Using MLAG in Dell Networking N-Series Switches

A Deployment and Configuration Guide for Dell Networking Switches

Dell Networking Solutions Engineering
September 2016

Revisions

Date	Description	Authors
September 2016	1.5 added to update VRRP-MLAG section	Manjesh Siddamurthy
February 2016	1.4 added support for Cisco RSTP-PV and QoS, changed formatting.	Andrew Waranowski, Victor Teeter
February 2015	1.3 contains full-mesh support with VLT, new method to single-home devices to one peer, and improvements on “show” reporting from the secondary peer.	Victor Teeter
August 2014	1.2 clarifies native VLAN assignment on the peer link; solutions for single-homing a partner device to one peer.	
March 2014	1.1 includes changes to full-mesh support with VLT, limitation of partner switches, and added clarification of ports that can be used in peer links.	
January 2014	1.0 Initial Release.	

Table of contents

Executive summary

Multi-switch link aggregation (MLAG) is a feature that allows two Dell Networking switches to act as a single switch, providing multiple paths across the network and offering benefits such as:

- Failover in cases of defective cables or switches
- Double the bandwidth of a single switch
- Elimination of port blocking and re-convergence delays of spanning tree

Create an MLAG domain by connecting one Dell Networking switch to another through peer link ports. This creates MLAG peers (the two connected switches). Other directly connected switches interact with the MLAG peers as if the peers were a single network switch.

All links in the MLAG carry data traffic across physically diverse topologies. If a link or switch fails, traffic continues to flow with minimal disruption. MLAG optimizes availability and bandwidth between attached devices in Dell EMC's Datacenter and Campus networking solutions.

The following Dell Networking N-series switches support MLAG and may be used in building the configurations in this guide:

N2024	**N3024**	**N4032**
N2024P	**N3024P**	**N4032F**
N2048	**N3024F**	**N4064**
N2048P	**N3048**	**N4064F**
	N3048P	

Note: Dell N15xx Series switches do not support MLAG.

1 Introduction

Dell Networking provides customers with the most efficient modern networking equipment at the lowest cost for data center, campus, and remote networks. Dell EMC servers, storage, and networking products with Dell EMC Solutions and Services enable organizations to achieve unique business goals, improve competitiveness and better serve their customers.

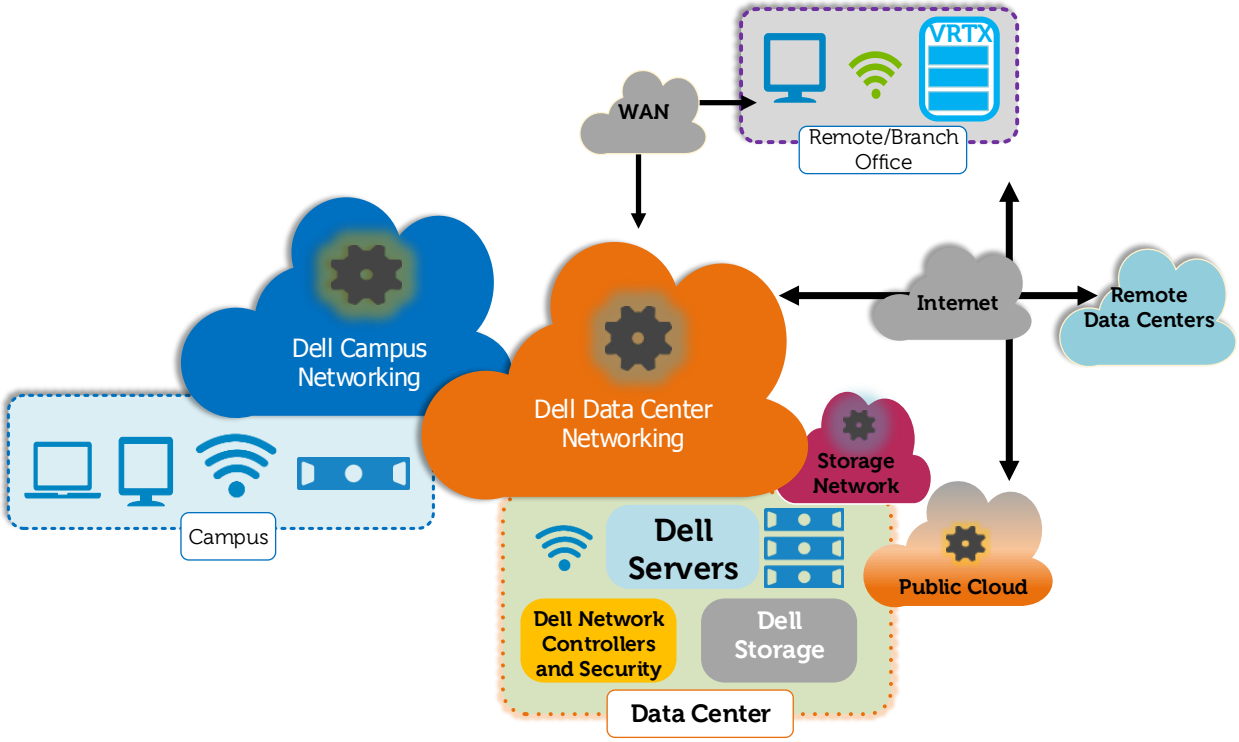

Figure 1 Comprehensive Modern Network

To achieve this, one needs a fault-tolerant and high-bandwidth network. To this end, Dell Networking N-Series switches support a networking feature called multi-switch link aggregation (MLAG).

MLAG provides an active-active split aggregation deployment across two switches acting as one, creating a more resilient network with higher bandwidth capabilities. This guide discusses MLAGs, how and when to use them, caveats to their use, and instructions for their implementation.

Figure 2 shows two very basic examples of MLAG domains. Both examples show MLAG peer switches linked with a special LAG (one or more cables as denoted by red lines in many figures in this document), called a peer link. The peer link can use any non-management port on the switch. With the peer link configured, the two switches appear as a single switch to partner switches upstream and downstream. Each partner switch contains MLAGs that are simply Link Aggregation Groups (LAGs) whose cables split between the two peers. With MLAG enabled, switch firmware automatically assigns primary and secondary peer roles.

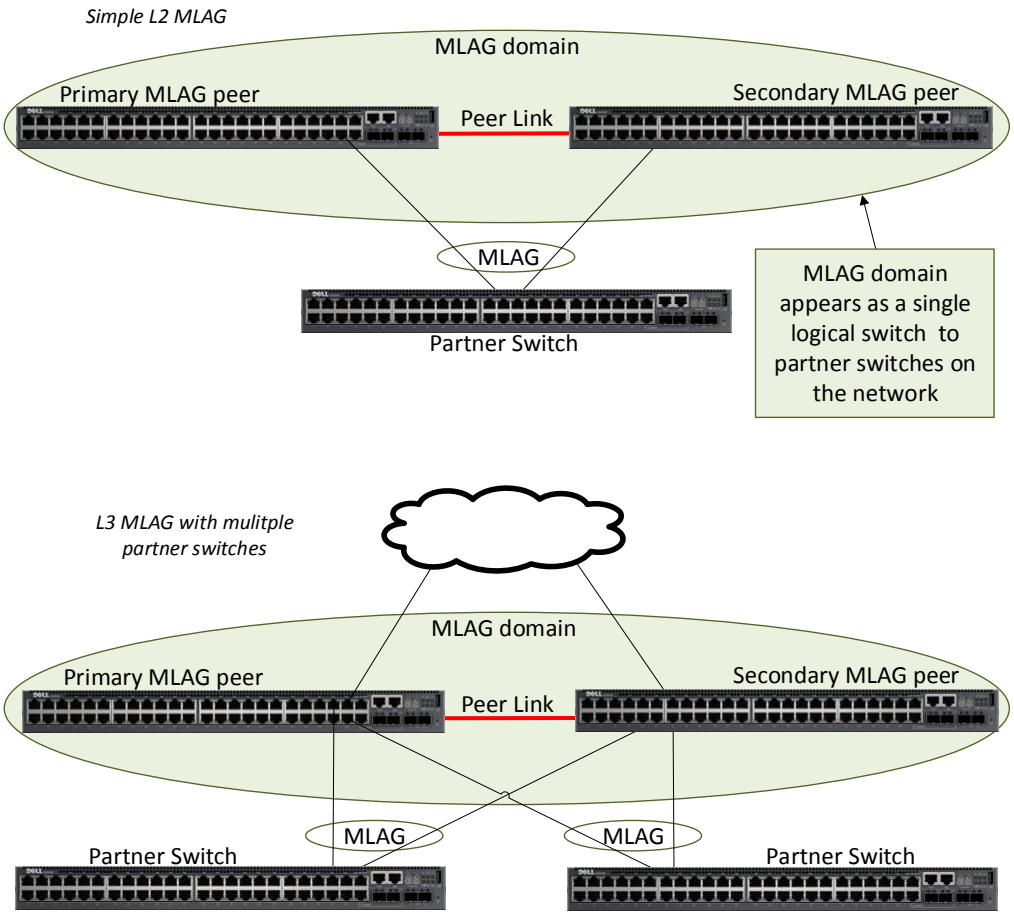

Figure 2 Two examples of a single-tier MLAG topology

2 Caveats

Following are some of the requirements when implementing MLAGs:

- All MLAG peers must be the same switch series. Therefore, all peers of N2000 Series switches are also N2000 Series switches, peers of N3000 Series switches are also N3000 Series switches, and so on.
- Peer devices must use the same expansion module type if ports from the expansion module are to be part of the MLAG interface.
- Neither of the two switches used as MLAG peers may be stacked with other switches.
- The peer link must have a native VLAN configured.

See the switch User Guide for additional information.

2.1 Spanning Tree Protocol

Be sure all devices have the appropriate configuration regarding the Spanning Tree Protocol used, including the MLAG peer link. Examples in this paper include RSTP, RSTP-PV and MSTP. The RSTP-PV protocol provides a high degree of compatibility with Cisco's RPVSTP+. MLAG supports MSTP as well, but RSTP-PV compatibility requires the recently released DNOS 6.3.

2.2 Consistency of MLAG Peers

As mentioned above, the two switches used as MLAG peers, as well as any expansion modules, must match. There are also six areas in the software configuration that must receive special attention to ensure they contain identical information prior to enabling the MLAG (see Figure 3).

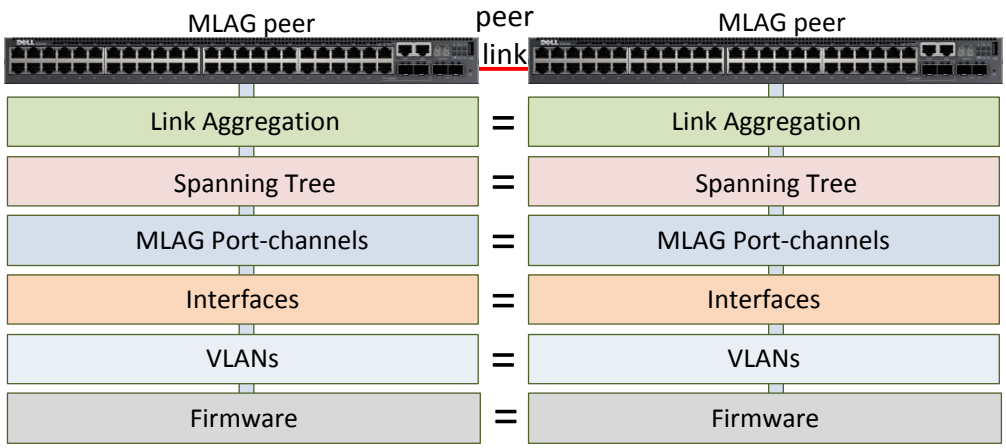

Figure 3 Consistent MLAG peer configurations

When changing any of the settings listed in Table 1, administrators must modify the settings on both MLAG peer switches. Enable MLAG only after configuring the settings on both peer switches.

Dell EMC recommends temporarily disabling MLAG when making changes to these settings.

Caution: Failure to make these settings identical on both peers may cause sporadic traffic issues on the network, which can be difficult to troubleshoot.

Note: Be sure to schedule down time if making changes that may negatively impact traffic or cause data loss.

Table 1 Settings that must match between MLAG peers

Option category	Settings
Link Aggregation	Hashing mode Minimum links Static/dynamic LAG LACP parameters o Actor parameters o Admin key o Collector max-delay o Partner parameters
Spanning Tree	Bpdufilter Bpduflood Auto-edge TCN-guard Cost Edgeport Root guard Loop guard STP Version STP MST VLAN configuration STP MST instance configuration (instance ID, port priority, port cost/mode)
MLAG Port-channels	Port-channel mode Link speed Duplex mode MTU Bandwidth VLAN configuration
Interfaces	PFC configuration CoS queue assignments
VLANs	MLAG VLANs must be configured on both MLAG Peers, and connect to two partner LAGs.
Firmware	Both peers require the same firmware version to operate correctly.
Misc.	FDB entry aging timers Static MAC entries ACL configuration

2.3 MLAG and Firmware Upgrades

When upgrading the firmware for switches in an MLAG configuration, refer to the switch's User's Guide found at support.dell.com.

An upgrade with minimal disruption involves shutting off the MLAG port channels and reloading each peer one at a time. Choose ONE peer should be chosen for the first reload. Complete the following items before reloading.

- Disable Dual Control Plane Detection Protocol (DCPDP), if used.
- Shut down physical ports going to partner switches.
- Shut down The MLAG peer link on the peer in question.
- DO NOT save the configuration.

Caution: Do not save the configuration when performing the procedure above.

Now the other MLAG peer is handling all MLAG traffic and the administrator can initiate the reload. Because the administrator did not save the configuration, the MLAG peer links and partners' links are enabled when the peer comes back online. The administrator can now repeat these steps on the other MLAG peer member.

2.4 Implementing iSCSI with MLAG

Most iSCSI devices should work fine when connected to partner switches. Problems may occur when connecting directly into MLAG domain peer switches. Consult the User Guides for your particular iSCSI devices to determine if network design requires that they connect directly into the MLAG domain peer switches. In some cases, this design may be unsupported.

3 Supported Topologies

MLAG topologies offer several options. They can be a single layer (one pair of MLAG peer switches) or two layers (two pairs of MLAG peer switches). The peer link can have anywhere from one to eight active interfaces to create the link. With these and other variables, there are dozens of ways to set up an MLAG. Table 2 lists all supported topology options:

Table 2 Parameters for an MLAG topology

Topological parameter	Supported options
MLAG domains per switch	1
Peer switches per MLAG domain	2
Interfaces per MLAG	2 to 8
Interfaces per peer link	1 to 8
MLAGs connecting to MLAG domain	Limited only by number of ports available
Layers	1 or 2

Note: Spanning tree is enabled by default on MLAG peer links. Do not disable spanning tree on 6.3.0.0 or later releases. Use a redundant link between MLAG peer switches to support routed Layer-3 link failures. Separate VLAN and MSTP instances are preferable in such situations. Please refer to N-series manuals for more details at https://support.dell.com

Figure 4 shows a few examples of MLAG topologies that the MLAG feature supports. The red lines show the peer links between the primary and secondary peer switches. The blue line in the bottom diagram shows compatibility with virtual link trunking (VLT) and virtual port channel (vPC) in a layer 2 topology. VLT is a technology similar to MLAG that is used with certain Dell EMC switches like the S4810. vPC is a technology similar to MLAG that is used with certain Cisco switches like the Nexus 5k and 7k. See the User Guide for the S4810 and other Dell EMC switches that use VLT for guidance on implementing a vPC.

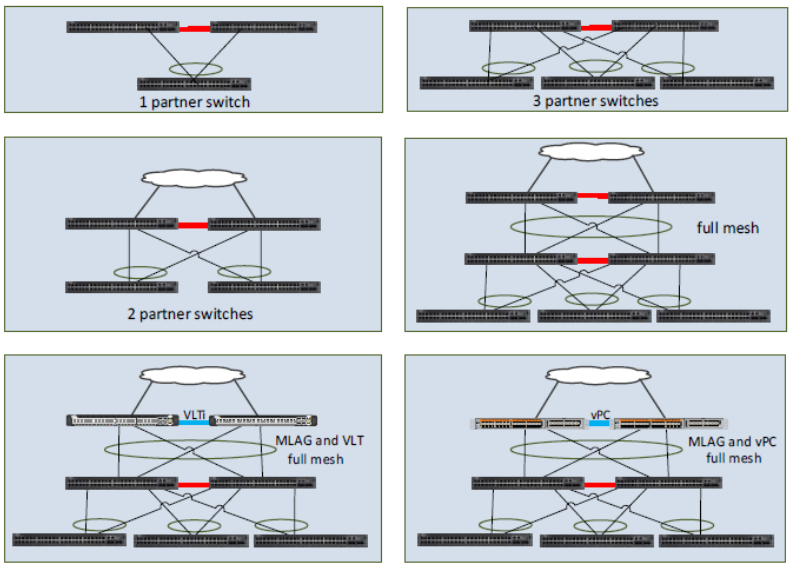

Figure 4 Examples of MLAG topologies

4 Single-Tier MLAG Example

Figure 5 shows the configuration of the two MLAG peers with two MLAG partners using the default Spanning Tree Protocol configuration.

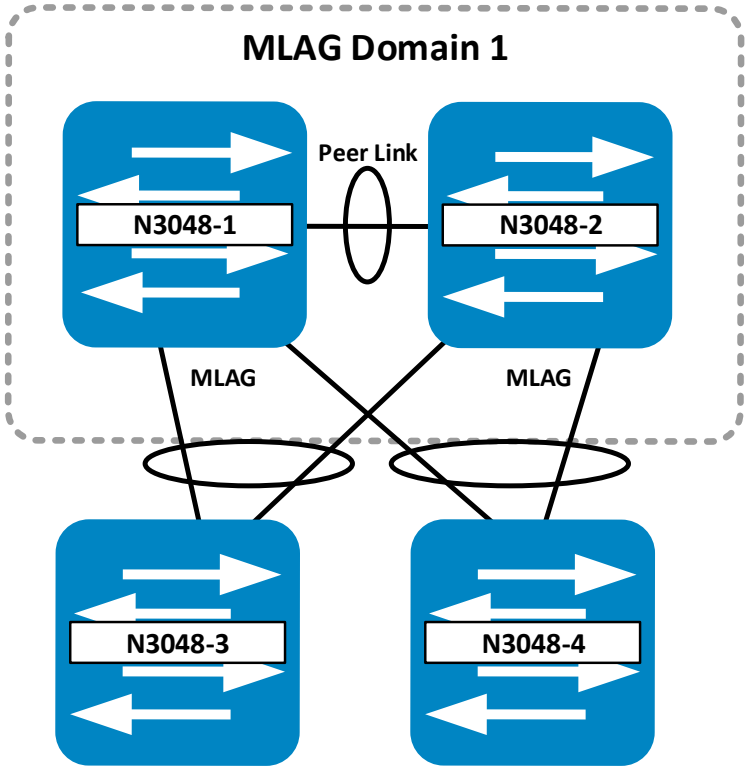

Figure 5 Single-tier MLAG topology

4.1 Physical Connectivity

After completion of the configuration, physical connectivity between all four switches can be established. Table 3 serves as a guide for cabling the switches.

