# Interoperating with Cisco Systems

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**D-Link HQ**

**Scope**
This guide is a one-stop resource to help users to setup their network quickly and optimize the features of D-Link and vendors' equipments smoothly. This guide focuses on the configuration of D-Link and Cisco switches and includes topology examples for setting up a multi-vendor environment.

Use this document to learn, use and configure the different features of D-Link and Cisco management switches.

**Audience**
This document is written for system administrators, network managers and IT personnel who are responsible for the deployment of management switches.

**About This Guide**
This guide is structured into 4 parts as follows:

| Title | Description |
|---|---|
| Terminology | Detailed descriptions of functions that are used to explain similar concepts on both D-Link & Cisco platforms. |
| Topology | Topology examples when working in interoperability mode. |
| Configuration | Step-by-step instructions on how to configure and setup the devices. |
| Troubleshooting Examples | Command examples on how to quickly troubleshoot and configure if interoperation fails. |

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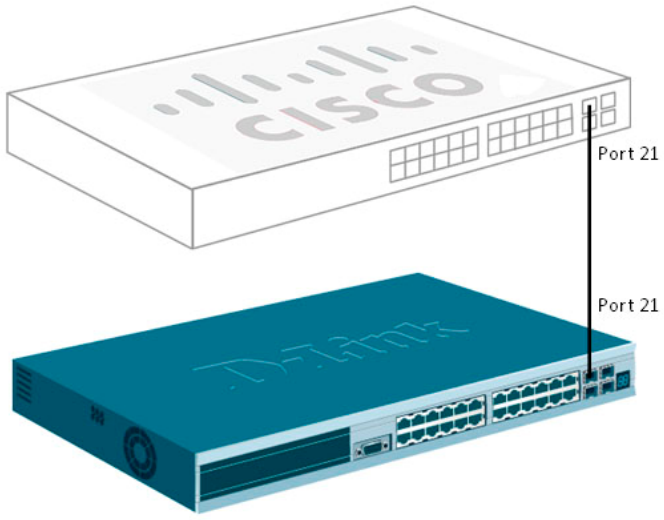
# VLAN Configuration

This chapter deals with port-based VLANs that Cisco and D-Link switches support.

## Terminology

| Cisco | D-Link | Description |
|---|---|---|
| Trunking Port | Tagged Port | This port carries multiple 802.1Q tagged VLANs that are usually used for uplink and IP phone ports. |
| Access Port | Untagged Port | A port which is an untagged member of a VLAN. |
| Native VLAN | Untagged Membership of Physical Ports | In a Cisco VLAN trunk, traffic belonging to the native vlan is not included in the VLAN trunk. That is, the untagged frames received by VLAN trunking port, will be assigned the access VLAN ID of this port.<br>By default, all VLAN membership of D-Link switches and access VLAN in Cisco switches is VLAN 1. |

## Topology




| Cisco Switch | | |
|---|---|---|
| Interface | VLAN | Ports |
| 192.168.0.1 | 1 | 19-24 |
| 192.168.10.1 | 10 | 1-6 |
| 192.168.20.1 | 20 | 7-12 |
| 192.168.30.1 | 30 | 13-18 |
| | Trunk | 21 |

| D-Link Switch | | | |
|---|---|---|---|
| Interface | VLAN | Ports | |
| 192.168.0.2 | 1 | Untagged | 19-24 |
| | | Tagged | -- -- |
| 192.168.10.2 | 10 | Untagged | 1-6 |
| | | Tagged | 21 |
| 192.168.20.2 | 20 | Untagged | 7-12 |
| | | Tagged | 21 |
| 192.168.30.2 | 30 | Untagged | 13-18 |
| | | Tag | 21 |

**Figure-1 Port-based VLAN Configuration**

## Configuration

### VLAN Configuration on a Cisco Switch

The following section lists step-by-step instructions for configuring VLAN & IP on Cisco and D-Link management switches.

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | Catalyst# config terminal<br>Catalyst(config)# vlan 10,20,30<br>Catalyst(config-vlan)# exit | To create VLAN interfaces for ports 10, 20 and 30. |
| **Step 2** | Catalyst(config)# interface range gigabitEthernet 1/0/1-6<br>Catalyst(config-if)# switchport mode access<br>Catalyst(config-if)# switchport access vlan 10<br>Catalyst(config-if)# exit<br><br>Catalyst(config)# interface range gigabitEthernet 1/0/7-12<br>Catalyst(config-if)# switchport mode access<br>Catalyst(config-if)# switchport access vlan 20<br>Catalyst(config-if)# exit<br><br>Catalyst(config)# interface range gigabitEthernet 1/0/13-18<br>Catalyst(config-if)# switchport mode access<br>Catalyst(config-if)# switchport access vlan 30<br>Catalyst(config-if)# exit | To change ports to access mode and assign membership for each VLAN. |
| **Step 3** | Catalyst(config)# interface gigabitEthernet 1/0/21<br>Catalyst(config-if)# switchport trunk encapsulation dot1q<br>Catalyst(config-if)# switchport trunk allowed vlan 1,10,20,30<br>Catalyst(config-if)# switchport mode trunk<br>Catalyst(config-if)# exit | To create a VLAN trunking port. |

**Note:** By default a Cisco VLAN trunk sends to and receives traffic from all VLANs. To restrict the traffic a VLAN trunk carries, remove vlan-list parameter to remove specific VLANs from the allowed list.

**Note:** By default, all ports of a Cisco switch belong to VLAN 1, access mode.

### IP Configuration on a Cisco Switch

The following configuration example is for L3 switches. For layer 3 switches, an IP address has to be defined for each VLAN and for a layer 2 switch, an IP address can only be configured on one VLAN for management purposes.

| | Command Example | Purpose |
|---|---|---|
| **Step 4** | Catalyst(config)# interface vlan 1<br>Catalyst(config-vlan)# ip address 192.168.0.1 255.255.255.0<br>Catalyst(config-vlan)# no shutdown<br>Catalyst(config-vlan)# exit<br><br>Catalyst(config)# interface vlan 10<br>Catalyst(config-vlan)# ip address 192.168.10.1 255.255.255.0<br>Catalyst(config-vlan)# no shutdown<br>Catalyst(config-vlan)# exit | To configure the IP addresses for the VLAN interfaces. |

| | | |
|---|---|---|
| | Catalyst(config)# interface vlan 20<br>Catalyst(config-vlan)# ip address 192.168.20.1<br>255.255.255.0<br>Catalyst(config-vlan)# no shutdown<br>Catalyst(config-vlan)# exit<br><br>Catalyst(config)# interface vlan 30<br>Catalyst(config-vlan)# ip address 192.168.30.1<br>255.255.255.0<br>Catalyst(config-vlan)# no shutdown<br>Catalyst(config-vlan)# exit | |

### VLAN Configuration on a D-Link Switch

In this example, ports 1 to 18 are removed from VLAN 1(default VLAN) and are assigned to each VLAN. Here are the details:

- Ports 1 to 6 are assigned to VLAN 10.
- Ports 7 to 12 are assigned to VLAN 20.
- Ports 13 to 18 are assigned to VLAN 30.
- Port 21 (uplink) is tagged with VLAN 10, 20, 30 and belongs to an untagged member of VLAN 1.

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | switch# create vlan 10 tag 10<br>switch# create vlan 20 tag 20<br>switch# create vlan 30 tag 30<br><br>switch# config vlan default delete 1-18<br>switch# config vlan 10 add untagged 1-6<br>switch# config vlan 20 add untagged 7-12<br>switch# config vlan 30 add untagged 13-18<br>switch# config vlan 10 add tagged 19-21<br>switch# config vlan 20 add tagged 19-21<br>switch# config vlan 30 add tagged 19-21 | To create VLAN interfaces for ports 10, 20, 30 and assign port membership. |

### IP Configuration on a D-Link Switch

The following configuration example is for L3 switches.
For layer 3 switches, an IP address has to be defined for each VLAN and for a layer 2 switch, only system IP address has to be defined.

| | Command Example | Purpose |
|---|---|---|
| **Step 2** | switch# config ipif System ipaddress 192.168.0.2/24<br>switch# create ipif 10 192.168.10.2/24 10<br>switch# create ipif 20 192.168.20.2/24 20<br>switch# create ipif 30 192.168.30.2/24 30 | To configure the IP addresses for the VLAN interfaces. |
| | | |

## Troubleshooting Examples

The following section lists command examples for verifying VLANs and port assignments on Cisco and D-Link switches.

### Verifying VLANs and Ports Assignments on a Cisco Switch

The following example shows you how to verify the member ports and all the VLAN interfaces.

**Command Example**

```
Catalyst# show vlan

VLAN       Name       Status    Ports
---- ------------------------------ --------- ---------------------------
1          default    active    Gi1/0/19, Gi1/0/20, Gi1/0/21, Gi1/0/22, Gi1/0/23,
Gi1/0/24
10         VLAN0010   active    Gi1/0/1, Gi1/0/2, Gi1/0/3, Gi1/0/4, Gi1/0/5, Gi1/0/6
20         VLAN0020   active    Gi1/0/7, Gi1/0/8, Gi1/0/9, Gi1/0/10, Gi1/0/11,
Gi1/0/12
30         VLAN0030   active    Gi1/0/13, Gi1/0/14, Gi1/0/15, Gi1/0/16, Gi1/0/17,
Gi1/0/18
```

The following example shows you how to set a trunking port.

