Ethernet Routing Switch
IP Phones
Engineering

Avaya / Cisco Interoperability Technical Configuration Guide

Avaya Data Solutions
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Abstract

The purpose of this TCG is to show some of the more common configurations for the interoperability of Avaya and Cisco products.

Revision Control

No	Date	Version	Revised by	Remarks
1	9/30/2009	1.0	ENS	Initial Document
2	3/16/2010	2.0	PRMGT	Added IP-VPN and Appendix A sections

Table of Contents

Document Updates

April 6, 2010

Conventions

This section describes the text, image, and command conventions used in this document.

Symbols:

Tip – Highlights a configuration or technical tip.

Note – Highlights important information to the reader.

Warning – Highlights important information about an action that may result in equipment damage, configuration or data loss.

Text:

Bold text indicates emphasis.

Italic text in a Courier New font indicates text the user must enter or select in a menu item, button or command:

ERS5520-48T# ***show running-config***

Output examples from Nortel devices are displayed in a Lucinda Console font:

ERS5520-48T# ***show running-config***

```
! Embedded ASCII Configuration Generator Script
! Model = Ethernet Routing Switch 5520-24T-PWR
! Software version = v5.0.0.011
enable
configure terminal
```

1. Cisco Trunk Interface and Native VLAN

When a Cisco switch is configured as a trunk interface, by default, traffic becoming to the native VLAN (VLAN 1) is not trunk encapsulated. Cisco uses the native VLAN for such proprietary protocols such as CDP, PAgP, and VTP. To tag the native VLAN, the Cisco global *vlan dot1q tag native* command must be used where, unless you change the native VLAN identifier at an interface level, VLAN 1 will be tagged. At an interface level, the switchport *trunk native vlan <1-4094>* command can be used to change the VLAN identifier of the native VLAN. For example, the following configuration enables native VLAN tagging using VLAN 1050 as the native VLAN on port 1/0/18 on a Cisco 3750.

```
!
vlan internal allocation policy ascending
vlan dot1q tag native
!
interface GigabitEthernet1/0/18
 switchport trunk encapsulation dot1q
 switchport trunk native vlan 1050
 switchport trunk allowed vlan 1000,1100
 switchport mode trunk
 priority-queue out
 mls qos trust dscp
!
```

If you have an older Cisco switch that does not support native VLAN tagging and you need to pass the native VLAN traffic via an Avaya switched network, the Avaya switch can be configured to support an untagged default VLAN. Although Avaya also uses VLAN 1 as the default VLAN, any VLAN number can be used as the default VLAN. The following shows a configuration example for both an ERS8600 and an ERS5000 switch using VLAN 1050 as the default untagged VLAN.

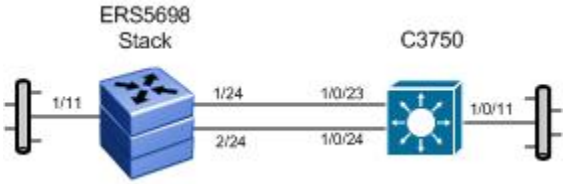
a) ERS8600 Configuration

```
#
# PORT CONFIGURATION - PHASE I
#

ethernet 3/2 perform-tagging enable

#
# PORT CONFIGURATION - PHASE II
#

ethernet 3/2 default-vlan-id 1050
ethernet 3/2 untag-port-default-vlan enable
```

b) ERS5500 Configuration

```
!
! *** VLAN ***
!
vlan create 1050 name "default-native" type port
vlan ports 1/3 tagging unTagPvidOnly  filter-untagged-frame disable
filter-unregistered-frames disable priority 0
vlan members 1050 1/3
vlan ports 1/3 pvid 1050
```

2. Basic Cisco EtherChannel to Avaya MLT without Spanning Tree



For this example, we will configure the following:

- MLT 2 with port member 1/24 and 2/24 on the Avaya 5698 stack
- EtherChannel on the Cisco 3750 using ports 1/0/23 and 1/0/24
- Enable 802.1Q tagging between the Avaya and Cisco switch with VLAN 300

2.1 Configuration Steps

2.1.1 ERS5698 Configuration

2.1.1.1 Create VLAN

5698TFD-1-PWR: Step 1 – Create VLAN 300

```
5698TFD-1-PWR(config)#vlan create 300 name services type port
5698TFD-1-PWR(config)#vlan configcontrol automatic
5698TFD-1-PWR(config)#vlan ports 1/24,2/24 tagging tagall
5698TFD-1-PWR(config)#vlan members add 300 1/11,1/24,2/24
5698TFD-1-PWR(config)#vlan members remove 1 1/11,1/24,2/24
```

2.1.1.2 Create MLT

5698TFD-1-PWR: Step 1 – Create MLT 2

```
5698TFD-1-PWR(config)# mlt 2 name cisco_ether enable member 1/24,2/24 learning
disable
```

2.1.1.3 Enable Spanning Tree Fast Start and BPDU filtering on all Access Ports

5698TFD-1-PWR: Step 1 – Enable STP Fast Start and BPDU Filtering
5698TFD-1-PWR(config)#***interface fastEthernet 1/11***
5698TFD-1-PWR(config-if)#***spanning-tree learning fast***
5698TFD-1-PWR(config-if)#***spanning-tree bpdu-filtering timeout 0***
5698TFD-1-PWR(config-if)#***spanning-tree bpdu-filtering enable***
5698TFD-1-PWR(config-if)#***exit***

2.1.2 Cisco 3750 Configuration

The following is the configuration used on the Cisco 3750 used for this example.

```
!
aaa session-id common
switch 7 provision ws-c3750g-24t
system mtu routing 1500
vtp mode transparent
ip subnet-zero
ip routing
ip domain-name mydomain.com
!
vlan 300
 name services
!
interface Port-channel1
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 300
 switchport mode trunk
 spanning-tree bpdufilter enable
!
interface GigabitEthernet1/0/11
 switchport access vlan 300
 switchport trunk encapsulation dot1q
 switchport mode access
 spanning-tree portfast
 spanning-tree bpduguard enable
!
interface GigabitEthernet1/0/23
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 300
 switchport mode trunk
 no cdp enable
 channel-group 1 mode on
!
interface GigabitEthernet1/0/24
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 300
 switchport mode trunk
 no cdp enable
 channel-group 1 mode on
!
```

2.2 Verification

2.2.1 Verify MLT on Avaya 5698 stack

Step 1 – Verify that the MLT instance and MLT VLAN members is configured correctly by issuing the following commands:
5698TFD-1-PWR#***show mlt 2***
Result:

```
        Id Name                 Members               Bpdu   Mode          Status
        -- -------------------- --------------------- ------ ------------- -------
        2  cisco_ether          1/24,2/24             All    Basic         Enabled
```

5698TFD-1-PWR#***show vlan interface vids 1/24,2/24***
Result:

```
        Unit/Port VLAN VLAN Name         VLAN VLAN Name         VLAN VLAN Name
        --------- ---- ----------------  ---- ----------------  ---- ----------------
        1/24      300  services
        --------- ---- ----------------  ---- ----------------  ---- ----------------
        2/24      300  services
        --------- ---- ----------------  ---- ----------------  ---- ----------------
```

Verify the following information:

Option	**Verify**
Members VLAN	Verify that the MLT is enabled and assigned to VLAN 300 • MLT 2: Member of VLANs ***300*** with port members ***1/24*** and ***2/24***
Status	Displays as ***Enabled***.
Mode	Displays as ***Basic*** which is the default setting for MLT load balancing using MAC hashing. A setting of *advance* provides MLT load balancing using IP hashing and is configurable using the CLI command *mlt 2 loadbalance <advance|basic>*

2.2.2 Verify EtherChannel on Cisco 3750 switch

Step 1 – Verify that the MLT instance and MLT VLAN members are configured correctly by issuing the following commands:

C3750-1# ***show etherchannel 1 port-channel***

Result:

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

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

       Age of the Port-channel   = 11d:23h:32m:14s
       Logical slot/port   = 10/1          Number of ports = 2
       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     Gi1/0/23 On                 0
         0     00     Gi1/0/24 On                 0

       Time since last port bundled:    0d:00h:59m:25s    Gi1/0/24
       Time since last port Un-bundled: 0d:00h:59m:40s    Gi1/0/24
```

C3750-1#***show interfaces port-channel 1***

Result:

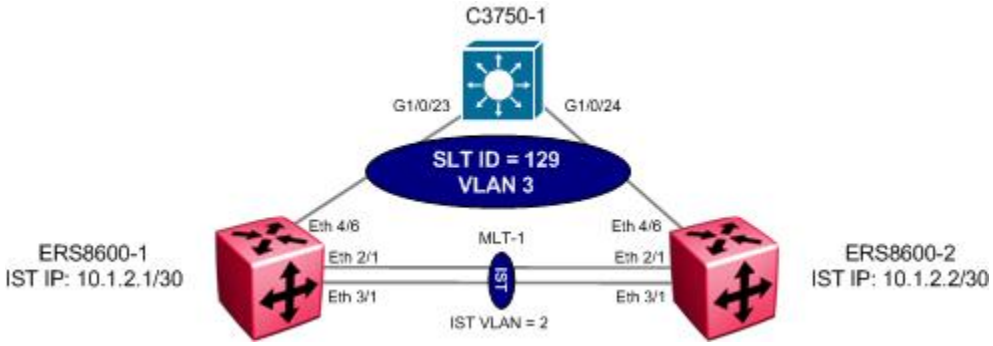
```
       Port-channel1 is up, line protocol is up (connected)
         Hardware is EtherChannel, address is 000d.65cc.0917 (bia 000d.65cc.0917)
         MTU 1500 bytes, BW 2000000 Kbit, DLY 10 usec,
            reliability 255/255, txload 1/255, rxload 0/255
         Encapsulation ARPA, loopback not set
         Keepalive set (10 sec)
         Full-duplex, 1000Mb/s, link type is auto, media type is unknown
         input flow-control is off, output flow-control is unsupported
         Members in this channel: Gi7/0/23 Gi7/0/24
         ARP type: ARPA, ARP Timeout 04:00:00
         Last input 01:43:59, output 6d02h, output hang never
         Last clearing of "show interface" counters never
         Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
         Queueing strategy: fifo
         Output queue: 0/40 (size/max)
         5 minute input rate 0 bits/sec, 0 packets/sec
         5 minute output rate 0 bits/sec, 0 packets/sec
            724558882 packets input, 49268190185 bytes, 0 no buffer
            Received 622359 broadcasts (618700 multicasts)
            0 runts, 0 giants, 0 throttles
            0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
            0 watchdog, 618700 multicast, 0 pause input
            0 input packets with dribble condition detected
            720546813 packets output, 49009901404 bytes, 0 underruns
```

```
            0 output errors, 0 collisions, 1 interface resets
            0 babbles, 0 late collision, 0 deferred
            0 lost carrier, 0 no carrier, 0 PAUSE output
            0 output buffer failures, 0 output buffers swapped out
```

Verify the following information:

Option	Verify
Port EC state	Verify that the EtherChannel running with the correct port member : • Port-channel 1 with port members ***1/0/23*** and ***1/0/24*** • EC State is ***On***
Port State	Displays as ***Port-channel Ag-inuse***. Otherwise, it would be displayed as ***Ag-Not-Inuse***. If not operational, use the *show interfaces port-channel 1* command and verify that the port-channel is up and the line protocol is up (connected) as shown above. If not, ensure that the interface speeds are the same on both the Avaya and Cisco switches and that the interfaces are configured as tagged trunk ports

3. Cisco EtherChannel to Avaya Switch Cluster



For this configuration example, a Cisco 3750 switch is used at the SMLT access layer using EtherChannel to connect to the ERS8600 Switch Cluster. Note that any local proprietary load-balance mechanism or 802.3ad can be used to connect to a Switch Cluster. Overall, we will configure the following items:

- IST using MLT 1 with port members 2/1 and 3/1 and IP subnet 10.1.2.0/30
- SLT 129 for the Cisco 3750 Edge switch with VLAN 3
- Enable EtherChannel on the Cisco 3750 with tagged port members 1/0/23 and 1/0/24

It is recommended to use the same MLT ID's between the two SMLT clusters for ease in configuration and trouble-shooting.

It is recommended to use a unique IP subnet between the SMLT Cluster.

Well, if you need an OSPF adjacency between the IST peers, you have to create a separate IP subnet on the IST, since we do not recommend enabling routing protocols over the IST IP

As illustrated in the diagram above, the SMLT or SLT ID is local to an SMLT Cluster. The ERS8600 support up to 128 SMLT ID's using ID's 1 to 128. The SLT ID's can be any value from 1 to 512, however, it is recommended to use a SLT ID greater than the maximum possible SMLT ID so as to not use up a possible SMLT instance. Hence the reason we are using SLT-129 in Switch Cluster. Please note that this is not a requirement; it just illustrates the flexibility of the solution. Also note that the SMLT ID or SLT ID used on each peer in the Switch Cluster must be the same.

3.1.1 Switch Cluster

3.1.1.1 Create VLANs

The following port based VLANs will be configured on the Switch cluster

- VLAN 2 to be used by the Inter Switch Trunk (IST)
- VLAN 3 to be used at Layer 2 for the C3750-1 users.

ERS8600-1: Step 1 – Create VLANs 2 and 3
ERS8600-1:5# ***config vlan 2 create byport 1 name IST***
ERS8600-1:5# ***config vlan 3 create byport 1 name Services***
ERS8600-2: Step 1 – Create VLAN 2 and 3
ERS8600-2:5# ***config vlan 2 create byport 1 name IST***
ERS8600-2:5# ***config vlan 3 create byport 1 name Services***

3.1.1.2 Change fdb aging timer for VLAN 3

ERS8600-1: Step 1 – Change fdb aging timer for VLAN 3
ERS8600-1:5# ***config vlan 3 fdb-entry aging-time 21601***
ERS8600-2: Step 1 – Change fdb aging timer for VLAN 3
ERS8600-2:5# ***config vlan 3 fdb-entry aging-time 21601***

3.1.1.3 Create IST

Multilink Trunking 1 (MLT 1) will be used for the IST with 802.1Q tagged port members 2/1 and 3/1. Spanning Tree will be disabled on all IST port members by default. We will enable VLACP will on the IST port members.

ERS8600-1: Step 1 – Create MLT 1 for IST
ERS8600-1:5# ***config mlt 1 create***
ERS8600-1:5# ***config mlt 1 name IST***
ERS8600-1:5# ***config mlt 1 add port 2/1,3/1***
ERS8600-1:5# ***config vlan 2 add-mlt 1***
ERS8600-2: Step 1 – Create MLT 1 for IST
ERS8600-2:5# ***config mlt 1 create***
ERS8600-2:5# ***config mlt 1 name IST***
ERS8600-2:5# ***config mlt 1 add port 2/1,3/1***

```
ERS8600-2:5# config vlan 2 add-mlt 1
```

ERS8600-1: Step 2 – Create IST

```
ERS8600-1:5# config vlan 2 ip create 10.1.2.1/30
ERS8600-1:5# config mlt 1 ist create ip 10.1.2.2 vlan-id 2
ERS8600-1:5# config mlt 1 ist enable
```

ERS8600-2: Step 2 – Create IST

```
ERS8600-2:5# config vlan 2 ip create 10.1.2.2/30
ERS8600-2:5# config mlt 1 ist create ip 10.1.2.1 vlan-id 2
ERS8600-2:5# config mlt 1 ist enable
```

ERS8600-1: Step 3 – Enable VLACP

```
ERS8600-1:5# ethernet 2/1,3/1 vlacp macaddress 01:80:c2:00:00:0f
ERS8600-1:5# ethernet 2/1,3/1 vlacp slow-periodic-time 10000
ERS8600-1:5# ethernet 2/1,3/1 vlacp enable
ERS8600-1:5# config vlacp enable
```

ERS8600-2: Step 3 – Enable VLACP

```
ERS8600-2:5# ethernet 2/1,3/1 vlacp macaddress 01:80:c2:00:00:0f
ERS8600-2:5# ethernet 2/1,3/1 vlacp slow-periodic-time 10000
ERS8600-2:5# ethernet 2/1,3/1 vlacp enable
ERS8600-2:5# config vlacp enable
```

It is recommended to use the reserved multicast MAC address of 01:80:c2:00:00:0f for the VLACP MAC address.

3.1.1.4 Add VLAN 3 to IST

ERS8600-1: Step 1 – Add VLAN 3 to IST MLT

```
ERS8600-1:5# config vlan 3 add-mlt 1
```

ERS8600-2: Step 1 – Add VLAN 3 to IST MLT

```
ERS8600-2:5# config vlan 3 add-mlt 1
```

3.1.1.5 SLT-129 to C3750-1

ERS8600-1: Step 1 – Create SLT-129

```
ERS8600-1:5# config ethernet 4/6 perform-tagging enable
ERS8600-1:5# config vlan 1 ports remove 4/6
ERS8600-1:5# config vlan 3 ports add 4/6
ERS8600-1:5# config ethernet 4/6 smlt 129 create
```

ERS8600-2: Step 1 – Create SLT-129

```
ERS8600-2:5# config ethernet 4/6 perform-tagging enable
ERS8600-2:5# config vlan 1 ports remove 4/6
ERS8600-2:5# config vlan 3 ports add 4/6
ERS8600-2:5# config ethernet 4/6 smlt 129 create
```

3.1.1.6 CP Limit – SMLT port members

CP Limit will be enabled on all the SLT Access port members. For this example, we will select the moderate recommendations for CP-Limit.

ERS8600-1: Step 1 – CP Limit for SLT Access ports

```
ERS8600-1:5# config ethernet 4/6 cp-limit enable multicast-limit 2500
broadcast-limit 2500
```

ERS8600-2: Step 1 – CP Limit for SLT Access ports

```
ERS8600-2:5# config ethernet 4/6 cp-limit enable multicast-limit 2500
broadcast-limit 2500
```

3.1.1.7 SLPP

For this example, we will pick ERS8600-1 as the primary switch for the switch cluster. SLPP will be enabled globally and on the SLT access port 4/6 on the switch cluster. On the SLT primary switch, we will set the SLPP packet-rx-threshold to 5 while on the SLT secondary switch, we will set the SLPP packet-rx-threshold to 50 for the access ports.

SLPP should only be enabled on the SMLT access or core ports and not on the IST port members.

ERS8600-1: Step 1 – Enable SLPP and in regards to the core port on the primary switch only, set the SLPP Rx-Threshold with a value of 5

```
ERS8600-1:5# config slpp add 3
ERS8600-1:5# config slpp operation enable
ERS8600-1:5# config ethernet 4/6 slpp packet-rx enable
ERS8600-1:5# config ethernet 4/6 slpp packet-rx-threshold 5
```

ERS8600-2: Step 1 – Enable SLPP
ERS8600-2:5# ***config slpp add 3***
ERS8600-2:5# ***config slpp operation enable***
ERS8600-2:5# ***ethernet 4/6 slpp packet-rx enable***
ERS8600-2:5# ***ethernet 4/6 slpp packet-rx-threshold 50***

3.1.1.8 Ext-CP Limit

Ext-CP Limit will be enable globally and on the SMLT access ports in the SMLT switch cluster. The SoftDown option will be used with the bandwidth utilization threshold set to 10%.

ERS8600-1: Step 1 – Enable EXT-CP-Limit
ERS8600-1:5# ***config sys ext-cp-limit extcplimit enable***
ERS8600-1:5# ***config sys ext-cp-limit max-ports-to-check 5***
ERS8600-1:5# ***config sys ext-cp-limit trap-level Normal***
ERS8600-1:5# ***config ethernet 4/6 ext-cp-limit SoftDown threshold-util-rate 10***
ERS8600-2: Step 2 – Enable EXT-CP-Limit
ERS8600-2:5# ***config sys ext-cp-limit extcplimit enable***
ERS8600-2:5# ***config sys ext-cp-limit max-ports-to-check 5***
ERS8600-2:5# ***config sys ext-cp-limit trap-level Normal***
ERS8600-2:5# ***config ethernet 4/6 ext-cp-limit SoftDown threshold-util-rate 10***

3.1.1.9 Discard Untagged Frames

It is recommended to enable discard untagged frames on all IST and SMLT ports.

ERS8600-1: Step 1 – Enable Discard Untagged Frames
ERS8600-1:5# ***config ethernet 2/1,3/1,4/6 untagged-frames-discard enable***
ERS8600-2: Step 1 – Enable Discard Untagged Frames
ERS8600-2:5# ***config ethernet 2/1,3/1,4/6 untagged-frames-discard enable***

3.1.2 Configuration - Edge Switch

Spanning Tree, PVST+, is enabled by default on a Cisco switch. Spanning Tree should be left enabled on all user ports and set for portfast, but disabled on the trunk EtherChannel ports. This can be accomplished on the Port-channel ports using the command 'spanning-tree bpdufilter enable' command.

The EtherChannel load balance method can be changed from the default setting by using the command *port-channel load-balance <dst-ip|dist-mac|src-dst-ip|src-dst-mac|src-ip|src-mac>.*

3.1.2.1 C3750

```
!
no aaa new-model
switch 1 provision ws-c3750g-24ts
system mtu routing 1500
vtp mode transparent
ip subnet-zero
ip routing
!
spanning-tree mode pvst
spanning-tree extend system-id
!
vlan 3
!
interface Port-channel1
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 3
 switchport mode trunk
  spanning-tree bpdufilter enable
!
interface GigabitEthernet1/0/3
 switchport access vlan 3
 switchport mode access
!
interface GigabitEthernet1/0/4
 switchport access vlan 3
 switchport mode access
!
interface GigabitEthernet1/0/23
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 3
 switchport mode trunk
 channel-group 1 mode on
!
interface GigabitEthernet1/0/24
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 3
 switchport mode trunk
 channel-group 1 mode on
!
```

```
no cdp run
!
```

If the EtherChannel is not coming up and you notice the Interface line protocol is down by using the *show interfaces gigabitEthernet <port>*, check to see if auto trunk encapsulation is enabled by issuing the command *show etherchannel detail*.

For example:

Problem: Interface line protocol is down

C3750-2#***show interfaces gigabitEthernet 1/0/24***
GigabitEthernet1/0/24 is up, line protocol is **down (suspended)**

Entering the following command to look at the EtherChannel details:

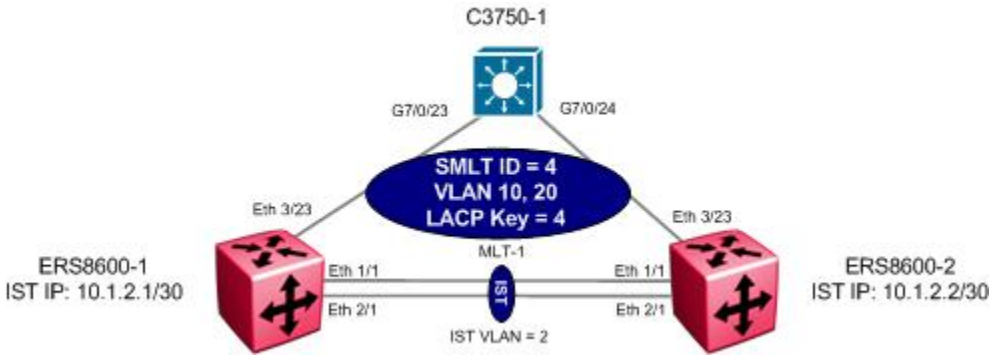
C3750-2# ***show etherchannel detail***
|
Probable reason: trunk encap of Gi1/0/24 is **auto**, Po1 is dot1q
Port-channels in the group:

This tells us we should disable auto trunk encapsulation on this interface

To fix this problem, enter the following commands:

C3750-2(config)#***interface range gigabitEthernet 1/0/23 - 24***
C3750-2(config-if-range)#***switchport trunk encapsulation dot1q***
C3750-2(config-if-range)#***do show int gig 1/0/23***
GigabitEthernet1/0/23 is up, line protocol is **up (connected)**

4. LACP Interoperability between a ERS8600 Switch Cluster and Cisco 3750



For this example, we will configure the following:

- A Link Aggregation Group (LAG) is configured between the ERS8600 triangle topology and a Cisco 3750.
  - VLANs 10 and 20 will be tagged across the LAG
  - LACP key = 4
  - MLT ID = 4
  - SMLT ID = 4
  - LACP Timeout = Long
- Use MLT 1, VLAN 2 for the IST with port members 1/1 and 2/1 using IP Subnet 10.1.2.0/30
- For this application to work, we will need to configure the SMLT System Identifier so that LACP global identifier is the same on both ERS8600-1 and ERS8600-2. Although you can use any MAC address, we will simple use the LACP identifier from ERS8600-1 to avoid any possible duplicate addresses.

Please note that Cisco does not support LACP short timer

Please note that in order for LACP to work all links must be operating at the same speed. If LACP does not come up, please check that the interfaces on both ERS8600 switches in the Switch Cluster are operating at the same speed. For example, if port 3/23 on ERS8600-1 is using a legacy module 8648TX and port 3/23 on ERS8600-2 is using an R-module 8648GTR, by default port 1/23 on ERS8600-1 will connect at 100Mbps and port 3/23 on ERS8600-2 will connect at 1000Mbps. To solve this issue, either set the speed to a fixed rate or set the auto-negotiation advertisements.

4.1 Configuration Steps

4.1.1 Switch Cluster Configuration

4.1.1.1 Create IST VLAN

Create VLAN 2 to be used by the Inter Switch Trunk (IST)

ERS8600-1: Step 1 – VLAN 2
ERS8600-1# ***config vlan 2 create byport 1 name IST***
ERS8600-2: Step 1 – Create 2
ERS8600-2# ***config vlan 2 create byport 1 name IST***

4.1.1.2 Create IST

Multilink Trunking 1 (MLT 1) will be used for the IST with port members 1/1 and 2/1. 802.1Q tagging will be enabled on all IST port members and Spanning Tree will be disabled on all IST port members by default. VLACP will be enabled on the IST trunk.

ERS8600-1: Step 1 – Create MLT 1 for IST
ERS8600-1# ***config mlt 1 create*** ERS8600-1# ***config mlt 1 name IST*** ERS8600-1# ***config mlt 1 add port 1/1,2/1*** ERS8600-1# ***config vlan 2 add-mlt 1***
ERS8600-2: Step 1 – Create MLT 1 for IST
ERS8600-2# ***config mlt 1 create*** ERS8600-2# ***config mlt 1 name IST*** ERS8600-2# ***config mlt 1 add port 1/1,2/1*** ERS8600-2# ***config vlan 2 add-mlt 1***
ERS8600-1: Step 2 – Create IST
ERS8600-1# ***config vlan 2 ip create 10.1.2.1/30*** ERS8600-1# ***config mlt 1 ist create ip 10.1.2.2 vlan-id 2*** ERS8600-1# ***config mlt 1 ist enable***
ERS8600-2: Step 2 – Create IST
ERS8600-2# ***config vlan 2 ip create 10.1.2.2/30*** ERS8600-2# ***config mlt 1 ist create ip 10.1.2.1 vlan-id 2***

```
ERS8600-2# config mlt 1 ist enable
```

ERS8600-1: Step 3 – Enable VLACP

```
ERS8600-1# config ethernet 1/1,2/1 vlacp macaddress 01:80:c2:00:00:0f
ERS8600-1# config ethernet 1/1,2/1 vlacp slow-periodic-time 10000
ERS8600-1# config ethernet 1/1,2/1 vlacp enable
ERS8600-1# config vlacp enable
```

ERS8600-2: Step 3 – Enable VLACP

```
ERS8600-2# config ethernet 1/1,2/1 vlacp macaddress 01:80:c2:00:00:0f
ERS8600-2# config ethernet 1/1,2/1 vlacp slow-periodic-time 10000
ERS8600-2# config ethernet 1/1,2/1 vlacp enable
ERS8600-2# config vlacp enable
```

It is recommended to use the reserved multicast MAC address of 01:80:c2:00:00:0f for the VLACP MAC address with a long timeout value of 5.

4.1.1.3 Create MLT with LACP Key

Create MLT 4 using key 4.

ERS8600-1: Step 1 – Create MLT 4 using LACP key 4

```
ERS8600-1# config mlt 4 create
ERS8600-1# config mlt 4 name c3750_lacp
ERS8600-1# config mlt 4 lacp key 4
ERS8600-1# config mlt 4 lacp enable
```

ERS8600-2: Step 1 – Create MLT 4 using LACP key 4

```
ERS8600-2# config mlt 4 create
ERS8600-2# config mlt 4 name c3750_lacp
ERS8600-2# config mlt 4 lacp key 4
ERS8600-2# config mlt 4 lacp enable
```

4.1.1.4 Create Access VLANs

ERS8600-1 Step 1 – Configure VLANs 10 and 20

```
ERS8600-1# config ethernet 3/23 perform-tagging enable
ERS8600-1# config vlan 1 ports remove 3/23
ERS8600-1# config vlan 10 create byport 1
ERS8600-1# config vlan 10 ports add 3/23
ERS8600-1# config vlan 20 create byport 1
ERS8600-1# config vlan 20 ports add 3/23
```

ERS8600-2 Step 1 – Configure VLANs 10 and 20

```
ERS8600-2# config ethernet 3/23 perform-tagging enable
ERS8600-2# config vlan 1 ports remove 3/23
ERS8600-2# config vlan 10 create byport 1
ERS8600-2# config vlan 10 ports add 3/23
ERS8600-2# config vlan 20 create byport 1
ERS8600-2# config vlan 20 ports add 3/23
```

4.1.1.5 Change fdb aging timer for VLAN 10 and 20

ERS8600-1 Step 1 – Change fdb aging timer for VLAN 10 and 20

```
ERS8600-1# config vlan 10 fdb-entry aging-time 21601
ERS8600-1# config vlan 20 fdb-entry aging-time 21601
```

ERS8600-2 Step 1 – Change fdb aging timer for VLAN 10 and 20

```
ERS8600-2# config vlan 10 fdb-entry aging-time 21601
ERS8600-2# config vlan 20 fdb-entry aging-time 21601
```

4.1.1.6 Configure LACP on Aggregation Ports

ERS8600-1 Step 1 – Enable LACP on each port and globally and add SMLT System ID of ERS8600-1

```
ERS8600-1# config ethernet 3/23 lacp enable
ERS8600-1# config ethernet 3/23 lacp key 4
ERS8600-1# config ethernet 3/23 lacp aggregation true
ERS8600-1# config lacp smlt-sys-id 00:01:81:28:84:00
ERS8600-1# config lacp enable
```

ERS8600-2 Step 1 – Enable LACP on each port and globally and add SMLT System ID of ERS8600-1
ERS8600-2# ***config ethernet 3/23 lacp enable***
ERS8600-2# ***config ethernet 3/23 lacp key 4***
ERS8600-2# ***config ethernet 3/23 lacp aggregation true***
ERS8600-2# ***config lacp smlt-sys-id 00:01:81:28:84:00***
ERS8600-2# ***config lacp enable***

To view the global LACP System ID, enter the following command

- ERS8600-1# ***show lacp info***

```
================================================
                        Lacp Global Information
================================================
              SystemId: 00:01:81:28:84:00
          SmltSystemId: 00:01:81:28:84:00
                  Lacp: enable
     system-priority: 32768
             timeout-admin: 3
 fast-periodic-time-admin: 1000
 slow-periodic-time-admin: 30000
     aggr-wait-time-admin: 2000
             timeout-oper: 3
 fast-periodic-time-oper: 1000
 slow-periodic-time-oper: 30000
     aggr-wait-time-oper: 2000
```

4.1.1.7 Create SMLT-4 to C3750

ERS8600-1: Step 1 – Create SMLT-4 and add VLANs 10 and 20 to the IST MLT 1
ERS8600-1# ***config mlt 4 smlt create smlt-id 4***
ERS8600-1# ***config vlan 10 add-mlt 1***
ERS8600-1# ***config vlan 20 add-mlt 1***
ERS8600-2: Step 1 – Create SMLT-4 and add VLANs 10 and 20 to the IST MLT 1
ERS8600-2# ***config mlt 4 smlt create smlt-id 4***
ERS8600-2# ***config vlan 10 add-mlt 1***
ERS8600-2# ***config vlan 20 add-mlt 1***

4.1.1.8 CP Limit – SMLT Port Members

CP Limit will be enabled on all the SMLT Access port members. For this example, we will select the moderate recommendations for CP-Limit.

ERS8600-1: Step 1 – CP Limit
ERS8600-1# ***config ethernet 3/23 cp-limit enable multicast-limit 2500 broadcast-limit 2500***
ERS8600-2: Step 1 – CP Limit
ERS8600-2# ***config ethernet 3/23 cp-limit enable multicast-limit 2500 broadcast-limit 2500***

4.1.1.9 SLPP

SLPP will be enabled globally and only on the SMLT access port 3/23 for VLAN 10 and 20. On the SMLT primary switch we will set the SLPP packet-rx-threshold to 5, while on the SMLT secondary switch we will set the SLPP packet-rx-threshold to 50. For this example, we will pick ERS8600-1 as the primary switch.

The recommended SLPP receive threshold value for the primary switch is 5 and 50 for the secondary switch in an SMLT cluster.

SLPP should only be enabled on the SMLT access ports and not on the IST port members.

ERS8600-1: Step 1 – Enable SLPP

```
ERS8600-1# config slpp add 10,20
ERS8600-1# config slpp operation enable
ERS8600-1# config ethernet 3/23 slpp packet-rx-threshold 5
ERS8600-1# config ethernet 3/23 slpp packet-rx enable
```

ERS8600-2: Step 1 – Enable SLPP

```
ERS8600-2# config slpp add 10,20
ERS8600-2# config slpp operation enable
ERS8600-2# config ethernet 3/23 slpp packet-rx-threshold 50
ERS8600-2# config ethernet 3/23 slpp packet-rx enable
```

4.1.1.10 Ext-CP Limit

Enable Extended CP-Limit globally with trap set to normal. Also enable Extended CP-Limit with SoftDown option on port 3/23. Since the port is a 100Mbps Ethernet interface, we will set the threshold to 80%.

ERS8600-1: Step 1 – Enable EXT-CP-Limit

```
ERS8600-1# config sys ext-cp-limit extcplimit enable
ERS8600-1# config sys ext-cp-limit max-ports-to-check 5
ERS8600-1# config sys ext-cp-limit trap-level Normal
ERS8600-1# config ethernet 3/23 ext-cp-limit SoftDown threshold-util-
rate 80
```

ERS8600-2: Step 1 – Enable EXT-CP-Limit

```
ERS8600-2# config sys ext-cp-limit extcplimit enable
ERS8600-2# config sys ext-cp-limit max-ports-to-check 5
```

```
ERS8600-2# config sys ext-cp-limit trap-level Normal
ERS8600-2# config ethernet 3/23 ext-cp-limit SoftDown threshold-util-
rate 80
```

4.1.1.11 Discard Untagged Frames

It is recommended to enable discard untagged frames on all IST and SMLT ports.

ERS8600-1: Step 1 – Enable Discard Untagged Frames
`ERS8600-1# config ethernet 3/23,1/1,2/1 untagged-frames-discard enable`
ERS8600-2: Step 1 – Enable Discard Untagged Frames
`ERS8600-2# config ethernet 3/23,1/1,2/1 untagged-frames-discard enable`

4.1.2 Cisco C3750 Configuration

The configuration configures port-channel 4 with the port-channel load-balance set for src-dst-mac. Note, when configuring port-channel on Cisco, you must configure this item first under the interface level prior to configuring the switchport settings. Also, all the access ports are configured for Spanning Tree portfast and multicast/broadcast rate limiting set to a limit of 10%.

