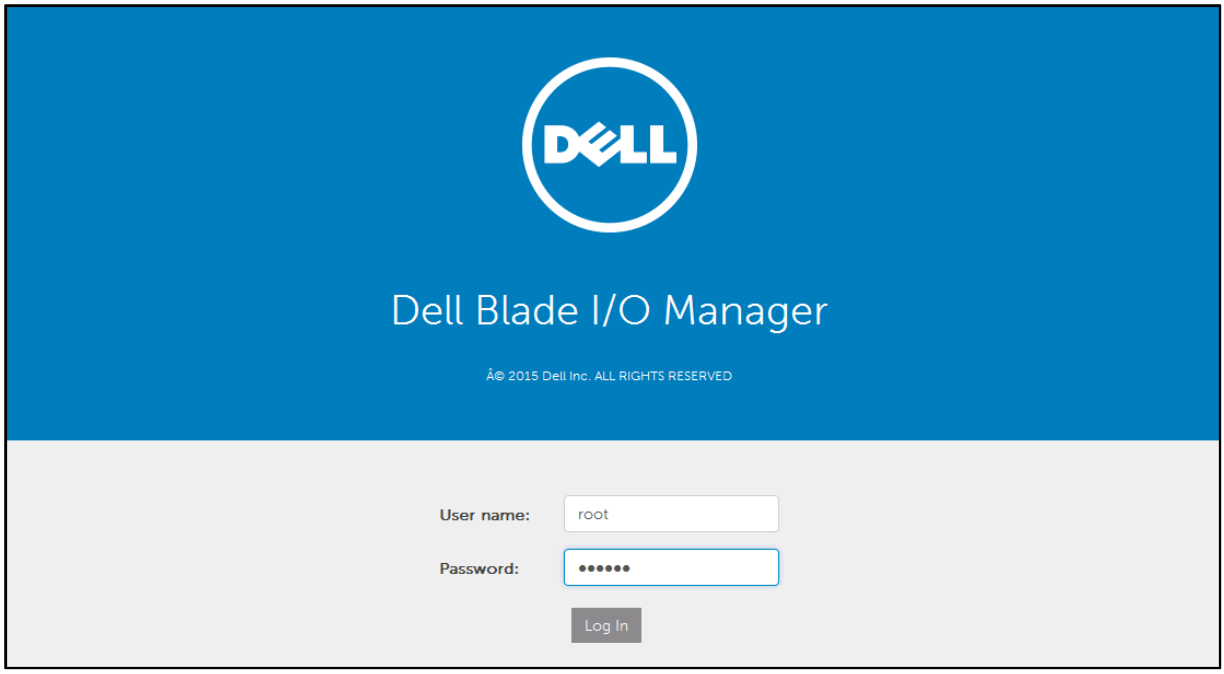


Figure 13 FX2 FN IOM Dell Blade IO Manager Login Screen

When the correct account credentials (default is root/calvin) are entered into the Dell Blade I/O Manager Login page, the initial Dashboard view will be presented (Figure 14).

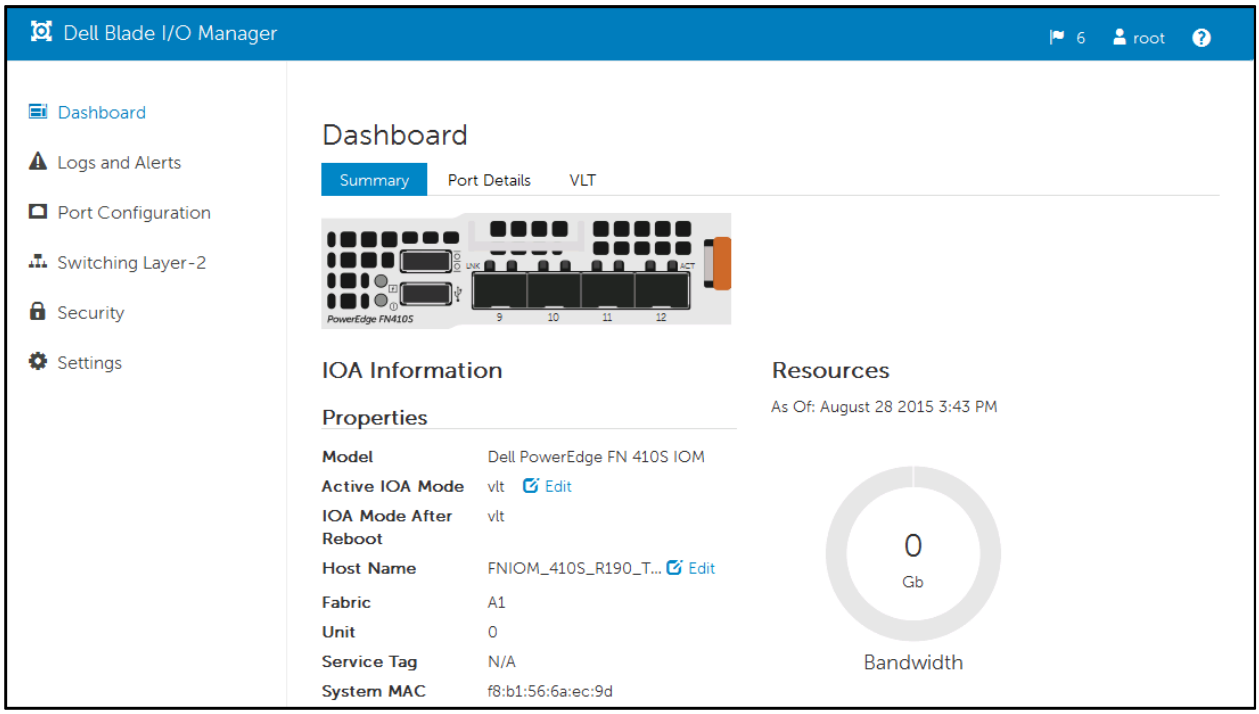


Figure 14 Dell Blade I/O Manager Dashboard

The Dell Blade I/O Manager Dashboard page allows an overall configuration view of the FN IOM, which includes:

- FN IOM Mode
- Management IP address
- Recently logged activity
- Bandwidth utilization
- Detailed Port view
- Detailed mode view (Standalone, VLT, Stacked, Programmable Mux, Full Switch)

The menu choices on the left include logging information, Port configuration (both internal and external), Switching, Security, and Settings. As can be seen from this brief overview, the FN IOM Dell Blade I/O Manager can provide much of the functionality that is typically relegated to the CLI.

5.2 FN IOM Internal Port Mapping -- Detailed Overview

Quarter-Height Slots - Dual Port CNAs

In quarter-height slots configured with dual port CNAs, the servers map to a single port on each of the two IOAs.

The naming convention for quarter-height slots are different from the naming conventions for the half-height and full-height slots. As shown in Figure 1514, the first row of the quarter-height slots are designated 1a through 1d, and the second row 3a through 3d. Figure 15 and Table 2 present the port mapping for quarter-height slots with dual port CNAs.

Note: Quad-port CNAs are not available for quarter-height servers.

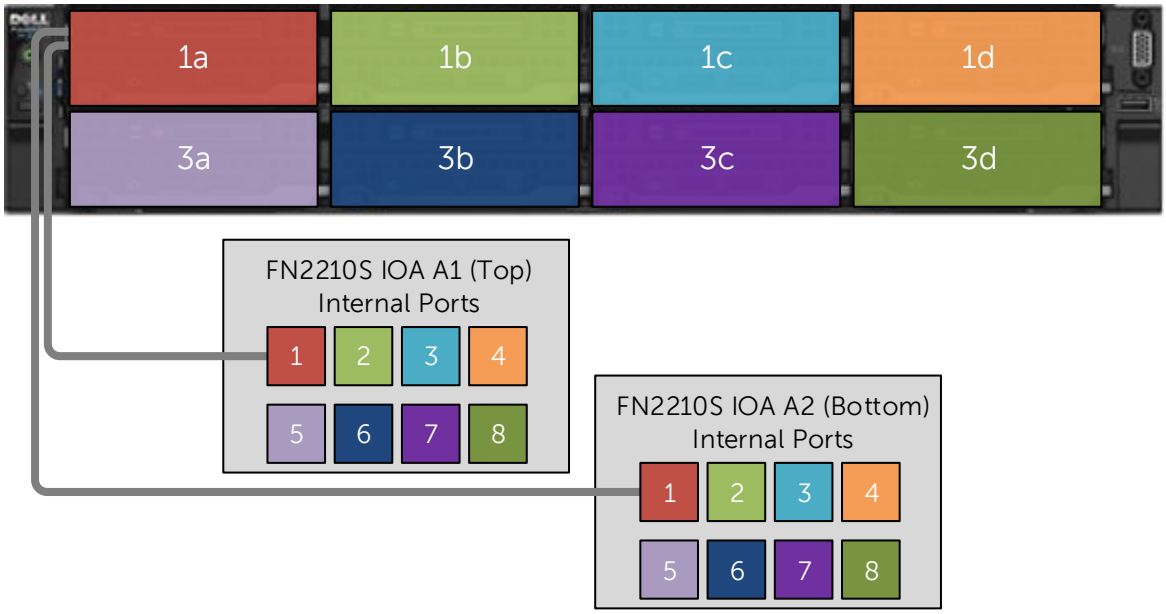


Figure 15 Quarter-Height Slots with Dual Port CNAs

Table 2 Half-Height Slots with Dual Port CNAs

Slot	IOA A1 Port Numbers (Top)	IOA A2 Port Numbers (Bottom)
1a	1	1
1b	2	2
1c	3	3
1d	4	4
3a	5	5
3b	6	6
3c	7	7
3d	8	8

Half-Height Slots - Dual Port CNAs

In half-height slots with dual port CNAs installed in the server blades, the servers map to a single port on each of the two IOAs. Figure 16 and Table 3 present the port mapping for half-height slots with dual port CNAs.

Note: Ports 2, 4, 6 and 8 are not used when using half-height blades with dual port adapters.

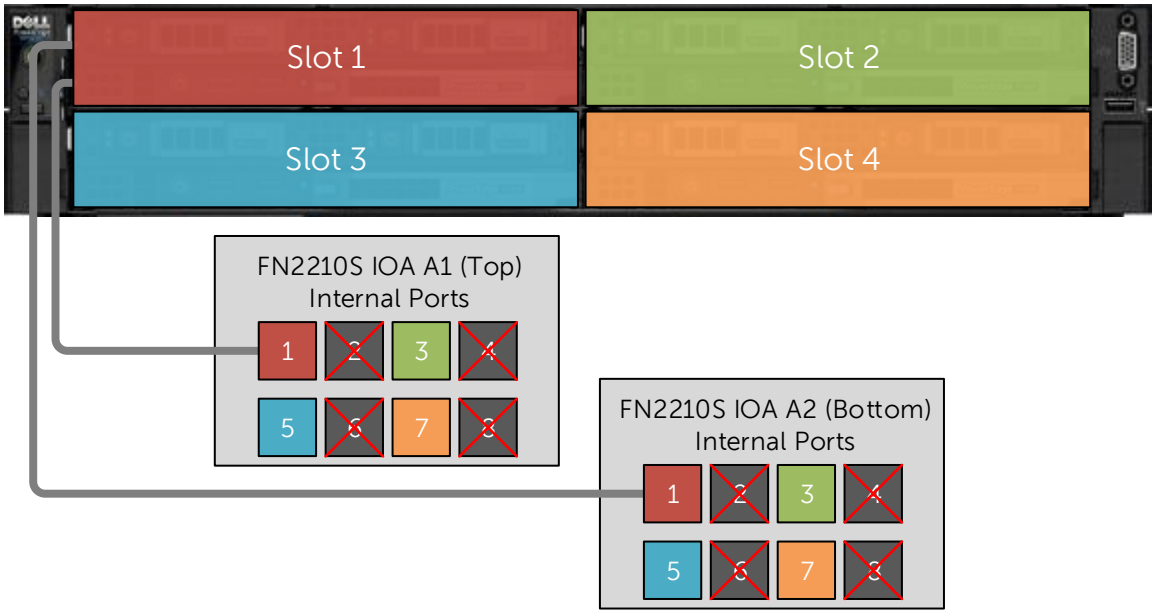


Figure 16 IOA Port Mapping Half-Height Slots with Dual Port CNAs

Table 3 Half-Height Slots with Dual Port CNAs

Slot	IOA A1 Port Numbers (Top)	IOA A2 Port Numbers (Bottom)
1	1	1
2	3	3
3	5	5
4	7	7

Half-Height Slots - Quad Port CNAs

In half-height slots with quad-port CNAs installed in the server blades, the slots map to two ports on each IOA. Figure 17 and Table 4 present the port mapping for half-height slots with quad-port CNAs.

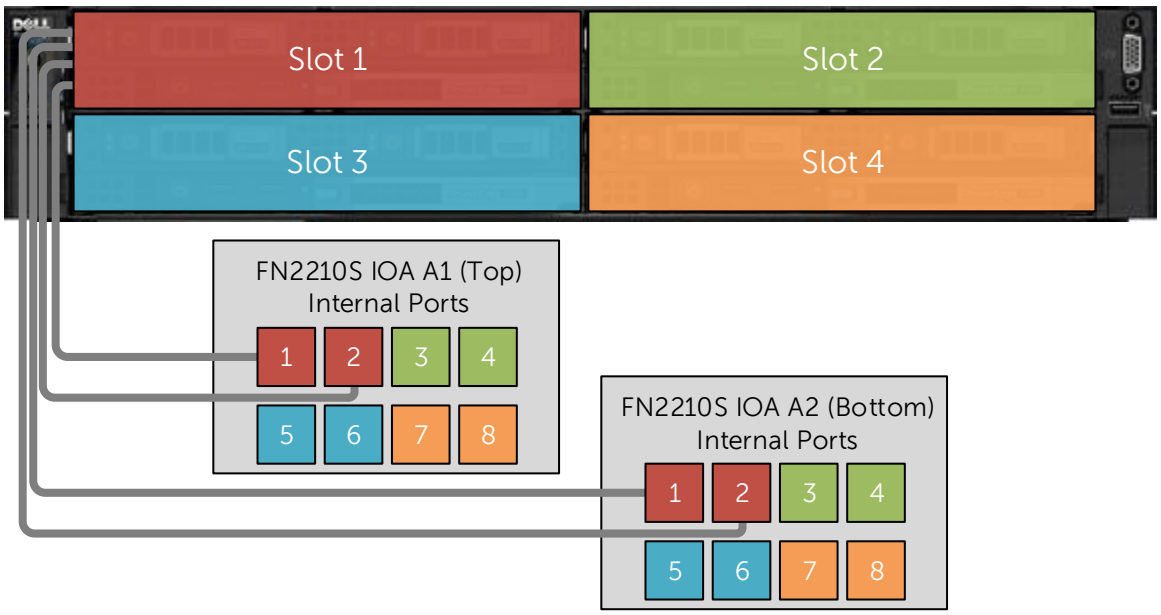


Figure 17 Half-Height Slots with Quad-Port CNAs

Table 4 Half-Height Slots with Quad-Port CNAs

Slot	IOA A1 Port Numbers (Top)	IOA A2 Port Numbers (Bottom)
1	1,2	1,2
2	3,4	3,4
3	5,6	5,6
4	7,8	7,8

6 Environment One: Basic VLT Deployment with VLT Mode

In this section, a basic VLT deployment (Figure 18) is created using the low-touch VLT mode. The purpose of this topology is to present the concept of VLT and how to enable it.

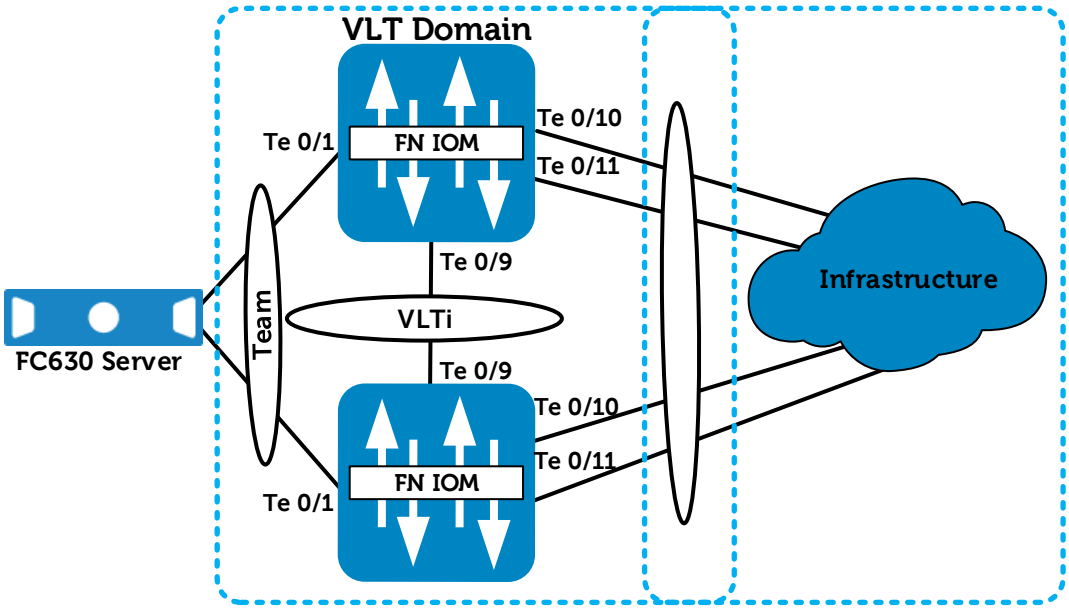


Figure 18 VLT deployment with FN 410S IOM

In the diagram above, internal port Te0/1 and external ports Te0/10 and Te0/11 are VLT members on both IOMs.

Note: If an IOM has been previously configured, existing configuration settings will be retained after changing IOM modes. Because of this, it is recommended that the IOMs be returned to factory defaults before configuring to a different mode. See the Reset FN IOM to Default Factory Configuration section for instructions on setting an IOM back to factory defaults.

6.1 Environment One: VLT Mode Configuration

This configuration requires the IOMs to be changed from the default mode of Standalone to VLT mode. Figure 20 presents the steps necessary to first verify the current mode of the IOMs, then to change IOMs to VLT mode. When validating the configurations in this guide the following management IP addresses (Table 5) were used.

Table 5 Management IP Address

Hostname	IP Address	Subnet
FN410S-A1	172.25.189.27	255.255.0.0
FN410S-A2	172.25.189.28	255.255.0.0

Important: Port Te0/9 is preconfigured for the VLTi peer-link and **must** be used for this purpose. No other port may be used for the VLTi peer-link when the IOM is in VLT mode.

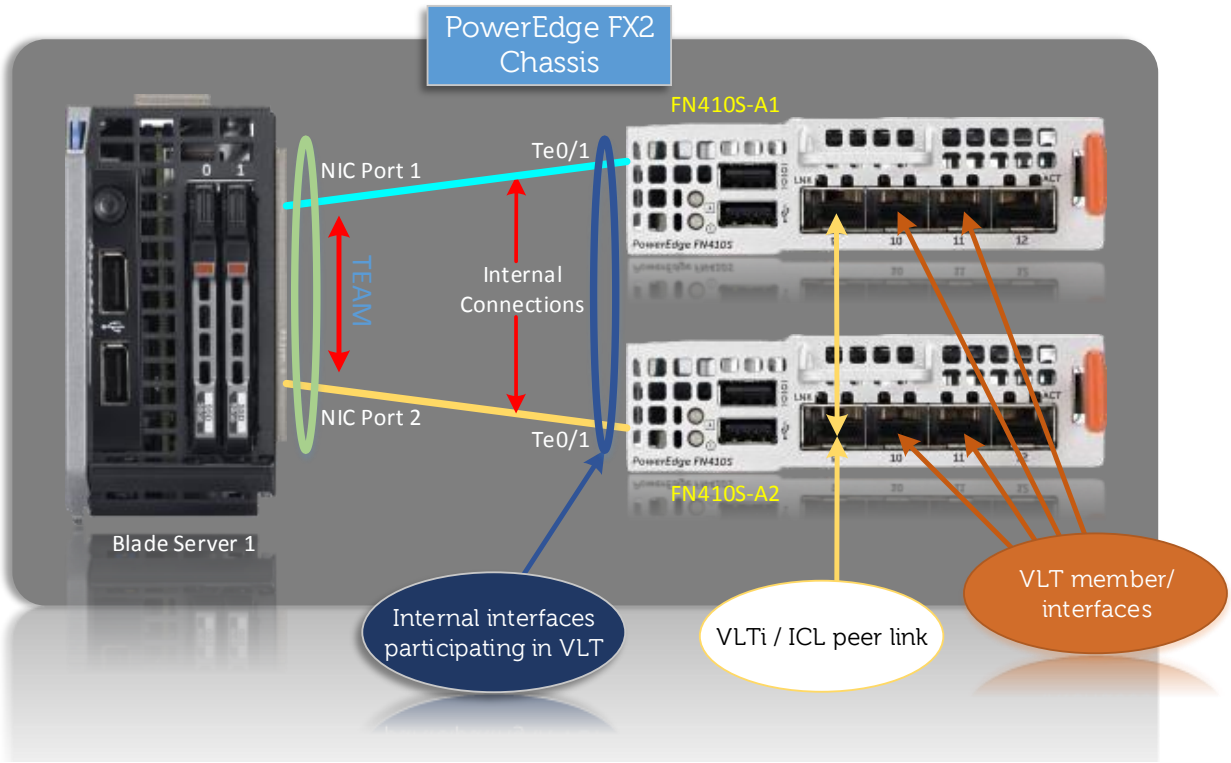


Figure 19 Physical VLT Configuration

FN410S-A1	FN410S-A2
Verify the initial mode for the IOM	Verify the initial mode for the IOM
`show system stack-unit 0 iom-mode`	`show system stack-unit 0 iom-mode`
If the previous command returns **standalone, full switch,** or **programmable-mux** then follow the next set of commands to set the IOM to VLT mode.	If the previous command returns **standalone, full switch,** or **programmable-mux** then follow the next set of commands to set the IOM to VLT mode.
`Configure stack-unit 0 iom-mode vlt`	`Configure stack-unit 0 iom-mode vlt`
Configure the ICL or peer-link interface Te0/9 of both IOMs. Configure the management interface IP address.	Configure the ICL or peer-link interface Te0/9 of both IOMs. Configure the management interface IP address

`interface te0/9`
`no shutdown`
`exit`
`interface ma0/0`
`ip address 172.25.189.27/16`
`no shut`
`end`
`copy running-config startup-config`
`reload`
	`interface te0/9`
	`no shutdown`
	`exit`
	`interface ma0/0`
	`ip address 172.25.189.28/16`
	`no shut`
	`end`
	`copy running-config startup-config`
	`reload`

Figure 20 Configuring VLT Mode on the IOMs

After entering the commands, accept the option to proceed with a reload. While the first IOM is reloading, plug in a 10GB Direct Access Cable (DAC) or fiber optic patch cable between interface Te0/9 on FN410S-A1 and Te0/9 on FN410S-A2

While the command `interface management 0/0 ip address 172.25.189.26/16` can set the ip address of the FN IOM module. Figure 21 below shows that from the **FX2 CMC** > **IO Module Overview** > **Setup**, an ip address can be either statically assigned or a DHCP IP address can be chosen to be assigned.