**Command Example**

```
Catalyst# show interfaces gigabitEthernet 1/0/21 switchport
Name: Gi1/0/19
Switchport: Enabled
Administrative Mode: trunk
Operational Mode: trunk
Administrative Trunking Encapsulation: dot1q
Operational Trunking Encapsulation: dot1q
Negotiation of Trunking: On
Access Mode VLAN: 1 (default)
Trunking Native Mode VLAN: 1 (default)
Administrative Native VLAN tagging: enabled
Voice VLAN: none
Administrative private-vlan host-association: none
Administrative private-vlan mapping: none
Administrative private-vlan trunk native VLAN: none
Administrative private-vlan trunk Native VLAN tagging: enabled
Administrative private-vlan trunk encapsulation: dot1q
Administrative private-vlan trunk normal VLANs: none
Administrative private-vlan trunk associations: none
Administrative private-vlan trunk mappings: none
Operational private-vlan: none
Trunking VLANs Enabled: 1,10,20,30
Pruning VLANs Enabled: 2-1001
Capture Mode Disabled
Capture VLANs Allowed: ALL

Protected: false
Unknown unicast blocked: disabled
Unknown multicast blocked: disabled
Appliance trust: none
```

The following example shows you how to set the access ports.

**Command Example**

```
Catalyst# show interfaces gigabitEthernet 1/0/1 switchport
Name: Gi1/0/1
Switchport: Enabled
Administrative Mode: static access
Operational Mode: down
Administrative Trunking Encapsulation: negotiate
```

```
Negotiation of Trunking: Off
Access Mode VLAN: 10 (VLAN0010)
Trunking Native Mode VLAN: 1 (default)
Administrative Native VLAN tagging: enabled
Voice VLAN: none
Administrative private-vlan host-association: none
Administrative private-vlan mapping: none
Administrative private-vlan trunk native VLAN: none
Administrative private-vlan trunk Native VLAN tagging: enabled
Administrative private-vlan trunk encapsulation: dot1q
Administrative private-vlan trunk normal VLANs: none
Administrative private-vlan trunk associations: none
Administrative private-vlan trunk mappings: none
Operational private-vlan: none
Trunking VLANs Enabled: ALL
Pruning VLANs Enabled: 2-1001
Capture Mode Disabled
Capture VLANs Allowed: ALL

Protected: false
Unknown unicast blocked: disabled
Unknown multicast blocked: disabled
Appliance trust: none
```

The following example shows you how to verify the IP address of each VLAN interface.

**Command Example**

```
Catalyst# show ip interface brief
Interface        IP-Address       OK? Method Status    Protocol
Vlan1            192.168.0.1      YES manual up        up
Vlan10           192.168.10.1     YES manual up        up
Vlan20           192.168.20.1     YES manual up        up
Vlan30           192.168.30.1     YES manual up        up
```

### Verifying VLANs and Port Assignments on D-Link Switches

The following example shows you how to verify all the VLAN interfaces and member ports.

**Command Example**

```
switch# show vlan
Command: show vlan

VID                  : 1             VLAN Name     : default
VLAN Type            : Static        Advertisement : Enabled
Member Ports         : 19-24
Static Ports         : 19-24
Current Tagged Ports :
Current Untagged Ports : 19-24
Static Tagged Ports  :
Static Untagged Ports : 19-24
Forbidden Ports      :
Status               : Active

VID                  : 10            VLAN Name     : 10
VLAN Type            : Static        Advertisement : Disabled
Member Ports         : 1-6,21
Static Ports         : 1-6,21
Current Tagged Ports : 21
```

```
Current Untagged Ports  : 1-6
Static Tagged Ports     : 21
Static Untagged Ports   : 1-6
Forbidden Ports         :
Status                  : Active

VID                     : 20            VLAN Name     : 20
VLAN Type               : Static        Advertisement : Disabled
Member Ports            : 7-12,21
Static Ports            : 7-12, 21
Current Tagged Ports    : 21
Current Untagged Ports  : 7-12
Static Tagged Ports     : 21
Static Untagged Ports   : 7-12
Forbidden Ports         :
Status                  : Active

VID                     : 30            VLAN Name     : 30
VLAN Type               : Static        Advertisement : Disabled
Member Ports            : 13-18,21
Static Ports            : 13-18,21
Current Tagged Ports    : 21
Current Untagged Ports  : 13-18
Static Tagged Ports     : 21
Static Untagged Ports   : 13-18
Forbidden Ports         :
Status                  : Active

Total Entries: 4
```

The following example shows you how to verify the IP address of each VLAN interface.

**Command Example**

```
switch# show ipif
Command: show ipif

IP Interface            : 10
VLAN Name               : 10
Interface Admin state   : Enabled
DHCPv6 Client State     : Disabled
IPv4 Address            : 192.168.10.2/24 (Manual)  Primary
Proxy ARP               : Disabled   (Local : Disabled)
IP Directed Broadcast   : Disabled
IP MTU                  : 1500

IP Interface            : 20
VLAN Name               : 20
Interface Admin state   : Enabled
DHCPv6 Client State     : Disabled
IPv4 Address            : 192.168.20.2/24 (Manual)  Primary
Proxy ARP               : Disabled   (Local : Disabled)
IP Directed Broadcast   : Disabled
IP MTU                  : 1500

IP Interface            : 30
VLAN Name               : 30
Interface Admin state   : Enabled
DHCPv6 Client State     : Disabled
```

```
IPv4 Address            : 192.168.30.2/24 (Manual)  Primary
Proxy ARP               : Disabled   (Local : Disabled)
IP Directed Broadcast   : Disabled
IP MTU                  : 1500

IP Interface            : System
VLAN Name               : default
Interface Admin state   : Enabled
DHCPv6 Client State     : Disabled
IPv4 Address            : 192.168.0.2/24 (Manual)  Primary
Proxy ARP               : Disabled   (Local : Disabled)
IP Directed Broadcast   : Disabled
IP MTU                  : 1500

 Total Entries   : 4
```

# Link Aggregation

This chapter deals with Link Aggregation Control Protocol (LACP) function that both Cisco and D-Link switches support.

## Terminology

| Cisco | D-Link | Description |
|---|---|---|
| Channel-group ID | Group ID | ID of a port aggregation group. |
| Port-channel | Link Aggregation Group | A logical port aggregation group. |

**Link Aggregation Group**
Cisco defines the Aggregation group as **Port-channel** and is configured as the **Interface Port-channel x**. The default **Port-channel** mode is Static trunk, and the LACP mode for a dynamic trunk. On the other hand, D-Link calls it **Link Aggregation Group** and is configured as type static for a Static trunk or type LACP for a dynamic trunk.

**Static and Dynamic Trunks/Channels**
In between two switches, a **static trunk** becomes an active trunk unconditionally and independently of the other switch's configuration. A static trunk does not require any protocols.

A **dynamic trunk** is active only when the dynamic trunk is enabled in both D-Link and Cisco switches. To do so, the switches exchange messages, either through Port aggregation protocol (PAgP) or Link Aggregation Control Protocol (LACP), to negotiate their status. If either of the switches are 'active' (LACP) or 'desirable' (PAgP), then the switch initiates negotiation. If the switch is 'passive' (LACP) or 'auto' (PAgP) then it forms a link aggregation automatically.

**LACP**
LACP is the Link Aggregation Control Protocol defined by the 802.3ad standard. It provides a way for both parts to negotiate a port aggregation. With LACP, one or more additional links can operate as standby links that will activate only if another active link goes down.
When connecting two switches with LACP, one of the switches must be active (send LACP frames) and another should be set to passive.

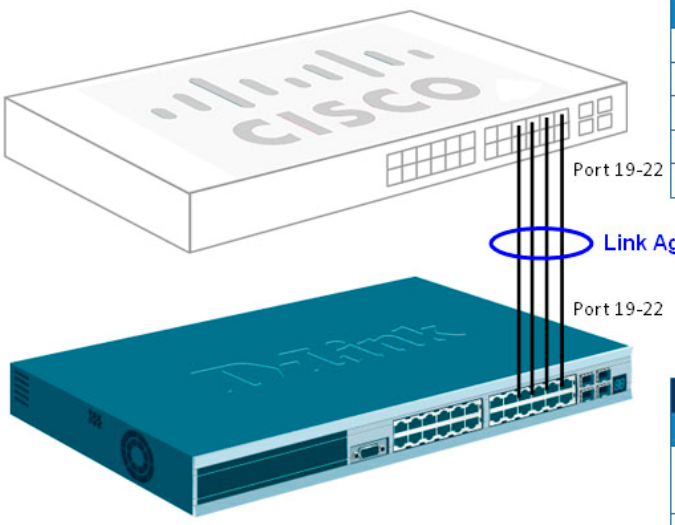
## Compatibility between D-Link Port-trunking and Cisco Port-Channel

The following table summarizes the options that can be combined to create a trunk on both D-Link and Cisco switches.

| D-Link Type-Mode \ Cisco Mode | Mode On | Mode Passive | Mode Active |
|---|---|---|---|
| Static | ✓ | | |
| LACP-Passive | | | ✓ |
| LACP- Active | | ✓ | |