Table 3 Physical Connectivity

Dell Networking N3048	
From Switch / Port	To Switch / Port
N3048-1 / te1/0/1	N3048-2 / te1/0/1
N3048-1 / gi1/0/47	N3048-3 / gi1/0/27
N3048-1 / gi1/0/48	N3048-4 / gi1/0/30
N3048-2 / gi1/0/11	N3048-3 / gi1/0/28
N3048-2 / gi1/0/12	N3048-4 / gi1/0/29

4.2 Configuring MLAG and Port Channels

The following steps show how to configure Single-tier MLAG. Figure 6 shows the MLAG configuration required for switches N3048-1 and N3048-2, including setting up port channels, creating the MLAG domain, and setting up the peer link.

The peer link requires configuration of a native VLAN. It can use VLAN 1 (the default native VLAN) or another VLAN that has been set to native. This is a limitation of the peer link keepalive messages.

Interfaces used to connect each peer to the partner switch LAG do not need to match on each peer. For instance, in the example above one partner LAG interface connects to 1/0/47 on the primary peer while the other interface connects to 1/0/11 on the secondary peer.

N3048-1	N3048-2
Create a VLAN for MLAG and all partner traffic.	Create a VLAN for MLAG and all partner traffic.

`configure`
`vlan 30`
`end`
	`configure`
	`vlan 30`
	`end`

Configure the port channel for the peer link - must be trunk mode.	Configure the port channel for the peer link - must be trunk mode.

`configure`
`interface port-channel 1`
`description MLAG_peer_link`
`switchport mode trunk`
`vpc peer link`
`end`
	`configure`
	`interface port-channel 1`
	`description MLAG_peer_link`
	`switchport mode trunk`
	`vpc peer link`
	`end`

Identify and configure the peer link interface -peer link requires a native VLAN (i.e. VLAN 1 or other VLAN made native)	Identify and configure the peer link interface -peer link requires a native VLAN (i.e. VLAN 1 or other VLAN made native)

`configure`
`interface tengigabitethernet 1/0/1`
`channel-group 1 mode active`
`description MLAG_peer_link`
`end`
	`configure`
	`interface tengigabitethernet 1/0/1`
	`channel-group 1 mode active`
	`description MLAG_peer_link`
	`end`

Create a LAG for partner switch N3048-3 to pass traffic. Assign a unique id for partner N3048-3.	Create a LAG for partner switch N3048-3 to pass traffic. Assign a unique id for partner N3048-3.

`configure`
`interface port-channel 30`
`switchport mode trunk`
`vpc 30`
`end`
	`configure`
	`interface port-channel 30`
	`switchport mode trunk`
	`vpc 30`
	`end`

Create a LAG for partner switch N3048-4 to pass traffic. Assign a unique id for partner N3048-4.	Create a LAG for partner switch N3048-4 to pass traffic. Assign a unique id for partner N3048-4.

`configure`
`interface port-channel 40`
`switchport mode trunk`
`vpc 40`
`end`
	`configure`
	`interface port-channel 40`
	`switchport mode trunk`
	`vpc 40`
	`end`

Assign interfaces to connect to partner switch N3048-3 LAG.	Assign interfaces to connect to partner switch N3048-3 LAG.

`configure`
`interface gigabitethernet 1/0/47`
`channel-group 30 mode active`
`description MLAG_Partner_link`
`end`
	`configure`
	`interface gigabitethernet 1/0/11`
	`channel-group 30 mode active`
	`description MLAG_Partner_link`
	`end`

Assign interfaces to connect to partner switch N3048-4 LAG.	Assign interfaces to connect to partner switch N3048-4 LAG.

`configure`
`interface gigabitethernet 1/0/48`
`channel-group 40 mode active`
`description MLAG_Partner_link`
`end`
	`configure`
	`interface gigabitethernet 1/0/12`
	`channel-group 40 mode active`
	`description MLAG_Partner_link`
	`end`

Enable the MLAG.	Enable the MLAG.

`configure`
`feature vpc`
`vpc domain 1`
`peer-keepalive enable`
`end`
	`configure`
	`feature vpc`
	`vpc domain 1`
	`peer-keepalive enable`
	`end`

Figure 6 MLAG configuration for N3048-1 and N3048-2

N3048-3	N3048-4
Create same VLAN on partners.	Create same VLAN on partners.

`configure`
`vlan 30`
`end`
	`configure`
	`vlan 30`
	`end`

Configure the port channel trunk for the partner link.	Configure the port channel trunk for the partner link.

`configure`
`interface port-channel 1`
`switchport mode trunk`
`end`
	`configure`
	`interface port-channel 1`
	`switchport mode trunk`
	`end`

Assign interfaces to LAG.	Assign interfaces to LAG.

`configure`
`interface gi1/0/27`
`channel-group 1 mode active`
`end`
	`configure`
	`interface gi1/0/29`
	`channel-group 1 mode active`
	`end`

Assign interfaces to LAG.	Assign interfaces to LAG.

`configure`
`interface gi1/0/28`
`channel-group 1 mode active`
`end`
	`configure`
	`interface gi1/0/30`
	`channel-group 1 mode active`
	`end`

Figure 7 LAG configuration for N3048-3 and N3048-4

Note: See the appendix section A.1 for the commands required to validate the configuration and to ensure that MLAG is working.

5 Two-Tier MLAG Example

Figure 8 shows a logical topology for a two-tier, fully meshed MLAG offering full redundancy across all four MLAG peers. The example uses six Dell N3024 switches, however the same principles and commands apply to the N2000 and N4000 series switches.

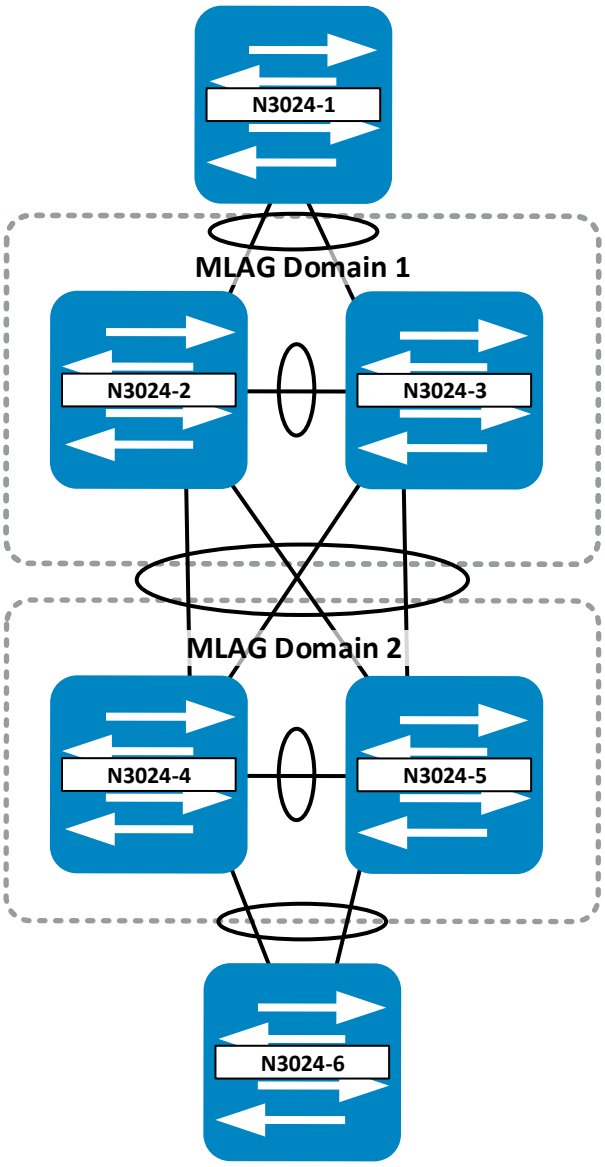

Figure 8 Two-tier MLAG example topology

5.1 Physical Connectivity

After completion of the configuration, physical connectivity between all six switches can be established. Table 4 serves as a guide for cabling the switches.

Table 4 Physical Connectivity

Dell Networking N3024			
From Switch / Port	To Switch / Port	From Switch / Port	To Switch / Port
N3024-1 / gi1/0/13	N3024-3 / gi1/0/13	N3024-3 / gi1/0/1	N3024-5 / gi1/0/2
N3024-1 / gi1/0/14	N3024-2 / gi1/0/14	N3024-3 / gi1/0/2	N3024-4 / gi1/0/2
N3024-2 / gi1/0/1	N3024-5 / gi1/0/1	N3024-4 / te1/0/1	N3024-5 / te1/0/1
N3024-2 / gi1/0/2	N3024-4 / gi1/0/1	N3024-4 / gi1/0/14	N3024-6 / gi1/0/14
N3024-2 / te1/0/1	N2024-3 / te1/0/1	N3024-5 / gi1/0/13	N3024-6 / gi1/0/13

5.2 Configuring MLAG and Port Channels

In a full mesh, all eight ports joined together in the MLAG occupy the same port channel to achieve maximum redundancy.

To configure the two-tier in a full mesh configuration, follow these steps:

1. Enter the commands below for each corresponding switch in the topology.
2. Cable the configuration as shown in Table 4.
3. Enable MLAG (using the feature vpc command) on each switch.

All four MLAG peer switches require similar commands. MLAG peers 2 and 3 must be consistent in their configurations following the guidelines set above in the Consistency of MLAG Peers section. MLAG peers 4 and 5 also follow consistency requirements. Though MLAG partner switches 1 and 6 may have similar configurations in this particular scenario, they have no such consistency requirements to each other or to the peer switches.

This document includes the following configurations as an attachment in the column to the left (paperclip).

This section deals with setting up the switches for MLAG and LACP port channels.

N3024-2	N3024-3
Create a VLAN for MLAG and all partner traffic.	Create a VLAN for MLAG and all partner traffic.

`configure`
`vlan 30`
`end`
	`configure`
	`vlan 30`
	`end`

Configure the port channel for the peer link - must be trunk mode.	Configure the port channel for the peer link - must be trunk mode.

`configure`
`interface port-channel 1`
`description MLAG_peer_link`
`switchport mode trunk`
`vpc peer link`
`end`
	`configure`
	`interface port-channel 1`
	`description MLAG_peer_link`
	`switchport mode trunk`
	`vpc peer link`
	`end`

Identify and configure the peer link interface -peer link requires a native VLAN (i.e. VLAN 1 or other VLAN made native).	Identify and configure the peer link interface -peer link requires a native VLAN (i.e. VLAN 1 or other VLAN made native).

`configure`
`interface tengigabitethernet 1/0/1`
`channel-group 1 mode active`
`description MLAG_peer_link`
`end`
	`configure`
	`interface tengigabitethernet 1/0/1`
	`channel-group 1 mode active`
	`description MLAG_peer_link`
	`end`

Create a LAG for partner switches 4-5 to pass traffic Assign a unique id for partner.	Create a LAG for partner switches 4-5 to pass traffic Assign a unique id for partner.

`configure`
`interface port-channel 40`
`switchport mode trunk`
`vpc 40`
`end`
	`configure`
	`interface port-channel 40`
	`switchport mode trunk`
	`vpc 40`
	`end`

Create a LAG for partner switch 1 to pass traffic. Assign a unique id for partner.	Create a LAG for partner switch 1 to pass traffic. Assign a unique id for partner.

`configure`
`interface port-channel 50`
`switchport mode trunk`
`vpc 50`
`end`
	`configure`
	`interface port-channel 50`
	`switchport mode trunk`
	`vpc 50`
	`end`

Assign interfaces to connect to partner 5's half of the full mesh LAG.	Assign interfaces to connect to partner 5's half of the full mesh LAG.
configure interface gigabitethernet 1/0/1 channel-group 40 mode active description MLAG_Partner_link end	configure interface gigabitethernet 1/0/1 channel-group 40 mode active description MLAG_Partner_link end
Assign interfaces to connect to partner 4's half of full mesh LAG.	Assign interfaces to connect to partner 4's half of full mesh LAG.
configure interface gigabitethernet 1/0/2 channel-group 40 mode active description MLAG_Partner_link end	configure interface gigabitethernet 1/0/2 channel-group 40 mode active description MLAG_Partner_link end
Assign interfaces to port channel that will connect to partner 1's LAG -put port 14 into LAG 50.	Assign interfaces to port channel that will connect to partner 1's LAG -put port 13 into LAG 50.
configure interface gigabitethernet 1/0/14 channel-group 50 mode active switchport mode trunk switchport trunk allowed vlan 30 end	configure interface gigabitethernet 1/0/13 channel-group 50 mode active switchport mode trunk switchport trunk allowed vlan 30 end
Enable the MLAG.	Enable the MLAG.
configure feature vpc vpc domain 1 peer-keepalive enable end	configure feature vpc vpc domain 1 peer-keepalive enable end

Figure 9 MLAG configuration for N3024-2 and N3024-3

N3024-4	N3024-5
Create a VLAN for MLAG and all partner traffic.	Create a VLAN for MLAG and all partner traffic.

`configure`
`vlan 30`
`end`
	`configure`
	`vlan 30`
	`end`

Configure the port channel for the peer link - must be trunk mode.	Configure the port channel for the peer link - must be trunk mode.

`configure`
`interface port-channel 1`
`description MLAG_peer_link`
`switchport mode trunk`
`vpc peer link`
`end`
	`configure`
	`interface port-channel 1`
	`description MLAG_peer_link`
	`switchport mode trunk`
	`vpc peer link`
	`end`

Identify and configure the peer link interface - peer link requires a native VLAN (i.e. VLAN 1 or other VLAN made native)	Identify and configure the peer link interface - peer link requires a native VLAN (i.e. VLAN 1 or other VLAN made native)

`configure`
`interface tengigabitethernet 1/0/1`
`channel-group 1 mode active`
`description MLAG_peer_link`
`end`
	`configure`
	`interface tengigabitethernet 1/0/1`
	`channel-group 1 mode active`
	`description MLAG_peer_link`
	`end`

Create a LAG for partner switches 2-3 to pass traffic. Assign a unique id for partner.	Create a LAG for partner switches 2-3 to pass traffic. Assign a unique id for partner.

`configure`
`interface port-channel 40`
`switchport mode trunk`
`vpc 40`
`end`
	`configure`
	`interface port-channel 40`
	`switchport mode trunk`
	`vpc 40`
	`end`

Create a LAG for partner switch 6 to pass traffic. Assign a unique id for partner.	Create a LAG for partner switch 6 to pass traffic. Assign a unique id for partner.

`configure`
`interface port-channel 60`
`switchport mode trunk`
`vpc 60`
`end`
	`configure`
	`interface port-channel 60`
	`switchport mode trunk`
	`vpc 60`
	`end`

Assign interfaces to connect to partner switch 2's LAG.	Assign interfaces to connect to partner switch 2's LAG.

configure interface gigabitethernet 1/0/1 channel-group 40 mode active description MLAG_Partner_link end	configure interface gigabitethernet 1/0/1 channel-group 40 mode active description MLAG_Partner_link end
Assign interfaces to connect to partner switch 3's LAG.	Assign interfaces to connect to partner switch 3's LAG.
configure interface gigabitethernet 1/0/2 channel-group 40 mode active description MLAG_Partner_link end	configure interface gigabitethernet 1/0/2 channel-group 40 mode active description MLAG_Partner_link end
Assign interfaces to port channel that will connect to partner 6's LAG -put port 14 into LAG 60.	Assign interfaces to port channel that will connect to partner 6's LAG -put port 13 into LAG 60.
configure interface gigabitethernet 1/0/14 channel-group 60 mode active switchport mode trunk switchport trunk allowed vlan 30 end	configure interface gigabitethernet 1/0/13 channel-group 60 mode active switchport mode trunk switchport trunk allowed vlan 30 end
Enable the MLAG.	Enable the MLAG.
configure feature vpc vpc domain 1 peer-keepalive enable end	configure feature vpc vpc domain 1 peer-keepalive enable end

Figure 10 MLAG configuration for N3024-4 and N3024-5

N3024-1	N3024-6
Create a VLAN for MLAG and all partner traffic.	Create a VLAN for MLAG and all partner traffic.
configure vlan 30 end	configure vlan 30 end
Configure the port channel trunks for the partner links.	Configure the port channel trunks for the partner links.
configure interface port-channel 1 switchport mode trunk end	configure interface port-channel 1 switchport mode trunk end
Assign first interface to the LAG.	Assign first interface to the LAG.
configure interface gi1/0/13 channel-group 1 mode active end	configure interface gi1/0/13 channel-group 1 mode active end
Assign second interface to the LAG.	Assign second interface to the LAG.
configure interface gi1/0/14 channel-group 1 mode active end	configure interface gi1/0/14 channel-group 1 mode active end

Figure 11 LAG configuration for N3024-1 and N3024-6

Note: See the appendix section A.2 for the commands required to validate the configuration and ensure that MLAG is working.

6 MLAG, vPC, and RSTP-PV Example

MLAG can be used in combination with Cisco's Virtual Port Channel (vPC) technology. vPC is a technology very similar to MLAG that is proprietary to Cisco products, such as Cisco Nexus switches. MLAG is compatible with Rapid Spanning Tree Protocol per VLAN (RSTP-PV), which is fully compatible with Cisco's Spanning Tree Protocol.

Figure 12 shows a diagram depicting a scenario that combines vPC and MLAG in a two-tier or double-sided configuration, while implementing RSTP-PV on all switches.

