CCNP ENTERPRISE 2020

ENCOR 350-401
ENARSI 300-410

WORKBOOK

For enrolling in Online "CCNP Enterprise" batch
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- Class# 2: https://youtu.be/TzJHkwt5EqM

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Device Initial Configuration -Switches

To make switches usable for new/next labs.
If incase there are vlans or configs already present in the switches, clear all the configurations to have brand new switch for your new/next lab.

Switch#erase /all nvram:
Erasing the nvram filesystem will remove all files! Continue? [confirm]
[OK]
Erase of nvram: complete
Switch#

Switch#reload
Proceed with reload? [confirm]

This will clear all the previous configs on the switch.

CCNP LAB TOPOLOGY {FULL}
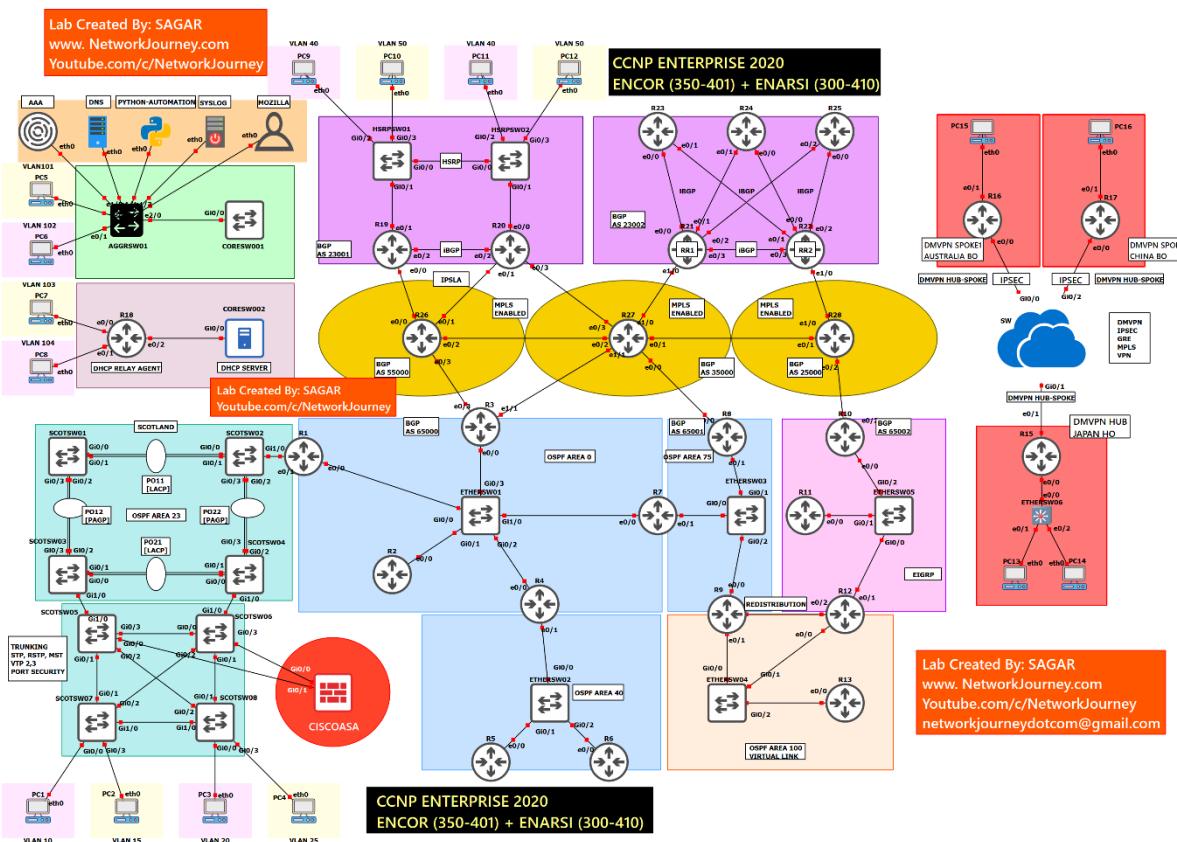
LAB #1 CREATE - VLAN, MANAGEMENT INTERFACE, TELNET & SSH
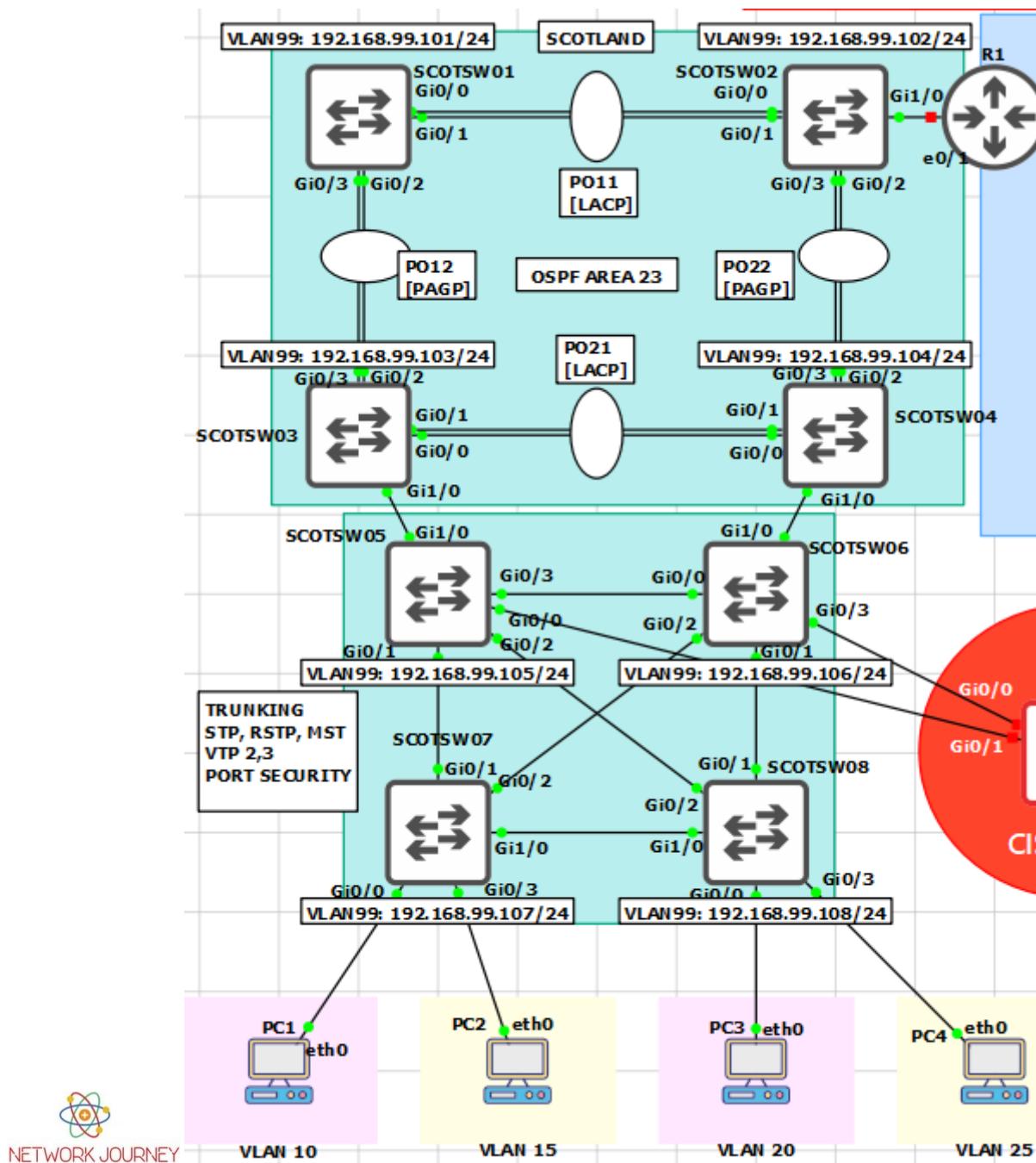
Objectives: Configure SCOTSW01, SCOTSW02, SCOTSW03, SCOTSW04, SCOTSW05, SCOTSW06, SCOTSW07, SCOTSW08 with the following:

1. Define Hostname accordingly as per the above topology section
2. Create VLANs as below:
   !
   vlan 99
   name MANAGEMENT
   !

vlan 100
name SERVERS
!
vlan 110
name GUEST
!
vlan 120
name OFFICE
!
vlan 999
name PARKING_LOT
state suspend
!
vlan 666
name NATIVE_DO_NOT_USE
exit

3. Create Management Interface on Vlan 99
4. Enable Telnet and SSH for Remote connection for user id "admin" with privilege level "15" with password "cisco"

Configuration:

SCOTSW01
Switch#configure terminal
Switch(config)#hostname SCOTSW01

SCOTSW01(config)#vlan 99
SCOTSW01(config-vlan)#name MANAGEMENT
SCOTSW01(config-vlan)#!
SCOTSW01(config-vlan)#vlan 100
SCOTSW01(config-vlan)#name SERVERS
SCOTSW01(config-vlan)#!
SCOTSW01(config-vlan)#vlan 110
SCOTSW01(config-vlan)#name GUEST
SCOTSW01(config-vlan)#!
SCOTSW01(config-vlan)#vlan 120
SCOTSW01(config-vlan)#name OFFICE
SCOTSW01(config-vlan)#!
SCOTSW01(config-vlan)#vlan 999
SCOTSW01(config-vlan)#name PARKING_LOT
SCOTSW01(config-vlan)#state suspend
SCOTSW01(config-vlan)#!
SCOTSW01(config-vlan)#vlan 666
SCOTSW01(config-vlan)#name NATIVE_DO_NOT_USE
SCOTSW01(config-vlan)#exit

NOTE: The VLANs will not appear in the VLAN database until the **exit** command is issued

To globally suspend a VLAN, use the **state suspend** command in the VLAN configuration mode. This state is propagated by VTP to all other switches in the VTP domain if VTP is in use.
To locally shut down a VLAN, use the **shutdown** command in the VLAN configuration mode. This setting is not propagated through VTP

SCOTSW01(config)#interface vlan 99
SCOTSW01(config-if)#ip address 192.168.99.101 255.255.255.0
SCOTSW01(config-if)#no shutdown
SCOTSW01(config-if)#exit

NOTE: Interface Vlan 99 will be initially Down as the Vlan 99 (broadcast) is not mapped with any interface.
Wait for some time. We will make Trunking between inter-switch's and allow Vlan 99

Create Telnet for remote connection:
SCOTSW01(config)#line vty 0 15
SCOTSW01(config-line)#login local
SCOTSW01(config-line)#transport input all
SCOTSW01(config)#username admin privilege 15 password cisco

NOTE: We are creating user "admin" with highest privilege of 15 level. Hence, no need to creating "enable secret " or "enable password "

Create SSH for remote connections:
SCOTSW01(config)#ip domain-name networkjourney.com
SCOTSW01(config)# crypto key zeroize
SCOTSW01(config)#crypto key generate rsa modulus 1024

Do not forget to configure above configurations on other Switches - SCOTSW02, SCOTSW03, SCOTSW04, SCOTSW05, SCOTSW06, SCOTSW07, SCOTSW08 accordingly.

The Hostname, Management IP address will differ for each switch. So please refer the topology for the right hostname and management IP address.

Verifications:

After configuring the VLANs, issue the **show vtp status** command and you will see that the all-important configuration revision number has increased based on these changes to the VLAN database. Note that the revision number you have when performing this lab may be different.

SCOTSW01#sh vtp status | i Revision
Configuration Revision   : 6

SCOTSW01#show vlan brief

```
VLAN Name                      Status   Ports
---- ------------------------------ -------- ------------------------------
1    default                   active   Gi0/0, Gi0/2, Gi0/3, Gi1/0
                                        Gi1/1, Gi1/2, Gi1/3, Gi2/0
                                        Gi2/1, Gi2/2, Gi2/3, Gi3/0
                                        Gi3/1, Gi3/2, Gi3/3
99   MANAGEMENT                active
100  SERVERS                   active
110  GUEST                     active
120  OFFICE                    active
666  NATIVE_DO_NOT_USE         active
999  PARKING_LOT               suspended
```

Management IP is configured on Interface Vlan 99
SCOTSW01#sh run interface vlan 99
interface Vlan99
 ip address 192.168.99.101 255.255.255.0
end

You can test if telnet and ssh are configured rightly or not by doing self-connection test
To self-test telnet:
SCOTSW01#telnet 192.168.99.101
Trying 192.168.99.101 ... Open

To self-test SSH:
SCOTSW01#ssh -l admin 192.168.99.101

```
***********************************************************************
* IOSv is strictly limited to use for evaluation, demonstration and IOS  *
* education. IOSv is provided as-is and is not supported by Cisco's     *
* Technical Advisory Center. Any use or disclosure, in whole or in part, *
* of the IOSv Software or Documentation to any third party for any      *
* purposes is expressly prohibited except as otherwise authorized by    *
* Cisco in writing.                                   *
***********************************************************************
```
Password:

Do not forget to configure above configurations on other Switches - SCOTSW02, SCOTSW03, SCOTSW04, SCOTSW05, SCOTSW06, SCOTSW07, SCOTSW08 accordingly.

The Hostname, Management IP address will differ for each switch. So please refer the topology for the right hostname and management IP address.

Verify the configured commands with the help of above "show …." Commands accordingly.

LAB #2 CONFIGURE - TRUNK and VTP version 2

Objectives: Configure SCOTSW01, SCOTSW02, SCOTSW03, SCOTSW04, SCOTSW05, SCOTSW06, SCOTSW07, SCOTSW08 as following:

1. The VTP domain should be configured to "CCNP_ENTERPRISE" (without the quotes)
2. Ensure that VTP traffic is MD5 secured using a password of "cisco" (without quotes)
3. Use VTP version 2
   "Server" mode on SCOTSW01 and SCOTSW02.
   "Transparent" mode on SCOTSW03 and SCOTSW04
   "Client" mode on SCOTSW05 and SCOTSW06
   "Transparent" mode on SCOTSW07 and SCOTSW08
4. Configure 802.1q trunk links between the switches according to the Layer 2 Diagram show above
5. Only active VLANs should be allowed on trunk links
6. VLAN 811 MTU(Maximum Transmission Unit) should be set to 1400
7. Ensure that VLAN 666 traffic is not tagged when sent over the trunk links
   SCOTSW01#
   int range gi0/0-1
   no switchport trunk native vlan 666

   SCOTSW02#
   int range gi0/0-1
   no sw trunk native vlan 666
8. After synchronization both switches must not propagate VLAN configuration changes to each other

---

Configuration:

SCOTW01
hostname SCOTSW01

vtp domain CCNP_ENTERPRISE
vtp version 2
vtp password cisco
vtp mode server

vlan 811
mtu 1400

interface range gi0/0-3
switchport trunk enc dot1q
sw tr native vlan 666
sw tr all vlan 99,100,110,120,666,999
sw mo trunk

vtp mode transparent (task#8)

SCOTSW02
hostname SCOTSW02

vtp domain CCNP_ENTERPRISE
vtp version 2
vtp password cisco
vtp mode server

interface range gi0/0-3
switchport trunk enc dot1q
sw tr native vlan 666
sw tr all vlan 99,100,110,120,666,999
sw mo trunk

vtp mode transparent (task#8)

SCOTSW03
hostname SCOTSW03

vtp domain CCNP_ENTERPRISE
vtp version 2
vtp password cisco
vtp mode transparent

interface range gi0/0-3, gi1/0
switchport trunk enc dot1q
sw tr native vlan 666
sw tr all vlan 99,100,110,120,666,999
sw mo trunk

SCOTSW04
hostname SCOTSW04

vtp domain CCNP_ENTERPRISE
vtp version 2
vtp password cisco
vtp mode transparent

interface range gi0/0-3, gi1/0
switchport trunk enc dot1q
sw tr native vlan 666
sw tr all vlan 99,100,110,120,666,999
sw mo trunk

SCOTSW05
hostname SCOTSW05

vtp domain CCNP_ENTERPRISE
vtp version 2
vtp password cisco
vtp mode client

interface range gi0/0-3, gi1/0
switchport trunk enc dot1q
sw tr native vlan 666
sw tr all vlan 99,100,110,120,666,999
sw mo trunk

SCOTSW06
hostname SCOTSW06

vtp domain CCNP_ENTERPRISE
vtp version 2
vtp password cisco
vtp mode client

interface range gi0/0-3, gi1/0
switchport trunk enc dot1q
sw tr native vlan 666
sw tr all vlan 99,100,110,120,666,999
sw mo trunk

SCOTSW07
hostname SCOTSW07

vtp domain CCNP_ENTERPRISE
vtp version 2
vtp password cisco
vtp mode transparent

interface range gi0/0-3, gi1/0
switchport trunk enc dot1q
sw tr native vlan 666
sw tr all vlan 99,100,110,120,666,999
sw mo trunk

SCOTSW08
hostname SCOTSW08

vtp domain CCNP_ENTERPRISE
vtp version 2
vtp password cisco
vtp mode transparent

interface range gi0/0-3, gi1/0
switchport trunk enc dot1q
sw tr native vlan 666
sw tr all vlan 99,100,110,120,666,999
sw mo trunk

NOTE: The VTP will only start working once "trunking" is configured and activated.
VTP is functional only on over Trunking interface.

Verifications:

**GNS3 and EVE-NG both failed at task 3. This might be due to IOS version used inside Emulators
**I got successful output with Packet-Tracer.
**As a turnover fix on GNS/Eveng, make SCOTSW03 SCOTSW04 as "client mode"

VERIFICATION TASK 1: To verify the VTP DOMAIN name
SCOTSW01#show vtp status
VTP Version capable   : 1 to 3
VTP version running   : 2
VTP Domain Name   : CCNP_ENTERPRISE
VTP Pruning Mode   : Disabled
VTP Traps Generation   : Disabled
Device ID   : 0c67.916e.8000
Configuration last modified by 0.0.0.0 at 4-12-20 19:49:46
Local updater ID is 0.0.0.0 (no valid interface found)

Feature VLAN:

VTP Operating Mode   : Server
Maximum VLANs supported locally   : 1005
Number of existing VLANs   : 27
Configuration Revision   : 18
MD5 digest   : 0x25 0xB6 0x82 0xAA 0x89 0xE6 0xBE 0x33
                       0xD7 0x6E 0xA6 0x03 0x19 0x4D 0xE5 0xAD

Note: MD5 digest changes everytime because the configuration revision number is used to calculate the hash and as it is different after creating the vlan then the md5 will be different.