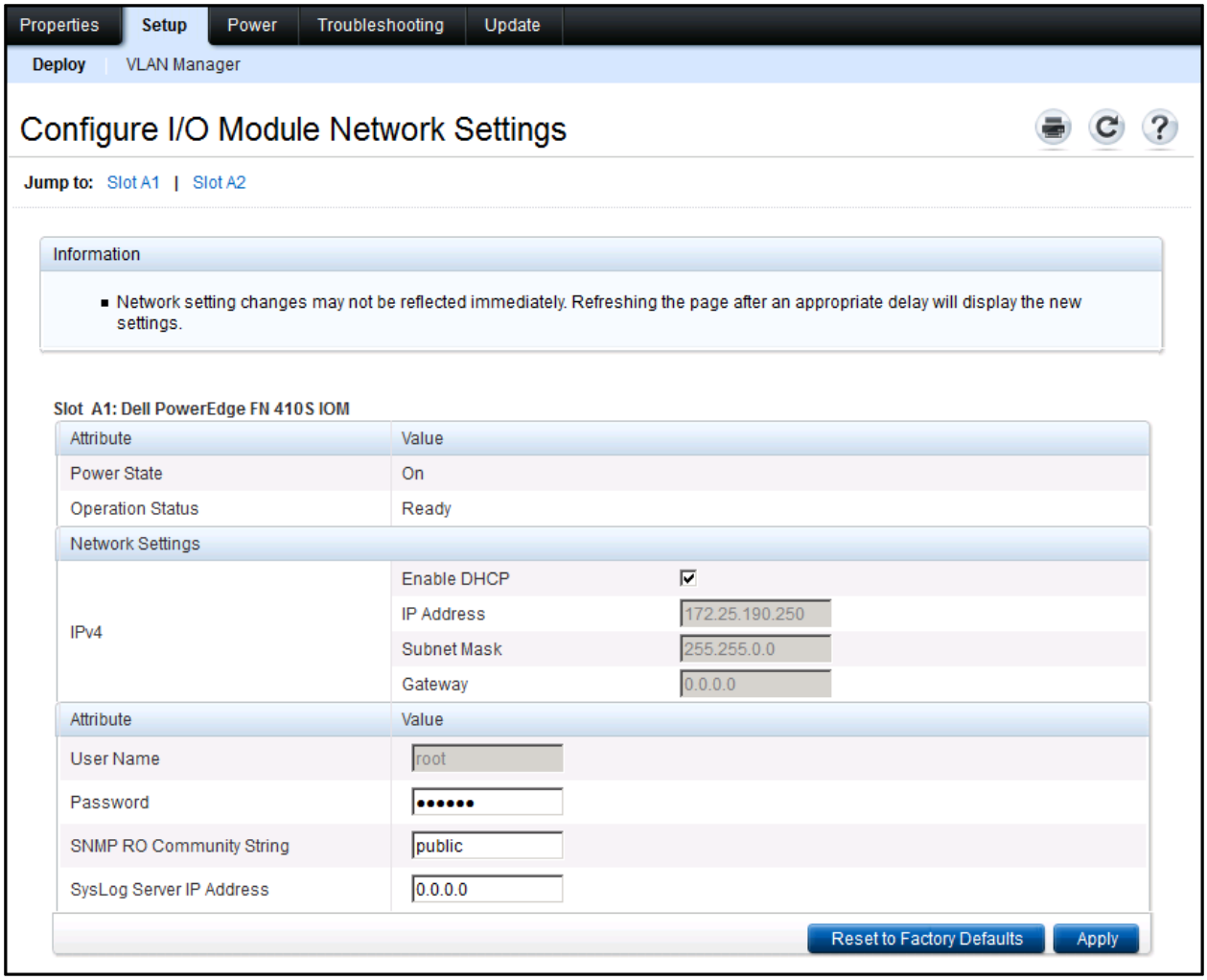


Figure 21 FX2 IO Module IP Address Configuration

After an IP address has been established via the FX2 CMC, it can be modified from the Dashboard view by clicking on the edit icon Edit and then either assigning all the static IP information, or choosing DHCP.

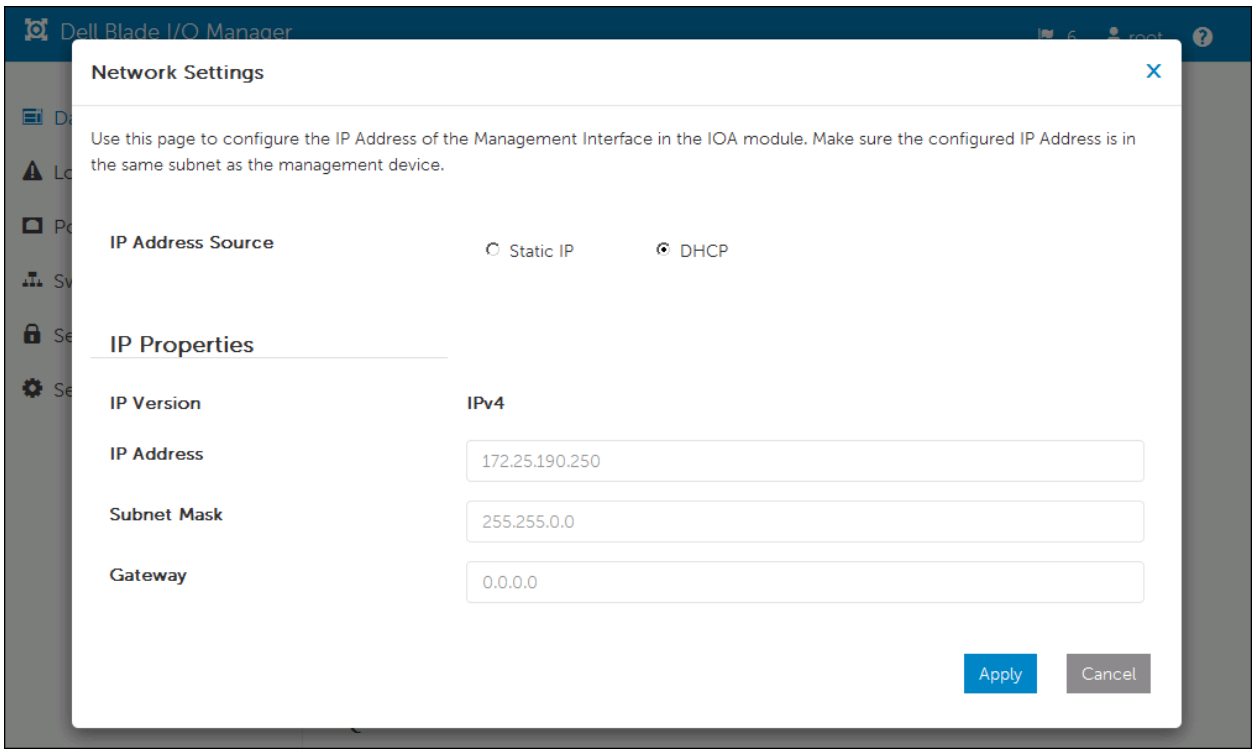


Figure 22 FN IOM Dell Blade I/O Manager IP Address Configuration

The next step in this process is to utilize the FN IOM Dell Blade I/O Manager GUI to change from Standalone Mode to VLT mode. In the Dashboard view click on the edit icon Edit next to Active IOA Mode; in the Mode Settings page choose Virtual Link Trunking (VLT).

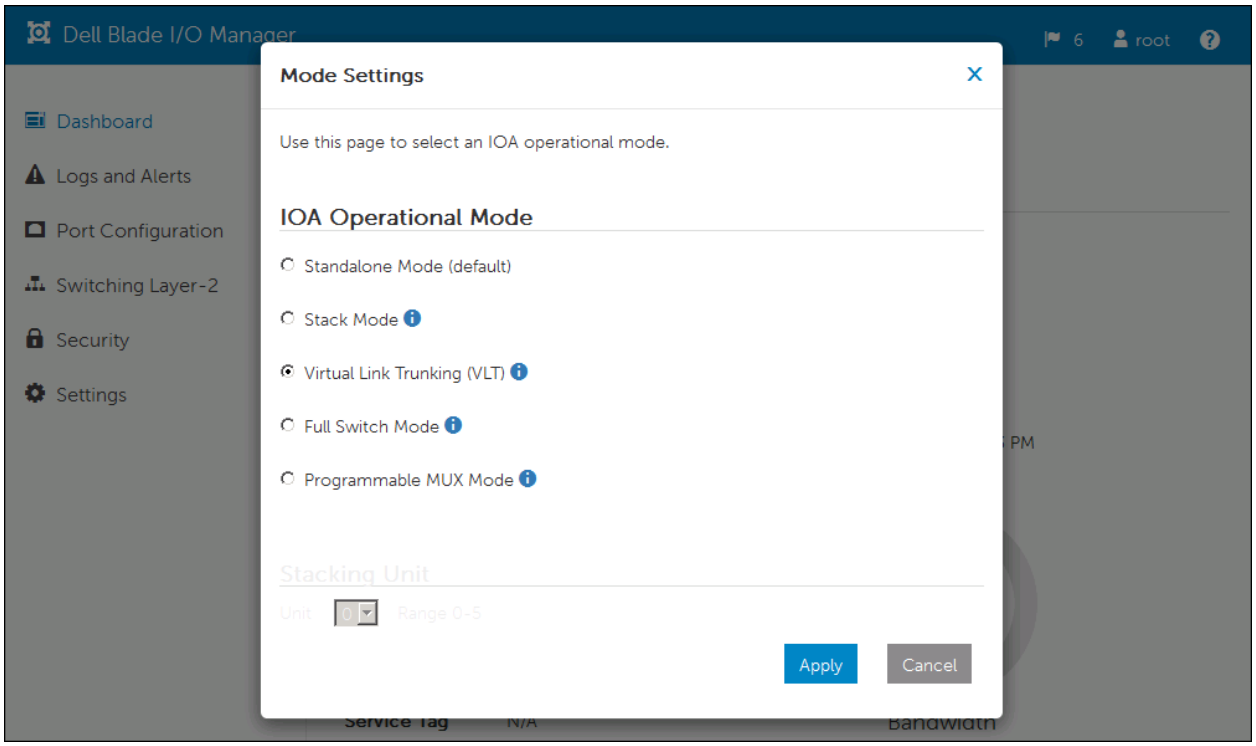


Figure 23 FN IOM Dell Blade I/O Manager Standalone to VLT Mode

Once the Apply button has been clicked, a final confirmation will appear. Click Yes to confirm and the FN IOM will switch modes and reboot.

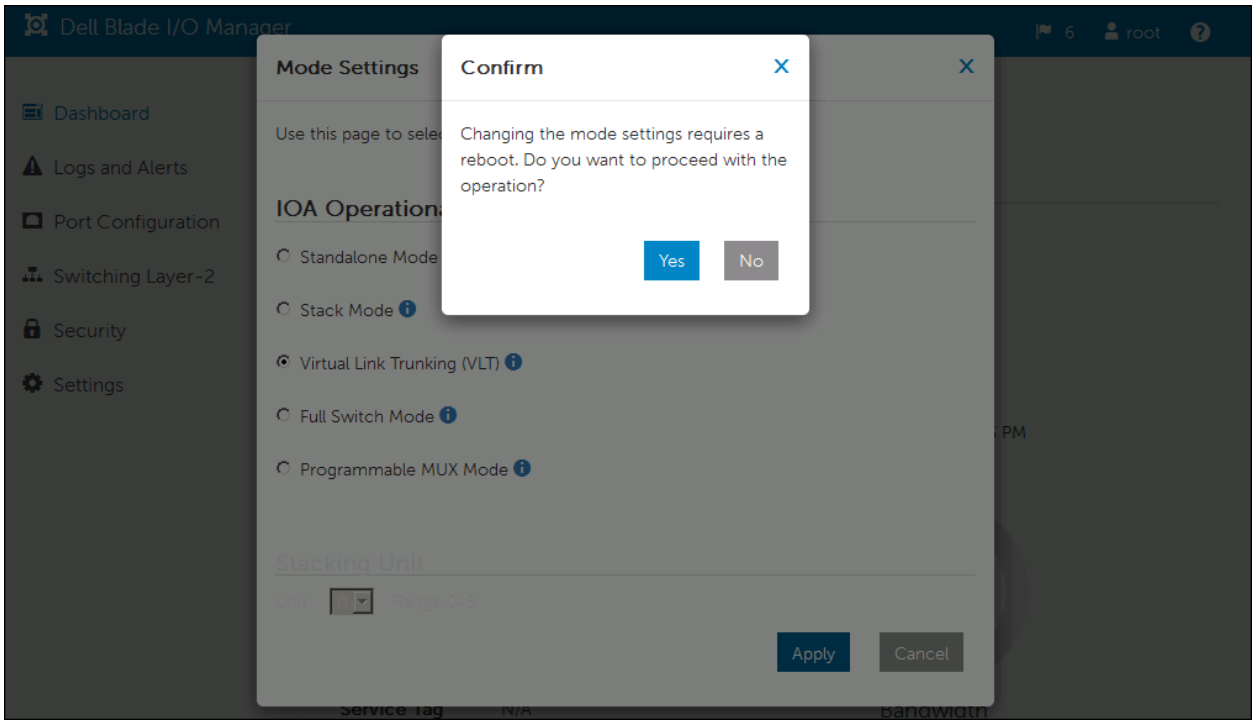


Figure 24 FN IOM Dell Blade I/O Manager Standalone to VLT Mode Final Confirmation

After the FN IOM has rebooted, The Dell Blade I/O Manager Dashboard view will show the Active IOA Mode as VLT. This is equivalent to the command `show system stack-unit 0 iom-mode`.

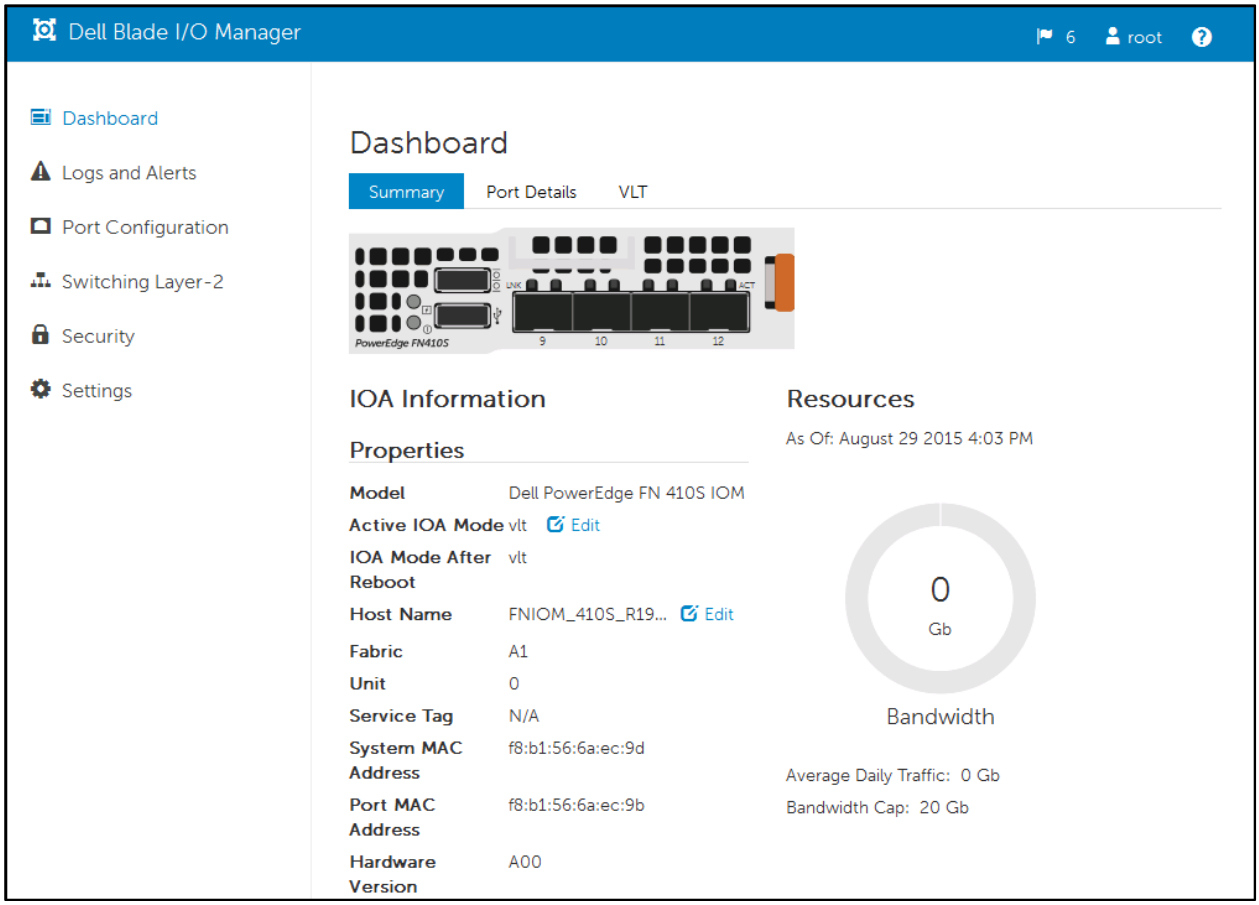


Figure 25 FN IOM Dell Blade I/O Manager VLT Mode Confirmation

6.2 Testing VLT Functionality

To test VLT functionality, a NIC team was created in the PowerEdge FC 630 series blade server. The LACP NIC team was created in Windows 2012 R2 using the native solution built into Windows. For an overview of NIC teaming in Windows 2012 R2, please visit http://technet.microsoft.com/en-us/library/hh831648.aspx

To test VLT, one link is connected from each IOM to an upstream switch. Create a port channel on the upstream switch. Once the port channel is created, an IP address and subnet mask can be assigned to the NIC team on the PowerEdge FC 630 series blade server. When the configuration is complete, any standard testing suite can be used to test the functionality of VLT. Depending on the testing suite, the testing can range from a simple ping loop between the two servers to testing the throughput between links with more substantial traffic.

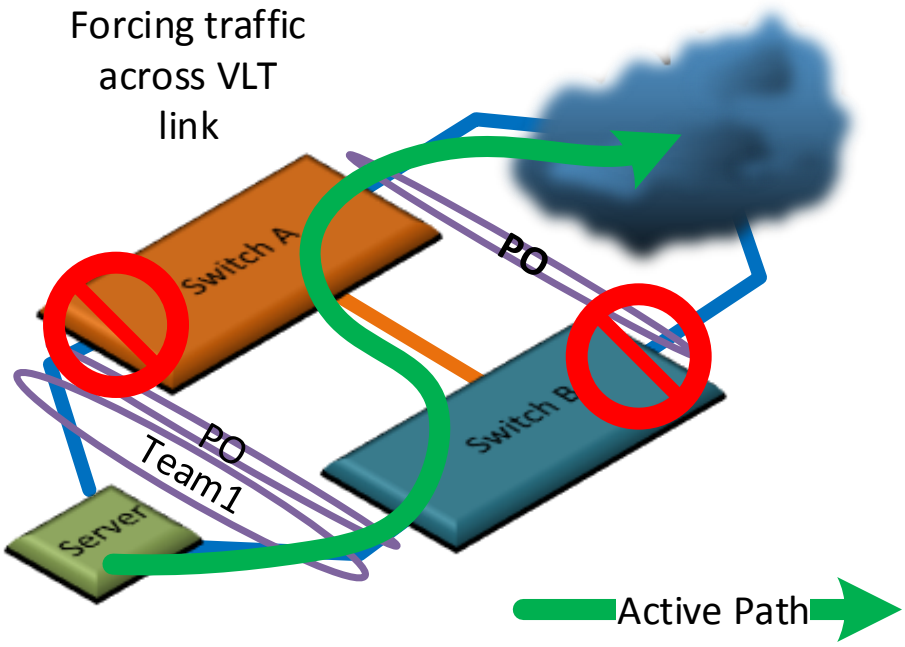


Figure 26 Disabling Links to Force Traffic Across the VLT Peer-link (ICL)

While traffic is running, individual ports on the IOMs can be administratively disabled in order to channel traffic out certain ports. Figure 26 is an example showing how to force traffic through the VLTi peer link. The red "No" symbols represent the ports which should be administratively disabled. The `show vlt statistics` command can be run to show the VLTi peer link is carrying data traffic.