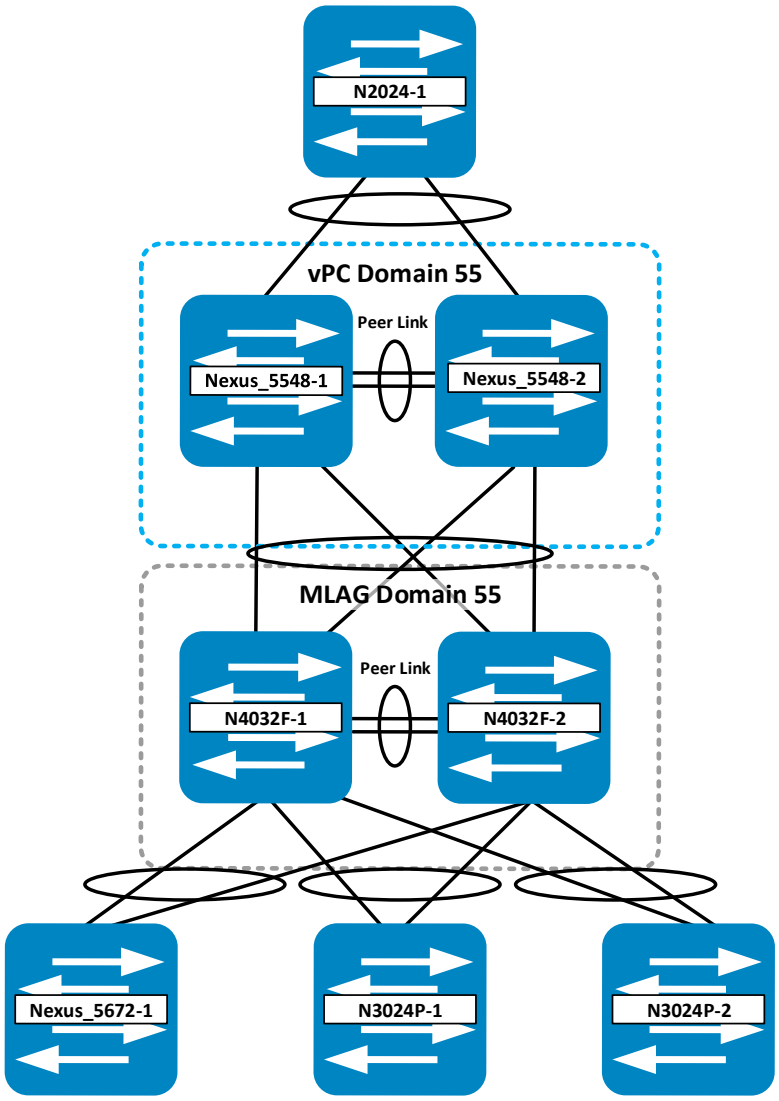

Figure 12 MLAG, vPC, and RSTP-PV example topology

6.1 Physical Connectivity

After completion of the configuration, physical connectivity between all eight switches can be established. Table 5 serves as a guide for cabling the switches.

Table 5 Physical Connectivity

Cisco Nexus 5548UP		**Dell Networking N4032F**	
From Switch / Port	To Switch / Port	From Switch / Port	To Switch / Port
5548UP-1 / eth 1/17	5548UP-2 / eth 1/17	N4032F-1 / te1/0/3	5672UP-1 / eth1/1
5548UP-1 / eth 1/18	5548UP-2 / eth 1/18	N4032F-1 / te1/0/4	N3024P-1 / te1/0/1
5548UP-1 / eth 1/21	N4032F-1 / te1/0/1	N4032F-1 / te1/0/5	N3024P-2 / te1/0/1
5548UP-1 / eth 1/22	N4032F-2 / te1/0/1	N4032F-1 / fo1/1/1	N4032F-2 / fo1/1/1
5548UP-1 / eth 1/32	N2024-1 / te1/0/1	N4032F-1 / fo1/1/2	N4032F-2 / fo1/1/2
5548UP-2 / eth 1/21	N4032F-1 / te1/0/2	N4032F-2 / te1/0/3	5672UP-1 / eth1/2
5548UP-2 / eth 1/22	N4032F-2 / te1/0/2	N4032F-2 / te1/0/4	N3024P-1 / te1/0/2
5548UP-2 / eth 1/32	N2024-1 / te1/0/2	N4032F-2 / te1/0/5	N3024P-2 / te1/0/2

6.2 Initial Setup and RSTP-PV Configuration

This section deals with setting up the switches for initial configuration and RSTP-PV.

N2024-1

Configure host name.
Create VLAN 999 for management.
Configure gi1/0/1 for Access mode VLAN 999.
Configure the IP for management.
Configure the default route for management.
Configure a user name and password.

```
configure
hostname N2024-1
vlan 999
exit
interface gi1/0/1
switchport access vlan 999
interface vlan 999
ip address 172.25.188.75
255.255.0.0
exit
ip default-gateway 172.25.188.254
username admin password Dell1234
privilege 15
end
```

Configure RSTP-PV.
Configure VLANs 10, 20, and 30.

```
configure
spanning-tree mode rapid-pvst
vlan 10
name Marketing
exit
vlan 20
name HR
exit
vlan 30
name Operations
end
```

Figure 13 Initial setup for N2024-1

Note: See appendix section B.1.1 for the corresponding Cisco initial configuration for this example environment.

N4032F-1	N4032F-2
Enable MLAG feature.	Enable MLAG feature.
configure feature vpc end	configure feature vpc end
Configure host name. Configure the IP and default route for management. Configure a user name and password.	Configure host name. Configure the IP and default route for management. Configure a user name and password.
configure hostname N4032F-1 interface out-of-band ip address 172.25.188.71 255.255.0.0 172.25.188.254 exit username admin password Dell1234 privilege 15 end	configure hostname N4032F-2 interface out-of-band ip address 172.25.188.72 255.255.0.0 172.25.188.254 exit username admin password Dell1234 privilege 15 end
Configure RSTP-PV. Configure VLANs 10, 20, and 30.	Configure RSTP-PV. Configure VLANs 10, 20, and 30.
configure spanning-tree mode rapid-pvst vlan 10 name Marketing exit vlan 20 name HR exit vlan 30 name Operations end	configure spanning-tree mode rapid-pvst vlan 10 name Marketing exit vlan 20 name HR exit vlan 30 name Operations end

Figure 14 Initial setup for N4032F-1 and N4032F-2

N3024P-1

Configure host name.
Configure the IP and default route for management.
Configure a user name and password.

```
configure
hostname N3024P-1
interface out-of-band
ip address 172.25.188.73
255.255.0.0 172.25.188.254
exit
username admin password Dell1234
privilege 15
end
```

Configure RSTP-PV.
Configure VLANs 10, 20, and 30.

```
configure
spanning-tree mode rapid-pvst
vlan 10
name Marketing
exit
vlan 20
name HR
exit
vlan 30
name Operations
end
```

N3024P-2

Configure host name.
Configure the IP and default route for management.
Configure a user name and password.

```
configure
hostname N3024P-2
interface out-of-band
ip address 172.25.188.74
255.255.0.0 172.25.188.254
exit
username admin password Dell1234
privilege 15
end
```

Configure RSTP-PV.
Configure VLANs 10, 20, and 30.

```
configure
spanning-tree mode rapid-pvst
vlan 10
name Marketing
exit
vlan 20
name HR
exit
vlan 30
name Operations
end
```

Figure 15 Initial setup for N3024P-1 and N3024P-2

6.3 Configuring MLAG and vPC

This section deals with setting up the switches for MLAG, vPC, and LACP port channels.

N2024-1

Configure the port channel connecting to the upstream vPC peer switches.

```
configure
interface port-channel 8
description te1/0/1-
2_to_Nexus_5548UP_vPC_Peers
switchport mode trunk
interface range te1/0/1-2
description te1/0/1-
2_to_Nexus_5548UP_vPC_Peers
switchport mode trunk
channel-group 8 mode active
end
```

Figure 16 LAG configuration for N2024-1

Note: See appendix B for the corresponding Cisco vPC configuration for this example environment.

N4032F-1	N4032F-2
Create an MLAG domain. Assign role priority. Assign the keepalive management IP address of N4032F-2.	Create an MLAG domain. Assign role priority. Assign the keepalive management IP address of N4032F-1.

`configure`
`vpc domain 55`
`role priority 1`
`peer-keepalive enable`
`peer-keepalive destination 172.25.188.72 source 172.25.188.71`
`peer detection enable`
`end`
	`configure`
	`vpc domain 55`
	`role priority 255`
	`peer-keepalive enable`
	`peer-keepalive destination 172.25.188.71 source 172.25.188.72`
	`peer detection enable`
	`end`

Configure port channel and port channel members for the MLAG peer link. Create a port channel. Configure the port channel for dot1q trunking. Assign as an MLAG peer link.	Configure port channel and port channel members for the MLAG peer link. Create a port channel. Configure the port channel for dot1q trunking. Assign as an MLAG peer link.

`configure`
`interface port-channel 55`
`description MLAG_Peer_Link`
`switchport mode trunk`
`vpc peer-link`
`end`
	`configure`
	`interface port-channel 55`
	`description MLAG_Peer_Link`
	`switchport mode trunk`
	`vpc peer-link`
	`end`

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

`configure`
`interface range fo1/1/1-2`
`description MLAG_Peer_Link`
`switchport mode trunk`
`channel-group 55 mode active`
`end`
	`configure`
	`interface range fo1/1/1-2`
	`description MLAG_Peer_Link`
	`switchport mode trunk`
	`channel-group 55 mode active`
	`end`

Configure the MLAG going to the Nexus 5548UP vPC peers. Create the port channel. Configure the port channel for dot1q trunking. Specify the MLAG ID.	Configure the MLAG going to the Nexus 5548UP vPC peers. Create the port channel. Configure the port channel for dot1q trunking. Specify the MLAG ID.

`configure`
`interface port-channel 100`
`description LAG_to_Nexus_5548_vPC_peers`
`switchport mode trunk`
`vpc 55`
`end`
	`configure`
	`interface port-channel 100`
	`description LAG_to_Nexus_5548_vPC_peers`
	`switchport mode trunk`
	`vpc 55`
	`end`

Assign interfaces to the port channel and enable LACP.	Assign interfaces to the port channel and enable LACP.
configure interface range te1/0/1-2 description te1/0/1- 2_to_Nexus_5548_vPC_peers switchport mode trunk channel-group 100 mode active end	configure interface range te1/0/1-2 description te1/0/1- 2_to_Nexus_5548_vPC_peers switchport mode trunk channel-group 100 mode active end
Configure the MLAG going to the Nexus 5672UP switch. Create the port channel. Configure the port channel for dot1q trunking. Specify the MLAG ID.	Configure the MLAG going to the Nexus 5672UP switch. Create the port channel. Configure the port channel for dot1q trunking. Specify the MLAG ID.
configure interface port-channel 10 description MLAG_to_Nexus_5672UP-1 switchport mode trunk vpc 10 end	configure interface port-channel 10 description MLAG_to_Nexus_5672UP-1 switchport mode trunk vpc 10 end
Assign interfaces to the port channel and enable LACP.	Assign interfaces to the port channel and enable LACP.
configure interface te1/0/3 description te1/0/3_to_Nexus_5672UP-1 switchport mode trunk channel-group 10 mode active end	configure interface te1/0/3 description te1/0/3_to_Nexus_5672UP-1 switchport mode trunk channel-group 10 mode active end
Configure the MLAG going to the N3024P-1 switch. Create the port channel. Configure the port channel for dot1q trunking. Specify the MLAG ID.	Configure the MLAG going to the N3024P-1 switch. Create the port channel. Configure the port channel for dot1q trunking. Specify the MLAG ID.
configure interface port-channel 20 description MLAG_to_N3024P-1 switchport mode trunk vpc 20 end	configure interface port-channel 20 description MLAG_to_N3024P-1 switchport mode trunk vpc 20 end
Assign interfaces to the port channel and enable LACP.	Assign interfaces to the port channel and enable LACP.

configure interface te1/0/4 description te1/0/4_to_N3024P-1 switchport mode trunk channel-group 20 mode active end	configure interface te1/0/4 description te1/0/4_to_N3024P-1 switchport mode trunk channel-group 20 mode active end
Configure the MLAG going to the N3024P-2 switch. Create the port channel. Configure the port channel for dot1q trunking. Specify the MLAG ID.	Configure the MLAG going to the N3024P-2 switch. Create the port channel. Configure the port channel for dot1q trunking. Specify the MLAG ID.
configure interface port-channel 30 description MLAG_to_N3024P-2 switchport mode trunk vpc 30 end	configure interface port-channel 30 description MLAG_to_N3024P-2 switchport mode trunk vpc 30 end
Assign interfaces to the port channel and enable LACP.	Assign interfaces to the port channel and enable LACP.
configure interface te1/0/5 description te1/0/5_to_N3024P-2 switchport mode trunk channel-group 30 mode active end	configure interface te1/0/5 description te1/0/5_to_N3024P-2 switchport mode trunk channel-group 30 mode active end

Figure 17 MLAG configuration for N4032F-1 and N4032F-2

N3024P-1	N3024P-2
Configure the port channel connecting to the upstream MLAG peer switches.	Configure the port channel connecting to the upstream MLAG peer switches.
configure interface port-channel 20 description Po20_to_N4032F_MLAG_Peers switchport mode trunk end	configure interface port-channel 20 description Po20_to_N4032F_MLAG_Peers switchport mode trunk end
Assign interfaces to the port channel and enable LACP.	Assign interfaces to the port channel and enable LACP.
configure interface range te1/0/1-2 description te1/0/1- 2_to_N4032F_MLAG_Peers switchport mode trunk channel-group 20 mode active end	configure interface range te1/0/1-2 description te1/0/1- 2_to_N4032F_MLAG_Peers switchport mode trunk channel-group 30 mode active end

Figure 18 LAG configuration for N3024P-1 and N3024P-2

Note: See the appendix section A.3 for the commands required to validate the configuration and to ensure that MLAG and vPC are working.

7 MLAG and VRRP Example

The following example scenario combines two-tier MLAG and Virtual Router Redundancy Protocol (VRRP).

Two N4032 and two N2048 switches in an MLAG configuration provide robust and high-capacity, Layer-2 transport to an access layer, N1532 switch. The N4032 switches acting aggregation/core layer provide gateway redundancy using VRRP on MLAG interfaces.

With VRRP configured, the two switches share a common virtual IP, which is used as the gateway address for clients on the network. One of the switches fills the role of the gateway for that address as long as it is available. That switch is said to be the active router. If the active router becomes unavailable, the VRRP backup peer takes over. In this way, a gateway can fail and no clients know anything happened. The backup switch fills the gateway role seamlessly. The scenario depicted in Figure 19 combines MLAG and VRRP.

The following sections provide instructions for only MLAG domains 55 and 56 with MLAG 13. Domain 57 and MLAG 14 would use similar commands for VLAN 20.

Note: In Figure 19, an N4032 switch splits the Layer-2 network from the Layer-3 network. MLAG does not currently support Layer-3 VLAN termination. Recovery from a Layer-3 link failure requires a dedicated link between MLAG peer switches to perform layer-3 routing. For more information please refer to the N-series user guide on support.dell.com

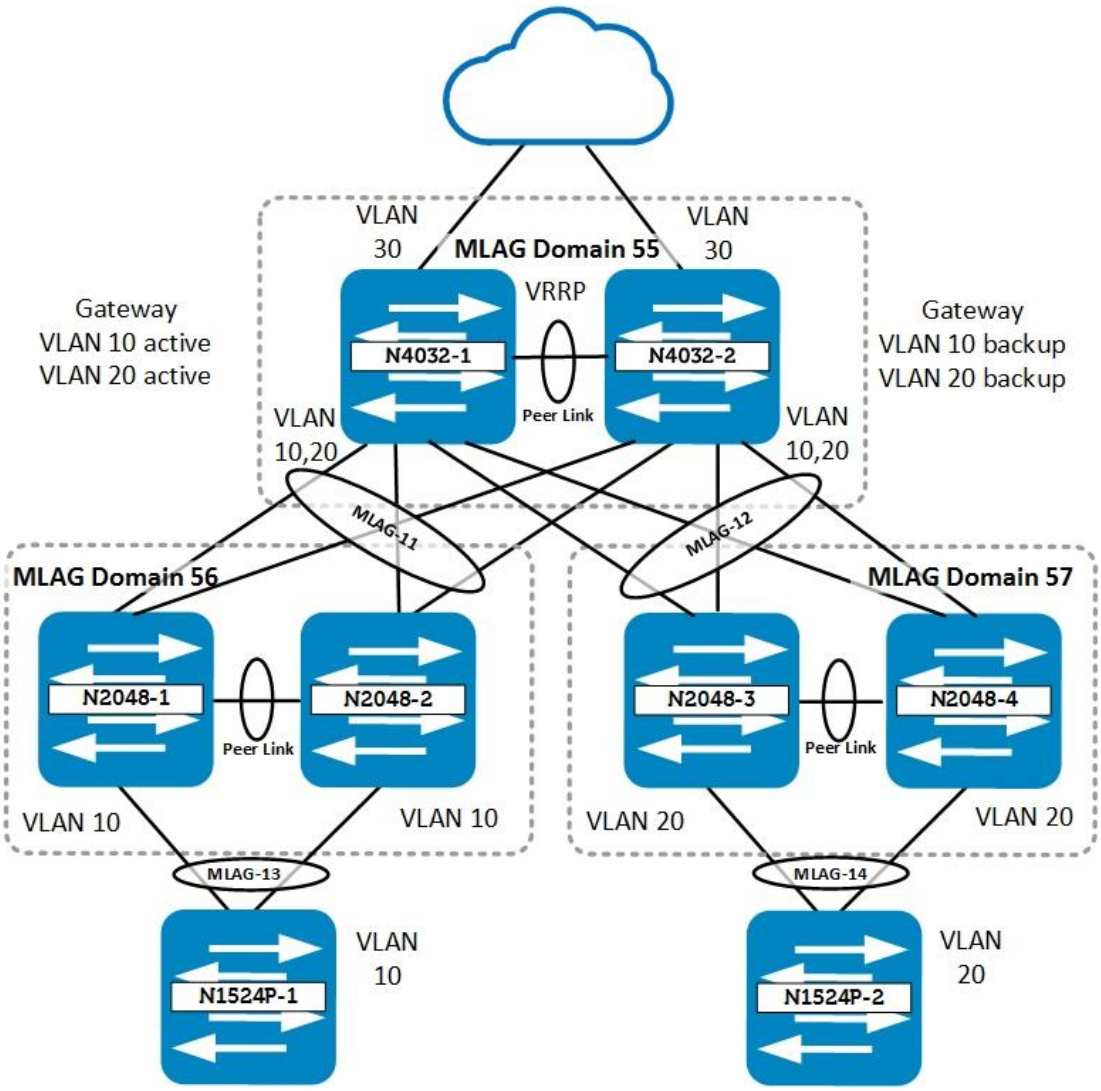

Figure 19 MLAG and VRRP example topology

7.1 Physical Connectivity

After completion of the configuration, all six switches can be physically interconnected. Table 6 serves as a guide for cabling the switches.