**Note:** All ports in a trunk group must be configured at the same speed and VLAN.

## Topology




| Cisco Switch | | |
|---|---|---|
| Interface | VLAN | Ports |
| 192.168.0.1 | 1 | 23-28 |
| 192.168.10.1 | 10 | 1-6 |
| 192.168.20.1 | 20 | 7-12 |
| 192.168.30.1 | 30 | 13-18 |
| | Trunk | 19-22 |

| D-Link Switch | | | |
|---|---|---|---|
| Interface | VLAN | Ports | |
| 192.168.0.2 | 1 | Untagged | 19-28 |
| | | Tagged | -- -- |
| 192.168.10.2 | 10 | Untagged | 1-6 |
| | | Tagged | 19-22 |
| 192.168.20.2 | 20 | Untagged | 7-12 |
| | | Tagged | 19-22 |
| 192.168.30.2 | 30 | Untagged | 13-18 |
| | | Tagged | 19-22 |

**Figure-2 Link Aggregation and VLAN Configuration**

## Configuration

### Static Trunk Configuration on a Cisco Switch

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | Catalyst# config terminal<br>Catalyst(config)# interface range gigabitEthernet 1/0/19-22<br>Catalyst(config-if)# channel-group 1 mode on | To create a channel group 1 with static mode. |

### Static Trunk Configuration on a D-Link Switch

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | switch# create link_aggregation group_id 1 type static<br>switch# config link_aggregation group_id 1 ports 19-22 state enable | To create a trunk group 1 with static mode. |

## Troubleshooting Examples

### Verifying the Static Channel Status on a Cisco Switch

The following example shows you how to correctly set the port mode and verify the channel group ports.

| Command Example |
|---|
| Catalyst# **show etherchannel 1 summary** |

```
Flags:  D - down        P - bundled in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      f - failed to allocate aggregator

        M - not in use, minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port

Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
1      Po1(SU)         -         Gi1/0/19(P) Gi1/0/20(P) Gi1/0/21(P)
                                 Gi1/0/22(P)

Catalyst#show etherchannel 1 detail
Group state = L2
Ports: 4   Maxports = 8
Port-channels: 1 Max Port-channels = 1
Protocol:    -
Minimum Links: 0
              Ports in the group:
              -------------------
Port: Gi1/0/19
------------

Port state    = Up Mstr In-Bndl
Channel group = 1          Mode = On            Gcchange = -
Port-channel  = Po1        GC   =   -           Pseudo port-channel = Po1
Port index    = 0          Load = 0x00          Protocol =    -

Age of the port in the current state: 0d:00h:04m:13s

Port: Gi1/0/20
------------

Port state    = Up Mstr In-Bndl
Channel group = 1          Mode = On            Gcchange = -
Port-channel  = Po1        GC   =   -           Pseudo port-channel = Po1
Port index    = 0          Load = 0x00          Protocol =    -

Age of the port in the current state: 0d:00h:04m:12s

Port: Gi1/0/21
------------

Port state    = Up Mstr In-Bndl
Channel group = 1          Mode = On            Gcchange = -
Port-channel  = Po1        GC   =   -           Pseudo port-channel = Po1
Port index    = 0          Load = 0x00          Protocol =    -

Age of the port in the current state: 0d:00h:04m:14s
```

```
Port: Gi1/0/22
------------

Port state    = Up Mstr In-Bndl
Channel group = 1          Mode = On            Gcchange = -
Port-channel  = Po1        GC   =   -           Pseudo port-channel = Po1
Port index    = 0          Load = 0x00          Protocol =    -

Age of the port in the current state: 0d:00h:04m:13s

              Port-channels in the group:
              ---------------------------

Port-channel: Po1
------------

Age of the Port-channel   = 0d:00h:04m:17s
Logical slot/port   = 10/1         Number of ports = 4
GC                = 0x00000000     HotStandBy port = null
Port state         = Port-channel Ag-Inuse
Protocol          =    -
Port security      = Disabled

Ports in the Port-channel:

Index   Load   Port     EC state       No of bits
------+------+------+------------------+-----------
  0     00     Gi1/0/19 On               0
  0     00     Gi1/0/20 On               0
  0     00     Gi1/0/21 On               0
  0     00     Gi1/0/22 On               0

Time since last port bundled:    0d:00h:04m:14s    Gi1/0/22
```

### Verifying the Static Trunk status on a D-Link Switch

The following example shows you how to correctly set the port mode and verify the channel group ports.

**Command Example**

```
switch# show link_aggregation
Command: show link_aggregation

Link Aggregation Algorithm = IP-Source
Group ID     : 1
Type         : TRUNK
Master Port   : 19
Member Port   : 19-22
Active Port   : 19-22
Status       : Enabled
Flooding Port : 19
```

### LACP Configuration on a Cisco Switch

The following example shows you how to create a channel group, when a switch plays an active role in a LACP trunk.

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | Catalyst# config terminal<br>Catalyst(config)# interface range gigabitEthernet 1/0/19-22<br>Catalyst(config-if)# channel-group 1 mode active | To create a channel group 1 with LACP-active mode. |

The following example shows you how to create a channel group, when a switch plays a passive role in a LACP trunk.

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | Catalyst# config terminal<br>Catalyst(config)# interface range gigabitEthernet 1/0/19-22<br>Catalyst(config-if)# channel-group 1 mode passive | To create a channel group 1 with LACP-passive mode. |

### LACP Configuration on a D-Link Switch

The following example shows you how to create a trunk group, when a switch plays an active role in a LACP trunk.

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | switch# create link_aggregation group_id 1 type lacp<br>switch# config link_aggregation group_id 1 master_port 19 ports 19-22 state enable<br>switch# config lacp_port 19-22 mode active | To create a trunk group 1 with LACP-active mode. |

The following example shows you how to create a trunk group, when a switch plays a passive role in a LACP trunk.

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | switch# create link_aggregation group_id 1 type lacp<br>switch# config link_aggregation group_id 1 master_port 19 ports 19-22 state enable<br>switch# config lacp_port 19-22 mode passive | To create a trunk group 1 with LACP-passive mode. |

**Note:** By default, the LACP port mode is set passive in D-Link switches.

### Verifying the LACP Configuration on a Cisco Switch

The following example shows you how to correctly set the port mode and verify the channel group ports.

| Command Example |
|---|

```
Catalyst# show interfaces etherchannel
----
GigabitEthernet1/0/19:
Port state    = Up Sngl-port-Bndl Mstr Not-in-Bndl
Channel group = 1          Mode = Active          Gcchange = -
Port-channel  = null       GC   =   -           Pseudo port-channel = Po1
Port index    = 0          Load = 0x00           Protocol =   LACP

Flags:  S - Device is sending Slow LACPDUs   F - Device is sending fast LACPDUs.
       A - Device is in active mode.       P - Device is in passive mode.

Local information:
                        LACP port     Admin     Oper    Port        Port
```

```
Port      Flags   State    Priority     Key      Key     Number      State
Gi1/0/19  SA      indep    32768        0x1      0x1     0x13        0x7D

Age of the port in the current state: 0d:00h:00m:51s

----
GigabitEthernet1/0/20:
Port state    = Up Sngl-port-Bndl Mstr Not-in-Bndl
Channel group = 1          Mode = Active         Gcchange = -
Port-channel  = null       GC   =   -            Pseudo port-channel = Po1
Port index    = 0          Load = 0x00           Protocol =   LACP

Flags:  S - Device is sending Slow LACPDUs   F - Device is sending fast LACPDUs.
        A - Device is in active mode.        P - Device is in passive mode.

Local information:
                        LACP port     Admin     Oper    Port        Port
Port      Flags   State    Priority     Key      Key     Number      State
Gi1/0/20  SA      indep    32768        0x1      0x1     0x14        0x7D

Age of the port in the current state: 0d:00h:00m:51s

----
GigabitEthernet1/0/21:
Port state    = Up Sngl-port-Bndl Mstr Not-in-Bndl
Channel group = 1          Mode = Active         Gcchange = -
Port-channel  = null       GC   =   -            Pseudo port-channel = Po1
Port index    = 0          Load = 0x00           Protocol =   LACP

Flags:  S - Device is sending Slow LACPDUs   F - Device is sending fast LACPDUs.
        A - Device is in active mode.        P - Device is in passive mode.

Local information:
                        LACP port     Admin     Oper    Port        Port
Port      Flags   State    Priority     Key      Key     Number      State
Gi1/0/21  SA      indep    32768        0x1      0x1     0x15        0x7D

Age of the port in the current state: 0d:00h:00m:55s

----
GigabitEthernet1/0/22:
Port state    = Up Sngl-port-Bndl Mstr Not-in-Bndl
Channel group = 1          Mode = Active         Gcchange = -
Port-channel  = null       GC   =   -            Pseudo port-channel = Po1
Port index    = 0          Load = 0x00           Protocol =   LACP

Flags:  S - Device is sending Slow LACPDUs   F - Device is sending fast LACPDUs.
        A - Device is in active mode.        P - Device is in passive mode.

Local information:
                        LACP port     Admin     Oper    Port        Port
Port      Flags   State    Priority     Key      Key     Number      State
Gi1/0/22  SA      indep    32768        0x1      0x1     0x16        0x7D

Age of the port in the current state: 0d:00h:00m:55s

----
```

```
Port-channel1:Port-channel1   (Primary aggregator)

Age of the Port-channel   = 0d:01h:42m:42s
Logical slot/port   = 10/1         Number of ports = 0
HotStandBy port = null
Port state         = Port-channel Ag-Not-Inuse
Protocol           =   LACP
Port security      = Disabled

Time since last port bundled:    0d:01h:42m:38s    Gi1/0/22
Time since last port Un-bundled: 0d:00h:01m:19s    Gi1/0/22
```

### Verifying the LACP Configuration on a D-Link Switch

The following example shows you how to correctly set the ports of a trunk group.