In VLT mode, the Dashboard view has a VLT tab (Figure 27) that can show most aspects of the VLT such as:

- Domain ID
- Role
- ICL, Heartbeat, and VLT Peer Status

This view is equivalent to the command `show vlt brief`

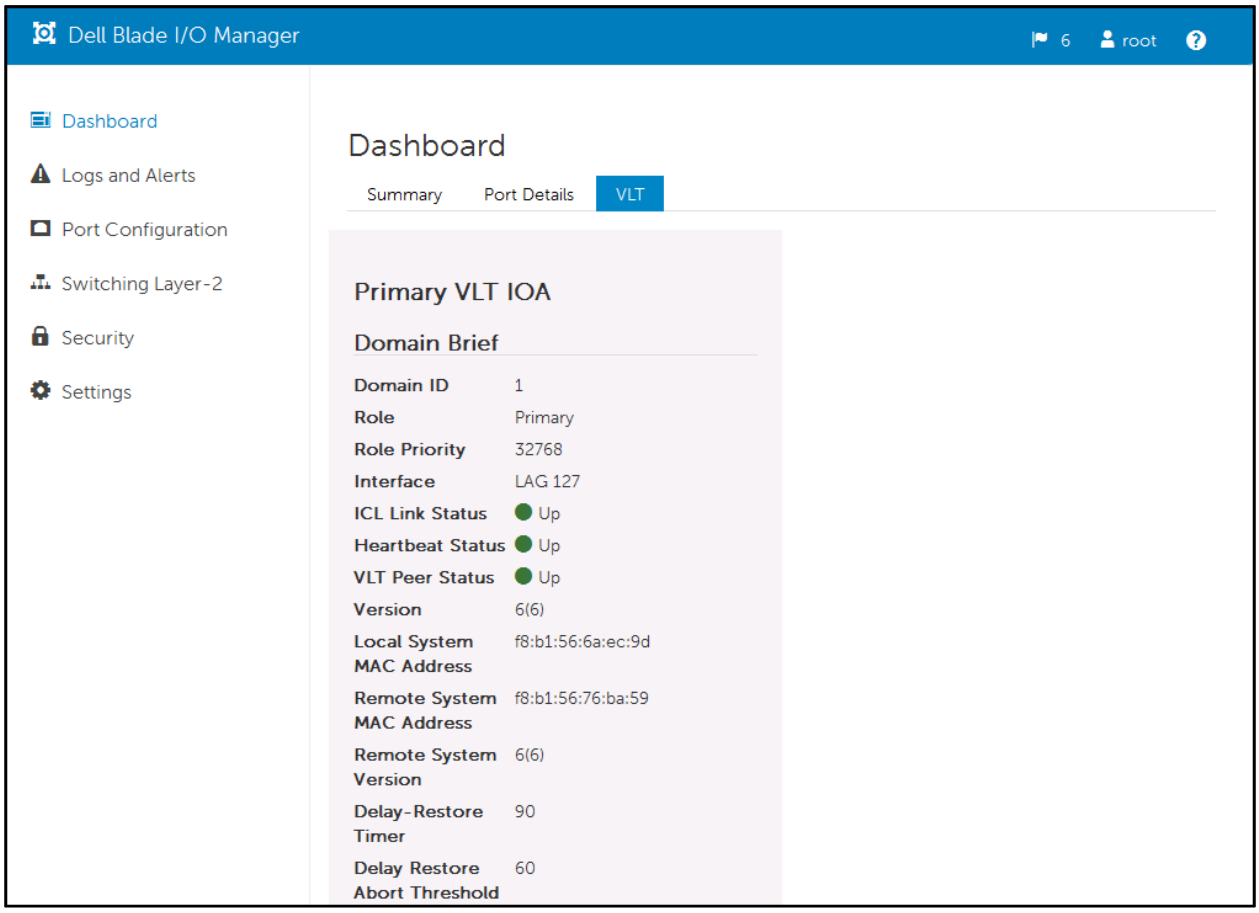


Figure 27 FN IOM Dell Blade I/O Manager Show VLT Brief

7 Environment Two: Dell Networking Switches with mVLT and IOM in Full Switch Mode

Full Switch mode is a new DNOS 9.9 feature that allows a network administrator to incorporate layer 3 functionality into a FN IOM environment. This new switch mode mirrors the same functionality as Dell's award-winning MXL switching module, made for the M1000e chassis.

The Dell Blade I/O Manager view (Figure 28) below shows the FN IOM in Full Switch mode.

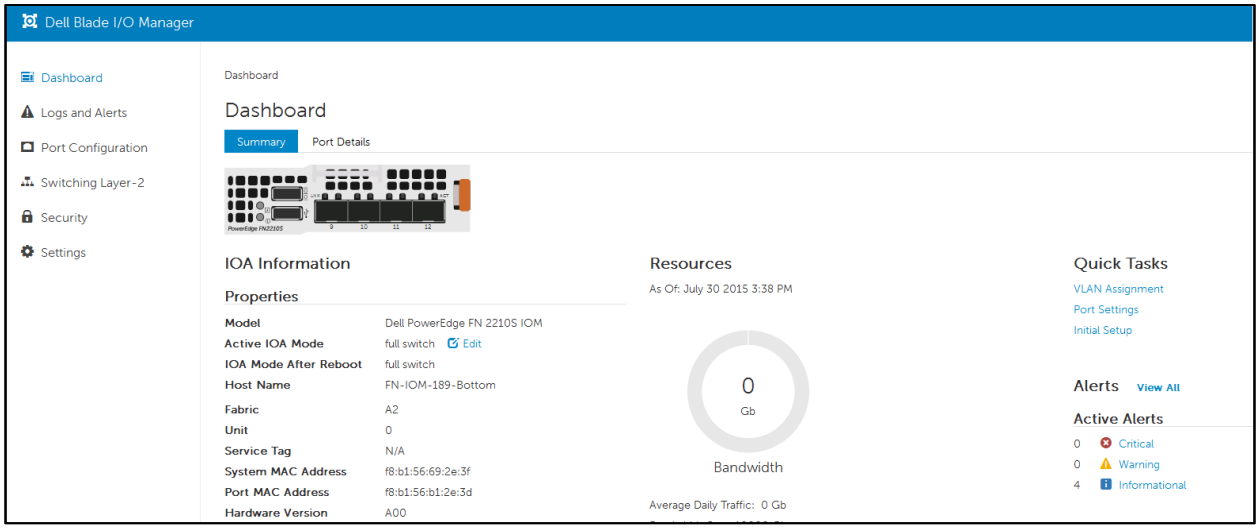


Figure 28 FN IOM Dell Blade I/O Manager Full Switch Mode

This section presents an example of Dell Networking S4810 and FN IOM switches working together in a multi-Virtual Link Trunking (mVLT) configuration.

Figure 29 illustrates using Dell's VLT protocol on a pair of IOMs in a switch environment connecting to two Dell Networking S4810s switches. In this mVLT configuration, multiple valid paths exist which enable the environment to survive the failure of one S4810 switch and/or one IOM, and/or one NIC interface per server. Because all paths are actively used, the result is a highly fault-tolerant environment, which makes full use of the throughput capabilities of all switches.

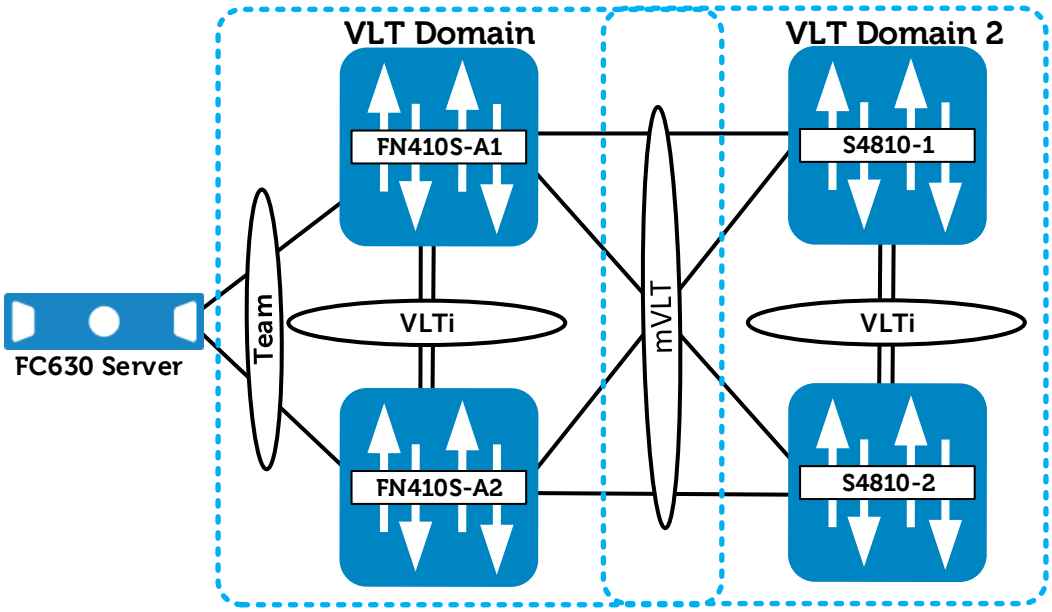


Figure 29 mVLT Configuration with a PowerEdge FX2, IOMs and S4810 Switches

7.1 Environment Two: IOM Full Switch Mode Configuration

The configuration steps outlined below are repeated on both IOMs. When validating the configurations in this guide the following management IP addresses (Table 6) were used.

Table 6 Management IP Address

Hostname	IP Address	Subnet
FN410S-A1	172.25.189.27	255.255.0.0
FN410S-A2	172.25.189.28	255.255.0.0

Note: If the IOMs have been previously configured, existing configuration settings will be retained when changing IOM modes. Because of this, it is recommended that the IOMs be returned to factory defaults before configuring. See the Reset FN IOM to Default Factory Configuration section for instructions on setting an IOM back to factory defaults.

7.1.1 Configuring the IOM for Full Switch Mode

In this section, the switch is set to Full Switch mode.

In Figure 30, Global Configuration mode is used to set the switch to Full Switch mode. Then the configuration is saved and the switch is reloaded. Once the reload is complete, the IOM mode is verified using the `show system stack-unit 0 iom-mode` command. Then, the management IP address is assigned to allow VLT heartbeats as well as SSH/telnet access.

Note: Only the VLT-related portions of the configurations are shown.

FN410S-A1	FN410S-A2
Configure the IOM for Full Switch mode	Configure the IOM for Full Switch mode

`configure`
`stack-unit 0 iom-mode full-switch`
`end`
	`configure`
	`stack-unit 0 iom-mode full-switch`
	`end`

Verify that the system is set to move to Full Switch mode for the next-boot, save, and reload	Verify that the system is set to move to Full Switch mode for the next-boot, save, and reload

`show system stack-unit 0 iom-mode`
`copy running-config startup-config`
`reload`
	`show system stack-unit 0 iom-mode`
	`copy running-config startup-config`
	`reload`

Confirm the iom-mode Configure the Management IP address	Confirm the iom-mode Configure the Management IP address

`show system stack-unit 0 iom-mode`
`configure`
`interface ma0/0`
`ip address 172.25.189.27/16`
`no shut`
	`show system stack-unit 0 iom-mode`
	`configure`
	`interface ma0/0`
	`ip address 172.25.189.28/16`
	`no shut`

Figure 30 Configuring the IOM for Full Switch mode

7.1.2 Configuring the VLTi Peer Link

In this section, the VLTi peer link is configured (Figure 31).

First, the port channel that will be assigned as the VLTi peer link is created and channel members are assigned. Next, in Full Switch mode, a VLT domain is created. The peer link is then assigned and the backup destination is configured to enable heartbeat communications over the management network. Finally, a unit ID is specified to ensure that the two IOM peer switches are assigned primary or secondary roles.

Note: In this example, the port channel number matches on both sides. This is not a strict requirement.

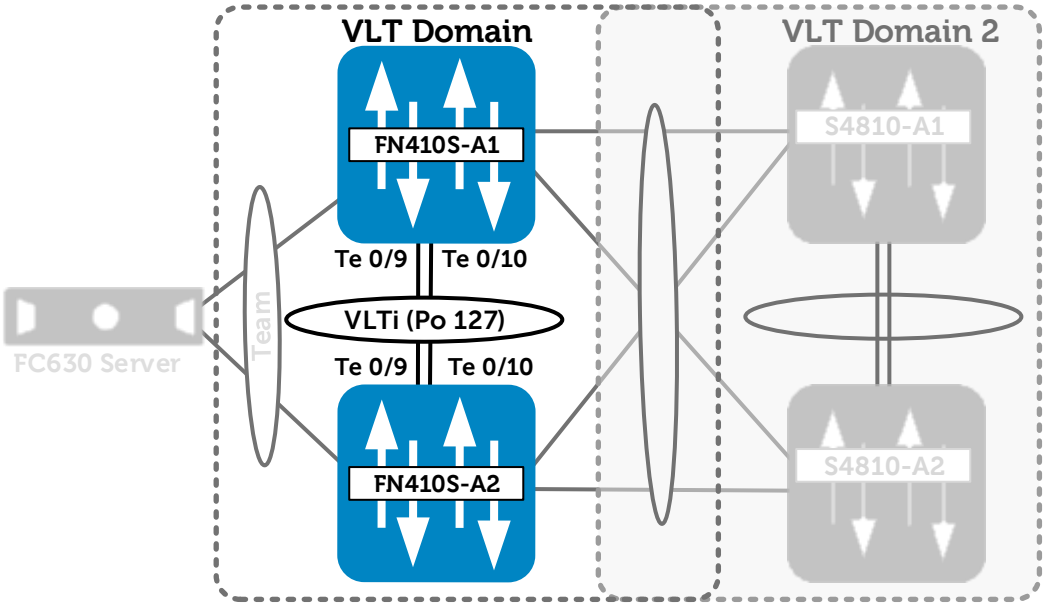


Figure 31 VLTi Peer-Link Configuration

FN410S- A1	FN410S- A2
Configure the VLTi port channel interface Add a description Add channel members	Configure the VLTi port channel interface Add a description Add channel members

`interface port-channel 127`
`  description VLTI link to VLT- Switch A2`
`channel-member te0/9 - 10`
`no switchport`
`no shutdown`
`exit`
	`interface port-channel 127`
	`  description VLTI link to VLT- Switch A1`
	`channel-member te0/9 - 10`
	`no switchport`
	`no shutdown`
	`exit`

Configure the VLT domain Set peer link port channel of Switch A2 Configure the backup destination management IP (management IP of the other switch) Set unit id	Configure the VLT domain Set peer link port channel of Switch A1 Configure the backup destination management IP (management IP of the other switch) Set unit id

`vlt domain 1`
`  peer-link port-channel 127`
`  back-up destination 172.25.189.28`
`  unit-id 0`
`  exit`
	`vlt domain 1`
	`  peer-link port-channel 127`
	`  back-up destination 172.25.189.27`
	`  unit-id 1`
	`  exit`

Figure 32 Configuring the VLT Participating Links

Next, another port channel is created for the FC630 blade server to communicate. A corresponding VLT peer lag is assigned to the peer switch. Internal port Te0/1 is added to the port channel and LACP is enabled with the mode active command.

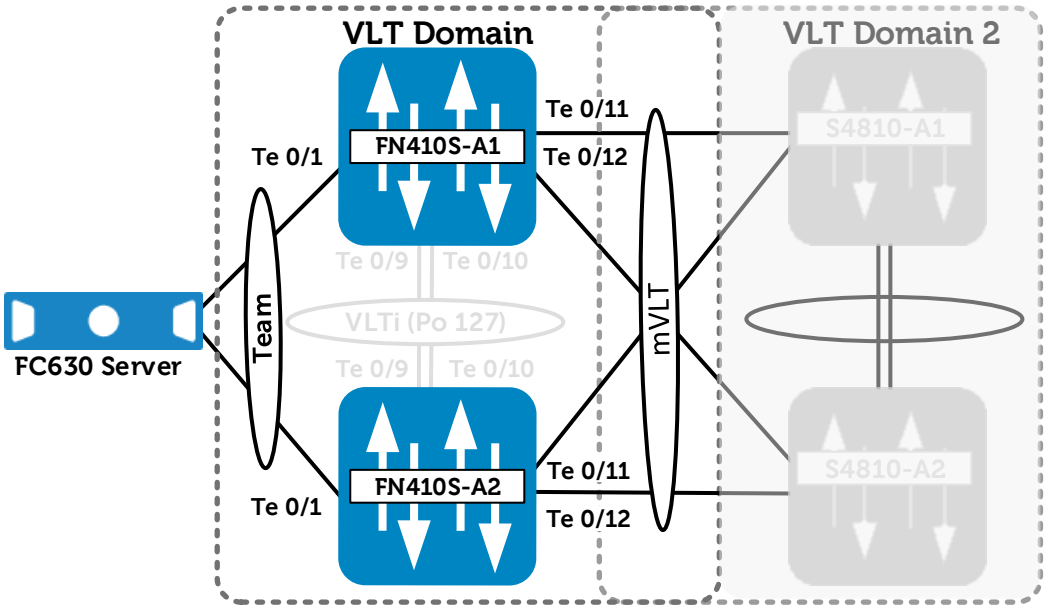


Figure 33 VLT LAG to Teamed NIC Interfaces (#1) and VLT LAG to mVLT S4810 Connection (#2)

A final port channel is created for upstream communication to the pair of S4810 switches. The VLT peer-lag is set to the same port channel ID. External interfaces 11 and 12 are added to this port channel and LACP is enabled with the mode active command.

Figure 34 contains the steps necessary to configure the peer LAG and the upstream links for the mVLT connection.

FN410S- A1	FN410S- A2
Configure the peer LAG, and then configure upstream links for the mVLT connection Create the port channel.	Configure the peer LAG, and then configure upstream links for the mVLT connection. Create the port channel.

`interface port-channel 101`
` description "PO to CNA NIC 1"`
` portmode hybrid`
` switchport`
` vlt-peer-lag po101`
` no shutdown`
` exit`
	`interface port-channel 101`
	` description "PO to CNA NIC 1"`
	` portmode hybrid`
	` switchport`
	` vlt-peer-lag po101`
	` no shutdown`
	` exit`

Configure the internal port and set the port channel.	Configure the internal port and set the port channel.

`interface te0/1`
` no switchport`
` port-channel-protocol lacp`
`  port-channel 101 mode active`
`  exit`
` no shutdown`
	`interface te0/1`
	` no switchport`
	` port-channel-protocol lacp`
	`  port-channel 101 mode active`
	`  exit`
	` no shutdown`

Configure the port channel for upstream links.	Configure the port channel for upstream links.

`interface port-channel 121`
`  description "PO to Dell S4810"`
`  portmode hybrid`
`  switchport`
`  vlt-peer-lag po121`
`  no shutdown`
`  exit`
	`interface port-channel 121`
	`  description "PO to Dell S4810"`
	`  portmode hybrid`
	`  switchport`
	`  vlt-peer-lag po121`
	`  no shutdown`
	`  exit`

Configure the interfaces that will participate in the VLT port channel.	Configure the interfaces that will participate in the VLT port channel.

`interface range te0/11-12`
` description "Link to Dell S4810"`
` no switchport`
` port-channel-protocol lacp`
`  port-channel 121 mode active`
`  exit`
	`interface range te0/11-12`
	` description "Link to Dell S4810"`
	` no switchport`
	` port-channel-protocol lacp`
	`  port-channel 121 mode active`
	`  exit`

```
no shutdown
exit
```

```
no shutdown
exit
```

Figure 34 Connection to Server NIC's and Connections to S4810 Switches

7.2 Environment Two: Configuring the Dell Networking S4810

In this section, the S4810 switches are configured (Figure 35). The configuration steps outlined below are repeated on both IOMs. When validating the configurations in this guide the following management IP addresses (Table 7) were used.

Table 7 Management IP Addresses

Hostname	IP Address	Subnet
S4810-1	172.25.190.37	255.255.0.0
S4810-2	172.25.190.38	255.255.0.0

The VLT active/active capabilities of the S4810 and the IOM are the same. Therefore, the configurations should look and behave in the same manner.

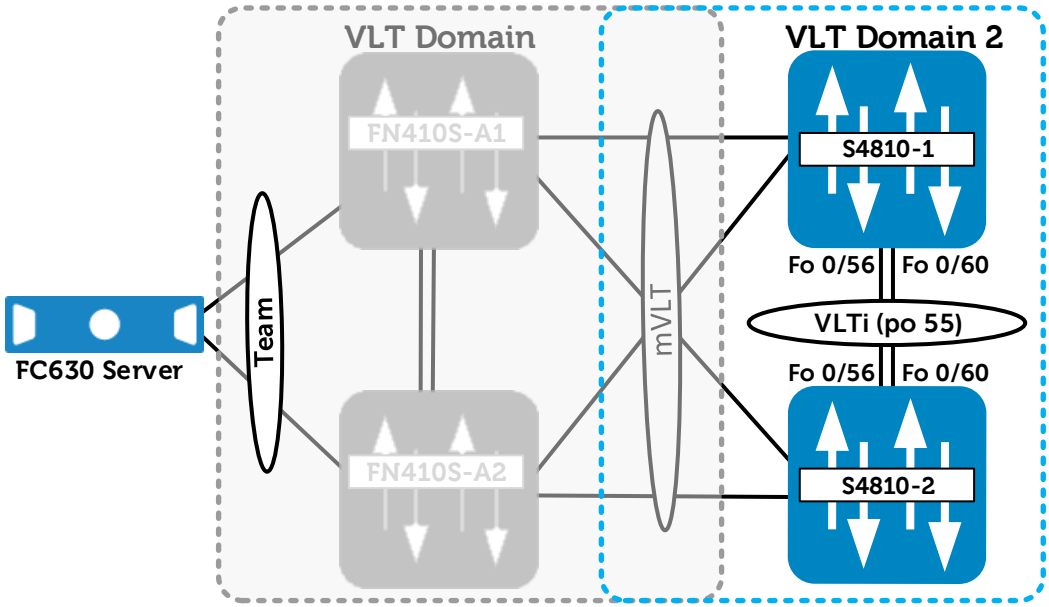


Figure 35 S4810 Member and Peer link (ICL) Configuration

The steps necessary to configure the VLT links are shown in Figure 36.