Table 6 Physical Connectivity

Dell Networking N4032		**Dell Networking N2048**	
From Switch / Port	To Switch / Port	From Switch / Port	To Switch / Port
N4032-1 / te1/0/23-24	N4032-2 / te1/0/23-24	N2048-1 / te1/0/1-2	N2048-2 / te1/0/1-2
N4032-1 / te1/0/1	N2048-1 / gi1/0/1	N2048-1 / gi1/0/14	N1524P-1 / gi1/0/14
N4032-1 / te1/0/2	N2048-2 / gi1/0/1	N2048-2 / gi1/0/13	N1524P-1 / gi1/0/13
N4032-2 / te1/0/1	N2048-1 / gi1/0/2	N2048-3 / te1/0/1-2	N2048-4 / te1/0/1-2
N4032-2 / te1/0/2	N2048-2 / gi1/0/2	N2048-3 / gi1/0/14	N1524P-2 / gi1/0/14
N4032-1 / te1/0/11	N2048-3 / gi1/0/1	N2048-4 / gi1/0/13	N1524P-2 / gi1/0/13
N4032-1 / te1/0/12	N2048-4 / gi1/0/1		
N4032-2 / te1/0/11	N2048-3 / gi1/0/2		
N4032-2 / te1/0/12	N2048-4 / gi1/0/2		

7.2 Initial Setup and MSTP Configuration

This section deals with setting up the switches for initial configuration and MSTP.

N4032-1	N4032-2
Configure host name. Configure the IP and default route for management. Configure a user name and password.	Configure host name. Configure the IP and default route for management. Configure a user name and password.
configure hostname N4032-1 interface out-of-band ip address 172.25.188.71 255.255.0.0 172.25.188.254 exit username admin password Dell1234 privilege 15 end	configure hostname N4032-2 interface out-of-band ip address 172.25.188.72 255.255.0.0 172.25.188.254 exit username admin password Dell1234 privilege 15 end
Configure MSTP Configure VLANs 10, 20 and 30.	Configure MSTP Configure VLANs 10, 20 and 30.
Configure SVIs for VLANs 10, 20 and 30.	Configure SVIs for VLANs 10, 20 and 30.
configure int vlan 10 ip address 192.168.10.2 255.255.255.0 int vlan 20 ip address 192.168.20.2 255.255.255.0 int vlan 30 ip address 192.168.30.2 255.255.255.0 end	configure int vlan 10 ip address 192.168.10.3 255.255.255.0 int vlan 20 ip address 192.168.20.3 255.255.255.0 int vlan 30 ip address 192.168.30.3 255.255.255.0 end
configure vlan 10 name Marketing exit vlan 20 name HR exit vlan 30 name Datacenter exit spanning-tree mode mst spanning-tree mst 1 priority 0 spanning-tree mst configuration name "Dell" instance 1 add vlan 10 instance 1 add vlan 20 end	configure vlan 10 name Marketing exit vlan 20 name HR exit vlan 30 name Datacenter exit spanning-tree mode mst spanning-tree mst 1 priority 4096 spanning-tree mst configuration name "Dell" instance 1 add vlan 10 instance 1 add vlan 20 end

Figure 20 Initial setup for N4032-1 and N4032-2

N2048-1	N2048-2
Configure host name. Configure the IP and default route for management. Configure a user name and password. Enable MLAG feature.	Configure host name. Configure the IP and default route for management. Configure a user name and password. Enable MLAG feature.
configure hostname N2048-1 interface out-of-band ip address 172.25.188.73 255.255.0.0 172.25.188.254 exit username admin password Dell1234 privilege 15 feature vpc end	configure hostname N2048-2 interface out-of-band ip address 172.25.188.74 255.255.0.0 172.25.188.254 exit username admin password Dell1234 privilege 15 feature vpc end
Configure MSTP. Configure VLAN 10 and 20.	Configure MSTP. Configure VLAN 10 and 20.
configure vlan 10 name Marketing exit vlan 20 name HR exit spanning-tree mode mst spanning-tree mst configuration name "Dell" instance 1 add vlan 10 instance 1 add vlan 20 end	configure vlan 10 name Marketing exit vlan 20 name HR exit spanning-tree mode mst spanning-tree mst configuration name "Dell" instance 1 add vlan 10 instance 1 add vlan 20 end

Figure 21 Initial setup for N2048P-1 and N2048P-2

N1524P-1

Configure host name.
Create VLAN 999 for management.
Configure gi1/0/1 for Access mode VLAN 999.
Configure the IP for management.
Configure the default route for management.
Configure a user name and password.

```
configure
hostname N1548-1
vlan 999
exit
interface gi1/0/1
switchport access vlan 999
interface vlan 999
ip address 172.25.188.77
255.255.0.0
exit
ip default-gateway 172.25.188.254
username admin password Dell1234
privilege 15
end
```

Configure MSTP.
Configure VLAN 10, 20.

```
Configure
vlan 10
name Marketing
exit
vlan 20
name HR
exit
spanning-tree mode mst
spanning-tree mst configuration
name "Dell"
instance 1 add vlan 10
instance 1 add vlan 20
end
```

Figure 22 Initial setup for N1524P-1

7.3 Configuring VRRP

This section deals with setting up the switches for VRRP.

N4032-1	N4032-2
Enable routing.	Enable routing.

`configure`
`ip routing`
`end`
	`configure`
	`ip routing`
	`end`

Enable VRRP globally. Create VRRP instance for VLAN 10. Set virtual IP address. Give the VRRP instance a higher priority. Enable VRRP on the interface.	Enable VRRP globally. Create VRRP instance for VLAN 10. Set virtual IP address. Enable VRRP on the interface.

`configure`
`ip vrrp`
`int vlan 10`
`vrrp 10`
`vrrp 10 mode`
`vrrp 10 ip 192.168.10.1`
`vrrp 10 priority 150`
`vrrp 10 accept-mode`
`end`
	`configure`
	`ip vrrp`
	`int vlan 10`
	`vrrp 10`
	`vrrp 10 mode`
	`vrrp 10 ip 192.168.10.1`
	`vrrp 10 accept-mode`
	`end`

Create VRRP instance for VLAN 20. Set virtual IP address. Give the VRRP instance a higher priority Enable VRRP on the interface.	Create VRRP instance for VLAN 20. Set virtual IP address. Enable VRRP on the interface.

`configure`
`int vlan 20`
`vrrp 20`
`vrrp 20 mode`
`vrrp 20 ip 192.168.20.1`
`vrrp 20 priority 150`
`vrrp 20 accept-mode`
`end`
	`configure`
	`int vlan 20`
	`vrrp 20`
	`vrrp 20 mode`
	`vrrp 20 ip 192.168.20.1`
	`vrrp 20 priority 150`
	`vrrp 20 accept-mode`
	`end`

Figure 23 VRRP configuration on N4032-1 and N4032-2

7.4 Configuring MLAG

This section deals with setting up the switches for MLAG.

N4032-1	N4032-2
Create an MLAG domain. Assign role priority. Assign the keepalive management IP address of N4032P-2.	Create an MLAG domain. Assign role priority. Assign the keepalive management IP address of N4032P-1.

`configure`
`vpc domain 55`
`role priority 1`
`peer-keepalive enable`
`peer-keepalive destination 172.25.188.72 source 172.25.188.71`
`peer detection enable`
`end`
	`configure`
	`vpc domain 55`
	`role priority 255`
	`peer-keepalive enable`
	`peer-keepalive destination 172.25.188.71 source 172.25.188.72`
	`peer detection enable`
	`end`

Create a port channel. Give the port channel a description. Configure the port channel for dot1q trunking. Assign as an MLAG peer link.	Create a port channel. Give the port channel a description. Configure the port channel for dot1q trunking. Assign as an MLAG peer link.

`configure`
`interface port-channel 55`
`description MLAG_Peer_Link`
`switchport mode trunk`
`vpc peer-link`
`end`
	`configure`
	`interface port-channel 55`
	`description MLAG_Peer_Link`
	`switchport mode trunk`
	`vpc peer-link`
	`end`

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

`configure`
`interface range te1/0/23-24`
`description MLAG_Peer_Link`
`switchport mode trunk`
`channel-group 55 mode active`
`end`
	`configure`
	`interface range te1/0/23-24`
	`description MLAG_Peer_Link`
	`switchport mode trunk`
	`channel-group 55 mode active`
	`end`

Configure one MLAG going to the N2048 switches. Create the port channel. Give the port channel a description. Configure the port channel for dot1q trunking VLAN 10. Specify the MLAG ID.	Configure one MLAG going to the N2048 switches. Create the port channel. Give the port channel a description. Configure the port channel for dot1q trunking VLAN 10. Specify the MLAG ID.

`configure`
`interface port-channel 11`
`description MLAG_to_N2048_switches`
`switchport mode trunk`
`switchport trunk allowed vlan 10`
`vpc 12`
`end`
	`configure`
	`interface port-channel 11`
	`description MLAG_to_N2048_switches`
	`switchport mode trunk`
	`switchport trunk allowed vlan 10`
	`vpc 12`
	`end`

Assign interface to the port channel and enable LACP.	Assign interface to the port channel and enable LACP.
configure interface te1/0/1-2 description MLAG_to_N2048_switches channel-group 11 mode active end	configure interface te1/0/1-2 description MLAG_to_N2048_switches channel-group 11 mode active end

Figure 24 MLAG configuration on N4032-1 and N4032-2

N2048-1	N2048-2
Create an MLAG domain. Assign role priority. Assign the keepalive management IP address of N2048P-2.	Create an MLAG domain. Assign role priority. Assign the keepalive management IP address of N2048P-1.
configure vpc domain 56 role priority 1 peer-keepalive enable peer-keepalive destination 172.25.188.74 source 172.25.188.73 peer detection enable end	configure vpc domain 56 role priority 255 peer-keepalive enable peer-keepalive destination 172.25.188.73 source 172.25.188.74 peer detection enable end
Create a port channel. Give the port channel a description. Configure the port channel for dot1q trunking. Assign as an MLAG peer link.	Create a port channel. Give the port channel a description. Configure the port channel for dot1q trunking. Assign as an MLAG peer link.
configure interface port-channel 56 description MLAG_Peer_Link switchport mode trunk vpc peer-link end	configure interface port-channel 56 description MLAG_Peer_Link switchport mode trunk vpc peer-link end
Assign interfaces to the port channel and enable LACP.	Assign interfaces to the port channel and enable LACP.
configure interface range te1/0/1-2 description MLAG_Peer_Link switchport mode trunk channel-group 56 mode active end	configure interface range te1/0/1-2 description MLAG_Peer_Link switchport mode trunk channel-group 56 mode active end

Configure one MLAG going to the N4032 switches. Create the port channel. Give the port channel a description. Configure the port channel for dot1q trunking VLAN 10. Specify the MLAG ID.	Configure one MLAG going to the N4032 switches. Create the port channel. Give the port channel a description. Configure the port channel for do1q trunking VLAN 10. Specify the MLAG ID.

`configure`
`interface port-channel 11`
`description MLAG_to_N4032_switches`
`switchport mode trunk`
`switchport trunk allowed vlan 10`
`vpc 11`
`end`
	`configure`
	`interface port-channel 11`
	`description MLAG_to_N4032_switches`
	`switch mode trunk`
	`switchport trunk allowed vlan 10`
	`vpc 11`
	`end`

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

`configure`
`interface gi1/0/1-2`
`description MLAG_to_N4032_switches`
`channel-group 11 mode active`
`end`
	`configure`
	`interface gi1/0/1-2`
	`description MLAG_to_N4032_switches`
	`channel-group 11 mode active`
	`end`

Configure the MLAG going to the N1524P-1 switch. Create the port channel. Configure the port channel for Access mode VLAN 10. Specify the MLAG ID.	Configure the MLAG going to the N1524P-1 switch. Create the port channel. Configure the port channel for Access mode VLAN 10. Specify the MLAG ID.

`configure`
`interface port-channel 13`
`description MLAG_to_N1524P-1`
`switchport access vlan 10`
`vpc 13`
`end`
	`configure`
	`interface port-channel 13`
	`description MLAG_to_N1524P-1`
	`switchport access vlan 10`
	`vpc 13`
	`end`

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

`configure`
`interface gi1/0/13`
`description gi1/0/13_to_N1524P-1`
`switchport access vlan 10`
`channel-group 13 mode active`
`end`
	`configure`
	`interface gi1/0/13`
	`description gi1/0/13_to_N1524P-1`
	`switchport access vlan 10`
	`channel-group 13 mode active`
	`end`

Figure 25 MLAG Configuration for N2048-1 and N2048-2

N1524P-1

Configure the port channel connecting to the upstream MLAG peer switches.

```
configure
interface port-channel 13
description gi1/0/13-
14_to_N2048_MLAG_Peers
switchport access vlan 10
interface range gi1/0/13-14
description te1/0/13-
14_to_N2048_MLAG_Peers
channel-group 13 mode active
end
```

Configure the port channel connecting to the upstream MLAG peer switches.

```
configure
interface port-channel 13
description gi1/0/13-
14_to_N2048_MLAG_Peers
switchport access vlan 10
interface range gi1/0/13-14
description te1/0/13-
14_to_N2048_MLAG_Peers
channel-group 13 mode active
end
```

Figure 26 LAG configuration for N1524P-1

Note: See appendix section A.4 for configuration validation commands and commands to ensure that MLAG and VRRP are working. Configurations for N2048-3 and N2048-4 resemble configurations for N2048-1 and N2048-2 except different VLAN. Also Layer-3 configuration for VLAN 30 is not shown as it varies based on the device/configuration used in Layer-3

8 VoIP and MLAG Example

MLAG is compatible with Voice VLAN and QoS for VoIP deployments. The following example provides instruction on setting up MLAG, RSTP-PV, and Voice VLAN, as well as configuring QoS for voice traffic prioritization. This allows for the combination of a highly robust, non-blocking architecture provided by MLAG with the fast-converging loop mitigation provided by RSTP-PV with the assurance of stutter-free voice traffic should the network encounter contention.

The scenario in Figure 27 combines MLAG, RSTP-PV, Voice VLAN, and QoS settings for VoIP prioritization.

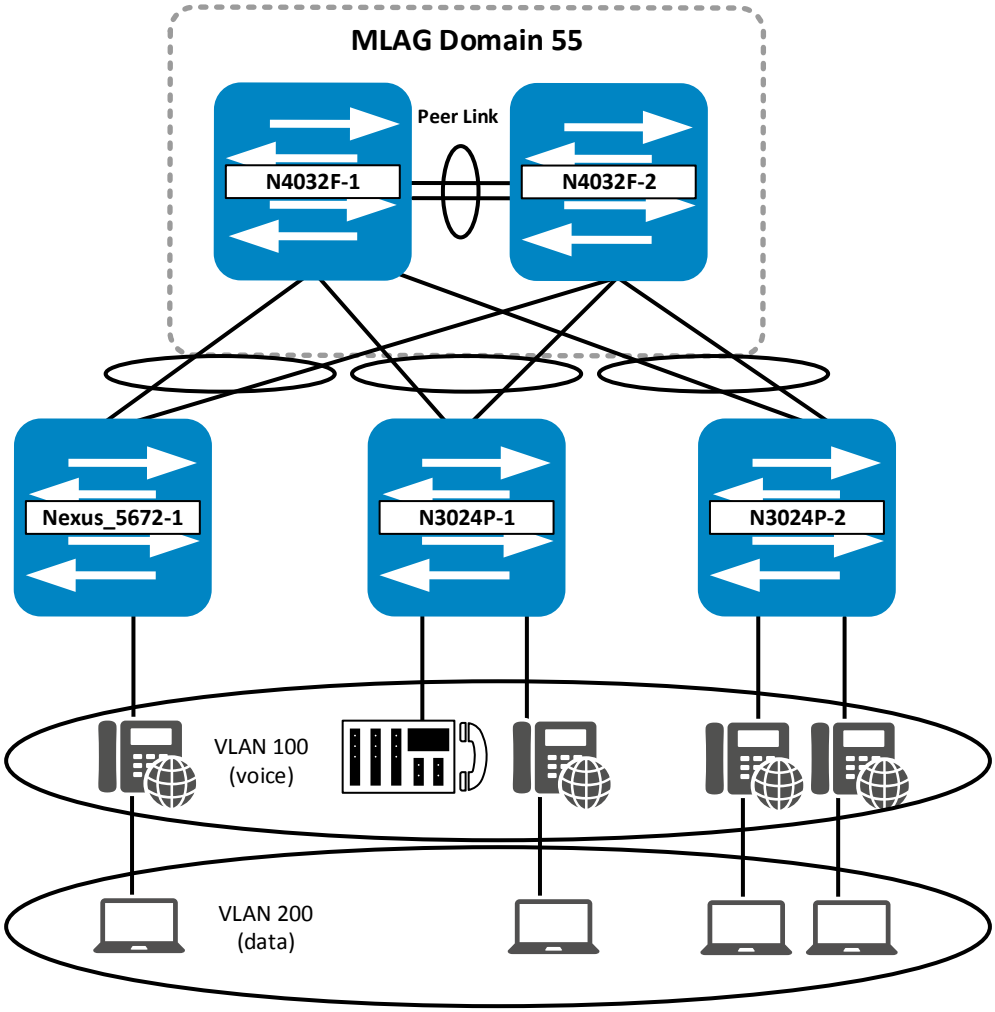

Figure 27 VoIP and MLAG example topology

Note: For more comprehensive documentation detailing VoIP deployment, see the QoS for VOIP on Dell N-Series and W-Series deployment guide.

8.1 Physical Connectivity

After completion of the configuration, physical connectivity between all five switches can be established. Table 7 serves as a guide for cabling the switches.

Table 7 Physical Connectivity

Dell Networking N4032F		**Access Switches**	
From Switch / Port	To Switch / Port	From Switch / Port	To Phone
N4032F-1 / te1/0/3	Nexus_5672UP-1 / eth1/1	Nexus_5672UP-1 eth 1/5	Cisco CP8961 IP phone
N4032F-1 / te1/0/4	N3024P-1 / te1/0/1	N3024P-1 / gi1/0/5	Cisco CP8961 IP phone
N4032F-1 / te1/0/5	N3024P-2 / te1/0/1	N3024P-2 / te1/0/5	Cisco CP8961 IP phone
N4032F-1 / fo1/1/1	N4032F-2 / fo1/1/1	N3024P-2 / te1/0/6	Cisco CP8961 IP phone
N4032F-1 / fo1/1/2	N4032F-2 / fo1/1/2		
N4032F-2 / te1/0/3	Nexus_5672UP-1 / eth1/2		
N4032F-2 / te1/0/4	N3024P-1 / te1/0/2		
N4032F-2 / te1/0/5	N3024P-2 / te1/0/2		

8.2 Initial Setup and RSTP-PV Configuration

This section deals with setting up the switches for initial configuration and RSTP-PV.