VERIFICATION TASK 2: Verify VTP password

SCOTSW01#show vtp password
VTP Password: cisco

VERIFICATION TASK 3: Verify VTP mode
SCOTSW01#show vtp status | i Operating
VTP Operating Mode   : Server

VERIFICATION TASK 4 & 5: VERIFY TRUNK ALLOWED ON INTERFACE
SCOTSW01#show running-config interface gigabitEthernet 0/3
!
interface GigabitEthernet0/3

switchport trunk allowed vlan 99,100,110,120,666,999
 switchport trunk encapsulation dot1q
 switchport trunk native vlan 666

```
 switchport mode trunk
 media-type rj45
 negotiation auto
 end
```

Second way to check if the Trunking vlans allowed in switches

SCOTSW01#show interfaces trunk

Port	Mode	Encapsulation	Status	Native vlan
Gi0/0	on	802.1q	trunking	666
Gi0/1	on	802.1q	trunking	666
Gi0/2	on	802.1q	trunking	666
Gi0/3	on	802.1q	trunking	666

Port	Vlans allowed on trunk
Gi0/0	99-100,110,120,666,999
Gi0/1	99-100,110,120,666,999
Gi0/2	99-100,110,120,666,999
Gi0/3	99-100,110,120,666,999

VERIFICATION TASK 6: Verify MTU size for VLAN 811

SCOTSW01#show vlan id 811

VLAN	Name	Status	Ports
811	VLAN0811	active	

VLAN	Type	SAID	MTU	Parent	RingNo	BridgeNo	Stp	BrdgMode	Trans1	Trans2
811	enet	100811	1400	-	-	-	-	-	0	0

Remote SPAN VLAN

Disabled

Primary	Secondary	Type	Ports

VERIFICATION TASK 7: Verify Native VLAN behavior

Tagged traffic on Wireshak for TRUNK interface:

Native VLAN = untagged traffic

Untagged traffic capture on Wireshark for NATIVE VLAN:

28 6.848057	192.168.66.200	192.168.66.100	ICMP	114 Echo (ping) reply id=0x0005, seq=4/1024, ttl=255 (request in 27)
29 6.969767	0c:67:91:59:b1:00	PVST+	STP	68 Conf. TC + Root = 32768/120/0c:67:91:59:b1:00 Cost = 0 Port = 0x80(
30 7.370869	0c:67:91:59:b1:00	PVST+	STP	64 Conf. TC + Root = 32768/666/0c:67:91:59:b1:00 Cost = 0 Port = 0x80(
31 7.497143	0c:67:91:6e:7e:00	PVST+	STP	68 Conf. Root = 32768/100/0c:67:91:14:be:00 Cost = 8 Port = 0x8001
32 7.862197	0c:67:91:59:b1:00	PVST+	STP	68 Conf. TC + Root = 32768/99/0c:67:91:59:b1:00 Cost = 0 Port = 0x800:
33 8.520624	0c:67:91:59:b1:00	PVST+	STP	68 Conf. TC + Root = 32768/110/0c:67:91:59:b1:00 Cost = 0 Port = 0x80(
34 9.112076	0c:67:91:59:b1:00	PVST+	STP	68 Conf. TC + Root = 32768/120/0c:67:91:59:b1:00 Cost = 0 Port = 0x80(

> Frame 28: 114 bytes on wire (912 bits), 114 bytes captured (912 bits) on interface 0
> Ethernet II, Src: 0c:67:91:59:82:9a (0c:67:91:59:82:9a), Dst: 0c:67:91:6e:82:9a (0c:67:91:6e:82:9a)
> Internet Protocol Version 4, Src: 192.168.66.200, Dst: 192.168.66.100
> Internet Control Message Protocol

VERIFICATION TASK 8:

Config:
SCOTSW01(config)#vtp mode transparent

SCOTSW02(config)#vtp mode transparent

Verifications:
SCOTSW01#sh vtp status | i Operating
VTP Operating Mode   : Transparent

SCOTSW02#sh vtp status | i Operating
VTP Operating Mode   : Transparent

LAB #3 CONFIGURE – VTP version 3
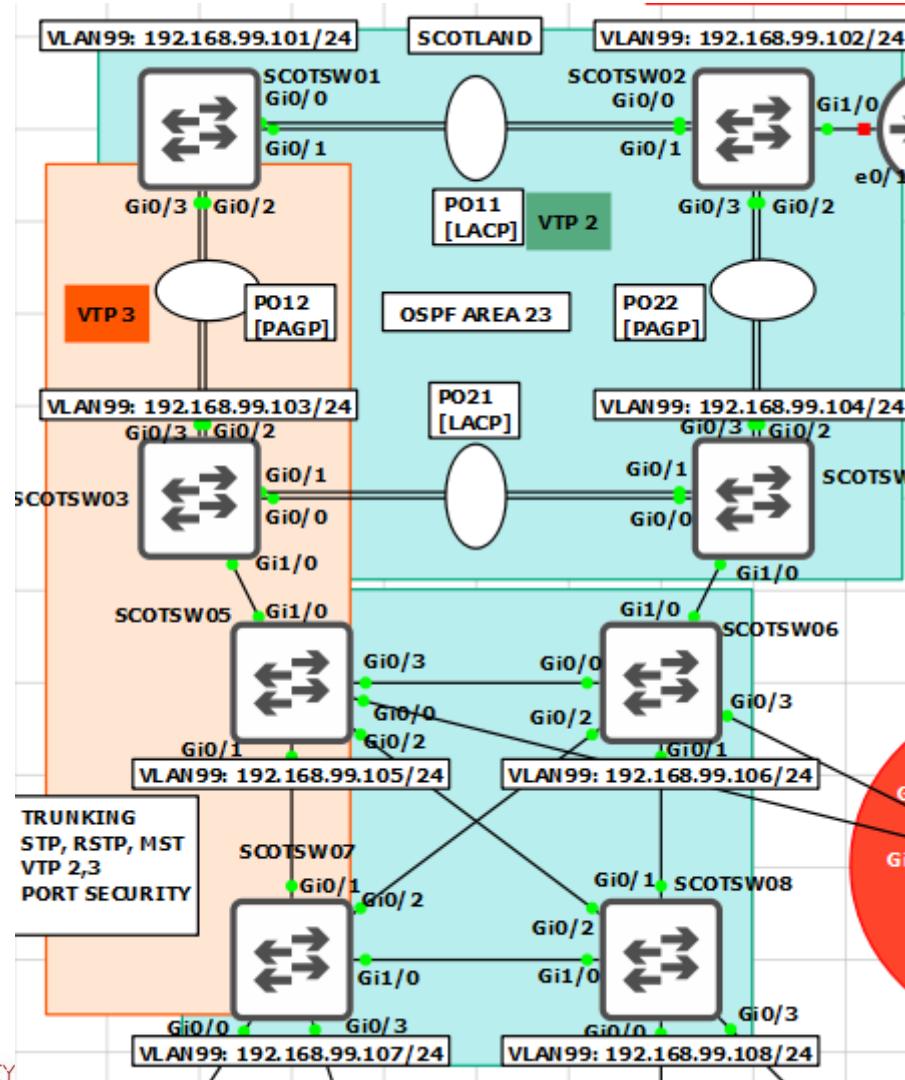
VTP version 3 is backwards compatible with VTP version 2; at the boundary of the two protocols, a VTP version 3 switch will send out both version 3 and version 2-compatible messages. Version 2 messages received by a version 3 switch are discarded.

Objectives: Configure SCOTSW01, SCOTSW03, SCOTSW05, SCOTSW07 as following:

VTP version 3 cannot be enabled unless a VTP domain name has been set, so for this step, setting the domain name is not needed as we are using the Lab#2 and upgrading some of the Switches to VTP 3 as per the diagram shown.

Switch(config)#vtp version 3
Cannot set the version to 3 because domain name is not configured

1. The VTP domain should be configured to "CCNP_ENTERPRISE" (without the quotes) since it is already done in Lab#2, goto Task#2.
2. Configure VTP version 3 on SCOTSW01, SCOTSW03, SCOTSW05, SCOTSW07.

3. Configure VTP version 3 on below switches
   "Primary Server" mode on SCOTSW01
   "Transparent" mode on SCOTSW03
   "Server" mode on SCOTSW05
   "Client" mode on SCOTSW07
4. Configure 802.1q trunk links between the switches according to the Layer 2 Diagram show above, this is already done from Lab#2, goto next Task#5
5. Create new Vlan 444 and see the VTP 3 and VTP 2 advertisements on the borders.

Configuration:

SCOTW01
vtp version 3

SCOTSW01#vtp primary vlan [to be configured on user privilege mode]
This system is becoming primary server for feature vlan
No conflicting VTP3 devices found.
Do you want to continue? [confirm]
!
Vlan 444
exit
!
SCOTW03
SCOTSW03(config)#vtp version 3
SCOTSW03(config)#vtp mode transparent

SCOTW05
SCOTSW05(config)#vtp version 3
SCOTSW05(config)#vtp mode server

SCOTW07
SCOTSW07(config)#vtp version 3
SCOTSW07(config)#vtp mode client

Answer for #4
SCOTW01
!
Vlan 444
exit
!

VERIFICATIONS:

VERIFICATION TASK 1:

Verify VTPv3 status on SCOTSW01

```
SCOTSW01#show vtp status
VTP Version capable        : 1 to 3
VTP version running        : 3
VTP Domain Name            : CCNP_ENTERPRISE
VTP Pruning Mode           : Disabled
VTP Traps Generation       : Disabled
Device ID                  : 0c67.916e.8000

Feature VLAN:
--------------
VTP Operating Mode               : Primary Server
Number of existing VLANs         : 5
Number of existing extended VLANs : 0
Maximum VLANs supported locally   : 4096
Configuration Revision           : 1
Primary ID                       : 0c67.916e.8000
Primary Description              : SCOTSW01
MD5 digest                       : 0x74 0xEB 0x87 0xFF 0xA2 0x91 0x60 0x2D
                                   0xFD 0x82 0x67 0x93 0xC4 0x6C 0x2B 0xB4


Feature MST:
--------------
VTP Operating Mode               : Transparent


Feature UNKNOWN:
--------------
VTP Operating Mode               : Transparent
```

VERIFICATION TASK 2:

Verify VTP packet versions getting by VTPv3 switch to another VTPv3 and also VTPv3 switch to VTPv2 using Wiresharks:

Wireshark capture between SCOTSW01 and SCOTSW03 (VTPv3 <-> VTPv3)

```
  12123 1136.105532      0c:67:91:6e:7e:02        CDP/VTP/DTP/PAgP/UDLD           VTP           898 Summary Advertisement, Revision: 0
  12163 1138.560783      0c:67:01:6e:7e:02        CDP/VTP/DTP/PAgP/UDLD           VTP           898 Summary Advertisement, Revision: 0
```

```
▸ Frame 12123: 898 bytes on wire (7184 bits), 898 bytes captured (7184 bits) on interface 0
▸ IEEE 802.3 Ethernet
▸ Logical-Link Control
▾ VLAN Trunking Protocol
    Version: 0x03
    Code: Summary Advertisement (0x01)
    Followers: 0
    Management Domain Length: 15
    Management Domain: CCNP_ENTERPRISE
```

VTPv3 Primary Server Switch will advertise advertisement of version 3 to Switch running on VTPv3 mode.

Wireshark capture between SCOTSW01 and SCOTSW02 (VTPv3 <-> VTPv2)

```
  2435 146.657185        0c:67:91:59:b1:01        CDP/VTP/DTP/PAgP/UDLD           VTP           1006 Subset Advertisement, Revision: 24, Seq: 1
```

```
▸ Frame 2435: 1006 bytes on wire (8048 bits), 1006 bytes captured (8048 bits) on interface 0
▸ Ethernet II, Src: 0c:67:91:59:b1:01 (0c:67:91:59:b1:01), Dst: CDP/VTP/DTP/PAgP/UDLD (01:00:0c:cc:cc:cc)
▸ 802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 1
▸ Logical-Link Control
▾ VLAN Trunking Protocol
    Version: 0x02
    Code: Subset Advertisement (0x02)
    Sequence Number: 1
    Management Domain Length: 15
    Management Domain: CCNP_ENTERPRISE
    Configuration Revision Number: 24
```

VTPv3 Primary Server Switch will advertise advertisement of version 2 to Switch running on VTPv2 mode.

VERIFICATION TASK 3:

All other Switches are pointing to SCOTSW01 which is VTPv3 Primary Server.

SCOTSW01#show vtp status | i ID
Device ID   : 0c67.916e.8000
Primary ID   : 0c67.916e.8000

SCOTSW02#show vtp status | i ID
Device ID   : 0c67.9159.8000

SCOTSW02#show vtp status | i ID
Device ID   : 0c67.912e.8000

LAB #4 CONFIGURE – STP, MANIPULATE PRIMARY ROOT SWITCH, PATH COST
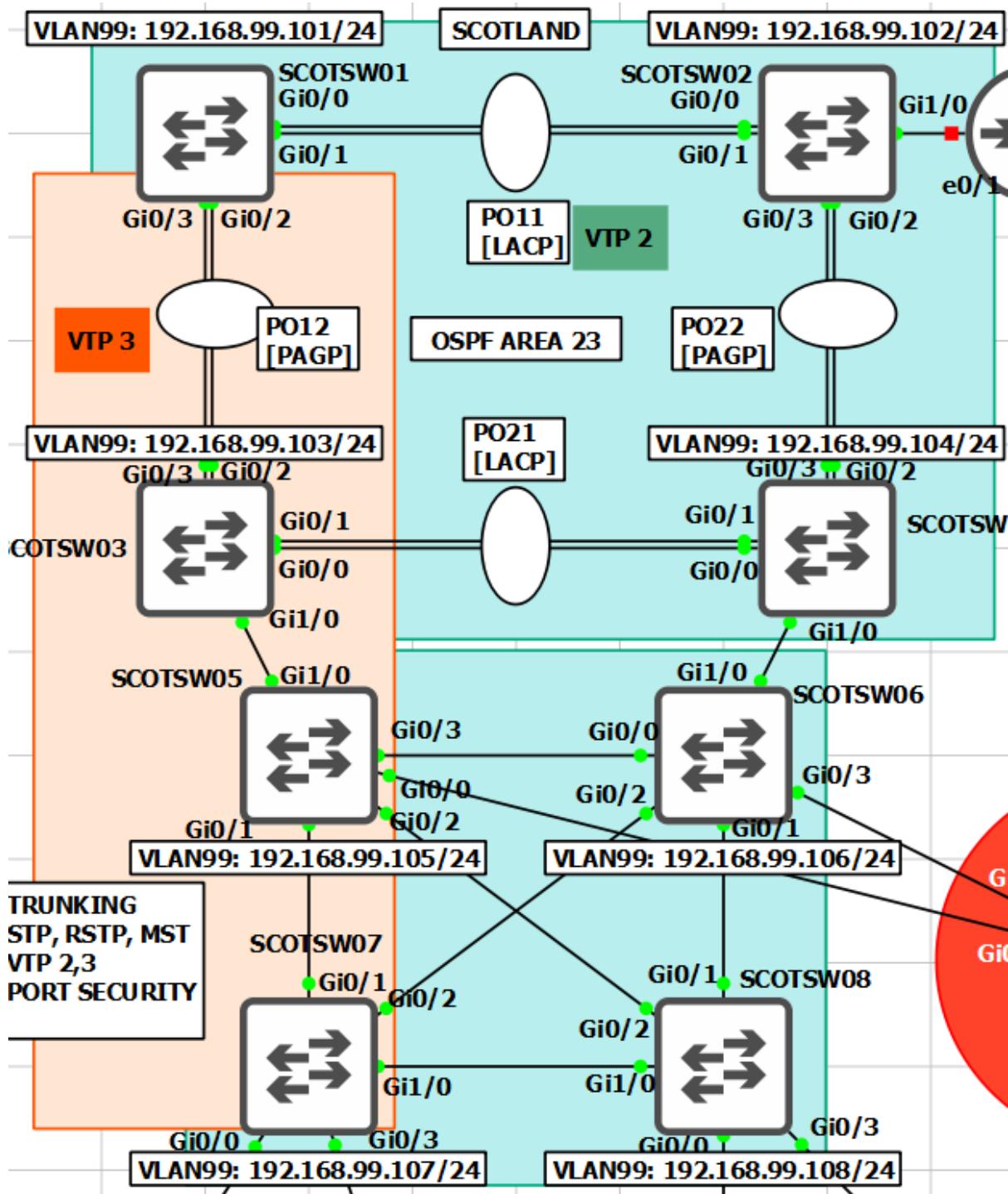
Objectives: Observe on SCOTSW01, SCOTSW02, SCOTSW03, SCOTSW04, SCOTSW05, SCOTSW06, SCOTSW07, SCOTSW08 as following:

1. Identify and modify the Root bridge
2. Manipulate port and path costs
3. Examine Re-convergence Time

CONFIGURATION FOR TASK#1:

Use the **show spanning-tree root** command on all of the switches to find the root switch for all of the VLANs. Note: Your results may vary from the examples.

SCOTTSW06#show spanning-tree root {currently acting as Root Bridge}

Vlan	Root ID	Root Cost	Hello Time	Max Age	Fwd Dly	Root Port
VLAN0001	32769 0c67.9114.be00	0	2	20	15	

SCOTTSW01#show spanning-tree root

Vlan	Root ID	Root Cost	Hello Time	Max Age	Fwd Dly	Root Port
VLAN0001	32769 0c67.9114.be00	8	2	20	15	Gi0/2

SCOTTSW05#show spanning-tree root

Vlan	Root ID	Root Cost	Hello Time	Max Age	Fwd Dly	Root Port
VLAN0001	32769 0c67.9114.be00	4	2	20	15	Gi0/0

The current root bridge was elected based on the lowest Bridge ID (consisting of the Priority, extended system ID equal to the VLAN ID, and base MAC address values). In the output above, the root's MAC is **0c67.9114.be00**

BRIDGE ID = PRIORITY (Base Priority + Sys-ext-ID) + MAC ADDRESS

There are two basic ways to manipulate the configuration to control the location of the root bridge.
• The **spanning-tree vlan** vlan-id **priority** value command can be used to manually set a priority value
• The **spanning-tree vlan** vlan-id **root { primary | secondary }** command can be used to automatically set a priority value.

The difference between the two is the **priority** command will set a specific number (multiple of 4096) as the priority, while the **root primary** command will set the local bridge's priority to 24,576 (if the local bridge MAC is lower than the current root bridge's MAC) or 4096 lower than the current root's priority (if the local bridge MAC is higher than the current root bridge's MAC).

The logic behind this operation is straight-forward. The **root primary** command tries to lower the priority only as much as is needed to win the root election, while leaving priorities between 24576 and the default 32768 for use by secondary bridges. The command always takes the entire Bridge ID into account when computing the resulting priority value.

SCOTTSW01# **conf t**
Enter configuration commands, one per line. End with CNTL/Z.
SCOTTSW01(config)# **spanning-tree vlan 1 root primary**
SCOTTSW02(config)# **exit**

SCOTTSW02# **conf t**
SCOTTSW02(config)# **spanning-tree vlan 1 root secondary**
SCOTTSW02(config)# **exit**

The Priority is lowered to 24,576 on Primary Root (Calculation: 32768-8192 for primary root)
SCOTTSW01# sh spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID   Priority   24577
        Address   0c67.916e.7e00
        This bridge is the root
        Hello Time   2 sec Max Age 20 sec Forward Delay 15 sec

  Bridge ID Priority   24577 (priority 24576 sys-id-ext 1)
        Address   0c67.916e.7e00
        Hello Time   2 sec Max Age 20 sec Forward Delay 15 sec
        Aging Time 300 sec

The Priority is lowered by 28,672 on Secondary Root (Calculation: 32768-4096 for secondary root)
SCOTTSW02# sh spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID   Priority   24577
        Address   0c67.916e.7e00
        Cost   4
        Port   1 (GigabitEthernet0/0)
        Hello Time   2 sec Max Age 20 sec Forward Delay 15 sec

  Bridge ID Priority   28673 (priority 28672 sys-id-ext 1)
        Address   0c67.9159.b100
        Hello Time   2 sec Max Age 20 sec Forward Delay 15 sec
        Aging Time 15 sec

The **show spanning-tree bridge** command also provides detailed information about the current configuration of the local bridge:

SCOTTSW01# show spanning-tree bridge
                         Hello Max Fwd
Vlan   Bridge ID   Time Age Dly Protocol
--------------- -------------------------------- ----- --- --- --------
VLAN0001   24577 (24576, 1) 0c67.916e.7e00   2   20   15 ieee

SCOTTSW02# show spanning-tree bridge

```
                                Hello  Max  Fwd
Vlan              Bridge ID        Time  Age  Dly  Protocol
---------------  -------------------------------  -----  ---  ---  --------
VLAN0001      28673 (28672,  1) 0c67.9159.b100  2   20   15  ieee
```

CONFIGURATION FOR TASK#2:

MANIPULATE PORT and PATH COSTS

As the network is implemented right now, there are two paths between each directly connected switch. As the Root Port is elected, path and port costs are evaluated to determine the shortest path to the root bridge.

In the case where there are multiple equal cost paths to the root bridge, additional attributes must be evaluated. In our case, the lower interface number (for example, Gi0/1) is chosen as the Root Port, and the higher interface number (for example, Gi0/2) is put into a spanning tree Blocking state.

You can see which ports are blocked with the show spanning-tree vlan-id command or the show spanning-tree blockedports command. For now, examine VLAN 1 on SCOTTSW02, SCOTTSW03, SCOTTSW04.