```
!
hostname C3750-1
!
no aaa new-model
switch 1 provision ws-c3750g-24ts
system mtu routing 1500
vtp mode transparent
ip subnet-zero
ip routing
!
vlan 10
!
vlan 20
!
port-channel load-balance src-dst-mac
no file verify auto
spanning-tree mode pvst
spanning-tree extend system-id
!
!
interface Port-channel4
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 10,20
 switchport mode trunk
 switchport nonegotiate
 spanning-tree bpdufilter enable
!
!
interface GigabitEthernet7/0/3
 switchport access vlan 10
```

```
 switchport mode access
 storm-control broadcast level 10.00
 storm-control multicast level 10.00
 storm-control action trap
 spanning-tree portfast
!
interface GigabitEthernet7/0/4
 switchport access vlan 10
 switchport mode access
 storm-control broadcast level 10.00
 storm-control multicast level 10.00
 storm-control action trap
 spanning-tree portfast
!
interface GigabitEthernet7/0/5
 switchport access vlan 10
 switchport mode access
 storm-control broadcast level 10.00
 storm-control multicast level 10.00
 storm-control action trap
 spanning-tree portfast
!
interface GigabitEthernet7/0/6
!
interface GigabitEthernet7/0/7
 switchport access vlan 20
 switchport mode access
 storm-control broadcast level 10.00
 storm-control multicast level 10.00
 storm-control action trap
 spanning-tree portfast
!
interface GigabitEthernet7/0/8
 switchport access vlan 20
 switchport mode access
 storm-control broadcast level 10.00
 storm-control multicast level 10.00
 storm-control action trap
 spanning-tree portfast
!
interface GigabitEthernet7/0/9
 switchport access vlan 20
 switchport mode access
 storm-control broadcast level 10.00
 storm-control multicast level 10.00
 storm-control action trap
 spanning-tree portfast
!
interface GigabitEthernet7/0/23
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 10,20
 switchport mode trunk
 no cdp enable
 channel-group 4 mode active
 spanning-tree bpdufilter enable
!
interface GigabitEthernet7/0/24
```

```
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 10,20
 switchport mode trunk
 no cdp enable
 channel-group 4 mode active
 spanning-tree bpdufilter enable
!
no cdp run
!
```

In order for LACP to come up between an Avaya and Cisco switch, Cisco DTP (Dynamic Trunking Protocol) and native VLAN encapsulation should be disabled. Use the *show interface gigibitEthernet <port number> switchport* command to verify if DTP is enabled or not. If it is, enter the command *switchport nonegotiate* command at the port-channel and interface level. Also, disable tagging of the native VLAN (VLAN 1 by default) by issuing the CLI command *no vlan dot1q tag native*. In addition, the Cisco switch VTP (VLAN Trunking Protocol) should be set for transparent and CDP (Cisco Discovery Protocol) should be disabled.

4.2 Verification

4.2.1 SMLT Cluster

4.2.1.1 Verify MLT Configuration

Step 1 – Verify that the MLT instances are configured correctly and are functioning by issuing the following command:

```
ERS8600-1# show mlt info
```

Result:

```
================================================================================
                              Mlt Info
================================================================================
                            PORT    SVLAN  MLT   MLT        PORT         VLAN
MLTID IFINDEX NAME          TYPE    TYPE  ADMIN CURRENT    MEMBERS      IDS
--------------------------------------------------------------------------------
1   4096  IST           trunk   normal ist    ist      1/1,2/1          2 10 20
4   4099  c3750_lacp    trunk   normal smlt   smlt     3/23             10 20

                MULTICAST             DESIGNATED   LACP      LACP
MLTID IFINDEX   DISTRIBUTION  NT-STG  PORTS        ADMIN     OPER
--------------------------------------------------------------------------------
1      6144     enable       enable   null       disable   down
9      6152     disable      disable  null       enable    up
```

On each ERS8600 in the switch cluster verify the following information:

Option	Verify
PORT MEMBERS VLAN IDS	Verify that the VLAN ids assigned to the IST and SMLT MLT are correct: • IST MLT 1: Member of VLANs ***10, 20*** & ***2*** with port members ***1/1*** and ***2/1*** • MLT 4: Member of VLAN ***10 & 20*** with port member ***3/23***
MLT Admin MLT CURRENT	Displays as ***smlt*** or ***ist***. The value ***normal*** under MLT CURRENT indicates that the IST or SMLT is not operational.
PORT TYPE	Displays as ***trunk*** for all IST and SMLT ports and will pass tagged frames. The value ***access*** indicates that the port will pass untagged frames.
LACP ADMIN LACP OPER	LACP Admin should be displayed as ***enable*** and LACP OPER should be displayed as ***up***.

4.2.1.2 Verify LACP Operations

Step 1a – The following command is used to verify the global VLACP System ID on 8600-1

```
ERS8600-1# show lacp info
```

Result:

```
================================================
                          Lacp Global Information
================================================
               SystemId: 00:01:81:28:84:00
            SmltSystemId: 00:01:81:28:84:00
                    Lacp: enable
          system-priority: 32768
                  timeout-admin: 3
      fast-periodic-time-admin: 1000
      slow-periodic-time-admin: 30000
          aggr-wait-time-admin: 2000
                  timeout-oper: 3
      fast-periodic-time-oper: 1000
      slow-periodic-time-oper: 30000
          aggr-wait-time-oper: 2000
```

Step 1b – The following command is used to verify the global VLACP System ID on 8600-2

```
ERS8600-2# show lacp info
```

Result:

```
================================================
                          Lacp Global Information
================================================
              SystemId: 00:e0:7b:bc:20:00
          SmltSystemId: 00:01:81:28:84:00
                  Lacp: enable
     system-priority: 32768
             timeout-admin: 3
  fast-periodic-time-admin: 1000
  slow-periodic-time-admin: 30000
      aggr-wait-time-admin: 2000
             timeout-oper: 3
  fast-periodic-time-oper: 1000
  slow-periodic-time-oper: 30000
      aggr-wait-time-oper: 2000
```

Step 2 – Verify LACP operation on the SMLT ports

```
ERS8600-1# show port info lacp actor-admin port 3/23
```

Result:

```
================================================================================
                          Actor Admin
================================================================================
INDEX SYS   SYS               KEY   PORT  PORT  STATE
      PRIO  ID                          PRIO
--------------------------------------------------------------------------------
3/23  32768 00:01:81:28:84:00 4     0x56    32768 act        long aggr
```

Step 3 – Verify far end LACP operation on the SMLT ports

```
ERS8600-1# show port info lacp partner-oper port 3/23
```

Result:

```
================================================================================
                          Partner Operational
================================================================================
INDEX SYS   SYS               KEY   PORT  PORT  STATE
      PRIO  ID                          PRIO
--------------------------------------------------------------------------------
3/23  32768 00:0d:65:cc:09:00 4     0x17    32768 act        long aggr sync col dis
```

On ERS8600-2 in the switch cluster verify the following information:

Option	Verify
SystemId	In an SMLT configuration, both switches in an SMLT cluster must use the same System ID. You can use the System ID from either switch. This is to ensure proper LACP operation at the edge switch in case of a SMLT cluster switch failure. This will ensure the edge always sees the same ID from the LACP packets from both switch in the cluster in case if one of the switches should fail
SYS ID	For this example, the value of ***00:01:81:28:84:00*** should be displayed when using the LACP actor-admin command via either switch in the SMLT cluster and also via the Cisco switch. The LACP partner value will be the value send by the Cisco switch and verified by using the command "*show lacp sys-id'* on the C3750. For this example, the value is ***00:0d:65:cc:09:00.***
STATE	When the LACP aggregation is up and running the following states should display on local interfaces (Actor) and far end interfaces (Partner): • short OR long : Negotiated timer type • aggr : Aggregation enabled • sync : Port is synchronized with far end • col : Port is collecting frames (receiving traffic) • dis : Port is distributing frames (transmitting traffic)

4.2.2 C3750

4.2.2.1 Verify LACP Operations

Step 1 – The following command is used to view the global LACP System ID

```
C3750#show lacp sys-id
```

Result:

```
          32768, 000d.65cc.0900
```

Step 2 – The following command is used to verify the interface level LACP operation

```
C3750# show interfaces port-channel 4 etherchannel
```

Result:

```
          Port-channel4   (Primary aggregator)

          Age of the Port-channel   = 00d:02h:11m:03s
          Logical slot/port   = 10/4          Number of ports = 2
          HotStandBy port = null
          Port state          = Port-channel Ag-Inuse
          Protocol            =   LACP

          Ports in the Port-channel:

          Index   Load   Port     EC state        No of bits
          ------+------+------+------------------+-----------
            0     00     Gi7/0/23 Active             0
            0     00     Gi7/0/24 Active             0

          Time since last port bundled:    00d:00h:23m:40s    Gi7/0/24
          Time since last port Un-bundled: 00d:00h:25m:53s    Gi7/0/24
```

Step 3 – The following command is used to verify local LACP operation and key

```
C3750# show lacp 4 internal
```

Result:

```
          Flags:  S - Device is requesting Slow LACPDUs
                  F - Device is requesting Fast LACPDUs
                  A - Device is in Active mode       P - Device is in Passive mode

          Channel group 4
                                       LACP port     Admin     Oper    Port     Port
          Port      Flags   State      Priority      Key       Key     Number   State
          Gi7/0/23  SA      bndl       32768         0x4       0x4     0x14F    0x3D
          Gi7/0/24  SA      bndl       32768         0x4       0x4     0x150    0x3D
```

Step 4 – The following command is used to view the LACP partner values

```
C3750# show lacp 4 neighbor
```

Result:

```
          Flags:  S - Device is requesting Slow LACPDUs
                  F - Device is requesting Fast LACPDUs
                  A - Device is in Active mode       P - Device is in Passive mode

          Channel group 4 neighbors

          Partner's information:

                           LACP port                        Oper    Port     Port
          Port      Flags   Priority  Dev ID          Age    Key     Number   State
          Gi7/0/23  SA      32768     0001.8128.8400  17s    0x4     0x56     0x3D
          Gi7/0/24  SA      32768     0001.8128.8400  19s    0x4     0xD7     0x3D
```

5. Spanning Tree interoperability between Avaya and Cisco

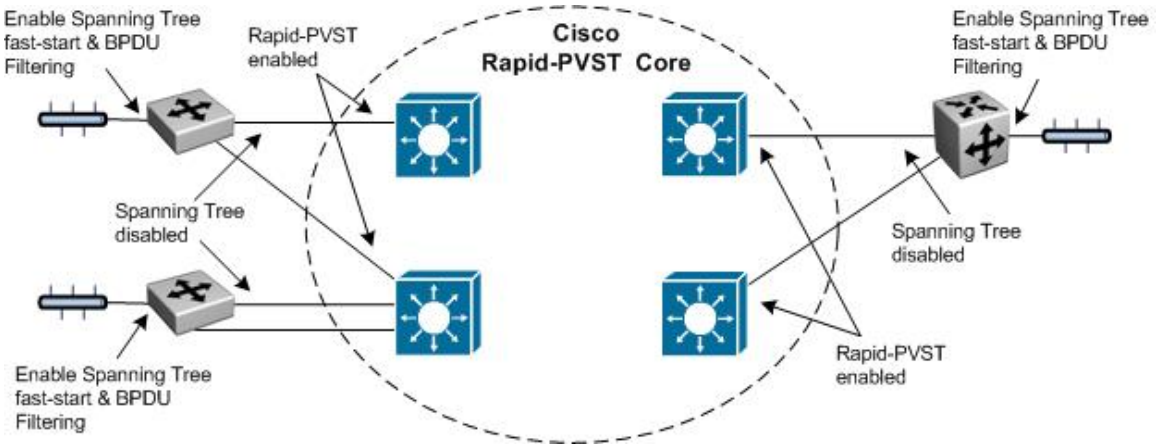
Cisco supports three Spanning Tree modes of operation, PVST+, Rapid-PVST, and MST. Of the three, only MST support standards based 802.1s which can interoperate with any of Avaya switches offered today. In regards to the ERS8600 only, it also supports the older PVST+ Spanning Tree mode of operation.

By default, Cisco comes enabled with Rapid-PVST. This proprietary protocol combines the functionality of RSTP with PVST creating an RSTP (802.1w) instance per VLAN. The Cisco implementation also defines a concept of "native" VLAN whereby BPDUs generated for the native vlan are standard compliant (802.1w for Rapid-PVST) whereas BPDUs generated for all other VLANs are modified with a Cisco multicast MAC address and are q-tagged with the vlan-id they belong to, thus rendering them incompatible with the standard.

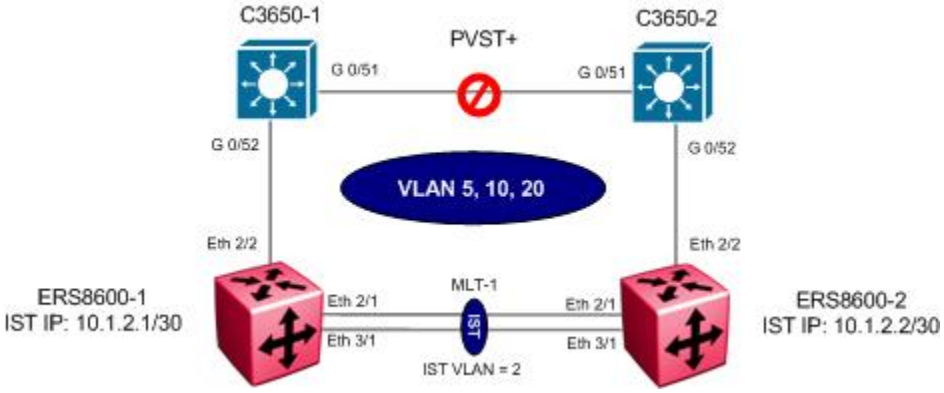
It is therefore highly recommended to avoid Cisco's proprietary Rapid-PVST and enable instead MST on Cisco and MSTP on the Avaya switches.

It is still possible to make the Rapid-PVST protocol interoperate with Avaya standards based 802.1w (RSTP) by letting Cisco's native VLAN instance interoperate with Avaya single RSTP instance and allowing the other Cisco Spanning Tree instances to be flooded transparently across the Avaya switches. The native VLAN by default is set to VLAN 1. This method will work providing the native RSTP instance on an Avaya switch never blocks any interface. Hence, it can get a little difficult setting up a network.

If the Avaya switches are being deployed as edge switches onto a Cisco Core using Rapid-PVST an even better approach is to simply disable Spanning Tree on the Avaya switch uplink ports to the Cisco core and let the Cisco core take care of any loops. This is illustrated in Figure 2. The proprietary BPDUs generated by the Cisco Core will simply be re-flooded in the vlan by the Avaya edge switch and thus one of the Cisco's will block one of the uplinks. Note that in this design only non-native VLANs must be tagged on the uplinks to the Avaya switches. The native VLAN on the Cisco Core needs to be set to some unused vlan; for instance left configured at default VLAN 1 which should never be used.



5.1 Cisco PVST+ to Avaya Switch Cluster Configuration Example



For this configuration example, two Cisco 3650 switches are used at the access layer and configured with PVST+ to connect to an ERS8600 Switch Cluster. The Cisco Switches could be seen as the Distribution Layer of a large Network or just as a couple of cascaded switches at the edge of a network where configuring Etherchannel is not possible because of the Cascade implementation.

This type of configuration is useful when transitioning from a Spanning Tree Solution (older L2 deployments) to an Avaya Switch Cluster Solution.

At this particular point in time, there is no elegant way to implement any flavor of Spanning Tree across a Switch Cluster Core. By design, the IST in a switch Cluster does not allow BPDU packets between the core switches.

In this particular configuration, we take advantage of the fact that PVST+ BPDUs are used in every VLAN except for the Default VLAN. PVST+ BPDUs uses a L2 Multicast Destination Address (01:00:0C:CC:CC:CD) which in turn make things simple when leaving via a tagged interface (802.1q) as the BPDUs are tagged with their corresponding VLAN ID.

The individual switches of an Avaya Switch Cluster do not recognize these Multicast addresses as BPDUs so they just flood these multicast frames on their appropriate VLANs (even across the IST).

This means that the Avaya Switch Cluster is completely transparent to PVST+ and the two Cisco Switches will go through their normal Spanning tree process of preventing a loop by eventually blocking a link. Depending on PVST+ configuration of the Cisco Switches, the blocked link will either be the link between the 2 Cisco Switches (as shown in the diagram) or one of the Cisco-Avaya links.

The configuration is very simple especially when considering that PVST+ is the default on Cisco Switches.

Note that in this scenario, the Avaya Switch Cluster is transparently passing the PVST+ BPDUs across the IST therefore allowing the Cisco Switches to detect a loop and eventually preventing any problem arising from such a loop by blocking a port on the specific VLAN. The Switch Cluster is not participating in any way to Spanning tree and therefore could never become a root bridge or ever block a link to prevent a loop from occurring nor will it fast age MAC addresses following a PVST+ active topology change.

In summary, we will configure the following:

- IST configured as normal using VLAN 2, MLT 1 with port members 2/1 and 3/1, and IP subnet 10.1.2.0/30
- Three VLANs will be configured with management VLAN 5 and VLANs 10 and 20 for end user access
- Since the Cisco switches will be using PVST+ to manage the dual homing to the Avaya Core, the Switch Cluster will not need to have a SMLT or an SLT link setup for the Cisco Switches. The only requirement is to have the correct VLANs set on the individual ports on each Core switch and for the VLAN to be crossing the IST of course.
- It will be possible of course to setup SMLT/SLT to other distributions or edges that support link Aggregation back to our switch Cluster.

The use of the default VLAN (VLAN 1) is not recommended in most cases, but in this particular scenario even more so. Even in PVST+ mode, the Default VLAN always sends its BPDUs to the IEEE STP MAC address (0180.c200.0000) in untagged frames. This could vary from inconvenient, when the BPDUs are dropped by the receiving port on the Switch Cluster, to potentially dangerous as there could be no way of detecting a loop on the Default VLAN. For that reason alone, the Default VLAN should not be used in this scenario.

In addition, it is also recommended not to use the Native VLAN setting on trunk ports used to interconnect to a Switch Cluster. The Native VLAN on a Trunk port (802.1Q) would be sent out as untagged frames and, according to Cisco documentation, the native VLAN would also send out BPDUs to the IEEE STP MAC address (0180.c200.0000) in untagged frames.

To keep things simple, do not use the Default VLAN (VLAN 1) and do not use the Native Vlan option on the trunk ports connecting to the Switch Cluster.

5.1.1 Configuation

5.1.1.1 Create VLANs

The following port based VLANs will be configured on the SMLT Switch cluster

- VLAN 2 to be used by the Inter Switch Trunk (IST)
- VLAN 5 to be used as Management VLAN for this Network
- VLAN 10 and 20 to be used as User VLANs out to the Cisco Switches

ERS8600-1: Step 1 – Create VLANs
ERS8600-1:5# ***config vlan 2 create byport 1 name IST***
ERS8600-1:5# ***config vlan 5 create byport 1 name Mgmt***
ERS8600-1:5# ***config vlan 10 create byport 1 name Data10***
ERS8600-1:5# ***config vlan 20 create byport 1 name Data20***
ERS8600-2: Step 1 – Create VLANs
ERS8600-2:5# ***config vlan 2 create byport 1 name IST***
ERS8600-2:5# ***config vlan 5 create byport 1 name Mgmt***
ERS8600-2:5# ***config vlan 10 create byport 1 name Data10***
ERS8600-2:5# ***config vlan 20 create byport 1 name Data20***

5.1.1.2 Change fdb aging timer for Management and User VLANs

ERS8600-1: Step 1 – Change fdb aging timer for VLAN 5,10 and 20
ERS8600-1:5# ***config vlan 5 fdb-entry aging-time 21601***
ERS8600-1:5# ***config vlan 10 fdb-entry aging-time 21601***
ERS8600-1:5# ***config vlan 20 fdb-entry aging-time 21601***
ERS8600-2: Step 1 – Change fdb aging timer for VLAN 5,10 and 20
ERS8600-2:5# ***config vlan 5 fdb-entry aging-time 21601***
ERS8600-2:5# ***config vlan 10 fdb-entry aging-time 21601***
ERS8600-2:5# ***config vlan 20 fdb-entry aging-time 21601***

5.1.1.3 Create IST

Multilink Trunking 1 (MLT 1) will be used for the IST with 802.1Q tagged port members 2/1 and 3/1. Spanning Tree will be disabled on all IST port members by default. We will enable VLACP on the IST port members.

It is recommended to use the reserved multicast MAC address of 01:80:c2:00:00:0f for the VLACP MAC address.

ERS8600-1: Step 1 – Create MLT 1 for IST

```
ERS8600-1:5# config mlt 1 create
ERS8600-1:5# config mlt 1 name IST
ERS8600-1:5# config mlt 1 add port 2/1,3/1
ERS8600-1:5# config vlan 2 add-mlt 1
```

ERS8600-2: Step 1 – Create MLT 1 for IST

```
ERS8600-2:5# config mlt 1 create
ERS8600-2:5# config mlt 1 name IST
ERS8600-2:5# config mlt 1 add port 2/1,3/1
ERS8600-2:5# config vlan 2 add-mlt 1
```

ERS8600-1: Step 2 – Create IST

```
ERS8600-1:5# config vlan 2 ip create 10.1.2.1/30
ERS8600-1:5# config mlt 1 ist create ip 10.1.2.2 vlan-id 2
ERS8600-1:5# config mlt 1 ist enable
```

ERS8600-2: Step 2 – Create IST

```
ERS8600-2:5# config vlan 2 ip create 10.1.2.2/30
ERS8600-2:5# config mlt 1 ist create ip 10.1.2.1 vlan-id 2
ERS8600-2:5# config mlt 1 ist enable
```

ERS8600-1: Step 3 – Enable VLACP

```
ERS8600-1:5# config ethernet 2/1,3/1 vlacp macaddress 01:80:c2:00:00:0f
ERS8600-1:5# config ethernet 2/1,3/1 vlacp slow-periodic-time 10000
ERS8600-1:5# config ethernet 2/1,3/1 vlacp enable
ERS8600-1:5# config vlacp enable
```

ERS8600-2: Step 3 – Enable VLACP

```
ERS8600-2:5# ethernet 2/1,3/1 vlacp macaddress 01:80:c2:00:00:0f
ERS8600-2:5# ethernet 2/1,3/1 vlacp slow-periodic-time 10000
ERS8600-2:5# ethernet 2/1,3/1 vlacp enable
ERS8600-2:5# config vlacp enable
```

5.1.1.4 Add Management and User VLANs to IST

ERS8600-1: Step 1 – Add VLANs 5, 10, and 20 to IST MLT

```
ERS8600-1:5# config vlan 5 add-mlt 1
ERS8600-1:5# config vlan 10 add-mlt 1
ERS8600-1:5# config vlan 20 add-mlt 1
```

ERS8600-2: Step 1 – Add VLANs 5, 10, and 20 to IST MLT

```
ERS8600-2:5# config vlan 5 add-mlt 1
ERS8600-2:5# config vlan 10 add-mlt 1
ERS8600-2:5# config vlan 20 add-mlt 1
```

5.1.1.5 Add VLAN port members to C3650 switch

ERS8600-1: Step 1 – Add VLAN port members

```
ERS8600-1:5# config ethernet 2/2 perform-tagging enable
ERS8600-1:5# config vlan 1 ports remove 2/2
ERS8600-1:5# config vlan 5 ports add 2/2
ERS8600-1:5# config vlan 10 ports add 2/2
ERS8600-1:5# config vlan 20 ports add 2/2
```

ERS8600-2: Step 1 – Add VLAN port members

```
ERS8600-2:5# config ethernet 2/2 perform-tagging enable
ERS8600-2:5# config vlan 1 ports remove 2/2
ERS8600-2:5# config vlan 5 ports add 2/2
ERS8600-2:5# config vlan 10 ports add 2/2
ERS8600-2:5# config vlan 20 ports add 2/2
```

5.1.1.6 CP Limit – on ports used for inter-switch connections

CP Limit will be enabled on all ports used for inter-switch connections. For this example, we will select the moderate recommendations for CP-Limit.

ERS8600-1: Step 1 – CP Limit
ERS8600-1:5# ***config ethernet 2/2 cp-limit enable multicast-limit 2500 broadcast-limit 2500***
ERS8600-2: Step 1 – CP Limit
ERS8600-2:5# ***config ethernet 2/2 cp-limit enable multicast-limit 2500 broadcast-limit 2500***

5.1.1.7 SLPP

To be extra safe, we will configure SLPP on the ports connecting to the Cisco Switches on the VLANs used on the Cisco Switches. This is to make sure that if a configuration error occurs on the Cisco Switches, the Avaya Switch Cluster will still be able to detect and prevent a loop from occurring

For this example, we will select ERS8600-1 as the primary switch for the switch cluster. SLPP will be enabled globally and on the ports used to connect to the Cisco Switches. On the primary switch, we will set the SLPP packet-rx-threshold to 5 while on the secondary switch; we will set the SLPP packet-rx-threshold to 50.

SLPP should not be enabled on the IST port members.

ERS8600-1: Step 1 – Enable SLPP
ERS8600-1:5# ***config slpp add 5,10,20***
ERS8600-1:5# ***config slpp operation enable***
ERS8600-1:5# ***config ethernet 2/2 slpp packet-rx enable***
ERS8600-1:5# ***config ethernet 2/2 slpp packet-rx-threshold 5***
ERS8600-2: Step 1 – Enable SLPP
ERS8600-2:5# ***config slpp add 5,10,20***
ERS8600-2:5# ***config slpp operation enable***
ERS8600-2:5# ***ethernet 2/2 slpp packet-rx enable***
ERS8600-2:5# ***ethernet 2/2 slpp packet-rx-threshold 50***

5.1.1.8 Ext-CP Limit

Ext-CP Limit will be enabled globally and on the ports used for inter-switch connections. The SoftDown option will be used with the bandwidth utilization threshold set to 10%.

ERS8600-1: Step 1 – Enable EXT-CP-Limit
ERS8600-1:5# ***config sys ext-cp-limit extcplimit enable***
ERS8600-1:5# ***config sys ext-cp-limit max-ports-to-check 5***
ERS8600-1:5# ***config sys ext-cp-limit trap-level Normal***
ERS8600-1:5# ***config ethernet 2/2 ext-cp-limit SoftDown threshold-util-rate 10***
ERS8600-2: Step 2 – Enable EXT-CP-Limit
ERS8600-2:5# ***config sys ext-cp-limit extcplimit enable***
ERS8600-2:5# ***config sys ext-cp-limit max-ports-to-check 5***
ERS8600-2:5# ***config sys ext-cp-limit trap-level Normal***
ERS8600-2:5# ***config ethernet 2/2 ext-cp-limit SoftDown threshold-util-rate 10***

5.1.1.9 Discard Untagged Frames

It is recommended to enable discard untagged frames on all IST and inter-switch connecting ports

ERS8600-1: Step 1 – Enable Discard Untagged Frames
ERS8600-1:5# ***config ethernet 2/1,3/1,2/2 untagged-frames-discard enable***
ERS8600-2: Step 1 – Enable Discard Untagged Frames
ERS8600-2:5# ***config ethernet 2/1,3/1,2/2 untagged-frames-discard enable***

5.1.2 Configuration – Cisco Edge Switches

The Configuration of the two Cisco switches will be very basic considering that PVST+ on the Cisco Switches is enabled by default

The two switches will be basically identical except for the Management IP address the Configurations are shown below in summarized form.

5.1.2.1 C3650-1 Configuration

```
!
version 12.2

no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Switch
!
!
no aaa new-model
system mtu routing 1500
ip subnet-zero
!
!
!
!
no file verify auto
!
spanning-tree mode pvst
spanning-tree extend system-id
!
vlan internal allocation policy ascending
!
interface GigabitEthernet0/1
 switchport access vlan 10
 spanning-tree portfast
!