N4032F-1	**N4032F-2**
Enable MLAG feature.	Enable MLAG feature.

`configure`
`feature vpc`
`end`
	`configure`
	`feature vpc`
	`end`

Configure host name. Configure the IP and default route for management. Configure a user name and password.	Configure host name. Configure the IP and default route for management. Configure a user name and password.

`configure`
`hostname N4032F-1`
`interface out-of-band`
`ip address 172.25.188.71 255.255.0.0 172.25.188.254`
`exit`
`username admin password Dell1234 privilege 15`
`end`
	`configure`
	`hostname N4032F-2`
	`interface out-of-band`
	`ip address 172.25.188.72 255.255.0.0 172.25.188.254`
	`exit`
	`username admin password Dell1234 privilege 15`
	`end`

Configure RSTP-PV. Configure VLANs 10, 20, 30, 100, and 200.	Configure RSTP-PV. Configure VLANs 10, 20, 30, 100, and 200.
configure spanning-tree mode rapid-pvst vlan 10 name Marketing exit vlan 20 name HR exit vlan 30 name Operations exit vlan 100 name Voice exit vlan 200 name Data end	configure spanning-tree mode rapid-pvst vlan 10 name Marketing exit vlan 20 name HR exit vlan 30 name Operations exit vlan 100 name Voice exit vlan 200 name Data end

Figure 28 Initial setup for N4032F-1 and N4032F-2

N3024P-1	N3024P-2
Configure host name. Configure the IP and default route for management. Configure a user name and password.	Configure host name. Configure the IP and default route for management. Configure a user name and password.
configure hostname N3024P-1 interface out-of-band ip address 172.25.188.73 255.255.0.0 172.25.188.254 exit username admin password Dell1234 privilege 15 end	configure hostname N3024P-2 interface out-of-band ip address 172.25.188.74 255.255.0.0 172.25.188.254 exit username admin password Dell1234 privilege 15 end
Configure RSTP-PV. Configure VLANs 10, 20, 30, 100, and 200.	Configure RSTP-PV. Configure VLANs 10, 20, 30, 100, and 200.

```
configure
spanning-tree mode rapid-pvst
vlan 10
name Marketing
exit
vlan 20
name HR
exit
vlan 30
name Operations
exit
vlan 100
name Voice
exit
vlan 200
name Data
end
```

```
configure
spanning-tree mode rapid-pvst
vlan 10
name Marketing
exit
vlan 20
name HR
exit
vlan 30
name Operations
exit
vlan 100
name Voice
exit
vlan 200
name Data
end
```

Figure 29 Initial setup for N3024P-1 and N3024P-2

Note: See appendix section B.2.1 for the corresponding Cisco initial configuration for this example environment.

8.3 Configuring MLAG and Port Channels

This section deals with setting up the switches for MLAG and LACP port channels.

N4032F-1	N4032F-2
Create an MLAG domain. Assign role priority. Assign the keepalive management IP address of N4032F-2.	Create an MLAG domain. Assign role priority. Assign the keepalive management IP address of N4032F-1.

`configure`
`vpc domain 55`
`role priority 1`
`peer-keepalive enable`
`peer-keepalive destination 172.25.188.72 source 172.25.188.71`
`peer detection enable`
`end`
	`configure`
	`vpc domain 55`
	`role priority 255`
	`peer-keepalive enable`
	`peer-keepalive destination 172.25.188.71 source 172.25.188.72`
	`peer detection enable`
	`end`

Configure port channel and port channel members for the MLAG peer link. Create a port channel. Configure the port channel for dot1q trunking. Assign as an MLAG peer link.	Configure port channel and port channel members for the MLAG peer link. Create a port channel. Configure the port channel for dot1q trunking. Assign as an MLAG peer link.

`configure`
`interface port-channel 55`
`description MLAG_Peer_Link`
`switchport mode trunk`
`vpc peer-link`
`end`
	`configure`
	`interface port-channel 55`
	`description MLAG_Peer_Link`
	`switchport mode trunk`
	`vpc peer-link`
	`end`

Assign interfaces to the port channel and enable LACP.	Assign interfaces to the port channel and enable LACP.
configure interface range fo1/1/1-2 description MLAG_Peer_Link switchport mode trunk channel-group 55 mode active end	configure interface range fo1/1/1-2 description MLAG_Peer_Link switchport mode trunk channel-group 55 mode active end
Configure the MLAG going to the Nexus 5672UP switch. Create the port channel. Configure the port channel for dot1q trunking. Specify the MLAG ID.	Configure the MLAG going to the Nexus 5672UP switch. Create the port channel. Configure the port channel for dot1q trunking. Specify the MLAG ID.
configure interface port-channel 10 description MLAG_to_Nexus_5672UP-1 switchport mode trunk vpc 10 end	configure interface port-channel 10 description MLAG_to_Nexus_5672UP-1 switchport mode trunk vpc 10 end
Assign interfaces to the port channel and enable LACP.	Assign interfaces to the port channel and enable LACP.
configure interface te1/0/3 description te1/0/3_to_Nexus_5672UP-1 switchport mode trunk channel-group 10 mode active end	configure interface te1/0/3 description te1/0/3_to_Nexus_5672UP-1 switchport mode trunk channel-group 10 mode active end
Configure the MLAG going to the N3024P-1 switch. Create the port channel. Configure the port channel for dot1q trunking. Specify the MLAG ID.	Configure the MLAG going to the N3024P-1 switch. Create the port channel. Configure the port channel for dot1q trunking. Specify the MLAG ID.
configure interface port-channel 20 description MLAG_to_N3024P-1 switchport mode trunk vpc 20 end	configure interface port-channel 20 description MLAG_to_N3024P-1 switchport mode trunk vpc 20 end
Assign interfaces to the port channel and enable LACP.	Assign interfaces to the port channel and enable LACP.

configure interface te1/0/4 description te1/0/4_to_Nexus_N3024P-1 switchport mode trunk channel-group 20 mode active end	configure interface te1/0/4 description te1/0/4_to_Nexus_N3024P-1 switchport mode trunk channel-group 20 mode active end
Configure the MLAG going to the N3024P-2 switch. Create the port channel. Configure the port channel for dot1q trunking. Specify the MLAG ID.	Configure the MLAG going to the N3024P-2 switch. Create the port channel. Configure the port channel for dot1q trunking. Specify the MLAG ID.
configure interface port-channel 30 description MLAG_to_N3024P-2 switchport mode trunk vpc 30 end	configure interface port-channel 30 description MLAG_to_N3024P-2 switchport mode trunk vpc 30 end
Assign interfaces to the port channel and enable LACP.	Assign interfaces to the port channel and enable LACP.
configure interface te1/0/5 description te1/0/5_to_N3024P-2 switchport mode trunk channel-group 30 mode active end	configure interface te1/0/5 description te1/0/5_to_N3024P-2 switchport mode trunk channel-group 30 mode active end

Figure 30 MLAG configuration for N4032F-1 and N4032F-2

N3024P-1	N3024P-2
Configure the port channel connecting to the upstream MLAG peer switches.	Configure the port channel connecting to the upstream MLAG peer switches.
configure interface port-channel 20 description Po20_to_N4032F_MLAG_Peers switchport mode trunk end	configure interface port-channel 30 description Po20_to_N4032F_MLAG Peers switchport mode trunk end
Assign interfaces to the port channel and enable LACP.	Assign interfaces to the port channel and enable LACP.
configure interface range te1/0/1-2 description te1/0/1-2_to N4032F_MLAG_Peers switchport mode trunk channel-group 20 mode active end	configure interface range te1/0/1-2 description te1/0/1-2_to N4032F_MLAG_Peers switchport mode trunk channel-group 30 mode active end

Figure 31 LAG configuration for N3024P-1 and N3024P-2

Note: See appendix section B.2.2 for the corresponding Cisco port channel configuration for this example environment.

8.4 QoS for VoIP Configuration

This section deals with configuring the switches for Voice VLAN and QoS on the N-Series switches. Information on how to set up the Cisco UCS can be found in the QoS for VOIP on Dell N-Series and W-Series (v2.0) deployment guide.

N4032F-1	N4032F-2
Globally enable Voice VLAN. Trust incoming DSCP markings. Map DSCP markings 24 and 46 to queue 5. Set queue 5 to strict priority scheduling.	Globally enable Voice VLAN. Trust incoming DSCP markings. Map DSCP markings 24 and 46 to queue 5. Set queue 5 to strict priority scheduling.

`configure`
`voice vlan`
`classofservice trust ip-dscp`
`classofservice ip-dscp-mapping 24 5`
`classofservice ip-dscp-mapping 46 5`
`cos-queue strict 5`
`end`
	`configure`
	`voice vlan`
	`classofservice trust ip-dscp`
	`classofservice ip-dscp-mapping 24 5`
	`classofservice ip-dscp-mapping 46 5`
	`cos-queue strict 5`
	`end`

Figure 32 Voice VLAN and QoS configuration for N4032F-1 and N4032F-2

N3024P-1	N3024P-2
Globally enable Voice VLAN. Trust incoming DSCP markings. Map DSCP markings 24 and 46 to queue 5. Set queue 5 to strict priority scheduling.	Globally enable Voice VLAN. Trust incoming DSCP markings. Map DSCP markings 24 and 46 to queue 5. Set queue 5 to strict priority scheduling.

`configure`
`voice vlan`
`classofservice trust ip-dscp`
`classofservice ip-dscp-mapping 24 5`
`classofservice ip-dscp-mapping 46 5`
`cos-queue strict 5`
`end`
	`configure`
	`voice vlan`
	`classofservice trust ip-dscp`
	`classofservice ip-dscp-mapping 24 5`
	`classofservice ip-dscp-mapping 46 5`
	`cos-queue strict 5`
	`end`

Assign access port for the Cisco Unified CM server, making sure it is in the Voice VLAN. Configure switch ports used by wired phones and PCs. Specify the voice vlan, and disable authentication.	Configure switch ports used by wired phones and PCs. Specify the voice vlan, and disable authentication.

`configure`
`interface gigabit 1/0/1`
`switchport access vlan 100`
`voice vlan 100`
`voice vlan auth disable`
`interface range gigabit 1/0/2-24`
`switchport mode general`
`switchport general pvid 200`
`switchport general allow vlan add 100 tagged`
`switchport general allow vlan add 200`
`voice vlan 100`
`voice vlan auth disable`
`exit`
	`configure`
	`interface range gigabit 1/0/1-24`
	`switchport mode general`
	`switchport general pvid 200`
	`switchport general allow vlan add 100 tagged`
	`switchport general allow vlan add 200`
	`voice vlan 100`
	`voice vlan auth disable`
	`exit`

Figure 33 Voice VLAN and QoS configuration for N3024P-1 and N3024P-2

Notes:

1. The purpose of this section is to show how to configure QoS for VoIP on the N-Series switches. See the Cisco Nexus 5672UP User Guide for instructions on configuring the corresponding QoS parameters for VoIP prioritization on the Nexus 5672UP.
2. See the appendix section A.5 for the commands required to validate the configuration and to ensure that MLAG and the VoIP features work properly.

9 MLAG with VLT Example

MLAG also works with Virtual Link Trunking (VLT). VLT is a technology similar to MLAG that can be used on certain Dell EMC switches like the S4810. Figure 12 shows VLT peers on one layer and MLAG peers on the second layer with a full-mesh LAG. The LAG connecting the two S4810 switches is the VLTi (VLT interconnect) for the VLT domain. The bottom LAG between the two N4032F switches is the peer link for the MLAG domain. The top and bottom partner switches may be any switch model.

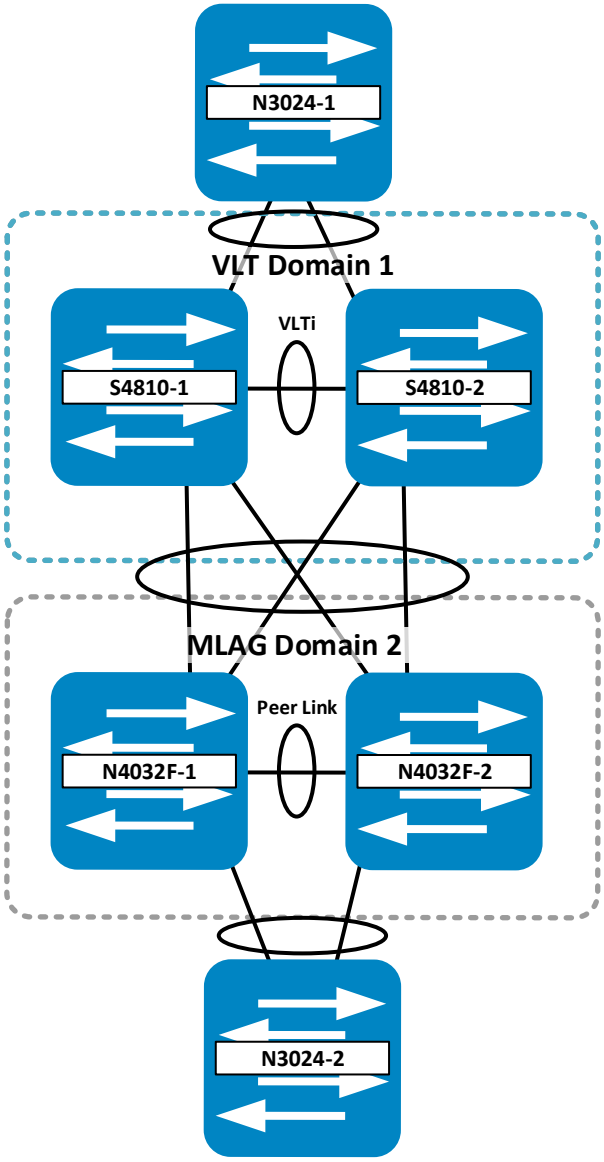

Figure 34 MLAG with VLT example topology

This topology in Figure 34 is similar to the one shown in Figure 8 on page 16. The former topology replaces N3024-2 and N3024-3 switches with S4810s, and N3024-4 and N3024-5 switches with N4032s to illustrate compatibility of VLT with MLAG protocols. This particular scenario also provides a full-mesh 10 GbE solution. The VLTi and peer link connections use 40 GbE interfaces.

Notes:
1. Other 10 GbE solutions include using all N4000 Series switches (MLAG only) or all S4810 switches (VLT only) in the place of the S4810 and 4032F switches.
2. In a full mesh of *MLAG-only* peer switches (as shown in the two-tier example in Figure 8), each peer pair must be in its own MLAG domain. However, with a full mesh of *one MLAG* peer pair and *one VLT* peer pair, each pair is already in its own domain within its protocol. For this reason, both peer pairs may use the same domain number if desired.

Enter the commands from section 9.2 for corresponding switches in the topology then cable the configuration as shown in Table 8.

The attachment column on the left also contains configurations. Click the paperclip icon to expose the list of attachments.

9.1 Physical Connectivity

After completing the configuration, physical connectivity between all six switches can be established. Table 8 serves as a guide for cabling the switches.

Table 8 Physical Connectivity

Dell Networking N-Series Switches		**Force10 S4810 switches**	
From Switch / Port	To Switch / Port	From Switch / Port	To Switch / Port
N3024-1 / te1/0/1	S4810-1 / te0/47	S4810-1 / te0/22	N4032F-2 / te1/0/1
N3024-1 / te1/0/2	S4810-2 / te0/47	S4810-1 / te0/23	N4032F-1 / te1/0/1
N4032F-1 / fo1/1/2	N4032F-2 / fo1/1/2	S4810-1 / fo0/56	S4810-2 / fo0/56
N4032F-1 / te1/0/24	N3024-2 / te1/0/2	S4810-2 / te0/22	N4032F-2 / te1/0/2
N4032F-2 / te1/0/24	N3024-2 / te1/0/1	S4810-2 / te0/23	N4032F-1 / te1/0/2

9.2 Configuring MLAG, VLT, and Port Channels

This section deals with setting up the switches for MLAG, VLT, and LACP port channels.

S4810-1	S4810-2
Enable Spanning Tree Protocol, which is disabled by default on the S4810.	Enable Spanning Tree Protocol, which is disabled by default on the S4810.

`configure`
`protocol spanning-tree rstp`
`no disable`
`end`
	`configure`
	`protocol spanning-tree rstp`
	`no disable`
	`end`

Create one or more VLANs for partner traffic.	Create one or more VLANs for partner traffic.

`configure`
`interface vlan 30`
`no shutdown`
`end`
	`configure`
	`interface vlan 30`
	`no shutdown`
	`end`

Configure the port channel for the peer link - can be different than the port channel going to N4032F-1 and 2. Assign the peer link interfaces.	Configure the port channel for the peer link - can be different than the port channel going to N4032F-1 and 2. Assign the peer link interfaces.

`configure`
`interface port-channel 1`
`description VLT-peer_link`
`no ip address`
`channel-member Fo 0/56`
`no shutdown`
`end`
	`configure`
	`interface port-channel 1`
	`description VLT-peer_link`
	`no ip address`
	`channel-member Fo 0/56`
	`no shutdown`
	`end`

Bring up the peer interfaces.	Bring up the peer interfaces.