**Command Example**

```
switch# show link_aggregation
Command: show link_aggregation

Link Aggregation Algorithm = IP-Source
Group ID     : 1
Type         : LACP
Master Port   : 19
Member Port   : 19-22
Active Port   : 19-22
Status       : Enabled
Flooding Port : 21


Total Entries : 1
```

The following example shows you how to correctly set the port mode.

**Command Example**

```
switch# show lacp
Command: show lacp_port

 Port    Activity

 -----    --------
 1       Passive
 2       Passive
 3       Passive
       ⋮
 19       Passive
 20       Passive
 21       Passive
 22       Passive
```

# Spanning Tree Configuration

## Terminology

| Cisco | D-Link | Description |
|---|---|---|
| Port Fast | Edge Port | Bypassing the listening and learning states, this port changes its state from blocking to forwarding directly to speed-up Spanning tree protocol (STP) convergence. |

**Note:** Since STP/RSTP function can only run in a single VLAN, all connections on Per-VLAN Spanning Tree (PVST) should be located in the same VLAN.

## Topology

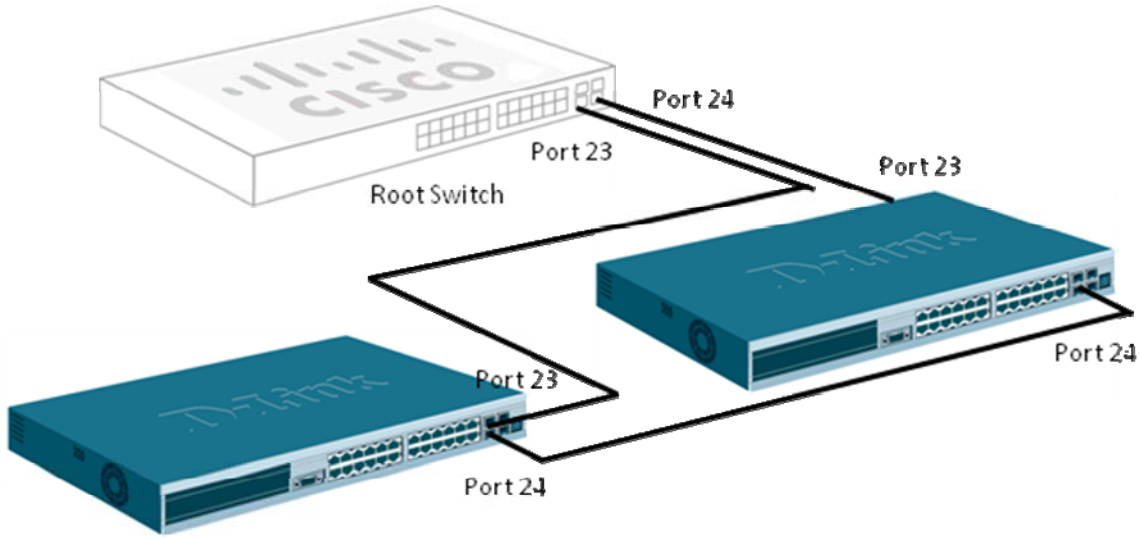



**Figure-3 Spanning Tree Configuration**

## Configuration

### Rapid-PVST Configuration on a Cisco Switch

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | `Catalyst# config terminal`<br>`Catalyst(config)# spanning-tree mode rapid-pvst` | To enable STP and choose rapid-PVST mode. |
| **Step 2** | `Catalyst(config)# spanning-tree vlan 1 priority 4096` | To change priority to 4096. |

### RSTP Configuration on a D-Link Switch

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | switch:admin# enable stp<br>switch:admin# config stp version rstp | To enable RSTP and choose RSTP. |
| **Step 2** | switch:admin# config stp ports 1-22 edge true<br>switch:admin# config stp ports 23-24 p2p true | Assume ports 1-22 are connected to PCs or an end terminal device. These ports should be set as edge ports. The ports 23-24 which are connected to the switch should be set as P2P ports. |

## Troubleshooting Examples

### Verifying RSTP Mode and Ports Status on a Cisco Switch

The following example shows you how to verify the STP protocol version, STP priority and port.

**Command Example**

```
Catalyst# show span vlan 1

VLAN0001
  Spanning tree enabled protocol rstp
  Root ID    Priority    4097
             Address     0021.56b0.5c00
             This bridge is the root
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    4097   (priority 4096 sys-id-ext 1)
             Address     0021.56b0.5c00
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time 300

Interface         Role Sts Cost      Prio.Nbr Type
----------------- ---- --- --------- -------- --------------------------------
Gi1/0/23          Desg FWD 4         128.23   P2p
Gi1/0/24          Desg FWD 4         128.24   P2p
```

The following example shows you how to check STP detail information.

**Command Example**

```
Catalyst# show spanning-tree detail

 VLAN0001 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 4096, sysid 1, address 0021.56b0.5c00
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  We are the root of the spanning tree
  Topology change flag not set, detected flag not set
  Number of topology changes 4 last change occurred 00:25:48 ago
         from GigabitEthernet1/0/23
```

```
 Times:  hold 1, topology change 35, notification 2
        hello 2, max age 20, forward delay 15
 Timers: hello 0, topology change 0, notification 0, aging 300

Port 23 (GigabitEthernet1/0/23) of VLAN0001 is designated forwarding
  Port path cost 4, Port priority 128, Port Identifier 128.23.
  Designated root has priority 4097, address 0021.56b0.5c00
  Designated bridge has priority 4097, address 0021.56b0.5c00
  Designated port id is 128.23, designated path cost 0
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 2
  Link type is point-to-point by default
  BPDU: sent 839, received 22

Port 24 (GigabitEthernet1/0/24) of VLAN0001 is designated forwarding
  Port path cost 4, Port priority 128, Port Identifier 128.24.
  Designated root has priority 4097, address 0021.56b0.5c00
  Designated bridge has priority 4097, address 0021.56b0.5c00
  Designated port id is 128.24, designated path cost 0
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 779, received 65
```

### Verifying the RSTP Mode and Ports Status on a D-Link Switch

The following example shows you how to verify if the spanning mode is RSTP and STP are enabled.

**Command Example**

```
switch:admin# show stp
Command: show stp

 STP Bridge Global Settings
 --------------------------
 STP Status          : Enabled
 STP Version         : RSTP
 Max Age             : 20
 Hello Time          : 2
 Forward Delay       : 15
 Max Hops            : 2
 TX Hold Count       : 6
 Forwarding BPDU     : Disabled
 Loopback Detection  : Enabled
 LBD Recover Time    : 60
 NNI BPDU Address    : dot1ad
```

The following example shows you how to verify the Root Bridge.

**Command Example**

```
switch:admin# show stp instance  0
Command: show stp instance 0

 STP Instance Settings
 --------------------------
 Instance Type       : CIST
 Instance Status     : Enabled
```

```
Instance Priority   : 32768(Bridge Priority : 32768, SYS ID Ext : 0 )

STP Instance Operational Status
-------------------------------
Designated Root Bridge : 4097 /00-21-56-B0-5C-00
External Root Cost     : 20000
Regional Root Bridge   : 32768/00-19-5B-12-43-00
Internal Root Cost     : 0
Designated Bridge      : 4097 /00-21-56-B0-5C-00
Root Port              : 23
Max Age                : 20
Forward Delay          : 15
Last Topology Change   : 978
Topology Changes Count : 5
```

The following example shows you how to verify the role of the interface.

**Command Example**

```
switch:admin# show stp ports 23
Command: show stp ports 23

MSTP Port Information
---------------------
Port Index    : 23    , Hello Time: 2 /2 , Port STP : Enabled  , LBD : No
External PathCost : Auto/20000    , Edge Port : False/No , P2P : True /Yes
Port RestrictedRole : False,  Port RestrictedTCN : False
Port Forward BPDU : Disabled
MSTI   Designated Bridge   Internal PathCost  Prio  Status     Role
-----  ------------------  -----------------  ----  ----------  ----------
0      1001/002156B05C00   20000              128   Forwarding  Root
```

# Multiple Spanning Tree Configuration

## Terminology

None

## Compatibility between MSTP and PVST

The following table summarizes the compatibility of PVST and MSTP functions.

| D-Link \ Cisco | PVST | PVST+ | Rapid PVST+ |
|---|---|---|---|
| MSTP | No | Yes (See note) | Yes (reverts to PVST+) |

**Note:** In a MSTP and PVST+ network, the Common Spanning-tree (CST) root must be inside the MST backbone, and a PVST+ switch cannot connect to multiple MST regions.