S4810-1	S4810-2
Configure the VLT links including the ICL/peer link on the S4810 Configure the peer link	Configure the VLT links including the ICL/peer link on the S4810 Configure the peer link

`interface port-channel 55`
` description "VLTi Link to 4810-2"`
` channel-member fortyGigE 0/56,60`
` no shutdown`
` exit`
`interface range fo0/56,fo0/60`
` description "VLTi Peer-Link"`
` no shutdown`
` exit`
	`interface port-channel 55`
	` description "VLTi Link to 4810-1"`
	` channel-member fortyGigE 0/56,60`
	` no shutdown`
	` exit`
	`interface range fo0/56,fo0/60`
	` description "VLTi Peer-Link"`
	` no shutdown`
	` exit`

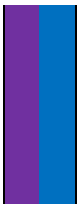
Configure the VLT domain Set the peer link port channel of Switch 2 Configure back-up destination management IP (management IP of the other switch)	Configure the VLT domain Set the peer link port channel of Switch 1 Configure back-up destination management IP (management IP of the other switch)

`vlt domain 2`
` peer-link port-channel 55`
` back-up destination 172.25.190.38`
` unit-id 0`
` exit`
	`vlt domain 2`
	` peer-link port-channel 55`
	` back-up destination 172.25.190.37`
	` unit-id 1`
	` exit`

Configure the port channel Configure the port channels member interfaces	Configure the port channel Configure the port channels member interfaces

`int port-channel 121`
` description "Port Channel to IOM Pair"`
` Portmode hybrid`
` Switchport`
` vlt-peer-lag po121`
` no shutdown`
` exit`
`interface range te0/1-2`
` description "Portchannel link to IOM"`
	`int port-channel 121`
	` description "Port Channel to IOM Pair"`
	` Portmode hybrid`
	` Switchport`
	` vlt-peer-lag po121`
	` no shutdown`
	` exit`
	`interface range te0/1-2`
	` description "Portchannel link to IOM"`

```
 no switchport
 port-channel-protocol lacp
 port-channel 121 mode
active
 exit
 no shutdown
```



```
 no switchport
 port-channel-protocol lacp
 port-channel 121 mode
active
 exit
 no shutdown
```

Figure 36 S4810 VLT Configuration

7.3 Verifying VLT Connectivity

VLT connectivity can be checked using the VLT commands listed in Table 8.

Table 8 show Commands

Command	Purpose
`show vlt brief`	Displays brief information about the VLT configuration
`show vlt detail`	Displays running configuration for VLT members
`show mac-address-table`	Displays the MAC address table

On each switch participating in VLT, perform a `show vlt brief`, `show vlt detail` and `show mac-address-table`. On the access switch, perform a `show mac-address-table`.

`show vlt brief`

The Role (Primary or Secondary) should be appropriate for the switch. The status of the ICL Link, HeartBeat and VLT Peer must all be up.

`show vlt detail`

This command shows the local LAG ID, the peer LAG ID, the local status of the VLT, the peer status of the VLT, and the active VLANs for the VLT.

In order for the LAG to be functional, the Local Status and Peer Status must be UP.

`show mac-address-table`

Each switch should be learning the upstream and downstream MAC addresses using all local port channels.

The following are examples of the output from these show commands.

Example of `show vlt brief` on switch FN410S-A1.

FN410S-A1

```
FN410S-A1#show vlt brief


 VLT Domain Brief
------------------
 Domain ID:                      1
 Role:                           Secondary
 Role Priority:                  32768
 ICL Link Status:                Up
 HeartBeat Status:               Up
 VLT Peer Status:                Up
 Local Unit Id:                  0
 Version:                        6(2)
 Local System MAC address:       00:1e:c9:de:01:7a
 Remote System MAC address:      00:1e:c9:de:01:72
 Remote system version:          6(2)
 Delay-Restore timer:            90 seconds
 Peer-Routing :                  Disabled
 Peer-Routing-Timeout timer:     0 seconds
 Multicast peer-routing timeout: 150 seconds
```

Example of `show vlt detail` on switch FN410S-A1.

FN410S-A1

```
FN410S-A1#show vlt detail


Local LAG Id  Peer LAG Id  Local Status  Peer Status  Active VLANs
------------  -----------  ------------  -----------  -------------
101           101          UP            UP            1
103           104          UP            UP            1
121           122          UP            UP            1
```

Example of `show mac-address-table` on switch FN410S-A1.

FN410S-A1

```
FN410S-A1#show mac-address-table

Codes: *N - VLT Peer Synced MAC
VlanId     Mac Address           Type           Interface
State
 1      00:01:e8:8b:32:4a       Dynamic (N)     Po 121
Active
 1      00:01:e8:8b:34:db       Dynamic (N)     Po 121
Active
 1      00:18:8b:a2:cb:3b       Dynamic (N)     Po 121
Active
 1      18:a9:9b:d9:28:81       Dynamic         Po 101
Active
 1      18:a9:9b:d9:28:84       Dynamic         Po 101
Active
 1      18:a9:9b:d9:2f:27       Dynamic (N)     Po 103
Active
 1      18:a9:9b:d9:2f:2a       Dynamic (N)     Po 103
Active
```

Example of `show vlt brief` on switch FN410S-A2.

FN410S-A2

```
FN410S-A2#show vlt brief

 VLT Domain Brief
------------------
 Domain ID:                      1
 Role:                           Primary
 Role Priority:                  32768
 ICL Link Status:                Up
 HeartBeat Status:               Up
 VLT Peer Status:                Up
 Local Unit Id:                  1
 Version:                        6(2)
 Local System MAC address:       00:1e:c9:de:01:72
 Remote System MAC address:      00:1e:c9:de:01:7a
 Remote system version:          6(2)
```

```
Delay-Restore timer:            90 seconds
Peer-Routing :                  Disabled
Peer-Routing-Timeout timer:     0 seconds
Multicast peer-routing timeout: 150 seconds
```

Example of `show vlt detail` on switch FN410S-A2.

FN410S-A2

```
FN410S-A2#show vlt detail

Local LAG Id     Peer LAG Id  Local Status   Peer Status  Active
VLANs
------------     ----------   ------------  -----------  ----------
---
101              101          UP                   UP     1
104              103          UP                   UP     1
122              121          UP                   UP     1
```

Example of `show mac-address-table` on switch FN410S-A2.

FN410S-A2

```
FN410S-A2#show mac-address-table

Codes: *N - VLT Peer Synced MAC
VlanId     Mac Address           Type          Interface
State
 1      00:01:e8:8b:32:4a       Dynamic         Po 122
Active
 1      00:01:e8:8b:34:db       Dynamic         Po 122
Active
 1      00:18:8b:a2:cb:3b       Dynamic         Po 122
Active
 1      18:a9:9b:d9:28:81       Dynamic (N)     Po 101
Active
 1      18:a9:9b:d9:28:84       Dynamic (N)     Po 101
Active
 1      18:a9:9b:d9:2f:27       Dynamic         Po 104
Active
 1      18:a9:9b:d9:2f:2a       Dynamic         Po 104
Active
```

Example of `show vlt brief` on switch S4810-1.

S4810-1

```
S4810-1#show vlt brief


 VLT Domain Brief
------------------
 Domain ID:                      2
 Role:                           Primary
 Role Priority:                  1
 ICL Link Status:                Up
 HeartBeat Status:               Up
 VLT Peer Status:                Up
 Local Unit Id:                  0
 Version:                        6(2)
 Local System MAC address:       00:01:e8:8b:32:48
 Remote System MAC address:      00:01:e8:8b:34:d9
 Remote system version:          6(2)
 Delay-Restore timer:            90 seconds
 Peer-Routing :                  Disabled
 Peer-Routing-timeout timer:     0 seconds
 Multicast peer-routing timeout: 150 seconds
```

Example of `show vlt detail` on switch S4810-1.

S4810-1

```
S4810-1#show vlt detail


Local LAG Id  Peer LAG Id  Local Status  Peer Status  Active VLANs
------------  -----------  ------------  -----------  -------------
111           111          UP            UP            1
123           124          UP            UP            1
```

Example of `show mac-address-table` on switch S4810-1.

S4810-1

```
S4810-1#show mac-address-table

Codes: *N - VLT Peer Synced MAC
VlanId     Mac Address           Type          Interface
State
 1      00:01:e8:8b:36:10       Dynamic         Po 111
Active
 1      00:18:8b:a2:cb:3b       Dynamic         Po 111
Active
 1      00:1e:c9:de:01:70       Dynamic         Po 123
Active
 1      00:1e:c9:de:01:78       Dynamic         Po 123
Active
 1      18:a9:9b:d9:28:81       Dynamic         Po 123
Active
 1      18:a9:9b:d9:2f:27       Dynamic         Po 123
Active
```

Example of `show vlt brief` on switch S4810-2.

S4810-2

```
S4810-2#show vlt brief
```

```
 VLT Domain Brief
------------------
 Domain ID:                      2
 Role:                           Secondary
 Role Priority:                  2
 ICL Link Status:                Up
 HeartBeat Status:               Up
 VLT Peer Status:                Up
 Local Unit Id:                  1
 Version:                        6(2)
 Local System MAC address:       00:01:e8:8b:34:d9
 Remote System MAC address:      00:01:e8:8b:32:48
 Remote system version:          6(2)
 Delay-Restore timer:            90 seconds
 Peer-Routing :                  Disabled
 Peer-Routing-timeout timer:     0 seconds
 Multicast peer-routing timeout: 150 seconds
```

Example of `show vlt detail` on switch `S4810-2`.

S4810-2

```
S4810-2#show vlt detail

Local LAG Id  Peer LAG Id  Local Status  Peer Status  Active VLANs
------------  -----------  ------------  -----------  -------------
111           111          UP            UP            1
124           123          UP            UP            1
```

Example of `show mac-address-table` on switch S4810-2.

S4810-2

```
S4810-2#show mac-address-table
```

```
Codes: *N - VLT Peer Synced MAC
VlanId     Mac Address           Type          Interface
State
 1      00:01:e8:8b:36:10       Dynamic (N)     Po 111
Active
 1      00:18:8b:a2:cb:3b       Dynamic (N)     Po 111
Active
 1      00:1e:c9:de:01:70       Dynamic (N)     Po 124
Active
 1      00:1e:c9:de:01:78       Dynamic (N)     Po 124
Active
 1      18:a9:9b:d9:28:81       Dynamic (N)     Po 124
Active
 1      18:a9:9b:d9:2f:27       Dynamic (N)     Po 124
Active
```

8 Environment Three: Dell Networking Switches with mVLT and FN IOM in Programmable MUX Mode.

This section presents an example of Dell Networking switches working together in a multi-Virtual Link Trunking (mVLT) configuration.

Figure 37 illustrates using Dell's VLT protocol on a pair of IOMs in a switch environment consisting of two Dell Networking S4810 switches. In this mVLT configuration, multiple valid paths exist which enable the environment to survive the failure of one S4810 switch and/or one IOM, and/or one NIC interface per server. Because all paths are actively used, the result is a highly fault-tolerant environment. This fault-tolerant environment makes full use of the throughput capabilities of all switches.

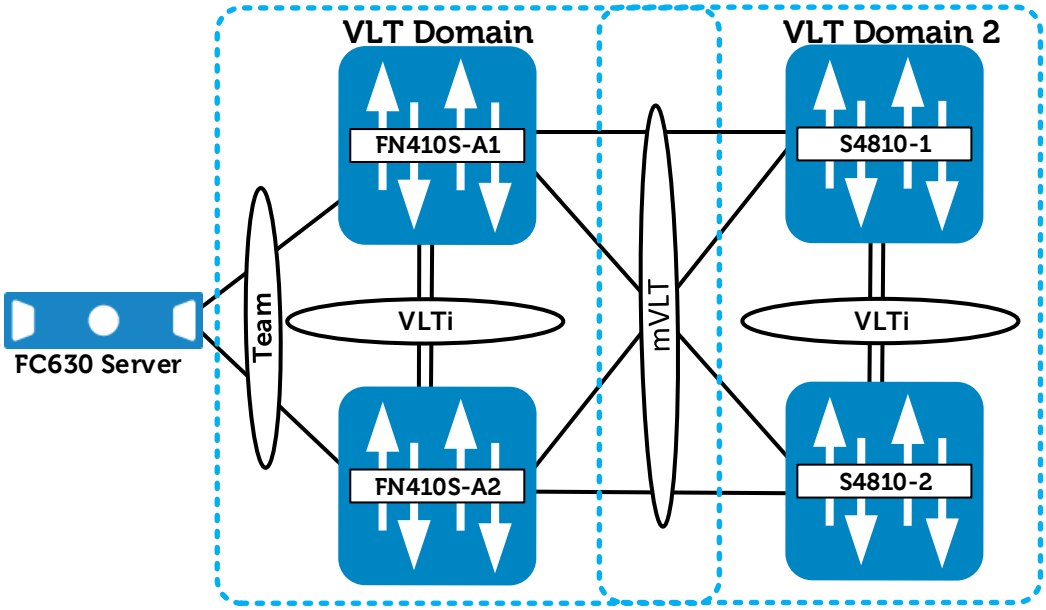


Figure 37 mVLT Configuration with a PowerEdge FX2, IOMs and S4810 Switches

8.1 Environment Three: FN IOM Configuration

The configuration steps outlined below are repeated on both IOMs. When validating the configurations in this guide the following management IP addresses (Table 9) were used.

Table 9 Management IP Address

Hostname	IP Address	Subnet
FN410S-A1	172.25.189.27	255.255.0.0
FN410S-A2	172.25.189.28	255.255.0.0

Note: If the IOMs have been previously configured, existing configuration settings will be retained when changing IOM modes. Because of this, it is recommended that the IOMs be returned to factory defaults before configuring. See the Reset FN IOM to Default Factory Configuration section for instructions on setting an IOM back to factory defaults.

8.1.1 Configuring the FN IOM for Programmable MUX Mode

In this section, the switch is set to Programmable MUX (PMUX) mode.

In Figure 38, configuration mode is used to set the switch to PMUX IOM mode, then the configuration is saved and the switch is reloaded. Once the reload is complete, the IOM mode is verified using the `show system stack-unit iom- mode` command. Then, the management IP address is assigned to allow VLT heartbeats as well as SSH/telnet access.

Note: Only the VLT-related portions of the configurations are shown.

FN410S-A1	FN410S-A2
Configure the IOM for Programmable MUX mode	Configure the IOM for Programmable MUX mode

`configure`
`stack-unit 0 iom-mode programmable-mux`
`end`
	`configure`
	`stack-unit 0 iom-mode programmable-mux`
	`end`

Verify that the system is set to move to Programmable-MUX mode for the next-boot and reload	Verify that the system is set to move to Programmable-MUX mode for the next-boot and reload
`show system stack-unit 0 iom-mode` `reload`	`show system stack-unit 0 iom-mode` `reload`
Confirm the iom-mode Configure the Management IP address	Confirm the iom-mode Configure the Management IP address

`show system stack-unit 0 iom-mode`
`configure`
`interface ma0/0`
`ip address 172.25.189.27/16`
	`show system stack-unit 0 iom-mode`
	`configure`
	`interface ma0/0`
	`ip address 172.25.189.28/16`

Figure 38 Configuring the FN IOM for PMUX Mode

8.1.2 Configuring VLT on the FN IOM

In this section, the VLTi peer link is configured (Figure 39).

First, the port channel that will be assigned as the VLTi peer link is created. Next, in PMUX mode, a VLT domain is created. The peer link is then assigned and the backup destination is configured to enable the heartbeats to go over the management network. Finally, a unit ID is specified to ensure that the two IOM peer switches are assigned primary or secondary roles.

Note: In this example, the port channel number matches on both sides. This is not a strict requirement.

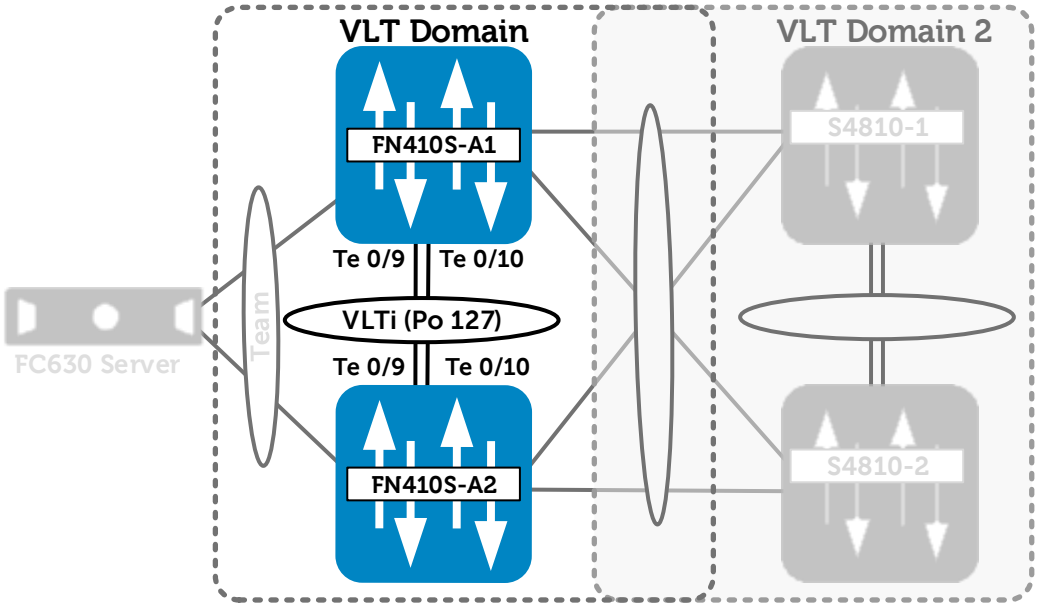


Figure 39 VLTi Peer Link Configuration

Figure 40 contains the steps necessary to configure the VLT peer links.

FN410S- A1	FN410S- A2
Configure the VLTi Port-Channel interface Add a description Add channel members	Configure the VLTi Port-Channel interface Add a description Add channel members

`interface port-channel 127`
`  description VLTI link to VLT- Switch A2`
`channel-member te0/9 - 10`
`no switchport`
`no shutdown`
`exit`
	`interface port-channel 127`
	`  description VLTI link to VLT- Switch A1`
	`channel-member te0/9 - 10`
	`no switchport`
	`no shutdown`
	`exit`

Configure the VLT domain Set peer link port channel of Switch A2 Configure the backup destination management IP (management IP of the other switch) Set unit id	Configure the VLT domain Set peer link port channel of Switch A1 Configure the backup destination management IP (management IP of the other switch) Set unit id

`vlt domain 1`
`  peer-link port-channel 127`
`  back-up destination 172.25.189.28`
`  unit-id 0`
`  exit`
	`vlt domain 1`
	`  peer-link port-channel 127`
	`  back-up destination 172.25.189.27`
	`  unit-id 1`
	`  exit`

Figure 40 Configuring the VLT Participating Links

Next, another port channel is created for the FC630 blade server to communicate. A corresponding VLT peer lag is assigned to the peer switch. Internal port te0/1 is added to the port channel and LACP is enabled with the active mode command (Figure 41).

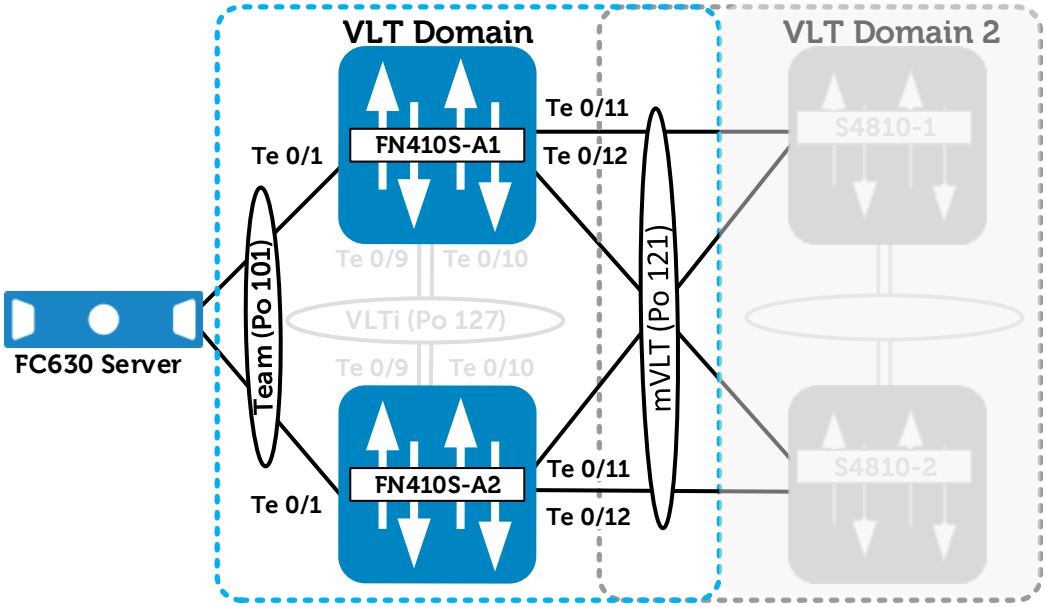


Figure 41 VLT LAG to Teamed NIC interfaces (#1) and VLT LAG to mVLT S4810 Connection (#2)

A final port channel is created for upstream communication to the pair of S4810 switches. The VLT peer lag is set to the same port channel ID. External facing interfaces 11 and 12 are added to this port channel and LACP is enabled with the active mode command

Figure 42 contains the steps necessary to configure the peer LAG and the upstream links for the mVLT connection.