.
.
.

interface GigabitEthernet0/24
 switchport access vlan 10
 spanning-tree portfast
!
interface GigabitEthernet0/25
 switchport access vlan 20
 spanning-tree portfast
```

```
!

.
.

interface GigabitEthernet0/48
 switchport access vlan 20
 spanning-tree portfast
!
interface GigabitEthernet0/49
!
interface GigabitEthernet0/50
!
interface GigabitEthernet0/51
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 5,10,20
 switchport mode trunk
!
interface GigabitEthernet0/52
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 5,10,20
 switchport mode trunk
!
interface Vlan1
 no ip address
 shutdown
!
interface Vlan5
 ip address 10.1.5.11 255.255.255.0
!
ip default-gateway 10.1.5.1
ip classless
ip http server
!
!
control-plane
!
!
line con 0
line vty 0 4
 login
line vty 5 15
 login
!
end
```

5.1.2.2 C3650-2 Configuration

```
!
version 12.2
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Switch
!
!
no aaa new-model
system mtu routing 1500
ip subnet-zero
!
!
!
!
no file verify auto
!
spanning-tree mode pvst
spanning-tree extend system-id
!
vlan internal allocation policy ascending
!
interface GigabitEthernet0/1
 switchport access vlan 10
 spanning-tree portfast
!

.
.
.

interface GigabitEthernet0/24
 switchport access vlan 10
 spanning-tree portfast
!
interface GigabitEthernet0/25
 switchport access vlan 20
 spanning-tree portfast
!

.
.

interface GigabitEthernet0/48
 switchport access vlan 20
 spanning-tree portfast
!
interface GigabitEthernet0/49
```

```
!
interface GigabitEthernet0/50
!
interface GigabitEthernet0/51
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 5,10,20
 switchport mode trunk
!
interface GigabitEthernet0/52
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 5,10,20
 switchport mode trunk
!
interface Vlan1
 no ip address
         shutdown
!
interface Vlan5
 ip address 10.1.5.12 255.255.255.0
!
interface Vlan10
 no ip address
 spanning-tree port-priority 16
!
ip default-gateway 10.1.5.1
ip classless
ip http server
!
!
control-plane
!
!
line con 0
line vty 0 4
 login
line vty 5 15
 login
!

End
```

5.1.3 Verify Operations

5.1.4 Cisco

To verify the Cisco Switches in this configuration are working as expected, enter the CLI command *show spanning-tree* on of each switch and ensure that each VLAN has a blocking port on the switch which is not the Root Bridge for that VLAN.

Step 1 – Enter the CLI command *show spanning-tree* to view the operational state for each interface on all VLANs on C3650-1

```
C3650-1#show spanning-tree
```

Result:

```
        VLAN0005
          Spanning tree enabled protocol ieee
          Root ID     Priority    32773
                      Address     0011.939e.8000
                      Cost        4
                      Port        52 (GigabitEthernet0/52)
                      Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

          Bridge ID   Priority    32773  (priority 32768 sys-id-ext 5)
                      Address     0022.0c40.cb80
                      Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
                      Aging Time 300

        Interface        Role Sts Cost      Prio.Nbr Type
        ---------------- ---- --- --------- -------- --------------------------------
        Gi0/51           Altn BLK 19        128.51   P2p
        Gi0/52           Root FWD 4         128.52   P2p


        VLAN0010
          Spanning tree enabled protocol ieee
          Root ID     Priority    32778
                      Address     0011.939e.8000
                      Cost        4
                      Port        52 (GigabitEthernet0/52)
                      Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

          Bridge ID   Priority    32778  (priority 32768 sys-id-ext 10)
                      Address     0022.0c40.cb80
                      Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
                      Aging Time 300

        Interface        Role Sts Cost      Prio.Nbr Type
        ---------------- ---- --- --------- -------- --------------------------------
        Gi0/51           Altn BLK 19        128.51   P2p
        Gi0/52           Root FWD 4         128.52   P2p

        VLAN0020
          Spanning tree enabled protocol ieee
          Root ID     Priority    4116
                      Address     0011.939e.8000
                      Cost        4
                      Port        52 (GigabitEthernet0/52)
                      Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

          Bridge ID   Priority    32788  (priority 32768 sys-id-ext 20)
```

```
                Address     0022.0c40.cb80
                Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
                Aging Time 300

        Interface        Role Sts Cost      Prio.Nbr Type
        ---------------- ---- --- --------- -------- --------------------------------
        Gi0/51           Altn BLK 19        128.51   P2p
        Gi0/52           Root FWD 4         128.52   P2p
```

Step 1 – Enter the CLI command *show spanning-tree* to view the operational state for each interface on all VLANs on C3650-2

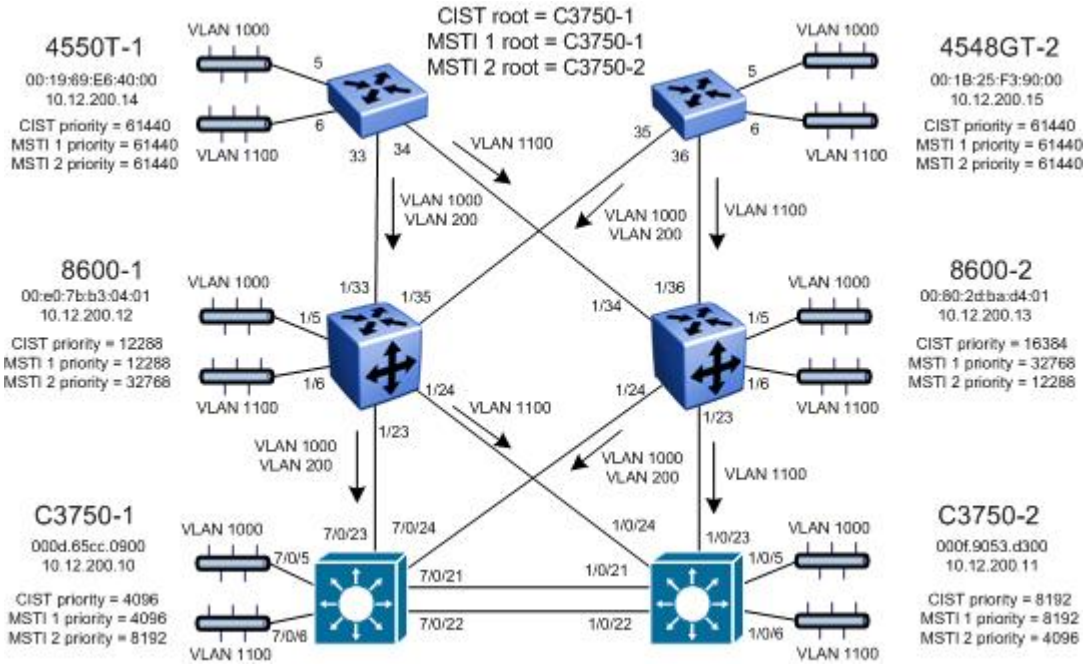
```
C3650-2#show spanning-tree
```

Result:

```
        VLAN0005
          Spanning tree enabled protocol ieee
          Root ID    Priority    32773
                     Address     0011.939e.8000
                     This bridge is the root
                     Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

          Bridge ID  Priority    32773  (priority 32768 sys-id-ext 5)
                     Address     0011.939e.8000
                     Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
                     Aging Time 300

        Interface        Role Sts Cost      Prio.Nbr Type
        ---------------- ---- --- --------- -------- --------------------------------
        Gi0/51           Desg FWD 19        128.51   P2p
        Gi0/52           Desg FWD 19        128.52   P2p


        VLAN0010
          Spanning tree enabled protocol ieee
          Root ID    Priority    32778
                     Address     0011.939e.8000
                     This bridge is the root
                     Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

          Bridge ID  Priority    32778  (priority 32768 sys-id-ext 10)
                     Address     0011.939e.8000
                     Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
                     Aging Time 300

        Interface        Role Sts Cost      Prio.Nbr Type
        ---------------- ---- --- --------- -------- --------------------------------
        Gi0/51           Desg FWD 19        128.51   P2p
        Gi0/52           Desg FWD 19        128.52   P2p


        VLAN0020
          Spanning tree enabled protocol ieee
          Root ID    Priority    32788
                     Address     0011.939e.8000
                     This bridge is the root
                     Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

          Bridge ID  Priority    32788  (priority 32768 sys-id-ext 20)
                     Address     0011.939e.8000
                     Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
                     Aging Time 300
```

```
Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Gi0/51           Desg FWD 19        128.51   P2p
Gi0/52           Desg FWD 19        128.52   P2p
```

5.2 MSTP Configuration Example – One Region



For this configuration example, we will configure the following:

- All switches are configured in the same region named *region1* and using *revision 1*
- C3750-1 will be configured so that it will become the CIST Root by configuring the lowest CIST Priority of 4096.
- C3750-2 will be configured so that it will become the CIST backup by configuring the next highest CIST Priority of 8192.
- Three VLANs will be configured, VLAN 200 for management and VLANs 1000 and 1100 for end user access
- For the management VLAN 200, we will configure a management IP address as shown in the diagram above – for this example, no routes are configured for the management as it is a simple Layer 2 network
- We will configure two MSTI instances; MSTI 1 for VLAN 200 and 1000, and MSTI 2 for VLAN 1100 to load balance traffic as illustrated in the diagram above
- C3750-1 will be configured as the root bridge for MSTI 1 and backup root for MSTI 2
- C3750-2 will be configured as the root bridge for MSTI 2 and backup root for MSTI 1
- 8600-1 will be configured with a CIST and MSTI 1 priority of 12288 so that will become both CIST and MSTI 1 root if both C3750-1 and C3750-2 should fail
- 8600-2 will be configured with a CIST priority of 16384 so that it will become CIST root if C3750-1, C3750-2, and 8600-1 should fail
- 8600-2 will be configured with a MSTI 2 priority of 12288 so that it will become MSTI 2 root if both C3750-1 and C3750-2 should fail

After all the switches have been configured using the above settings, the traffic flow for each MSTI instance and CIST should be as that shown in the following diagrams.

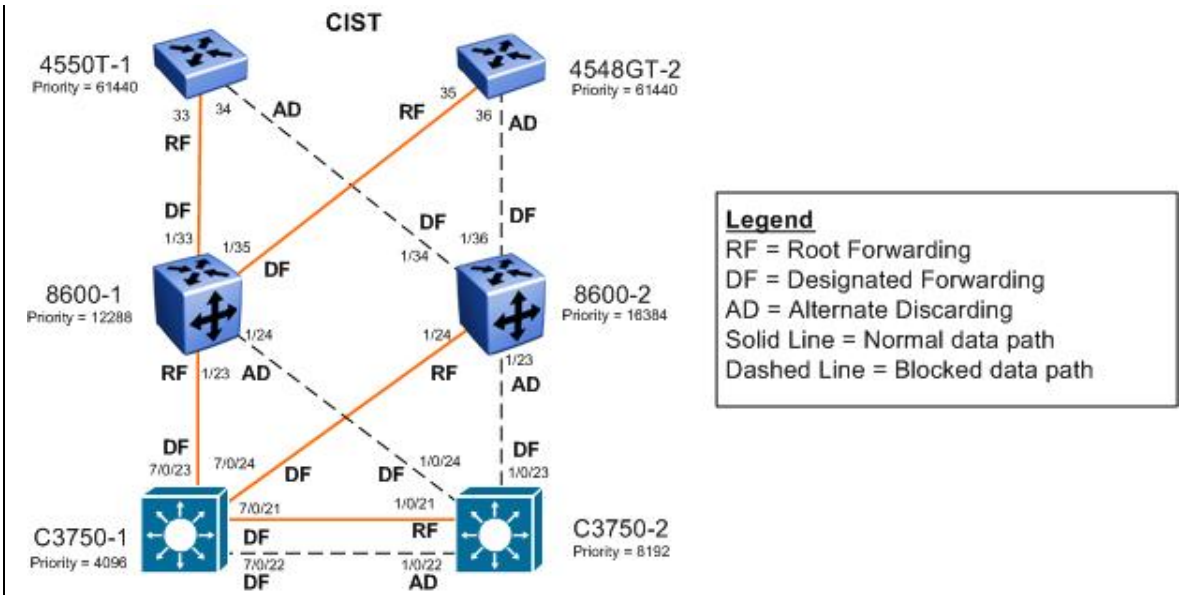


Figure 1: MSTP Example with One Region – CIST Instance 0 Data Flow

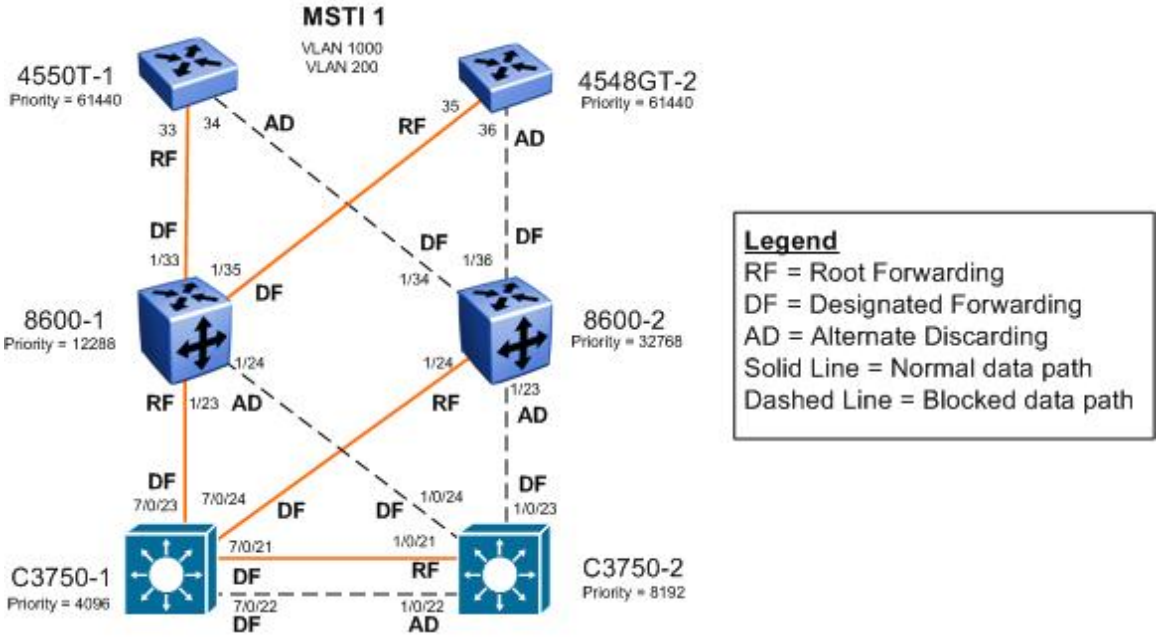


Figure 2: MSTP Example with One Region – MSTI 1 Data Flow

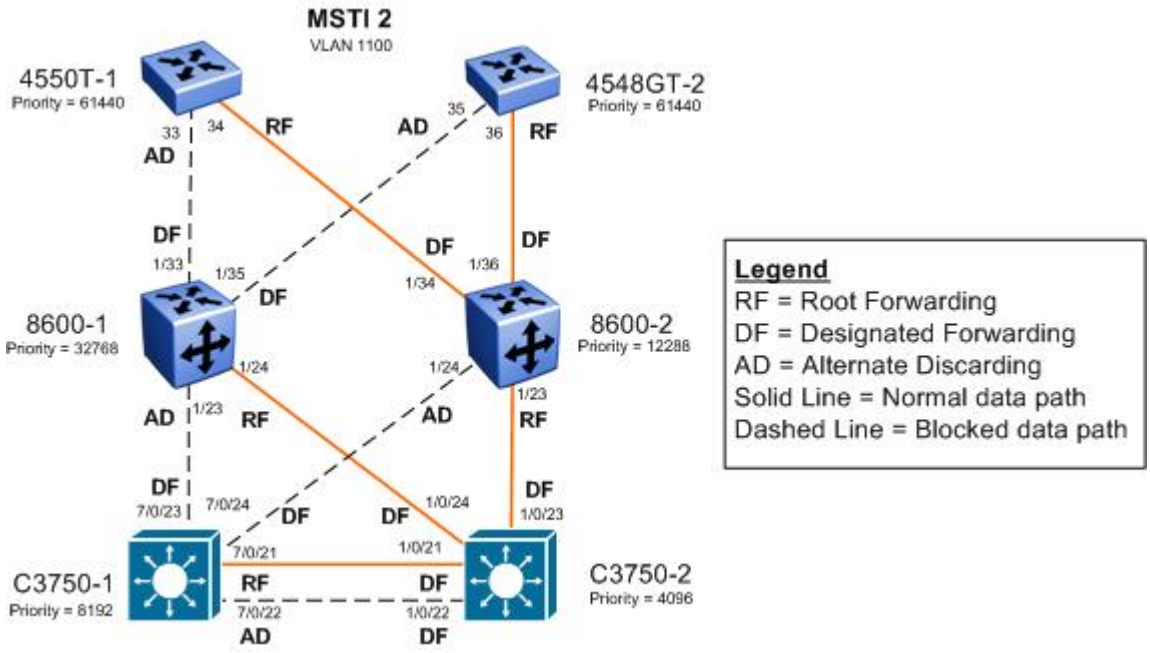


Figure 3: MSTP Example with One Region – MSTI 2 Data Flow

5.2.1 Configuration

In this configuration example, NNCLI will be used on 8600-1 while CLI will be used on 8600-2.

5.2.1.1 Set Spanning Tree Mode to MSTP

ERS8600-1: Step 1 – Set the bootconfig Spanning Tree mode to MSTP
ERS-8610:5(config)#***boot config flags spanning-tree-mode mstp***
ERS-8610:5(config)#***save bootconfig***
ERS-8610:5(config)#***boot –y***
ERS-8610:5(config)#***sys name ERS8600-1***
ERS8600-2: Step 1 – Set the bootconfig Spanning Tree mode to MSTP
ERS-8610:5# ***config bootconfig flags spanning-tree-mode mstp***
ERS-8610:5# ***save bootconfig***
ERS-8610:5# ***boot –y***
ERS-8610:5# ***config sys set name ERS8600-2***

ERS4550T-1: Step 1 – Set Spanning Tree Operation mode to MSTP
4550T(config)#***spanning-tree op-mode mstp*** 4550T(config)#***write memory*** 4550T(config)#***boot*** Reboot the unit(s) (y/n) ? ***y*** 4550T(config)#***snmp-server name 4550T-1*** 4550T-1(config)#***banner disabled***
ERS4528GT-2: Step 1 – Set Spanning Tree Operation mode to MSTP
4548GT#(config)#***spanning-tree op-mode mstp*** 4548GT#(config)#***write memory*** 4548GT#(config)#***boot*** Reboot the unit(s) (y/n) ? ***y*** 4548GT(config)#***snmp-server name 4548GT-2*** 4548GT(config)#***banner disabled***
C3750-1: Step 1 – Set Spanning Tree mode to MSTP
C3750(config)#***spanning-tree mode mst*** C3750(config)#***hostname C3750-1***
C3750-2: Step 1 – Set Spanning Tree mode to MSTP
C3750(config)#***spanning-tree mode mst*** C3750(config)#***hostname C3750-2***

5.2.1.2 Create VLANs

ERS8600-1: Step 1 – Create VLANs 200, 1000, and 1100 and add port members
ERS8600-1:5(config)#***vlan create 200 name mgmt type port-mstprstp 1*** ERS8600-1:5(config)# ***vlan create 1000 type port-mstprstp 1*** ERS8600-1:5(config)#***vlan create 1100 type port-mstprstp 2*** ERS8600-1:5(config)#***vlan ports 1/23,1/24,1/33,1/35 tagging tagAll*** ERS8600-1:5(config)#***vlan members remove 1 1/5,1/6,1/23,1/24,1/33,1/35*** ERS8600-1:5(config)#***vlan members add 200 1/23,1/24,1/33,1/35*** ERS8600-1:5(config)#***vlan members add 1000 1/5,1/23,1/24,1/33,1/35*** ERS8600-1:5(config)#***vlan members add 1100 1/6,1/23,1/24,1/33,1/35***

ERS8600-2: Step 1 – Create VLANs 200, 1000, and 1100 and add port members

```
ERS8600-2:5# config vlan 200 create byport-mstprstp 1 name mgmt
ERS8600-2:5# config vlan 1000 create byport-mstprstp 1
ERS8600-2:5# config vlan 1100 create byport-mstprstp 2
ERS8600-2:5# config ethernet 1/23,1/24,1/34,1/36 perform-tagging enable
ERS8600-2:5# config vlan 1 ports remove 1/5,1/6,1/23,1/24,1/34,1/36
ERS8600-2:5# config vlan 200 ports add 1/23,1/24,1/34,1/36
ERS8600-2:5# config vlan 1000 ports add 1/5,1/23,1/24,1/34,1/36
ERS8600-2:5# config vlan 1100 ports add 1/6,1/23,1/24,1/34,1/36
```

ERS4550T-1: Step 1 – Create VLANs 200, 1000, and 1100 and add port members

```
4550T-1(config)#spanning-tree mstp msti 1
4550T-1(config)#spanning-tree mstp msti 2
4550T-1(config)#vlan create 200 name mgmt type port msti 1
4550T-1(config)#vlan create 1000 type port msti 1
4550T-1(config)#vlan create 1100 type port msti 2
4550T-1(config)#vlan configcontrol automatic
4550T-1(config)#vlan ports 33,34 tagging tagall
4550T-1(config)#vlan members add 200 33,34
4550T-1(config)#vlan members add 1000 5,33,34
4550T-1(config)#vlan members add 1100 6,33,34
4550T-1(config)#vlan members remove 1 5,6,33,34
```

ERS4528GT-2: Step 1 – Create VLANs 200, 1000, and 1100 and add port members

```
4548GT-2(config)#spanning-tree mstp msti 1
4548GT-2(config)#spanning-tree mstp msti 2
4548GT-2(config)#vlan create 200 name mgmt type port msti 1
4548GT-2(config)#vlan create 1000 type port msti 1
4548GT-2(config)#vlan create 1100 type port msti 2
4548GT-2(config)#vlan configcontrol automatic
4548GT-2(config)#vlan ports 35,36 tagging tagall
4548GT-2(config)#vlan members add 200 35,36
4548GT-2(config)#vlan members add 1000 5,35,36
4548GT-2(config)#vlan members add 1100 6,35,36
4548GT-2(config)#vlan members remove 1 5,6,35,36
```

C3750-1: Step 1 – Create VLANs 200, 1000, and 1100 and add port members

```
C3750-1(config)#vtp mode transparent
C3750-1(config)#vlan 200
C3750-1(config-vlan)#name mgmt
C3750-1(config-vlan)#vlan 1000
C3750-1(config-vlan)#vlan 1100
C3750-1(config-vlan)#exit
C3750-1(config)#interface range gigabitEthernet 7/0/21 – 24
C3750-1(config-if-range)#switchport trunk encapsulation dot1q
C3750-1(config-if-range)#switchport mode trunk
C3750-1(config-if-range)#switchport trunk allowed vlan 200,1000,1100
C3750-1(config-if-range)#exit
C3750-1(config)#interface gigabitEthernet 7/0/5
C3750-1(config-if)#switchport mode access
C3750-1(config-if)#switchport access vlan 1000
C3750-1(config-if)#exit
C3750-1(config)#interface gigabitEthernet 7/0/6
C3750-1(config-if)#switchport mode access
C3750-1(config-if)#switchport access vlan 1100
C3750-1(config-if)#exit
```

C3750-2: Step 1 – Create VLANs 200, 1000, and 1100 and add port members

```
C3750-2(config)#vtp mode transparent
C3750-2(config)#vlan 200
C3750-2(config-vlan)#name mgmt
C3750-2(config-vlan)#vlan 1000
C3750-2(config-vlan)#vlan 1100
C3750-2(config-vlan)#exit
C3750-2(config)#interface range gigabitEthernet 1/0/21 – 24
C3750-2(config-if-range)#switchport trunk encapsulation dot1q
C3750-2(config-if-range)#switchport mode trunk
C3750-2(config-if-range)#switchport trunk allowed vlan 200,1000,1100
C3750-2(config-if-range)#exit
C3750-2(config)#interface gigabitEthernet 1/0/5
C3750-2(config-if)#switchport mode access
```

```
C3750-2(config-if)#switchport access vlan 1000
C3750-2(config-if)#exit
C3750-2(config)#interface gigabitEthernet 1/0/6
C3750-2(config-if)#switchport mode access
C3750-2(config-if)#switchport access vlan 1100
C3750-2(config-if)#exit
```

On the ERS4500, if a port is removed from the default VLAN (VLAN 1) prior to adding the port as a port member to a different VLAN, STP participation is disabled for this port. Hence, at an interface level, Spanning Tree Port must be re-enabled for each removed port. This inconvenience can be avoided if the port or ports are removed from the default VLAN after the port or ports are added to a different VLAN.

5.2.1.3 MSTP Configuration

ERS8600-1: Step 1 – Add MSTP configuration

```
ERS8600-1:5(config)#spanning-tree mstp region region-name region1 region-version 1
ERS8600-1:5(config)#spanning-tree mstp priority 12288
ERS8600-1:5(config)#spanning-tree mstp msti 1 priority 12288
```

ERS8600-2: Step 1 – Add MSTP configuration

```
ERS8600-2:5# config mstp region name region1
ERS8600-2:5# config mstp region revision 1
ERS8600-2:5# config mstp cist priority 16384
ERS8600-2:5# config mstp msti 2 priority 12288
```

ERS4550T-1: Step 1 – Add MSTP configuration

```
4550T-1(config)#spanning-tree mstp region region-name region1 region-version 1
4550T-1(config)#spanning-tree mstp msti 1 enable
4550T-1(config)#spanning-tree mstp msti 2 enable
4550T-1(config)#spanning-tree mstp priority f000
4550T-1(config)#spanning-tree mstp msti 1 priority f000
4550T-1(config)#spanning-tree mstp msti 2 priority f000
```

ERS4528GT-2: Step 1 – Add MSTP configuration

```
4548GT-2(config)#spanning-tree mstp region region-name region1 region-version 1
4548GT-2(config)#spanning-tree mstp msti 1 enable
4548GT-2(config)#spanning-tree mstp msti 2 enable
```

```
4548GT-2(config)#spanning-tree mstp priority f000
4548GT-2(config)#spanning-tree mstp msti 1 priority f000
4548GT-2(config)#spanning-tree mstp msti 2 priority f000
```

C3750-1: Step 1 – Add MSTP configuration

```
C3750-1(config)#spanning-tree mst configuration
C3750-1(config-mst)#name region1
C3750-1(config-mst)#revision 1
C3750-1(config-mst)#instance 1 vlan 200,1000
C3750-1(config-mst)# instance 2 vlan 1100
C3750-1(config-mst)#exit
C3750-1(config)#spanning-tree mst 0,1 priority 4096
C3750-1(config)#spanning-tree mst 2 priority 8192
```

C3750-2: Step 1 – Add MSTP configuration

```
C3750-2(config)#spanning-tree mst configuration
C3750-2(config-mst)#name region1
C3750-2(config-mst)#revision 1
C3750-2(config-mst)#instance 1 vlan 200,1000
C3750-2(config-mst)#instance 2 vlan 1100
C3750-2(config-mst)#exit
C3750-2(config)#spanning-tree mst 0,1 priority 8192
C3750-2(config)#spanning-tree mst 2 priority 4096
```

ERS8600-1: Step 2 – Configure access ports as Edge Port

```
ERS8600-1:5(config)#interface fastEthernet 1/5,1/6
ERS8600-1:5(config-if)#spanning-tree mstp edge-port true
ERS8600-1:5(config-if)#exit
```

ERS8600-2: Step 2 – Configure access ports as Edge Port

```
ERS8600-2:5# config ethernet 1/5,1/6 mstp cist edge-port true
```

ERS4550T-1: Step 2 – Configure access ports as Edge Port

```
4550T-1(config)#interface fastEthernet 5,6
4550T-1(config-if)#spanning-tree mstp edge-port true
4550T-1(config-if)#exit
```

ERS4528GT-2: Step 2 – Configure access ports as Edge Port
4548GT-2(config)#***interface fastEthernet 5,6***
4548GT-2(config-if)#***spanning-tree mstp edge-port true***
4548GT-2(config-if)#***exit***

Note that Cisco does not have a MSTP Edge Port configurable parameter, but, it is activated with the portfast command.

5.2.1.4 Management VLAN Configuration

ERS8600-1: Step 2 – Add management IP address and add port members
ERS8600-1:5(config)#***interface vlan 200***
ERS8600-1:5(config-if)#***ip address 10.12.200.12 255.255.255.0***
ERS8600-1:5(config-if)#***exit***
ERS8600-2: Step 2 – Add management IP address
ERS8600-2:5# ***config vlan 200 ip create 10.12.200.13/24***
ERS4550T-1: Step 2 – Add management IP address
4550T-1(config)#***vlan mgmt 200***
4550T-1(config)#***ip address 10.12.200.14 netmask 255.255.255.0***
ERS4528GT-2: Step 2 – Add management IP address
4548GT-2(config)#***vlan mgmt 200***
4548GT-2(config)#***ip address 10.12.200.15 netmask 255.255.255.0***
C3750-1: Step 2 – Add management IP address
C3750-1(config)#***interface vlan 200***
C3750-1(config-if)#***ip address 10.12.200.10 255.255.255.0***
C3750-1(config-if)#***exit***
C3750-2: Step 2 – Add management IP address
C3750-2(config)#***interface vlan 200***
C3750-2(config-if)#***ip address 10.12.200.11 255.255.255.0***
C3750-2(config-if)#***exit***

5.2.2 Verify Operations

5.2.2.1 Verify CIST Root

Step 1 – Verify that the CIST root and CIST Regional root is C3750-1:

```
ERS8600-1:5#show spanning-tree mstp status
```

Result:

```
================================================================
                                MSTP Status
================================================================
----------------------------------------------------------------
Bridge Address                : 00:e0:7b:b3:04:01
Cist Root                     : 10:00:00:0d:65:cc:09:00
Cist Regional Root            : 10:00:00:0d:65:cc:09:00
Cist Root Port                : 1/23
Cist Root Cost                : 0
Cist Regional Root Cost       : 200000
Cist Instance Vlan Mapped     : 1-199,201-999,1001-1024
Cist Instance Vlan Mapped2k   : 1025-1099,1101-2048
Cist Instance Vlan Mapped3k   : 2049-3072
Cist Instance Vlan Mapped4k   : 3073-4094
Cist Max Age                  : 20 seconds
Cist Forward Delay            : 15 seconds
```

```
ERS8600-2:5# show mstp status
```

Result:

```
================================================================
                                MSTP Status
================================================================
----------------------------------------------------------------
Bridge Address                : 00:80:2d:ba:d4:01
Cist Root                     : 10:00:00:0d:65:cc:09:00
Cist Regional Root            : 10:00:00:0d:65:cc:09:00
Cist Root Port                : 1/24
Cist Root Cost                : 0
Cist Regional Root Cost       : 200000
Cist Instance Vlan Mapped     : 1-199,201-999,1001-1024
Cist Instance Vlan Mapped2k   : 1025-1099,1101-2048
Cist Instance Vlan Mapped3k   : 2049-3072
Cist Instance Vlan Mapped4k   : 3073-4094
Cist Max Age                  : 20 seconds
Cist Forward Delay            : 15 seconds
```

```
4550T-1#show spanning-tree mstp status
```

Result:

```
Bridge Address:          00:19:69:E6:40:00
Cist Root:               10:00:00:0D:65:CC:09:00
Cist Regional Root:      10:00:00:0D:65:CC:09:00
Cist Root Port:          33
Cist Root Cost:          0
Cist Regional Root Cost: 400000
Cist Max Age:            20 seconds
Cist Forward Delay:      15 seconds
```

C3750-2#***show spanning-tree mst 0***

Result:

```
#####  MST0    vlans mapped:   1-199,201-999,1001-1099,1101-4094
Bridge         address 000f.9053.d300  priority      8192  (8192 sysid 0)
Root           address 000d.65cc.0900  priority      4096  (4096 sysid 0)
               port    Gi1/0/21        path cost     0
Regional Root  address 000d.65cc.0900  priority      4096  (4096 sysid 0)
                                       internal cost 20000     rem hops 19
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
Gi1/0/21         Root FWD 20000     128.21   P2p
Gi1/0/22         Altn BLK 20000     128.22   P2p
Gi1/0/23         Desg FWD 200000    128.23   P2p
Gi1/0/24         Desg FWD 200000    128.24   P2p
```

On each switch, verify the following information:

Option	Verify
CIST Root	Verify that the CIST root bridge is C3750-1 whose address is ***000d.65cc.0900***.
CIST Regional Root	Verify that all switches recognize the same CIST Regional root; this indicates that all switches are in the same MST Region; in this case the CIST Regional root matches the CIST Root
Root Port	Verify that under normal operations that the correct port to the CIST root is used: • 8600-1: Port ***1/23*** • 8600-2: Port ***1/24*** • 4550T-1: Port ***33*** • 4548GT-2: Port ***35*** • C3750-2: Either port ***1/0/21*** or ***1/0/22***

5.2.2.2 Verify MSTI 1 Root and port forwarding state

Step 1 – Verify that the MSTI 1 root is C3750-1:

```
ERS8600-1:5#show spanning-tree mstp msti config 1
```

Result:

```
============================================================
                              MSTP Instance Status
============================================================
Instance Id                     : 1
Msti Bridge Regional Root       : 10:00:00:0d:65:cc:09:00
Msti Bridge Priority            : 32768 (0x8000)
Msti Root Cost                  : 200000
Msti Root Port                  : 1/23
Msti Instance Vlan Mapped       : 200,1000
Msti Instance Vlan Mapped2k     :
Msti Instance Vlan Mapped3k     :
Msti Instance Vlan Mapped4k     :
```

```
ERS8600-2:5# show mstp instance 1
```

Result:

```
============================================================
                              MSTP Instance Status
============================================================
Instance Id                     : 1
Msti Bridge Regional Root       : 10:00:00:0d:65:cc:09:00
Msti Bridge Priority            : 32768 (0x8000)
Msti Root Cost                  : 200000
Msti Root Port                  : 1/24
Msti Instance Vlan Mapped       : 200,1000
Msti Instance Vlan Mapped2k     :
Msti Instance Vlan Mapped3k     :
Msti Instance Vlan Mapped4k     :
```

```
4550T-1# show spanning-tree mstp msti config 1
```

Result:

```
Msti Bridge Regional Root:  10:00:00:0D:65:CC:09:00
Msti Bridge Priority (hex): F000
Msti Root Cost:             400000
Msti Root Port:             33
Msti State:                 Enabled

VLAN members
------ ------ ------ ------ ------ ------ ------ ------
200    1000
```

```
4548GT-2#show spanning-tree mstp msti config 1
```

Result:

```
Msti Bridge Regional Root:  10:00:00:0D:65:CC:09:00
Msti Bridge Priority (hex): F000
Msti Root Cost:             400000
Msti Root Port:             35
Msti State:                 Enabled
```

```
VLAN members
------ ------ ------ ------ ------ ------ ------ ------
200    1000
```

C3750-1#***show spanning-tree mst 1***

Result:

```
##### MST1    vlans mapped:   200,1000
Bridge        address 000d.65cc.0900  priority      4097  (4096 sysid 1)
Root          this switch for MST1

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- ----------------------------
Gi7/0/21         Desg FWD 20000     128.345  P2p
Gi7/0/22         Desg FWD 20000     128.346  P2p
Gi7/0/23         Desg FWD 200000    128.347  P2p
Gi7/0/24         Desg FWD 200000    128.348  P2p
```

C3750-2#***show spanning-tree mst 1***

Result:

```
##### MST1    vlans mapped:   200,1000
Bridge        address 000f.9053.d300  priority      8193  (8192 sysid 1)
Root          address 000d.65cc.0900  priority      4097  (4096 sysid 1)
              port    Gi1/0/21        cost          20000     rem hops 19

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Gi1/0/21         Root FWD 20000     128.21   P2p
Gi1/0/22         Altn BLK 20000     128.22   P2p
Gi1/0/23         Desg FWD 200000    128.23   P2p
Gi1/0/24         Desg FWD 200000    128.24   P2p
```

Step 2 – Verify that MSTI 1 port state:

ERS8600-1:5#***show spanning-tree mstp msti port role 1/23,1/24,1/33,1/35***

Result:

```
================================================================================
                          MSTI Port Roles and States
================================================================================

Port-Index   Instance-Id   Port-Role   Port-State   Port-STP     Port-Oper
--------------------------------------------------------------------------------
1/23         1             Root        Forwarding      Enabled        Enabled
1/23         2             Alternate   Discarding      Enabled        Enabled
1/24         1             Alternate   Discarding      Enabled        Enabled
1/24         2             Root        Forwarding      Enabled        Enabled
1/33         1             Designated  Forwarding      Enabled        Enabled
1/33         2             Designated  Forwarding      Enabled        Enabled
1/35         1             Designated  Forwarding      Enabled        Enabled
1/35         2             Designated  Forwarding      Enabled        Enabled
```

ERS8600-2:5# ***show port info mstp mstirole port 1/23,1/24,1/34,1/36***

Result:

```
================================================================================
                          MSTI Port Roles and States
```

```
================================================================================

Port-Index   Instance-Id   Port-Role   Port-State   Port-STP     Port-Oper
--------------------------------------------------------------------------------
1/23         1             Alternate   Discarding      Enabled        Enabled
1/23         2             Root        Forwarding      Enabled        Enabled
1/24         1             Root        Forwarding      Enabled        Enabled
1/24         2             Alternate   Discarding      Enabled        Enabled
1/34         1             Designated  Forwarding      Enabled        Enabled
1/34         2             Designated  Forwarding      Enabled        Enabled
1/36         1             Designated  Forwarding      Enabled        Enabled
1/36         2             Designated  Forwarding      Enabled        Enabled
```

4550T-1#***show spanning-tree mstp msti port role 1***

Result:

```
Port     Role       State     STP Status  Oper Status
----  ----------  ----------  ----------  -----------
5     Disabled    Discarding  Enabled     Disabled
33    Root        Forwarding  Enabled     Enabled
34    Alternate   Discarding  Enabled     Enabled
```

4548GT-2#***show spanning-tree mstp msti port role 1***

Result:

```
Port     Role       State     STP Status  Oper Status
----  ----------  ----------  ----------  -----------
5     Disabled    Discarding  Enabled     Disabled
35    Root        Forwarding  Enabled     Enabled
36    Alternate   Discarding  Enabled     Enabled
```

On each switch, verify the following information:

Option	Verify
Root	Verify that the MIST 1 root bridge is C3750-1 whose address is ***000d.65cc.0900***.
MSTI 1 Root Port	Verify that under normal operations that the correct port to the MIST 1 root bridge is used: • 8600-1: Port ***1/23*** • 8600-2: Port ***1/24*** • 4550T-1: Port ***33*** • 4548GT-2: Port ***35*** • C3750-2: Either port ***1/0/21*** or ***1/0/22***
VLANs	Verify that only VLANs 200 and 1000 are configured for MSTI 1. If not, the MSTI instance will not come up on the corresponding switch.

5.2.2.3 Verify MSTI 2 Root and port forwarding state

Step 1 – Verify that the MSTI 2 root is C3750-2:

```
ERS8600-1:5#show spanning-tree mstp msti config 2
```

Result:

```
============================================================
                            MSTP Instance Status
============================================================
Instance Id                     : 2
Msti Bridge Regional Root       : 10:00:00:0f:90:53:d3:00
Msti Bridge Priority            : 32768 (0x8000)
Msti Root Cost                  : 200000
Msti Root Port                  : 1/24
Msti Instance Vlan Mapped       :
Msti Instance Vlan Mapped2k     : 1100
Msti Instance Vlan Mapped3k     :
Msti Instance Vlan Mapped4k     :
```

```
ERS8600-2:5# show mstp instance 2
```

Result:

```
============================================================
                            MSTP Instance Status
============================================================
Instance Id                     : 2
Msti Bridge Regional Root       : 10:00:00:0f:90:53:d3:00
Msti Bridge Priority            : 12288 (0x3000)
Msti Root Cost                  : 200000
Msti Root Port                  : 1/23
Msti Instance Vlan Mapped       :
Msti Instance Vlan Mapped2k     : 1100
Msti Instance Vlan Mapped3k     :
Msti Instance Vlan Mapped4k     :
```

```
4550T-1#show spanning-tree mstp msti config 2
```

Result:

```
Msti Bridge Regional Root:  10:00:00:0F:90:53:D3:00
Msti Bridge Priority (hex): F000
Msti Root Cost:             400000
Msti Root Port:             34
Msti State:                 Enabled

VLAN members
------ ------ ------ ------ ------ ------ ------ ------
1100
```

```
4548GT-2#show spanning-tree mstp msti config 2
```

Result:

```
Msti Bridge Regional Root:  10:00:00:0F:90:53:D3:00
Msti Bridge Priority (hex): F000
Msti Root Cost:             400000
Msti Root Port:             36
Msti State:                 Enabled
```

```
VLAN members
------ ------ ------ ------ ------ ------ ------ ------
1100
```

C3750-1#***show spanning-tree mst 2***

Result:

```
##### MST2    vlans mapped:   1100
Bridge        address 000d.65cc.0900  priority      28674 (28672 sysid 2)
Root          address 000f.9053.d300  priority      4098  (4096 sysid 2)
              port    Gi7/0/21        cost          20000     rem hops 19

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Gi7/0/21         Root FWD 20000     128.345  P2p
Gi7/0/22         Altn BLK 20000     128.346  P2p
Gi7/0/23         Desg FWD 200000    128.347  P2p
Gi7/0/24         Desg FWD 200000    128.348  P2p
```

C3750-2#***show spanning-tree mst 2***

Result:

```
##### MST2    vlans mapped:   1100
Bridge        address 000f.9053.d300  priority      4098  (4096 sysid 2)
Root          this switch for MST2

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------
Gi1/0/21         Desg FWD 20000     128.21   P2p
Gi1/0/22         Desg FWD 20000     128.22   P2p
Gi1/0/23         Desg FWD 200000    128.23   P2p
Gi1/0/24         Desg FWD 200000    128.24   P2p
```

Step 2 – Verify that the MSTI 2 port state:

ERS8600-1:5#***show spanning-tree mstp msti port role 1/23,1/24,1/33,1/35***

Result:

```
================================================================================
                          MSTI Port Roles and States
================================================================================

Port-Index   Instance-Id   Port-Role   Port-State   Port-STP     Port-Oper
--------------------------------------------------------------------------------
1/23         1             Root        Forwarding      Enabled        Enabled
1/23         2             Alternate   Discarding      Enabled        Enabled
1/24         1             Alternate   Discarding      Enabled        Enabled
1/24         2             Root        Forwarding      Enabled        Enabled
1/33         1             Designated  Forwarding      Enabled        Enabled
1/33         2             Designated  Forwarding      Enabled        Enabled
1/35         1             Designated  Forwarding      Enabled        Enabled
1/35         2             Designated  Forwarding      Enabled        Enabled
```

ERS8600-2:5# ***show port info mstp mstirole port 1/23,1/24,1/34,1/36***

Result:

```
================================================================================
                          MSTI Port Roles and States
```

```
================================================================================

Port-Index   Instance-Id   Port-Role   Port-State   Port-STP     Port-Oper
--------------------------------------------------------------------------------
1/23         1             Alternate   Discarding      Enabled        Enabled
1/23         2             Root        Forwarding      Enabled        Enabled
1/24         1             Root        Forwarding      Enabled        Enabled
1/24         2             Alternate   Discarding      Enabled        Enabled
1/34         1             Designated  Forwarding      Enabled        Enabled
1/34         2             Designated  Forwarding      Enabled        Enabled
1/36         1             Designated  Forwarding      Enabled        Enabled
1/36         2             Designated  Forwarding      Enabled        Enabled
```

4550T-1#***show spanning-tree mstp msti port role 2***

Result:

```
Port     Role       State     STP Status  Oper Status
----  ----------  ----------  ----------  -----------
6     Disabled    Discarding  Enabled     Disabled
33    Alternate   Discarding  Enabled     Enabled
34    Root        Forwarding  Enabled     Enabled
```

4548GT-2#***show spanning-tree mstp msti port role 2***

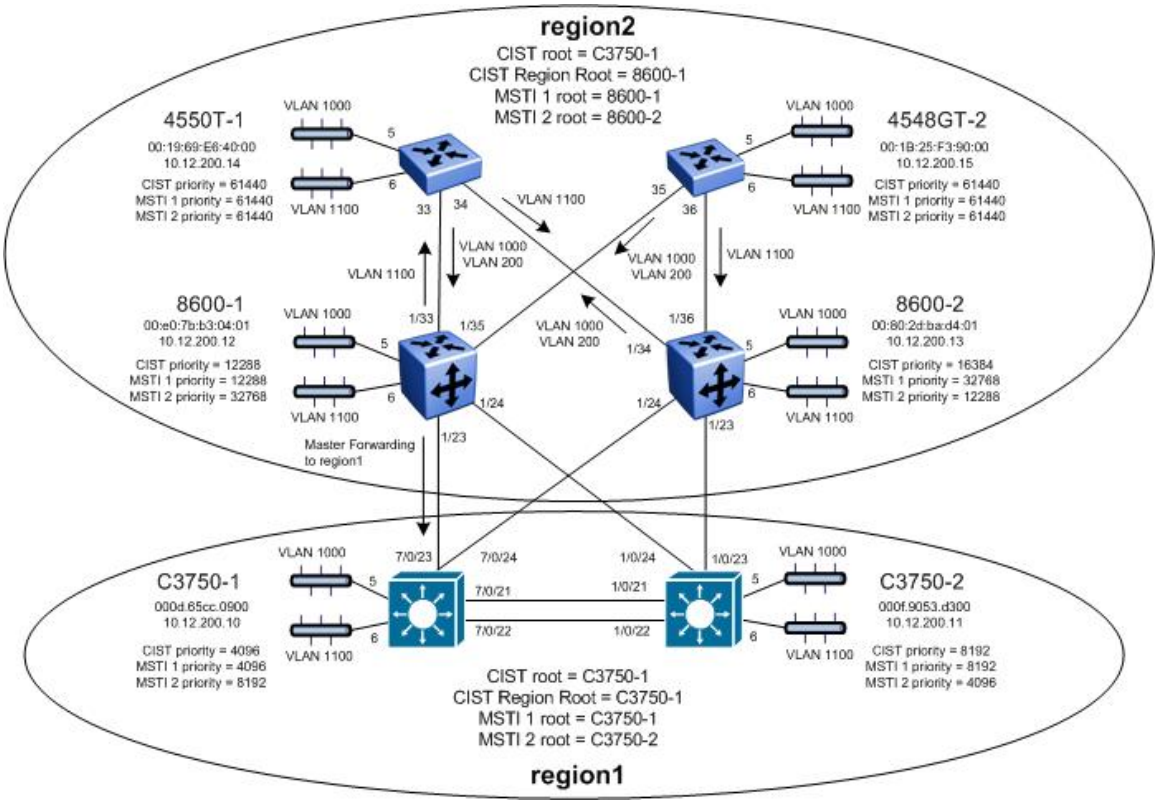
Result:

```
Port     Role       State     STP Status  Oper Status
----  ----------  ----------  ----------  -----------
6     Disabled    Discarding  Enabled     Disabled
35    Alternate   Discarding  Enabled     Enabled
36    Root        Forwarding  Enabled     Enabled
```

On each switch, verify the following information:

Option	Verify
Root	Verify that the MIST 2 root bridge is C3750-2 whose address is ***000f.9053.d300***.
MSTI 2 Root Port	Verify that under normal operations that the correct port to the MIST 2 root bridge is used: • 8600-1: Port ***1/24*** • 8600-2: Port ***1/23*** • 4550T-1: Port ***34*** • 4548GT-2: Port ***36*** • C3750-2: Either port ***1/0/21*** or ***1/0/22***
VLANs	Verify that only VLAN 1100 is configured for MSTI 2. If not, the MSTI instance will not come up on the corresponding switch.

5.3 MSTP Configuration Example - Two Regions



In this configuration example, we take the exact same configuration used in Section 3 with the exception of creating a second region with switches 8600-1, 8600-2, 4550T-1, and 4548GT-2. All the same CIST and MSTI priorities will be used. The only configuration change will be the MSTP region name as illustrated in the diagram above. This will result in only one forwarding port between the two regions via 8600-1 port 1/23. In the region named “region2”, 8600-1 will become the root bridge for MSTI 1 while 8600-2 will become the root bridge for MSTI 2. 8600-1 will also become the CIST Regional Root for the region named “region2” based on the priority settings configured.

After all the switches have been configured using the above settings, the traffic flow for each MSTI instance should as that shown in the following diagrams.

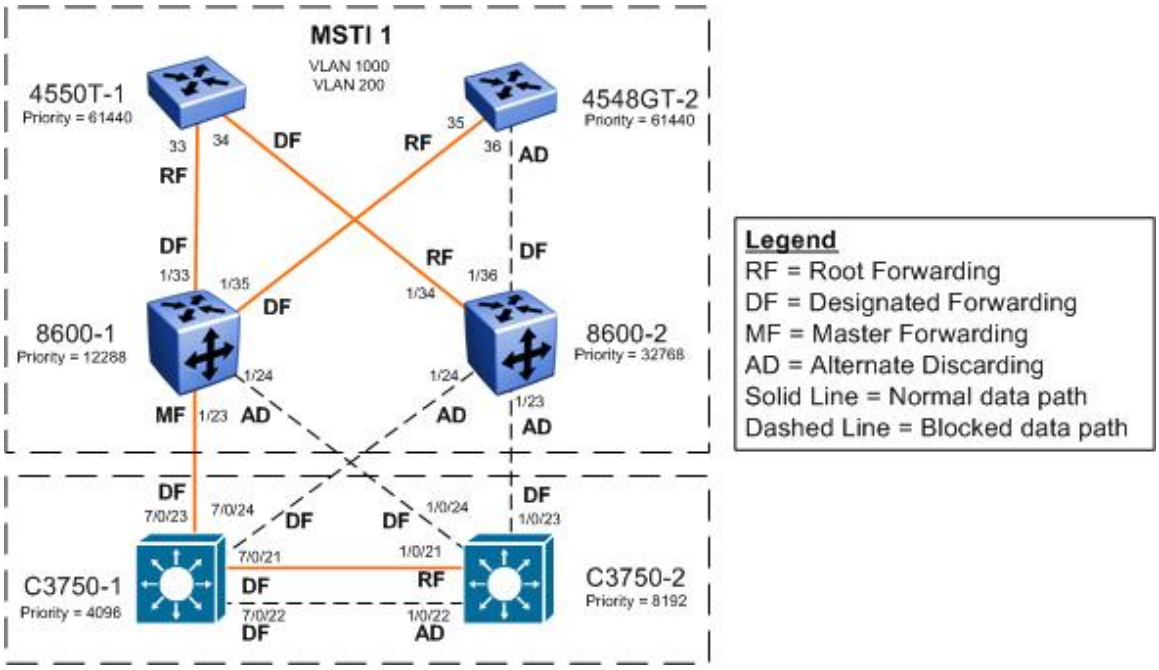


Figure 4: MSTP Example with Two Regions – MSTI 1 Data Flow

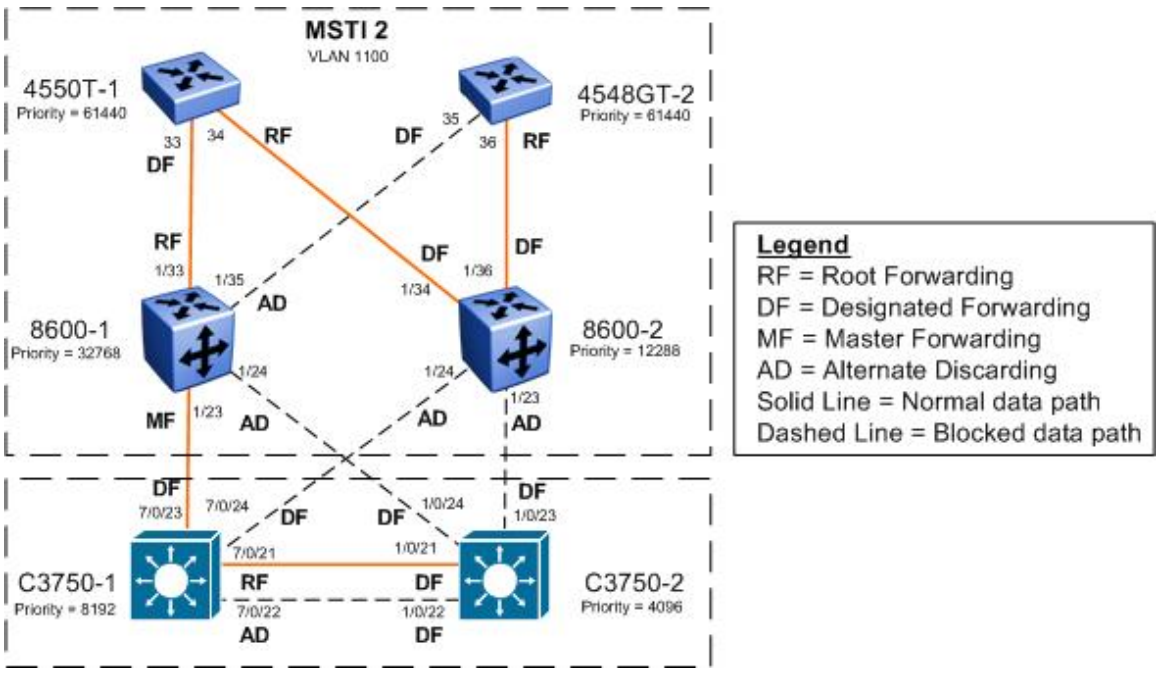


Figure 5: MSTP Example with Two Regions – MSTI 2 Data Flow

5.3.1 Configuration

5.3.1.1 MSTP Configuration

Please note that the exact same configuration is used in this example from Section 4.1 with the exception of changing the MSTP region name for switches 8600-1, 8600-2, 4550T-1, and 4548GT-2.

ERS8600-1: Step 1 – Add MSTP configuration
`ERS8600-1:5(config)#`***`spanning-tree mstp region region-name region2 region-version 1`***
ERS8600-2: Step 1 – Add MSTP configuration
`ERS8600-2:5#` ***`config mstp region name region2`*** `ERS8600-2:5#` ***`config mstp region revision 1`***
ERS4550T-1: Step 1 – Add MSTP configuration
`4550T-1(config)#`***`spanning-tree mstp region region-name region2 region-version 1`***
ERS4528GT-2: Step 1 – Add MSTP configuration
`4548GT-2(config)#`***`spanning-tree mstp region region-name region2 region-version 1`***

5.3.2 Verify Operations

5.3.2.1 Verify CIST Root and Regional Root

Step 1 – Verify that the CIST root bridge is C3750-1. Verify that the regional root bridge is C3750-1 for the region named "region1" and 8600-2 for the region named "region2". There should only be one forwarding port between the regions which should be via port 1/23 on 8600-1.

```
ERS8600-1:5#show spanning-tree mstp status
```

Result:

```
============================================================
                              MSTP Status
============================================================
------------------------------------------------------------
Bridge Address               : 00:e0:7b:b3:04:01
Cist Root                    : 10:00:00:0d:65:cc:09:00
Cist Regional Root           : 30:00:00:e0:7b:b3:04:01
Cist Root Port               : 1/23
Cist Root Cost               : 200000
Cist Regional Root Cost      : 0
Cist Instance Vlan Mapped    : 1-199,201-999,1001-1024
Cist Instance Vlan Mapped2k  : 1025-1099,1101-2048
Cist Instance Vlan Mapped3k  : 2049-3072
Cist Instance Vlan Mapped4k  : 3073-4094
Cist Max Age                 : 20 seconds
Cist Forward Delay           : 15 seconds
```

```
ERS8600-2:5# show mstp status
```

Result:

```
============================================================
                              MSTP Status
============================================================
------------------------------------------------------------
Bridge Address               : 00:80:2d:ba:d4:01
Cist Root                    : 10:00:00:0d:65:cc:09:00
Cist Regional Root           : 30:00:00:e0:7b:b3:04:01
Cist Root Port               : 1/34
Cist Root Cost               : 200000
Cist Regional Root Cost      : 400000
Cist Instance Vlan Mapped    : 1-199,201-999,1001-1024
Cist Instance Vlan Mapped2k  : 1025-1099,1101-2048
Cist Instance Vlan Mapped3k  : 2049-3072
Cist Instance Vlan Mapped4k  : 3073-4094
Cist Max Age                 : 20 seconds
Cist Forward Delay           : 15 seconds
```

```
4550T-1#show spanning-tree mstp status
```

Result:

```
Bridge Address:          00:19:69:E6:40:00
Cist Root:               10:00:00:0D:65:CC:09:00
Cist Regional Root:      30:00:00:E0:7B:B3:04:01
Cist Root Port:          33
```

```
        Cist Root Cost:          200000
        Cist Regional Root Cost: 200000
        Cist Max Age:            20 seconds
        Cist Forward Delay:      15 seconds
```

4548GT-2#***show spanning-tree mstp status***

Result:

```
        Bridge Address:          00:1B:25:F3:90:00
        Cist Root:               10:00:00:0D:65:CC:09:00
        Cist Regional Root:      30:00:00:E0:7B:B3:04:01
        Cist Root Port:          35
        Cist Root Cost:          200000
        Cist Regional Root Cost: 200000
        Cist Max Age:            20 seconds
        Cist Forward Delay:      15 seconds
```

C3750-1#***show spanning-tree mst 0***

Result:

```
        ##### MST0    vlans mapped:   1-199,201-999,1001-1099,1101-4094
        Bridge        address 000d.65cc.0900  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
        ---------------- ---- --- --------- -------- --------------------------------
        Gi7/0/1          Desg FWD 200000    128.325  P2p
        Gi7/0/21         Desg FWD 20000     128.345  P2p
        Gi7/0/22         Desg FWD 20000     128.346  P2p
        Gi7/0/23         Desg FWD 200000    128.347  P2p
        Gi7/0/24         Desg FWD 200000    128.348  P2p
```

C3750-2#***show spanning-tree mst 0***

Result:

```
        ##### MST0    vlans mapped:   1-199,201-999,1001-1099,1101-4094
        Bridge        address 000f.9053.d300  priority      8192  (8192 sysid 0)
        Root          address 000d.65cc.0900  priority      4096  (4096 sysid 0)
                      port    Gi1/0/21        path cost     0
        Regional Root address 000d.65cc.0900  priority      4096  (4096 sysid 0)
                                              internal cost 20000     rem hops 19
        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
        Gi1/0/21         Root FWD 20000     128.21   P2p
        Gi1/0/22         Altn BLK 20000     128.22   P2p
        Gi1/0/23         Desg FWD 200000    128.23   P2p
        Gi1/0/24         Desg FWD 200000    128.24   P2p
```

On each switch, verify the following information:

Option	Verify
CIST Root	Verify that the CIST root bridge is C3750-1 whose address is ***000d.65cc.0900.***
CIST Regional Root	Verify that the regional root bridge is C3750-1 for the region named "region1" and 8600-1 for the region named "region2" whose address is ***00:E0:7B:B3:04:01***
Root Port	Verify that under normal operations that the correct port to the CIST root is used: • 8600-1: Port ***1/23*** • 8600-2: Port ***1/34*** • 4550T-1: Port ***33*** • 4548GT-2: Port ***35*** • C3750-2: Either port ***1/0/21*** or ***1/0/22***

5.3.2.2 Verify MSTI 1 Root and port forwarding state

Step 1 – Verify that the MSTI 1 root is 8600-1 for the region named "region2" and C3750-1 is the MSTI 1 root for the region named "region1":

```
ERS8600-1:5#show spanning-tree mstp msti config 1
```

Result:

```
============================================================
                            MSTP Instance Status
============================================================
Instance Id                    : 1
Msti Bridge Regional Root      : 30:00:00:e0:7b:b3:04:01
Msti Bridge Priority           : 12288 (0x3000)
Msti Root Cost                 : 0
Msti Root Port                 : cpp
Msti Instance Vlan Mapped      : 200,1000
Msti Instance Vlan Mapped2k    :
Msti Instance Vlan Mapped3k    :
Msti Instance Vlan Mapped4k    :
```

```
ERS8600-2:5# show mstp instance 1
```

Result:

```
============================================================
============================================================
                              MSTP Instance Status
============================================================
Instance Id                     : 1
Msti Bridge Regional Root       : 30:00:00:e0:7b:b3:04:01
Msti Bridge Priority            : 32768 (0x8000)
Msti Root Cost                  : 400000
Msti Root Port                  : 1/34
Msti Instance Vlan Mapped       : 200,1000
Msti Instance Vlan Mapped2k     :
Msti Instance Vlan Mapped3k     :
Msti Instance Vlan Mapped4k     :
```

4550T-1#***show spanning-tree mstp msti config 1***

Result:

```
Msti Bridge Regional Root:  30:00:00:E0:7B:B3:04:01
Msti Bridge Priority (hex): F000
Msti Root Cost:             200000
Msti Root Port:             33
Msti State:                 Enabled

VLAN members
------ ------ ------ ------ ------ ------ ------ ------
200    1000
```

4548GT-2#***show spanning-tree mstp msti config 1***

Result:

```
Msti Bridge Regional Root:  30:00:00:E0:7B:B3:04:01
Msti Bridge Priority (hex): F000
Msti Root Cost:             200000
Msti Root Port:             35
Msti State:                 Enabled

VLAN members
------ ------ ------ ------ ------ ------ ------ ------
200    1000
```

C3750-1#***show spanning-tree mst 1***

Result:

```
##### MST1    vlans mapped:   200,1000
Bridge        address 000d.65cc.0900  priority      4097  (4096 sysid 1)
Root          this switch for MST1

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Gi7/0/21         Desg FWD 20000     128.345  P2p
Gi7/0/22         Desg FWD 20000     128.346  P2p
Gi7/0/23         Desg FWD 200000    128.347  P2p
Gi7/0/24         Desg FWD 200000    128.348  P2p
```

C3750-2#***show spanning-tree mst 1***

Result:

```
##### MST1    vlans mapped:   200,1000
Bridge        address 000f.9053.d300  priority      8193  (8192 sysid 1)
Root          address 000d.65cc.0900  priority      4097  (4096 sysid 1)
```

```
                port    Gi1/0/21        cost          20000     rem hops 19

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Gi1/0/21         Root FWD 20000     128.21   P2p
Gi1/0/22         Altn BLK 20000     128.22   P2p
Gi1/0/23         Desg FWD 200000    128.23   P2p
Gi1/0/24         Desg FWD 200000    128.24   P2p
```

Step 2 – Verify that the MSTI 1 port state.