## Topology

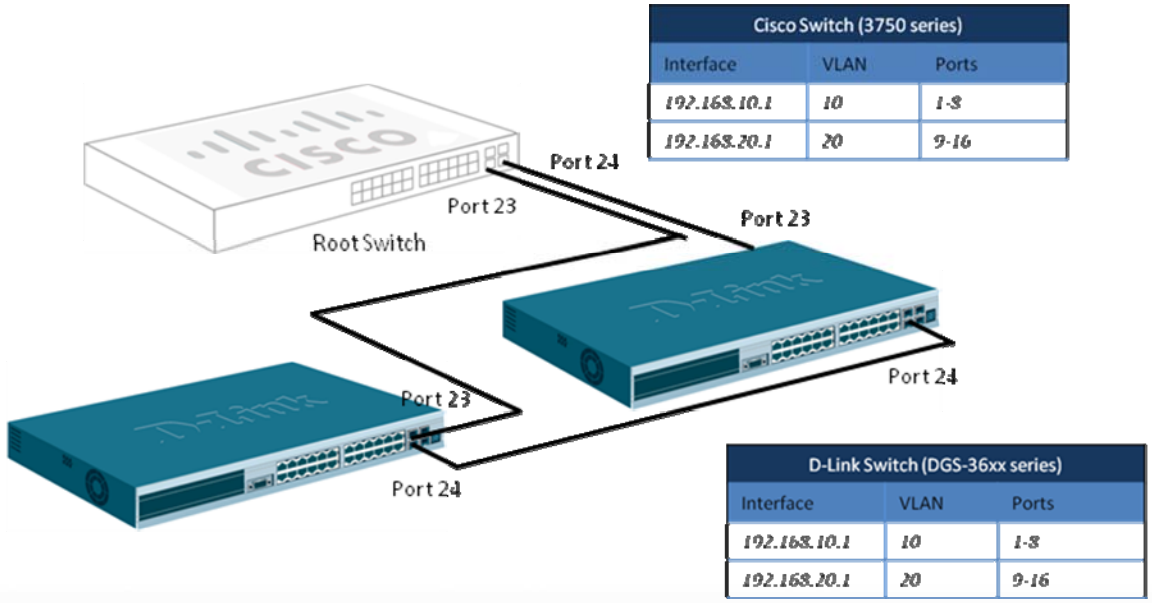



**Figure-4 Multiple Spanning Tree Configuration**

## Configuration

### Multiple Spanning Configuration on a Cisco Switch

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | `Catalyst# config terminal`<br>`Catalyst(config)# vlan 10,20,30` | To create VLAN interface for ports 10 and 20. |
| **Step 2** | `Catalyst(config)# interface range gigabitEthernet 1/0/1-8`<br>`Catalyst(config-if-range)# switchport access vlan 10`<br>`Catalyst(config-if-range)# interface range gigabitEthernet 1/0/9-16` | To assign interfaces for 0/1/0-8 to VLAN 10 and 0/1/9-16 to VALN 20. |

| | | |
|---|---|---|
| | Catalyst(config-if-range)# switchport access vlan 20 | |
| **Step 3** | Catalyst(config)# interface range gigabitEthernet 1/0/23-24<br>Catalyst(config-if-range)# switchport mode trunk<br>Catalyst(config-if-range)# switchport trunk allowed vlan 1,10,20<br>Catalyst(config-if-range)# switchport trunk encapsulation dot1q | To set interfaces for 0/1/23-24 as the trunk interfaces. |
| **Step 4** | Catalyst(config)# interface vlan 10<br>Catalyst(config-if)# ip address 192.168.10.1 255.255.255.0<br>Catalyst(config)# interface vlan 20<br>Catalyst(config-if)# ip address 192.168.20.1 255.255.255.0 | To create two IP interfaces on VLAN 10 and 20. |
| **Step 5** | Catalyst(config)# spanning-tree mode mst<br>Catalyst(config)# spanning-tree mst configuration<br>Catalyst(config-mst)# name test<br>Catalyst(config-mst)# revision 1<br>Catalyst(config-mst)# instance 1 vlan 10<br>Catalyst(config-mst)# instance 2 vlan 20 | To setup Multiple Spanning Tree name/revision/instance and VLAN mapping as the same value on all switches. |
| **Step 6** | Catalyst(config)# spanning-tree mst 1 priority 4096<br>Catalyst(config)# spanning-tree mst 2 priority 4096<br>Catalyst(config)# spanning-tree mst 3 priority 4096 | To set a Cisco switch as the root switch. |

**Multiple Spanning Configuration on a D-Link Switch**

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | switch:admin# create vlan 10 tag 10<br>switch:admin# create vlan 20 tag 20<br>switch:admin# config vlan default delete 1-16<br>switch:admin# config vlan 10 add untagged 1-8<br>switch:admin# config vlan 10 add tagged 23-24<br>switch:admin# config vlan 20 add untagged 9-16<br>switch:admin# config vlan 20 add tagged 23-24 | To create VLAN interfaces for ports 10, 20 and port assignment. |
| **Step 2** | switch:admin# create ipif 10 192.168.10.2/24 10<br>switch:admin# create ipif 20 192.168.20.2/24 20 | To create two IP interfaces on VLAN 10 and 20. |
| **Step 3** | switch:admin# config stp mst_config_id name test<br>switch:admin# config stp mst_config_id revision_level 1<br>switch:admin# config stp version mstp<br>switch:admin# create stp instance_id 1<br>switch:admin# create stp instance_id 2<br>switch:admin# config stp instance_id 1 add_vlan 10<br>switch:admin# config stp instance_id 2 add_vlan 20<br>switch:admin# enable stp | To setup Multiple Spanning Tree name/revision/instance and VLAN mapping as the same value on all switches. |

## Troubleshooting Examples

### Verifying MSTP Mode and Ports Status on a Cisco Switch

The following example shows you how to verify an MSTP instance and VLAN mapping information.

**Command Example**

```
Catalyst(config-mst)# show pending
Pending MST configuration
Name     [test]
Revision  1    Instances configured 3

Instance  Vlans mapped
--------  ---------------------------------------------------------------------
0         1-9,11-19,21-4094
1         10
2         20
-------------------------------------------------------------------------------


Catalyst# show spanning-tree mst configuration
Name     [test]
Revision  1    Instances configured 3

Instance  Vlans mapped
--------  ---------------------------------------------------------------------
0         1-9,11-19,21-4094
1         10
2         20
-------------------------------------------------------------------------------
```

The following example shows you how to check STP information.

**Command Example**

```
Catalyst# show spanning-tree detail

 VLAN0001 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 4096, sysid 1, address 0021.56b0.5c00
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  We are the root of the spanning tree
  Topology change flag not set, detected flag not set
  Number of topology changes 4 last change occurred 00:25:48 ago
         from GigabitEthernet1/0/23
  Times:  hold 1, topology change 35, notification 2
         hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 23 (GigabitEthernet1/0/23) of VLAN0001 is designated forwarding
   Port path cost 4, Port priority 128, Port Identifier 128.23.
   Designated root has priority 4097, address 0021.56b0.5c00
   Designated bridge has priority 4097, address 0021.56b0.5c00
   Designated port id is 128.23, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 2
   Link type is point-to-point by default
```

```
  BPDU: sent 839, received 22

 Port 24 (GigabitEthernet1/0/24) of VLAN0001 is designated forwarding
  Port path cost 4, Port priority 128, Port Identifier 128.24.
  Designated root has priority 4097, address 0021.56b0.5c00
  Designated bridge has priority 4097, address 0021.56b0.5c00
  Designated port id is 128.24, designated path cost 0
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 779, received 65
```

The following example shows you how to check the STP Status.

**Command Example**

```
Catalyst# show spanning-tree

MST0
  Spanning tree enabled protocol mstp
  Root ID    Priority    4096
             Address     0021.56b0.5c00
             This bridge is the root
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    4096   (priority 4096 sys-id-ext 0)
             Address     0021.56b0.5c00
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

Interface          Role Sts Cost      Prio.Nbr Type
------------------ ---- --- --------- -------- --------------------------------
Gi1/0/1            Desg FWD 200000    128.1    P2p Edge
Gi1/0/9            Desg FWD 200000    128.9    P2p Edge
Gi1/0/23           Desg FWD 20000     128.23   P2p
Gi1/0/24           Desg FWD 20000     128.24   P2p


MST1
  Spanning tree enabled protocol mstp
  Root ID    Priority    4097
             Address     0021.56b0.5c00
             This bridge is the root
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    4097   (priority 4096 sys-id-ext 1)
             Address     0021.56b0.5c00
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

Interface          Role Sts Cost      Prio.Nbr Type
------------------ ---- --- --------- -------- --------------------------------
Gi1/0/1            Desg FWD 200000    128.1    P2p Edge
Gi1/0/23           Desg FWD 20000     128.23   P2p
Gi1/0/24           Desg FWD 20000     128.24   P2p


MST2
  Spanning tree enabled protocol mstp
  Root ID    Priority    4098
```

```
           Address    0021.56b0.5c00
           This bridge is the root
           Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    4098   (priority 4096 sys-id-ext 2)
           Address    0021.56b0.5c00
           Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

Interface         Role Sts Cost     Prio.Nbr Type
----------------- ---- --- -------- -------- --------------------------------
Gi1/0/9           Desg FWD 200000   128.9    P2p Edge
Gi1/0/23          Desg FWD 20000    128.23   P2p
Gi1/0/24          Desg FWD 20000    128.24   P2p
```

The following example shows you how to check the MST protocol information.