FN410S-A1	FN410S-A2
Configure the peer LAG, and then configure upstream links for the mVLT connection. Create the port channel	Configure the peer LAG, and then configure upstream links for the mVLT connection. Create the port channel

`interface port-channel 101`
` description "PO to CNA NIC 1"`
` portmode hybrid`
` switchport`
` vlt-peer-lag po101`
` no shutdown`
` exit`
	`interface port-channel 101`
	` description "PO to CNA NIC 1"`
	` portmode hybrid`
	` switchport`
	` vlt-peer-lag po101`
	` no shutdown`
	` exit`

Configure the internal port and set the port channel	Configure the internal port and set the port channel

`interface te0/1`
` no switchport`
` port-channel-protocol lacp`
`  port-channel 101 mode active`
`  no shutdown`
`  exit`
	`interface te0/1`
	` no switchport`
	` port-channel-protocol lacp`
	`  port-channel 101 mode active`
	`  no shutdown`
	`  exit`

Configure the port channel for upstream interfaces	Configure the port channel for upstream interfaces

`interface port-channel 121`
`  description "PO to Dell S4810"`
`  portmode hybrid`
`  switchport`
`  vlt-peer-lag po121`
`  no shutdown`
`  exit`
	`interface port-channel 121`
	`  description "PO to Dell S4810"`
	`  portmode hybrid`
	`  switchport`
	`  vlt-peer-lag po121`
	`  no shutdown`
	`  exit`

Configure the interfaces that will participate in the VLT port channel.	Configure the interfaces that will participate in the VLT port channel.

`interface range te0/11-12`
` description "Link to Dell S4810"`
` no switchport`
` port-channel-protocol lacp`
	`interface range te0/11-12`
	` description "Link to Dell S4810"`
	` no switchport`
	` port-channel-protocol lacp`

```
 port-channel 121 mode
active
 exit
no shutdown
exit
```

```
 port-channel 121 mode
active
 exit
no shutdown
exit
```

Figure 42 Connection to Server NICs and Connections to S4810 Switches

8.2 Environment Three: Configuring the Dell Networking S4810

In this section, the S4810 switches are configured (Figure 43). The configuration steps outlined below are repeated on both IOMs. When validating the configurations in this guide the following management IP addresses (Table 10) were used.

Table 10 Management IP Addresses

Hostname	IP Address	Subnet
S4810-1	172.25.190.37	255.255.0.0
S4810-2	172.25.190.38	255.255.0.0

The VLT active/active capabilities of the S4810 and the IOM are the same. Therefore, the configurations should look and behave in the same manner.

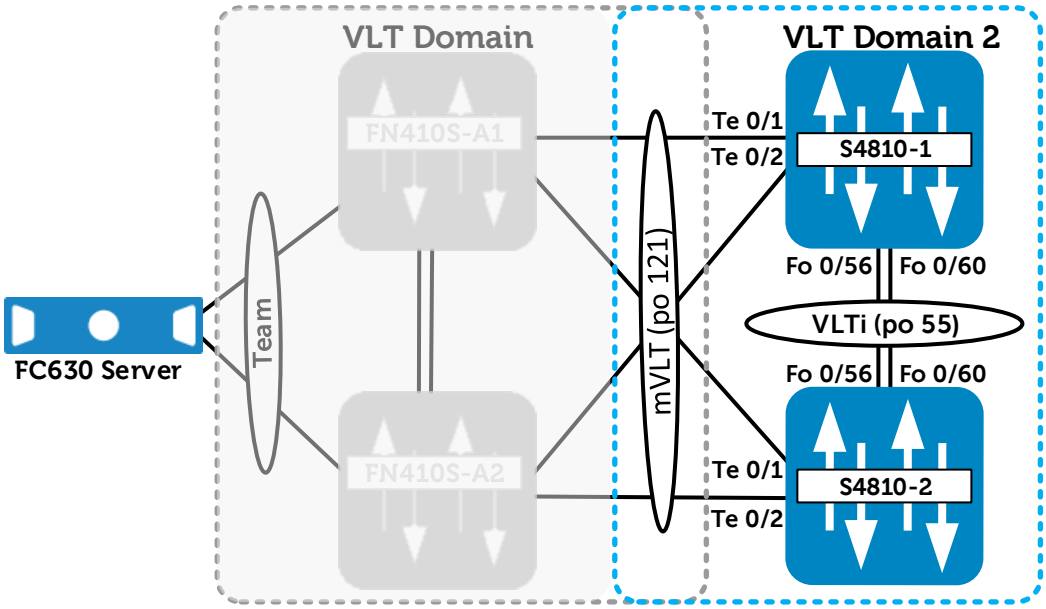


Figure 43 S4810 Member and Peer Link (ICL) Configuration

The steps necessary to configure the VLT links are shown in Figure 44.

S4810-1	S4810-2
Configure the VLT links including the ICL/peer link on the S4810 Configure the peer link	Configure the VLT links including the ICL/peer link on the S4810 Configure the peer link

`interface port-channel 55`
` description "VLTi Link to 4810-2"`
` channel-member fortyGigE 0/56,60`
` no shutdown`
` exit`
`interface range fo0/56,fo0/60`
` description "VLTi Peer-Link"`
` no shutdown`
` exit`
	`interface port-channel 55`
	` description "VLTi Link to 4810-1"`
	` channel-member fortyGigE 0/56,60`
	` no shutdown`
	` exit`
	`interface range fo0/56,fo0/60`
	` description "VLTi Peer-Link"`
	` no shutdown`
	` exit`

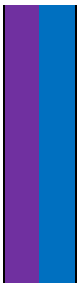
Configure the VLT domain Set the peer link port channel of Switch 2 Configure back-up destination management IP (management IP of the other switch)	Configure the VLT domain Set the peer link port channel of Switch 1 Configure back-up destination management IP (management IP of the other switch)

`vlt domain 2`
` peer-link port-channel 55`
` back-up destination 172.25.190.38`
` unit-id 0`
` exit`
	`vlt domain 2`
	` peer-link port-channel 55`
	` back-up destination 172.25.190.37`
	` unit-id 1`
	` exit`

Configure the participating port channel Configure the links that are part of the port channel	Configure the participating port channel Configure the links that are part of the port channel

`int port-channel 121`
` description "Port Channel to IOM Pair"`
` Portmode hybrid`
` Switchport`
` vlt-peer-lag po121`
` no shutdown`
` exit`
`interface range te0/1-2`
	`int port-channel 121`
	` description "Port Channel to IOM Pair"`
	` Portmode hybrid`
	` Switchport`
	` vlt-peer-lag po121`
	` no shutdown`
	` exit`
	`interface range te0/1-2`

```
 description "Portchannel
link to IOM"
 no switchport
 port-channel-protocol lacp
 port-channel 121 mode
active
 exit
 no shutdown
```



```
 description "Portchannel
link to IOM"
 no switchport
 port-channel-protocol lacp
 port-channel 121 mode
active
 exit
 no shutdown
```

Figure 44 S4810 VLT Configuration

Note: When you create a VLT domain on a switch, the system automatically assigns a unique unit ID (0 or 1) to each peer switch. Optionally, the unit ID can be manually configured as shown in the examples above to minimize the time required for the VLT system to determine the unit ID assigned to each peer switch when one peer switch reboots.

8.3 Environment Three: Verifying VLT Connectivity

VLT connectivity can be checked using the VLT commands listed in Table 11.

Table 11 show Commands

Command	Purpose
`show vlt brief`	Displays brief information about the VLT configuration
`show vlt detail`	Displays running configuration for VLT members
`show mac-address-table`	Displays the MAC address table

On each switch participating in VLT, perform a `show vlt brief`, `show vlt detail` and `show mac-address-table`. On the access switch, perform a `show mac-address-table`.

`show vlt brief`

The Role (Primary or Secondary) should be appropriate for the switch. The status of the ICL Link, HeartBeat and VLT Peer must all be up.

`show vlt detail`

This command shows the local LAG ID, the peer LAG ID, the local status of the VLT, the peer status of the VLT, and the active VLANs for the VLT.

Columns Local Status and Peer status must be UP in order for the LAG to be functional.

`show mac-address-table`

Each switch should be learning the upstream and downstream MAC addresses using all local port channels.

The following are examples of the output from these show commands.

Example of `show vlt brief` on switch FN410S-A1.

FN410S-A1

```
FN410S-A1#show vlt brief


 VLT Domain Brief
------------------
 Domain ID:                       1
 Role:                            Secondary
 Role Priority:                   32768
 ICL Link Status:                 Up
 HeartBeat Status:                Up
 VLT Peer Status:                 Up
 Local Unit Id:                   0
 Version:                         6(2)
 Local System MAC address:        00:1e:c9:de:01:7a
 Remote System MAC address:       00:1e:c9:de:01:72
 Remote system version:           6(2)
 Delay-Restore timer:             90 seconds
 Peer-Routing :                   Disabled
 Peer-Routing-Timeout timer:      0 seconds
 Multicast peer-routing timeout: 150 seconds
```

Example of `show vlt detail` on switch FN410S-A1.

FN410S-A1

```
FN410S-A1#show vlt detail


Local LAG Id  Peer LAG Id  Local Status  Peer Status  Active VLANs
------------  -----------  ------------  -----------  -------------
101           101          UP            UP            1
103           104          UP            UP            1
121           122          UP            UP            1
```

Example of `show mac-address-table` on switch FN410S-A1.

FN410S-A1

```
FN410S-A1#show mac-address-table


Codes: *N - VLT Peer Synced MAC
VlanId     Mac Address           Type           Interface
State
 1      00:01:e8:8b:32:4a       Dynamic (N)     Po 121
Active
 1      00:01:e8:8b:34:db       Dynamic (N)     Po 121
Active
 1      00:18:8b:a2:cb:3b       Dynamic (N)     Po 121
Active
 1      18:a9:9b:d9:28:81       Dynamic         Po 101
Active
 1      18:a9:9b:d9:28:84       Dynamic         Po 101
Active
 1      18:a9:9b:d9:2f:27       Dynamic (N)     Po 103
Active
 1      18:a9:9b:d9:2f:2a       Dynamic (N)     Po 103
Active
```

Example of `show vlt brief` on switch FN410S-A2.

FN410S-A2

```
FN410S-A2#show vlt brief
```

```
VLT Domain Brief
------------------
 Domain ID:                      1
 Role:                           Primary
 Role Priority:                  32768
 ICL Link Status:                Up
 HeartBeat Status:               Up
 VLT Peer Status:                Up
 Local Unit Id:                  1
 Version:                        6(2)
 Local System MAC address:       00:1e:c9:de:01:72
 Remote System MAC address:      00:1e:c9:de:01:7a
 Remote system version:          6(2)
 Delay-Restore timer:            90 seconds
 Peer-Routing :                  Disabled
 Peer-Routing-Timeout timer:     0 seconds
 Multicast peer-routing timeout: 150 seconds
```

Example of `show vlt detail` on switch FN410S-A2.

FN410S-A2

```
FN410S-A2#show vlt detail

Local LAG Id     Peer LAG Id  Local Status   Peer Status  Active
VLANs
------------     ----------   ------------  -----------  ----------
---
101              101          UP                  UP     1
104              103          UP                  UP     1
122              121          UP                  UP     1
```

Example of `show mac-address-table` on switch FN410S-A2.

FN410S-A2

```
FN410S-A2#show mac-address-table

Codes: *N - VLT Peer Synced MAC
VlanId     Mac Address           Type          Interface
State
 1      00:01:e8:8b:32:4a       Dynamic         Po 122
Active
 1      00:01:e8:8b:34:db       Dynamic         Po 122
Active
 1      00:18:8b:a2:cb:3b       Dynamic         Po 122
Active
 1      18:a9:9b:d9:28:81       Dynamic (N)     Po 101
Active
 1      18:a9:9b:d9:28:84       Dynamic (N)     Po 101
Active
 1      18:a9:9b:d9:2f:27       Dynamic         Po 104
Active
 1      18:a9:9b:d9:2f:2a       Dynamic         Po 104
Active
```

Example of `show vlt brief` on switch S4810-1.

S4810-1

```
S4810-1#show vlt brief


 VLT Domain Brief
------------------
 Domain ID:                      2
 Role:                           Primary
 Role Priority:                  1
 ICL Link Status:                Up
 HeartBeat Status:               Up
 VLT Peer Status:                Up
 Local Unit Id:                  0
 Version:                        6(2)
 Local System MAC address:       00:01:e8:8b:32:48
 Remote System MAC address:      00:01:e8:8b:34:d9
 Remote system version:          6(2)
 Delay-Restore timer:            90 seconds
 Peer-Routing :                  Disabled
 Peer-Routing-timeout timer:     0 seconds
 Multicast peer-routing timeout: 150 seconds
```

Example of `show vlt detail` on switch S4810-1.

S4810-1

```
S4810-1#show vlt detail


Local LAG Id  Peer LAG Id  Local Status  Peer Status  Active VLANs
------------  -----------  ------------  -----------  -------------
111           111          UP            UP            1
123           124          UP            UP            1
```

Example of `show mac-address-table` on switch S4810-1.

S4810-1

```
S4810-1#show mac-address-table

Codes: *N - VLT Peer Synced MAC
VlanId     Mac Address           Type          Interface
State
 1      00:01:e8:8b:36:10       Dynamic         Po 111
Active
 1      00:18:8b:a2:cb:3b       Dynamic         Po 111
Active
 1      00:1e:c9:de:01:70       Dynamic         Po 123
Active
 1      00:1e:c9:de:01:78       Dynamic         Po 123
Active
 1      18:a9:9b:d9:28:81       Dynamic         Po 123
Active
 1      18:a9:9b:d9:2f:27       Dynamic         Po 123
Active
```

Example of `show vlt brief` on switch S4810-2.

S4810-2

```
S4810-2#show vlt brief
```

```
 VLT Domain Brief
------------------
 Domain ID:                      2
 Role:                           Secondary
 Role Priority:                  2
 ICL Link Status:                Up
 HeartBeat Status:               Up
 VLT Peer Status:                Up
 Local Unit Id:                  1
 Version:                        6(2)
 Local System MAC address:       00:01:e8:8b:34:d9
 Remote System MAC address:      00:01:e8:8b:32:48
 Remote system version:          6(2)
 Delay-Restore timer:            90 seconds
 Peer-Routing :                  Disabled
 Peer-Routing-timeout timer:     0 seconds
 Multicast peer-routing timeout: 150 seconds
```

Example of `show vlt detail` on switch S4810-2.

S4810-2

```
S4810-2#show vlt detail

Local LAG Id  Peer LAG Id  Local Status  Peer Status  Active VLANs
------------  -----------  ------------  -----------  -------------
111           111          UP            UP            1
124           123          UP            UP            1
```

Example of `show mac-address-table` on switch S4810-2.

S4810-2

```
S4810-2#show mac-address-table
```

```
Codes: *N - VLT Peer Synced MAC
VlanId     Mac Address           Type          Interface
State
 1      00:01:e8:8b:36:10       Dynamic (N)     Po 111
Active
 1      00:18:8b:a2:cb:3b       Dynamic (N)     Po 111
Active
 1      00:1e:c9:de:01:70       Dynamic (N)     Po 124
Active
 1      00:1e:c9:de:01:78       Dynamic (N)     Po 124
Active
 1      18:a9:9b:d9:28:81       Dynamic (N)     Po 124
Active
 1      18:a9:9b:d9:2f:27       Dynamic (N)     Po 124
Active
```

9 Environment Four: VLT Interoperability with Cisco vPC

As switching environments become more complex and non-vendor specific, fault tolerant designs have to interoperate with protocols which are similar, but not exactly the same as VLT. In this environment, VLT interacts with Cisco Nexus vPC (virtual PortChannel).

The diagram in Figure 45 shows a typical small environment using the VLT protocol on a pair of FN IOMs interoperating with a pair of Cisco Nexus 5000 series switches using the vPC. In this example, multiple valid paths exist that allow the environment to survive a failure of one Cisco switch and/or one FN IOM, and/or one NIC interface per server. It will also survive multiple cable or switch interface failures on the links where fault tolerance is used.

Since all paths are actively used, the result is a highly fault-tolerant environment, which makes full use of the throughput capabilities of all switches.

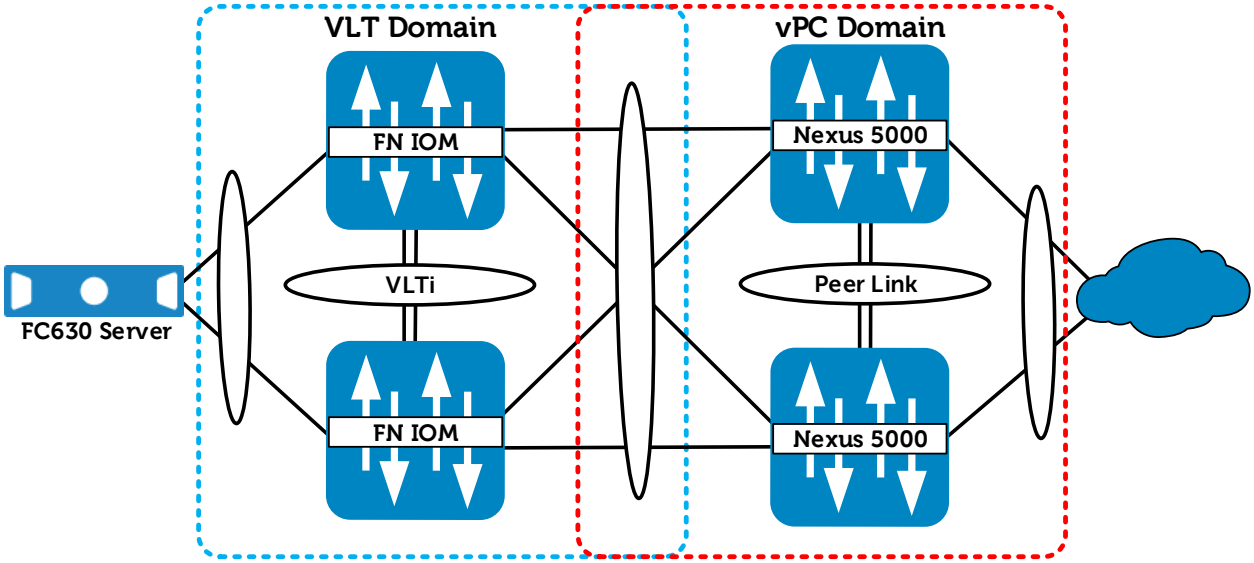


Figure 45 Multiple Vendor Environment: VLT Interoperability with Cisco vPC

The configuration examples that follow assume the switches have been restored to their default configurations. For the FN IOM, see the Reset FN IOM to Default Factory Configuration section for instructions on setting an IOM back to factory defaults. For the Nexus 5000 switches, use the `write erase` command or check your system documentation.

Note: Only the VLT and vPC related portions of the configurations are shown.

9.1 Environment Four: FN IOM Configuration

The configuration steps outlined below are repeated on both IOMs. When validating the configurations in this guide the following management IP addresses (Table 12) were used.

Table 12 Management IP Addresses

Hostname	IP Address	Subnet
FN410S-A1	172.25.210.55	255.255.0.0
FN410S-A2	172.25.210.56	255.255.0.0

9.1.1 Configuring the FN IOM for Programmable MUX Mode

In this section, the switch is set to Programmable MUX (PMUX) mode.

In Figure 46, configuration mode is used to set the switch to PMUX IOM mode, then the configuration is saved and the switch is reloaded. Once the reload is complete, the IOM mode is verified using the show system stack-unit iom mode command. Then, the management IP address is assigned to allow VLT heartbeats as well as SSH/telnet access.

FN410S-A1	FN410S-A2
Configure the IOM for Programmable MUX mode.	Configure the IOM for Programmable MUX mode.

`configure`
`stack-unit 0 iom-mode programmable-mux`
`end`
	`configure`
	`stack-unit 0 iom-mode programmable-mux`
	`end`

Verify that the system is set to move to Programmable-MUX mode for the next boot and reload.	Verify that the system is set to move to Programmable-MUX mode for the next boot and reload.
`show system stack-unit 0 iom-mode` `reload`	`show system stack-unit 0 iom-mode` `reload`
Confirm the FN IOM mode. Configure the management IP address.	Confirm the FN IOM mode. Configure the management IP address.

`show system stack-unit 0 iom-mode`
`configure`
`interface ma0/0`
`ip address 172.25.210.55/16`
	`show system stack-unit 0 iom-mode`
	`configure`
	`interface ma0/0`
	`ip address 172.25.210.56/16`

Figure 46 Switch to PMUX Mode

Note: When an FN IOM is connected to a Cisco Nexus in the default state, a number of DCBX (Data Center Bridging Exchange) error messages will be logged and shown on the FN IOM serial console each time a port or port channel is shutdown or brought up. To suppress these messages, either configure DCBX on the FN IOM and Nexus switches (which is out of the scope of this document) or disable DCB on the FN IOM with the command: **`Dell(conf)#no dcb enable`**

9.1.2 Configuring VLT on the FN IOM

In this section, the VLT domain and VLTi (VLT interconnect) participating links are configured (Figure 476).

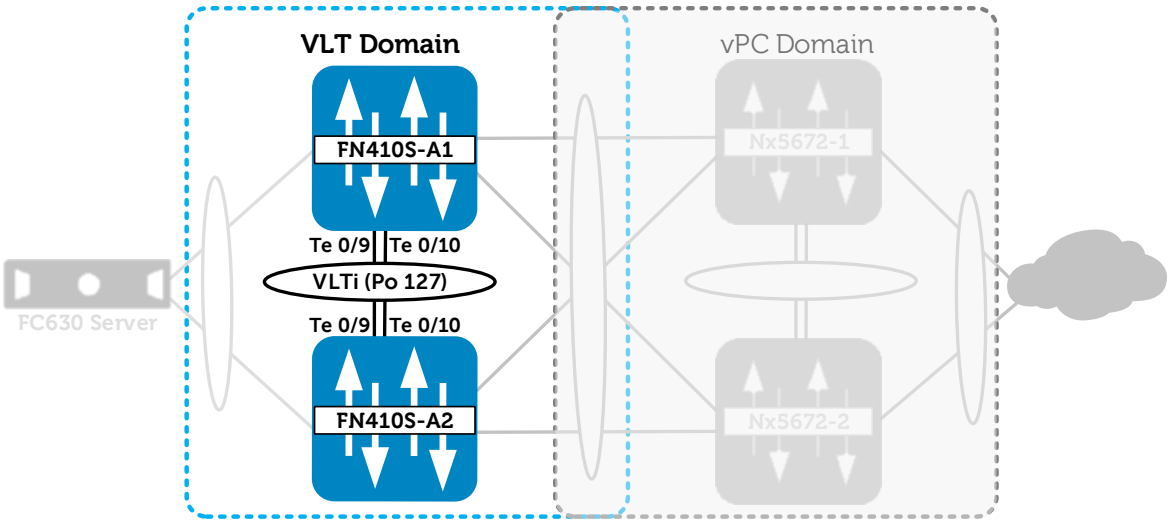


Figure 47 FN410S VLT Configuration and VLTi Setup

Figure 48 contains the steps necessary to configure the VLTi.