`config`
`interface forty 0/56`
`no shutdown`
`end`
	`config`
	`interface forty 0/56`
	`no shutdown`
	`end`

Set up the VLT domain - identify a port channel - provide the management address of the other peer - lower priority will be primary - provide a MAC for the pair - provide correct unit-id (0-1)	Set up the VLT domain - identify a port channel - provide the management address of the other peer - lower priority will be primary - provide a MAC for the pair - provide correct unit-id (0-1)

```
config
vlt domain 1
peer link port-channel 1
back-up destination 172.25.194.24
primary-priority 1
system-mac mac-address
aa:bb:cc:dd:12:34
unit-id 0
end
```

Create a LAG for partner switches 4 and 5.
- put into L2 mode
- set rate interval
- port channel of peer (same here for ease of remembering)

```
configure
interface port-channel 40
no ip address
switchport
rate-interval 30
vlt-peer-lag port-channel 40
no shutdown
end
```

Assign interfaces to connect to partner 4's half of full mesh LAG.

```
configure
interface Te 0/22
description Link_to_MLAG
no ip address
port-channel-protocol LACP
port-channel 40 mode active
no shutdown
end
```

Assign interfaces to connect to partner 5's half of full mesh LAG.

```
configure
interface Te 0/23
description Link_to_MLAG
no ip address
port-channel-protocol LACP
port-channel 40 mode active
no shutdown
end
```

```
config
vlt domain 1
peer link port-channel 1
back-up destination 172.25.194.25
primary-priority 2
system-mac mac-address
aa:bb:cc:dd:12:34
unit-id 1
end
```

Create a LAG for partner switch switches 4 and 5.
- put into L2 mode
- set rate interval
- port channel of peer (same here for ease of remembering)

```
configure
interface port-channel 40
no ip address
switchport
rate-interval 30
vlt-peer-lag port-channel 40
no shutdown
end
```

Assign interfaces to connect to partner 4's half of full mesh LAG.

```
configure
interface Te 0/22
description Link_to_MLAG
no ip address
port-channel-protocol LACP
port-channel 40 mode active
no shutdown
end
```

Assign interfaces to connect to partner 5's half of full mesh LAG.

```
configure
interface Te 0/23
description Link_to_MLAG
no ip address
port-channel-protocol LACP
port-channel 40 mode active
no shutdown
end
```

Create a LAG for partner switch 1 to pass traffic. - put into L2 mode - set rate interval - port channel of peer (same here for ease of remembering)	Create a LAG for partner switch 1 to pass traffic. - put into L2 mode - set rate interval - port channel of peer (same here for ease of remembering)

`configure`
`interface port-channel 50`
`no ip address`
`switchport`
`rate-interval 30`
`vlt-peer-lag port-channel 50`
`no shutdown`
`end`
	`configure`
	`interface port-channel 50`
	`no ip address`
	`switchport`
	`rate-interval 30`
	`vlt-peer-lag port-channel 50`
	`no shutdown`
	`end`

Add VLAN 30 to the port channels.	Add VLAN 30 to the port channels.

`configure`
`interface vlan 30`
`tagged port-channel 40,50`
`end`
	`configure`
	`interface vlan 30`
	`tagged port-channel 40,50`
	`end`

Assign interfaces to VLAN that will connect to partner 1's LAG. - put both into same LAG 50	Assign interfaces to VLAN that will connect to partner 1's LAG. - put both into same LAG 50

`configure`
`interface Te 0/47`
`no ip address`
`port-channel-protocol LACP`
`port-channel 50 mode active`
`no shutdown`
`end`
	`configure`
	`interface Te 0/47`
	`no ip address`
	`port-channel-protocol LACP`
	`port-channel 50 mode active`
	`no shutdown`
	`end`

Figure 35 VLT configuration for S4810-1 and S4810-2

N4032F-1	N4032F-2
Create a VLAN for MLAG and all partner traffic.	Create a VLAN for MLAG and all partner traffic.
configure vlan 30 end	configure vlan 30 end
Configure the port channel for the peer link - must be trunk mode.	Configure the port channel for the peer link - must be trunk mode.
configure interface port-channel 1 description MLAG_peer_link switchport mode trunk vpc peer link end	configure interface port-channel 1 description MLAG_peer_link switchport mode trunk vpc peer link end
Identify and configure the switch 4-5 peer link interfaces.	Identify and configure the switch 4-5 peer link interfaces.
configure interface fo 1/1/2 channel-group 1 mode active description MLAG_peer_link end	configure interface fo 1/1/2 channel-group 1 mode active description MLAG_peer_link end
Create a LAG for partner switches S4810-1 and S4810-2 to pass traffic. Assign a unique id for partner.	Create a LAG for partner switches S4810-1 and S4810-2 to pass traffic. Assign a unique id for partner.
configure interface port-channel 40 switchport mode trunk vpc 40 end	configure interface port-channel 40 switchport mode trunk vpc 40 end
Assign interfaces to connect to switch 2's half of full mesh LAG.	Assign interfaces to connect to switch 2's half of full mesh LAG.
configure interface te 1/0/1 channel-group 40 mode active description MLAG_Partner_Link end	configure interface te 1/0/1 channel-group 40 mode active description MLAG_Partner_Link end
Assign interfaces to connect to switch 3's half of full mesh LAG.	Assign interfaces to connect to switch 3's half of full mesh LAG.
configure interface te 1/0/2 channel-group 40 mode active description MLAG_Partner_Link end	configure interface te 1/0/2 channel-group 40 mode active description MLAG_Partner_Link end

Create a LAG for partner switch 5 to pass traffic. Assign a unique id for partner switch 5.	Create a LAG for partner switch 5 to pass traffic. Assign a unique id for partner switch 5.
configure interface port-channel 60 switchport mode trunk vpc 60 end	configure interface port-channel 60 switchport mode trunk vpc 60 end
Assign interfaces to VLAN that will connect to partner 5's LAG - put both into same LAG 60.	Assign interfaces to VLAN that will connect to partner 5's LAG - put both into same LAG 60.
configure interface te 1/0/24 channel-group 60 mode active switchport mode trunk description MLAG_Partner_Link end	configure interface te 1/0/24 channel-group 60 mode active switchport mode trunk description MLAG_Partner_Link end
Enable the MLAG.	Enable the MLAG.
configure feature vpc vpc domain 2 peer-keepalive enable end	configure feature vpc vpc domain 2 peer-keepalive enable end

Figure 36 MLAG configuration for N4032F-1 and N4032F-2

N3024-1	N3024-2
Create same VLAN on partners.	Create same VLAN on partners.

`configure`
`vlan 30`
`end`
	`configure`
	`vlan 30`
	`end`

Configure the port channel trunks for the partner links.	Configure the port channel trunks for the partner links.

`configure`
`interface port-channel 1`
`switchport mode trunk`
`end`
	`configure`
	`interface port-channel 1`
	`switchport mode trunk`
	`end`

Assign first interface to LAG (channel-group).	Assign first interface to LAG (channel-group).

`configure`
`interface te 1/0/1`
`channel-group 1 mode active`
`end`
	`configure`
	`interface te 1/0/1`
	`channel-group 1 mode active`
	`end`

Assign second interface to LAG (channel-group).	Assign second interface to LAG (channel-group).

`configure`
`interface te 1/0/2`
`channel-group 1 mode active`
`end`
	`configure`
	`interface te 1/0/2`
	`channel-group 1 mode active`
	`end`

Figure 37 LAG configuration for N3024-1 and N3024-2

Note: See the appendix section A.6 for the commands required to validate the configuration and ensure that MLAG works properly.

10 Connecting single-homed partners

By single-homing a device (attaching it to only one peer) does not actually create an MLAG *partner.* When configuring an MLAG topology, partner devices (switches, servers, storage, or other) must use an MLAG link aggregation that spans both MLAG peers in order to be a partner. Using only one cable or port-channel going into only one of the MLAG peers (Figure 38) does not take advantage of the multiple path MLAG and can lead to data loss.

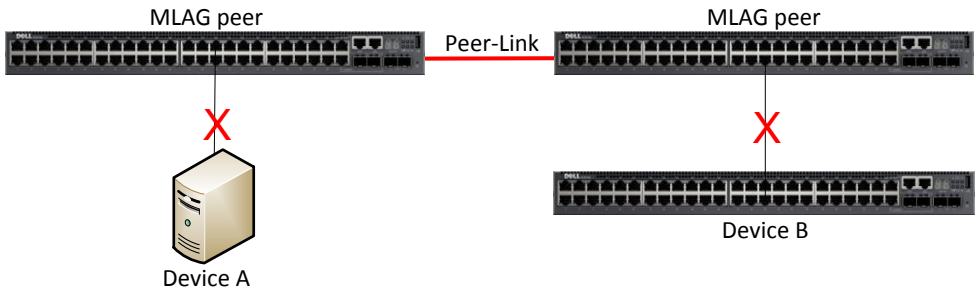

Figure 38 Unsupported single-homed partner devices

Traffic to and from non-redundant ports is filtered and never crosses the MLAG peer link. Such ports/VLANs need to obtain connectivity via an alternative to the MLAG-connected ports/VLANs. There are three ways to circumvent the problem of a singled-homed device that allows it to attach and pass traffic through the MLAG topology.

Solution 1

The first solution, as shown in Figure 39, is to attach single-homed devices to only one MLAG peer. An extra port channel connection between the MLAG peers allows for non-MLAG VLAN traffic from the single-homed devices to cross from one peer to the other. To prevent Spanning Tree Protocol from blocking one of these ports, disable Spanning Tree Protocol from the extra port being added between the MLAG peers. In this example, VLANs 1-39 are used in the MLAG, with VLAN 40 dedicated to be used only by devices with non-redundant links. Attached devices achieve no MLAG benefits using this method.

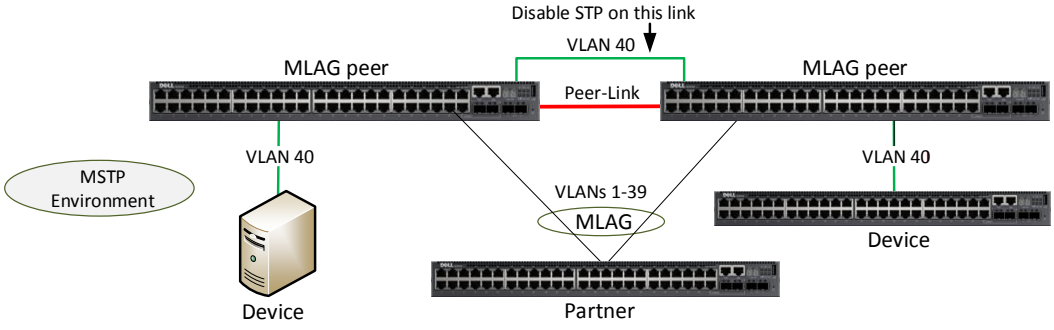

Figure 39 Solution 1 - Adding a VLAN link between the MLAG peers

MLAG interfaces and non-redundant ports cannot be members of the same VLAN. That is, a VLAN may contain MLAG interfaces or a VLAN may contain non-redundant ports, but not both.

Note: Solution 1 can run in an MSTP or RSTP-PV environment. Remove STP from the extra link to keep the peer link unblocked.

Solution 2

The second solution, as shown in Figure 40, is to configure one or more MLAG partner switches between the MLAG peers and the devices that require a single link. The single-homed devices (A, B, C, and D) can then pass traffic across the MLAG domain.

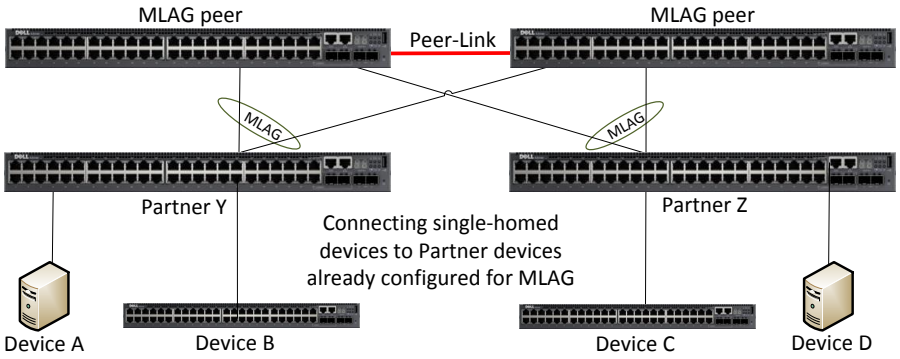

Figure 40 Solution 2 - Connecting devices to a partner switch

Solution 3

A third solution, as shown in Figure 41, is to *multi-home* the partner device, thereby creating an MLAG. Add one or more cables to the device, creating a LAG with half the cables going to each MLAG peer attaining the redundant multi-path advantage. To take advantage of MLAG, a device must attach to a minimum of two partner devices.

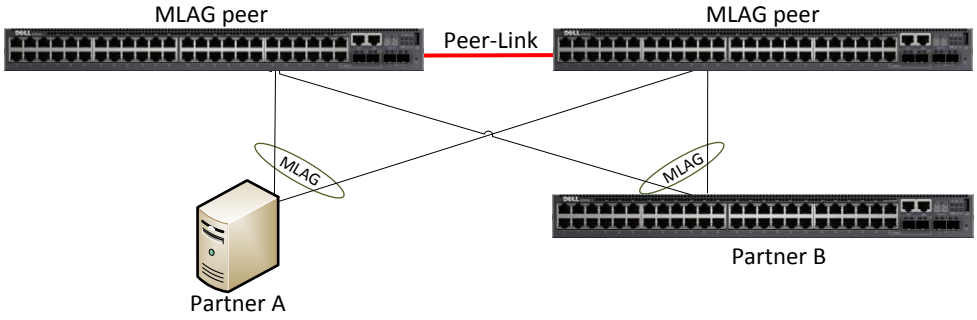

Figure 41 Solution 3 – Multi-homed, Multi-switch LAG (MLAG)

The primary purpose of this guide is to explain the MLAG method (solution 3). Find a complete explanation including N-Series switch configurations for this topology in the Single-Tier MLAG Example on page 12. To configure link aggregation for servers, storage or other devices, consult the User Guides for the NICs being used in those devices.

A Validation

A.1 Single-Tier Example

Run the `show vpc brief` command on either MLAG peer to display all information for both peers.

MLAG peer 1 (N3048-1)	MLAG peer 2 (N3048-2)
show vpc brief VPC domain ID..... 1 VPC admin status..... Enabled Keep-alive admin status..... Enabled VPC operational status..... Enabled Self role..... Primary Peer role..... Secondary Peer detection admin status..... Disabled Operational VPC MAC..... ECF4.BBF5.2502 Operational VPC system priority.... 32767 peer link details ---------- Interface..... Po1 peer link admin status..... Enabled peer link STP admin status..... Enabled Configured VLANs..... 1,30 Egress tagged VLANs..... 30 VPC Details ---------- Number of VPCs configured..... 2 Number of VPCs operational..... 2 VPC id# 30 ---------- Interface..... Po30 Configured VLANs..... 1,30 VPC interface state..... Active Local Members Status ---------- ------ Gi1/0/47 Up Peer Members Status ---------- ------ Gi1/0/11 Up VPC id# 40 ---------- Interface..... Po40 Configured VLANs..... 1,30 VPC interface state..... Active	**show vpc brief** VPC domain ID..... 1 VPC admin status..... Enabled Keep-alive admin status..... Enabled VPC operational status..... Enabled Self role..... Secondary Peer role..... Primary Peer detection admin status..... Disabled Operational VPC MAC..... ECF4.BBF5.2502 Operational VPC system priority..... 32767 peer link details ---------- Interface..... Po1 peer link admin status..... Enabled peer link STP admin status..... Enabled Configured VLANs..... 1,30 Egress tagged VLANs..... 30 VPC Details ---------- Number of VPCs configured..... 2 Number of VPCs operational..... 2 VPC id# 30 ---------- Interface..... Po30 Configured VLANs..... 1,30 VPC interface state..... Active Local Members Status ---------- ------ Gi1/0/11 Up Peer Members Status ---------- ------ Gi1/0/47 Up VPC id# 40 ---------- Interface..... Po40 Configured VLANs..... 1,30 VPC interface state..... Active

```
Local Members        Status
                  ------------------    ------
Gi1/0/48              Up

Peer Members         Status
----------------     ------
Gi1/0/12              Up
```

```
Local Members        Status
------------------   ------
Gi1/0/12              Up

Peer Members         Status
----------------     ------
Gi1/0/48              Up
```

Figure 42 `show vpc brief` command output for N3048 MLAG peers in Single-tier topology

Results of the command should be the same as shown above. All member ports must show **UP**, and the *VPC interface state* must show **Active**. When partner switches are correctly configured with MLAGs and connected to the MLAG Peers, the *Number of VPCs operational* in the **show vpc brief** command will show 1 or more. A value of 0 indicates improperly configured partner switches.

The **show interface port-channel** is another helpful command to verify whether the configured LAG ports are up and running. This command can be run on both the primary and secondary peers on a single layer MLAG topology. If correctly configured, the port(s) in the LAG are listed with an Active status. If there are any inactive ports, check for cabling or configuration issues.

Single-tier MLAG peer

show interface port-channel 40

```
Channel   Ports                    Ch-Type  Hash Type Min-links Local Prf
-------   -------------------------- -------- --------- --------- ----
Po40      Active: Gi1/0/48        Dynamic  7       1       Disabled

Hash Algorithm Type
1 - Source MAC, VLAN, EtherType, source module and port Id
2 - Destination MAC, VLAN, EtherType, source module and port Id
3 - Source IP and source TCP/UDP port
4 - Destination IP and destination TCP/UDP port
5 - Source/Destination MAC, VLAN, EtherType, source MODID/port
6 - Source/Destination IP and source/destination TCP/UDP port
7 - Enhanced hashing mode
```

Figure 43 `show interface port-channel 40` command output for N3048 in Single-tier topology

A.2 Two-Tier Example

Run the `show vpc brief` command on either MLAG peer to display information for both peers.

Notes:
1. Interfaces used to connect each peer to the partner switch LAG are not required to match on each peer. For instance, in the example above, one partner LAG interface connects to 1/0/47 on the primary peer while the other interface connects to 1/0/11 on the secondary peer. The peers can use different ports.
2. The partner switch configurations must include LAGs and connections to the MLAG Peers, or the "Number of VPCs operational" in the `show vpc brief` command will show 0.

MLAG peer 1 (N3024-2)	MLAG peer 2 (N3024-3)
show vpc brief VPC domain ID..... 1 VPC admin status..... Enabled Keep-alive admin status..... Enabled VPC operational status..... Enabled Self role..... Primary Peer role..... Secondary Peer detection admin status..... Disabled Operational VPC MAC..... ECF4.BBF6.2512 Operational VPC system priority.... 32767 peer link details ---------- Interface..... Po1 peer link admin status..... Enabled peer link STP admin status..... Enabled Configured VLANs..... 1,30 Egress tagged VLANs..... 30 VPC Details ---------- Number of VPCs configured..... 2 Number of VPCs operational..... 2 VPC id# 40 ---------- Interface..... Po40 Configured VLANs..... 1,30 VPC interface state..... Active Local Members Status ---------- ------ Gi1/0/1 Up Gi1/0/2 Up Peer Members Status ---------- ------ Gi1/0/1 Up Gi1/0/2 Up VPC id# 50 ---------- Interface..... Po50 Configured VLANs..... 1,30 VPC interface state..... Active Local Members Status ---------- ------ Gi1/0/14 Up Peer Members Status ---------- ------ Gi1/0/13 Up	**show vpc brief** VPC domain ID..... 1 VPC admin status..... Enabled Keep-alive admin status..... Enabled VPC operational status..... Enabled Self role..... Secondary Peer role..... Primary Peer detection admin status..... Disabled Operational VPC MAC..... ECF4.BBF6.2512 Operational VPC system priority.... 32767 peer link details ---------- Interface..... Po1 peer link admin status..... Enabled peer link STP admin status..... Enabled Configured VLANs..... 1,30 Egress tagged VLANs..... 30 VPC Details ---------- Number of VPCs configured..... 2 Number of VPCs operational..... 2 VPC id# 40 ---------- Interface..... Po40 Configured VLANs..... 1,30 VPC interface state..... Active Local Members Status ---------- ------ Gi1/0/1 Up Gi1/0/2 Up Peer Members Status ---------- ------ Gi1/0/1 Up Gi1/0/2 Up VPC id# 50 ---------- Interface..... Po50 Configured VLANs..... 1,30 VPC interface state..... Active Local Members Status ---------- ------ Gi1/0/13 Up Peer Members Status ---------- ------ Gi1/0/14 Up

Figure 44 `show vpc brief` command output for both N3024 MLAG peers in Two-tier topology

All member ports must show **UP**, and the *VPC interface state* must show **Active**.