SCOTTSW02#show spanning-tree blockedports
```
Name              Blocked Interfaces List
------------------  -----------------------------------
VLAN0001           Gi0/1
Number of blocked ports (segments) in the system : 1
```

SCOTTSW02#show spanning-tree
```
VLAN0001
 Spanning tree enabled protocol ieee
 Root ID   Priority   24577
        Address    0c67.916e.7e00
        Cost     4
        Port     1 (GigabitEthernet0/0)
        Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
 Bridge ID  Priority   28673  (priority 28672 sys-id-ext 1)
        Address    0c67.9159.b100
        Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
        Aging Time   300 sec
Interface        Role Sts Cost     Prio.Nbr Type
------------------ ---- --- -------- ------- -------------------------------

Gi0/0          Root FWD 4       128.1   P2p
Gi0/1          Altn BLK 4       128.2   P2p
Gi0/2          Desg FWD 4       128.3   P2p
Gi0/3          Desg FWD 4       128.4   P2p
Gi1/0          Desg FWD 4       128.5   P2p
Gi1/1          Desg FWD 4       128.6   P2p
Gi1/2          Desg FWD 4       128.7   P2p
```

TIME TO MANIPULATE USING STP COST:

It is possible to manipulate which port becomes the Root Port on non-root bridges by manipulating the port cost value, or by changing the port priority value. Remember that this change could have an impact on downstream switches as well. For this example, we will examine both options.

> **Note**: The changes you are about to implement are considered topology changes and could have a significant impact on the overall structure of the spanning tree in your switch network. Do not make these changes in a production network without careful planning and prior coordination.

Goto SCOTTSW03 and Manipulate the Cost for Gi0/3 (currently STP blocked port)

```
SCOTTSW03#show spanning-tree blockedports
Name              Blocked Interfaces List
------------------- ------------------------------------
VLAN0001          Gi0/3
Number of blocked ports (segments) in the system : 1

SCOTTSW03#sh spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority    24577
             Address     0c67.916e.7e00
             Cost        4
             Port        3 (GigabitEthernet0/2)
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32769  (priority 32768 sys-id-ext 1)
             Address     0c67.912e.9400
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time  15  sec

Interface         Role Sts Cost     Prio.Nbr Type
------------------- ---- --- --------- -------- -------------------------------
Gi0/0            Desg FWD 4        128.1   P2p
Gi0/1            Desg FWD 4        128.2   P2p
Gi0/2            Root FWD 4        128.3   P2p
Gi0/3            Altn BLK 4        128.4   P2p
Gi1/0            Desg FWD 4        128.5   P2p
Gi1/1            Desg FWD 4        128.6   P2p
Gi1/2            Desg FWD 4        128.7   P2p


SCOTTSW03# conf t
Enter configuration commands, one per line.  End with CNTL/Z.
SCOTTSW03(config)#int ran gi0/2-3
SCOTTSW03(config-if-range)#shut
SCOTTSW03(config-if-range)#exit

SCOTTSW03(config)#interface gi0/3
SCOTTSW03(config-if)#spanning-tree cost 2
```

SCOTTSW03(config-if)#exit

SCOTTSW03(config)#int ran gi0/2-3
SCOTTSW03(config-if-range)#no shut
SCOTTSW03(config-if-range)#end

SCOTTSW03#sh spanning-tree blockedports
Name   Blocked Interfaces List
-------------------- ------------------------------------
VLAN0001   Gi0/2
Number of blocked ports (segments) in the system : 1

SCOTTSW03#show spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID   Priority   24577
           Address   0c67.916e.7e00
           Cost   2
           Port   4 (GigabitEthernet0/3)
           Hello Time   2 sec Max Age 20 sec Forward Delay 15 sec
  Bridge ID Priority   32769 (priority 32768 sys-id-ext 1)
           Address   0c67.912e.9400
           Hello Time   2 sec Max Age 20 sec Forward Delay 15 sec
           Aging Time 300 sec
Interface   Role Sts Cost   Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------------
Gi0/0   Desg FWD 4   128.1   P2p
Gi0/1   Desg FWD 4   128.2   P2p
Gi0/2   Altn BLK 4   128.3   P2p
Gi0/3   Root FWD 2   128.4   P2p
Gi1/0   Desg FWD 4   128.5   P2p
Gi1/1   Desg FWD 4   128.6   P2p
Gi1/2   Desg FWD 4   128.7   P2p

Alternatively, you can modify this behaviour with manipulating Port-Priority as well:

SCOTTSW03 (config)#int gi0/0
SCOTTSW03 (config-if)#spanning-tree port-priority ?
  <0-224> port priority in increments of 32

```
Interface              Role Sts Cost      Prio.Nbr Type
------------------     ---- --- --------- -------- ------
Gi0/0                  Desg FWD 4         128.1    P2p
```

Verifications:

Examine Re-convergence Time:
Enable Debug STP command to see the convergence timers
SCOTTSW03#debug spanning-tree events

SCOTTSW03#
*Apr 20 13:13:57.732: STP: VLAN0001 Gi0/2 -> listening
*Apr 20 13:13:58.090: STP: VLAN0001 heard root 24577-0c67.916e.7e00 on Gi0/2
*Apr 20 13:13:58.091:   supersedes 32769-0c67.9114.be00
*Apr 20 13:14:12.731: STP: VLAN0001 Gi0/2 -> learning
*Apr 20 13:14:27.738: STP[1]: Generating TC trap for port GigabitEthernet0/2
*Apr 20 13:14:27.740: STP: VLAN0001 sent Topology Change Notice on Gi0/2
*Apr 20 13:14:27.740: STP: VLAN0001 Gi0/2 -> forwarding
*Apr 20 13:14:29.156: STP: VLAN0001 Topology Change rcvd on Gi0/0
*Apr 20 13:14:29.158: STP: VLAN0001 sent Topology Change Notice on Gi0/2

LAB #5 CONFIGURE – RSTP, PORTFAST, BPDUGUARD, BPDUFILTER, ROOTGUARD, LOOPGUARD

Objectives: Observe on SCOTSW01, SCOTSW02, SCOTSW03, SCOTSW04, SCOTSW05, SCOTSW06, SCOTSW07, SCOTSW08 as following:

1. Configure Rapid-STP and verify its behaviour
2. Configure and Verify Portfast
3. Configure and Verify BPDUGuard
4. Configure and Verify BPDUFilter
5. Configure and Verify RootGuard
6. Configure and Verify LoopGuard
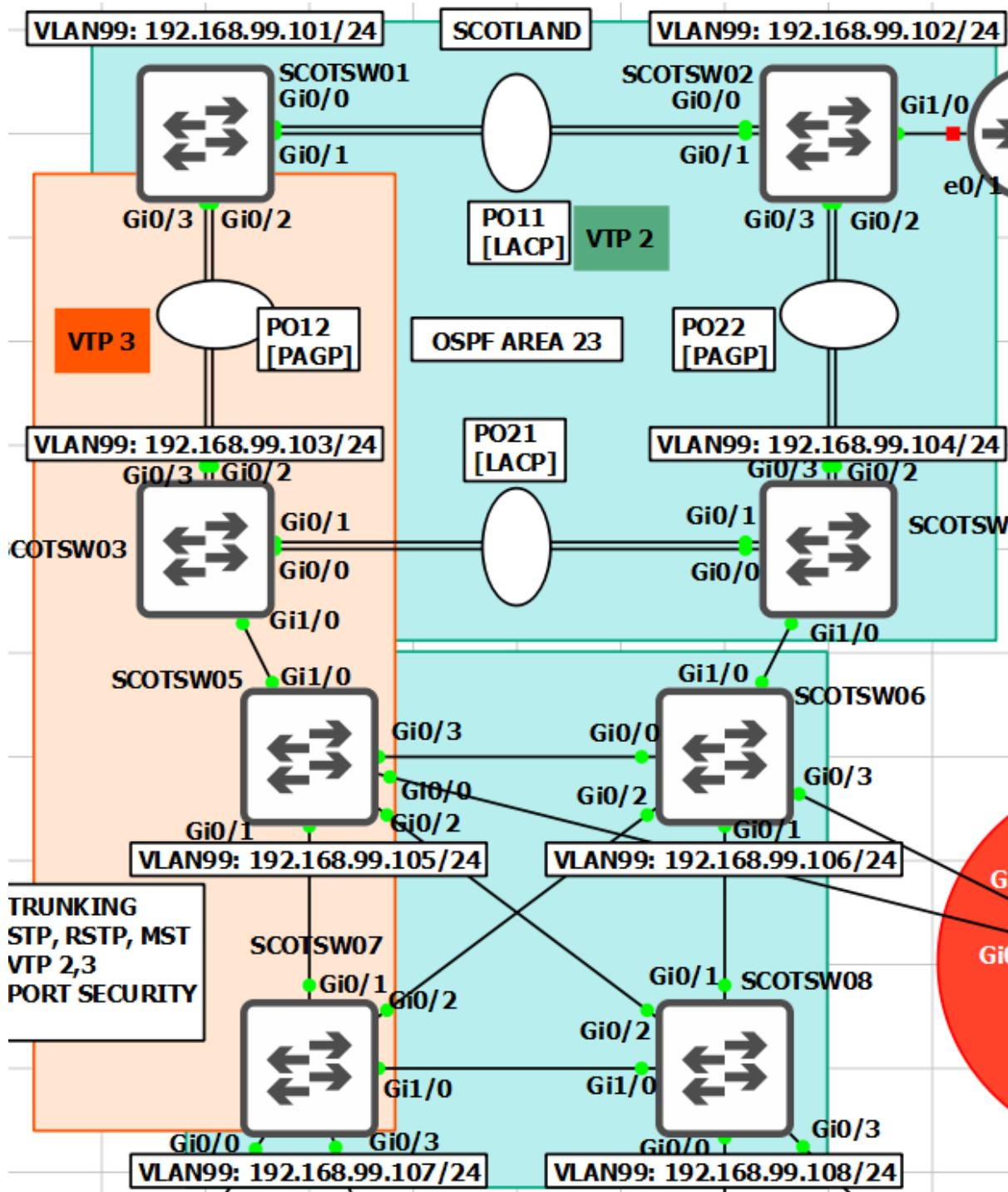
CONFIGURATION FOR TASK#1:

RSTP is backward compatible with legacy STP 802.1D

Enable RSTP on all switches:

SCOTSW01(config)#spanning-tree mode rapid-pvst
SCOTSW01(config)#end

SCOTSW02(config)#spanning-tree mode rapid-pvst
SCOTSW02(config)#end

SCOTSW03(config)#spanning-tree mode rapid-pvst
SCOTSW03(config)#end

SCOTSW04(config)#spanning-tree mode rapid-pvst
SCOTSW04(config)#end

SCOTSW05(config)#spanning-tree mode rapid-pvst
SCOTSW05(config)#end

SCOTSW06(config)#spanning-tree mode rapid-pvst
SCOTSW06(config)#end

SCOTSW07(config)#spanning-tree mode rapid-pvst
SCOTSW07(config)#end

SCOTSW08(config)#spanning-tree mode rapid-pvst
SCOTSW08(config)#end

Upon activating RSTP on every switch, you can see "proposal" and "agreements"

To enable debug for rstp
SCOTSW01#debug spanning-tree events

Debug Packets for RSTP on Root Bridge Switch
*Apr 21 20:46:00.427: RSTP(1): Gi2/2 fdwhile Expired
*Apr 21 20:46:00.445: STP[1]: Generating TC trap for port GigabitEthernet1/1
*Apr 21 20:46:00.446: STP[1]: Generating TC trap for port GigabitEthernet1/2
*Apr 21 20:46:00.447: STP[1]: Generating TC trap for port GigabitEthernet1/3
*Apr 21 20:46:00.505: RSTP(1): transmitting a proposal on Gi2/3
*Apr 21 20:46:00.506: RSTP(1): Gi2/3 fdwhile Expired
*Apr 21 20:46:00.509: RSTP(1): transmitting a proposal on Gi3/0
*Apr 21 20:46:00.512: RSTP(1): transmitting a proposal on Gi3/1
*Apr 21 20:46:00.515: RSTP(1): transmitting a proposal on Gi3/2
*Apr 21 20:46:00.519: RSTP(1): transmitting a proposal on Gi3/3

Debug Packets for RSTP on Non Root-bridge switch
*Apr 21 20:49:38.033: RSTP(1): Gi0/2 rcvd info expired
*Apr 21 20:49:38.033: RSTP(1): Gi0/2 is now designated

*Apr 21 20:49:38.054: RSTP(1): updt roles, received superior bpdu on Gi0/2
*Apr 21 20:49:38.055: RSTP(1): Gi0/2 is now alternate
SCOTSW05#sh spanning-tree
VLAN0001
  Spanning tree enabled protocol rstp
  Root ID   Priority   32769
           Address   0c67.9114.be00
           This bridge is the root
           Hello Time   2 sec Max Age 20 sec Forward Delay 15 sec

  Bridge ID Priority   32769 (priority 32768 sys-id-ext 1)
           Address   0c67.9114.be00
           Hello Time   2 sec Max Age 20 sec Forward Delay 15 sec
           Aging Time 300 sec

Interface   Role Sts Cost   Prio.Nbr Type
------------------ ---- --- --------- -------- --------------------------------
Gi0/0   Desg FWD 4   128.1   P2p Peer(STP)
Gi0/1   Desg FWD 4   128.2   P2p
Gi0/2   Desg FWD 4   128.3   P2p
Gi0/3   Desg FWD 4   128.4   P2p
Gi1/0   Desg FWD 4   128.5   P2p
Gi1/1   Desg FWD 4   128.6   P2p
Gi1/2   Desg FWD 4   128.7   P2p
Gi1/3   Desg FWD 4   128.8   P2p

> P2p Peer(STP) is for interoperability.
> It is seen between RSTP and legacy STP running on interface.
> RSTP will fallback to legacy STP behaviour of 50 sec of transition period on such interoperability interfaces.

In addition to above output, we can see additional two features "ALT BLK" port and "BACKUP BLK" port in RSTP.

SCOTSW01#sh spanning-tree
VLAN0001
  Spanning tree enabled protocol rstp
  Root ID   Priority   4097
           Address   0c67.91c0.f900
           Cost   12
           Port   3 (GigabitEthernet0/2)
           Hello Time   2 sec Max Age 20 sec Forward Delay 15 sec

  Bridge ID Priority   32769 (priority 32768 sys-id-ext 1)
           Address   0c67.916e.7e00
           Hello Time   2 sec Max Age 20 sec Forward Delay 15 sec
           Aging Time 300 sec

Interface   Role Sts Cost   Prio.Nbr Type
------------------ ---- --- --------- -------- --------------------------------

<!output omitted>
Gi0/3   Altn BLK 4   128.4   P2p   Altn BLK = Uplinkfast (Alternate port)

SCOTSW08#show spanning-tree
VLAN0001
  Spanning tree enabled protocol rstp
  Root ID   Priority   32769
        Address   0c67.9114.be00
        Cost   4
        Port   3 (GigabitEthernet0/2)
        Hello Time   2 sec Max Age 20 sec Forward Delay 15 sec

  Bridge ID Priority   32769 (priority 32768 sys-id-ext 1)
        Address   0c67.911c.e000
        Hello Time   2 sec Max Age 20 sec Forward Delay 15 sec
        Aging Time 300 sec

Interface   Role Sts Cost   Prio.Nbr Type
------------------ ---- --- -------- -------- ------------------------------
<!output omitted>
Gi0/3   Back BLK 4   128.4   P2p Back BLK = Backbonefast (Backup port)

  Manipulating Root Bridge Switches:

Make SCOTSW01 to be Root Bridge:
This can be done as similar as done on legacy STP.
Manipulate the priority or set keyword "primary" on SCOTSW01 as shown below:

SCOTSW01(config)#spanning-tree vlan 1 priority 4096

Or

SCOTSW01(config)#spanning-tree vlan 1 root primary

Make SCOTSW03_Gi0/3 to be DSG FWD:
By default, due to STP calculations:

SCOTSW03_Gi0/2 = DSG FWD
SCOTSW03_Gi0/3 = ALT BLK

However, I want to make SCOTSW03_Gi0/3 as DSG FWD

Method 1: Manipulate using STP Path Cost:
SCOTTSW03(config)#int ran gi0/2-3
SCOTTSW03(config-if-range)#shut
SCOTTSW03(config-if-range)#exit

SCOTTSW03(config)#interface gi0/3

SCOTTSW03(config-if)#spanning-tree cost 2
SCOTTSW03(config-if)#exit

SCOTTSW03(config)#int ran gi0/2-3
SCOTTSW03(config-if-range)#no shut
SCOTTSW03(config-if-range)#end

Method 2: Alternatively, you can modify this behaviour with manipulating Port-Priority as well:
Switch(config)#int gi0/0
Switch(config-if)#spanning-tree port-priority ?
 <0-224> port priority in increments of 32

CONFIGURATION FOR TASK#2: To configure & verify Portfast
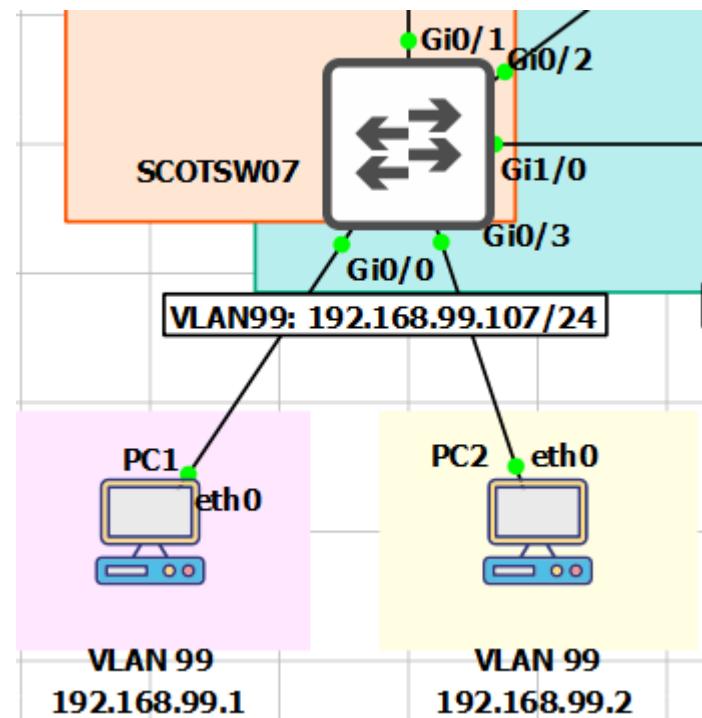
Initial Config PC1, PC2 and SCOTSW07:

PC1:
#
#
This is a sample network config uncomment lines to configure the network
#
Static config for eth0
auto eth0
iface eth0 inet static
address 192.168.99.1
netmask 255.255.255.0
gateway 192.168.99.100
up echo nameserver 192.168.0.1 > /etc/resolv.conf

DHCP config for eth0
auto eth0
iface eth0 inet dhcp

PC2:
#
This is a sample network config uncomment lines to configure the network
#
Static config for eth0
auto eth0
iface eth0 inet static
address 192.168.99.2
netmask 255.255.255.0
gateway 192.168.99.100
up echo nameserver 192.168.0.1 > /etc/resolv.conf

DHCP config for eth0
auto eth0
iface eth0 inet dhcp

SCOTSW07:
interface vlan 99
ip address 192.168.99.107 255.255.255.0
no shut
exit
int gi0/0
switchport mode access
switchport access vlan 99
no shut
int gi0/3
switchport mode access
switchport access vlan 99
no shut

Now ping from PC1 to PC2 over RSTP, it would take 1 second to switchport transit from "Learning" to "Forwarding"

SCOTSW07#sh span int gi0/3

Vlan	Role	Sts	Cost	Prio.Nbr	Type
VLAN0099	Desg	LRN	4	128.4	P2p

Switch#sh span int gi0/3

Vlan	Role	Sts	Cost	Prio.Nbr	Type
VLAN0099	Desg	LRN	4	128.4	P2p

Switch#sh span int gi0/3

Vlan	Role	Sts	Cost	Prio.Nbr	Type
VLAN0099	Desg	LRN	4	128.4	P2p

Switch#sh span int gi0/3

Vlan	Role	Sts	Cost	Prio.Nbr	Type
VLAN0099	Desg	FWD	4	128.4	P2p

Let us see by enabling the "Portfast" features on Egde port, SCOTSW07_Gi0/0 and Gi0/3

SCOTSW07(config)#int gi0/0
SCOTSW07(config-if)#spanning-tree portfast

SCOTSW07(config)#int gi0/3
SCOTSW07(config-if)#spanning-tree portfast

%Warning: portfast should only be enabled on ports connected to a single
 host. Connecting hubs, concentrators, switches, bridges, etc... to this
 interface when portfast is enabled, can cause temporary bridging loops.
 Use with CAUTION

 %Portfast has been configured on GigabitEthernet0/0 but will only
  have effect when the interface is in a non-trunking mode.