FN410S-A1	FN410S-A2
Configure the VLTi and member links	Configure the VLTi and member links

`interface Port-channel 127`
` description "VLTi LAG to FN410S-A2"`
` channel-member TenGigabitEthernet 0/9-10`
` no shutdown`
` exit`
`interface range TenGigabitEthernet 0/9-10`
` description "Link to FN410S-A2"`
` no switchport`
` no shutdown`
` exit`
	`interface Port-channel 127`
	` description "VLTi LAG to FN410S-A2"`
	` channel-member TenGigabitEthernet 0/9-10`
	` no shutdown`
	` exit`
	`interface range TenGigabitEthernet 0/9-10`
	` description "Link to FN410S-A2"`
	` no switchport`
	` no shutdown`
	` exit`

Configure the VLT domain and set the peer link port channel Configure the backup destination (management IP of the other switch)	Configure the VLT domain and set the peer link port channel Configure the backup destination (management IP of the other switch)

`vlt domain 1`
`  peer-link port-channel 127`
`  back-up destination 172.25.210.56`
`  unit-id 0`
`  exit`
	`vlt domain 1`
	`  peer-link port-channel 127`
	`  back-up destination 172.25.210.55`
	`  unit-id 1`
	`  exit`

Figure 48 IOM VLT Peer Link Configuration

Note: When you create a VLT domain on a switch, the system automatically assigns a unique unit ID (0 or 1) to each peer switch. Optionally, the unit ID can be manually configured as shown above to minimize the time required for the VLT system to determine the unit ID assigned to each peer switch when one peer switch reboots.

Next, the VLT port channels and member ports are configured (Figure 49).

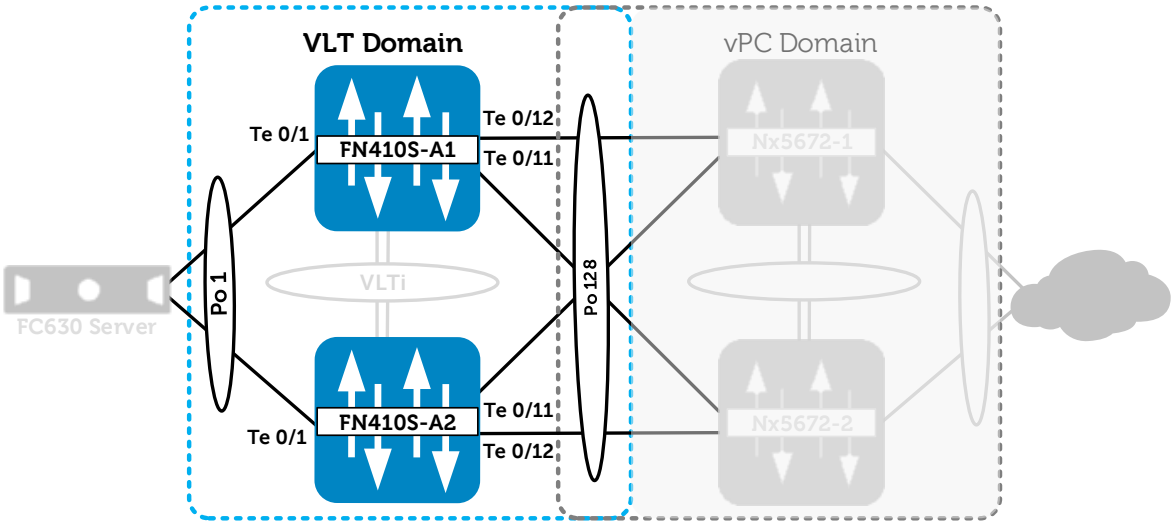


Figure 49 VLT Port Channels and Member Ports

Figure 50 shows the necessary steps to configure the VLT peer LAGs.

FN410S-A1	FN410S-A2
Configure the downstream VLT LAG to the Server	Configure the downstream VLT LAG to the Server

`interface Port-channel 1`
` description "VLT LAG to FC430 Server"`
` portmode hybrid`
` switchport`
` vlt-peer-lag port-channel 1`
` no shutdown`
` exit`
	`interface Port-channel 1`
	` description "VLT LAG to FC430 Server"`
	` portmode hybrid`
	` switchport`
	` vlt-peer-lag port-channel 1`
	` no shutdown`
	` exit`

Configure the downstream interface that will participate in the VLT LAG	Configure the downstream interface that will participate in the VLT LAG

`interface TenGigabitEthernet 0/1`
` description "Link to FC430 Server"`
` no switchport`
` port-channel-protocol LACP`
`  port-channel 1 mode active`
` exit`
` no shutdown`
` exit`
	`interface TenGigabitEthernet 0/1`
	` description "Link to FC430 Server"`
	` no switchport`
	` port-channel-protocol LACP`
	`  port-channel 1 mode active`
	` exit`
	` no shutdown`
	` exit`

Configure the upstream VLT peer LAG to the Nexus 5672	Configure the upstream VLT peer LAG to the Nexus 5672

`interface Port-channel 128`
` description "VLT LAG to 5672"`
` portmode hybrid`
` switchport`
` vlt-peer-lag port-channel 128`
` no shutdown`
` exit`
	`interface Port-channel 128`
	` description "VLT LAG to 5672"`
	` portmode hybrid`
	` switchport`
	` vlt-peer-lag port-channel 128`
	` no shutdown`
	` exit`

Configure the upstream interfaces that will participate in the VLT LAG	Configure the upstream interfaces that will participate in the VLT LAG
`interface range TenGigabitEthernet 0/11-12` ` description "Link to 5672"`	`interface range TenGigabitEthernet 0/11-12` ` description "Link to 5672"`

```
no switchport
port-channel-protocol LACP
 port-channel 128 mode
active
 exit
 no shutdown
 exit
```

```
no switchport
port-channel-protocol LACP
 port-channel 128 mode
active
 exit
 no shutdown
 exit
```

Figure 50 Configuring VLT Member Ports to Downstream Servers and Uplinked Cisco Nexus

9.2 Environment Four: Cisco Nexus 5000 Series vPC Configuration

In this section, vPC is configured on the Cisco Nexus 5672 (Figure 51 thru Figure 57).

Note: The following vPC configuration is based on recommendations from: Cisco NX-OS Software Virtual PortChannel: Fundamental Concepts 5.0 (Cisco Inc.).

A single vPC domain with the following critical components is required for a successful vPC deployment:

- **vPC Peer Switches:** Two switches connected using a special port channel known as a vPC Peer-Link.
- **vPC Peer Link:** This port channel is used to synchronize data between the vPC peer switches. The link carrier controls traffic between two vPC switches as well as multicast and broadcast data.
- **vPC Domain:** A vPC domain contains both vPC peer switches, the vPC peer keepalive link and all of the port channels in the vPC connected to the downstream devices. A domain can be assigned with a value from 1 to 1000.
- **vPC Peer Keepalive Link:** The keepalive link monitors the vitality of a vPC peer switch. This link will send periodic keepalive messages between vPC peer switches. This link can be part of the management network, as it does not send data or synchronization traffic, only keepalive messages.
- **vPC Member Ports:** vPC member ports are interfaces that belong to the vPCs.

Note: A full list of terms can be found in the Terminology section of the Appendix.

Figure 51 shows that the Dell Networking architecture for mVLT is very similar to this brand-varied Multi-Chassis Link Aggregation Group (MC-LAG) architecture.

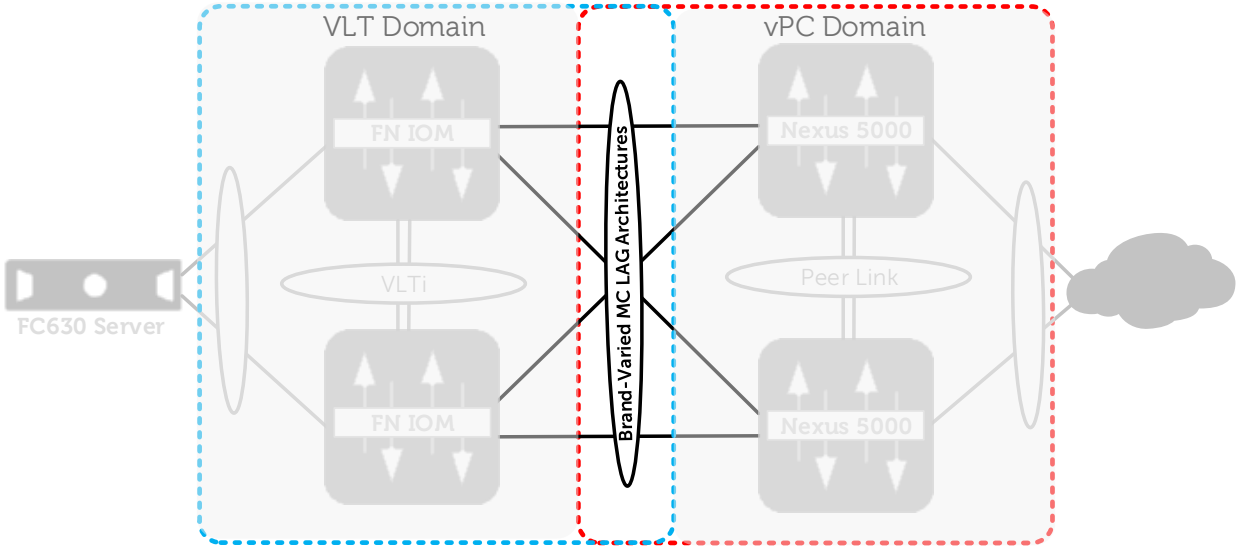


Figure 51 Cisco vPC – Dell Networking VLT – Multi-Vendor Same Port Channels

The configuration steps outlined below are repeated on both Nexus switches. When validating the configurations in this guide the following management IP addresses (Table 13) were used.

Table 13 IP Addresses

Hostname	IP Address	Subnet
Nx5672-1	172.25.109.37	255.255.0.0
Nx5672-2	172.25.109.24	255.255.0.0

In this section, the vPC domain and vPC Peer Link ports are configured.

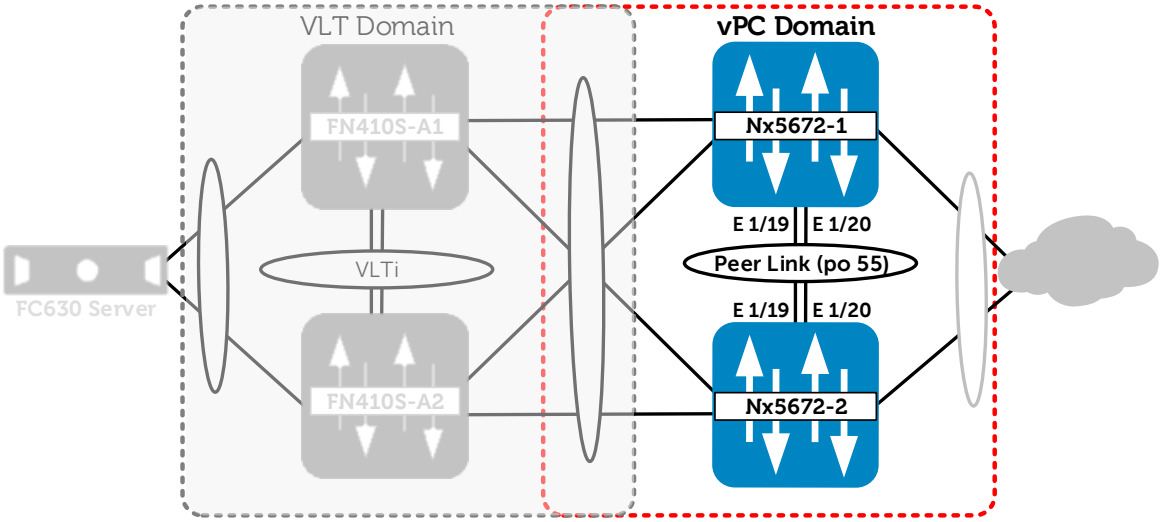


Figure 52 vPC Domain and vPC Peer Links

Figure 5352 presents the steps to configure the vPC domain.

Nx5672-1	Nx5672-2
Enable the features and management interface for vPC Enable LACP and vPC features	Enable the features and management interface for vPC Enable LACP and vPC features

`configure`
`feature lacp`
`feature vpc`
	`configure`
	`feature lacp`
	`feature vpc`

Assign an IP address to management interface	Assign an IP address to management interface

`interface mgmt 0`
` ip address`
`172.25.109.37/16`
` no shutdown`
` exit`
	`interface mgmt 0`
	` ip address`
	`172.25.109.24/16`
	` no shutdown`
	` exit`

Create the VPC domain Assign a role priority of 1 Assign the keepalive management IP of Switch A2	Create the VPC domain Assign a role priority of 65535 Assign the keepalive management IP of Switch A1

`vpc domain 1`
` role priority 1`
` peer-keepalive dest`
`172.25.109.24`
`exit`
	`vpc domain 1`
	` role priority 65535`
	` peer-keepalive dest`
	`172.25.109.37`
	`exit`

Figure 53 vPC Domain and Initial Configuration

The `role priority 1` command specifies that Switch Nx5672-1 will be the primary switch in the vPC domain. On the other switch, a role priority of 65535 will be used to ensure the roles will be assigned properly if the switches are rebooted. Finally, a peer keepalive address is specified. The peer keepalive address is the management address of the vPC peer switch. This setting allows keepalive heartbeat packets to flow through the management network.

In these next steps, the port channel and port channel members for the vPC peer link are configured.

Interface ports Ethernet 1/19 and 1/20 are added to port channel 55 and set to use LACP unconditionally using the `mode active` option.

Nx5672-1	Nx5672-2
Configure the port channel and port channel members for the vPC peer link Create the port channel Enable the switchport mode trunk and assign as vpc peer link	Configure the port channel and port channel members for the vPC peer link Create the port channel Enable the switchport mode trunk and assign as vpc peer link

`interface port-channel 55`
`description "vPC Peer-Link to Nx5672-2"`
`switchport mode trunk`
`switchport mode trunk allowed vlan all`
`no shutdown`
`vpc peer-link`
`exit`
	`interface port-channel 55`
	`description "vPC Peer-Link to Nx5672-1"`
	`switchport mode trunk`
	`switchport mode trunk allowed vlan all`
	`no shutdown`
	`vpc peer-link`
	`exit`

Assign interfaces to the port channel and enable LACP	Assign interfaces to the port channel and enable LACP.

`interface ethernet 1/19-20`
`description "Link to Nx5672-2"`
`switchport mode trunk`
`channel-group 55 mode active`
`no shutdown`
`exit`
	`interface ethernet 1/19-20`
	`description "Link to Nx5672-1"`
	`switchport mode trunk`
	`channel-group 55 mode active`
	`no shutdown`
	`exit`

Figure 54 vPC Peer Link Setup

Once the vPC domain is created, the vPC Peer-Link is formed using port channel 55. The port channel connects both vPC peer switches and should be configured to carry all VLANs. Finally, the port channel is

enabled and the `vpc peer link` command is issued to specify the role of this port channel in the vPC domain.

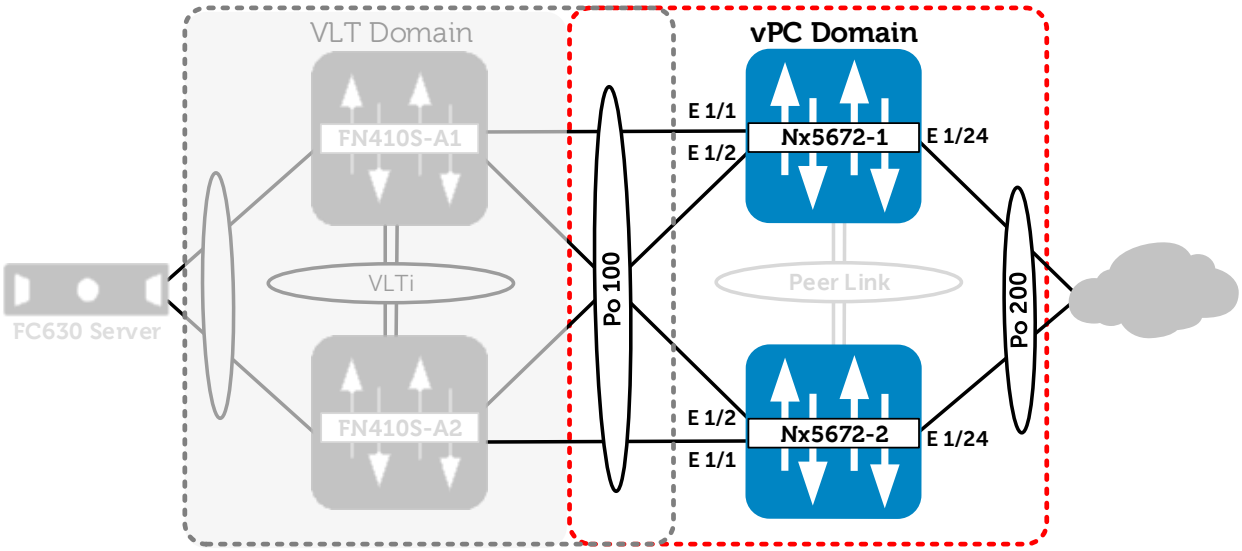


Figure 55 Nexus Virtual Port Channels and vPC Member Ports

The virtual port channels and vPC member ports are configured for connectivity to the FN IOM's (Figure 55).

Nx5672-1	Nx5672-2
Configure the port channel and port channel member links for downstream connectivity to the FN IOMs	Configure the port channel and port channel member links for downstream connectivity to the FN IOMs

`interface port-channel 100`
`description "vPC to FN410S"`
`switchport mode trunk`
`switchport mode trunk`
`allowed vlan all`
`vpc 100`
`no shutdown`
`exit`
	`interface port-channel 100`
	`description "vPC to FN410S"`
	`switchport mode trunk`
	`switchport mode trunk`
	`allowed vlan all`
	`vpc 100`
	`no shutdown`
	`exit`

Assign interfaces to the port channel and enable LACP	Assign interfaces to the port channel and enable LACP

`interface ethernet 1/1-2`
`description "Link to FN410S"`
`switchport mode trunk`
`channel-group 100 mode active`
`no shutdown`
`exit`
	`interface ethernet 1/1-2`
	`description "Link to FN410S"`
	`switchport mode trunk`
	`channel-group 100 mode active`
	`no shutdown`
	`exit`

Figure 56 Port Channel Configuration to IOM from vPC

Port Channel 200 is created and connectivity to the external network is configured

Nx5672-1	Nx5672-2
Configure the port channel and port channel members for upstream connectivity to the external network	Configure the port channel and port channel members for upstream connectivity to the external network

`interface port-channel 200`
`description "vPC to External Network"`
`switchport mode trunk`
`switchport mode trunk allowed vlan all`
`vpc 200`
`no shutdown`
`exit`
	`interface port-channel 200`
	`description "vPC to External Network"`
	`switchport mode trunk`
	`switchport mode trunk allowed vlan all`
	`vpc 200`
	`no shutdown`
	`exit`

Assign an interface to the port channel and enable LACP	Assign an interface to the port channel and enable LACP

`interface ethernet 1/24`
`description "Link to External Network"`
`switchport mode trunk`
`channel-group 200 mode active`
`no shutdown`
`exit`
	`interface ethernet 1/24`
	`description "Link to External Network"`
	`switchport mode trunk`
	`channel-group 200 mode active`
	`no shutdown`
	`exit`

Figure 57 Port Channel Configuration to External Network from vPC

9.3 Environment Four: Verify VLT Connectivity

VLT connectivity can be checked using the VLT commands listed in table 13.

Table 14 show Commands

Command	Purpose
show vlt brief	Displays brief information about the VLT configuration
show vlt detail	Displays running configuration for VLT members
show mac-address-table	Displays the MAC address table

See section 8.3 Environment Three: Verifying VLT Connectivity for sample output of the above commands.

9.4 Environment Four: Verify VPC Connectivity

Use the following commands (Table 154) to verify that the vPC configuration is valid.

Table 15 vPC show commands used to verify the vPC configuration

Command	Purpose
show feature	Reports if vPC is enabled or not
show vpc brief	Displays brief information about the vPCs
show interface port-channel	Displays vPC status and vPC number of the port channel
show running-config vpc	Displays running configuration for vPCs
show vpc peer-keepalive	Displays information about the peer-keepalive

The output of the `show feature` command shown below has been passed to grep and filtered for any enabled features. The results show that *lacp* and *vpc* are both *enabled*.

Nx5672-1

```
Nx5672-1# show feature | grep enabled

lacp                  1         enabled
lldp                  1         enabled
sshServer             1         enabled
telnetServer          1         enabled
vpc                   1         enabled
```

`Show vpc brief` gives a quick verification that the vPC domain is functioning. The important point to note in the output of this command are `Configuration, Per-vlan and Type-2 consistency` all show the status of `success`.

Nx5672-1

```
5548-1# show vpc brief

Legend:

                (*) - local vPC is down, forwarding via vPC peer-link

vPC domain id                     : 1

Peer status                       : peer adjacency formed ok

vPC keep-alive status             : peer is alive

Configuration consistency status  : success

Per-vlan consistency status       : success

Type-2 consistency status         : success

vPC role                          : primary

Number of vPCs configured         : 2

Peer Gateway                      : Disabled

Dual-active excluded VLANs        : -

Graceful Consistency Check        : Enabled

Auto-recovery status              : Enabled (timeout = 240 seconds)

vPC Peer-link status

---------------------------------------------------------------------

id   Port   Status Active vlans

--   ----   ------ -------------------------------------------------

1    Po55   up     1

vPC status

----------------------------------------------------------------------------
-

id     Port        Status Consistency Reason                     Active
vlans

------ ----------- ------ ----------- -------------------------- ----------
-
```

```
100     Po100       up      success     success                    1

200     Po200       up      success     success                    1
```

The output of the show `interface port-channel` command is also updated with the vPC status and vPC number for port channels configured for vPC.