**Command Example**

```
Catalyst# show spanning-tree mst

##### MST0    vlans mapped:   1-9,11-19,21-4094
Bridge       address 0021.56b0.5c00  priority     4096  (4096 sysid 0)
Root         this switch for the CIST
Operational   hello time 2 , forward delay 15, max age 20, txholdcount 6
Configured    hello time 2 , forward delay 15, max age 20, max hops    20

Interface       Role Sts Cost     Prio.Nbr Type
--------------- ---- --- -------- -------- --------------------------------
Gi1/0/1         Desg FWD 200000   128.1    P2p Edge
Gi1/0/9         Desg FWD 200000   128.9    P2p Edge
Gi1/0/23        Desg FWD 20000    128.23   P2p
Gi1/0/24        Desg FWD 20000    128.24   P2p

##### MST1    vlans mapped:   10
Bridge       address 0021.56b0.5c00  priority     4097  (4096 sysid 1)
Root         this switch for MST1

Interface       Role Sts Cost     Prio.Nbr Type
--------------- ---- --- -------- -------- --------------------------------
Gi1/0/1         Desg FWD 200000   128.1    P2p Edge
Gi1/0/23        Desg FWD 20000    128.23   P2p
Gi1/0/24        Desg FWD 20000    128.24   P2p

##### MST2    vlans mapped:   20
Bridge       address 0021.56b0.5c00  priority     4098  (4096 sysid 2)
Root         this switch for MST2

Interface       Role Sts Cost     Prio.Nbr Type
--------------- ---- --- -------- -------- --------------------------------
Gi1/0/9         Desg FWD 200000   128.9    P2p Edge
Gi1/0/23        Desg FWD 20000    128.23   P2p
Gi1/0/24        Desg FWD 20000    128.24   P2p
```

### Verifying the RSTP Mode and Ports Status on a D-Link Switch

The following example shows you how to verify if the spanning mode is MSTP and STP is enabled.

**Command Example**

```
switch:admin# show stp
Command: show stp

 STP Bridge Global Settings
 --------------------------
 STP Status          : Enabled
 STP Version         : MSTP
 Max Age             : 20
 Forward Delay       : 15
 Max Hops            : 20
 TX Hold Count       : 6
 Forwarding BPDU     : Disabled
 Loopback Detection  : Enabled
 LBD Recover Time    : 60
 NNI BPDU Address    : dot1ad
```

The following example shows you how to check the spanning instance information.

**Command Example**

```
switch:admin# show stp instance 0
Command: show stp instance 0

 STP Instance Settings
 ---------------------------
 Instance Type          : CIST
 Instance Status        : Enabled
 Instance Priority      : 32768(Bridge Priority : 32768, SYS ID Ext : 0 )

 STP Instance Operational Status
 -------------------------------
 Designated Root Bridge : 32768/00-19-5B-12-43-00
 External Root Cost     : 0
 Regional Root Bridge   : 32768/00-19-5B-12-43-00
 Internal Root Cost     : 0
 Designated Bridge      : 32768/00-19-5B-12-43-00
 Root Port              : None
 Max Age                : 20
 Forward Delay          : 15
 Last Topology Change   : 74717
 Topology Changes Count : 22
```

The following example shows you how to check the STP instance and VALN mapping.

**Command Example**

```
switch:admin# show stp mst_config_id
Command: show stp mst_config_id

 Current MST Configuration Identification
 ----------------------------------------

 Configuration Name : test                          Revision Level :1
 MSTI ID    Vid list
 -------    ------------------------------------------------------------
    CIST    1-9,11-19,21-4094
       1    10
```

2 20

# Open Shortest Path Fast (OSPF) Configuration

## Terminology

None

## Topology – Single OSPF Area

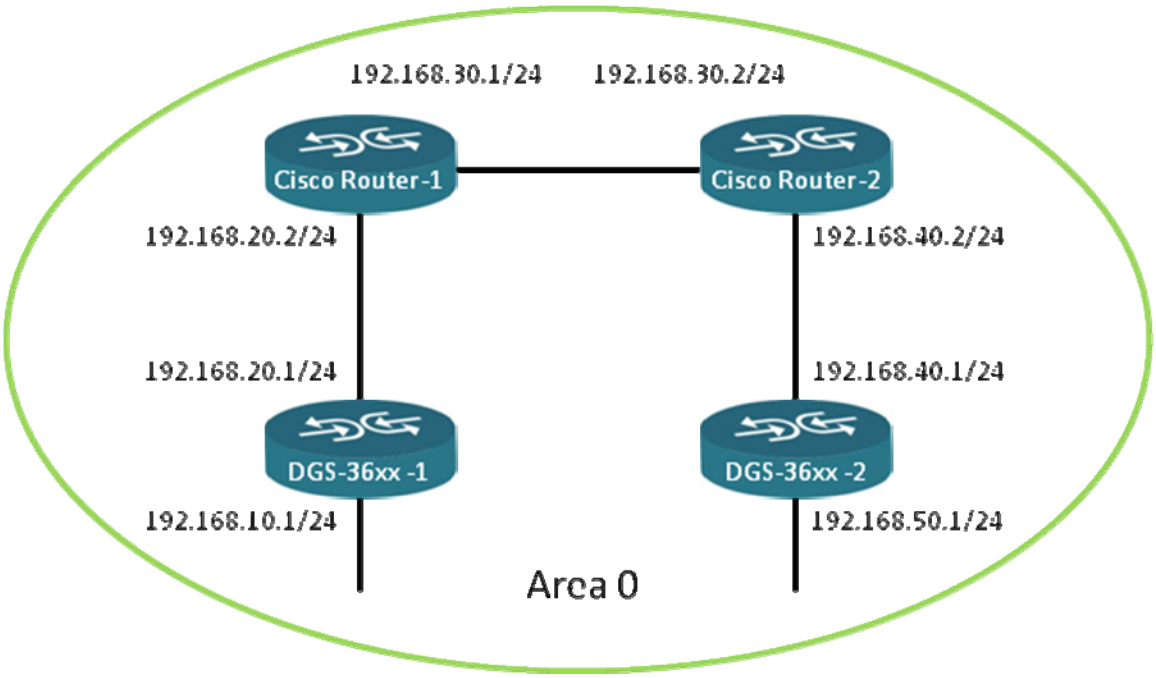



**Figure-5 Single OSPF Area Configuration**

## Configuration

### OSPF Configuration on a Cisco Switch - 1

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | Catalyst# config terminal<br>Catalyst(config)# interface gigabitEthernet 1/0/23<br>Catalyst(config-if)# no switchport<br>Catalyst(config-if)# ip address 192.168.20.2 255.255.255.0<br>Catalyst(config-if)# no shut<br>Catalyst(config-if)# exit<br>Catalyst(config)# interface gigabitEthernet 1/0/22<br>Catalyst(config-if)# no switchport<br>Catalyst(config-if)# ip address 192.168.30.1 255.255.255.0<br>Catalyst(config-if)# no shutdown<br>Catalyst(config-if)# exit | To create two IP interfaces - (192.168.20.0/ 192.168.30.0) |

| | | |
|---|---|---|
| **Step 2** | Catalyst(config)# ip routing<br>Catalyst(config)# router ospf 100<br>Catalyst(config-router)# router-id 192.168.20.1<br>Catalyst(config-router)# network 192.168.20.0 0.0.0.255 area 0<br>Catalyst(config-router)# network 192.168.30.0 0.0.0.255 area 0 | To enable OSPF on specific interfaces and setup router ID. |

**OSPF Configuration on a Cisco Switch - 2**

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | Catalyst# config terminal<br>Catalyst(config)# interface gigabitEthernet 1/0/23<br>Catalyst(config-if)# no switchport<br>Catalyst(config-if)# ip address 192.168.40.2 255.255.255.0<br>Catalyst(config-if)# no shut<br>Catalyst(config-if)# exit<br>Catalyst(config)# interface gigabitEthernet 1/0/22<br>Catalyst(config-if)# no switchport<br>Catalyst(config-if)# ip address 192.168.30.1 255.255.255.0<br>Catalyst(config-if)# no shutdown<br>Catalyst(config-if)# exit | To create two IP interfaces (192.168.30.0 / 192.168.40.0). |
| **Step 2** | Catalyst(config)# ip routing<br>Catalyst(config)# router ospf 100<br>Catalyst(config-router)# router-id 192.168.30.1<br>Catalyst(config-router)# network 192.168.30.0 0.0.0.255 area 0<br>Catalyst(config-router)# network 192.168.40.0 0.0.0.255 area 0 | To enable OSPF on specific interfaces and setup router ID. |