```
ERS8600-1:5#show spanning-tree mstp msti port role
```

Result:

```
================================================================================
                            MSTI Port Roles and States
================================================================================

Port-Index   Instance-Id   Port-Role   Port-State   Port-STP     Port-Oper
--------------------------------------------------------------------------------
1/5          1             Disabled    Discarding      Enabled        Disabled
1/6          2             Disabled    Discarding      Enabled        Disabled
1/23         1             Master      Forwarding      Enabled        Enabled
1/23         2             Master      Forwarding      Enabled        Enabled
1/24         1             Alternate   Discarding      Enabled        Enabled
1/24         2             Alternate   Discarding      Enabled        Enabled
1/33         1             Designated  Forwarding      Enabled        Enabled
1/33         2             Root        Forwarding      Enabled        Enabled
1/35         1             Designated  Forwarding      Enabled        Enabled
1/35         2             Alternate   Discarding      Enabled        Enabled
```

```
ERS8600-2:5# show port info mstp mstirole port 1/23,1/24,1/34,1/36
```

Result:

```
================================================================================
                            MSTI Port Roles and States
================================================================================

Port-Index   Instance-Id   Port-Role   Port-State   Port-STP     Port-Oper
--------------------------------------------------------------------------------
1/23         1             Alternate   Discarding      Enabled        Enabled
1/23         2             Alternate   Discarding      Enabled        Enabled
1/24         1             Alternate   Discarding      Enabled        Enabled
1/24         2             Alternate   Discarding      Enabled        Enabled
1/34         1             Root        Forwarding      Enabled        Enabled
1/34         2             Designated  Forwarding      Enabled        Enabled
1/36         1             Designated  Forwarding      Enabled        Enabled
1/36         2             Designated  Forwarding      Enabled        Enabled
```

```
4550T-1#show spanning-tree mstp msti port role 1
```

Result:

```
Port     Role       State      STP Status  Oper Status
----  ----------  ----------  ----------  -----------
5     Disabled    Discarding  Enabled     Disabled
33    Root        Forwarding  Enabled     Enabled
34    Designated  Forwarding  Enabled     Enabled
```

```
4548GT-2#show spanning-tree mstp msti port role 1
```

Result:

```
Port     Role       State      STP Status  Oper Status
----  ----------  ----------  ----------  -----------
5     Disabled    Discarding  Enabled     Disabled
35    Root        Forwarding  Enabled     Enabled
36    Alternate   Discarding  Enabled     Enabled
```

On each switch, verify the following information:

Option	Verify
Root	Verify that the MIST 1 root bridge is C3750-1 for region named "region1" whose address is ***000d.65cc.0900.*** Verify that the MSTI 1 root bridge is 8600-1 for region named "region2" whose address is ***00:E0:7B:B3:04:01***.
MSTI 1 Root Port	Verify that under normal operations that the correct port to the MIST 1 root bridge is used: • 8600-1: Port ***1/23*** (Master Forwarding to "region1") • 8600-2: Port ***1/34*** • 4550T-1: Port ***33*** • 4548GT-2: Port ***35*** • C3750-2: Either port ***1/0/21*** or ***1/0/22***
VLANs	Verify that only VLANs 200 and 1000 are configured for MSTI 1. If not, the MSTI instance will not come up on the corresponding switch.

5.3.2.3 Verify MSTI 2 Root and port forwarding state

Step 1 – Verify that the MSTI 2 root is C3750-2 for region named "region1" and the MSTI 2 root is 8600-2 for region named "region2":

```
ERS8600-1:5#show spanning-tree mstp msti config 2
```

Result:

```
============================================================
                              MSTP Instance Status
============================================================
Instance Id                    : 2
Msti Bridge Regional Root      : 30:00:00:80:2d:ba:d4:01
Msti Bridge Priority           : 32768 (0x8000)
Msti Root Cost                 : 400000
Msti Root Port                 : 1/33
Msti Instance Vlan Mapped      :
Msti Instance Vlan Mapped2k    : 1100
Msti Instance Vlan Mapped3k    :
Msti Instance Vlan Mapped4k    :
```

ERS8600-2:5# ***show mstp instance 2***

Result:

```
================================================================
                              MSTP Instance Status
================================================================
Instance Id                       : 2
Msti Bridge Regional Root         : 30:00:00:80:2d:ba:d4:01
Msti Bridge Priority              : 12288 (0x3000)
Msti Root Cost                    : 0
Msti Root Port                    : cpp
Msti Instance Vlan Mapped         :
Msti Instance Vlan Mapped2k       : 1100
Msti Instance Vlan Mapped3k       :
Msti Instance Vlan Mapped4k       :
```

4550T-1#***show spanning-tree mstp msti config 2***

Result:

```
Msti Bridge Regional Root:  10:00:00:80:2D:BA:D4:01
Msti Bridge Priority (hex): F000
Msti Root Cost:             200000
Msti Root Port:             34
Msti State:                 Enabled

VLAN members
------ ------ ------ ------ ------ ------ ------ ------
1100
```

4548GT-2#***show spanning-tree mstp msti config 2***

Result:

```
Msti Bridge Regional Root:  30:00:00:80:2D:BA:D4:01
Msti Bridge Priority (hex): F000
Msti Root Cost:             200000
Msti Root Port:             36
Msti State:                 Enabled

VLAN members
------ ------ ------ ------ ------ ------ ------ ------
1100
```

C3750-1#***show spanning-tree mst 2***

Result:

```
##### MST2    vlans mapped:   1100
Bridge        address 000d.65cc.0900  priority      28674 (28672 sysid 2)
Root          address 000f.9053.d300  priority      4098  (4096 sysid 2)
              port    Gi7/0/21        cost          20000     rem hops 19

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Gi7/0/21         Root FWD 20000     128.345  P2p
Gi7/0/22         Altn BLK 20000     128.346  P2p
Gi7/0/23         Desg FWD 200000    128.347  P2p
Gi7/0/24         Desg FWD 200000    128.348  P2p
```

C3750-2#***show spanning-tree mst 2***

Result:

```
##### MST2    vlans mapped:   1100
Bridge        address 000f.9053.d300  priority      4098  (4096 sysid 2)
Root          this switch for MST2

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------
Gi1/0/21         Desg FWD 20000     128.21   P2p
Gi1/0/22         Desg FWD 20000     128.22   P2p
Gi1/0/23         Desg FWD 200000    128.23   P2p
Gi1/0/24         Desg FWD 200000    128.24   P2p
```

Step 2 – Verify that the MSTI 2 port state:

ERS8600-1:5#***show spanning-tree mstp msti port role***

Result:

```
================================================================================
                            MSTI Port Roles and States
================================================================================

Port-Index   Instance-Id   Port-Role   Port-State   Port-STP     Port-Oper
--------------------------------------------------------------------------------
1/5          1             Disabled    Discarding      Enabled        Disabled
1/6          2             Disabled    Discarding      Enabled        Disabled
1/23         1             Master      Forwarding      Enabled        Enabled
1/23         2             Master      Forwarding      Enabled        Enabled
1/24         1             Alternate   Discarding      Enabled        Enabled
1/24         2             Alternate   Discarding      Enabled        Enabled
1/33         1             Designated  Forwarding      Enabled        Enabled
1/33         2             Root        Forwarding      Enabled        Enabled
1/35         1             Designated  Forwarding      Enabled        Enabled
1/35         2             Alternate   Discarding      Enabled        Enabled
```

ERS8600-2:5# ***show port info mstp mstirole port 1/23,1/24,1/34,1/36***

Result:

```
================================================================================
                            MSTI Port Roles and States
================================================================================

Port-Index   Instance-Id   Port-Role   Port-State   Port-STP     Port-Oper
--------------------------------------------------------------------------------
1/23         1             Alternate   Discarding      Enabled        Enabled
1/23         2             Alternate   Discarding      Enabled        Enabled
1/24         1             Alternate   Discarding      Enabled        Enabled
1/24         2             Alternate   Discarding      Enabled        Enabled
1/34         1             Root        Forwarding      Enabled        Enabled
1/34         2             Designated  Forwarding      Enabled        Enabled
1/36         1             Designated  Forwarding      Enabled        Enabled
1/36         2             Designated  Forwarding      Enabled        Enabled
```

4550T-1#***show spanning-tree mstp msti port role 2***

Result:

```
Port     Role        State      STP Status  Oper Status
----  ----------  ----------  ----------  -----------
6     Disabled    Discarding  Enabled     Disabled
33    Designated  Forwarding  Enabled     Enabled
34    Root        Forwarding  Enabled     Enabled
```

```
4548GT-2#show spanning-tree mstp msti port role 2
```

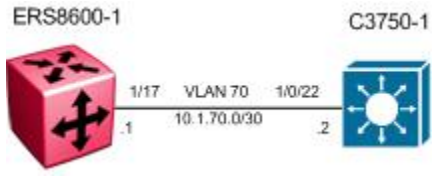
Result:

```
Port     Role        State      STP Status  Oper Status
----  ----------  ----------  ----------  -----------
6     Disabled    Discarding  Enabled     Disabled
35    Designated  Forwarding  Enabled     Enabled
36    Root        Forwarding  Enabled     Enabled
```

On each switch, verify the following information:

Option	Verify
Root	Verify that the MIST 2 root bridge is C3750-2 whose address is ***000f.9053.d300***. Verify that the MSTI 2 root bridge is 8600-2 for region named "region2" whose address is ***00:80:2d:ba:d4:01***
MSTI 2 Root Port	Verify that under normal operations that the correct port to the MIST 2 root bridge is used: • 8600-1: Port ***1/33*** Port ***1/24*** (Master Forwarding to "region1") • 4550T-1: Port ***34*** • 4548GT-2: Port ***36*** • C3750-2: Either port ***1/0/21*** or ***1/0/22***
VLANs	Verify that only VLAN 1100 is configured for MSTI 2 If not, the MSTI instance will not come up on the corresponding switch.

6. OSPF MD5 Authentication



For this example, we will configure the following:

- MD5 OSPF authentication between an Avaya ERS8600 switch and a Cisco 3750 switch
- We will set the MD5 password to *avayatocisco*

Note that Cisco will send OSPF hello messages with LLS (Link-Local Signaling). The Avaya ERS8600 does not accept LLS and thus will never form an OSPF neighbor if LLS is left enabled.

6.1 Configuration Steps

6.1.1 Enable MD5

ERS8600-1: Step 1 – Add and enable MD5 message key
ERS8600-1# ***config ip ospf interface 10.1.70.1 add-message-digest-key 1 md5-key avayatocisco***
ERS8600-1# ***config ip ospf interface 10.1.70.1 authentication-type message-digest***
C3750-1: Step 1 – Add and enable MD5 message key
C3750-1(config)#***interface vlan 70***
C3750-1(config-if)#***ip ospf authentication message-digest***
C3750-1(config-if)#***ip ospf message-digest-key 1 md5 avayatocisco***
C3750-1(config-if)# ***ip ospf lls disable***
C3750-1(config-if)#***exit***

6.2 Verify Operations

6.2.1 ERS8600

Step 1 – Verify that MD5 message-digest is configured on the appropriate interface

```
ERS8600-8:5# show ip ospf int-auth
```

Result:

```
=============================================================================
                      OSPF Interface AuthKey - GlobalRouter
=============================================================================
INTERFACE       AUTHTYPE AUTHKEY
-----------------------------------------------------------------------------
10.1.70.1       message-digest
```

Step 2 – Verify that the Cisco switch is an OSPF neighbor:

```
ERS8600-8:5# show ip ospf neighbors
```

Result:

```
================================================================================
                          OSPF Neighbors - GlobalRouter
================================================================================
INTERFACE       NBRROUTERID     NBRIPADDR       PRIO_STATE    RTXQLEN PERMANENCE
--------------------------------------------------------------------------------
10.1.70.1       10.1.1.2        10.1.70.2       1    Full     0       Dynamic

Total ospf neighbors: 1
```

Step 3 – Verify that the MLT MD5 key is configured:

```
ERS8600-8:5# config ip ospf interface 10.1.70.1 info
```

Result:

```
Sub-Context: clear config dump monitor mplsping mplstrace peer show switchover t
est trace wsm asfm sam
Current Context:

                admin-status : enabled
              interface-type : broadcast
                        area : 0.0.0.0
       authentication-key :
      authentication-type : message-digest
            dead-interval : 40
           hello-interval : 10
     add-message-digest-key :
                                    - 1
                           md5-key - *****
                                    - PRIMARY KEY

     change-primary-md5-key : N/A
```

```
          delete-message-digest-key : N/A
                             metric : 10
                         mtu-ignore : disable
                      poll-interval : 120
                           priority : 1
                  retransmit-interval : 5
                        transit-delay : 1
                           bfd-enable : disabled
```

Verify the following information:

Option	Verify
AUTHTYPE AUTHKEY	Should be displayed as ***message-digest***. This just indicates that message digest has been configured and enabled for the shown interface. Use the command *config ip ospf interface 10.1.70.1 info* as shown above to verify that a MD5 key has been added.
STATE	If everything is working, the Cisco switch neighbor state should be displayed as ***Full***.

6.2.2

6.2.3 Cisco 3750

Step 1 – Verify that MD5 message-digest is configured on the appropriate interface, the line protocol is up, and that LLS is disabled

```
C3750-1#show ip ospf interface vlan 70
```

Result:

```
Vlan70 is up, line protocol is up
  Internet Address 10.1.70.2/30, Area 0
  Process ID 1, Router ID 47.133.58.137, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 10.12.1.2, Interface address 10.1.70.1
  Backup Designated router (ID) 47.133.58.137, Interface address 10.1.70.2
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:09
  Does not support Link-local Signaling (LLS)
  Cisco NSF helper support disabled
  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 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 10.12.1.2  (Designated Router)
  Suppress hello for 0 neighbor(s)
  Message digest authentication enabled
    Youngest key id is 1
```

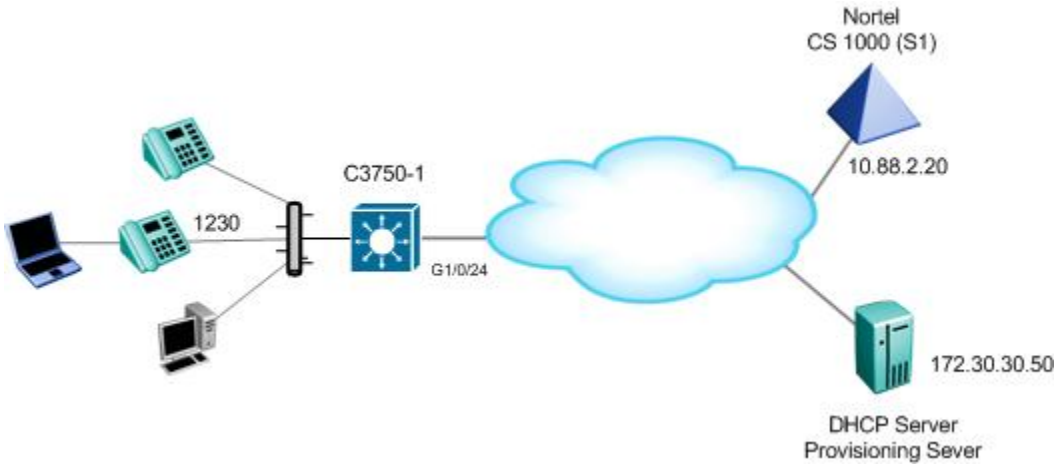
Step 1 – Verify that the Avaya switch is an OSPF neighbor:

```
C3750-1#show ip ospf neighbor
```

Result:

```
Neighbor ID     Pri   State           Dead Time   Address         Interface
10.12.1.2         1   FULL/DR         00:00:32    10.1.70.1       Vlan70
```

7. Avaya IP Phone to Cisco Switch



The following configuration example covers various methods for configuring a Cisco 3750 to support both voice and data on the same port with an Avaya IP Phone.

The access ports will be configured to allow untagged data traffic and tagged voice traffic using VLAN 1000 for the Data VLAN and VLAN 600 for the Voice VLAN. The Avaya IP Phone can either use double DHCP to get the Voice VLAN ID from a DHCP request on the data VLAN or the Cisco 3750 switch could be configured for LLDP-MED to tell the Avaya IP Phone what the voice VLAN ID is.

For QoS, the Cisco 3750 can either be configured to trust the layer 2 p-bit value or layer 3 DSCP value. At a layer 2 level, the switch can be setup to only trust only the tagged voice VLAN 802.1p value and remark all untagged traffic with a DSCP value of 0. At a layer 3 level, the switch can be configured to trust the DSCP values from both the voice and data VLANs without a policy-map configured, or only trust the DSCP value from the voice VLAN and remark the data VLAN with a policy-map defined.

7.1 Config Steps

For this configuration example, we will assume an Avaya model 1230 IP Phone.

7.1.1 PoE

By default, on a Cisco 3750, the switch automatically detects and supplies power if the connected device requires it. If you wish, use the following interface commands to set the desired PoE settings:

```
interface gigabitEthernet <interface number>
    power inline auto (default setting and preferred for Avaya IP Phones)
    power inline auto max <4000-15400> milli-watts (To limit the power in auto mode)
    power inline static (To turn on power to the port even if there is no PoE device
    detected)
    power inline static max <4000-15400> milli-watts (To limit the power in static mode)
    power inline never (To turn off power to the port)
```

power inline consumption <4000-15400> milli-watts (To set the amount of power consumption)

7.1.2 Avaya IP Phone default DSCP values when used with a Cisco Switch

The Avaya IP Phones uses a p-bit value of 6 and DSCP value of 46 for Voice Media. For Voice Signaling, the Avaya IP Phone uses a p-bit value of 5 and DSCP value of 40. The following command displays the default DSCP mappings on a Cisco switch.

C3750-2#***show mls qos maps cos-dscp***

```
Cos-dscp map:
     cos:   0  1  2  3  4  5  6  7
   --------------------------------
     dscp:  0  8 16 24 32 40 48 56
```

In order to support Avaya IP Phones on the Cisco switch, we need to change CoS value 6 with a DSCP value of 46. The can be accomplished by using issuing the following commands:

```
C3750-2(config)#mls qos map cos-dscp 0 8 16 24 32 40 46 56
C3750-2(config)#mls qos (enter this command to enable QoS)
C3750-2(config)#do show mls qos maps cos-dscp
   Cos-dscp map:
        cos:   0  1  2  3  4  5  6  7
      --------------------------------
        dscp:  0  8 16 24 32 40 46 56
```

7.1.3 QoS at Layer 2 Option

If we configure the Cisco switch, as in this example, to support untagged data traffic and tagged voice traffic, the switch can be setup to trust only the 802.1p (p-bit) values from the tagged voice VLAN. All untagged traffic will be remarked with a DSCP value of 0. This can be accomplished with the *mls qos trust cos* interface level command.

Overall, the configuration should look like the configuration shown below to trust only the p-bit values from the tagged voice VLAN. We will also change the cos-dscp 6 value from the default DSCP value of 48 to a DSCP value of 46.

C3750-1 - Trust CoS Configuration Example for Avaya IP Phones: Trust only the tagged traffic and remark the untagged traffic with DSCP value of 0

```
!
vtp mode transparent
!
!
mls qos map cos-dscp 0 8 16 24 32 40 46 56
mls qos
!
vlan 600
 name voice
!
vlan 1000
 name data
!
interface GigabitEthernet1/0/17
 switchport access vlan 1000
```

```
 switchport mode access
 switchport voice vlan 600
 priority-queue out
 mls qos trust cos
 spanning-tree portfast
!
```

If you wish, you can also add a default CoS value for the untagged data VLAN traffic. By default, all the data traffic is remarked with a DSCP value of 0. If you set the **mls qos cos <0-7>** on a port, the switch will set the CoS value of all frames from the untagged data VLAN to the configured CoS value. The following shows a configuration changing default CoS value of 0 to 2 which in turn will remark all the untagged data traffic with a DSCP value of 16.

C3750-1: Trust CoS Configuration Example for Avaya IP Phones: Trust the tagged traffic and remark the untagged traffic with a default DSCP value of 16

```
!
vtp mode transparent
!
!
mls qos map cos-dscp 0 8 16 24 32 40 46 56
mls qos
!
vlan 600
 name voice
!
vlan 1000
 name data
!
interface GigabitEthernet1/0/17
 switchport access vlan 1000
 switchport mode access
 switchport voice vlan 600
 priority-queue out
 mls qos cos 2
 mls qos trust cos
 spanning-tree portfast
!
```

7.1.4 QoS at Layer 3 Option

The following is a configuration example of configuring the Cisco switch to trust the DSCP value instead of the p-bit value. Please see Section 7.1.2 regarding changing the default CoS mappings to support Avaya IP phone.

C3750-1 - Trust DSCP Configuration Example for Avaya IP Phones: Trust DSCP value from both tagged voice VLAN and untagged data VLAN

```
!
vtp mode transparent
!
mls qos map cos-dscp 0 8 16 24 32 40 46 56
mls qos
!
vlan 600
 name voice
!
```

```
vlan 1000
 name data
!
interface GigabitEthernet1/0/17
 switchport access vlan 1000
 switchport mode access
 switchport voice vlan 600
 priority-queue out
 mls qos trust dscp
 spanning-tree portfast
!
```

The above configuration will trust all traffic both from the untagged data VLAN and the tagged voice VLAN. In some cases, you may not want to trust the data VLAN. If this is the case, a policy-map can be created to pass the voice VLAN traffic as-is and remark the data VLAN traffic. Assuming the data VLAN uses a subnet of 192.168.100.0/24 and the voice VLAN uses a subnet of 192.168.60.0/24, the following configuration will pass the CoS traffic from the voice VLAN as-is and remark the data VLAN traffic to a DSCP value of AF11.

C3750-1 - Trust DSCP Configuration Example for Avaya IP Phones: Trust DSCP value from tagged voice VLAN IP subnet and remark untagged data VLAN IP subnet with default DSCP value of 16 using a policy-map

```
!
vtp mode transparent
!
mls qos map cos-dscp 0 8 16 24 32 40 46 56
mls qos
!
vlan 600
 name voice
!
vlan 1000
 name data
!
class-map match-all data-1
 match access-group name data-subnet
class-map match-all voice-1
 match access-group name voice-subnet
!
!
policy-map policy-1
 class voice-1
  trust cos
 class data-1
  set dscp af11
!
interface GigabitEthernet1/0/17
 switchport access vlan 1000
 switchport mode access
 switchport voice vlan 600
 priority-queue out
 mls qos trust dscp
 spanning-tree portfast
 service-policy input policy-1
!
ip access-list extended data-subnet
```

```
 permit ip 192.168.100.0 0.0.0.255 any
ip access-list extended voice-subnet
 permit ip 192.168.60.0 0.0.0.255 any
!
```

7.1.5 LLDP-MED

To enable LLDP-MED, you simple have to enter the command *lldp run*. The interface level *switchport voice vlan <1-4094>* command determines the voice VLAN ID sent by the switch. By default, LLDP transmit, receive and policy will be enabled at an interface level.

C3750-1 – LLDP-MED configuration

```
!
vtp mode transparent
!
!
mls qos map cos-dscp 0 8 16 24 32 40 46 56
mls qos
!
vlan 600
 name voice
!
vlan 1000
 name data
lldp run
!
!
interface GigabitEthernet1/0/17
 switchport access vlan 1000
 switchport mode access
 switchport voice vlan 600
 priority-queue out
 mls qos trust dscp
 spanning-tree portfast
!
```

7.1.6 LLDP-MED : Verify the local attached Avaya IP Phone

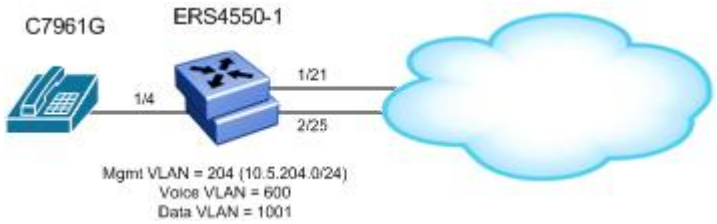
Step 1 – Verify that the Avaya IP phone using LLDP-MED assuming an Avaya IP Phone model 1230 is connected via port 1/0/15 on the Cisco 3750 switch

```
C3750-2#show lldp neighbors gigabitEthernet 1/0/15 detail
```

Result:

```
        Chassis id: 192.168.60.20
        Port id: 0024.000d.8dcd
        Port Description: Nortel IP Phone
        System Name - not advertised

        System Description:
        Nortel IP Telephone 1230, Firmware:062AC6R

        Time remaining: 179 seconds
        System Capabilities: B,T
        Enabled Capabilities: B,T
        Management Addresses - not advertised
        Auto Negotiation - supported, enabled
        Physical media capabilities:
            100base-TX(FD)
            100base-TX(HD)
            10base-T(FD)
            10base-T(HD)
        Media Attachment Unit type: 16

        MED Information:

            MED Codes:
                  (NP) Network Policy, (LI) Location Identification
                  (PS) Power Source Entity, (PD) Power Device
                  (IN) Inventory

            F/W revision: 062AC6R
            Manufacturer: Nortel-05
            Model: IP Phone 1230
            Capabilities: NP, LI, PD, IN
            Device type: Endpoint Class III
            Network Policy(Voice): VLAN 600, tagged, Layer-2 priority: 0, DSCP: 0
            PD device, Power source: Unknown, Power Priority: High, Wattage: 6.0
        ----------------------------------------------
```

8. Cisco Phone to Avaya Switch



For this configuration example, we will configure the following

- Configure ERS4550-1 as a Layer 2 switch
- Add management VLAN 204, data VLAN 1001, and voice VLAN 600
- Configure MLT 1 using ports 1/21 and 2/25 for the uplink to the core network
- Enable ports 1/4 as untagPvidOnly to allow untagged data VLAN (PVID = 1001) and tagged voice VLAN (PVID = 600)
    - Enable LLDP-MED on port 1/4 and configure the LLDP-MED using ADAC
- Set the PoE priority level to high on port 1/4 for the IP Phone set

8.1 4500-1 Configuration

8.1.1 Go to configuration mode.

ERS4550-1 Step 1 - Enter configuration mode
4550-PWR>***enable***
4550-PWR#***configure terminal***
4550-1-PWR(config)#***banner disable***
4550-1-PWR(config)#***snmp-server name 4550-1-PWR***

8.1.2 Add MLT

ERS4550-1 Step 1 – Add MLT with port members 1/21 and 2/25 and enable port tagging
4550-1-PWR(config)#***vlan ports 1/21,2/25 tagging tagall***
4550-1-PWR(config)#***mlt 1 enable member 1/21,2/25 learning disable***

8.1.3 Enable ADAC Globally

ERS4550-1 Step 1 – Enable ADAC using VLAN 600, set the operation mode to tagged-frames, and add one of the uplink port member, i.e. port 1/21

```
4550-1-PWR(config)#adac voice-vlan 600
4550-1-PWR(config)#adac op-mode tagged-frames
4550-1-PWR(config)#adac uplink-port 1/21
4550-1-PWR(config)#adac enable
```

8.1.4 Add data and management VLANs and port members

ERS4550-1 Step 1 – Add data and management VLANs

```
4550-1-PWR(config)# vlan configcontrol automatic
4550-1-PWR(config)#vlan create 1001 name data type port
4550-1-PWR(config)#vlan create 204 name mgmt type port
4550-1-PWR(config)#vlan members add 1001 1/4,1/21,2/25
4550-1-PWR(config)#vlan members add 204 1/21,2/25
```

8.1.5 Enable ADAC at interface level

ERS4550-1 Step 1 – Enable ADAC on port member 1/4, set the ADAC detection to LLDP only, and enable the ADAC tag mode to tagged frames and untag the default VLAN

```
4550-1-PWR(config)#interface fastEthernet 1/4
4550-1-PWR(config-if)#adac detection lldp
4550-1-PWR(config-if)#no adac detection mac
4550-1-PWR(config-if)#adac tagged-frames-tagging untag-pvid-only
4550-1-PWR(config-if)#adac enable
4550-1-PWR(config-if)#exit
```

Note that by default, ADAC detection for MAC and LLDP is enabled. Hence, the command *adac detection lldp* is not required and only used in this example to show that there is a command to enable or disable the detection type.

8.1.6 Enable LLDP-MED

ERS4550-1 Step 1 – Enable LLDP-MED on port 1/4

```
4550-1-PWR(config)#interface fastEthernet 1/4
4550-1-PWR(config-if)#lldp tx-tlv local-mgmt-addr port-desc sys-cap sys-desc sys-name
4550-1-PWR(config-if)#lldp status txAndRx config-notification
4550-1-PWR(config-if)#lldp tx-tlv med extendedPSE med-capabilities network-policy
4550-1-PWR(config-if)#exit
```

8.1.7 Configure PoE levels

ERS4550-1 Step 1 – Set PoE Power level high on all VoIP ports

```
5520-1(config)#interface fastEthernet 1/4
5520-1 (config-if)#poe poe-priority high
5520-1 (config-if)#exit
```

8.1.8 Set Management VLAN

ERS4550-1 Step 1 – Configure VLAN 204 as the management VLAN and set the management IP address

```
4550-1-PWR(config)#vlan mgmt 204
4550-1-PWR(config)#ip address switch 10.5.204.5 netmask 255.255.255.0 default-gateway 10.5.204.1
```

8.1.9 Enable SNMP Management

ERS4550-1 Step 1 – If you wish, enable SNMP management by entering the following command