The **show interface port-channel** is another helpful tool to let you know if the configured LAGs are up and running. When correctly configured, ports in the LAG are listed with an **Active** status. Inactive ports indicate a possible cabling or configuration issue.

MLAG peers
show interfaces port-channel 40 Channel Ports Ch-Type Hash Type Min-links Local Prf ------- ---------- -------- --------- --------- --------- Po20 Active: Gi1/0/1, Gi1/0/2 Dynamic 7 1 Disabled   Hash Algorithm Type 1 - Source MAC, VLAN, EtherType, source module and port Id 2 - Destination MAC, VLAN, EtherType, source module and port Id 3 - Source IP and source TCP/UDP port 4 - Destination IP and destination TCP/UDP port 5 - Source/Destination MAC, VLAN, EtherType, source MODID/port 6 - Source/Destination IP and source/destination TCP/UDP port 7 - Enhanced hashing mode

Figure 45 `show interface port-channel 40` command output for N3024-1 in Two-tier topology

A.3 MLAG, vPC and RSTP-PV example

Run the `show vpc brief` command on either MLAG peer to display information on both peers

vPC peer 1 (Nexus_5548-1)	**vPC peer 2 (Nexus_5548-2)**
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	**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 : secondary 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	id Port Status Active vlans
-- ---- ------ ----------	-- ---- ------ ----------
1 Po55 up 1,10,20,30,100,200	1 Po55 up 1,10,20,30,100,200
vPC status	vPC status
----------	----------
id Port Status Consistency Reason Active vlans	id Port Status Consistency Reason Active vlans
------ ---------- ------ ---------- ---------- ----------	------ ---------- ------ ---------- ---------- ----------
8 Po8 up success success 1,10,20,30, 100,200	8 Po8 up success success 1,10,20,30, 100,200
100 Po100 up success success 1,10,20,30, 100,200	100 Po100 up success success 1,10,20,30, 100,200

Figure 46 `show vpc brief` command output for Nexus_5548UP vPC peers in MLAG, vPC, and RSTP-PV topology

MLAG peer 1 (N4032F-1)	MLAG peer 2 (N4032F-2)
show vpc brief	**show vpc brief**
VPC Domain ID..... 55 VPC admin status..... Enabled Keep-alive admin status..... Enabled VPC operational status..... Enabled Self role..... Primary Peer role..... Secondary Peer detection admin status..... Peer detected, VPC Operational Operational VPC MAC..... ECF4.BBF4.2437 Operational VPC system priority..... 32767	VPC Domain ID..... 55 VPC admin status..... Enabled Keep-alive admin status..... Enabled VPC operational status..... Enabled Self role..... Secondary Peer role..... Primary Peer detection admin status..... Peer detected, VPC Operational Operational VPC MAC..... ECF4.BBF4.2437 Operational VPC system priority..... 32767
Peer-Link details ----------	Peer-Link details ----------
Interface..... Po55 Peer-link admin status..... Enabled Peer-link STP admin status..... Enabled Configured VLANs..... 1,10,20,30,100,200 Egress tagged VLANs..... 10,20,30,100,200	Interface..... Po55 Peer-link admin status..... Enabled Peer-link STP admin status..... Enabled Configured VLANs..... 1,10,20,30,100,200 Egress tagged VLANs..... 10,20,30,100,200
VPC Details ----------	VPC Details ----------
Number of VPCs configured..... 4	Number of VPCs configured..... 4

```
Number of VPCs operational..... 4


VPC id# 10
----------
Interface..... Po10
Configured VLANs.....
1,10,20,30,100,200
VPC interface state..... Active

Local Members       Status
----------------   ------
Te1/0/3            Up

Peer Members        Status
---------------    ------
Te1/0/3            Up

VPC id# 20
----------
Interface..... Po20
Configured VLANs.....
1,10,20,30,100,200
VPC interface state..... Active

Local Members       Status
----------------   ------
Te1/0/4            Up

Peer Members        Status
---------------    ------
Te1/0/4            Up

VPC id# 30
----------
Interface..... Po30
Configured VLANs.....
1,10,20,30,100,200
VPC interface state..... Active

Local Members       Status
----------------   ------
Te1/0/5            Up

Peer Members        Status
---------------    ------
Te1/0/5            Up

VPC id# 100
----------
Interface..... Po100
Configured VLANs.....
1,10,20,30,100,200
VPC interface state..... Active

Local Members       Status
```

```
Number of VPCs operational..... 4


VPC id# 10
----------
Interface..... Po10
Configured VLANs.....
1,10,20,30,100,200
VPC interface state..... Active

Local Members       Status
----------------   ------
Te1/0/3            Up

Peer Members        Status
---------------    ------
Te1/0/3            Up

VPC id# 20
----------
Interface..... Po20
Configured VLANs.....
1,10,20,30,100,200
VPC interface state..... Active

Local Members       Status
----------------   ------
Te1/0/4            Up

Peer Members        Status
---------------    ------
Te1/0/4            Up

VPC id# 30
----------
Interface..... Po30
Configured VLANs.....
1,10,20,30,100,200
VPC interface state..... Active

Local Members       Status
----------------   ------
Te1/0/5            Up

Peer Members        Status
---------------    ------
Te1/0/5            Up

VPC id# 100
----------
Interface..... Po100
Configured VLANs.....
1,10,20,30,100,200
VPC interface state..... Active

Local Members       Status
```

---------------- ------ Te1/0/1 Up Te1/0/2 Up Peer Members Status ---------------- ------ Te1/0/1 Up Te1/0/2 Up	---------------- ------ Te1/0/1 Up Te1/0/2 Up Peer Members Status ---------------- ------ Te1/0/1 Up Te1/0/2 Up

Figure 47 `show vpc brief` command output for N4032F MLAG peers in MLAG, vPC, and RSTP-PV topology

A.4 MLAG and VRRP Example

Run the `show vrrp` command on either VRRP peer to display all information for both peers.

MLAG peer 1 (N4032-1)	MLAG peer 2 (N4032-2)
show vrrp Admin Mode..... Enable Router Checksum Errors..... 0 Router Version Errors..... 0 Router VRID Errors..... 0 Vlan 10 - Group 10 Primary IP Address..... 192.168.10.1 VMAC Address.....0000.5E00.010A Authentication Type..... None Priority..... 150 Configured Priority..... 150 Advertisement Interval (secs)..... 1 Accept Mode..... Disable Pre-empt Mode..... Enable Pre-empt delay..... 0 Administrative Mode..... Enable State..... Master Timers Learn mode..... Disable Description..... No interfaces are tracked for this vrid and interface combination No routes are tracked for this vrid and interface combination Vlan 10 - Group 10 Primary IP Address..... 192.168.10.1 VMAC Address..... 0000.5E00.0114 Authentication Type..... None Priority..... 150 Configured Priority..... 150 Advertisement Interval (secs)..... 1 Accept Mode..... Enable Pre-empt Mode..... Enable Pre-empt delay..... 0 Administrative Mode..... Enable State..... Backup Timers Learn mode..... Disable Description..... No interfaces are tracked for this vrid and interface combination No routes are tracked for this vrid and interface combination	**show vrrp** Admin Mode..... Enable Router Checksum Errors..... 0 Router Version Errors..... 0 Router VRID Errors..... 0 Vlan 10 - Group 10 Primary IP Address..... 192.168.10.1 VMAC Address..... 0000.5E00.010A Authentication Type..... None Priority..... 100 Configured Priority..... 100 Advertisement Interval (secs)..... 1 Accept Mode..... Disable Pre-empt Mode..... Enable Pre-empt delay..... 0 Administrative Mode..... Enable State..... Backup Timers Learn mode..... Disable Description..... No interfaces are tracked for this vrid and interface combination No routes are tracked for this vrid and interface combination Vlan 10 - Group 10 Primary IP Address..... 192.168.10.1 VMAC Address..... 0000.5E00.0114 Authentication Type..... None Priority..... 100 Configured Priority..... 100 Advertisement Interval (secs)..... 1 Accept Mode..... Enable Pre-empt Mode..... Enable Pre-empt delay..... 0 Administrative Mode..... Enable State..... Master Timers Learn mode..... Disable Description..... No interfaces are tracked for this vrid and interface combination No routes are tracked for this vrid and interface combination

Figure 48 `show vrrp` command output for N4032 VRRP peers in MLAG and VRRP topology

Run the `show vpc brief` command on either MLAG peer to display all information for both peers.

MLAG peer 1 (N4032-1)	MLAG peer 2 (N4032-2)
show vpc brief VPC Domain ID..... 55 VPC admin status..... Enabled Keep-alive admin status..... Enabled VPC operational status..... Enabled Self role..... Primary Peer role..... Secondary Peer detection admin status..... Peer detected, VPC Operational Operational VPC MAC..... ECF4.BBF4.2437 Operational VPC system priority..... 32767 Peer-Link details ---------- Interface..... Po55 Peer-link admin status..... Enabled Peer-link STP admin status..... Enabled Configured VLANs..... 1,20 Egress tagged VLANs..... 20 VPC Details ---------- Number of VPCs configured..... 3 Number of VPCs operational..... 3 VPC id# 11 ---------- Interface..... Po11 Configured VLANs..... 10 VPC interface state..... Active Local Members Status ---------- ------ Tei1/0/1-2 Up Peer Members Status ---------- ------ Gii1/0/1 Up VPC id# 12 ---------- Interface..... Po12 Configured VLANs..... 20 VPC interface state..... Active Local Members Status ---------- ------ Te1/0/11-12 Up	**show vpc brief** VPC Domain ID..... 55 VPC admin status..... Enabled Keep-alive admin status..... Enabled VPC operational status..... Enabled Self role..... Secondary Peer role..... Primary Peer detection admin status..... Peer detected, VPC Operational Operational VPC MAC..... ECF4.BBF4.2437 Operational VPC system priority..... 32767 Peer-Link details ---------- Interface..... Po55 Peer-link admin status..... Enabled Peer-link STP admin status..... Enabled Configured VLANs..... 1,20 Egress tagged VLANs..... 20 VPC Details ---------- Number of VPCs configured..... 3 Number of VPCs operational..... 3 VPC id# 11 ---------- Interface..... Po11 Configured VLANs..... 10 VPC interface state..... Active Local Members Status ---------- ------ Tei1/0/1-2 Up Peer Members Status ---------- ------ Gi1/0/2 Up VPC id# 12 ---------- Interface..... Po12 Configured VLANs..... 20 VPC interface state..... Active Local Members Status ---------- ------ Te1/0/11-12 Up

```
Peer Members        Status
----------------    ------
Gi1/0/1             Up

VPC id# 55
----------
Interface..... Po55
Configured VLANs..... 10,20
VPC interface state..... Active

Local Members       Status
-----------------   ------
Te1/0/23-24         Up

Peer Members        Status
----------------    ------
Te1/0/23-24         Up
```

```
Peer Members        Status
----------------    ------
Gi1/0/2             Up

VPC id# 55
----------
Interface..... Po55
Configured VLANs..... 10,20
VPC interface state..... Active

Local Members       Status
-----------------   ------
Te1/0/23-24         Up

Peer Members        Status
----------------    ------
Te1/0/2 3-24        Up
```

Figure 49 `show vpc brief` command output for N4032 MLAG peers in MLAG and VRRP Example topology

A.5 VoIP and MLAG Example

Run the `show vpc brief` command on either MLAG peer to display all information for both peers.

MLAG peer 1 (N4032F-1)	MLAG peer 2 (N4032F-2)
show vpc brief VPC Domain ID..... 55 VPC admin status..... Enabled Keep-alive admin status..... Enabled VPC operational status..... Enabled Self role..... Primary Peer role..... Secondary Peer detection admin status..... Peer detected, VPC Operational Operational VPC MAC..... ECF4.BBF4.2437 Operational VPC system priority..... 32767 Peer-Link details ---------- Interface..... Po55 Peer-link admin status..... Enabled Peer-link STP admin status..... Enabled Configured VLANs..... 1,10,20,30,100,200 Egress tagged VLANs..... 10,20,30,100,200 VPC Details ---------- Number of VPCs configured..... 4 Number of VPCs operational..... 4 VPC id# 10 ---------- Interface..... Po10 Configured VLANs..... 1,10,20,30,100,200 VPC interface state..... Active Local Members Status ---------- ------ Te1/0/3 Up Peer Members Status ---------- ------ Te1/0/3 Up VPC id# 20 ---------- Interface..... Po20	**show vpc brief** VPC Domain ID..... 55 VPC admin status..... Enabled Keep-alive admin status..... Enabled VPC operational status..... Enabled Self role..... Secondary Peer role..... Primary Peer detection admin status..... Peer detected, VPC Operational Operational VPC MAC..... ECF4.BBF4.2437 Operational VPC system priority..... 32767 Peer-Link details ---------- Interface..... Po55 Peer-link admin status..... Enabled Peer-link STP admin status..... Enabled Configured VLANs..... 1,10,20,30,100,200 Egress tagged VLANs..... 10,20,30,100,200 VPC Details ---------- Number of VPCs configured..... 4 Number of VPCs operational..... 4 VPC id# 10 ---------- Interface..... Po10 Configured VLANs..... 1,10,20,30,100,200 VPC interface state..... Active Local Members Status ---------- ------ Te1/0/3 Up Peer Members Status ---------- ------ Te1/0/3 Up VPC id# 20 ---------- Interface..... Po20

```
Configured VLANs.....
1,10,20,30,100,200
VPC interface state..... Active

Local Members       Status
----------------   ------
Te1/0/4           Up

Peer Members        Status
---------------    ------
Te1/0/4           Up

VPC id# 30
----------
Interface..... Po30
Configured VLANs.....
1,10,20,30,100,200
VPC interface state..... Active

Local Members       Status
----------------   ------
Te1/0/5           Up

Peer Members        Status
---------------    ------
Te1/0/5           Up

VPC id# 100
----------
Interface..... Po100
Configured VLANs.....
1,10,20,30,100,200
VPC interface state..... Active

Local Members       Status
----------------   ------
Te1/0/1           Up
Te1/0/2           Up

Peer Members        Status
---------------    ------
Te1/0/1           Up
Te1/0/2           Up
```

```
Configured VLANs.....
1,10,20,30,100,200
VPC interface state..... Active

Local Members       Status
----------------   ------
Te1/0/4           Up

Peer Members        Status
---------------    ------
Te1/0/4           Up

VPC id# 30
----------
Interface..... Po30
Configured VLANs.....
1,10,20,30,100,200
VPC interface state..... Active

Local Members       Status
----------------   ------
Te1/0/5           Up

Peer Members        Status
---------------    ------
Te1/0/5           Up

VPC id# 100
----------
Interface..... Po100
Configured VLANs.....
1,10,20,30,100,200
VPC interface state..... Active

Local Members       Status
----------------   ------
Te1/0/1           Up
Te1/0/2           Up

Peer Members        Status
---------------    ------
Te1/0/1           Up
Te1/0/2           Up
```

Figure 50 `show vpc brief` command output for N4032F MLAG peers in VoIP and MLAG topology

MLAG partner (N3024P-1)	MLAG partner (N3024P-2)
show classofservice ip-dscp-mapping IP DSCP Traffic Class ---------- ---------- 0(be/cs0) 1 1 1 2 1 3 1 4 1 5 1 6 1 7 1 8(cs1) 0 9 0 10(af11) 0 11 0 12(af12) 0 13 0 14(af13) 0 15 0 16(cs2) 0 17 0 18(af21) 0 19 0 20(af22) 0 21 0 22(af23) 0 23 0 24(cs3) 5 25 1 26(af31) 1 27 1 28(af32) 1 29 1 30(af33) 1 31 1 32(cs4) 2 33 2 34(af41) 2 35 2 36(af42) 2 37 2 38(af43) 2 39 2 40(cs5) 2 41 2 42 2 43 2 44 2 45 2 46(ef) 5	**show voice vlan** Administrative Mode..... Enable

Figure 51 `show classofservice ip-dscp-mapping` and `show voice vlan` command output for N3024P-1 VoIP and MLAG topology

A.6 MLAG and VLT Example

Run the `show vpc brief` command on one of the MLAG peers to display information for the MLAG peers.

Notes:
1. Interfaces used to connect each peer to the partner switch LAG are not required to match on each peer. For instance, in the example above, one partner LAG interface connects to 1/0/47 on the primary peer while the other interface connects to 1/0/11 on the secondary peer. The peers can use different ports
2. Configurations on the partner switches must include LAGs and connections to the MLAG Peers, or the "Number of VPCs operational" in the **show vlt brief** command show 0.