**OSPF Configuration on a D-Link Switch - 1**

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | switch:admin# create vlan 10 tag 10<br>switch:admin# create vlan 20 tag 20<br>switch:admin# config vlan default delete 1-16<br>switch:admin# config vlan 10 add untagged 1-8<br>switch:admin# config vlan 20 add untagged 9-16,23 | To create VLAN interfaces for ports 10 and 20 and assign relative ports to each VLAN. |
| **Step 2** | switch:admin# create ipif 10 192.168.10.1/24 10<br>switch:admin# create ipif 20 192.168.20.1/24 20 | To create two IP interfaces on VLAN 10 and 20. |
| **Step 3** | config ospf router_id 192.168.10.1<br>switch:admin# config ospf ipif 10 area 0.0.0.0 state enable<br>switch:admin# config ospf ipif 20 area 0.0.0.0 state enable<br>switch:admin# enable ospf | To enable OSPF on specific interfaces and setup router ID. |

### OSPF Configuration on a D-Link Switch - 2

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | switch:admin# create vlan 40 tag 40<br>switch:admin# create vlan 50 tag 50<br>switch:admin# config vlan default delete 1-16<br>switch:admin# config vlan 40 add untagged 1-8,24<br>switch:admin# config vlan 50 add untagged 9-16 | To create VLAN interfaces for ports 40 and 50 and assign relative ports to each VLAN. |
| **Step 2** | switch:admin# create ipif 40 192.168.10.1/24 40<br>switch:admin# create ipif 50 192.168.20.1/24 50 | To create two IP interfaces on VLAN 40 and 50. |
| **Step 3** | config ospf router_id 192.168.40.1<br>switch:admin# config ospf ipif 40 area 0.0.0.0 state enable<br>switch:admin# config ospf ipif 50 area 0.0.0.0 state enable<br>switch:admin# enable ospf | To enable OSPF on specific interfaces and setup router ID. |

## Troubleshooting Examples

### Verifying OSPF information on a Cisco Switch

The following example shows you how to check OSPF information.

| Command Example |
|---|

```
Catalyst# show ip ospf
 Routing Process "ospf 100" with ID 192.168.20.1
 Start time: 00:01:21.528, Time elapsed: 00:00:52.454
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval
*Mar  1 00:02:12.623: %OSPF-5-ADJCHG: Process 100, Nbr 192.168.30.1 on
GigabitEthernet1/0/22 from LOADING to FULL, Loading Done5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 0. Checksum Sum 0x000000
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 Number of areas transit capable is 0
 External flood list length 0
```

```
IETF NSF helper support enabled
Cisco NSF helper support enabled
Reference bandwidth unit is 100 mbps
   Area BACKBONE(0)
       Number of interfaces in this area is 2
       Area has no authentication
       SPF algorithm last executed 00:00:37.984 ago
       SPF algorithm executed 2 times
       Area ranges are
       Number of LSA 8. Checksum Sum 0x043353
       Number of opaque link LSA 0. Checksum Sum 0x000000
       Number of DCbitless LSA 4
       Number of indication LSA 0
       Number of DoNotAge LSA 0
       Flood list length 0
```

The following example shows you how to verify if the OSPF neighbors are established.

**Command Example**

```
Catalyst# show ip ospf neighbor

Neighbor ID     Pri   State      Dead Time   Address         Interface
192.168.30.1      1   FULL/DR    00:00:38    192.168.30.2    GigabitEthernet1/0/22
192.168.10.1      1   FULL/DR    00:00:36    192.168.20.1    GigabitEthernet1/0/23
```

The following example shows you how to verify if the route entries that are learnt by the switches.

**Command Example**

```
Catalyst# show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.30.0/24 is directly connected, GigabitEthernet1/0/22
O    192.168.10.0/24 [110/2] via 192.168.20.1, 00:02:07, GigabitEthernet1/0/23
O    192.168.40.0/24 [110/2] via 192.168.30.2, 00:02:07, GigabitEthernet1/0/22
C    192.168.20.0/24 is directly connected, GigabitEthernet1/0/23
O    192.168.50.0/24 [110/3] via 192.168.30.2, 00:02:07, GigabitEthernet1/0/22
```

The following example shows you how to check the OSPF interface status.

**Command Example**

```
Catalyst# show ip ospf interface
GigabitEthernet1/0/22 is up, line protocol is up (connected)
  Internet Address 192.168.30.1/24, Area 0
  Process ID 100, Router ID 192.168.20.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 192.168.30.1, Interface address 192.168.30.2
  Backup Designated router (ID) 192.168.20.1, Interface address 192.168.30.1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
```

```
    oob-resync timeout 40
    Hello due in 00:00:01
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.30.1  (Designated Router)
  Suppress hello for 0 neighbor(s)
GigabitEthernet1/0/23 is up, line protocol is up (connected)
  Internet Address 192.168.20.2/24, Area 0
  Process ID 100, Router ID 192.168.20.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 192.168.10.1, Interface address 192.168.20.1
  Backup Designated router (ID) 192.168.20.1, Interface address 192.168.20.2
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:07
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 5
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.10.1  (Designated Router)
  Suppress hello for 0 neighbor(s)
```

### Verifying the OSPF status on a D-Link Switch

The following example shows you how to verify if the OSPF is enabled on correct interfaces.

**Command Example**

```
switch:admin# show ospf
Command: show ospf

OSPF Router ID : 192.168.10.1
State          : Enabled

OSPF Interface Settings

Interface    IP Address        Area ID        State    Link     Metric
                                                 Status
------------ ----------------- -------------- -------- -------- ---------
System       10.90.90.90/8     0.0.0.0        Disabled Link Up   1
10           192.168.10.1/24    0.0.0.0        Enabled  Link Up   1
20           192.168.20.1/24    0.0.0.0        Enabled  Link Up   1


Total Entries : 3

OSPF Area Settings
```

```
Area ID        Type   Stub Import Summary LSA Stub Default Cost Translate
-------------- ------ --------------------- ---------------- ---------
0.0.0.0        Normal None                  None             None

Total Entries : 1

Virtual Interface Configuration
Transit      Virtual         Hello     Dead       Authentication      Link
Area ID      Neighbor Router Interval  Interval                       Status
----------   -------------- --------  --------   --------------      ------

Total Entries : 0

OSPF Area Aggregation Settings

Area ID      Aggregated       LSDB     Advertise
             Network Address  Type
------------ ---------------- -------- ---------

Total Entries : 0

OSPF Host Route Settings

Host Address    Metric   Area ID
--------------- -------  ---------------

Total Entries : 0
```

The following example shows you how to verify if the OSPF neighbor is established.

**Command Example**

```
switch:admin# show ospf neighbor
Command: show ospf neighbor

IP Address of   Router ID of    Neighbor Neighbor
Neighbor        Neighbor        Priority State
--------------- --------------- -------- -------------
192.168.20.2    192.168.20.2     1        Full

Total Entries : 1
```

The following example shows you how to check the OSPF interface information.

**Command Example**

```
switch:admin# show ospf ipif 10
Command: show ospf ipif 10

Interface Name: 10                  IP Address: 192.168.10.1/24 (Link Up)
Network Medium Type: BROADCAST        Metric: 1
Area ID: 0.0.0.0                    Administrative State: Enabled
Priority: 1                         DR State: DR
DR Address: 192.168.10.1              Backup DR Address: None
Hello Interval: 10                  Dead Interval: 40
Transmit Delay: 1                   Retransmit Time: 5
Authentication: None

Passive Mode: Disabled
```

```
Total Entries : 1
```

The following example shows you how to verify all the route entries that are learnt by the switches.

**Command Example**

```
switch:admin# show iproute
Command: show iproute


Routing Table

IP Address/Netmask  Gateway         Interface     Cost      Protocol
------------------  --------------  ------------  --------  --------
10.0.0.0/8         0.0.0.0         System       1         Local
192.168.10.0/24     0.0.0.0         10           1         Local
192.168.20.0/24     0.0.0.0         20           1         Local
192.168.30.0/24     192.168.20.2     20           2         OSPF
192.168.40.0/24     192.168.20.2     20           3         OSPF
192.168.50.0/24     192.168.20.2     20           4         OSPF

Total Entries : 6
Total Entries : 1
```