To test the "portfast" behaviour, shut/no shutdown SCOTSW07_Gi0/0 and observe the time it takes
to allow PING reachability between PC1 and PC2

SCOTSW07(config-if)#int gi0/0
SCOTSW07(config-if)#shut
SCOTSW07(config-if)#no shut

SCOTSW07# show spanning interface gi0/0

Vlan   Role Sts Cost   Prio.Nbr Type
------------------- ---- --- --------- -------- -------------------------------
VLAN0099   Desg FWD 4   128.1   P2p Edge

*Apr 21 21:30:29.503: RSTP(99): initializing port Gi0/0
*Apr 21 21:30:29.504: RSTP(99): Gi0/0 is now designated
*Apr 21 21:30:29.686: %LINK-3-UPDOWN: Interface GigabitEthernet0/0, changed state to down
*Apr 21 21:30:32.568: %LINK-3-UPDOWN: Interface GigabitEthernet0/0, changed state to up

It was instantaneous without any delay.
Portfast is enabled between Switch and Non-BPDU end host only.
Do not enable between two BPDU switches will result in looping and layer 2 security attacks.

TASK#2: To configure & verify BPDUGuard

> BPDU Guard feature can be enabled globally at Global configuration mode or per interface at Interface configuration mode.
> When a BPDU Guard enabled port receive BPDU from the connected device, BPDU Guard disables the port and the port state is changed to **Errdisable state**.
> Global and Interface config has the same impact on receiving any BPDU, they would put the switchport in "err-disabled" state.
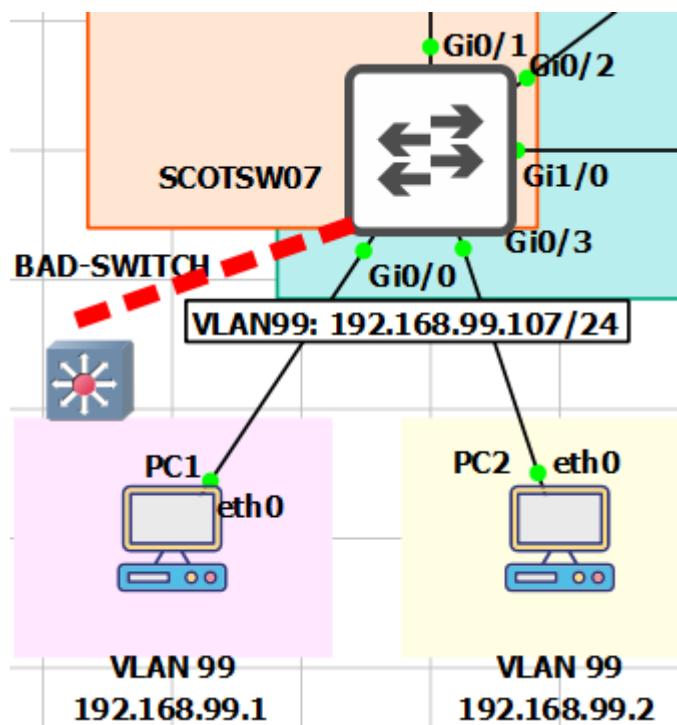
Initial Config PC1, PC2 and SCOTSW07 as above done for "portfast" lab

Considering the fact, you have already configured "portfast" on SCOTSW07_Gi0/0 in the previous Task.

Now let us enable "BPDUGuard" on SCOTSW07_Gi0/0

SCOTSW07(config)#interface gigabitEthernet 0/0
SCOTSW07(config-if)#spanning-tree bpduguard enable

Remove the cable between SCOTSW07 and PC1, plug the same cable between SCOTSW07 <-> BAD-SWITCH
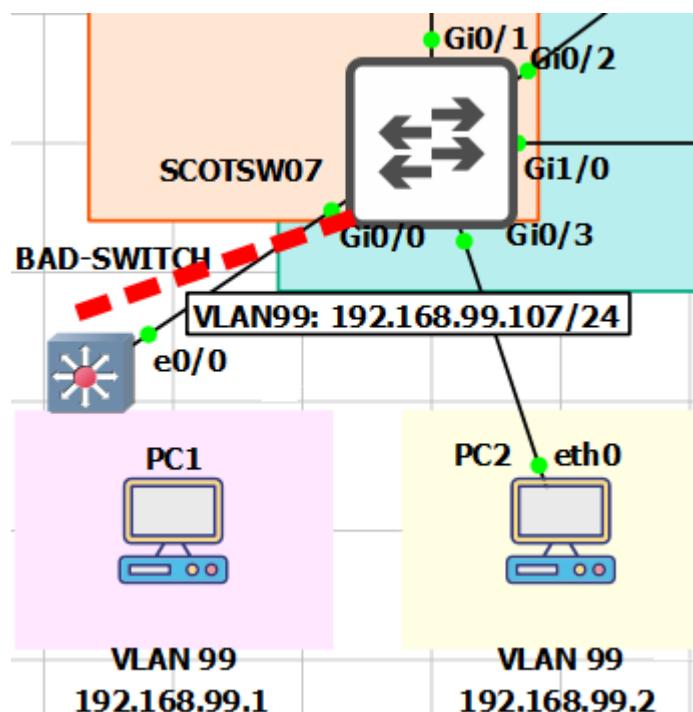
SCOTSW07(config-if)#

*Apr 21 21:42:19.264: %SPANTREE-2-BLOCK_BPDUGUARD: Received BPDU on port Gi0/0 with BPDU Guard enabled. Disabling port.
*Apr 21 21:42:19.264: %PM-4-ERR_DISABLE: bpduguard error detected on Gi0/0, putting Gi0/0 in err-disable state
*Apr 21 21:42:20.264: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0, changed state to down
*Apr 21 21:42:21.265: %LINK-3-UPDOWN: Interface GigabitEthernet0/0, changed state to down

Interface is down due to bpduguard impact:
SCOTSW07#sh ip int br | i 0/0
GigabitEthernet0/0   unassigned   YES unset down   down

SCOTSW07#show inter gi0/0
GigabitEthernet0/0 is down, line protocol is down (err-disabled)

The reason for detection and going into errdisable state is because by default "bpduguard" detection is enabled on all switches as shown below:

SCOTSW07#show errdisable detect | i bpdu
bpduguard   Enabled   port

As of now the automatic recovery is set to "disabled"

SCOTSW07#show errdisable recovery | i bpdu

bpduguard   Disabled

We can set the automatic recovery for "bpduguard" for every "30" seconds

SCOTSW07(config)#errdisable recovery interval 30

SCOTSW07(config)#errdisable recovery cause bpduguard

SCOTSW07#sh errdisable recovery

ErrDisable Reason   Timer Status

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

arp-inspection   Disabled

bpduguard   Enabled

The interface is back to "connected" mode:

SCOTSW07#

SCOTSW07#sh int gi0/0

GigabitEthernet0/0 is up, line protocol is up (connected)

TASK#3: To configure & verify BPDUFilter

- **BPDU Filtering at the global level** will work with Portfast interfaces, and simply kick them out of portfast if a BPDU is received.
- **BPDU Filtering configured on the interface level** will COMPLETELY stop send/receive BPDU, and if you plug in two switches then you may have a loop because they don't 'see' each other as a problem.
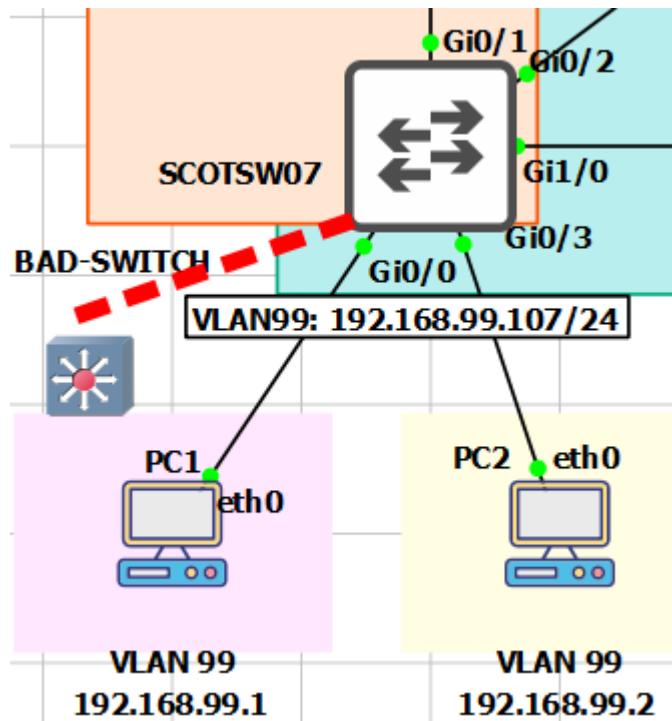
BPDUFILTER AT INTERFACE LEVEL:
SCOTSW07(config-if)#int e0/0
SCOTSW07(config-if)# spanning-tree portfast edge
SCOTSW07(config-if)# spanning-tree bpdufilter enable

Let's verify the output of BPDUFilter at Interface level
BPDUs are stopped now as we configured the BPDUFilter interface level

SW01#sh spanning-tree interface gi0/0 detail
 Port 1 (Ethernet0/0) of VLAN0001 is designated forwarding
   Port path cost 100, Port priority 128, Port Identifier 128.1.
   Designated root has priority 32769, address aabb.cc00.0300
   Designated bridge has priority 32769, address aabb.cc00.0300
   Designated port id is 128.1, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is shared by default
   Bpdu filter is enabled
   BPDU: sent 3576, received 3 (do not increment)

Now let us assume someone disconnected the PC1 and connected that cable to another BPDU switch "BAD-SWITCH" as show in diagram below:
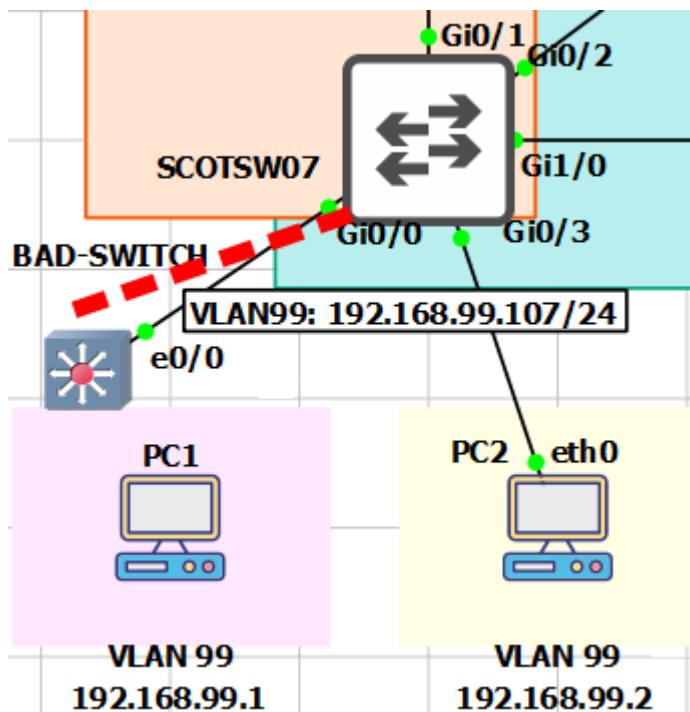
Also, both Switch SCOTSW07 <-> BAD-SWITCH becomes Root Bridge for Vlan 1 because BPDU are not sent/received

SCOTSW07(config)#show spanning vlan 1
VLAN0001
Spanning tree enabled protocol rstp
Root ID   Priority   32769
Address   aabb.cc00.0300
==This bridge is the root==
Hello Time   2 sec Max Age 20 sec Forward Delay 15 sec

BAD-SWITCH# show spanning-tree vlan 1
VLAN0001
Spanning tree enabled protocol rstp
Root ID   Priority   32769
Address   aabb.cc00.0400
==This bridge is the root==
Hello Time   2 sec Max Age 20 sec Forward Delay 15 sec

BPDUFILTER AT GLOBAL LEVEL:
SW01(config-if)# spanning-tree portfast bpdufilter default (upon receiving any BPDUs, it kicks the switchport out of portfast mode)

SCOTSW07 (config)#spanning-tree portfast bpdufilter default

SCOTSW07# show spanning-tree int gi0/0 detail
<<output truncated >>
The port is in the portfast mode
Link type is shared by default
Bpdu filter is enabled by default
BPDU: sent 9, received 0

Let's connect the cable to BAD-SWITCH_Eth0/0 and watch the changes:

The **BPDU FILTER mode is removed in Global mode once BPDU is rcvd**

SCOTSW07 #show spanning-tree int gi0/0 det
<<output truncated >>
 The port is in the portfast mode
   Link type is shared by default
   BPDU: sent 12, received 18

TASK#4: To configure & verify RootGuard

If a root-guard-enabled port receives BPDUs that are superior to those that the current root bridge is sending, then that port is moved to a root-inconsistent state, which is effectively equal to an STP listening state, and no data traffic is forwarded across that port.

I want SCOTSW01 to be my Root Switch always.
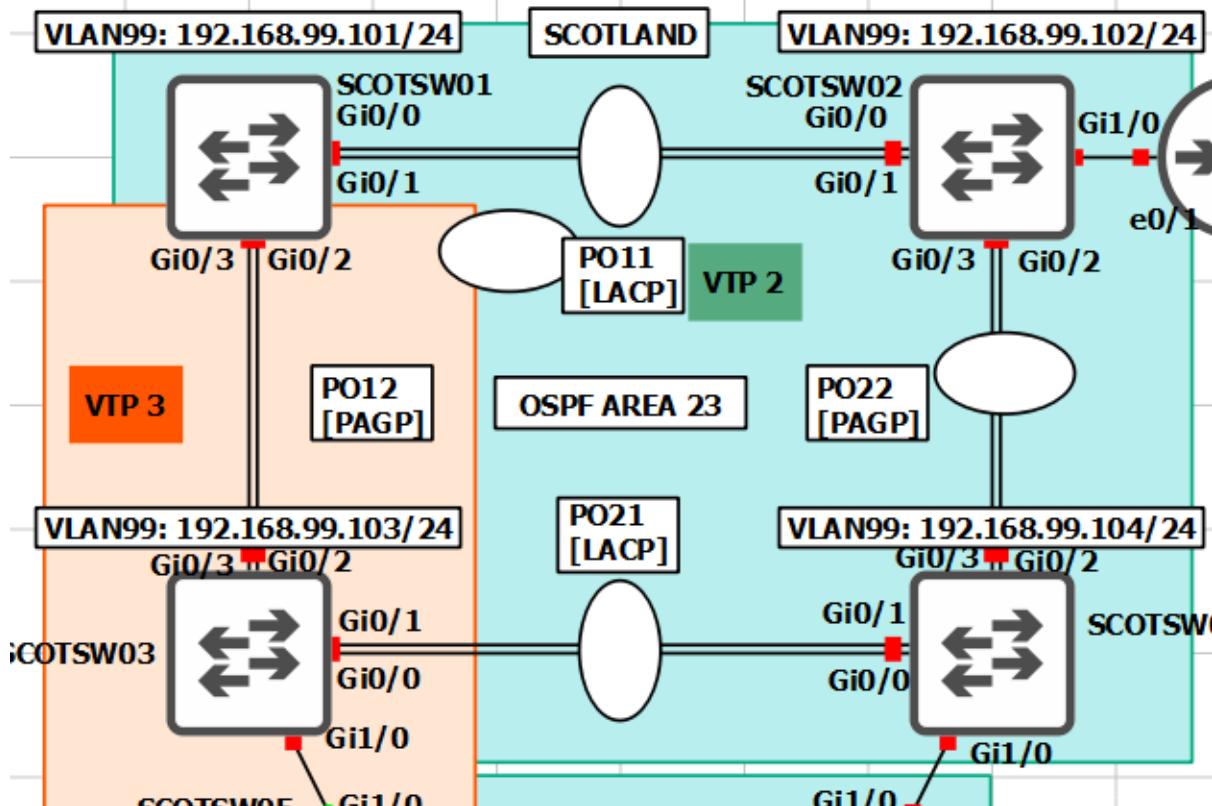
BEFORE ROOTGUARD:
SCOTSW01(config)#do sh span
VLAN0001
  Spanning tree enabled protocol rstp
  Root ID   Priority   32769
         Address   0c67.912e.9400
         Cost   4
         Port   3 (GigabitEthernet0/2)
         Hello Time   2 sec Max Age 20 sec Forward Delay 15 sec

AFTER ROOTGUARD:
Let us make SCOTSW01 as ROOT SWITCH.
If SCOTSW01 received any superior BPDU it will put that switchport into "root-inconsistent state".

SCOTSW01 (config)#int range gi0/0-3
SCOTSW01 (config-if-range)#spanning-tree guard root

*Apr 22 15:46:36.056: %SPANTREE-2-ROOTGUARD_CONFIG_CHANGE: Root guard enabled on port GigabitEthernet0/0.
*Apr 22 15:46:36.086: %SPANTREE-2-ROOTGUARD_CONFIG_CHANGE: Root guard enabled on port GigabitEthernet0/1.
*Apr 22 15:46:36.113: %SPANTREE-2-ROOTGUARD_CONFIG_CHANGE: Root guard enabled on port GigabitEthernet0/2.
*Apr 22 15:46:36.158: %SPANTREE-2-ROOTGUARD_CONFIG_CHANGE: Root guard enabled on port GigabitEthernet0/3.
*Apr 22 15:46:36.408: %SPANTREE-2-ROOTGUARD_BLOCK: Root guard blocking port GigabitEthernet0/2 on VLAN0001.

Detected Superior BPDU receiving from the neighbouring switch.

SCOTSW01#show spanning-tree inconsistentports
Name   Interface   Inconsistency
------------------- ------------------------ ------------------
VLAN0001   GigabitEthernet0/2   Root Inconsistent
VLAN0001   GigabitEthernet0/3   Root Inconsistent
Number of inconsistent ports (segments) in the system : 2

SCOTSW01#show spanning-tree
<!output omitted>
Gi0/2   Desg BKN*4   128.3   P2p Peer(STP) *ROOT_Inc
Gi0/3   Desg BKN*4   128.4   P2p Peer(STP) *ROOT_Inc

Remove that Switch which is sending Superior BPDU to SCOTSW01, you can remove the switch or shutdown that interface.

Bounce the switchport (Shut/No Shutdown) on SCOTSW01 to **rectify** the "Inconsistency" mode:

SCOTSW01 (config)#int range gi0/0-3
SCOTSW01 (config-if-range)# shutdown
SCOTSW01 (config-if-range)# no shutdown

*April 7 16:49:36.362: %SPANTREE-2-ROOTGUARD_UNBLOCK: Root guard unblocking port Gi0/2 on VLAN0001.