Nx5672-1

```
Nx5672-1# show interface port-channel 100


port-channel100 is up

 vPC Status: Up, vPC number: 100

  Hardware: Port-Channel, address: 002a.6adf.a0e8 (bia
002a.6adf.a0e8)

  Description: "vPC to FN410S"

  MTU 1500 bytes, BW 20000000 Kbit, DLY 10 usec

  reliability 255/255, txload 68/255, rxload 20/255

  Encapsulation ARPA

  Port mode is trunk

  full-duplex, 10 Gb/s

  Input flow-control is off, output flow-control is off

  Switchport monitor is off

  EtherType is 0x8100

  Members in this channel: Eth1/1, Eth1/2

  Last clearing of "show interface" counters never

  5 interface resets

  30 seconds input rate 1597191976 bits/sec, 143982 packets/sec

  30 seconds output rate 5434989272 bits/sec, 484950 packets/sec

  Load-Interval #2: 5 minute (300 seconds)
```

```
    input rate 1.60 Gbps, 143.70 Kpps; output rate 5.37 Gbps,
479.12 Kpps

RX

    644993875 unicast packets  1646 multicast packets  88 broadcast
packets

    644995613 input packets  901181970961 bytes

    0 jumbo packets  0 storm suppression bytes

    0 runts  0 giants  0 CRC  0 no buffer

    0 input error  0 short frame  0 overrun   0 underrun  0 ignored

0 watchdog  0 bad etype drop  0 bad proto drop  0 if down drop

    0 input with dribble  0 input discard

    0 Rx pause

  TX

    1959105966 unicast packets  21150 multicast packets  123
broadcast packets

    1959127229 output packets  2745782142132 bytes

    0 jumbo packets

    0 output error  0 collision  0 deferred  0 late collision

    0 lost carrier  0 no carrier  0 babble 0 output discard

    0 Tx pause

  5 interface resets
```

The `show running config vpc` command can be used to filter the running configuration to show only vPC related settings.

Nx5672-1

```
x5672-1# show running-config vpc

!Command: show running-config vpc
!Time: Sun Feb 17 21:06:03 2002
version 7.0(1)N1(1)
feature vpc
vpc domain 1
  role priority 1
  peer-keepalive destination 172.25.109.24
  delay restore 150
  auto-recovery
interface port-channel55
  vpc peer-link
interface port-channel100
  vpc 100
interface port-channel200
  vpc 200
```

Further information about the vPC peer switch keepalive can be extracted using `show vpc peer-keepalive`. The current status, IP address and the VRF associated with the keepalive are shown in the following output.

Nx5672-1

```
5548-1# show vpc peer-keepalive


vPC keep-alive status           : peer is alive
--Peer is alive for             : (1048732) seconds, (737) msec
--Send status                   : Success
--Last send at                  : 2014.05.13 11:35:04 592 ms
--Sent on interface             : mgmt0
--Receive status                : Success
--Last receive at               : 2014.05.13 11:35:04 477 ms
--Received on interface         : mgmt0
--Last update from peer         : (0) seconds, (215) msec
vPC Keep-alive parameters
--Destination                   : 172.25.109.24
--Keepalive interval            : 1000 msec
--Keepalive timeout             : 5 seconds
--Keepalive hold timeout        : 3 seconds
--Keepalive vrf                 : management
--Keepalive udp port            : 3200
--Keepalive tos                 : 192
```

A References

Alexis Dacquay. (2012). *Virtual Link Trunking Overview.* Retrieved from www.dell.com: http://www.dell.com/learn/us/en/04/shared-content~data-sheets~en/documents~dell_force10_s4810_vlt_technical_guide.pdf

Cisco Inc. (n.d.). *Cisco NX-OS Software Virtual PortChannel: Fundamental Concepts 5.0.* Retrieved from Cisco.com: http://www.cisco.com/c/en/us/products/collateral/switches/nexus-5000-series-switches/design_guide_c07-625857.html

B Components

The following table (Table 16) presents the versions of the hardware and software components used to configure and validate the solutions provided in this guide.

Table 16 Hardware and Software Components

Component	Version
FN IOMs	
PowerEdge FN410S	Dell Networking OS 9.9(0.0)
Switches	
Dell Networking S4810	Dell Networking OS 9.9(0.0)
Cisco Nexus 5672UP	Cisco NX-OS 7.0(1)N1(1)
Servers	
Dell PowerEdge FC630	System BIOS 1.2.5
Dell PowerEdge FC430	System BIOS 1.1.5
Network Adapters	
Qlogic BCM57810	Firmware Revision 7.12
Operating Systems	
Windows 2012 R2	

C Terminology

CLI (Command Line Interface): Text-based telnet, secure shell (SSH), or serial type interface that is used for issuing commands to a device.

DHCP (Dynamic Host Configuration Protocol): A network management protocol used to dynamically assign network settings to devices connected to a network.

Fault Tolerance: Enables a network to continue operating properly in the event of a failure of some of its components.

ICL (Inter-Chassis Links): Provides physical connectivity between two switches.

FN IOM (FN I/O Module): FN IOM refers to the switch modules on the rear of the Dell PowerEdge FX2 chassis that will receive and transmit network IO from the blade servers. This includes the FN410S, FN410T and FN2210S.

LACP (Link Aggregation Control Protocol): LACP is used to control the bundling (aggregating) of several physical ports together to form a single logical channel. LACP allows a network device to negotiate an automatic bundling of links by sending LACP packets to the peer (which is a directly connected device that also implements LACP).

LAG (Link Aggregation Group): Two or more network links bundled (aggregated) together to function as a single link.

LAN (Local Area Networks): A network contained within a single room, building, campus or other limited geographical area.

MAC Address (Media Access Control Address): A hardware specific address that uniquely identifies each node of a network. MAC addresses are typically assigned by the vendors of network interface controllers and stored in the hardware.

MLAG or MC-LAG (Multi-Chassis Link Aggregation Group): MLAG is a type of LAG, which allows link aggregation between multiple devices.

NIC Teaming: NIC Teaming allows multiple network interfaces on a computer to be placed into a team to combine bandwidth or provide traffic failover to prevent connectivity loss in the event of a network component failure.

PMUX Mode: Programmable MUX mode provides flexibility of operation by creating multiple LAGs, configuring VLANs on uplinks and the server side, configuring data center bridging (DCB) parameters, and so forth.

Port Channels: Port channels combine multiple interfaces into one virtual interface. Port channels provide increased bandwidth, redundancy and load balancing.

ToR (Top of Rack): A ToR switch is a switch that is positioned at the top of a server rack in a data center.

SSH (Secure Shell): Permits a user to log in to another computer over a network, execute commands on a remote machine and move files from one machine to another. Secure Shell provides strong authentication and secure communications methods over insecure channels.

Telnet: Terminal Emulation Protocol enables system users to log in and use resources on remote networks.

vPC: A virtual PortChannel allows links that are physically connected to two different Cisco switches to appear to be coming from a single device as part of a single port channel to a third downstream device.

vPC Peer Switches: Two switches connected using a special port channel known as a vPC Peer-Link.

vPC Peer Link: This port channel is used to synchronize data between the vPC peer devices. The link carries control traffic between two vPC switches as well as multicast and broadcast data.

vPC Domain: A vPC domain contains both vPC peer switches, the vPC peer keepalive link and all of the port channels in the vPC connected to the downstream devices. A domain can be assigned with a value from 1 to 1000.

vPC Peer Keepalive Link: The keepalive link monitors the vitality of a vPC peer switch. This link will send periodic keepalive messages between vPC peer devices. This link can be part of the management network, as it does not send data or synchronization traffic, only keepalive messages.

vPC Member Ports: vPC member ports are interfaces that belong to the vPCs.

VLT: Virtual Link Trunking is a protocol that enables active/active aggregation of Dell Networking OS based switches providing connections to two switches but appearing as one logical switch to participating members.

VLT Domain: A VLT domain contains both VLT peer switches, the VLT peer keepalive link and all of the port channels in the VLT connected to the downstream devices.

VLTi (VLT interconnect): A port channel used to synchronize data between the VLT peer devices. This link carries control traffic between two VLT switches as well as multicast and broadcast data.

VLT Member Ports: Interfaces that belong to the switches with VLT aggregation configured.

VLT Members: Upstream and downstream switches connected using a special port channel known as a VLTi Peer-Link.

VLT Mode: An operational mode for an IOM that automatically configures VLT using external facing port 9 as the VLTi, leaving the three remaining ports available for upstream connectivity.

VLT Peer Keepalive Link: A VLT peer keepalive link monitors the vitality of a VLT peer switch by sending periodic keepalive messages between VLT peer devices. No data or synchronization traffic is sent over this link, only keepalive messages.

VLT Peer-Link: See **VLTi**.

D Reset FN IOM to Default Factory Configuration

The FN IOM can be checked for factory default mode in two ways. With the new firmware revision 9.9, the Dell Blade I/O manager can show the currently configured mode from the Dashboard view. Figure 58 and Figure 59 show how to launch the Dell Blade I/O Manager and the Dashboard view with the Active IOA Mode showing Standalone. Figure 60 is the traditional view utilizing the standard CLI command `show system stack-unit 0 iom-mode`

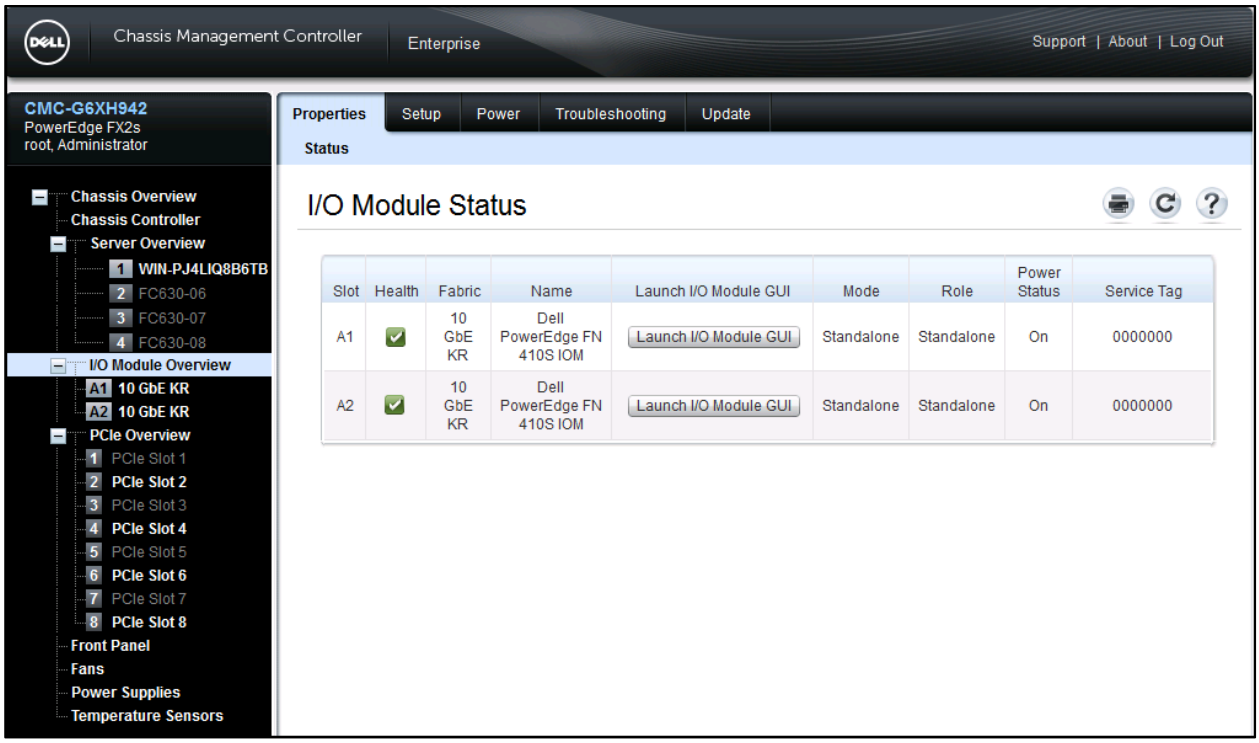


Figure 58 CMC I/O Module Overview page

Ensure the FN IOM is in Standalone Mode using the Dell Blade I/O Manager GUI Dashboard view (Figure 598) below.

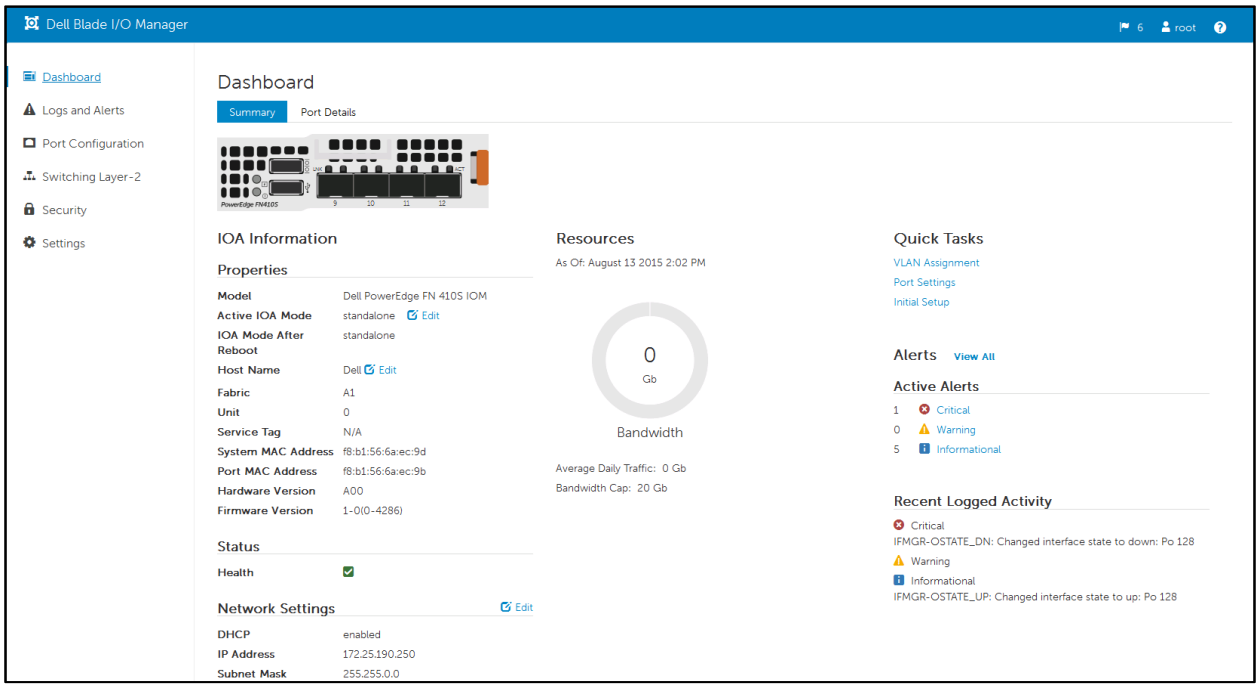


Figure 59 Dell Blade I/O Manager Standalone Mode Dashboard View

The CLI command `show system stack-unit 0 iom-mode` (Figure 609) can also be used to confirm this default state.

```
Dell#show system stack-unit 0 iom-mode

Unit   Boot-Mode        Next-Boot
-----------------------------------------------

0         standalone
```

Figure 60 FN IOM Mode Show Command

If it is not in Standalone Mode, reset the FN IOM to factory defaults. Figure 61 shows how to reset to factory defaults in the CLI while Figure 62 through Figure 67 shows how to use the Dell Blade I/O Manager.

Note: It is a best practice to reset the FN IOM to factory defaults when changing between modes of operation i.e. Standalone mode to VLT, Stacking, Full Switch, or Programmable Mux.

The CLI command below will restore the FN IOM to factory defaults, put it into Standalone mode and reboot it.

```
Dell#restore factory-defaults stack-unit 0 clear-all

Proceed with factory settings? Confirm [yes/no]:y
```

Figure 61 FN IOM Restore Factory Defaults

To reset the FN IOM to factory default Standalone Mode using the Blade I/O Manager GUI page below, from the initial Dashboard view (Figure 62) click on Settings, then click on the edit icon Edit to the right of Restore IOA.

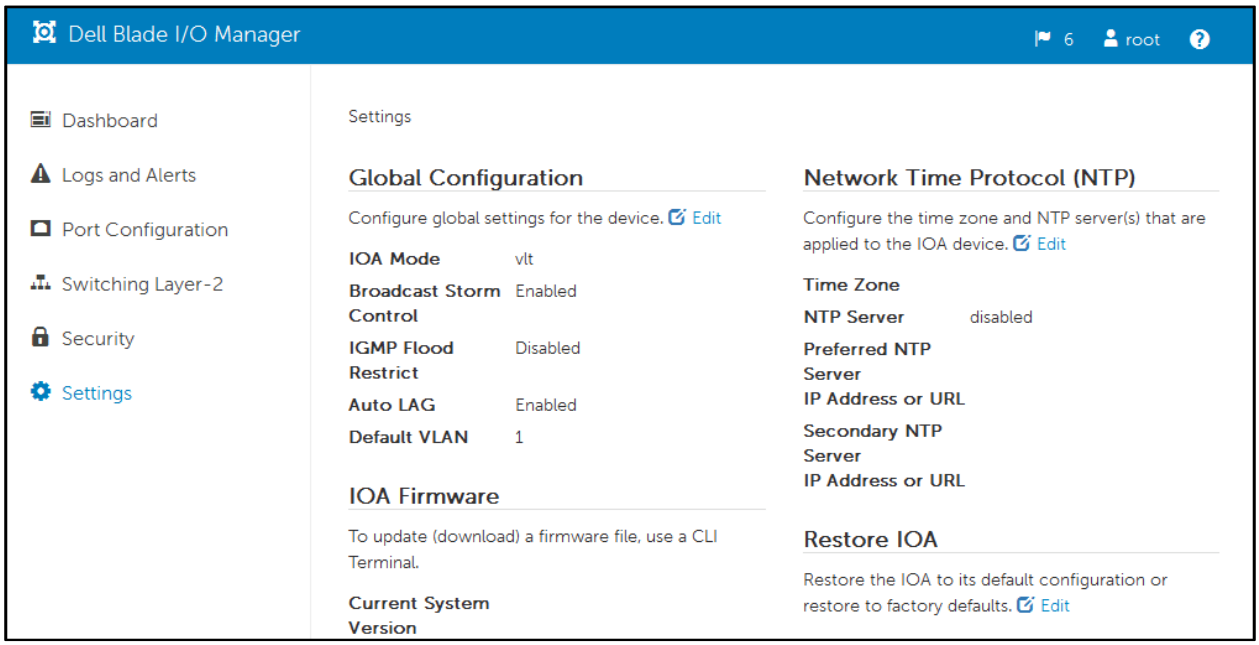


Figure 62 Initial Dashboard View

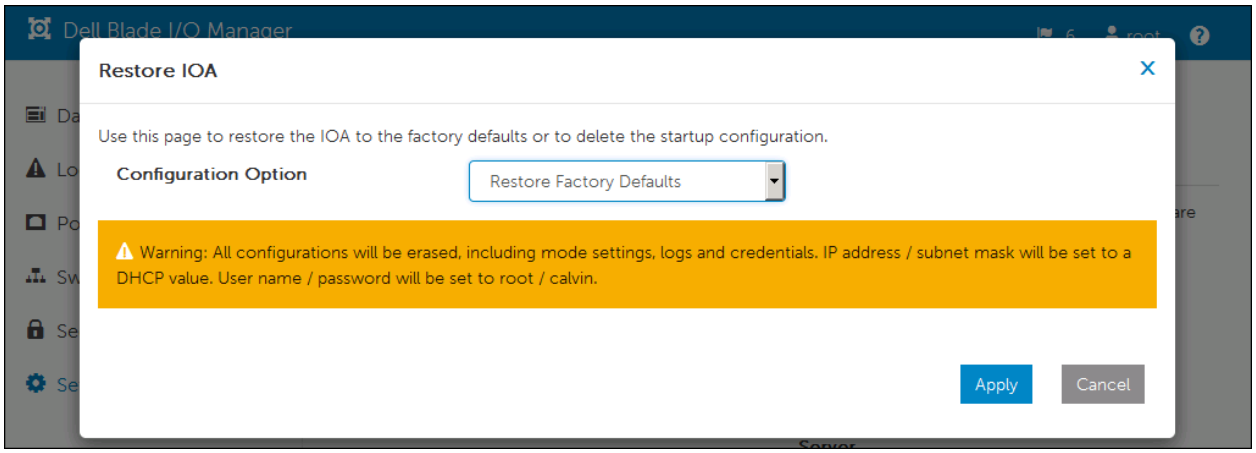


Figure 63 Restore IOA

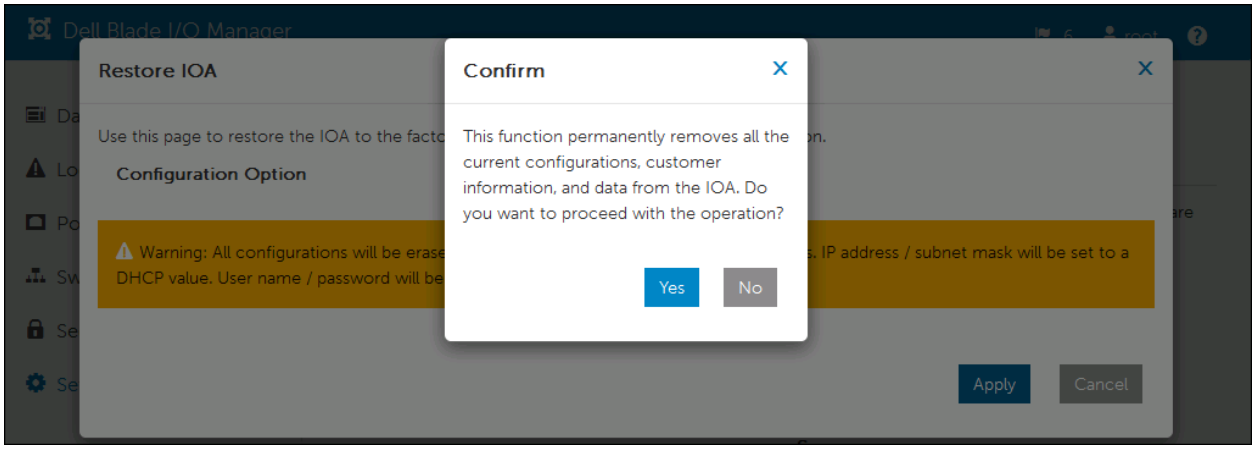


Figure 64 Confirm Restore

When the FN IOM Dell Blade I/O Manager is restarted after the factory reset process, an Initial Setup Wizard (Figure 654) will automatically be launched. This wizard allows a network administrator to set fundamental parameters such as new User Name and Password credentials other than the default root/calvin, as well as Management IP Address, Network Time Protocol, etc.