```
4550-1-PWR(config)#snmp-server enable
```

8.1.10 Enable IP DHCP Snooping and ARP Inspection

The following commands are optional and only used if DHCP is used.

ERS4550-1 Step 1 – Enable IP DHCP Snooping for voice VLAN 600 and data VLAN 1001
4550-1-PWR(config)#***ip dhcp-snooping vlan 600*** 4550-1-PWR(config)#***ip dhcp-snooping vlan 1001*** 4550-1-PWR(config)#***ip dhcp-snooping enable***
ERS4550-1 Step 2 – Enable IP Arp Inspection for voice VLAN 600 and data VLAN 1001
4550-1-PWR(config)#***ip arp-inspection vlan 600*** 4550-1-PWR(config)#***ip arp-inspection vlan 1001***
ERS4550-1 Step 3 – Enable core ports 1/21 and 2/25 as a trusted ports
4550-1-PWR(config)#***interface fastEthernet 1/21,2/25*** 4550-1-PWR(config-if)#***ip dhcp-snooping trusted*** 4550-1-PWR(config-if)#***ip arp-inspection trusted*** 4550-1-PWR(config-if)#***exit***

8.1.11 Enable Spanning Tree Fast Start and BPDU filtering on access ports

ERS4550-1 Step 3 – Enable STP Fast Start and BPDU filtering on access port 1/4
4550-1-PWR(config)# ***interface fastEthernet 1/4*** 4550-1-PWR(config-if)# ***spanning-tree learning fast*** 4550-1-PWR(config-if)# ***spanning-tree bpdu-filtering timeout 0*** 4550-1-PWR(config-if)#***spanning-tree bpdu-filtering enable*** 4550-1-PWR(config-if)#***exit***

8.1.12 Remove port members from default VLAN (VLAN 1)

ERS4550-1 Step 3 – Remove port member from the default VLAN
4550-1-PWR(config)#***vlan members remove 1 1/4,1/21,2/25***

8.2 Cisco Phone Configuration

The Cisco phone used for this example is based on software version SCCP41.8-3-4SR1S in SCCP mode. A remote Cisco call server (CUCM) was set up to recognize and register the phone when contacted.

Note that the Cisco phone is required to support LLDP-MED in order to inter-operate with the ERS 4500. Support for LLDP-MED was introduced in release 8.3(3) on most, but not all, phone models. Please consult release notes.

C7961G Step 1 – Confirm the Cisco phone supports LLDP-MED
• Press the "Settings" button • Select "3 – Device Configuration" • Select "9 – Network Configuration" • Ensure that "LLDP: PC Port" is set to "Enabled" • Ensure that "LLDP-MED: SW Port" is set to "Enabled" • Press "Exit" twice to return to the main "Settings" menu.
C7961G Step 2 – Confirm that the Voice VLAN Id is not statically configured and DHCP is enabled
• Select "2 – Network Configuration" • Verify that the parameter "21 - Admin. VLAN Id" is set to a null value (i.e. should be blank, no value). The Voice VLAN Id should not be statically configured because it will be advertised by the ERS 4500 via LLDP-MED. If this needs to be changed press "**#" to unlock the configuration and make the change. • Verify that "22 – DHCP" is set to "Yes" • Press "Exit" twice to exit the "Settings" menu.

8.3 Verify Operations

8.3.1 Verify LLDP Neighbors

Step 1 – Verify the LLDP neighbor using the following commands:

```
4550-1-PWR# show lldp neighbor
```

Result:

```
-------------------------------------------------------------------------------
                            lldp neighbor
-------------------------------------------------------------------------------
Port: 1/4   Index: 12                Time: 19 days, 02:04:16
        ChassisId: Network address    IPv4  10.1.60.66
        PortId:    Locally assigned   001E4A34C6AB:P1
        SysName:   SEP001E4A34C6AB.cisco.com
        SysCap:    TB / TB            (Supported/Enabled)
        PortDesc:  SW PORT
        SysDescr:  Cisco IP Phone CP-7961G,V2, SCCP41.8-3-4SR1S

-------------------------------------------------------------------------------
Sys capability: O-Other; R-Repeater; B-Bridge; W-WLAN accesspoint; r-Router;
T-Telephone; D-DOCSIS cable device; S-Station only.
Total neighbors: 1
```

```
4550-1-PWR#show lldp neighbor-mgmt-addr
```

Result:

```
-------------------------------------------------------------------------------
                          lldp neighbor-mgmt-addr
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
Port: 1/4   Index: 12                Time: 19 days, 02:04:16
        ChassisId: Network address    IPv4  10.1.60.66
        PortId:    Locally assigned   001E4A34C6AB:P1
        MgmtAddr:  IPv4  10.1.60.66
        MgmtOID:   0.0
        Interface: type-unknown, number:0
```

8.3.2 Verify ADAC Operation and correct VLAN is used

Step 1 – Verify the Cisco IP phone is detected via ADAC using the following command:

```
4550-1-PWR#show adac interface 1/4
```

Result:

```
Unit/                 Auto       Oper       Auto
Port    Type  Detection  State      Configuration  T-F PVID   T-F Tagging
-----   ----  ---------  --------   -------------  ---------  ---------------
1/4     T     Enabled    Enabled    Applied        No Change  Untag PVID Only
```

Step 2 – Verify the voice VLAN is used on port 1/4:
4550-1-PWR# ***show vlan vid 600***
Result:

```
        Id  Name                 Type     Protocol         User PID Active IVL/SVL Mgmt
        --- -------------------- -------- ---------------- -------- ------ ------- ----
        600 Voice_VLAN           Port     None             0x0000   Yes    IVL     No
                Port Members: 1/4,1/21,2/25
```

8.3.3 Verify Cisco Phone operations

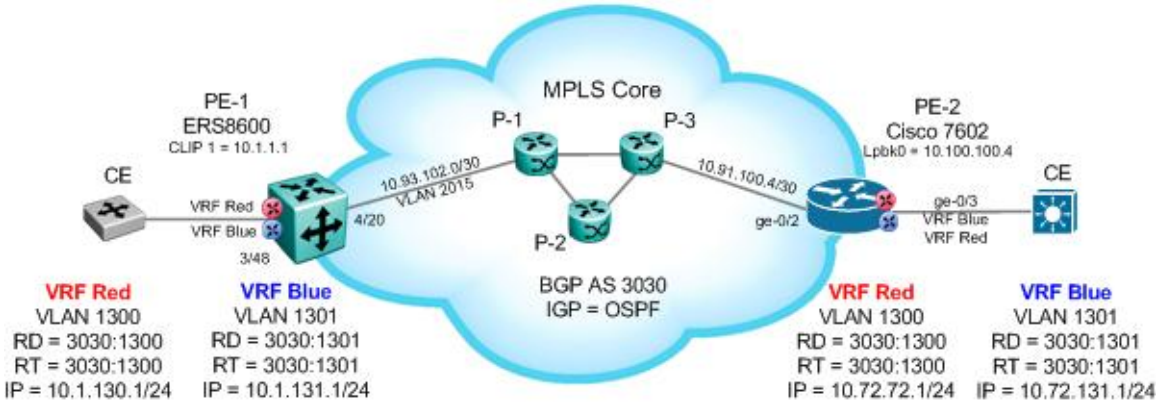
Once the phone learns the Voice VLAN via LLDP-MED it sends a DHCP Discovery/Request. The DHCP Server returned an IP address, default gateway, DNS Server, DNS Domain Name, and DHCP option 150 – "TFTP Server IP Address" so that the phone can reach its Call Server. Note that there are multiple methods in which the Cisco phone can learn of its Call Server:

- Static IP address
- Option 150 (single IP address)
- Option 66 (first IP address or Domain Name System [DNS] name)
- Lookup CiscoCM1.your.domain

To verify that the Cisco phone learned the Voice VLAN:

- Press the "Settings" button
- Select "2 – Network Configuration"
- Verify that the parameter "20 – Operational VLAN Id" is set to the Voice VLAN Id.

9. IP-VPN interoperability between Avaya and Cisco



In this configuration example, we will configure the following PE routers Avaya ERS8600 and Cisco 7602 with the following:

- Routing protocol between CE and PE routers
  - OSPF
- Protocol between PE and P routers
  - OSPF
    - OSPF area 0.0.0.0
  - LDP
- Protocol between PE routers
  - BGP
    - AS: 3030
    - iBGP – internal BGP configured between PE routers
    - Enable VPN-IPv4 via CLIP address between ERS8600 and C-7602
- On the ERS8600 PE:
  - The Circuitless IP Address (CLIP) will be used as OSPF Router-ID which in turn will become the BGP Router-ID and used to create the iBGP peers between the PE routers
  - The Circuitless IP Address (CLIP) will be used as the MPLS Router-ID
  - The Route Distinguisher equals the AS number, RD = 3030
  - The Route Target equals the VLAN ID, RT = 1300 (VRF red) and RT = 1301 (VRF blue)

Node	VRF Name	VLAN	Subnet
ERS8600 (PE1)	Red	1300	10.1.130.0/24
	Blu	1301	10.1.131.0/24
Cisco 7602 (PE2)	Red	1300	10.72.72.0/24
	Blue	1301	10.72.131.0/24

9.1 Configuration Steps

All configuration steps are shown using both CLI and PPCLI configuration mode.

9.1.1 PE 1 Configuration: ERS8600

9.1.1.1 Create MPLS Core VLAN

PE-1 Step 1 – Create VLAN 2015 to MPLS core

CLI

```
ERS8600-1:5(config)#vlan members remove 1 4/20
ERS8600-1:5(config)#vlan create 2015 type port 1
ERS8600-1:5(config)#vlan members add 2015 4/20
ERS8600-1:5(config)#interface vlan 2015
ERS8600-1:5(config-if)#ip address 10.93.102.2 255.255.255.252
ERS8600-1:5(config-if)#ip ospf enable
ERS8600-1:5(config-if)#exit
```

PPCLI

```
ERS8600-1:5# config vlan 1 ports remove 4/20
ERS8600-1:5# config vlan 2015 create byport 1 name core-vlan2015
ERS8600-1:5# config vlan 2015 ports add 4/20
ERS8600-1:5# config vlan 2015 ip create 10.93.102.2/30
ERS8600-1:5# config vlan 2015 ip ospf enable
ERS8600-1:5# config vlan 2015 ip mpls ldp state enable
```

PE-1 Step 2 – Disable Spanning Tree on core port
CLI
ERS8600-1:5(config)#*interface gigabitEthernet 4/20* **ERS8600-1:5(config-if)#*no spanning-tree stp 1*** **ERS8600-1:5(config-if)#*shutdown*** **ERS8600-1:5(config-if)#*no shutdown*** **ERS8600-1:5(config-if)#*exit***
PPCLI
ERS8600-1:5# *config ethernet 4/20 stg 1 stp disable* **ERS8600-1:5# *config ethernet 4/20 state disable*** **ERS8600-1:5# *config ethernet 4/20 state enable***
PE-1 Step 3 – Add Circuitless IP Address (CLIP). Assuming no other CLIP address has been added, we will use CLIP id 1. This address will be used for the OSPF Router-Id, LDP, and the BDP Router-Id
CLI
ERS8600-1:5(config)#*interface loopback 1* **ERS8600-1:5(config-if)#*ip address 10.1.1.1/32*** **ERS8600-1:5(config-if)#*ip ospf*** **ERS8600-1:5(config-if)#*exit***
PPCLI
ERS8600-1:5# *config ip circuitless-ip-int 1 create 10.1.1.1/32* **ERS8600-1:5# *config ip circuitless-ip-int 1 ospf enable***
PE-1 Step 4 – Add CLIP address as the OSPF Router Id and enable OSPF globally
CLI
ERS8600-1:5(config)#*router ospf* **ERS8600-1:5(config-ospf)#*router-id 10.11.1.1*** **ERS8600-1:5(config-ospf)#*exit*** **ERS8600-1:5(config)#*router ospf enable***

PPCLI
ERS8600-2:6# ***config ip ospf router-id 10.1.1.1*** **ERS8600-2:5#** ***config ip ospf enable***
PE-1 Step 5 – Enable LDP on core VLAN
CLI
ERS8600-1:5(config)#*interface vlan 2015* **ERS8600-1:5(config-if)#*mpls ldp*** **ERS8600-1:5(config-if)#*exit***
PPCLI
ERS8600-1:5# ***config vlan 2015 ip mpls rsvp state enable***
ERS8600-1 Step 6 – Use the CLIP address as the MPLS router-id and enable LDP globally
CLI
ERS8600-1:5(config)#*mpls router-id 10.1.1.1* **ERS8600-1:5(config)#** ***mpls ldp***
PPCLI
ERS8600-1:5# ***config mpls router-id 10.1.1.1*** **ERS8600-1:5#** ***config mpls ldp state enable***

9.1.1.2 VRF Configuration

PE-1: Step 1 – Create VRF instances
CLI
ERS8600-1:5(config)#*ip vrf red vrfid 11* **ERS8600-1:5(config)#*ip vrf blue vrfid 12***
PPCLI
ERS8600-1:5# ***config ip vrf red create id 11*** **ERS8600-1:5#** ***config ip vrf blue create id 12***
PE-1: Step 2 – Enable OSPF to each VRF instance

CLI
ERS8600-1:5(config)#router vrf blue ERS8600-1:5(router-vrf)#ip ospf ERS8600-1:5(router-vrf)#exit ERS8600-1:5(config)#router vrf red ERS8600-1:5(router-vrf)#ip ospf ERS8600-1:5(router-vrf)#exit
PPCLI
ERS8600-1:5# config ip vrf blue ospf create ERS8600-1:5# config ip vrf blue ospf enable ERS8600-1:5# config ip vrf red ospf create ERS8600-1:5# config ip vrf red ospf enable
PE-1: Step 3 – Create VLAN 1300 for VRF red and 1301 for VRF blue
CLI
ERS8600-1:5(config)#vlan ports 3/48 tagging tagall ERS8600-1:5(config)#vlan members remove 1 3/48 ERS8600-1:5(config)#vlan create 1300 name red type port 1 ERS8600-1:5(config)#vlan members add 1300 3/48 ERS8600-1:5(config)#interface vlan 1300 ERS8600-1:5(config-if)#vrf red ERS8600-1:5(config-if)#exit ERS8600-1:5(config)#vlan create 1301 name blue type port 1 ERS8600-1:5(config)#vlan members add 1301 3/48 ERS8600-1:5(config)#interface vlan 1301 ERS8600-1:5(config-if)#vrf blue ERS8600-1:5(config-if)#exit
PPCLI
ERS8600-1:5# config vlan 1 ports remove 3/48 ERS8600-1:5# config ethernet 3/48 perform-tagging enable ERS8600-1:5# config vlan 1300 create byport 1 ERS8600-1:5# config vlan 1300 name red ERS8600-1:5# config vlan 1300 vrf red

```
ERS8600-1:5# config vlan 1300 ports add 3/48
ERS8600-1:5# config vlan 1301 create byport 1
ERS8600-1:5# config vlan 1301 name blue
ERS8600-1:5# config vlan 1301 vrf blue
ERS8600-1:5# config vlan 1301 ports add 3/48
```

PE-1: Step 4 – Add IP address and enable OSPF to each VRF instance

CLI

```
ERS8600-1:5(config)#interface vlan 1300
ERS8600-1:5(config-if)#ip address 10.1.130.1 255.255.255.0
ERS8600-1:5(config-if)#ip ospf enable
ERS8600-1:5(config-if)#exit
ERS8600-1:5(config)#interface vlan 1301
ERS8600-1:5(config-if)#ip address 10.1.131.1 255.255.255.0
ERS8600-1:5(config-if)#ip ospf enable
ERS8600-1:5(config-if)#exit
```

PPCLI

```
ERS8600-1:5# config vlan 1300 ip create 10.1.130.1/24
ERS8600-1:5# config vlan 1300 ip ospf enable
ERS8600-1:5# config vlan 1301 ip create 10.1.131.1/24
ERS8600-1:5# config vlan 1301 ip ospf enable
```

PE-1: Step 5 – Enable OSPF globally for VRF 11 and 12

CLI

```
ERS8600-1:5(config)#router vrf blue
ERS8600-1:5(router-vrf)#ip ospf admin-state
ERS8600-1:5(router-vrf)#exit
ERS8600-1:5(config)#router vrf red
ERS8600-1:5(router-vrf)#ip ospf admin-state
ERS8600-1:5(router-vrf)#exit
```

PPCLI

```
ERS8600-1:5# config ip vrf blue ospf enable
ERS8600-1:5# config ip vrf red ospf enable
```

9.1.1.3 BGP Configuration

PE-1 Step 1 – Configure BGP Globally
CLI
ERS8600-1:5(config)#***router bgp*** ERS8600-1:5(router-bgp)#***no auto-summary*** ERS8600-1:5(router-bgp)#***no synchronization*** ERS8600-1:5(router-bgp)#***no bgp aggregation enable*** ERS8600-1:5(router-bgp)#***exit*** ERS8600-1:5(config)#***router bgp 3030 enable***
PPCLI
ERS8600-1:5# ***config ip bgp auto-summary disable*** ERS8600-1:5# ***config ip bgp*** synchronization ***disable*** ERS8600-1:5# ***config ip bgp local-as 3030*** ERS8600-1:5# ***config ip bgp aggregation disable*** ERS8600-1:5# ***config ip bgp enable***
PE-1 Step 2 – Configure MP-BGP neighbor to the Cisco PE-2 router using the loopback address of 10.100.100.4 as the peer
CLI
ERS8600-1:5(config)#***router bgp*** ERS8600-1:5(router-bgp)#***neighbor 10.100.100.4*** ERS8600-1:5(router-bgp)#***neighbor 10.100.100.4 remote-as 3030*** ERS8600-1:5(router-bgp)#***neighbor 10.100.100.4 address-family vpnv4 enable*** ERS8600-1:5(router-bgp)#***neighbor 10.100.100.4 update-source 10.1.1.1*** ERS8600-1:5(router-bgp)#***neighbor 10.100.100.4 enable***
PPCLI
ERS8600-1:5# ***config ip bgp neighbor 10.100.100.4 create*** ERS8600-1:5# ***config ip bgp neighbor 10.100.100.4 remote-as 3030*** ERS8600-1:5# ***config ip bgp neighbor 10.100.100.4 address-family vpnv4 enable*** ERS8600-1:5# ***config ip bgp neighbor 10.100.100.4 update-source-interface 10.1.1.1 add*** ERS8600-1:5# ***config ip bgp neighbor 10.100.100.4 admin-state enable***

PE-1 Step 3 – Configure BGP on each VRF
CLI
ERS8600-1:5(config)#***router vrf blue*** ERS8600-1:5(router-vrf)#***ip bgp*** ERS8600-1:5(router-vrf)#***no ip bgp auto-summary*** ERS8600-1:5(router-vrf)#***no ip bgp synchronization*** ERS8600-1:5(router-vrf)#***ip bgp enable*** ERS8600-1:5(router-vrf)#***exit*** ERS8600-1:5(config)#***router vrf red*** ERS8600-1:5(router-vrf)#***ip bgp*** ERS8600-1:5(router-vrf)#***no ip bgp auto-summary*** ERS8600-1:5(router-vrf)#***no ip bgp synchronization*** ERS8600-1:5(router-vrf)#***ip bgp enable*** ERS8600-1:5(router-vrf)#***exit***
PPCLI
ERS8600-1:5# ***config ip vrf blue bgp create*** ERS8600-1:5# ***config ip vrf blue bgp auto-summary disable*** ERS8600-1:5# ***config ip vrf blue bgp synchronization disable*** ERS8600-1:5# ***config ip vrf blue bgp enable*** ERS8600-1:5# ***config ip vrf red bgp create*** ERS8600-1:5# ***config ip vrf red bgp auto-summary disable*** ERS8600-1:5# ***config ip vrf red bgp synchronization disable*** ERS8600-1:5# ***config ip vrf red bgp enable***

9.1.1.4 IP VPN Configuration

PE-1 Step 1 – Configure IPVPN where the RD equals the node number and VRF id and RT equals VRF id
CLI
ERS8600-1:5(config)#***router vrf blue*** ERS8600-1:5(router-vrf)#***ipvpn*** ERS8600-1:5(router-vrf)#***rd 3030 1301*** ERS8600-1:5(router-vrf)#***route-target import 3030 1301*** ERS8600-1:5(router-vrf)#***route-target export 3030 1301*** ERS8600-1:5(router-vrf)#***ipvpn enable*** ERS8600-1:5(router-vrf)#***exit*** ERS8600-1:5(config)#***router vrf red*** ERS8600-1:5(router-vrf)#***ipvpn*** ERS8600-1:5(router-vrf)#***rd 3030 1300*** ERS8600-1:5(router-vrf)#***route-target both 3030 1300*** ERS8600-1:5(router-vrf)#***ipvpn enable*** ERS8600-1:5(router-vrf)#***exit***
PPCLI
ERS8600-1:5# ***config ip vrf blue ipvpn create*** ERS8600-1:5# ***config ip vrf blue ipvpn rd 3030:1301*** ERS8600-1:5# ***config ip vrf blue ipvpn rt add both 3030:1301*** ERS8600-1:5# ***config ip vrf blue ipvpn enable*** ERS8600-1:5# ***config ip vrf red ipvpn create*** ERS8600-1:5# ***config ip vrf red ipvpn rd 3030:1300*** ERS8600-1:5# ***config ip vrf red ipvpn rt add both 3030:1300*** ERS8600-1:5# ***config ip vrf red ipvpn enable***

9.1.1.5 Add Route Policy to Re-distribute VRF BGP Routes into the VRF OSPF Instance

All external routes learned by IP-VPN will be distributed by BGP. In order for the CE routers to learn these routes, we must configure each VRF as and OSPF ASBR and enable route re-distribution.

PE-1 Step 1 – Enable each VRF as an OSPF ASBR

CLI

```
ERS8600-1:5(config)#router vrf blue
ERS8600-1:5(router-vrf)#ip ospf as-boundary-router enable
ERS8600-1:5(router-vrf)# ip ospf redistribute bgp
ERS8600-1:5(router-vrf)#ip ospf redistribute bgp enable
ERS8600-1:5(router-vrf)#exit
ERS8600-1:5(config)#router vrf red
ERS8600-1:5(router-vrf)#ip ospf as-boundary-router enable
ERS8600-1:5(router-vrf)# ip ospf redistribute bgp
ERS8600-1:5(router-vrf)#ip ospf redistribute bgp enable
ERS8600-1:5(router-vrf)#exit
```

PPCLI

```
ERS8600-1:5# config ip vrf blue ospf as-boundary-router enable
ERS8600-1:5# config ip vrf red ospf as-boundary-router enable
```

PE-1 Step 2 – Enable BGP redistribution into OSPF for each VRF

CLI

```
ERS8600-1:5(config)#router vrf blue
ERS8600-1:5(router-vrf)#ip ospf as-boundary-router enable
ERS8600-1:5(router-vrf)#exit
ERS8600-1:5(config)#router vrf red
ERS8600-1:5(router-vrf)#ip ospf as-boundary-router enable
ERS8600-1:5(router-vrf)#exit
```

PPCLI

```
ERS8600-1:5# config ip vrf blue ospf redistribute bgp create
ERS8600-1:5# config ip vrf blue ospf redistribute bgp enable
ERS8600-1:5# config ip vrf red ospf redistribute bgp create
ERS8600-1:5# config ip vrf red ospf redistribute bgp enable
```

9.1.2 PE 2 Configuration: Cisco 7602

```
!
no aaa new-model
ip source-route
ip cef
!
ip vrf blue
 rd 3030:1301
 route-target export 3030:1301
 route-target import 3030:1301
!
ip vrf red
 rd 3030:1300
 route-target export 3030:1300
 route-target import 3030:1300
!
no ipv6 cef
!
multilink bundle-name authenticated
mpls label protocol ldp
!
archive
 log config
  hidekeys
!
interface Loopback1
 ip address 10.100.100.4 255.255.255.255
!
interface Loopback2
 ip vrf forwarding red
 ip address 10.0.72.1 255.255.255.255
!
interface GigabitEthernet0/2
 ip address 10.91.100.5 255.255.255.252
 duplex auto
 speed auto
 media-type rj45
 no negotiation auto
 mpls bgp forwarding
 mpls label protocol ldp
 mpls ip
!
interface GigabitEthernet0/3
 no ip address
 duplex full
 speed 100
 media-type rj45
 no negotiation auto
 no cdp enable
!
interface GigabitEthernet0/3.1300
 encapsulation dot1Q 1300
 ip vrf forwarding red
 ip address 10.72.72.1 255.255.255.0
!
interface GigabitEthernet0/3.1301
 encapsulation dot1Q 1301
 ip vrf forwarding blue
 ip address 10.72.131.1 255.255.255.0
!
router ospf 2 vrf red
 router-id 10.0.72.1
 log-adjacency-changes
 redistribute bgp 3030 metric-type 1
subnets
 network 10.72.72.0 0.0.0.255 area 0
!
router ospf 1
 router-id 10.100.100.4
 log-adjacency-changes
 network 10.91.100.4 0.0.0.3 area 0
 network 10.100.100.4 0.0.0.0 area 0
!
router bgp 3030
 bgp router-id 10.100.100.4
 no bgp log-neighbor-changes
 timers bgp 30 90
 neighbor vpn peer-group
 neighbor vpn remote-as 3030
 neighbor vpn update-source Loopback1
 neighbor 10.1.1.1 peer-group vpn
 !
 address-family ipv4
  neighbor vpn send-community extended
  neighbor 10.1.1.1 activate
  no auto-summary
  no synchronization
 exit-address-family
 !
 address-family vpnv4
  neighbor vpn send-community extended
  neighbor 10.1.1.1 activate
  exit-address-family
 !
 address-family ipv4 vrf red
  redistribute connected
  redistribute ospf 2 vrf red
  neighbor 10.1.1.1 remote-as 3030
  neighbor 10.1.1.1 activate
  no synchronization
 exit-address-family
 !
 address-family ipv4 vrf blue
  redistribute connected
  neighbor 10.1.1.1 remote-as 3030
  neighbor 10.1.1.1 activate
  no synchronization
 exit-address-family
!
mpls ldp router-id Loopback1
!
control-plane
!
mgcp fax t38 ecm
mgcp behavior g729-variants static-pt
!
```

9.2 Verify Operations

9.2.1 Verify OSPF Operations

9.2.1.1 Verify OSPF Admin State and Router ID

Step 1 – Verify that the OSPF admin state and Router ID.

```
ERS8600-1:5#show ip ospf
PPCLI: ERS8600:6# show ip ospf info
```

Result:

```
================================================================================
                          OSPF General - GlobalRouter
================================================================================

            RouterId: 10.1.1.1
           AdminStat: enabled
       VersionNumber: 2
    AreaBdrRtrStatus: false
      ASBdrRtrStatus: false
      ExternLsaCount: 0
   ExternLsaCksumSum: 0(0x0)
          TOSSupport: 0
    OriginateNewLsas: 306
           RxNewLsas: 4252
          TrapEnable: false
  AutoVirtLinkEnable: false
     SpfHoldDownTime: 10
Rfc1583Compatibility: disable
```

9.2.1.2 Verify OPSF Neighbors

Step 1 – Verify that the OSPF neighbors.