MLAG peer 1 (N4032F-1)	**MLAG peer 2 (N4032F-2)**
show vpc brief VPC domain ID..... 2 VPC admin status..... Enabled Keep-alive admin status..... Enabled VPC operational status..... Enabled Self role..... Primary Peer role..... Secondary Peer detection admin status..... Disabled Operational VPC MAC..... ECF4.BBF4.2402 Operational VPC system priority..... 32767 peer link details ---------- Interface..... Po1 peer link admin status..... Enabled peer link STP admin status..... Enabled Configured VLANs..... 1,30 Egress tagged VLANs..... 30 VPC Details ---------- Number of VPCs configured..... 2 Number of VPCs operational..... 2 VPC id# 40 ---------- Interface..... Po40 Configured VLANs..... 1,30 VPC interface state..... Active Local Members Status ---------- ------ Te1/0/1 Up Te1/0/2 Up Peer Members Status ---------- ------	**show vpc brief** VPC domain ID..... 2 VPC admin status..... Enabled Keep-alive admin status..... Enabled VPC operational status..... Enabled Self role..... Secondary Peer role..... Primary Peer detection admin status..... Disabled Operational VPC MAC..... ECF4.BBF4.2402 Operational VPC system priority..... 32767 peer link details ---------- Interface..... Po1 peer link admin status..... Enabled peer link STP admin status..... Enabled Configured VLANs..... 1,30 Egress tagged VLANs..... 30 VPC Details ---------- Number of VPCs configured..... 2 Number of VPCs operational..... 2 VPC id# 40 ---------- Interface..... Po40 Configured VLANs..... 1,30 VPC interface state..... Active Local Members Status ---------- ------ Te1/0/1 Up Te1/0/2 Up Peer Members Status ---------- ------

```
Te1/0/1                 Up
Te1/0/2                 Up

VPC id# 60
-----------
Interface..................................... Po60
Configured VLANs.............................. 1,30
VPC interface state........................... Active

Local Members       Status
-----------------   ------
Te1/0/24             Up

Peer Members        Status
----------------    ------
Te1/0/24             Up
```

```
Te1/0/1                 Up
Te1/0/2                 Up

VPC id# 60
-----------
Interface..................................... Po60
Configured VLANs.............................. 1,30
VPC interface state........................... Active

Local Members       Status
-----------------   ------
Te1/0/24             Up

Peer Members        Status
----------------    ------
Te1/0/24             Up
```

Figure 52 `show vpc brief` command output for N4032F MLAG peers in MLAG and VLT topology

Results of the command should be the same as shown above. All member ports must show **Up**, and the *VPC interface state* must show **Active**.

The **show interface port-channel** is another helpful tool to let you know if the configured LAGs are up and running. If correctly configured, ports in the primary LAG are listed with an **Active** status. Inactive ports indicate a possible cabling or configuration issue.

MLAG peers

show interfaces port-channel 40

```
Channel   Ports                    Ch-Type  Hash Type Min-links Local Prf
-------  -------------------------- -------- --------- --------- ---------
Po40     Active: Te1/0/1, Te1/0/2     Dynamic  7       1       Disabled
```

show interfaces port-channel 60

```
Channel   Ports                    Ch-Type  Hash Type Min-links Local Prf
-------  -------------------------- -------- --------- --------- ---------
Po60     Active: Te1/0/24           Dynamic  7       1       Disabled
```

Figure 53 `show interface port-channel` command output for N4032F-1 in MLAG and VLT topology

Run `show vlt brief` and other commands on one of the VLT peers to display information for the VLT peers. ICL Link, Heartbeat, and VLT peer Status should all show **Up**.

Results of the command should be similar to what is seen in the following table. The Destination should show the management IP address of the peer switch, and the peer Heartbeat status should be **Up**.

Consult the S4810 User Guide or VLT Deployment Guide for additional information on implementing VLT.

VLT peer 1 (S4810-1)	VLT peer 2 (S4810-2)
show vlt brief VLT Domain Brief ---------- Domain ID: 1 Role: Primary Role Priority: 1 ICL Link Status: Up HeartBeat Status: Up VLT peer Status: Up Local Unit Id: 0 Version: 6(4) Local System MAC address: 00:01:e8:8b:36:0e Remote System MAC address: 00:01:e8:8b:3b:6f Configured System MAC address: aa:bb:cc:dd:12:34 Remote system version: 6(4) Delay-Restore timer: 90 seconds Delay-Restore Abort Threshold: 60 seconds Peer-Routing : Disabled Peer-Routing-Timeout timer: 0 seconds Multicast peer-routing timeout: 150 seconds	**show vlt brief** VLT Domain Brief ---------- Domain ID: 1 Role: Secondary Role Priority: 2 ICL Link Status: Up HeartBeat Status: Up VLT peer Status: Up Local Unit Id: 1 Version: 6(4) Local System MAC address: 00:01:e8:8b:3b:6f Remote System MAC address: 00:01:e8:8b:36:0e Configured System MAC address: aa:bb:cc:dd:12:34 Remote system version: 6(4) Delay-Restore timer: 90 seconds Delay-Restore Abort Threshold: 60 seconds Peer-Routing : Disabled Peer-Routing-Timeout timer: 0 seconds Multicast peer-routing timeout: 150 seconds
show vlt detail Local LAG Id peer LAG Id Local peer VLANs ---------- ---------- ------- ------- --------- 40 40 UP UP 30 50 50 UP UP 30	**show vlt detail** Local LAG Id peer LAG Id Local peer VLANs ---------- ---------- ------- ------- --------- 40 40 UP UP 30 50 50 UP UP 30
show running-config vlt vlt domain 1 peer link port-channel 1 back-up destination 172.25.194.24 primary-priority 1 system-mac mac-address aa:bb:cc:dd:12:34 unit-id 0	**show running-config vlt** vlt domain 1 peer link port-channel 1 back-up destination 172.25.194.25 primary-priority 2 system-mac mac-address aa:bb:cc:dd:12:34 unit-id 0
show vlt backup-link VLT Backup Link	**show vlt backup-link** VLT Backup Link

---------- Destination: peer HeartBeat status: Destination VRF: HeartBeat Timer Interval: HeartBeat Timeout: UDP Port: HeartBeat Messages Sent: HeartBeat Messages Received:	 172.25.194.24 Up default 1 3 34998 257900 257868
---------- Destination: peer HeartBeat status: Destination VRF: HeartBeat Timer Interval: HeartBeat Timeout: UDP Port: HeartBeat Messages Sent: HeartBeat Messages Received:	 172.25.194.25 Up default 1 3 34998 257877 257879

Figure 54 Vlt command output for S4810 VLT peers in MLAG and VLT topology

B Cisco Configurations

B.1 MLAG, vPC, and RSTP-PV Example

B.1.1 Initial Setup and RSTP-PV Configuration

Nexus_5548UP-1	Nexus_5548UP-2
Enable the required features for vPC. Enable the LLDP, Telnet, LACP, and vPC features.	Enable the required features for vPC. Enable the LLDP, Telnet, LACP, and vPC features.
config feature telnet feature lldp feature lacp feature vpc end	config feature telnet feature lldp feature lacp feature vpc end
Configure the host name. Configure the IP for management. Configure the default route for management. Configure a user name and password.	Configure the host name. Configure the IP for management. Configure the default route for management. Configure a user name and password.
configure hostname Nexus_5548UP-1 interface mgmt 0 ip address 172.25.189.60 255.255.0.0 exit vrf context management ip route 0.0.0.0/0 172.25.189.254 username admin password Dell1234 end	configure hostname Nexus_5548UP-2 interface mgmt 0 ip address 172.25.188.60 255.255.0.0 exit vrf context management ip route 0.0.0.0/0 172.25.188.254 username admin password Dell1234 end
Configure RSTP-PV. Configure VLANs 10, 20, and 30.	Configure RSTP-PV. Configure VLANs 10, 20, and 30.
configure spanning-tree mode rapid-pvst vlan 10 name Marketing exit vlan 20 name HR exit vlan 30 name Operations end	configure spanning-tree mode rapid-pvst vlan 10 name Marketing exit vlan 20 name HR exit vlan 30 name Operations end

Figure 55 Initial setup for Nexus_5548UP-1 and Nexus_5548UP-2

Nexus_5672UP-1

Enable the required features and management interface for vPC.
Enable the Telnet, LLDP and LACP features.

```
config
feature telnet
feature lldp
feature lacp
end
```

Configure the host name.
Configure the IP for management.
Configure the default route for management.
Configure a user name and password.

```
configure
hostname Nexus_5672UP-1
interface mgmt 0
ip address 172.25.188.61
255.255.0.0
exit
vrf context management
ip route 0.0.0.0/0 172.25.188.254
username admin password Dell1234
end
```

Configure RSTP-PV.
Configure VLANs 10, 20, and 30.

```
configure
spanning-tree mode rapid-pvst
vlan 10
name Marketing
exit
vlan 20
name HR
exit
vlan 30
name Operations
end
```

Figure 56 Initial setup for Nexus_5672UP-1

B.1.2 Configuring MLAG and vPC

Nexus_5548UP-1	Nexus_5548UP-2
Create a vPC domain. Assign role priority. Assign the keepalive management IP address of Nexus_5548UP-2.	Create a vPC domain. Assign role priority. Assign the keepalive management IP address of Nexus_5548UP-1.

`configure`
`vpc domain 1`
`role priority 1`
`peer-keepalive destination 172.25.188.60`
`end`
	`configure`
	`vpc domain 1`
	`role priority 65535`
	`peer-keepalive destination 172.25.189.60`
	`end`

Configure port channel and port channel members for the vPC peer link. Create a port channel. Configure the port channel for dot1q trunking. Assign as a vPC peer link.	Configure port channel and port channel members for the vPC peer link. Create a port channel. Configure the port channel for dot1q trunking. Assign as a vPC peer link.

`configure`
`interface port-channel 55`
`description vPC Peer Link`
`switchport mode trunk`
`vpc peer-link`
`end`
	`configure`
	`interface port-channel 55`
	`description vPC Peer Link`
	`switchport mode trunk`
	`vpc peer-link`
	`end`

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

`configure`
`interface ethernet 1/17-18`
`description vPC Peer Link`
`switchport mode trunk`
`channel-group 55 mode active`
`end`
	`configure`
	`interface ethernet 1/17-18`
	`description vPC Peer Link`
	`switchport mode trunk`
	`channel-group 55 mode active`
	`end`

Configure the vPC going to the N4032F MLAG peers. Create the port channel. Configure the port channel for dot1q trunking. Specify the vPC ID.	Configure the vPC going to the N4032F MLAG peers. Create the port channel. Configure the port channel for dot1q trunking. Specify the vPC ID.

`configure`
`interface port-channel 100`
`description Port Channel to N4032F MLAG Peers`
`switchport mode trunk`
`vpc 100`
`end`
	`configure`
	`interface port-channel 100`
	`description Port Channel to N4032F MLAG Peers`
	`switchport mode trunk`
	`vpc 100`
	`end`

Assign interfaces to the port channel and enable LACP.

```
configure
interface ethernet 1/21-22
description eth1/21-22 to N4032F
MLAG Peers
switchport mode trunk
channel-group 100 mode active
end
```

Configure the vPC going to the N2024-1.
Create the port channel.
Configure the port channel for dot1q trunking.
Specify the vPC ID.

```
configure
interface port-channel 8
description Port Channel to N2024-1
switchport mode trunk
vpc 8
end
```

Assign interfaces to the port channel and enable LACP.

```
configure
interface ethernet 1/32
description eth1/32 to N2024-1
switchport mode trunk
channel-group 8 mode active
end
```

Assign interfaces to the port channel and enable LACP.

```
configure
interface ethernet 1/21-22
description eth1/21-22 to N4032F
MLAG Peers
switchport mode trunk
channel-group 100 mode active
end
```

Configure the vPC going to the N2024-1.
Create the port channel.
Configure the port channel for dot1q trunking.
Specify the vPC ID.

```
configure
interface port-channel 8
description Port Channel to N2024-1
switchport mode trunk
vpc 8
end
```

Assign interfaces to the port channel and enable LACP.

```
configure
interface ethernet 1/32
description eth1/32 to N2024-1
switchport mode trunk
channel-group 8 mode active
end
```

Figure 57 vPC configuration for Nexus_5548UP-1 and Nexus_5548UP-2

Nexus_5672UP-1

Configure the port channel connecting to the upstream MLAG peer switches.

```
configure
interface port-channel 10
description Po10 to N4032F MLAG Peers
switchport mode trunk
end
```

Assign interfaces to the port channel and enable LACP.

```
configure
interface eth1/1-2
description Eth1/1-2 to N4032F MLAG Peers
switchport mode trunk
channel-group 10 mode active
end
```

Figure 58 MLAG configuration for Nexus_5672UP-1

B.2 VoIP and MLAG Examples

B.2.1 Initial Setup and RSTP-PV Configuration

Nexus_5672UP-1

Enable the required features and management interface for vPC.
Enable the Telnet, LLDP and LACP features.

```
config
feature telnet
feature lldp
feature lacp
end
```

Configure the host name.
Configure the IP for management.
Configure the default route for management.
Configure a user name and password.

```
configure
hostname Nexus_5548UP-1
interface mgmt 0
ip address 172.25.189.60
255.255.0.0
exit
vrf context management
ip route 0.0.0.0/0 172.25.189.254
username admin password Dell1234
end
```

Configure RSTP-PV.
Configure VLANs 10, 20, and 30.

```
configure
spanning-tree mode rapid-pvst
vlan 10
name Marketing
exit
vlan 20
name HR
exit
vlan 30
name Operations
exit
vlan 100
name Voice
exit
vlan 200
name Data
end
```

Figure 59 Initial setup for Nexus_5672UP-1

B.2.2 Configuring MLAG and Port Channels

Nexus_5672UP-1

Configure the port channel connecting to the upstream MLAG peer switches.

```
configure
interface port-channel 10
description Po10_to_N4032F_MLAG
Peers
switchport mode trunk
end
```

Assign interfaces to the port channel and enable LACP.

```
configure
interface eth1/1-2
description Eth1/1-2_to_N4032F_MLAG
Peers
switchport mode trunk
channel-group 10 mode active
end
```

Figure 60 LAG configuration for Nexus_5672UP-1

C Component Information

This paper was compiled using the following components and versions.

Table 9 Component information

	Component	Revision
Network	Dell N2000, N3000, N4000	6.3.0.0
	Dell S4810	Dell Application Software (Firmware) Version 9.6
	Cisco Nexus 5548UP	7.2.0.N1.1
	Cisco Nexus 5672UP	7.1.2.N1.1
Cables	SFP+ Optical Transceivers (SR) with Fiber Cables	Five meter cables
VoIP equipment	Cisco UCS C-Series Server	C220
	Cisco Unified CM	10.5
	Cisco VoIP Phones	Models 9971 and CP-7926G

D Additional Resources

Support.dell.com is focused on meeting your needs with proven services and support.

DellTechCenter.com is an IT Community where you can connect with Dell EMC Customers and Dell EMC employees for the purpose of sharing knowledge, best practices, and information about Dell EMC products and installations.

Referenced or recommended Dell EMC publications:

- Dell Networking Support
  - http://www.dell.com/support
- Dell TechCenter (community forums and blogs for Dell EMC customers)
  - http://delltechcenter.com
- Dell Networking Whitepapers
  - http://en.community.dell.com/techcenter/networking/p/guides
- Dell Networking N2000/N3000/N4000 User Guides and Firmware downloads
  - http://en.community.dell.com/techcenter/networking/p/guides#N-series
- QoS for VoIP on Dell N-Series and W-Series
  - http://en.community.dell.com/techcenter/extras/m/white_papers/20439292/download

E Unsupported Configurations

The configurations and topologies found in this guide are supported. This appendix discusses a few unsupported configuration models.

Different types of expansion modules in a peer link are unsupported. Peer devices must use the same type of expansion module if ports from the expansion modules are to be part of the MLAG interface.

Stacking of either MLAG peer is unsupported. Neither switch used as an MLAG peer may be stacked with other switches.

Using two different series switch models as MLAG peers is unsupported. MLAG peers must use the same series switch model. This means any N2000 Series must be peered with another N2000 Series, an N3000 Series with another N3000 Series, and an N4000 Series with another N4000 Series.

Figure 61 shows another unsupported configuration, attempting to connect an MLAG peer with a non-MLAG peer, such as a VLTi (shown) or Cisco vPC/VSS peer. MLAG does not support these types of scenarios.

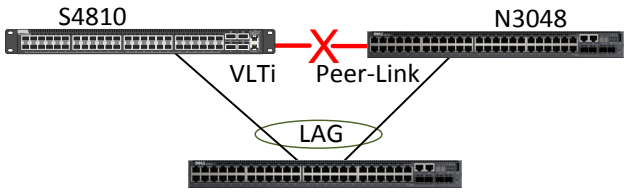

Figure 61 Unsupported peer configuration

Other features and configurations that are incompatible with MLAG include iSCSI, IGMP and MLD.

Layer 3 VLAN termination is also unsupported with MLAG. As shown in the Supported Topologies section, MLAG supports only layer 2 topologies.

F Terminology

DSCP: Distributed Services Code Point is a field in the header of IPv4 and IPv6 packets which usually finds its use in Quality of Service.

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.

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: MLAG stands for Multi-Switch LAG. MLAG extends the LAG bandwidth advantage across multiple Dell Networking N-series switches connected to LAG partner device. The two peer switches appear as single switch with a single MAC address to the partner.

MLAG Partner: MLAG partner refers to a switch on the other end of the MLAG. It can be running MLAG, but it doesn't have to. It can be a single switch connecting to two MLAG peers as though it is connecting to one single switch.

MLAG Peer: MLAG peers are switches in the same MLAG domain, which share MLAG port channels in order to balance load and provide redundancy. They achieve this by syncing switching information via the peer link.

MSTP: Multiple Spanning Tree Protocol (802.1s) is a version of Spanning Tree Protocol which combines Rapid Spanning Tree Protocol (802.1w) with the ability to explicitly define and create instances of STP. VLANs can then be mapped to these instances, rather than having an instance for every VLAN, as in RSTP-PV and PVST.

Partner: This refers to MLAG Partner.

Peer: This refers to MLAG Peer.

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

QoS: Quality of Service means classifying different kinds of traffic and then giving them different priorities by means of assigning them different queues.

RSTP-PV: Per-VLAN Rapid Spanning Tree Protocol is a version of Spanning Tree Protocol which provides an instance of STP for each VLAN. This capability is combined with the fast-convergence of RSTP (802.1w) enabled by handshake-based link failure detection.

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

Voice VLAN: Voice VLAN is a feature that enables switch ports to carry voice traffic with an administrator-defined priority so as to enable prioritization of voice traffic over data traffic.

VoIP: Voice over Internet Protocol is a set of methodologies for the delivery of voice communications over Internet Protocol.

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**.

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

VRRP: VRRP stands for Virtual Router Redundancy Protocol. It provides a means of gateway redundancy through the concept of a virtual router. Two or more routers maintain communication between one another via keepalives in order to decide which physical router assumes the role of the gateway, or the virtual router.

Support and Feedback

Contacting Technical Support

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

Feedback for this document

We encourage readers of this publication to provide feedback on the quality and usefulness of this deployment guide by sending an email to: DELL_NETWORKING_SOLUTIONS@dell.com

About Dell EMC

Dell EMC is a worldwide leader in data center and campus solutions, which includes the manufacturing and distribution of servers, network switches, storage devices, personal computers, and related hardware and software. For more information on these and other products, please visit the Dell EMC website at http://www.dell.com.