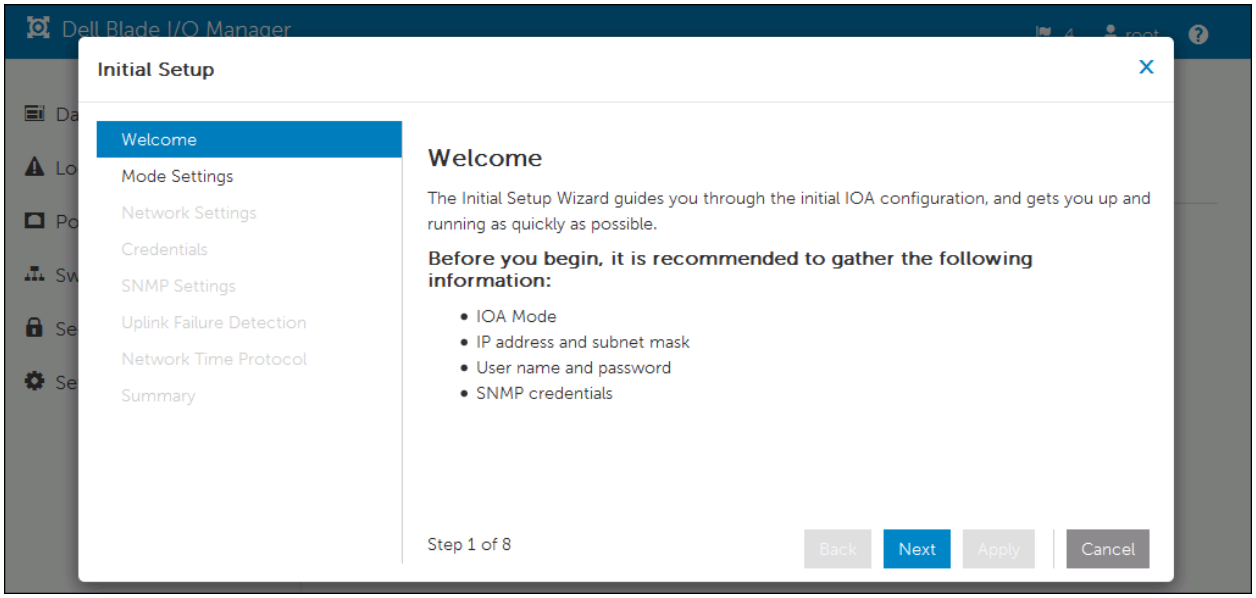


Figure 65 FN IOM Initial Setup Wizard

Note: The Initial Setup Wizard can be invoked at any time from the Dell Blade I/O Manager Dashboard view. The Initial Setup link under Quick Tasks on the right side of the page can restart the setup process if needed.

Once all the setup questions have been answered, click **Apply** (Figure 66)

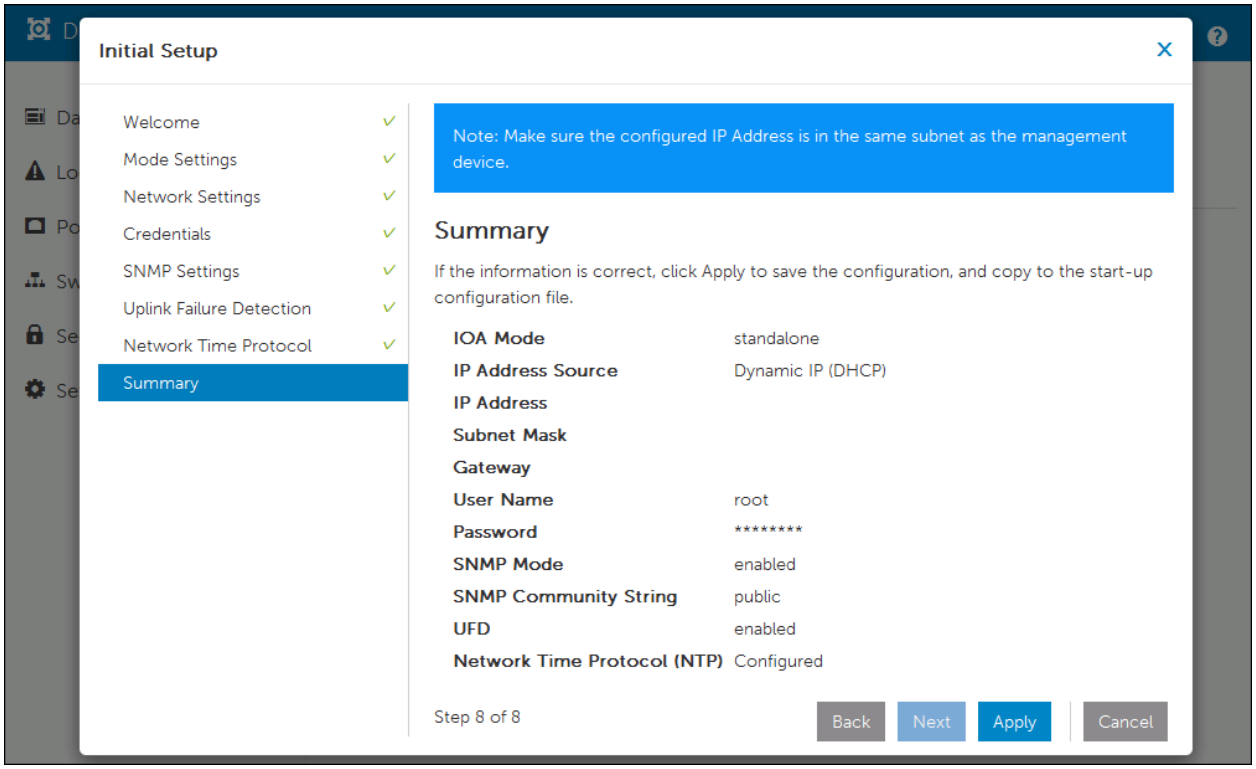


Figure 66 FN IOM Initial Setup Wizard Summary Confirmation

Once the apply button has been clicked, the FN IOM (Figure 66) will request a final confirmation to reboot and write the settings to the startup-config file.

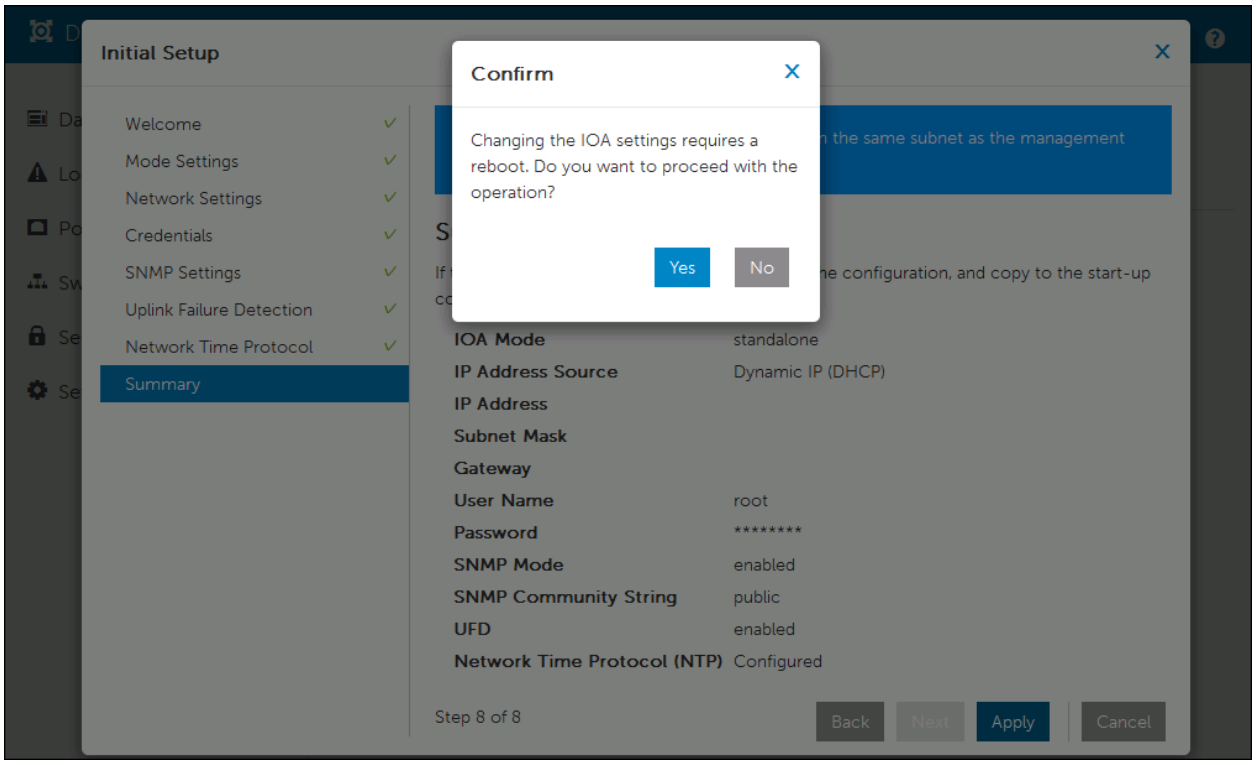


Figure 67 FN IOM Initial Setup Wizard Final Confirmation

E FN IOM Initial Out of Box Configuration and Default Settings

This section applies to the Dell PowerEdge FN I/O Module (FN IOM) in Standalone mode. Modules in this section include the FN410S, FN410T, and FN2210S (applicable to ports in Ethernet mode only). This section provides configuration examples for common upstream switches to establish a functional uplink and bring up network ports on PowerEdge FC-Series servers (FC830, FC630, FC430, FC620 and FC420) in three easy steps:

1. Ensure the FN IOM is in Standalone Mode
2. Create an LACP LAG on the upstream top-of-rack (ToR) switch
3. Verify the connection

Note: This section covers basic configuration in a factory default standalone mode and is not required for VLT configuration.

By default, the FN IOM is shipped from the factory in Standalone Mode, which consists of the following default settings:

Setting	Default Value
Chassis Management Controller Configuration	Yes
Stacking and VLT	Disabled
Data Center Bridging Exchange Protocol (DCBx)	Enabled
FIP Snooping Bridge (FSB)	Enabled on FN 410S and FN 410T Disabled on FN 2210S
NPIV Proxy Gateway Mode (NPG)	Enabled in FN 2210S Disabled on FN 410S and FN 410T
iSCSI Optimization	Enabled
Broadcast Storm Control	Enabled
Internet Group Management Protocol (IGMP) Flood Restrict	Enabled
Network Time Protocol (NTP)	Enabled
Enable and Disable ports	All ports enabled by default. Disable ports via Command Line Interface
Uplink Failure Detection (UFD)	Enabled
TACACS+/RADIUS (AAA Auth/Acct; Auth coming up)	Disabled
DHCP	Enabled in client only mode
Internet Group Management Protocol (IGMP) v2 & v3	Enabled
Auto LACP LAG	Enabled on all ports (Uplink created by

	default based on LACP PDU)
VLANS	All server and uplink ports are in all VLANs

Table 17 Standalone Mode Default Settings

By default, network ports on the PowerEdge FC-Series servers installed in the FX2 chassis will be down until the uplink port channel is operational on the FN IOM. This is due to a feature called Uplink Failure Detection whereby, when upstream connectivity fails, the FN IOM disables the downstream links.

Note: For more information on Uplink Failure Detection and all other configuration settings, see the Dell PowerEdge FN I/O Module Configuration Guide.

E.1 Configure Interfaces and the Port Channel on the Upstream Switch

This step provides the commands used to configure port channels on common upstream switches that may be connected to the FN IOM (Figure 68).

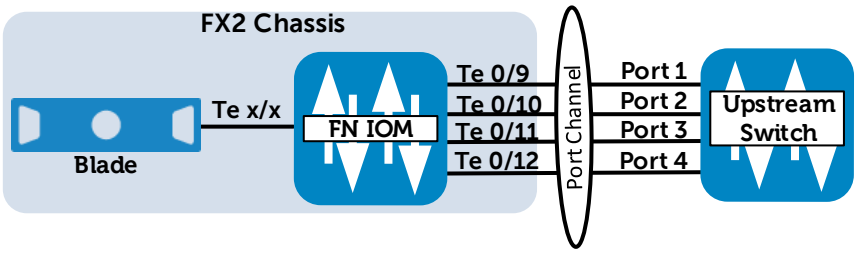


Figure 68 Interface and Port Channel View

Note: The diagram above (Figure 687) is applicable to the FN 410S and FN 410T. If you are using the FN 2210S in its default configuration, you will only use Ethernet ports Te 0/11 and Te 0/12 in the uplink port channel since ports Te 0/9 and Te 0/10 have been replaced by fibre channel ports. Ports 0/9 and 0/10 can be converted to Ethernet ports if desired by typing the command: `stack-unit 0 port-group 0 portmode ethernet`

By default on the FN IOM, the external Ethernet ports are preconfigured in port channel 128 with LACP enabled. Port channel 128 is in hybrid (trunk) mode.

In order for the downstream (server) ports on the FN IOM to come up, port channel 128 must be up. Port channel 128 will come up when connected to a properly configured port channel on an upstream switch.

To accomplish this, start by connecting any combination of the FN IOM's external Ethernet ports (ports Te 0/9-12) to the upstream switch. The port channel may have a minimum of one and a maximum of four links. Configure a port channel on your upstream switch as shown in the following examples.

Upstream Switch Configuration Examples

Note the following when configuring the upstream switch:

- No configuration is required on the FN IOM. All configuration is done on the upstream switch.
- In each example, four interfaces are configured in the port channel. You will only need to configure as many interfaces as you have connected. Change the port numbers shown to match your switch.
- Any valid ID number can be used for the port channel number on the upstream switch. The examples below use port channel 128 except for the Cisco Nexus. On the Nexus, 128 is reserved so 10 has been assigned instead.

Dell Networking OS 9.X

```
S4810(conf)#interface range tengigabitethernet 0/1-4
S4810(conf-if-te-0/1)#no shut
S4810(conf-if-te-0/1)#port-channel-protocol lacp
S4810(conf-if-te-0/1-lacp)#port-channel 128 mode active

S4810(conf)#interface port-channel 128
S4810(conf-if-po-128)#portmode hybrid
S4810(conf-if-po-128)#switchport
S4810(conf-if-po-128)#no shut
```

Figure 69 Dell Networking S4810 Port Channel Configuration

Arista 4.X

```
Arista(config)#interface Ethernet 21-24
Arista(config-if-Et21-24)#switchport mode trunk
Arista(config-if-Et21-24)#channel-group 128 mode active
Arista(config-if-Et21-24)#no shut

Arista(config)#int port-Channel 128
Arista(config-if-Po128)#switchport mode trunk
Arista(config-if-Po128)#no shut
```

Figure 70 Arista 7050Q-16 Port Channel Configuration

Cisco NX-OS Release 7

```
Nx5548(config)# interface Ethernet 1/1-4
Nx5548(config-if-range)# switchport mode trunk
Nx5548(config-if-range)# channel-group 10 mode active
Nx5548(config-if-range)# no shut

Nx5548(config-if-range)# interface port-channel 10
Nx5548(config-if)# switchport mode trunk
Nx5548(config-if)# no shut
```

Figure 71 Cisco Nexus 5548 Port Channel Configuration

Brocade Network OS 4.X

```
VDX(config)# interface TenGigabitEthernet 10/0/1-4
VDX(conf-if-te-10/0/1-4)# channel-group 128 mode active type
standard
VDX(conf-if-te-10/0/1-4)# no shut

VDX(config)# interface Port-channel 128
VDX(config-Port-channel-128)# switchport
VDX(config-Port-channel-128)# switchport mode trunk
VDX(config-Port-channel-128)# no shut
```

Figure 72 Brocade VDX6730 Port Channel Configuration

E.2 Verify the Configuration

When the port channel of the upstream switch has been properly configured, the port channel on the FN IOM will come up. A series of messages will be logged on the FN IOM indicating that port channel 128 is up and ports connected to the servers downstream have been brought up as well:

```
Changed interface state to up: Po 128


Downstream interface cleared from UFD error-disabled: Te 0/1

Downstream interface cleared from UFD error-disabled: Te 0/2

Downstream interface cleared from UFD error-disabled: Te 0/3

…etc.
```

Figure 73 Port Channel 128 Informational Message

You may also run commands such as the following to verify the status:

```
Dell#show interfaces port-channel 128

Port-channel 128 is up, line protocol is up
```

Figure 74 Port Channel 128 Show Command

```
Dell#show uplink-state-group

Uplink State Group: 1   Status: Enabled, Up
```

Figure 75 Uplink State Group Show Command

The Blade I/O Manager has a View LAG Membership feature (Figure 765) that is equivalent to the CLI `show interfaces port-channel 128` verification command (Figure 743). This feature can be accessed by going to **Switching Layer-2** > **View LAG Membership**. A healthy LAG can also be viewed from the main Switching Layer-2 page.

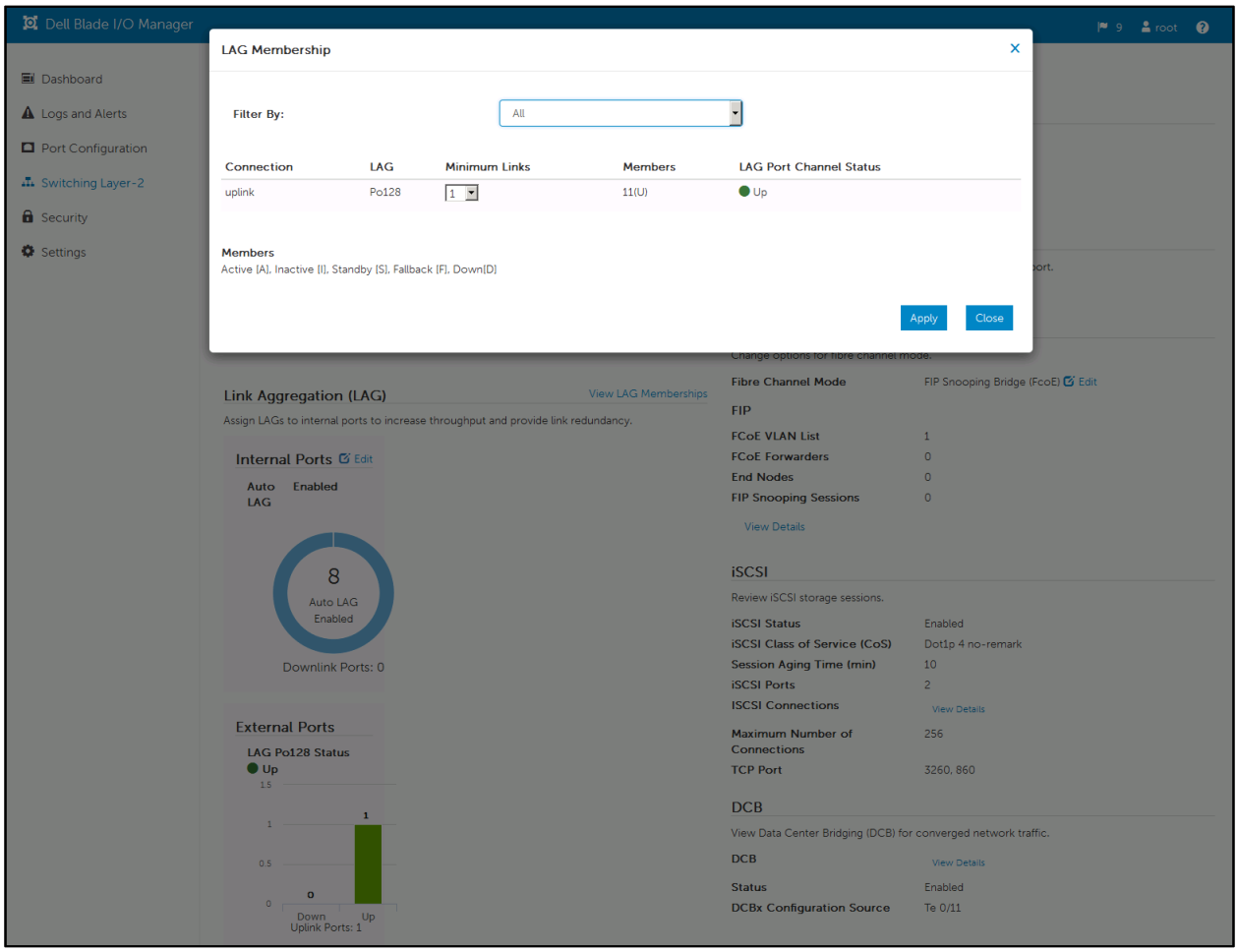


Figure 76 Dell Blade I/O Manager LAG Membership

F Support and Feedback

Contacting Technical Support

Support Contact Information	Web: http://Support.Dell.com/
	Telephone: USA: 1-800-945-3355

Feedback for this document

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