## Topology – Multiple OSPF Areas

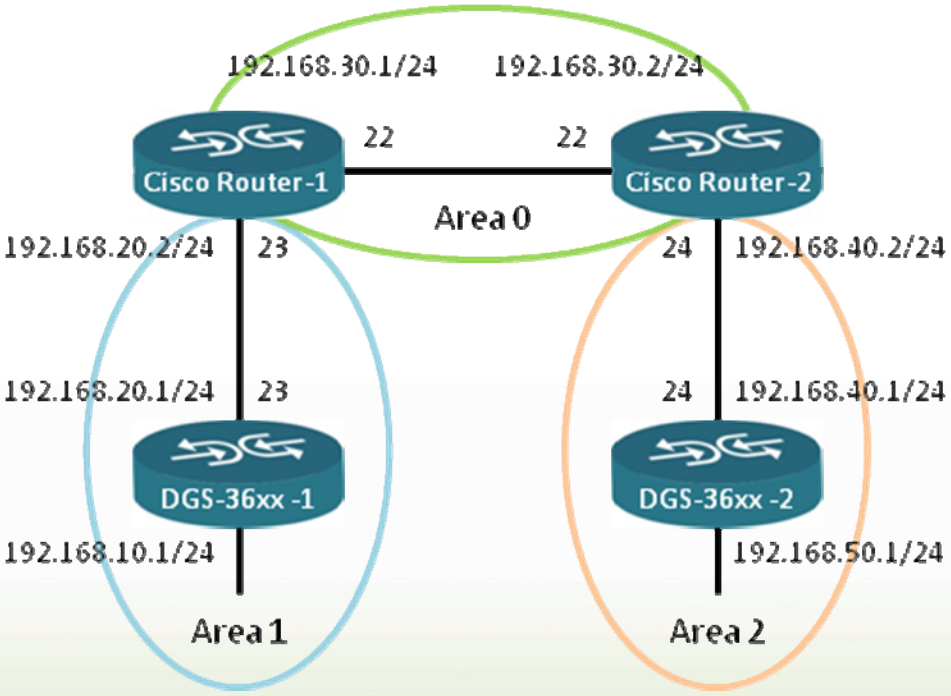



**Figure-6 Multiple OSPF Areas Configuration**

## Configuration

### OSPF Configuration on Cisco Switch - 1

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | Switch#config terminal<br>Switch(config)#interface gigabitEthernet 1/0/23<br>Switch(config-if)#no switchport<br>Switch(config-if)#ip address 192.168.20.2 255.255.255.0<br>Switch(config-if)#no shut<br>Switch(config-if)#exit<br>Switch(config)#interface gigabitEthernet 1/0/22<br>Switch(config-if)#no switchport<br>Switch(config-if)#ip address 192.168.30.1 255.255.255.0<br>Switch(config-if)#no shutdown<br>Switch(config-if)#exit | Create two IP interfaces (192.168.20.0 / 192.168.30.0) |
| **Step 2** | Switch(config)#interface loopback 0<br>Switch(config-if)#ip address 10.0.0.1 255.255.255.255<br>Switch(config-if)#no shut | Create a Loopback interface for Router ID. Cisco router prefers the address of loopback interface over the address of all physical interfaces while choosing Router ID. |
| **Step 3** | Switch(config)#ip routing<br>Switch(config)#router ospf 100<br>Switch(config-router)#network 192.168.20.0 0.0.0.255 area 1<br>Switch(config-router)#network 192.168.30.0 0.0.0.255 area 0 | Enable OSPF on specific interfaces. |

### OSPF Configuration on Cisco Switch - 2

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | Switch#config terminal<br>Switch(config)#interface gigabitEthernet 1/0/23<br>Switch(config-if)#no switchport<br>Switch(config-if)#ip address 192.168.40.2 255.255.255.0<br>Switch(config-if)#no shut<br>Switch(config-if)#exit<br>Switch(config)#interface gigabitEthernet 1/0/22<br>Switch(config-if)#no switchport<br>Switch(config-if)#ip address 192.168.30.1 255.255.255.0<br>Switch(config-if)#no shutdown<br>Switch(config-if)#exit | Create two IP interfaces (192.168.30.0 / 192.168.40.0) |
| **Step 2** | Switch(config)#interface loopback 0<br>Switch(config-if)#ip address 10.0.0.2 255.255.255.255<br>Switch(config-if)#no shut | Create a Loopback interface for Router ID. Cisco router prefers the address of loopback |

| | | |
|---|---|---|
| | | interface over the address of all physical interfaces while choosing Router ID. |
| **Step 3** | Switch(config)#ip routing<br>Switch(config)#router ospf 100<br>Switch(config-router)#router-id 192.168.30.1<br>Switch(config-router)#network 192.168.30.0 0.0.0.255 area 0<br>Switch(config-router)#network 192.168.40.0 0.0.0.255 area 2 | Enable OSPF on specific interfaces and setup router ID |

**OSPF Configuration on D-Link Switch - 1**

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | DGS-3627:admin#create vlan 10 tag 10<br>DGS-3627:admin#create vlan 20 tag 20<br>DGS-3627:admin#config vlan default delete 1-16<br>DGS-3627:admin#config vlan 10 add untagged 1-8<br>DGS-3627:admin#config vlan 20 add untagged 9-16,23 | Create VLAN 10 and 20 and assign relative ports to each VLAN |
| **Step 2** | DGS-3627:admin#create ipif 10 192.168.10.1/24 10<br>DGS-3627:admin#create ipif 20 192.168.20.1/24 20 | Create two IP interfaces on VLAN 10 and 20 |
| **Step 3** | DGS-3627:admin#config ospf router_id 192.168.10.1<br>DGS-3627:admin#create ospf area 0.0.0.1 type normal<br>DGS-3627:admin#config ospf ipif 10 area 0.0.0.1 state enable<br>DGS-3627:admin#config ospf ipif 20 area 0.0.0.1 state enable<br>DGS-3627:admin#enable ospf | Enable OSPF on specific interfaces and assign interfaces on area 1. |

**OSPF Configuration on D-Link Switch - 2**

| | Command Example | Purpose |
|---|---|---|
| **Step 1** | DGS-3627:admin#create vlan 40 tag 40<br>DGS-3627:admin#create vlan 50 tag 50<br>DGS-3627:admin#config vlan default delete 1-16<br>DGS-3627:admin#config vlan 40 add untagged 1-8,24<br>DGS-3627:admin#config vlan 50 add untagged 9-16 | Create VLAN 40 and 50 and assign relative ports to each VLAN |
| **Step 2** | DGS-3627:admin#create ipif 40 192.168.10.1/24 40<br>DGS-3627:admin#create ipif 50 192.168.20.1/24 50 | Create two IP interfaces on VLAN 40 and 50 |
| **Step 3** | DGS-3627:admin#config ospf router_id 192.168.40.1<br>DGS-3627:admin#create ospf area 0.0.0.2 type normal<br>DGS-3627:admin#config ospf ipif 40 area 0.0.0.2 state enable<br>DGS-3627:admin#config ospf ipif 50 area 0.0.0.2 state enable<br>DGS-3627:admin#enable ospf | Enable OSPF on specific interfaces and assign interfaces on area 2. |

## Troubleshooting Examples

### Verifying OSPF information on a Cisco Switch

The following example shows you how to check OSPF detailed information on Cisco Switch. Cisco Switch uses loopback interface to be Router ID and Area 1 should be created

**Command Example**

```
Catalyst# show ip ospf
 Routing Process "ospf 100" with ID 10.0.0.1
 Start time: 00:01:21.528, Time elapsed: 4d19h
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 It is an area border router
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 0. Checksum Sum 0x000000
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 2. 2 normal 0 stub 0 nssa
 Number of areas transit capable is 0
 External flood list length 0
 IETF NSF helper support enabled
 Cisco NSF helper support enabled
 Reference bandwidth unit is 100 mbps
    Area BACKBONE(0)
        Number of interfaces in this area is 1
        Area has no authentication
        SPF algorithm last executed 00:27:19.763 ago
        SPF algorithm executed 14 times
        Area ranges are
        Number of LSA 8. Checksum Sum 0x07E502
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 1
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
    Area 1
        Number of interfaces in this area is 1
        Area has no authentication
        SPF algorithm last executed 00:33:43.525 ago
        SPF algorithm executed 8 times
        Area ranges are
        Number of LSA 6. Checksum Sum 0x036A95
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 1
```

```
      Number of indication LSA 0
      Number of DoNotAge LSA 0
      Flood list length 0
```

### Checking OSPF status on D-Link Switch

The following example shows you how to verify if the OSPF is enabled on correct interfaces and if the area assignment is correct.

**Command Example**

```
switch:admin# show ospf
Command: show ospf

OSPF Router ID   : 192.168.10.1
State            : Enabled

OSPF Interface Settings

Interface     IP Address       Area ID       State     Link      Metric
                                             Status
------------ ---------------- -----------   --------  --------  --------
System        10.90.90.90/8    0.0.0.0       Disabled  Link Up       1
10            192.168.10.1/24  0.0.0.1       Enabled   Link Up       1
20            192.168.20.1/24  0.0.0.1       Enabled   Link Up       1

Total Entries : 3

OSPF Area Settings

Area ID   Type      Stub Import Summary LSA    Stub Default Cost   Translate
--------  ------    -----------------------    -----------------   ---------
0.0.0.0   Normal    None                       None                None
0.0.0.1   Normal    None                       None                None

Total Entries : 2

Virtual Interface Configuration

Transit       Virtual          Hello     Dead      Authentication   Link
Area ID       Neighbor Router  Interval  Interval                   Status
----------    ---------------  --------  --------  --------------   ------

Total Entries : 0

OSPF Area Aggregation Settings

Area ID          Aggregated          LSDB      Advertise
                 Network Address     Type
---------------  ------------------  --------  ---------

Total Entries : 0

OSPF Host Route Settings

Host Address     Metric    Area ID
---------------  ------    ---------------
```

```
Total Entries : 0
```

The following example shows you how to verify if the OSPF interface information are correct.

**Command Example**

```
switch:admin# show ospf ipif 10
Command: show ospf ipif 10

Interface Name: 10                IP Address: 192.168.10.1/24 (Link Up)
Network Medium Type: BROADCAST    Metric: 1
Area ID: 0.0.0.1                  Administrative State: Enabled
Priority: 1                       DR State: DR
DR Address: 192.168.10.1          Backup DR Address: None
Hello Interval: 10                Dead Interval: 40
Transmit Delay: 1                 Retransmit Time: 5
Authentication: None

Passive Mode: Disabled

Total Entries : 1
```