SCOTSW01# show spanning inconsistentports
Name   Interface   Inconsistency
------------------- ------------------------ ------------------
Number of inconsistent ports (segments) in the system : 0

LAB #6 CONFIGURE – MSTP
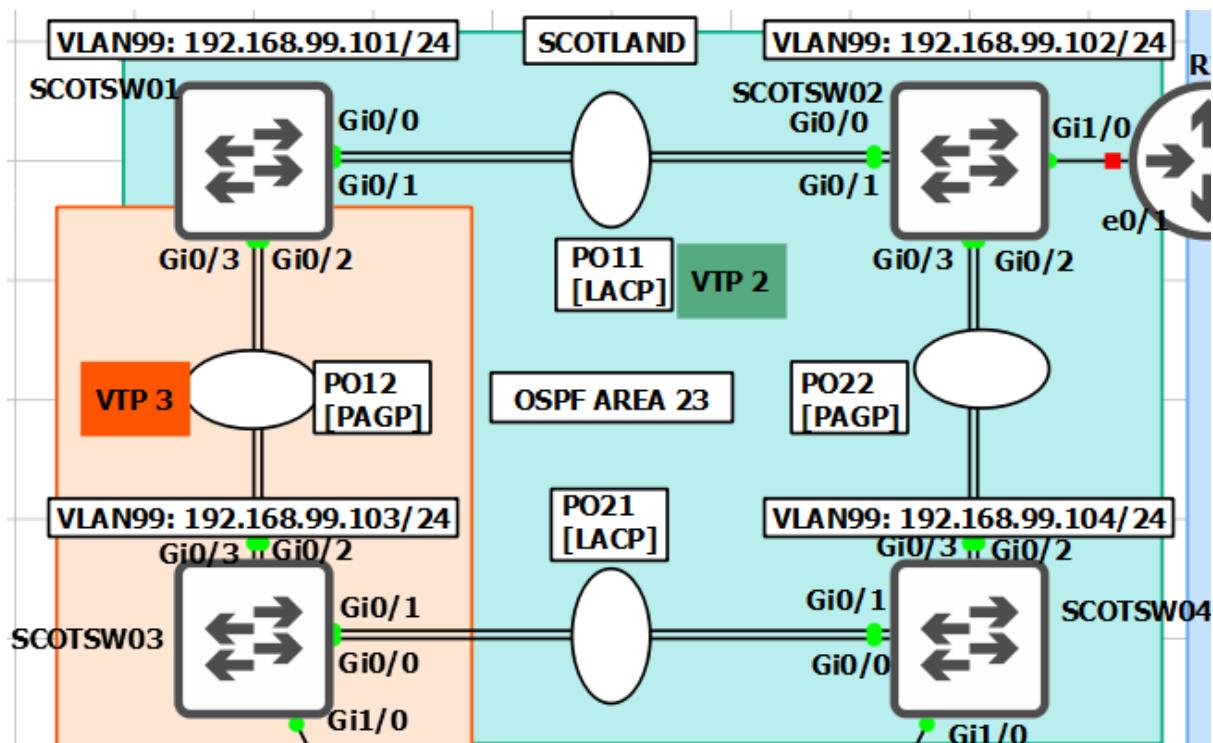
Objectives: Observe on SCOTSW01, SCOTSW02, SCOTSW03, SCOTSW04 as following:

1. Configure MSTP Region 1 on SCOTSW01, SCOTSW02 and verify its behaviour
2. Configure MSTP Region 1 on SCOTSW01, SCOTSW02 and MSTP Region 2 on SCOTSW04 and verify its behaviour
3. Configure MSTP Region 1 on SCOTSW01, SCOTSW02 and RSTP on SCOTSW03 and verify its behaviour
4. To manipulate "instance priority" between SCOTSW01 <-> SCOTSW02
5. To manipulate "port cost" between SCOTSW02_Gi0/2-3 <-> SCOTSW04_Gi0/2-3
6. To manipulate "port priority" between SCOTSW02_Gi0/2-3 <-> SCOTSW04_Gi0/2-3
7. To manipulate "hello timer" in MST switch SCOTSW02
8. To manipulate "forward timer" in MST switch SCOTSW02
9. To manipulate "max age timer" in MST switch SCOTSW02

CONFIGURATION TASK#1,2 & 3: To configure & verify MST Region 1, Region 2 and Interoperability

SCOTSW01 (config)#
spanning-tree mode mst
spanning-tree mst configuration
 name **region1**
 revision 1
 instance 1 vlan 99,100
 instance 2 vlan 110,120
spanning-tree mst 1 priority 0
spanning-tree mst 2 priority 4096

SCOTSW02 (config)#
spanning-tree mode mst
spanning-tree mst configuration
 name **region1**
 revision 1
 instance 1 vlan 99,100
 instance 2 vlan 110,120
spanning-tree mst 1 priority 4096
spanning-tree mst 2 priority 0

SCOTSW03 (config)#
spanning-tree mode rapid-pvst

SCOTSW04 (config)#
spanning-tree mode mst
spanning-tree mst configuration
 name **region2**
 revision 1
 instance 1 vlan 99,100
 instance 2 vlan 110,120
spanning-tree mst 1 priority 8192
spanning-tree mst 2 priority 8192

VERIFICATION TASK#1: To configure & verify <u>MST Region 1</u>

SCOTSW01 switching running MST ROOT for VLAN 99,100

SCOTSW01#sh spanning-tree mst 0
MST0   vlans mapped: 1-98,101-109,111-119,121-4094
Bridge   address 0c67.916e.7e00 priority   32768 (32768 sysid 0)
Root   address 0c67.9159.b100 priority   32768 (32768 sysid 0)
        port   Gi0/0   path cost   0
Regional Root address 0c67.9159.b100 priority   32768 (32768 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

```
---------------- ---- --- --------- -------- -------------------------------
Gi0/0        Root FWD 20000    128.1   P2p
Gi0/1        Altn BLK 20000    128.2   P2p
Gi0/2        Desg FWD 20000    128.3   P2p Bound(PVST)
Gi0/3        Desg FWD 20000    128.4   P2p Bound(PVST)


SCOTSW01#sh spanning-tree mst 1

##### MST1   vlans mapped:  99-100
Bridge      address 0c67.916e.7e00  priority     1    (0 sysid 1)
Root        this switch for MST1

Interface       Role Sts Cost    Prio.Nbr Type
---------------- ---- --- --------- -------- -------------------------------
Gi0/0        Desg FWD 20000    128.1   P2p
Gi0/1        Desg FWD 20000    128.2   P2p
Gi0/2        Desg FWD 20000    128.3   P2p Bound(PVST)
Gi0/3        Desg FWD 20000    128.4   P2p Bound(PVST)


SCOTSW01#sh spanning-tree mst 2
##### MST2   vlans mapped:  110,120
Bridge      address 0c67.916e.7e00  priority     4098  (4096 sysid 2)
Root        address 0c67.9159.b100  priority     2    (0 sysid 2)
            port   Gi0/0       cost       20000    rem hops 19

Interface       Role Sts Cost    Prio.Nbr Type
---------------- ---- --- --------- -------- -------------------------------
Gi0/0        Root FWD 20000    128.1   P2p
Gi0/1        Altn BLK 20000    128.2   P2p
Gi0/2        Desg FWD 20000    128.3   P2p Bound(PVST)
Gi0/3        Desg FWD 20000    128.4   P2p Bound(PVST)


SCOTSW02 running MST ROOT for VLAN 110, 120
SCOTSW02 elected AS IST MASTER = CIST due to superior BPDU [Bridge ID = PRI+MAC ADD]
SCOTSW02#show spanning-tree mst 0
##### MST0   vlans mapped:  1-98,101-109,111-119,121-4094
Bridge      address 0c67.9159.b100  priority     32768 (32768 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
---------------- ---- --- --------- -------- -------------------------------
Gi0/0        Desg FWD 20000    128.1   P2p
Gi0/1        Desg FWD 20000    128.2   P2p
Gi0/2        Desg FWD 20000    128.3   P2p
Gi0/3        Desg FWD 20000    128.4   P2p
```

SCOTSW02#show spanning-tree mst 1

MST1   vlans mapped: 99-100
Bridge   address 0c67.9159.b100 priority   4097 (4096 sysid 1)
Root   address 0c67.916e.7e00 priority   1   (0 sysid 1)
         port Gi0/0   cost   20000   rem hops 19

Interface   Role Sts Cost   Prio.Nbr Type
---------------- ---- --- --------- -------- -------------------------------
Gi0/0   Root FWD 20000   128.1   P2p
Gi0/1   Altn BLK 20000   128.2   P2p
Gi0/2   Desg FWD 20000   128.3   P2p
Gi0/3   Desg FWD 20000   128.4   P2p

SCOTSW02#show spanning-tree mst 2
MST2   vlans mapped: 110,120
Bridge   address 0c67.9159.b100 priority   2   (0 sysid 2)
Root   this switch for MST2

Interface   Role Sts Cost   Prio.Nbr Type
---------------- ---- --- --------- -------- -------------------------------
Gi0/0   Desg FWD 20000   128.1   P2p
Gi0/1   Desg FWD 20000   128.2   P2p
Gi0/2   Desg FWD 20000   128.3   P2p
Gi0/3   Desg FWD 20000   128.4   P2p

SCOTSW03 running on RSTP (non-mst switch)
We can see RSTP running per VLAN basis (multiple instance of RSTP running)
VLAN0099
 Spanning tree enabled protocol rstp
 Root ID   Priority   32768
       Address   0c67.9159.b100
       Cost   4
       Port   3 (GigabitEthernet0/2)
       Hello Time   2 sec Max Age 20 sec Forward Delay 15 sec

  Bridge ID Priority   32867 (priority 32768 sys-id-ext 99)
       Address   0c67.912e.9400
       Hello Time   2 sec Max Age 20 sec Forward Delay 15 sec
       Aging Time 300 sec

Interface   Role Sts Cost   Prio.Nbr Type
------------------- ---- --- --------- -------- -------------------------------
Gi0/0   Desg FWD 4   128.1 P2p Peer(STP)
Gi0/1   Desg FWD 4   128.2 P2p Peer(STP)
Gi0/2   Root FWD 4   128.3 P2p Peer(STP)
Gi0/3   Altn BLK 4   128.4 P2p Peer(STP)

VLAN0100
 Spanning tree enabled protocol rstp

```
    Root ID    Priority    32768
           Address     0c67.9159.b100
           Cost       4
           Port       3 (GigabitEthernet0/2)
           Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec


  Bridge ID  Priority    32868  (priority 32768 sys-id-ext 100)
           Address     0c67.912e.9400
           Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
           Aging Time   300 sec


Interface          Role Sts Cost     Prio.Nbr Type
------------------- ---- --- --------- -------- -------------------------------
Gi0/0          Desg FWD 4       128.1   P2p Peer(STP)
Gi0/1          Desg FWD 4       128.2   P2p Peer(STP)
Gi0/2          Root FWD 4       128.3   P2p Peer(STP)
Gi0/3          Altn BLK 4       128.4   P2p Peer(STP)


VLAN0110
  Spanning tree enabled protocol rstp
  Root ID    Priority    32768
           Address     0c67.9159.b100
           Cost       4
           Port       3 (GigabitEthernet0/2)
           Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec


  Bridge ID  Priority    32878  (priority 32768 sys-id-ext 110)
           Address     0c67.912e.9400
           Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
           Aging Time   300 sec


Interface          Role Sts Cost     Prio.Nbr Type
------------------- ---- --- --------- -------- -------------------------------
Gi0/0          Desg FWD 4       128.1   P2p Peer(STP)
Gi0/1          Desg FWD 4       128.2   P2p Peer(STP)
Gi0/2          Root FWD 4       128.3   P2p Peer(STP)
Gi0/3          Altn BLK 4       128.4   P2p Peer(STP)


VLAN0120
  Spanning tree enabled protocol rstp
  Root ID    Priority    32768
           Address     0c67.9159.b100
           Cost       4
           Port       3 (GigabitEthernet0/2)
           Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec


  Bridge ID  Priority    32888  (priority 32768 sys-id-ext 120)
           Address     0c67.912e.9400
           Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
           Aging Time   300 sec
```

```
Interface        Role Sts Cost    Prio.Nbr Type
------------------ ---- --- --------- -------- ------------------------------
Gi0/0          Desg FWD 4      128.1  P2p Peer(STP)
Gi0/1          Desg FWD 4      128.2  P2p Peer(STP)
Gi0/2          Root FWD 4      128.3  P2p Peer(STP)
Gi0/3          Altn BLK 4      128.4  P2p Peer(STP)
```

==SCOTSW04 running MST on REGION2==
==Since there are no other Switch in MST Region 2, SCOTSW04 will declare itself as Root bridge for==
==both Instance 1 and 2==
SCOTSW04#sh spanning-tree mst 0

```
##### MST0   vlans mapped:  1-98,101-109,111-119,121-4094
Bridge     address 0c67.91d3.c500  priority    32768 (32768 sysid 0)
Root       address 0c67.9159.b100  priority    32768 (32768 sysid 0)
        port  Gi0/2      path cost   20000
```
==Regional Root this switch==
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
--------------- ---- --- --------- -------- ------------------------------
Gi0/0          Desg BKN*20000    128.1   P2p Bound(PVST) *PVST_Inc
Gi0/1          Desg BKN*20000    128.2   P2p Bound(PVST) *PVST_Inc
Gi0/2          Root FWD 20000    128.3   P2p Bound(RSTP)
Gi0/3          Altn BLK 20000    128.4   P2p Bound(RSTP)
Gi1/0          Desg FWD 20000    128.5   P2p
```

SCOTSW04#sh spanning-tree mst 1
```
##### MST1   vlans mapped:  99-100
Bridge     address 0c67.91d3.c500  priority    8193  (8192 sysid 1)
```
==Root   this switch for MST1==

```
Interface        Role Sts Cost    Prio.Nbr Type
--------------- ---- --- --------- -------- ------------------------------
Gi0/0          Desg BKN*20000    128.1   P2p Bound(PVST) *PVST_Inc
Gi0/1          Desg BKN*20000    128.2   P2p Bound(PVST) *PVST_Inc
Gi0/2          ==Mstr== FWD 20000   128.3   P2p Bound(RSTP)
Gi0/3          Altn BLK 20000    128.4   P2p Bound(RSTP)
```

SCOTSW04#sh spanning-tree mst 2
```
##### MST2   vlans mapped:  110,120
Bridge     address 0c67.91d3.c500  priority    8194  (8192 sysid 2)
```
==Root   this switch for MST2==

```
Interface        Role Sts Cost    Prio.Nbr Type
--------------- ---- --- --------- -------- ------------------------------
Gi0/0          Desg BKN*20000    128.1   P2p Bound(PVST) *PVST_Inc
Gi0/1          Desg BKN*20000    128.2   P2p Bound(PVST) *PVST_Inc
```

```
Gi0/2       Mstr FWD 20000    128.3   P2p Bound(RSTP)
Gi0/3       Altn BLK 20000    128.4   P2p Bound(RSTP)
```

CONFIGURATION TASK#4: To manipulate "instance priority" in SCOTSW01, SCOTSW02

Configuring the MST1 as Root in SCOTSW01 and MST2 as Root in SCOTSW02:
SCOTSW01(config)#
spanning-tree mst 1 priority 0
spanning-tree mst 2 priority 4096
**********or**************
SCOTSW01(config)#
spanning-tree mst 1 root primary
spanning-tree mst 2 root secondary

SCOTSW02(config)
spanning-tree mst 1 priority 4096
spanning-tree mst 2 priority 0
**********or**************
SCOTSW02(config)
spanning-tree mst 1 root secondary
spanning-tree mst 2 root primary

VERIFICATION TASK#4: To manipulate "instance priority" in SCOTSW01, SCOTSW02

SCOTSW01#sh spanning-tree mst 1
MST1   vlans mapped: 99-100
Bridge   address 0c67.916e.7e00 priority   1   (0 sysid 1)
Root   this switch for MST1

```
Interface       Role Sts Cost    Prio.Nbr Type
--------------- ---- --- -------- -------- -------------------------------
Gi0/0       Desg FWD 20000    128.1   P2p
Gi0/1       Desg FWD 20000    128.2   P2p
Gi0/2       Desg FWD 20000    128.3   P2p Bound(PVST)
Gi0/3       Desg FWD 20000    128.4   P2p Bound(PVST)
```

SCOTSW02#sh spanning-tree mst 2
MST2   vlans mapped: 110,120
Bridge   address 0c67.9159.b100 priority   2   (0 sysid 2)
Root   this switch for MST2