```
ERS8600-1:5#show ip ospf neighbor
```

Result:

```
================================================================================
                         OSPF Neighbors - GlobalRouter
================================================================================
INTERFACE       NBRROUTERID     NBRIPADDR       PRIO_STATE    RTXQLEN PERMANENCE
--------------------------------------------------------------------------------
10.93.102.2     10.100.100.1    10.93.102.1     0    Full     0       Dynamic
```

9.2.1.3 MPLS LDP State

Step 1 – Verify that the LDP state

```
ERS8600-1:5#show mpls ldp
PPCLI: ERS8600:5# show mpls ldp info
```

Result:
State : **enabled** Penultimate Hop Pop : implicit-null Hello Hold Time : 15 Session Keep Alive : 40 Loop Detect Hop Count Limit : disabled Loop Detect Path Vector Limit: disabled Redist-connected : disabled Session Status Traps : disabled Session Threshold Traps : disabled Path Vector Limit Traps : disabled

On the ERS8600 switch, verify the following information:

Option	Verify
State	Verify that the LDP state is ***Enabled.***

9.2.1.4 Verify LDP ID

Step 1 – Verify LDP Id
ERS8600-1:5#***show mpls ldp summary***
Result:
Local Ldp Id : **10.1.1.1:0** Routes : 18 Interface Adjacencies : 2 Extended Adjacencies : 0 Sessions : 2 Label Switched Paths : 14 Programmed In-segments : 9 Programmed Out-segments: 5 Redist-connected : disabled

On the ERS8600 switch, verify the following information:

Option	Verify
Local Ldp Id	Verify that the LDP is the CLIP address configured on the switch. For the PE-1 switch, the LDP ID should be displayed as ***10.1.1.1***.

9.2.1.5 Verify LDP Interface, Session, Discovery, and Neighbors

Step 1 – Verify LDP interface

```
ERS8600-1:5#show mpls ldp interface
```

Result:

```
        Local LDP Id : 10.1.1.1:0
           Interface : Vlan 2015 ; State : Up
              Nbr Count : 1
              Hello Interval : 5 ; Next Hello : 5
```

Step 2 – Verify LDP session

```
ERS8600-1:5# show mpls ldp session
```

Result:

```
        Local LDP ID : 10.1.1.1:0
            Peer LDP ID : 10.100.100.1:0 ; State : Operational
                 Hold Time : 30 ; Hold Time Remaining : 28

        Total LDP sessions : 1
```

Step 3 – Verify LDP discovery

```
ERS8600-1:5#show mpls ldp discovery
```

Result:

```
        Peer Ldp Id : 10.100.100.1:0 ; Transport Address : 10.100.100.1
              Interface : Vlan 2015
              Hello Holdtime : 15
              Config Seq Num : 1
```

Step 4 – Verify LDP neighbor

```
ERS8600-1:5#show mpls ldp neighbor
PPCLI: ERS8600-1:5# show mpls ldp peer-address
```

Result:

```
        Peer LDP ID : 10.100.100.1:0
             Address : 10.91.100.1
                       10.91.100.6
                       10.93.102.1
                       10.100.100.1
```

On PE-1, verify the following information:

Option	Verify
Local Ldp Id	Verify that the Local LDP ID is the CLIP address configured on the switch. For the PE-1 switch, the LDP ID should be displayed as ***10.1.1.1***.
Peer LDP ID & Interface & State	Verify the Peer LDP ID is that for the direct neighbors. In the case of PE-1 which is connected to MPLS router P1, the Peer LDP ID should show up depending on how the direct P router is configured. For this example, P-1 LDP ID is ***10.100.100.1*** via interface ***VLAN 2015***. The State should also be ***Operational.***

9.2.1.6 MPLS LDP Path

Step 1 – Verify that the LDP labels used by issuing the following command:

```
ERS8600-1:5#show mpls ldp bindings
PPCLI: ERS8600:5# show mpls ldp path
```

Result:

```
        Fec : 10.1.1.1/32
               Local Binding : Label:3
              Remote Binding : 10.100.100.1:0 ; Label : 100096(inactive)

         Fec : 10.100.100.1/32
              Remote Binding : 10.100.100.1:0 ; Label : 3(active)

         Fec : 10.100.100.2/32
              Remote Binding : 10.100.100.1:0 ; Label : 100000(active)

         Fec : 10.100.100.4/32
              Remote Binding : 10.100.100.1:0 ; Label : 100032(active)

        Total LDP paths : 4
```

On the ERS8600 switch, verify the following information:

Option	Verify
Fec Local Binding Remote Binding	The LDP Forwarding Equivalence Class (FEC) is displayed here with each label it distributes. Both the local and remote LDP label is displayed here and which label is active or inactive. The active binding should follow the IGP route table.

9.2.1.7 LDP Statistics

By default, MPLS receive and transmit statistic are disabled and can be enabled by using the following commands:

PPCLI

- ERS8600-2:6# ***config mpls statistics receive***

```
Sub-Context:
Current Context:

    disable
    enable
    start-label <label#>
    info
```

- ERS8600-2:6# ***config mpls statistics transmit enable***

```
Sub-Context:
Current Context:

    disable
    enable
    start-label <label#>
    info
```

CLI

- ERS8600-1:5(config)#***mpls statistics transmit***

```
  start-label  Transmit lsp start label
  <cr>
```

- ERS8600-1:5(config)#***mpls statistics receive***

```
  start-label  Receive lsp start label
<cr>
```

9.2.1.8 Verify IP-VPN Route Distinguisher and Route Targets

Step 1 – Verify that the IP-VPN RD ant RT
ERS8600-1:5# ***show ip vrf ipvpn info*** CLI: ERS8600:5#***show ip ipvpn***
Result:

```
VRF Name             : red
Ipvpn-state          : enabled
Route-distinguisher  : Type-0 - 3030 : 1300
Import Route-Targets : Type-0 - 3030 : 1300
Export Route-Targets : Type-0 - 3030 : 1300
Svc Label Option     : per-vrf


VRF Name             : blue
Ipvpn-state          : enabled
Route-distinguisher  : Type-0 - 3030 : 1301
Import Route-Targets : Type-0 - 3030 : 1301
Export Route-Targets : Type-0 - 3030 : 1301
Svc Label Option     : per-vrf
```

On the ERS8600 switch, verify the following information:

Option	**Verify**
VRF Name	For each VRF, using the parameters in this configuration example, the IPVPN Route Distinguisher and Route Targets should be as shown below. In this example, the route distinguisher is equal to the combination of the BGP AS number and the PE-1 number plus VRF number. The IPVPN Route Target is equal to the BGP AS number and the VRF id.

Node	**VRF**	**RD**	**RT (import & export)**
PE-1	Blue	3030:1301	3030:1301
	Red	3030:1300	3030:1300
PE-2	Blue	3030:1301	3030:1301
	Red	3030:1300	3030:1300

9.2.1.9 VRF Routes

Use the following command to verify the VRF routes. For this example, we will simply view the routes for the red VRF on PE-1.

Step 1 – VRF route table for the blue VRF

```
ERS8600-1:5# show ip route info vrf red
NNCLI: ERS8600:5#show ip route vrf red
```

Result:

```
================================================================================
                              IP Route - VRF red
================================================================================
                                                 NH          INTER
DST              MASK            NEXT            VRF    COST FACE   PROT AGE TYPE PRF
--------------------------------------------------------------------------------
10.0.72.1      255.255.255.255 10.100.100.4    Glob~ 0    2015   BGP   0   IBV  175
10.1.130.0     255.255.255.0   10.1.130.1       -    1    1300   LOC   0   DB   0
10.1.140.0     255.255.255.0   10.1.130.10     red   11   1300   OSPF  0   IB   20
10.1.141.0     255.255.255.0   10.1.130.10     red   11   1300   OSPF  0   IB   20
10.72.72.0     255.255.255.0   10.93.102.1     Glob~ 0    2015   BGP   0   IBV  175
10.72.140.0    255.255.255.0   10.93.102.1     Glob~ 0    2015   BGP   0   IBV  175
10.72.141.0    255.255.255.0   10.93.102.1     Glob~ 0    2015   BGP   0   IBV  175
10.130.1.1     255.255.255.255 10.130.1.1       -    1    0      LOC   0   DB   0

8 out of 8 Total Num of Route Entries, 8 Total Num of Dest Networks displayed.
--------------------------------------------------------------------------------
TYPE Legend:
I=Indirect Route, D=Direct Route, A=Alternative Route, B=Best Route, E=Ecmp Rout
e,
U=Unresolved Route, N=Not in HW, F=Replaced by FTN, V=IPVPN Route
PROTOCOL Legend:
v=Inter-VRF route redistributed
```

On each ERS8600 in the switch cluster verify the following information:

Option	Verify
NH VRF INTERFACE PROT	All local routes learned, in this case by PE-1, via the locally attached CE router with display a “NH VRF” value of red via VLAN 1300 using a protocol of OSPF. All external routes from PE-1 are learned via BGP via VLAN 2015.
TYPE	For all external routes learned, the Type will be displayed with “V” to indicate an IP-VPN route.

If the VRF routes are not showing up or missing: a) ensure that the IGP protocol (OSPF in this example) is up and operation and peered with each neighbor, b) ensure that LDP is operational, c) ensure that you have PE-PE connectivity by performing an ‘mplsping’ to the remote PE CLIP address and d) ensure that you ping the VRF interfaces.

For example, in reference to PE-1, ensure that it can ping PE routers PE-1 and PE-2 as follows using CLIP/Loopback addresses:

- ERS8600-1:5# ***ping 10.100.100.4 source ipvpn source 10.1.1.1***

```
10.91.1.1 is alive
```

- CLI: ***ping-mpls ipv4 10.100.100.4/32 source 10.1.1.1***

9.2.1.10 View VRF BGP Route Table

To view BGP route table for each VRF, please issue the following command. The following example shows the route table for the red VRF via PE-1's perspective.

Step 1 – VRF BGP route table for the red VRF

```
ERS8600-1:5# show ip bgp route vrf red
```

Result:

```
================================================================================
                              BGP Routes - VRF red
================================================================================
The total number of routes is 4

NETWORK/MASK       PEER REM ADDR   NEXTHOP ADDRESS ORG LOC PREF
--------------------------------------------------------------------------------
10.0.72.1/32       10.100.100.4    10.100.100.4    INC 100
        AS_PATH: path-is-empty
        MED:0
10.72.72.0/24      10.100.100.4    10.100.100.4    INC 100
        AS_PATH: path-is-empty
        MED:0
10.72.140.0/24     10.100.100.4    10.100.100.4    INC 100
        AS_PATH: path-is-empty
        MED:2
10.72.141.0/24     10.100.100.4    10.100.100.4    INC 100
        AS_PATH: path-is-empty
        MED:2
```

On PE-1, verify the following information:

Option	Verify
PEER REM ADDR NEXTHOP	Please note that the BGP Peer and Next-hop address from PE-1 perspective is the circuitless IP (CLIP) address from PE-2.

9.2.1.11 View BGP IP-VPN Learned Routes

To view the VPN-IPv4 routes for each VRF, please use the following command. The following is in reference to the red VRF via PE-1 perspective.

Step 1 – VRF BGP route table for the red VRF

```
ERS8600-2:5# show ip bgp route-vpnv4 ext-community vrf red
NNCLI: ERS8600#show ip bgp vpnv4 ext-community vrf red
```

Result:

```
================================================================================
                            IPVPN BGP Routes - VRF red
================================================================================

 The total number of vpn routes are 4

NETWORK/MASK       PEER REM ADDR   NEXTHOP ADDRESS ORG LOC PREF  SVC LABEL
--------------------------------------------------------------------------------

10.0.72.1/32       10.100.100.4    10.100.100.4    INC 100       70

        Svc Label: 0x46
        RD -Type: ASNUM  Value: 3030:1300

        RT -Type: ASNUM   Value: 3030:1300

10.72.72.0/24      10.100.100.4    10.100.100.4    INC 100       79

        Svc Label: 0x4f
        RD -Type: ASNUM  Value: 3030:1300

        RT -Type: ASNUM   Value: 3030:1300


10.72.140.0/24     10.100.100.4    10.100.100.4    INC 100       98

        Svc Label: 0x62
        RD -Type: ASNUM  Value: 3030:1300

        RT -Type: ASNUM   Value: 3030:1300

10.72.141.0/24     10.100.100.4    10.100.100.4    INC 100       81

        Svc Label: 0x51
        RD -Type: ASNUM  Value: 3030:1300

        RT -Type: ASNUM   Value: 3030:1300
```

On PE-1, verify the following information:

Option	Verify
NEXTHOP RD RT	For nexthop of ***10.100.100.4,*** RD of ***3030:1300*** and RT of ***3030:1300*** should be displayed

9.2.1.12 Viewing MPLS Label

Step 1a – Enter the following command to view the global route table; notice for the type of "IBF" are replaced with MPLS label as displayed via the "show mpls ftn info" command in step 1b below

```
ERS8600-1:5# show ip route info
```

Result:

```
================================================================================
                            IP Route - GlobalRouter
================================================================================
                                                 NH          INTER
DST              MASK            NEXT           VRF    COST FACE   PROT AGE TYPE PRF
--------------------------------------------------------------------------------
10.1.1.1       255.255.255.255 10.1.1.1          -     1    0      LOC  0   DB   0
|
|
10.100.100.2   255.255.255.255 10.93.102.1     Glob~ 11   2015   OSPF 0   IBF  20
10.100.100.4   255.255.255.255 10.93.102.1     Glob~ 12   2015   OSPF 0   IBF  20
|
|

81 out of 81 Total Num of Route Entries, 81 Total Num of Dest Networks displayed
.

--------------------------------------------------------------------------------
TYPE Legend:
I=Indirect Route, D=Direct Route, A=Alternative Route, B=Best Route, E=Ecmp Rout
e,
U=Unresolved Route, N=Not in HW, F=Replaced by FTN, V=IPVPN Route
PROTOCOL Legend:
v=Inter-VRF route redistributed
```

Step 1b – Enter the following command to display the MPLS out label pushed out, for this example, by PE-1. FTN refers to the FEC (Forwarding Equivalence Class) to HHLFE (Next Hop Label Forwarding Entry).

```
ERS8600-1:5# show mpls ftn info
```

NNCLI command: ERS8600:5# ***show mpls ftn***

Result:

```
      Dest/Mask : 10.100.100.2/255.255.255.255
            Out Label : 100000 ; Out Port : Vlan 2015 ; Next-Hop : 10.93.102.1
            Type : ldp-dynamic
       Dest/Mask : 10.100.100.4/255.255.255.255
            Out Label : 100032 ; Out Port : Vlan 2015 ; Next-Hop : 10.93.102.1
            Type : ldp-dynamic
```

Step 2 – Use the following command to specify a specific path, for example, to PE-2 Circuitless IP address

```
ERS8600-1:5# show mpls ftn info 10.100.100.4/32
```

```
NNCLI: ERS8600:5# show mpls ftn 10.100.100.4/32
```

Result:

```
     Dest/Mask : 10.100.100.4/255.255.255.255
           Out Label : 100032 ; Out Port : Vlan 2015 ; Next-Hop : 10.93.102.1
           Type : ldp-dynamic
```

Step 3 – To test if the MPLS path is operation, i.e. to 10.100.100.4/32, enter the following command

```
ERS8600-1:5# mplsping ipv4 10.100.100.4/32 count 3
NNCLI: ERS8600:5#ping-mpls ipv4 10.100.100.4/32 count 3
```

Results:

```
     Success for FEC 10.100.100.4/32: mpls_seq=1.
     Success for FEC 10.100.100.4/32: mpls_seq=2.
     Success for FEC 10.100.100.4/32: mpls_seq=3.
     Label Switched Path to FEC 10.100.100.4/32 is operational.
     ------ MPLS PING Statistics------
      3 packets transmitted, 3 packets received, 0% packet loss
```

10. Appendix A

10.1 Cisco to Avaya CLI Command Comparison

Config Task Description	Cisco (based on IOS 12.2(46)SE Catalyst 3750-E & 3560-E)	Avaya 4500/5000 (based on CLI ERS5000 & ERS4500 rel. 5.x)	Avaya ERS8600 Release 5.x
CLI Mode: CLI/PPCLI			
Convert between PPCLI to CLI			ERS-8610:5# **save config file /flash/<new CLI file name> backup /flash/<orginal PPCLI file name> mode nncli**
Convert between CLI to PPCLI			ERS8610:5# ***save*** **config file /flash/<new PPCLI file name> backup /flash/<original CLI file name> mode cli**
Enable CLI Mode from PPCLI interface			ERS-8610:5# **config boot choice primary config-file /flash/config_nncli.cfg** ERS-8610:5# **config boot flags nncli true**
Logistics			
Enter privileged EXEC Mode	Switch>**enable**	5520-48-PWR>**enable**	ERS-8610:5>**enable**
Enter Global Config Mode	Switch#**configure terminal**	5520-48-PWR#**configure terminal**	ERS-8610:5#**configure terminal**
Set System Name (Hostname) and domain name	Switch(config)#**hostname <name>**	5520-48-PWR(config)#**snmp-server name <name>**	ERS-8610:5(config)#**snmp-server name <name>**
	C3750(config)#**ip domain-name <cisco.com>**	ERS5520(config)#**ip domain-name <nortel.com>**	ERS8600:5(config)#**ip domain-name <nortel.com>**
Setting encrypted Password to *secret_password* to access privileged EXEC Mode	C3750(config)#**enable secret <secret_password>**		ERS8600:5(config)#**cli password <rwa> read-write-all** Enter the old password : ******* Enter the New password : *** Re-enter the New password : ***
Enable login via console with password	C3750(config)#**line console 0** C3750(config-line)#**password <word>** **C3750(config-line)#login** C3750(config-line)#**exit**	ERS5520(config)#**cli password serial local** ERS5520(config)#**cli password read-write <password>**	No separate password for console or telnet; use **<rwa>** user configured access as above

Config Task Description	Cisco (based on IOS 12.2(46)SE Catalyst 3750-E & 3560-E)	Avaya 4500/5000 (based on CLI ERS5000 & ERS4500 rel. 5.x)	Avaya ERS8600 Release 5.x
Enable login via telnet with password *telnet_password*	C3750(config)#**line vty 0 4** C3750(config-line)#**password <word>** C3750(config-line)#**login** C3750(config-line)#**exit**	ERS5520(config)#**cli password telnet local** ERS5520(config)#**cli password read-write <password>**	No separate password for console or telnet; use **<rwa>** user configured access as above
Setting Switch management IP address and default gateway			ERS8600:5(config)#**boot config net mgmt ip <192.168.168.1> <255.255.255.0>**
Use VLAN 1 for management	C3750(config)#**interface vlan <1>**	ERS5520(config)#**vlan mgmt <1>**	ERS8600:5(config)#**interface vlan <1>**
Assign management IP address	C3750(config-if)#**ip address <a.b.c.d> <x.x.x.x>** **Example:** Using VLAN 200 for management Cat2950-1-6(config)#**vlan 200** Cat2950-1-6(config-vlan)#n**ame mgmt** Cat2950-1-6(config-vlan)#**exit** Cat2950-1-6(config)#i**nterface vlan 200** Cat2950-1-6(config-if)#**ip address 192.168.1.10 255.255.255.0** Cat2950-1-6(config-if)#**exit** Cat2950-1-6(config)#i**p default-gateway 192.168.1.1** C3750(config-if)#**exit**	Layer 2 Mode: ERS5520(config)#**ip address switch <a.b.c.d> netmask <x.x.x.x> default-gateway (a.b.c.d>** ERS5520(config)#**ip address stack < a.b.c.d > netmask <x.x.x.x> default-gateway < a.b.c.d>** Layer 3 Mode: ERS5520(config-if)#**ip address < a.b.c.d> <x.x.x.x>** **L3 Example:** Using VLAN 200 for management ERS5520(config)#**vlan create 200 type port** ERS5520(config)#**vlan mgmt 200** ERS5520(config)#**interface vlan 200** ERS5520(config-if)#**ip address 192.168.1.254 255.255.255.0**	ERS8600:5(config-if)#**ip address <a.b.c.d> <x.x.x.x>** ERS8600:5(config-if)#**exit**
Assign out-of-band IP route			ERS8600:5(config)#**boot config net mgmt route <47.0.0.0/255.0.0.0 47.162.102.1>**
Configure default gateway	C3750(config)#**ip default-gateway <192.168.1.1>**	Layer 2: ERS5520(config)#**ip default-gateway <192.168.1.1>**	ERS8600:5(config)#**ip route <a.b.c.d x.x.x.x a.b.c.d> weight <1>**

VLAN			
Show VLANs	C3750#**show vlan**	ERS5520(config)#**show vlan**	ERS8600:5#**show vlan basic**
Disable VTP participation – recommended setting	C3750(config)#**vtp mode transparent**	**N/A**	**N/A**
Creating two VLANs: Vlan 10 Engineering and VLAN 20 Marketing	C3750(config)#**vlan 10** C3750(config-vlan)#**name Engineering** C3750(config-vlan)#**exit** C3750(config-vlan)#**vlan 20** C3750(config-vlan)#**name Marketing** C3750(config-vlan)#**exit**	ERS5520(config)#**vlan create 10 type port** ERS5520(config)#**vlan name 10 Engineering** ERS5520(config)#**vlan create 20 type port** ERS5520(config)#**vlan name 20 Marketing**	ERS-8610:5(config)#**vlan create 10 type port** ERS-8610:5(config)#**vlan name 10 Engineering** ERS-8610:5(config)#**vlan create 20 type port** ERS-8610:5(config)#**vlan name 20 Marketing**
Adding an acces port to a VLAN, i.e. VLAN 1000	C3750(config)#**interface gigabitEthernet 7/0/12** C3750(config-if)#**switchport mode access** C3750(config-if)#**switchport access vlan 1000**	5520-1(config)#***vlan members add 1000 12***	ERS-8610:5(config)#***vlan members add 1000 12***
Adding a range of access ports to a VLAN	C3750(config)#**interface range gigabitEthernet 7/0/3-11** C3750(config-if)#**switchport mode access** C3750(config-if)#**switchport access vlan 1000**	5520-1(config)#***vlan members add 1000 3-11***	ERS-8610:5(config)#***vlan members add 1000 3/30-3/35***
Configuring trunk port with 802.1Q encapsulation	C3750(config)#**interface gi1/0/41** C3750(config-if)#**switchport trunk encapsulation dot1q** C3750(config-if)#**switchport mode trunk**	ERS5520(config)#**vlan port 41 tagging enable** or 5520(config)#**vlan ports 41 tagging tagall**	ERS-8610:5(config)#**vlan ports 1/33 tagging tagAll**
Configuring trunk port with 802.1Q encapsulation and add VLAN's	C3750(config)#**interface gi1/0/41** C3750(config-if)#**switchport trunk encapsulation dot1q** C3750(config-if)#**switchport switchport trunk allowed vlan 804,1000** C3750(config-if)#**switchport mode trunk**	5520(config)#**vlan ports 41 tagging tagall** 5520(config)#**vlan members add 804 41** 5520(config)#**vlan members add 1000 41**	ERS-8610:5(config)#**vlan ports 1/33 tagging tagAll** ERS-8610:5(config)#**vlan members add 804 1/33** ERS-8610:5(config)#**vlan members add 1000 1/33**
Adding tagged Voice VLAN and untagged data VLAN on same port	C3750(config)#**interface range gigabitEthernet 7/0/3-11** C3750(config-if)#**switchport access vlan 1000** C3750(config-if)#**switchport mode access** C3750(config-if)#s**witchport voice vlan 804**	5520(config)#**vlan ports 3-11 tagging untagpvidOnly** 5520(config)#**vlan members add 1000 3-11** 5520(config)#**vlan members add 804 3-11** 5520(config)#**vlan ports 3-11 pvid 1000**	ERS-8610:5(config)#**vlan ports 1/33 tagging tagAll** ERS-610:5(config)#**interface fastEthernet 1/33** ERS-8610:5(config-if)#**untag-port-default-vlan enable** ERS-8610:5(config-if)# **default-vlan-id 1000**
Verify VLAN configuration	C3750#**show interfaces switchport**	ERS5520#**show vlan interface info**	ERS-8610:5#**show vlan members**
	C3750#**show interfaces trunk**	ERS5520#**show vlan interface vids**	
	C3750#**show vlan**	ERS5520#**show vlan**	ERS-8610:5#**show vlan members** ERS-8610:5#**show vlan basic**

			ERS-8610:5#**show vlan advance**
View forwarding database	C3750#**show mac-address-table**	ERS5520#**show mac-address-table**	ERS-8610:5#**show vlan mac-address-entry**
Setting VLAN PVID (port VLAN ID)		ERS5520#**vlan port <port #> pvid <1-4094>**	
Using Exec commands in Configuration Mode	C3750(config)#**do show vlan**	5520(config)#**show vlan** **Note:** ERS 5500 does not require "do" in front of Exec command	ERS-8610:5(config)#**show vlan basic** **Note:** ERS 8600 does not require "do" in front of Exec command
Maintanence			
VLAN configuration file	By default, all VLAN and VTP information is stored in flash using the file name of "vlan.dat". VLAN information in configuration file is vtp transparent is enabled		
Save configuration	C3750#**copy running-config startup-config** or C3750#**write memory**	5520-1#**copy config nvram** 5520-1#**write memory** 5520-1#**save config**	ERS-8610:5#**copy running-config startup-config** or ERS-8610:5#**write memory**
Reboot	C3750# **reload** System configuration has been modified. Save? [yes/no]: **yes** Building configuration... [OK] Proceed with reload? [confirm]**y**	5520-1#**boot** Reboot the unit(s) (y/n) ?**y**	ERS-8610:5#**boot -y**
Time	C3750#**clock set 11:59:10 11 November 2008**	5520(config)#**clock set <mmddyyyyhhmmss>** 5520(config)#**clock source <rtc|sntp|sysUpTime>** 5520(config)#**clock time-zone <word> <dif from UTC>** Example: EST: 11:01am, Jan. 29, 2010 5520(config)#**clock set 01292010110100** 5520(config)#**clock source rtc** 5520(config)#**clock time-zone EST -5** 5520(config)#**clock summer-time EST date 14 March 2010 02:00 1 November 2010 02:00 +60**	ERS8600-5:5#**clock set <MMddyyyyhhmmss>**
Enable HTTP server	C3750(config)#**enable http server**	ERS5520(config)#**web-server enable**	ERS8600:5(config)#**web-server enable**
Saving configuration	C3750#**copy running-config startup-config**	ERS552#**copy config nvram** ERS552#**write memory** ERS552#**save config**	ERS8600:5#**copy running-config startup-config**

Show configuration file	C3750#**show running-config**	ERS5520(config)#**show running-config**	ERS8600:5#**show running-config**
Copy config file to tftp server	C3750#**copy system:running-config tftp://10.98.5.23/c3750_config.txt** **or** C3750#**copy system:running-config tftp:** Address or name of remote host []? ***10.98.5.23*** Destination filename []? **c3750-config.txt** !! 6880 bytes copied in 0.939 secs (7327 bytes/sec)	5520-1#**copy running-config tftp address 47.132.15.7 filename 5520.txt**	ERS-8610:5#**copy /flash/<file_name> <ip_addr>:<file_name>** Example: ERS-8610:5#**copy /flash/config.cfg 172.50.50.32:config.cfg**
Load Sharing			
Etherchannel vs MLT for SMLT Access	C3750(config)#**interface port-channel <1-48>** C3750(config-if)#**switchport trunk encapsulation <dot1q|isl|negotiate>** C3750(config-if)#**switchport trunk allowed vlan <add|all|except|except|none|remove>** C3750(config-if)#**switchport mode <access|dot1q-tunnel|dynamic|trunk>** C3750(config-if)#**spanning-tree <bpdufilter|bpduguard|cost|guard|link-type|mst|port-priority|portfast|stack-port|vlan>** C3750(config-if)#**exit** C3750(config)#**interface <ethernet|fastethernet|gigibit ethernet|10gigabitether> <port #>** C3750(config-if)#c**hannel-group <1-48> mode <active|auto|disirable|on|passive>** ***Example:*** C3750(config)#**interface port-channel 2** C3750(config-if)#**switchport trunk encapsulation dot1q** C3750(config-if)#**switchport trunk allowed vlan 804,1000** C3750(config-if)#**switchport mode trunk** C3750(config-if)#**spanning-tree bpdufilter enable** C3750(config-if)#**exit**	5520-1(config)#**mlt <1-32> enable name <word> member <port #> learning <disable|fast|normal>** ***Example:*** 5520-1(config)#**mlt 2 name mlt_2 enable member 20-21 learning disable**	ERS-8610:5(config)#**mlt <1-256> enable name <word, 0-20>** ERS-8610:5(config)#**mlt <1-256> member <slot/port-slot/port>** ERS-8610:5(config)#**mlt <1-256> encapsulation dot1q** ERS-8610:5(config)#**mlt <1-256> vlan <1-4094>**

	C3750(config)#**interface range gigabitEthernet 7/0/20-21** C3750(config-if-range)#**channel-group 2 mode on**		
Load Balance method	C3750(config)#**port-channel load-balance <dst-ip|dst-mac|src-dst-ip|src-dst-mac|src-ip|src-mac>**	5520-1(config)#**mlt <1-32> loadbalance <advance|basic>**	
LACP	C3750(config)#**interface port-channel 3** C3750(config-if)#**switchport trunk encapsulation dot1q** C3750(config-if)#**switchport trunk allowed vlan 804,1000** C3750(config-if)#**switchport mode trunk** C3750(config-if)#**spanning-tree bpdufilter enable** C3750(config-if)#**exit** C3750(config)#**interface range gigabitEthernet 7/0/20-21** C3750(config-if-range)#**channel-group 2 mode active**	5520-1(config)#**interface fastEthernet 20-21** 5520-1(config-if)#**lacp key 3** 5520-1(config-if)#**lacp mode active** 5520-1(config-if)#**lacp aggregation enable** 5520-1(config-if)#**spanning-tree learning disable**	ERS-8610:5(config)#**interface fastEthernet 1/33-1/34** ERS-8610:5(config-if)#**lacp key 3** ERS-8610:5(config-if)#**lacp mode active** ERS-8610:5(config-if)#**lacp aggregation enable**
Interface Level Config			
Interface Level Configuration - Base	C3750(config)#**interface ethernet <port #>** C3750(config)#**interface fastethernet <port #>** C3750(config)#**interface gigabitEthernet** C3750(config)#**interface tengigabitethernet <port>**	5520-1(config)#**interface FastEthernet <port #>**	ERS-610:5(config)#**interface FastEthernet <port #>** ERS-610:5(config)#**interface GigabitEthernet <port #>**
Interface Level: Port Ranges	C3750(config)#**interface range gigabitEthernet 7/0/3-11**	5520-1(config-if)#**interface fastEthernet 3-11**	ERS-610:5(config)#**interface fastEthernet 1/30-1/35**
Interface Level Configuration - Port Speed	C3750(config)#**interface gigabitEthernet 7/0/3** C3750(config-if)#**speed <10|100|1000|auto>**	5520-1(config)#***interface fastEthernet 3*** 5520-1(config-if)#***speed <10|100|1000|auto>***	ERS-8610:5(config)#**interface fastEthernet 1/30** ERS-8610:5(config-if)#**speed <10|100>** ERS-8610:5(config-if)#**auto-negotiate enable** ERS-8610:5(config-if)#**no auto-negotiate enable**
Interface Level Configuration - Port Duplex	C3750(config)#**interface gigabitEthernet 7/0/3** C3750(config-if)#duplex **<auto|full|half>**	5520-1(config)#***interface fastEthernet 3*** 5520-1(config-if)#***duplex <auto|full|half>***	ERS-8610:5(config)#**interface fastEthernet 1/30** ERS-8610:5(config-if)#**duples <half|full>** ERS-8610:5(config-if)#**auto-negotiate enable** ERS-8610:5(config-if)#**no auto-negotiate enable**

Broadcast/multicast control	C3750(config)#**interface gigabitEthernet 7/0/3** C3750(config-if)#**storm-control broadcast level [<0.00 - 100.00|bps|pps]** C3750(config-if)#**storm-control multicast level [<0.00 - 100.00|bps|pps]** C3750(config-if)#**storm-control unicast level [<0.00 - 100.00|bps|pps]** C3750(config-if)#**storm-control action <shutdown|trap>**	5520-1(config)#**interface fastEthernet 3** 5520-1(config-if)#**rate-limit broadcast <0-10>** 5520-1(config-if)#**rate-limit multicast <0-10>** 5520-1(config-if)#**rate-limit both <0-10>** ***NOTE:*** The only choices are a) broadcast, b) multicast, or c) both. You cannot use the commands "rate-limit broadcast" and "rate-limit multicast" together; you must use "rate-limit both".	ERS-8610:5(config)#**interface fastEthernet 1/30** ERS-8610:5(config-if)#**rate-limit broadcast <1-65535>** ERS-8610:5(config-if)#**rate-limit multicast <1-65535>** **NOTE:** Rate-limit value is expressed in pkts/sec
Security			
ARP Inspection: VLAN Level when DHCP is used	C3750(config)#**ip arp inspection vlan 1000** or C3750(config)#**ip arp inspection vlan 1000 logging <acl-match|arp-probe|dhcp-bindings>**	5520-1(config)#**ip arp-inspection vlan 1000**	
ARP Inspection - Setting port as Trusted	C3750(config)#**interface gigabitEthernet 7/0/3** C3750(config-if)#**ip arp inspection trust** C3750(config-if)#**exit**	5520-1(config)#**interface fastEthernet 3** 5520-1(config-if)#**ip arp-inspection trusted** 5520-1(config-if)#**exit**	
Verify IP ARP Inspection	C3750#**show ip arp inspection <interfaces|log|statistics|vlan>** Example: C3750#**show ip arp inspection statistics vlan 1000**	5520 (config)#**show ip arp-inspection <vlan|interface>**	
Verify ARP Inspection: Interface level	C3750#**show ip arp inspection interfaces** C3750#**show ip arp inspection interfaces <ethernet|fastethernet|GigabitEthernet|10GigabitEthernet|Port-channel> <port #>** Example: C3750#**show ip arp inspection interfaces gigabitEthernet 7/0/3**	5520-1#**show ip arp-inspection interface** 5520-1#**show ip arp-inspection interface fastEthernet 3**	
IP DHCP Snooping	C3750(config)#**ip dhcp snooping <database|information|verify|vlan>**	5520(config)#**ip dhcp-snooping <enable|vlan>**	
IP DHCP Snooping: VLAN	C3750(config)#**ip dhcp snooping vlan <vlan # or range>**	5520-1(config)#**ip dhcp-snooping vlan <vlan #>** 5520-1(config)#**ip dhcp-snooping enable**	

IP DHCP Snooping - Setting interface as trusted	C3750(config)#**interface gigabitEthernet 7/0/3** C3750(config-if)#**ip dhcp snooping trust** C3750(config-if)#**exit**	5520-1(config)#**interface fastEthernet 3** 5520-1(config-if)#**ip dhcp-snooping trusted** 5520-1(config-if)#**exit**	
Show IP DHCP Bindings	C3750#**show ip dhcp snooping binding**	5520-1#**show ip dhcp-snooping binding**	
Show IP DHCP Database	C3750#**show ip dhcp snooping database**	5520(config)#**show ip dhcp-snooping <binding|vlan|interface>**	
IP Source Guard	C3750(config)#**interface gigabitEthernet 7/0/3** C3750(config-if)#**ip verify source** or C3750(config-if)#**ip verify source port-security**	5520-1(config)#**interface fastEthernet 3** 5520-1(config-if)#**ip verify source**	
Verfify IP Source Guard	C3750#**show ip source binding <a.b.c.d|h.h.h|dhcp-snooping|interface|static|vlan>** **Example:** **C3750#show ip source binding** or C3750#**show ip source binding interface gigabitEthernet 7/0/3**	5520-1#**show ip source binding <a.b.c.d|interface>** Example: 5520-1#**show ip source binding** or 5520-1#**show ip source binding interface fastEthernet 3**	
Port Security - Enabling	C3750(config)#**interface gigabitEthernet 7/0/3** C3750(config-if)#**switchport port-security**	5520-1(config)#**mac-security enable**	
Port Security - Add static MAC with violation of shutdown	C3750(config)#**interface gigabitEthernet 7/0/3** C3750(config-if)#**switchport port-security** C3750(config-if)#**switchport port-security mac-address 0011.0022.0033** C3750(config-if)#**switchport port-security violation shutdown**	5520-1(config)#**mac-security enable** 5520-1(config)#**mac-security security-list 1 add 3** 5520-1(config)#**mac-security mac-address-table address 00.11.00.22.00.33 security-list 1** 5520-1(config)#**interface fastEthernet 3** 5520-1(config-if)#**mac-security enable**	
Port Security - Dynamic	C3750(config)#**interface gigabitEthernet 7/0/3** C3750(config-if)#**switchport port-security** C3750(config-if)#**switchport port-security maximum <1-6144>** C3750(config-if)#**switchport port-security mac-address sticky**	5520-1(config)#**mac-security enable** 5520-1(config)#**interface fastEthernet 3** 5520-1(config-if)#**mac-security auto-learning port 3 max-addrs <1-25>** 5520-1(config-if)#**mac-security auto-learning port 3 enable**	
Port Security - Set aging time	C3750(config)#**interface gigabitEthernet 7/0/3** C3750(config-if)#**switchport port-security aging time <1-1440; time in minutes>**	5520-1(config)#**mac-security intrusion-timer <0-65535>**	
Show Port Security Address	C3750#**show port-security address**	5520-1(config)#**show mac-security mac-address-table**	

Show Port Security at Interface Leve	C3750#**show port-security interface gigabitEthernet 7/0/3**	5520-1#**show mac-security port 3**	
LLDP			
LLDP Global	C3750(config)#**lldp run**	**Method 1**: Using ADAC 5520-1(config)#**adac voice-vlan <vlan #>** 5520-1(config)#**adac op-mode tagged-frames** 5520-1(config)#**adac <uplink-port|call-server-port> <port #>** 5520-1(config)#**adac enable** **Method 2:** Without ADAC No global configuration	
LLDP Interface Configuration	C3750(config)#**interface gigabitEthernet 7/0/3** C3750(config-if)#**lldp receive** C3750(config-if)#**lldp transmit** **## See note below** C3750(config-if)#**lldp med-tlv-select inventory-management** C3750(config-if)#**lldp med-tlv-select location** C3750(config-if)#**lldp med-tlv-select network-policy** C3750(config-if)#**lldp med-tlv-select power-management** C3750(config-if)#**exit** **NOTE:** all of the lldp med-tlv setting are enabled by default. The example above just illustrates what can be configured.	**Method 1:** Using ADAC 5520-1(config)#**interface fastEthernet 3** **# Note:** by default, both LLDP and MAC ADAC detection is enabled 5520-1(config-if)#**no adac detection mac** 5520-1(config-if)#**adac tagged-frames-tagging untag-pvid-only** 5520-1(config-if)#**adac enable** 5520-1(config-if)#**lldp tx-tlv local-mgmt-addr port-desc sys-cap sys-name** 5520-1(config-if)#**lldp status txandRx config-notification** 5520-1(config-if)#**lldp tx-tlv med extendedPSE med-capabilities network-policy** 5520-1(config-if)#**exit** **Method 2:** Without ADAC ERS5520-1(config)#**interface fastEthernet 3** ERS5520-1(config-if)#**lldp tx-tlv local-mgmt-addr port-desc sys-cap sys-desc sys-name** ERS5520-1(config-if)#**lldp status txandRx config-notification** ERS5520-1(config-if)#**lldp tx-tlv med extendedPSE med-capabilities network-policy** ERS5520-1(config-if)#**lldp med-network-policies voice tagging tagged vlan-id 805** ERS5520-1(config-if)#**exit**	
Show LLDP	C3750#**show lldp**	5520-1#**show lldp**	
Show all LLDP Entries	C3750#**show lldp entry ***	5520-1#**show lldp neighbor**	
Show LLDP Neighbor Details	C3750#**show lldp neighbors gigabitEthernet 7/0/3 detail**	5520-1#**show lldp port 3 neighbor detail**	

Spanning Tree			
PVST+	For interopabiility with other vendors, the native VLAN must be configured and on trunk ports, VLAN 1 (not nessessarilty the native VLAN) must be allowed.		
Configuring STP mode	C3750(config)#**spanning-tree mode pvst | rapid-pvst | mst**	ERS5520(config)#**spanning-tree op-mode stpg | rstp | mstp** **Example:** 5520-24T-PWR(config)#**spanning-tree op-mode mstp** New operational mode MSTP will take effect upon reset 5520-24T-PWR(config)#**boot**	ERS-8610:5(config)#**boot config flags spanning-tree-mode <mstp|rstp>** **Note:** Must reboot switch for changes to take place
Disable STP	C3750(config)#**no spanning-tree vlan <*vlan_id*>**	ERS5520(config)#**spanning-tree stp <1..8> disable**	
Change priority of the bridge	C3750(config)#**spanning-tree vlan <*vlan_id*> priority <*value*>**	ERS5520(config)#**spanning-tree stp <1..8> priority <*value*>**	
Change STP cost for port	C3750(config)#**interface <gi1/0/1>** C3750(config-if)#**spanning-tree cost <value>**	ERS5520(config)#**interface fastEthernet <1/1>** ERS5520(config-if)#**spanning-tree cost <value>**	
Port level BPDU guard configuration	C3750(config)#**interface gigabitEthernet 7/0/3** C3750(config-if)#s**panning-tree portfast** C3750(config-if)#**spanning-tree bpduguard enable**	5520-1(config-if)#**spanning-tree learning fast** 5520-1(config-if)#***spanning-tree bpdu-filtering <enable|timeout>***	
Configuring fast learning on access ports	C3750(config-if)#**spanning-tree portfast**	ERS5520(config-if)#**spanning-tree learning fast**	
	C3750(config)#**interface gigabitEthernet 7/0/3** C3750(config-if)#**spanning-tree bpdufilter enable** C3750(config-if)#**exit**	ERS5520(config-if)#**spanning-tree bpdu-filtering enable** ERS5520(config-if)#**exit**	
Verify Spanning Tree on ports and VLANs	C3750#**show spanning-tree**	ERS5520#**show spanning-tree config**	
Verify Spanning Tree on ports	C3750#**show spanning-tree interface <*interface_id*>**	ERS5520#**show spanning-tree config port**	
Verify Spanning Tree on VLANs	C3750#**show spanning-tree vlan <*vlan_id*>**	ERS5520#**show spanning-tree config vlans**	
Summary information for STP on VLANs	C3750#**show spanning-tree summary**		
MSTP Configuration			
Enable MSTP	C3750(config)#**spanning-tree mode mst**	ERS5520(config)#**spanning-tree op-mode mstp**	ERS-8610:5(config)#**boot config flags spanning-tree-mode mstp**
Enter MSTP config mode	C3750(config)#**spanning-tree mst configuration**		

Exit and commit changes to active MSTP region	C3750(config-mst)#**exit**		
Assign Region name	C3750(config)#**spanning-tree mst configuration** C3750(config-mst)#**name <*region_name*>**	ERS5520(config)#**spanning-tree mstp region region-name <*region_name*>**	ERS-8610:5(config)#**spanning-tree mstp region region-name <region_name>**
Assign a region configuration revision number	C3750(config)#**spanning-tree mst configuration** C3750(config-mst)#**revision <*version_number*>**	ERS5520(config)#**spanning-tree mstp region region-version <*version_number*>**	ERS-8610:5(config)#**spanning-tree mstp region region-version <version_number>**
Map VLANs to MSTP instance	C3750(config)#**spanning-tree mst configuration** C3750(config-mst)#**instance <1..65> <*vlan_list*>**	ERS5520(config)#**spanning-tree mstp msti <1..7> add-vlan <*vlan_list*>**	
Change priority of the MSTP instance	C3750(config)#**spanning-tree mst <instance range: 0-3,5,7-9> priority <0-61440>**	5520-24T-PWR(config)#**spanning-tree mstp msti <1-7> priority <0000|1000|2000|3000|4000|5000|6000|7000|8000|9000|a000|b000|c0000|d000|e000|f000>** **Example:** 5520-24T-PWR(config)#**spanning-tree mstp msti 1 priority 1000**	ERS-8610:5(config)#**spanning-tree mstp msti <1-63> priority <4096|8192|12288|16384|20480|24576|28672|32768|36864|40960|45056|49152|53248|57344|61440>** **Example:** ERS-8610:5(config)#**spanning-tree mstp msti 1 priority 4096**
Change priority of the MSTP instance to root	C3750(config)#**spanning-tree mst <instance id> root**	5520-24T-PWR(config)#**spanning-tree mstp msti <1-7> priority 1000**	ERS-8610:5(config)#**spanning-tree mstp msti <1-63> priority 4096**
Change MSPT Port Priority	C3750(config)#**interface gigabitEthernet <port #>** C3750(config-if)#**spanning-tree mst <id> port-priority <0-240;increments of 16>**	5520-24T-PWR(config)#**interface fastEthernet <port #>** 5520-24T-PWR(config-if)#**spanning-tree mstp msti <id> priority <00|10|20|30|40|50|60|70|80|90|a0|b0|c0|d0|e0|f0>**	ERS-8610:5(config)#**interface fastEthernet <port #>** ERS-8610:5(config-if)#**spanning-tree mstp msti <id> priority <0-240;increments of 16>**
Change MSTP Port Cost	C3750(config)#**interface gigabitEthernet <port #>** C3750(config-if)#**spanning-tree mst <id> cost <1-200000000>**	5520-24T-PWR(config)#**interface fastEthernet <port #>** 5520-24T-PWR(config-if)#**spanning-tree mstp msti <id> cost <1-200000000>**	ERS-8610:5(config)#**interface fastEthernet <port #>** ERS-8610:5(config-if)#**spanning-tree mstp msti <id> cost <1-200000000>**

MSTP Example	C3750(config)#**vlan 1500** C3750(config-vlan)#**name mstp1** C3750(config-vlan)#**exit** C3750(config)#**vlan 1501** C3750(config-vlan)#**name mstp2** C3750(config-vlan)#**exit** C3750(config)#**interface range gigabitEthernet 7/0/19 - 20** C3750(config-if-range)#**switchport trunk encapsulation dot1q** C3750(config-if-range)#**switchport trunk allowed vlan 804,1000** C3750(config-if-range)#**switchport mode trunk** C3750(config-if-range)#**exit** C3750(config)#**spanning-tree mode mst** C3750((config)#**spanning-tree mst configuration** C3750((config-mst)#**revision 1** C3750((config-mst)#**name region1** C3750((config-mst)#**instance 1 vlan 1500** C3750((config-mst)#**instance 2 vlan 1501** C3750((config-mst)#**exit**	5520-24T-PWR(config)#**spanning-tree op-mode mstp** New operational mode MSTP will take effect upon reset 5520-24T-PWR(config)#**boot** 5520-24T-PWR(config)#**spanning-tree mstp region region-name region1 region-version 1** 5520-24T-PWR(config)#**vlan ports 19-20 tagging tagall** 5520-24T-PWR(config)#**spanning-tree mstp msti 1** 5520-24T-PWR(config)#s**panning-tree mstp msti 2** 5520-24T-PWR(config)#**vlan create 1500 name mstp1 type port msti 1** 5520-24T-PWR(config)#**vlan create 1501 name mstp2 type port msti 2** 5520-24T-PWR(config)#**vlan members add 1500 19-20** 5520-24T-PWR(config)#**vlan members add 1501 19-20** 5520-24T-PWR(config)#**spanning-tree mstp msti 1 enable** 5520-24T-PWR(config)#**spanning-tree mstp msti 2 enable** **Note:** You need to add the the msti instances prior to configuring the VLAN's, i.e. "spanning-tree mspt mst <1-7>" prior to entering the command "vlan create <vlan #> type port msti <1-7>". This is not the case with the ERS 8600.	ERS-8610:5(config)#**boot config flags spanning-tree-mode mstp** ERS-8610:5#**save boot** ERS-8610:5#**boot -y** ERS-8610:5(config)#**spanning-tree mstp region region-name region1 region-version 1** ERS-8610:5(config)#**vlan create 1500 name mstp1 type port-mstprstp 1** ERS-8610:5(config)#**vlan create 1501 name mstp2 type port-mstprstp 2** **% MSTI 2 does not exist** **% Vlan added to CIST** **5520-24T-PWR(config)#spanning-tree mstp msti 1 add-vlan 1500** ERS-8610:5(config)#**vlan ports 1/33-1/34 tagging tagAll** ERS-8610:5(config)#**vlan members add 1500 1/33-1/34** ERS-8610:5(config)#**vlan members add 1501 1/33-1/34** **ERS-8610:5(config)#vlan members remove 1 1/33-1/34**
Show active MSTP instances	C3750#**show spanning-tree active** for more details: C3750#**show spanning-tree active detail**		
Show Root bridge for all instances	C3750#**show spanning-tree root** **Additional commands:** C3750#**show spanning-tree root <address|cost|forward-time|hello-time|id|max-age|port|priority>**	5520-24T-PWR#**show spanning-tree mstp msti port config <1-7>**	ERS-8610:5#**show spanning-tree mstp msti port config**
Show Bridge ID	C3750#**show spanning-tree bridge**	5520-24T-PWR#**show spanning-tree mstp config** 5520-24T-PWR#**show spanning-tree mstp msti port config <1-7>**	ERS-8610:5#**show spanning-tree mstp msti config** ERS-8610:5#**show spanning-tree mstp config**

Show MSTP Configuration	C3750#**show spanning-tree mst configuration** **Addition details:** C3750#**show spanning-tree mst detail**		ERS-8610:5#**show spanning-tree mstp msti config**
Verity MSTP Port role	C3750#**show spanning-tree interface gigabitEthernet <port #>**		ERS-8610:5#**show spanning-tree mstp msti port role**
Verify MSTP instance	C3750#**show spanning-tree mst <1..7>**	ERS5520(config)#show **spanning-tree mstp msti <1..7>**	
RSTP Configuration			
Enable RSTP	C3750(config)#**spanning-tree mode mst**	ERS5520(config)#**spanning-tree op-mode rstp** 5520-24T-PWR(config)#**boot**	ERS-8610:5(config)#**boot config flags spanning-tree-mode rstp** ERS-8610:5(config)#**save bootconfig** ERS-8610:5(config)#**boot -y**
RSTP Example	C3750(config)#**vlan 1500** C3750(config-vlan)#**exit** C3750(config)#**vlan 1501** C3750(config-vlan)#**exit** C3750(config)#**interface range gigabitEthernet 7/0/19 - 20** C3750(config-if-range)#**switchport trunk encapsulation dot1q** C3750(config-if-range)#**switchport trunk allowed vlan 804,1000** C3750(config-if-range)#**switchport mode trunk** C3750(config-if-range)#**exit** C3750(config)#**spanning-tree mode mst**	5520-24T-PWR(config)#**vlan ports 19-20 tagging tagall** 5520-24T-PWR(config)#**vlan create 1500 type port** 5520-24T-PWR(config)#**vlan create 1501 type port** 5520-24T-PWR(config)#**vlan members add 1500 19-20** 5520-24T-PWR(config)#**vlan members add 1501 19-20** 5520-24T-PWR(config)#**vlan members remove 1 19-20** 5520-24T-PWR(config)#**vlan ports 19,20 filter-untagged-frame disable**	ERS-8610:5(config)#**vlan create 1500 type port-mstprstp 0** ERS-8610:5(config)#**vlan create 1501 type port-mstprstp 0** ERS-8610:5(config)#**vlan ports 1/33,1/34 tagging tagAll** ERS-8610:5(config)#**vlan members add 1500 1/33,1/34** ERS-8610:5(config)#**vlan members add 1501 1/33,1/34** ERS-8610:5(config)#**vlan members remove 1 1/33,1/34**
RSTP Priority	C3750(config)#**spanning-tree mst 0 priority <0-61440>**	5520-24T-PWR(config)#**spanning-tree rstp priority <0000|1000|2000|3000|4000|5000|6000|7000|8000|9000|a000|b000|c0000|d000|e000|f000>**	ERS-8610:5(config)#**spanning-tree rstp priority <4096|8192|12288|16384|20480|24576|28672|32768|36864|40960|45056|49152|53248|57344|61440>**
RSTP Root	C3750(config)#**spanning-tree mst 0 root**	5520-24T-PWR(config)#**spanning-tree rstp priority 0000**	ERS-8610:5(config)#**spanning-tree rstp priority 4096**
RSTP Edge Port	C3750(config)#**interface gigabitEthernet <port>** C3750(config-if)#**spanning-tree portfast**	5520-24T-PWR(config)#**interface fastEthernet <port #>** 5520-24T-PWR(config-if)#**spanning-tree rstp edge-port <true|false>**	ERS-8610:5(config)#**interface fastEthernet** ERS-8610:5(config-if)#**spanning-tree rstp edge-port <true|false>**
RSTP Link Type point-to-point	C3750(config)#**interface gigabitEthernet <port>** C3750(config-if)#**spanning-tree link-type <point-to-point|shared>**	5520-24T-PWR(config)#**interface fastEthernet <port #>** 5520-24T-PWR(config-if)#**spanning-tree rstp p2p <auto|force-false|force-true>**	ERS-8610:5(config)#**interface fastEthernet** ERS-8610:5(config-if)#**spanning-tree rstp p2p <auto|force-false|force-true>**

Change MSPT Port Priority	C3750(config)#**interface gigabitEthernet <port #>** C3750(config-if)#**spanning-tree mst 0 port-priority <0-240;increments of 16>**	5520-24T-PWR(config)#**interface fastEthernet <port #>** 5520-24T-PWR(config-if)#**spanning-tree rstp priority <00|10|20|30|40|50|60|70|80|90|a0|b0|c0|d0|e0|f0>**	ERS-8610:5(config)#**interface fastEthernet <port #>** ERS-8610:5(config-if)#**spanning-tree rstp priority <0-240;increments of 16>**
Layer 3			
Configuring routing between VLANs	C3750(config)#**interface vlan <*vlan_id*>** C3750(config-if)#**ip address <10.10.10.254> <255.255.255.0>** C3750(config-if)#**exit**	ERS5520(config)#**interface vlan <*vlan_id*>** ERS5520(config-if)#**ip address <10.10.10.253> <255.255.255.0>** ERS5520(config-if)#**exit**	ERS8600:5(config)#**interface vlan <*vlan_id*>** ERS8600:5(config-if)# **ip address <10.10.10.253> <255.255.255.0>** ERS8600:5(config)#**exit**
Enable IP routing globally	C3750(config)#**ip routing**	ERS5520(config)#**ip routing**	ERS8600:5(config)#**ip routing**
Configuring default route	C3750(config)#**ip route <0.0.0.0> <0.0.0.0> <10.10.10.1>**	ERS5520(config)#**ip route <0.0.0.0> <0.0.0.0> <10.10.10.1> <1-255>**	ERS8600(config)#**ip route <0.0.0.0> <0.0.0.0> <10.10.10.1> weight <1-65535> perference <1-255>**
Configuring static route	C3750(config)#**ip route <30.0.0.0> <255.0.0.0> <10.10.10.2>**	ERS5520(config)#**ip route <30.0.0.0> <255.0.0.0> <10.10.10.2> <1>**	ERS8600(config)#**ip route <30.0.0.0> <255.0.0.0> <10.10.10.2> weight <1-65535> perference <1-255>**
	C3750(config)#**exit**	ERS5520(config)#**exit**	
Verify L3 IP routing		ERS5520#**show ip routing**	ERS8600(config)#**show ip routing**
Verify IP configuration on physical interfaces	C3750#**show ip interface**	ERS5520#**show vlan ip**	ERS8600#**show ip interface**
Verify IP configuration on VLANs	C3750#**show ip interface vlan <*vlan_id*>**	ERS5520#**show vlan ip vid <*vlan_id*>**	N/A, only at interface level ERS8600-5:5#**show ip interface < fastethernet| gigabitethernet> <port#>**
Verify IP routing table	C3750#**show ip route**	ERS5520#**show ip route**	ERS8600#**show ip route**
Troubleshooting IP connectivity	C3750#**ping <10.10.10.1>**	ERS5520#**ping <10.10.10.1>**	ERS8600#**ping <10.10.10.1>**
	C3750#**traceroute <20.20.20.1>**	ERS5520#**traceroute <20.20.20.1>**	
VRRP Global		ERS5520(config)#**router vrrp enable**	

VRPP Configuration	C3750(config)#**interface vlan <*vlan_id*>** C3750(config-if)#**ip address <10.10.10.254> <255.255.255.0>** C3750(config-if)#**vrrp <1> ip <10.10.10.1>** C3750(config-if)#**vrrp <1> priority <1..254>** C3750(config-if)#**exit** C3750(config)#**exit**	ERS5520(config)#**interface vlan <*vlan_id*>** ERS5520(config-if)#**ip address <10.10.10.253> <255.255.255.0>** ERS5520(config-if)#**ip vrrp address <1> <10.10.10.1>** ERS5520(config-if)#**ip vrrp <1> priority <1..255>** ERS5520(config-if)#**ip vrrp <1> enable** ERS5520(config-if)#**exit** ERS5520(config)#**exit**	ERS8600:5(config)#**interface vlan <*vlan_id*>** ERS8600:5(config-if)#**ip address <10.10.10.252> <255.255.255.0>** ERS8600:5(config-if)#**ip vrrp <1> <10.10.10.1>** ERS8600:5(config-if)#**ip vrrp <1> priority <1..255>** ERS8600:5(config-if)#**ip vrrp <1> enable** ERS8600:5(config-if)#**exit** ERS8600:5(config)#**exit**
Show VRRP interface	C3750#**show vrrp**	ERS5520#**show ip vrrp interface**	ERS8600:5#**show ip vrrp interface**
Dynamic Routing protocols			
Basic RIP configuration	C3750(config)#**router rip** C3750(config-router)#**network <10.0.0.0>** C3750(config-router)#**exit** C3750(config)#**exit**	ERS5520(config)#**router rip enable** ERS5520(config)#**router rip** ERS5520(config-router)#**network <10.0.0.0>** ERS5520(config-router)#**exit** Or ERS5520(config)#**interface vlan <*vlan_id*>** ERS5520(config-if)#**ip rip enable** ERS5520(config-if)#**exit**	ERS8600(config)#**router rip enable** ERS8600-5:5(config)#**router rip** ERS8600(config-rip)#**network 10.1.1.1** ERS8600(config-rip)#**exit** Or ERS8600(config)#**interface vlan <*vlan_id*>** ERS8600(config-if)#**ip rip enable** ERS8600(config-if)#**exit**
Redistribute directly connected and OSPF routes into RIP	C3750(config)#**router rip** C3750(config-router)#**redistribute connected metric <5>** C3750(config-router)#**redistribute ospf <1> metric <4>**	N/A	ERS8600:5(config)#**router rip** ERS8600:5(config-rip)#**redistribute direct** ERS8600:5(config-rip)#**redistribute direct metric <5>** ERS8600:5(config-rip)#**redistribute direct enable** ERS8600:5(config-rip)#**redistribute ospf** ERS8600:5(config-rip)#**redistribute ospf metric <4>** ERS8600:5(config-rip)#**redistribute ospf enable** ERS8600:5(config-rip)#**exit** ERS8600:5(config)#**ip rip apply redistribute direct** ERS8600:5(config)#**ip rip apply redistribute ospf**
Show commands	C3750#**show ip protocols**	ERS5520#**show ip rip**	ERS8600#**show ip rip**
	C3750#**show ip rip database**	ERS5520#**show ip rip interface**	ERS8600-5:5#**show ip rip interface**

Basic OSPF configuration	C3750(config)#**router ospf <1>** C3750(config-router)#**network <10.10.10.0> <0.0.0.255> area <0.0.0.0>** C3750(config-router)#**exit** C3750(config)#**exit**	ERS5520(config)#**router ospf enable** ERS5520(config)#**router ospf** ERS5520(config-router)#**network <10.10.10.253> area <0.0.0.0>** ERS5520(config-router)#**exit** Or ERS5520(config)#**interface vlan <*vlan_id*>** ERS5520(config-if)#**ip ospf enable** ERS5520(config-if)#**exit** ERS5520(config)#**exit**	ERS8600(config)#**router ospf enable** ERS8600(config)#**router ospf** ERS8600(config-router)#**network <10.10.10.253> area <0.0.0.0>** ERS8600(config-router)#**exit** Or ERS8600(config)#**interface vlan <*vlan_id*>** ERS5520(config-if)#**ip ospf enable** ERS8600(config-if)#**exit** ERS8600(config)#**exit**
Redistribute RIP routes into OSPF	C3750(config)#**router ospf <1>** C3750(config-router)#**redistribute rip metric-type <1> subnets metric <30>**	ERS5520(config)#**router ospf** ERS5520(config-router)#**as-boundary-router enable** ERS5520(config-router)#**redisribute rip metric <30> metric-type <type1> subnets allow** ERS5520(config-router)#**redistribute rip enable** ERS5520(config-router)#**exit** ERS5520(config)#**ip ospf apply redistribute rip**	ERS8600:5(config)#**router ospf** ERS8600:5(config-ospf)#**as-boundary-router enable** ERS8600:5(config-ospf)#**redistribute rip** ERS8600:5(config-ospf)#**redistribute rip metric <30>** ERS8600:5(config-ospf)#**redistribute rip metric-type <type1>** ERS8600:5(config-ospf)#**redistribute rip subnets allow** ERS8600:5(config-ospf)#**redistribute rip enable** ERS8600:5(config-ospf)#**exit** ERS8600:5(config)#**ip ospf apply redistribute rip**
ECMP	C3750(config)#**router ospf <1>** C3750(config-router)#**maximum-paths <4>**	ERS5520(config)#**ospf maximum-path <4>**	ERS8600:5(config)#**ip ecmp** ERS8600:5(config)#**ip ecmp max-path <4>**
Show commands	C3750#**show ip ospf** C3750#**show ip ospf interface**	ERS5520#**show ip ospf** ERS5520#**show ip ospf interface**	ERS8600:5(config)#**show ip ospf** ERS8600:5(config)#**show ip ospf interface**
QoS			

Basic QoS for VoIP on access ports and an uplink	C3750(config)#**mls qos** C3750(config)#**interface range <gi1/0/1 - 20>** C3750(config-if-range)#**switchport voice vlan <30>** C3750(config-if-range)#**mls qos trust cos** C3750(config-if-range)#**switchport priority extend cos <0>** C3750(config-if-range)#**exit** C3750(config)#**exit**	ERS5520(config)#**qos l2-element <1> vlan-min <30> vlan-max <30> ethertype <0x800>** ERS5520(config)#**qos classifier <1> set-id <1> name <Voice_Class> element-type l2 element-id <1>** ERS5520(config)#**qos if-group name <Unrestricted> class unrestricted** ERS5520(config)#**qos if-assign port <1-20> name <Unrestricted>** ERS5520(config)#**qos policy <1> name <Voice_Policy> if-group <Unrestricted> clfr-type classifier clfr-name <Voice_Class> in-profile-action-name Null_Action non-match-action-name Standard_Service precedence <10>** ERS5520(config)#**exit**	
Configure uplink to be trusted	C3750(config)#**interface <gi1/0/41>** C3750(config-if)#**mls qos trust cos**	ERS5520(config)#**qos if-group name <Core> class trusted** ERS5520(config)#**qos if-assign port <41> name <Core>** ERS5520#**show qos classifier**	
Simple ACLs			
Deny all hosts from 192.168.1.0/24 network	C3750(config)#**access-list <1> deny <192.168.1.0> <0.0.0.255>** C3750(config)#**access-list <1> permit any**	ERS5520(config)# **qos traffic-profile classifier name <acl1> src-ip <192.168.1.0/24> drop-action enable**	ERS8600(config)#**filter act <1> name <src-ip>** ERS8600(config)#**filter act <1> ip <srcIp>** ERS8600(config)#**filter apply act <1>** ERS8600(config)#**filter acl <1> type <inPort> act <1>** ERS8600(config)#**filter acl port <1> <port #>** ERS8600(config)#**filter acl ace <1> <1> name <acl-1>** ERS8600(config)# **filter acl ace action <1> <1> deny** ERS8600(config)# **filter acl ace ip <1> <1> src-ip eq <192.168.1.0-192.168.1.255>** ERS8600(config)#**filter acl ace <1> <1> enable**

Permit SMTP connection from any host to mail server	C3750(config)#**access-list <100> permit tcp any host <47.1.1.1> eq smtp**	5520-6(config)#**qos traffic-profile classifier name <acl2> dst-ip 47.1.1.1/32 protocol <6> dst-port-min 25 dst-port-max 25**	ERS8600(config)#**filter act <1>** ERS8600(config)#**filter act <1> ip <dstIp>** ERS8600(config)#**filter act <1> protocol <tcpDstPort>** ERS8600(config)#**filter apply act <1>** ERS8600(config)#**filter acl 1 type <inPort> act <1>** ERS8600(config)#**filter acl port <1> <port #>** ERS8600(config)#**filter acl ace <1> <1> name <acl2>** ERS8600(config)#**filter acl ace action <1> <1> permit** ERS8600(config)#**filter acl ace ip <1> <1> dst-ip eq <47.1.1.1>** ERS8600(config)#**filter acl ace protocol <1> <1> <tcp-dst-port> eq <25>** ERS8600(config)#**filter acl ace <1> <1> enable**
Apply ACL to interfaces	C3750(config)#**interface range <gi1/0/1 - 20>** C3750(config-if-range)#**ip access-group <1> in** C3750(config-if-range)#**ip access-group <100> in** C3750(config)#**exit**	ERS5520(config)# **qos traffic-profile set port <port #> name <acl1>**	See above
Show filters	C3750(config)#**show access-lists**	5520#**show qos traffic-profile classifier** 5520-6#**show qos traffic-profile set**	ERS8600#**show filter act** ERS8600#**show filter acl** ERS8600#**show filter acl ace** ERS8600#**show running-config module filter**