```
Interface       Role Sts Cost    Prio.Nbr Type
--------------- ---- --- -------- -------- -------------------------------
Gi0/0       Desg FWD 20000    128.1   P2p
Gi0/1       Desg FWD 20000    128.2   P2p
Gi0/2       Desg FWD 20000    128.3   P2p
Gi0/3       Desg FWD 20000    128.4   P2p
```

CONFIGURATION TASK#5: To manipulate "port cost" between SCOTSW02_Gi0/2-3 <-> SCOTSW04_Gi0/2-3

Before Change:

SCOTSW02#show spanning-tree mst interface gi0/2

<!output omitted>

1   Desg FWD 20000   128.3   99-100
2   Desg FWD 20000   128.3   110,120

SCOTSW02#show spanning-tree mst interface gi0/3

<!output omitted>

1   Desg FWD 20000   128.4   99-100
2   Desg FWD 20000   128.4   110,120

SCOTSW04#show spanning mst interface gi0/2

<!output omitted>

1   Mstr FWD 20000   128.3   99-100
2   Mstr FWD 20000   128.3   110,120

SCOTSW04#show spanning mst interface gi0/3

<!output omitted>

1   Altn BLK 20000   128.4   99-100
2   Altn BLK 20000   128.4   110,120

Now change this behaviour by manipulating Port-cost of SCOTSW04_Gi0/3

CONFIGURATIONS:

SCOTSW04(config)# interface gi0/3
SCOTSW04(config-if)#spanning-tree mst 0 cost 2000
SCOTSW04(config-if)#shutdown
SCOTSW04(config-if)#no shutdown

VERIFICATION TASK#5

SCOTSW04#show spanning int gi0/3

Mst Instance	Role Sts Cost	Prio.Nbr	Type
MST0	Root FWD 2000	128.4	P2p Bound(RSTP)
MST1	Mstr FWD 20000	128.4	P2p Bound(RSTP)
MST2	Mstr FWD 20000	128.4	P2p Bound(RSTP)

SCOTSW04#show spanning int gi0/2

Mst Instance	Role Sts Cost	Prio.Nbr	Type
MST0	Altn BLK 20000	128.3	P2p Bound(RSTP)
MST1	Altn BLK 20000	128.3	P2p Bound(RSTP)
MST2	Altn BLK 20000	128.3	P2p Bound(RSTP)

CONFIGURATION TASK#6: To manipulate "port priority" between SCOTSW02_Gi0/2-3 <-> SCOTSW04_Gi0/2-3

Configuring Port Priority:
SCOTSW04(config)# interface gi0/3
SCOTSW04(config-if)# spanning-tree mst 1 port-priority 32
SCOTSW04(config-if)#shutdown
SCOTSW04(config-if)#no shutdown

VERIFICATION TASK#6

SCOTSW04#show spanning int gi0/3
Mst Instance   Role Sts Cost   Prio.Nbr Type
------------------ ---- --- --------- -------- -------------------------------
MST0   Root FWD 20000   64.4   P2p Bound(RSTP)
MST1   Mstr FWD 20000   64.4   P2p Bound(RSTP)
MST2   Mstr FWD 20000   64.4   P2p Bound(RSTP)

SCOTSW04#show spanning int gi0/2
Mst Instance   Role Sts Cost   Prio.Nbr Type
------------------ ---- --- --------- -------- -------------------------------
MST0   Altn BLK 20000   128.3   P2p Bound(RSTP)
MST1   Altn BLK 20000   128.3   P2p Bound(RSTP)
MST2   Altn BLK 20000   128.3   P2p Bound(RSTP)

CONFIGURATION TASK#7: To manipulate "hello timer" in MST switch SCOTSW02

Manipulate the Hello Time
SCOTSW02(config)#spanning-tree mst hello-time 5 ###default = 2 seconds

VERIFICATION TASK#7:

SCOTSW02# show spanning-tree mst
MST0   vlans mapped: 1-98,101-109,111-119,121-4094
Bridge   address 0c67.9159.b100 priority   32768 (32768 sysid 0)
Root   this switch for the CIST
Operational   hello time 5 , forward delay 15, max age 20, txholdcount 6
Configured   hello time 5 , forward delay 15, max age 20, max hops   20

CONFIGURATION TASK#8: To manipulate "forward timer" in MST switch SCOTSW02

Manipulate the Forwarding-Delay Time
SCOTSW02(config)# spanning-tree mst forward-time 10 ###default = 15 seconds

The forward delay is the number of seconds a port waits before changing from its spanning-tree learning and listening states to the forwarding state.

VERIFICATION TASK#8:

SCOTSW02# show spanning-tree mst
MST0   vlans mapped: 1-98,101-109,111-119,121-4094
Bridge   address 0c67.9159.b100 priority   32768 (32768 sysid 0)
Root   this switch for the CIST
Operational   hello time 5 , forward delay 10, max age 20, txholdcount 6
Configured   hello time 5 , forward delay 10, max age 20, max hops   20

CONFIGURATION TASK#9: To manipulate "max age timer" in MST switch SCOTSW02

Manipulating the Maximum-Aging Time
SCOTSW02(config)#spanning-tree mst max-age 30 ###default = 20 seconds

The maximum-aging time is the number of seconds a switch waits without receiving spanning-tree configuration messages before attempting a reconfiguration.

VERIFICATION TASK#9:

SCOTSW02#show spanning-tree mst
MST0   vlans mapped: 1-98,101-109,111-119,121-4094
Bridge   address 0c67.9159.b100 priority   32768 (32768 sysid 0)
Root   this switch for the CIST
Operational   hello time 2 , forward delay 10, max age 30, txholdcount 6
Configured   hello time 2 , forward delay 10, max age 30, max hops   20

IMPORTANT FACT!!!

To restart the protocol migration process (force the renegotiation with neighboring switches) on the switch, use the below command under privileged EXEC command.:

clear spanning-tree detected-protocols

LAB #7 CONFIGURE – DTP (DYNAMIC TRUNKING PROTOCOL)
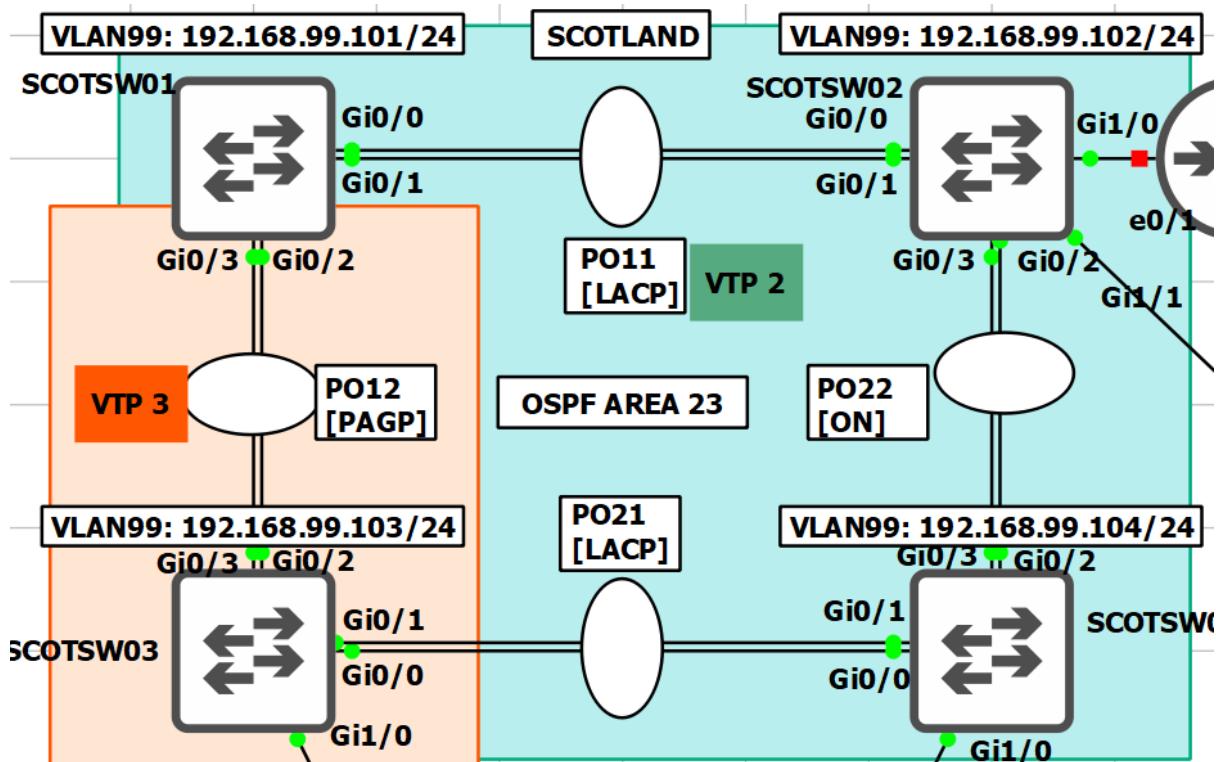
Objectives: Observe on SCOTSW01, SCOTSW02, SCOTSW03, SCOTSW04 as following:

1. Configure "DTP desirable-desirable" between SCOTSW01 <-> SCOTSW02
2. Configure "DTP auto-desriable" between SCOTSW01 <-> SCOTSW03
3. Configure "DTP auto-auto" between SCOTSW03 <-> SCOTSW04
4. Configure "DTP" between SCOTSW02_Trunk_Dot1Q <-> SCOTSW04_Auto
5. Configure DTP between SCOTSW02_Trunk Dot1Q <-> SCOTSW04_desirable

CONFIGURATION TASK#1: Configure "DTP desirable-desirable" between SCOTSW01 <-> SCOTSW02

SCOTSW01(config)#default interface range gi0/0-1
SCOTSW01(config)#interface range gigabitEthernet 0/0-1
SCOTSW01(config-if-range)#switchport mode dynamic desirable

SCOTSW02(config)#default interface range gi0/0-1
SCOTSW02(config)#interface range gigabitEthernet 0/0-1
SCOTSW02(config-if-range)#switchport mode dynamic desirable

VERIFICATION TASK#1:

SCOTSW01#show interfaces trunk

Port	Mode	Encapsulation	Status	Native vlan
Gi0/0	desirable	n-isl	trunking	1
Gi0/1	desirable	n-isl	trunking	1

<!—output omitted>

SCOTSW01#sh interfaces gi0/0 swi
Name: Gi0/0
Switchport: Enabled
Administrative Mode: dynamic desirable
Operational Mode: trunk
Administrative Trunking Encapsulation: negotiate
Operational Trunking Encapsulation: isl
Negotiation of Trunking: On
Access Mode VLAN: 1 (default)
Trunking Native Mode VLAN: 1 (default)
<!output omitted>

SCOTSW02#show interface trunk

Port	Mode	Encapsulation	Status	Native vlan
Gi0/0	desirable	n-isl	trunking	1
Gi0/1	desirable	n-isl	trunking	1

<!—output omitted>

SCOTSW02#show interfaces gi0/0 switchport
Name: Gi0/0
Switchport: Enabled
Administrative Mode: dynamic desirable
Operational Mode: trunk
Administrative Trunking Encapsulation: negotiate
Operational Trunking Encapsulation: isl
Negotiation of Trunking: On
Access Mode VLAN: 1 (default)
Trunking Native Mode VLAN: 1 (default)
Administrative Native VLAN tagging: enabled
<!output omitted>

DTP is cisco proprietary
DTP negotiation by default negotiate over "n-isl"
As we know ISL header carries "26 bytes" which is a drawback of DTP negotiations. The payload (data) gets shrinked (or reduced) to accumulate extra ISL header size.

CONFIGURATION TASK#2: Configure "DTP auto-desirable" between SCOTSW01 <-> SCOTSW03

SCOTSW01(config)#default interface range gi0/2-3
SCOTSW01(config)#interface range gi0/2-3
SCOTSW01(config-if-range)#switchport mode dynamic auto

SCOTSW03(config)#default interface range gi0/2-3
SCOTSW03(config)#interface range gi0/2-3
SCOTSW03(config-if-range)#switchport mode dynamic desirable

VERIFICATION TASK#2:

SCOTSW01#show interfaces trunk

Port	Mode	Encapsulation	Status	Native vlan
Gi0/2	auto	n-isl	trunking	1
Gi0/3	auto	n-isl	trunking	1

<!—output omitted>

SCOTSW03#show interfaces trunk

Port	Mode	Encapsulation	Status	Native vlan
Gi0/2	desirable	n-isl	trunking	1
Gi0/3	desirable	n-isl	trunking	1

<!—output omitted>

CONFIGURATION TASK#3: Configure "DTP auto-auto" between SCOTSW03 <-> SCOTSW04

SCOTSW03(config)#default interface range gi0/0-1
SCOTSW03(config)#interface range gi0/0-1
SCOTSW03(config-if-range)#sw mo dynamic auto

SCOTSW04(config)#default interface range gi0/0-1
SCOTSW04(config)#interface range gi0/0-1
SCOTSW04(config-if-range)#sw mo dynamic auto
SCOTSW03#show inter gi0/1 trunk

Port	Mode	Encapsulation	Status	Native vlan
Gi0/1	auto	negotiate	not-trunking	1

```
Port      Vlans allowed on trunk
Gi0/1     1


Port      Vlans allowed and active in management domain
Gi0/1     1


Port      Vlans in spanning tree forwarding state and not pruned
Gi0/1     1


SCOTSW03#show inter gi0/1 sw
SCOTSW03#show inter gi0/1 switchport
Name: Gi0/1
Switchport: Enabled
Administrative Mode: dynamic auto
Operational Mode: static access
Administrative Trunking Encapsulation: negotiate
Operational Trunking Encapsulation: native
Negotiation of Trunking: On
Access Mode VLAN: 1 (default)
Trunking Native Mode VLAN: 1 (default)
Administrative Native VLAN tagging: enabled
<!output omitted>
```

Dynamic AUTO on both sides will not bring up "n-Trunking"as shown here SCOTSW03_gi0/0-1 <-> SCOTSW04_gi0/0-1.
It is recommended statically make it "Trunking" and do not keep DTP auto negotiations.
Some IOS software comes by default with "Auto" enabled on switchports.

CONFIGURATION TASK#4: Configure DTP between SCOTSW02_Trunk Dot1Q <-> SCOTSW04_auto

```
SCOTSW02(config)#default interface range gi0/2-3
SCOTSW02(config)#interface range gi0/2-3
SCOTSW02(config-if-range)#sw trunk encapsulation dot1q
SCOTSW02(config-if-range)#sw mode trunk


SCOTSW04(config)#default inter range gi0/2-3
SCOTSW04(config)#interface range gi0/2-3
SCOTSW04(config-if-range)#sw mode dynamic auto


SCOTSW02#sh inter trunk
```

Port	Mode	Encapsulation	Status	Native vlan
Gi0/2	on	802.1q	trunking	1
Gi0/3	on	802.1q	trunking	1

SCOTSW04#sh inter trunk

Port	Mode	Encapsulation	Status	Native vlan
Gi0/2	desirable	n-isl	trunking	1
Gi0/3	desirable	n-isl	trunking	1

CONFIGURATION TASK#5: Configure DTP between SCOTSW02_Trunk Dot1Q <-> SCOTSW04_desirable

---

SCOTSW02(config)#default interface range gi0/2-3
SCOTSW02(config)#interface range gi0/2-3
SCOTSW02(config-if-range)#sw trunk encapsulation dot1q
SCOTSW02(config-if-range)#sw mo trunk

SCOTSW04(config)#default inter range gi0/2-3
SCOTSW04(config)#interface range gi0/2-3
SCOTSW04(config-if-range)#sw mode dynamic **desirable**

SCOTSW02#sh inter trunk

Port	Mode	Encapsulation	Status	Native vlan
Gi0/2	on	802.1q	trunking	1
Gi0/3	on	802.1q	trunking	1

SCOTSW04#sh inter trunk

Port	Mode	Encapsulation	Status	Native vlan
Gi0/2	auto	n-isl	trunking	1
Gi0/3	auto	n-isl	trunking	1

LAB #8 CONFIGURE – ETHERCHANNEL
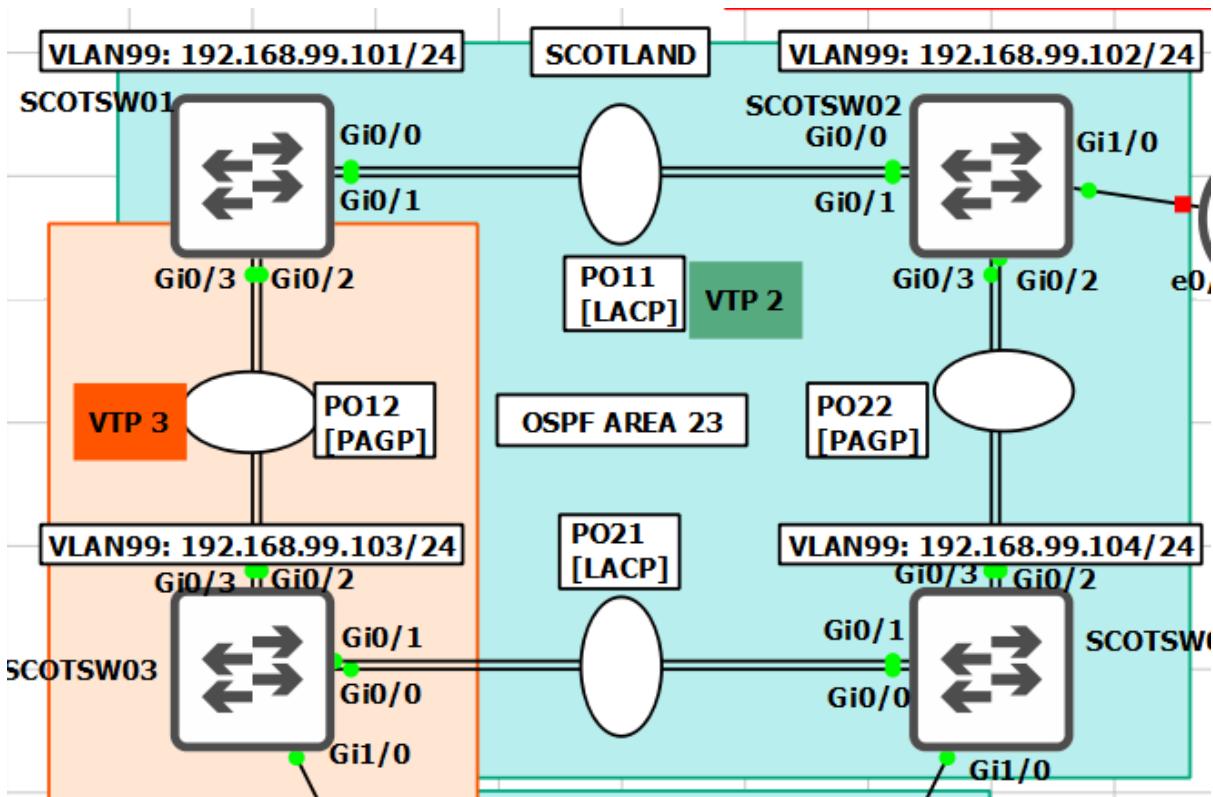
Objectives: Observe on SCOTSW01, SCOTSW02, SCOTSW03, SCOTSW04 as following:

1. Configure "PAgP" between SCOTSW01_gi0/2-3 <-> SCOTSW03_gi0/2-3
2. Configure "LACP" between SCOTSW01_gi0/0-1 <-> SCOTSW02_gi0/0-1
3. Configure "ON" between SCOTSW02 <-> SCOTSW04
4. Configure "LACP Fast"
5. Configure Minimum Number of Port-Channel Member Interfaces
6. Configure Maximum Number of Port-Channel Member Interfaces
7. Configure LACP System Priority
8. Configure LACP Interface Priority
9. Configure EtherChannel Misconfiguration Guard

CONFIGURATION TASK#1: Configure "PAgP" between SCOTSW01 <-> SCOTSW03

SCOTSW01 PAgP Configuration
SCOTSW01(config)#default interface range gi0/2-3
SCOTSW01 (config)#no interface port-channel 12

SCOTSW01 (config)#interface range gi0/2-3
SCOTSW01 (config-if-range)#switchport trunk encapsulation dot1q
SCOTSW01 (config-if-range)#switchport mode trunk
SCOTSW01 (config-if-range)#switchport trunk allowed vlan 99,100,110,120,666,999
SCOTSW01 (config-if-range)#channel-protocol pagp (optional)
SCOTSW01 (config-if-range)#channel-group 12 mode auto

SCOTSW03 PAgP Configuration
SCOTSW03(config)#default interface range gi0/2-3
SCOTSW03(config)#no interface port-channel 12

SCOTSW03(config)#interface range gi0/2-3
SCOTSW03(config-if-range)#switchport trunk encapsulation dot1q
SCOTSW03(config-if-range)#switchport mode trunk
SCOTSW03(config-if-range)#switchport trunk allowed vlan 99,100,110,120,666,999
SCOTSW03(config-if-range)#channel-protocol pagp (optional)
SCOTSW03(config-if-range)#channel-group 12 mode desirable

VERIFICATION TASK#1

- show etherchannel summary
- show etherchannel detail
- show etherchannel port-channel
- show pagp counter
- show pagp neighbor

SCOTSW03# show etherchannel summary
Flags: D - down   P - bundled in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3   S - Layer2
        U - in use   N - not in use, no aggregation
        f - failed to allocate aggregator

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

        A - formed by Auto LAG

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

```
Group  Port-channel  Protocol    Ports
------+-------------+-----------+----------------------------------------------
12    Po12(SU)      PAgP        Gi0/2(P)  Gi0/3(P)
```

SCOTSW03#show etherchannel detail
        Channel-group listing:

! This is the header that indicates all the ports that are for the first
! EtherChannel interface. Every member link interface will be listed
Group: 12

Group state = L2
Ports: 2   Maxports = 4
Port-channels: 1 Max Port-channels = 1
Protocol: PAgP
Minimum Links: 0
! This is the first member interface for interface Po12. This interface
! is configured for PAgP active
        Ports in the group:

Port: Gi0/2

Port state   = Up Mstr In-Bndl
Channel group = 12   Mode = Automatic-Sl   Gcchange = 0
Port-channel = Po12   GC   = 0x000C0001   Pseudo port-channel = Po12
Port index   = 0   Load = 0x00   Protocol =   PAgP

Flags: S - Device is sending Slow hello. C - Device is in Consistent state.
        A - Device is in Auto mode.   P - Device learns on physical port.
        d - PAgP is down.
Timers: H - Hello timer is running.   Q - Quit timer is running.
        S - Switching timer is running.   I - Interface timer is running.

Local information:
                        Hello   Partner PAgP   Learning Group
Port   Flags State Timers Interval Count Priority Method Ifindex
Gi0/2   SAC   U6/S7 HQ   30s   1   128   Any   19

! This interface's partner is configured with PAgP Slow packets, has a system-id
! of 0c67.916e.8000 , a port priority of 128 , and is desirable in the bundle
! for 0d:01h:27m:31s.
Partner's information:

        Partner   Partner   Partner   Partner Group
Port   Name   Device ID   Port   Age Flags Cap.
Gi0/2   SCOTSW01.networkjour 0c67.916e.8000 Gi0/2   26s SC   C0001

Age of the port in the current state: 0d:01h:27m:31s

Port: Gi0/3

Port state   = Up Mstr In-Bndl
Channel group = 12   Mode = Automatic-Sl   Gcchange = 0
Port-channel = Po12   GC   = 0x000C0001   Pseudo port-channel = Po12
Port index   = 0   Load = 0x00   Protocol = PAgP

Flags: S - Device is sending Slow hello. C - Device is in Consistent state.
     A - Device is in Auto mode.   P - Device learns on physical port.
     d - PAgP is down.
Timers: H - Hello timer is running.   Q - Quit timer is running.
     S - Switching timer is running.   I - Interface timer is running.

Local information:
                 Hello   Partner PAgP   Learning Group
Port   Flags State Timers Interval Count Priority Method Ifindex
Gi0/3   SAC U6/S7 HQ   30s   1   128   Any   19

Partner's information:

      Partner   Partner   Partner   Partner Group
Port   Name   Device ID   Port   Age Flags Cap.
Gi0/3   SCOTSW01.networkjour 0c67.916e.8000 Gi0/3   22s SC   C0001

Age of the port in the current state: 0d:01h:27m:31s

        Port-channels in the group:

Port-channel: Po12

Age of the Port-channel   = 0d:01h:27m:43s
Logical slot/port   = 16/0   Number of ports = 2
GC   = 0x000C0001   HotStandBy port = null
Port state   = Port-channel Ag-Inuse
Protocol   = PAgP
Port security   = Disabled

Ports in the Port-channel:

Index Load Port   EC state   No of bits
------+------+------+-----------------+-----------
 0   00   Gi0/2 Automatic-Sl   0
 0   00   Gi0/3 Automatic-Sl   0

Time since last port bundled: 0d:01h:27m:31s   Gi0/3

SCOTSW03#show etherchannel port-channel
        Channel-group listing:

Group: 12

        Port-channels in the group:

Port-channel: Po12

Age of the Port-channel   = 0d:01h:29m:57s
Logical slot/port   = 16/0   Number of ports = 2
GC   = 0x000C0001   HotStandBy port = null
Port state   = Port-channel Ag-Inuse
Protocol   =   PAgP
Port security   = Disabled

Ports in the Port-channel:

Index   Load   Port   EC state   No of bits
------+------+------+-----------------+-----------
  0   00   Gi0/2   Automatic-Sl   0
  0   00   Gi0/3   Automatic-Sl   0

Time since last port bundled: 0d:01h:29m:45s   Gi0/3

SCOTSW03# show pagp counters
        Information   Flush   PAgP
Port   Sent   Recv   Sent   Recv   Err Pkts

Channel group: 12
Gi0/2   198   200   0   0   0
Gi0/3   198   201   0   0   0

SCOTSW03#show pagp neighbor
Flags: S - Device is sending Slow hello. C - Device is in Consistent state.
       A - Device is in Auto mode.   P - Device learns on physical port.

Channel group 12 neighbors
        Partner   Partner   Partner   Partner Group
Port   Name   Device ID   Port   Age Flags Cap.
Gi0/2   SCOTSW01.networkjour 0c67.916e.8000   Gi0/2   8s SC   C0001
Gi0/3   SCOTSW01.networkjour 0c67.916e.8000   Gi0/3   29s SC   C0001
SCOTSW03#

When viewing the output of the show etherchannel summary command, the first thing that should be checked is the EtherChannel status, which is listed in the Port-channel column. The status should be SU

CONFIGURATION TASK#2: "LACP" between SCOTSW01 <-> SCOTSW02

SCOTSW01 LACP Configuration
SCOTSW01(config)#interface range gi0/0-1
SCOTSW01(config-if-range)#switchport trunk encapsulation dot1q
SCOTSW01(config-if-range)#switchport mode trunk
SCOTSW01(config-if-range)#switchport trunk allowed vlan 99,100,110,120,666,999
SCOTSW01(config-if-range)#channel-protocol lacp (optional)
SCOTSW01(config-if-range)#channel-group 11 mode active

SCOTSW02 LACP Configuration
SCOTSW02(config)#interface range gi0/0-1
SCOTSW02(config-if-range)#switchport trunk encapsulation dot1q
SCOTSW02(config-if-range)#switchport mode trunk
SCOTSW02(config-if-range)#channel-protocol lacp (optional)
SCOTSW02(config-if-range)#channel-group 11 mode passive

VERIFICATION TASK#2

- show etherchannel summary
- show etherchannel detail
- show etherchannel port-channel
- show spanning-tree vlan 1
- show lacp counters
- show lacp neighbor

SCOTSW02#show etherchannel summary
Flags: D - down   P - bundled in port-channel
    I - stand-alone s - suspended
    H - Hot-standby (LACP only)
    R - Layer3   S - Layer2
    U - in use   N - not in use, no aggregation
    f - failed to allocate aggregator

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

A - formed by Auto LAG

Number of channel-groups in use: 2
Number of aggregators: 2

Group Port-channel Protocol   Ports
------+-------------+-----------+---
11   Po11(SU)   LACP   Gi0/0(P)   Gi0/1(P)
SCOTSW02#show etherchannel detail
        Channel-group listing:

Group: 11

Group state = L2
Ports: 2   Maxports = 4
Port-channels: 1 Max Port-channels = 4
Protocol: LACP
Minimum Links: 0

        Ports in the group:

Port: Gi0/0

Port state   = Up Mstr Assoc In-Bndl
Channel group = 11   Mode = Passive   Gcchange = -
Port-channel = Po11   GC = -   Pseudo port-channel = Po11
Port index   = 0   Load = 0x00   Protocol = LACP

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

Local information:
                  LACP port   Admin   Oper   Port   Port
Port   Flags State   Priority   Key   Key   Number   State
Gi0/0   SP   bndl   32768   0xB   0xB   0x1   0x3C

Partner's information:

            LACP port   Admin Oper Port   Port
Port   Flags Priority Dev ID   Age   key   Key   Number State
Gi0/0   SA   32768   0c67.916e.8000 13s   0x0   0xB   0x1   0x3D

Age of the port in the current state: 0d:01h:21m:31s

Port: Gi0/1

Port state   = Up Mstr Assoc In-Bndl
Channel group = 11   Mode = Passive   Gcchange = -
Port-channel = Po11   GC = -   Pseudo port-channel = Po11
Port index   = 0   Load = 0x00   Protocol = LACP

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

Local information:
                LACP port   Admin   Oper   Port   Port
Port   Flags State   Priority Key   Key   Number   State
Gi0/1   SP   bndl   32768   0xB   0xB   0x2   0x3C

Partner's information:

          LACP port   Admin Oper   Port   Port
Port   Flags Priority Dev ID   Age   key   Key   Number State
Gi0/1   SA   32768   0c67.916e.8000 5s   0x0   0xB   0x2   0x3D

Age of the port in the current state: 0d:01h:15m:31s

        Port-channels in the group:

Port-channel: Po11   (Primary Aggregator)

Age of the Port-channel   = 0d:01h:43m:38s
Logical slot/port   = 16/0   Number of ports = 2
HotStandBy port = null
Port state   = Port-channel Ag-Inuse
Protocol   =   LACP
Port security   = Disabled

Ports in the Port-channel:

Index Load Port   EC state   No of bits
------+------+------+-----------------+-----------
 0   00   Gi0/0   Passive   0
 0   00   Gi0/1   Passive   0

Time since last port bundled: 0d:01h:15m:31s   Gi0/1
Time since last port Un-bundled: 0d:01h:15m:35s   Gi0/1

SCOTSW02#sh spanning-tree vlan 99

VLAN0099
  Spanning tree enabled protocol ieee

```
Root ID    Priority    32867
           Address    0c67.912e.9400
           Cost       6
           Port       65 (Port-channel11)
           Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

 Bridge ID  Priority    32867  (priority 32768 sys-id-ext 99)
           Address    0c67.9159.b100
           Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
           Aging Time  300 sec

Interface          Role Sts Cost     Prio.Nbr Type
------------------- ---- --- --------- -------- -------------------------------
Po11               Root FWD 3        128.65   P2p
```

SCOTSW02#show lacp counters
```
         LACPDUs      Marker    Marker Response   LACPDUs
Port     Sent  Recv   Sent  Recv   Sent  Recv    Pkts Err
---------------------------------------------------------------------
Channel group: 11
Gi0/0    246  245   0   0    0   0     0
Gi0/1    256  256   0   0    0   0     0
```

SCOTSW02#show lacp neighbor
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 11 neighbors

Partner's information:

```
          LACP port                Admin Oper  Port   Port
Port   Flags Priority Dev ID       Age   key  Key   Number State
Gi0/0  SA    32768    0c67.916e.8000 25s   0x0  0xB   0x1   0x3D
Gi0/1  SA    32768    0c67.916e.8000 13s   0x0  0xB   0x2   0x3D
SCOTSW02#
```

The LACP counters can be cleared with the command clear lacp counters.

CONFIGURATION TASK#3: "ON" between SCOTSW02 <-> SCOTSW04
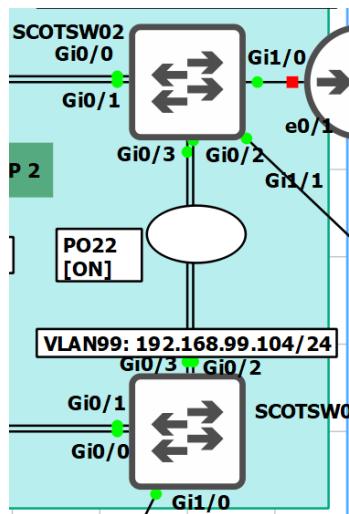
SCOTSW02 Etherchannel "On" Configuration
SCOTSW02(config)#default interface range gi0/2-3
SCOTSW02(config)#no interface port-channel 1

SCOTSW02(config)#interface range gi 0/2-3
SCOTSW02(config-if-range)#switchport trunk encapsulation dot1q
SCOTSW02(config-if-range)#switchport trunk allowed vlan 99,100,110,120,666,999
SCOTSW02(config-if-range)#switchport mode trunk
SCOTSW02(config-if-range)#channel-group 22 mode on

SCOTSW04 Etherchannel "On" Configuration
SCOTSW04(config)#default interface range gi0/2-3
SCOTSW04(config)#no interface port-channel 1

SCOTSW04(config)#interface range gi0/2-3
SCOTSW04(config-if-range)#switchport trunk encapsulation dot1q
SCOTSW04(config-if-range)#switchport trunk allowed vlan 99,100,110,120,666,999
SCOTSW04(config-if-range)#switchport mode trunk
SCOTSW04(config-if-range)#channel-group 22 mode on

VERIFICATION TASK#3

show etherchannel summary
show etherchannel detail
show etherchannel port-channel
show spanning-tree vlan 99

SCOTSW04#show etherchannel summary
Flags: D - down   P - bundled in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)

R - Layer3   S - Layer2
U - in use   N - not in use, no aggregation
f - failed to allocate aggregator

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

A - formed by Auto LAG

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

Group Port-channel Protocol   Ports
------+-------------+-----------+---
22   Po22(SU)   -   Gi0/2(P)   Gi0/3(P)

SCOTSW04#show etherchannel detail
        Channel-group listing:

Group: 22

Group state = L2
Ports: 2   Maxports = 4
Port-channels: 1 Max Port-channels = 1
Protocol: -
Minimum Links: 0

        Ports in the group:

Port: Gi0/2

Port state   = Up Mstr In-Bndl
Channel group = 22   Mode = On   Gcchange = -
Port-channel = Po22   GC = -   Pseudo port-channel = Po22
Port index   = 0   Load = 0x00   Protocol =   -

Age of the port in the current state: 0d:01h:49m:48s

Port: Gi0/3

Port state   = Up Mstr In-Bndl
Channel group = 22   Mode = On   Gcchange = -

Port-channel = Po22   GC = -   Pseudo port-channel = Po22
Port index   = 0   Load = 0x00   Protocol =   -

Age of the port in the current state: 0d:01h:49m:48s

        Port-channels in the group:

Port-channel: Po22

Age of the Port-channel   = 0d:01h:50m:28s
Logical slot/port   = 16/0   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   Gi0/2   On   0
 0   00   Gi0/3   On   0

Time since last port bundled: 0d:01h:49m:48s   Gi0/3
Time since last port Un-bundled: 0d:01h:50m:25s   Gi0/3

SCOTSW04#show spanning-tree vlan 99

VLAN0099
  Spanning tree enabled protocol ieee
  Root ID   Priority   32867
         Address   0c67.912e.9400
         Cost   4
         Port   1 (GigabitEthernet0/0)
         Hello Time   2 sec Max Age 20 sec Forward Delay 15 sec

  Bridge ID Priority   32867 (priority 32768 sys-id-ext 99)
         Address   0c67.91d3.c500
         Hello Time   2 sec Max Age 20 sec Forward Delay 15 sec
         Aging Time 300 sec

Interface   Role Sts Cost   Prio.Nbr Type
------------------- ---- --- -------- -------- -------------------------------
Po22   Desg FWD 3   128.65 P2p

Advanced LACP Configuration Options

CONFIGURATION TASK#4: Configure "LACP Fast"

LACP provides some additional tuning that is not available with PAgP.

LACP Fast:

The original LACP standards sent out LACP packets every 30 seconds. A link is deemed unusable if an LACP packet is not received after three intervals, which results in a potential 90 seconds of packet loss for a link before that member interface is removed from a port channel.

An amendment to the standards was made so that **LACP packets are advertised every 1 second.** This is known as LACP fast because a link can be identified and **removed in 3 seconds** compared to the 90 seconds specified in the initial LACP standard.

LACP fast is enabled on the member interfaces with the interface configuration command lacp rate fast.

All the interfaces on both switches need to be configured the same—either using LACP fast or LACP slow—for the EtherChannel to successfully come up.

SCOTSW01(config)# interface range gi0/1-2
SCOTSW01(config-if-range)# lacp rate fast

Remember: Best practice is to configure "lacp fast" on every Switch interface.

SCOTSW01# show lacp internal
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 1

| | | LACP port | Admin | Oper | Port | Port | |
Port	Flags	State	Priority	Key	Key	Number	State
Gi1/0/1	FA	bndl	32768	0x1	0x1	0x102	0x3F
Gi1/0/2	FA	bndl	32768	0x1	0x1	0x103	0xF

CONFIGURATION TASK#5: Minimum Number of Port-Channel Member Interfaces

An EtherChannel interface becomes active and up when only one member interface successfully forms an adjacency with a remote device.

In some design scenarios using LACP, **a minimum number of adjacencies is required before a port-channel interface becomes active**. This option can be configured with the port-channel interface command port-channel min-links min-links.

SCOTSW01(config)# interface port-channel 1
SCOTSW01(config-if)# port-channel min-links 2

Test the behaviour by shutting one of the physical member manually "shutdown"
SCOTSW01(config-if)# interface gi1/0/1
SCOTSW01(config-if)# shutdown
10:44:46.516: %ETC-5-MINLINKS_NOTMET: Port-channel Po1 is down bundled ports (1)
   doesn't meet min-links
10:44:47.506: %LINEPROTO-5-UPDOWN: Line protocol on Interface Gigabit
   Ethernet1/0/2, changed state to down
10:44:47.508: %LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel1,
   changed state to down
10:44:48.499: %LINK-5-CHANGED: Interface GigabitEthernet1/0/1, changed state to
   administratively down
10:44:48.515: %LINK-3-UPDOWN: Interface Port-channel1, changed state to down

SCOTSW01# show etherchannel summary
! Output Ommitted for Brevity
Flags: D - down   P - bundled in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3   S - Layer2
        U - in use   f - failed to allocate aggregator
        M - not in use, minimum links not met
Group Port-channel Protocol   Ports
------+-------------+-----------+---
1   Po1(SM)   LACP   Gi1/0/1(D) Gi1/0/2(P)

By default having only 1 active member interface will bring up "Etherchannel".
Best practice is enable "min-links" and set to 2 so that unless we have 2 active physical member the "Etherchannel" wouldn't come up.

CONFIGURATION TASK#6: Maximum Number of Port-Channel Member Interfaces

An EtherChannel can be configured to have a specific maximum number of member interfaces in a port channel.

This may be done to ensure that the active member interface count proceeds with powers of two (for example, 2, 4, 8) to accommodate load-balancing hashes.

The maximum number of member interfaces in a port channel can be configured with the port-channel interface command lacp max-bundle max-links.

SCOTSW01(config)# interface port-channel1
SCOTSW01(config-if)# lacp max-bundle 1
11:01:11.972: %LINEPROTO-5-UPDOWN: Line protocol on Interface Gigabit
    Ethernet1/0/1, changed state to down
11:01:11.979: %LINEPROTO-5-UPDOWN: Line protocol on Interface Gigabit
    Ethernet1/0/2, changed state to down
11:01:11.982: %LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel1,
    changed state to down
11:01:13.850: %LINEPROTO-5-UPDOWN: Line protocol on Interface Gigabit
    Ethernet1/0/1, changed state to up
11:01:13.989: %LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel1,
    changed state to up

SCOTSW01# show etherchannel summary
! Output omitted for brevity
Flags: D - down   P - bundled in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3   S - Layer2
        U - in use   f - failed to allocate aggregator

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

        A - formed by Auto LAG

Group Port-channel Protocol   Ports
------+-------------+-----------+---
1   Po1(SU)   LACP   Gi1/0/1(P) Gi1/0/2(H)
The maximum number of port-channel member interfaces needs to be configured only on the master switch for that port channel; however, configuring it on both switches is recommended to accelerate troubleshooting and assist operational staff.

The **port-channel master switch controls which member interfaces (and associated links) are active by examining the LACP port priority**. A **lower port priority** is preferred. If the port priority is the same, then the **lower interface number** is preferred.

CONFIGURATION TASK#7: LACP System Priority

This identifies which switch is the master switch for a port channel.

The master switch on a port channel is responsible for choosing which member interfaces are active in a port channel when there are more member interfaces than the maximum number of member interfaces associated with a port-channel interface.

The switch with the lower system priority is preferred.

The LACP system priority can be changed with the command lacp system-priority priority.

PRE_CHECKS:
SCOTSW01# show lacp sys-id
32768, 0062.ec9d.c500

CONFIG:
SCOTSW01# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
SW1(config)# lacp system-priority 1

POST_CHECKS:
SCOTSW01# show lacp sys-id
1, 0062.ec9d.c50

CONFIGURATION TASK#8: LACP Interface Priority

LACP interface priority enables the master switch to choose which member interfaces are active in a port channel when there are more member interfaces than the maximum number of member interfaces for a port channel.

A port with a lower port priority is preferred.

The interface configuration command lacp port-priority priority sets the interface priority.

SCOTSW01 is the master switch for port channel 11, the Gi0/1 interface becomes active, and port Gi0/1 becomes Hot-standby.

PRE_CHECKS:
SCOTSW01# show etherchannel summary | b Group
Group Port-channel Protocol   Ports

```
------+-------------+-----------+----------------------------------------------
11    Po1(SU)      LACP     Gi0/0(P)  Gi0/1(H)
```

CONFIGS:
SCOTSW01(config)# interface gi0/1
SCOTSW01(config-if)# lacp port-priority 1

POST_CHECKS:
SCOTSW01# show etherchannel summary | b Group
Group Port-channel Protocol   Ports
```
------+-------------+-----------+----------------------------------------------
11    Po1(SU)      LACP     Gi0/0(H)  Gi0/1(P)
```

CONFIGURATION TASK#9: EtherChannel Misconfiguration Guard

- EtherChannel Guard is a way of finding out error in the etherchannel port channel.
- Etherchannel guard finding if one end of the EtherChannel is not configured properly.
- This could be that there are some parameters not matching up such as duplex a speed.

SCOTSW01(config)#spanning-tree etherchannel guard misconfig
SCOTSW02(config)#spanning-tree etherchannel guard misconfig

SCOTSW01#show spanning-tree summary
SCOTSW02#show spanning-tree summary

SCOTSW01# show interfaces status err-disabled
SCOTSW01=2# show interfaces status err-disabled

```
SW1#show spanning-tree summary
Switch is in rapid-pvst mode
Root bridge for: VLAN0001
Extended system ID               is enabled
Portfast Default                 is disabled
Portfast Edge BPDU Guard Default is disabled
Portfast Edge BPDU Filter Default is disabled
Loopguard Default                is disabled
PVST Simulation Default          is enabled but
Bridge Assurance                 is enabled
EtherChannel misconfig guard     is enabled
Configured Pathcost method used is short
UplinkFast                       is disabled
BackboneFast                     is disabled
```

LAB #9 CONFIGURE – HSRPv1
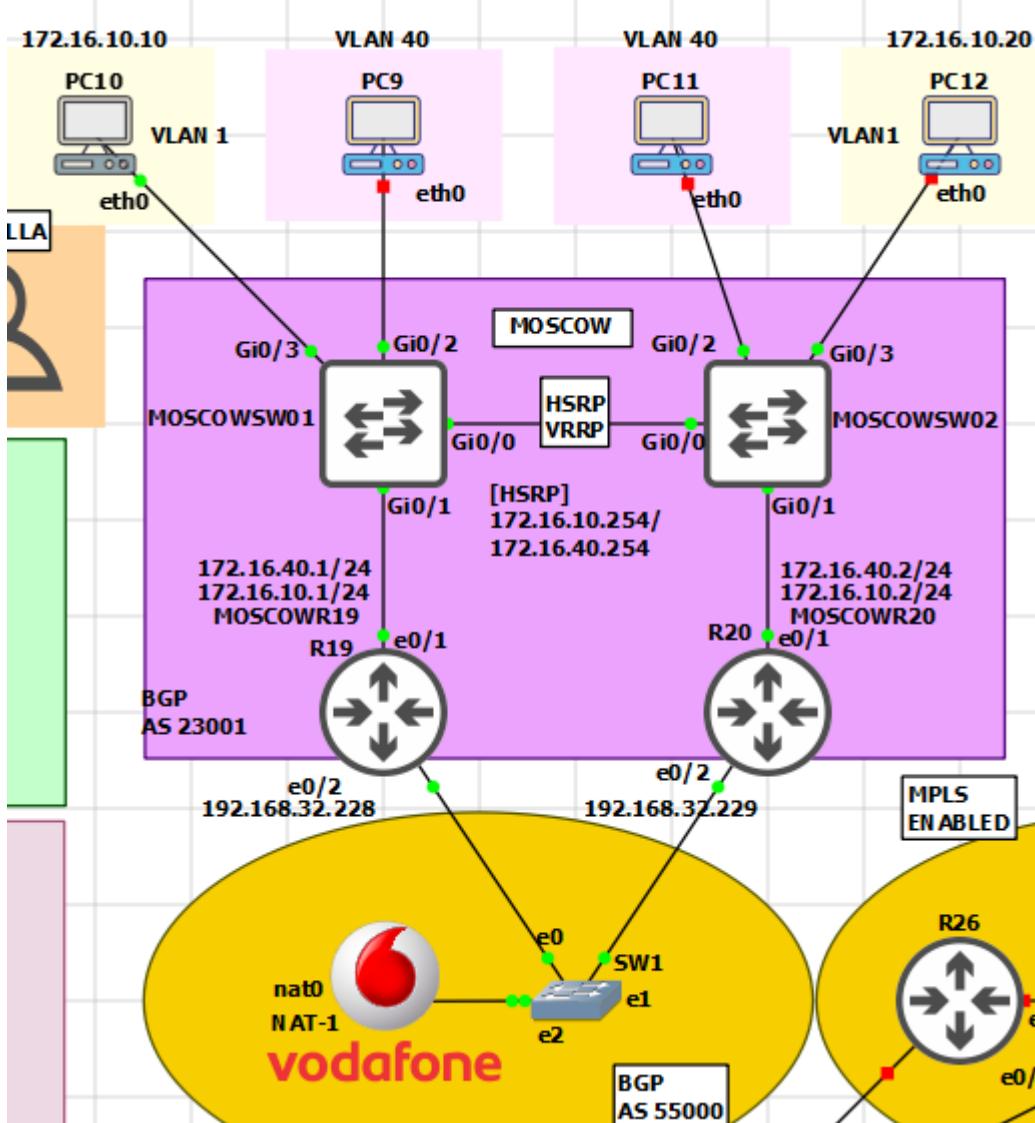
Objectives: Consider MOSCOWR19, MOSCOWR20, MOSCOWSW01, MOSCOWSW02, PC10, PC19, PC11, PC12 as following:

1. Configure "Initial config" on MOSCOWR19, MOSCOWR20, MOSCOWSW01, MOSCOWSW02, PC10, PC19, PC11, PC12
2. Configure "HSRPv1", Preempt for "Vlan 1 and Vlan 40", observe the behaviour (do not configure the priority as of now)
3. From step#2, configure Priority110 on MOSCOWR20 and observe the behaviour
4. Try loadsharing, by making Vlan 1 "ACTIVE" on MOSCOWR19 and Vlan 40 "ACTIVE" on MOSCOWR20, verify the patch adopted by ping/traceroute from PC10 (vlan1) and PC9(vlan40) towards 8.8.8.8
5. Configure Tracking Object and verify the WAN link switchport failures.

CONFIGURATION TASK#1: Configure "Initial config" on MOSCOWR19, MOSCOWR20, MOSCOWSW01, MOSCOWSW02, PC10, PC19, PC11, PC12

MOSCOWR19
interface e0/1
no shutdown
interface e0/1.1
encap dot 1
ip address 172.16.10.1 255.255.255.0
interface e0/1.40
encap dot 40
ip address 172.16.40.1 255.255.255.0

interface Ethernet0/2
 ip address dhcp
end

MOSCOWR20
interface e0/1
no shut
interface e0/1.1
encap dot 1
ip address 172.16.10.2 255.255.255.0
interface e0/1.40
encap dot 40
ip address 172.16.40.2 255.255.255.0

interface Ethernet0/2
 ip address dhcp
end

MOSCOWSW01
interface gi0/3
no shutdown
interface gi0/2
no shutdown
switchport mode access
switchport access vlan 40
interface range gi0/0-1
switchport tr enc dot1
switchport mode trunk
switchport trunk allowed vlan 1,40

MOSCOWSW02
interface gi0/3
no shutdown
interface gi0/2
no shutdown
switchport mode access
switchport access vlan 40
interface range gi0/0-1
switchport tr enc dot1

switchport mode trunk
switchport trunk allowed vlan 1,40

PC10

```
#
# This is a sample network config uncomment lines to configure the network
#


# Static config for eth0
auto eth0
iface eth0 inet static
            address 172.16.10.10
            netmask 255.255.255.0
            gateway 172.16.10.1
            up echo nameserver 192.168.0.1 > /etc/resolv.conf

# DHCP config for eth0
# auto eth0
# iface eth0 inet dhcp
```

PC9

```
#
# This is a sample network config uncomment lines to configure the network
#


# Static config for eth0
auto eth0
iface eth0 inet static
            address 172.16.40.10
            netmask 255.255.255.0
            gateway 172.16.40.1
            up echo nameserver 192.168.0.1 > /etc/resolv.conf

# DHCP config for eth0
# auto eth0
# iface eth0 inet dhcp
```

PC11

PC11 interfaces

```
#
# This is a sample network config uncomment lines to configure the network
#


# Static config for eth0
auto eth0
iface eth0 inet static
            address 172.16.40.20
            netmask 255.255.255.0
            gateway 172.16.40.1
            up echo nameserver 192.168.0.1 > /etc/resolv.conf

# DHCP config for eth0
# auto eth0
# iface eth0 inet dhcp
```

PC12

PC12 interfaces

```
#
# This is a sample network config uncomment lines to configure the network
#


# Static config for eth0
auto eth0
iface eth0 inet static
            address 172.16.10.20
            netmask 255.255.255.0
            gateway 172.16.10.1
            up echo nameserver 192.168.0.1 > /etc/resolv.conf

# DHCP config for eth0
# auto eth0
# iface eth0 inet dhcp
```

By default, all PC's are pointing to their respective Gateway Ips
Once we have HSRP (standby) successfully configured, we shall change the gateway to HSRP
Virtual IP (VIP) for redundancy purpose.

VERIFICATIONS TASK#1: Configure "Initial config" on MOSCOWR19, MOSCOWR20, MOSCOWSW01, MOSCOWSW02

MOSCOWR19#show ip int br | exclude unass

```
Interface           IP-Address     OK? Method Status          Protocol
Ethernet0/1.1        172.16.10.1    YES NVRAM  up               up
Ethernet0/1.40       172.16.40.1    YES NVRAM  up               up
Ethernet0/2          192.168.32.228 YES DHCP   up               up
```

MOSCOWR19#ping 8.8.8.8
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 8.8.8.8, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 47/72/91 ms
MOSCOWR19#

MOSCOWR20#show ip int brief | ex unass
```
Interface           IP-Address     OK? Method Status          Protocol
Ethernet0/1.1        172.16.10.2    YES NVRAM  up               up
Ethernet0/1.40       172.16.40.2    YES NVRAM  up               up
Ethernet0/2          192.168.32.229 YES DHCP   up               up
```

MOSCOWR20#ping 8.8.8.8
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 8.8.8.8, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/61/85 ms
MOSCOWR20#

MOSCOWSW01#show interfaces trunk
```
Port    Mode          Encapsulation Status      Native vlan
Gi0/0   on            802.1q        trunking     1
Gi0/1   on            802.1q        trunking     1
Port    Vlans allowed on trunk
Gi0/0   1,40
Gi0/1   1,40
Port    Vlans allowed and active in management domain
Gi0/0   1,40
Gi0/1   1,40
Port    Vlans in spanning tree forwarding state and not pruned
Gi0/0   1,40
Gi0/1   1,40
```

MOSCOWSW01#show run int gi0/2
interface GigabitEthernet0/2
 switchport access vlan 40
 switchport mode access
 media-type rj45
 negotiation auto
end

MOSCOWSW01#show run int gi0/3
interface GigabitEthernet0/3
 media-type rj45
 negotiation auto

end

MOSCOWSW02#show interfaces trunk
Port   Mode   Encapsulation Status   Native vlan
Gi0/0   on   802.1q   trunking   1
Gi0/1   on   802.1q   trunking   1
Port   Vlans allowed on trunk
Gi0/0   1,40
Gi0/1   1,40
Port   Vlans allowed and active in management domain
Gi0/0   1,40
Gi0/1   1,40
Port   Vlans in spanning tree forwarding state and not pruned
Gi0/0   1,40
Gi0/1   1,40

Ping initiated to internet from PC10
PC10 console is now available... Press RETURN to get started.
/ # ping 8.8.8.8
PING 8.8.8.8 (8.8.8.8): 56 data bytes
64 bytes from 8.8.8.8: seq=0 ttl=127 time=150.310 ms
64 bytes from 8.8.8.8: seq=1 ttl=127 time=170.947 ms
^C
--- 8.8.8.8 ping statistics ---
2 packets transmitted, 2 packets received, 0% packet loss
round-trip min/avg/max = 150.310/160.628/170.947 ms

/ # traceroute 8.8.8.8
traceroute to 8.8.8.8 (8.8.8.8), 30 hops max, 46 byte packets
 1 172.16.10.1 (172.16.10.1) 4.968 ms 3.694 ms 4.079 ms →packet going via MOSCOWR19
 2 192.168.32.2 (192.168.32.2) 5.946 ms 5.493 ms 6.467 ms

CONFIGURATION TASK #2: Configure "HSRPv1" for "Vlan 1", observe the behaviour.

Configure HSRPv1
MOSCOWR19(router)
interface e0/1.1
standby 1 ip 172.16.10.254
standby 1 preempt
interface e0/1.40
standby 40 ip 172.16.40.254

MOSCOWR20(router)
interface e0/1.1
standby 1 ip 172.16.10.254
interface e0/1.40
standby 40 ip 172.16.40.254
standby 40 preempt

VERIFICATION TASK #2:

MOSCOWR19#sh stand br
   P indicates configured to preempt.
    |

Interface	Grp	Pri	P	State	Active	Standby	Virtual IP
Et0/1.1	1	100	P	Active	local	172.16.10.2	172.16.10.254
Et0/1.40	40	100		Active	local	172.16.40.2	172.16.40.254

MOSCOWR20#sh standby br
   P indicates configured to preempt.
    |

Interface	Grp	Pri	P	State	Active	Standby	Virtual IP
Et0/1.1	1	100		Standby	172.16.10.1	local	172.16.10.254
Et0/1.40	40	100	P	Standby	172.16.40.1	local	172.16.40.254

Observation:
1. By default, whenever there is no priority set on HSRP, the highest IP address wins the election and takes up "ACTIVE" role so that way MOSCOWR20 should have been the "ACTIVE" as it has highest IP on its interface.
2. However, here in our scenario, MOSCOWR19 is elected as "ACTIVE" because "MOSCOWR19" was configured first and it declared itself as "ACTIVE" and when you configure "MOSCOWR20" is it going to take "Standby" role.
3. Though we have "Preempt" configured under MOSCOWR20, it is not going to become "ACTIVE" until "Priority" is set greater than 100 (default)
4. *Please note, if you configure on both router at same time the HSRP election would pick MOSCOWR20 to be "ACTIVE" being having highest interface IP address*

  MOSCOWR20# show stand brief
    P indicates configured to preempt.
     |

Interface	Grp	Pri	P	State	Active	Standby	Virtual IP
Et0/1.1	*1*	*100*		*Active*	*local*	*unknown*	*172.16.10.254*
Et0/1.40	*40*	*100*	*P*	*Active*	*local*	*unknown*	*172.16.40.254*

MOSCOWR19#show standby
Ethernet0/1.1 - Group 1
　State is Standby
　　6 state changes, last state change 00:03:08
　Virtual IP address is 172.16.10.254
　Active virtual MAC address is 0000.0c07.ac01
　　Local virtual MAC address is 0000.0c07.ac01 (v1 default)
　Hello time 3 sec, hold time 10 sec
　　Next hello sent in 1.296 secs
　Preemption enabled
　Active router is 172.16.10.2, priority 110 (expires in 9.456 sec)
　Standby router is local
　Priority 100 (default 100)
　Group name is "hsrp-Et0/1.1-1" (default)
Ethernet0/1.40 - Group 40
　State is Standby
　　6 state changes, last state change 00:18:41
　Virtual IP address is 172.16.40.254
　Active virtual MAC address is 0000.0c07.ac28
　　Local virtual MAC address is 0000.0c07.ac28 (v1 default)
　Hello time 3 sec, hold time 10 sec
　　Next hello sent in 1.904 secs
　Preemption disabled
　Active router is 172.16.40.2, priority 110 (expires in 10.800 sec)
　Standby router is local
　Priority 100 (default 100)
　Group name is "hsrp-Et0/1.40-40" (default)
MOSCOWR19#

MOSCOWR20#show standby
Ethernet0/1.1 - Group 1
　State is Active
　　2 state changes, last state change 00:04:14
　Virtual IP address is 172.16.10.254
　Active virtual MAC address is 0000.0c07.ac01
　　Local virtual MAC address is 0000.0c07.ac01 (v1 default)
　Hello time 3 sec, hold time 10 sec
　　Next hello sent in 0.704 secs
　Preemption disabled
　Active router is local
　Standby router is 172.16.10.1, priority 100 (expires in 11.008 sec)
　Priority 110 (configured 110)
　Group name is "hsrp-Et0/1.1-1" (default)
Ethernet0/1.40 - Group 40
　State is Active
　　2 state changes, last state change 00:19:32
　Virtual IP address is 172.16.40.254
　Active virtual MAC address is 0000.0c07.ac28
　　Local virtual MAC address is 0000.0c07.ac28 (v1 default)

  Hello time 3 sec, hold time 10 sec
    Next hello sent in 0.960 secs
  Preemption enabled
  Active router is local
  Standby router is 172.16.40.1, priority 100 (expires in 10.032 sec)
  Priority 110 (configured 110)
  Group name is "hsrp-Et0/1.40-40" (default)
MOSCOWR20#

MOSCOWR20(config)#interface e0/1.1
MOSCOWR20(config-subif)#standby 1 priority 110

MOSCOWR20(config)#interface e0/1.40
MOSCOWR20(config-subif)#standby 40 priority 110

MOSCOWR20#sh stand brief
          P indicates configured to preempt.
          |
Interface   Grp Pri P State   Active   Standby   Virtual IP
Et0/1.1   1   110   Active local   unknown   172.16.10.254
Et0/1.40   40   110 P Active local   172.16.40.1   172.16.40.254

MOSCOWR19#sh stand br
          P indicates configured to preempt.
          |
Interface   Grp Pri P State   Active   Standby   Virtual IP
Et0/1.1   1   100 P Standby 172.16.10.2   local   172.16.10.254
Et0/1.40   40   100   Standby 172.16.40.2   local   172.16.40.254

Observation:
   1. As soon as you configured the "priority 110" on MOSCOWR20, the "preempt" triggered
       up the re-election, MOSCOWR20 is "ACTIVE" for both Vlan 1 and 40

CONFIGURATION TASK #4: Configure "Load Sharing".
Vlan1 Active on MOSCOWR19 and Vlan40 Active on MOSCOWR20

MOSCOWR19(config)#
interface e0/1.1
standby 1 priority 120

MOSCOWR19#sh stand br
        P indicates configured to preempt.
        |
Interface Grp Pri P State Active   Standby   Virtual IP
Et0/1.1   1   120 P `Active` local   unknown   172.16.10.254
Et0/1.40 40 100 Standby 172.16.40.2   local   172.16.40.254

MOSCOWR20#sh stand brief
        P indicates configured to preempt.
        |
Interface Grp Pri P State Active   Standby   Virtual IP
Et0/1.1   1   110   `Standby` 172.16.10.1   local   172.16.10.254
Et0/1.40 40 110 P Active local   172.16.40.1   172.16.40.254

Observation:
Nothing to be changed for Vlan40 as Vlan40 is already "Active" on MOSCOWR20.

CONFIGURATION TASK #5: Object-tracking (WAN side facing)

1. Let us assume *MOSCOWR19_e0/2 goes Down.*
   Configure "HSRP Object-Tracking" so that the re-election takes place the traffic switchovers to MOSCOWR20 router

Pre-checks
From PC10:
PC10/ # traceroute 8.8.8.8
traceroute to 8.8.8.8 (8.8.8.8), 30 hops max, 46 byte packets
 1 172.16.10.1 (172.16.10.2) 7.521 ms 3.646 ms 7.701 ms →*packet going via MOSCOWR19*
 2 192.168.32.2 (192.168.32.2) 5.977 ms 7.163 ms 6.677 ms

MOSCOWR19#show standby brief
Interface Grp Pri P State Active   Standby   Virtual IP
Et0/1.1   1   `120` P `Active` local   unknown   172.16.10.254
Et0/1.40 40 100 Standby 172.16.40.2   local   172.16.40.254

#configure prempt as this was not configured earlier
MOSCOWR20(router)
interface e0/1.1
standby 1 preempt

#configure object-tracking on WAN facing interface
MOSCOWR19(config)#
track 1 interface ethernet 0/2 line-protocol
exit
interface e0/1.1
standby 1 track 1 decrement 30

VERIFICATION TASK #5:

To verify the "object tracking" behaviour "**shutdown**" interface ethernet0/2 of MOSCOWR19

MOSCOWR19(config)#
interface e0/2
shut

*May 14 19:17:52.042: %TRACK-6-STATE: 1 interface Et0/2 line-protocol Up -> Down
*May 14 19:20:25.463: %HSRP-5-STATECHANGE: Ethernet0/1.1 Grp 1 state Active -> Speak
*May 14 19:20:36.203: %HSRP-5-STATECHANGE: Ethernet0/1.1 Grp 1 state Speak -> Standby

Post-checks:
MOSCOWR19#show standby brief

Interface	Grp	Pri	P	State	Active	Standby	Virtual IP
Et0/1.1	1	90	P	Standby	172.16.10.2	local	172.16.10.254
Et0/1.40	40	100		Standby	172.16.40.2	local	172.16.40.254

> Observations:
> Priority decreased by "30" as per the object-tracking command
> We have set decrement of "30" incase of MOSCOWR19_Eth0/2 Line-protocol going "Down"

/ # traceroute 8.8.8.8
traceroute to 8.8.8.8 (8.8.8.8), 30 hops max, 46 byte packets
 1 172.16.10.2 (172.16.10.2) 7.146 ms 4.018 ms 3.937 ms →*now traffic goes over MOSCOWR20*
 2 192.168.32.2 (192.168.32.2) 7.994 ms 7.780 ms 7.122 ms

Gratuitous ARP:

53	14.505837	All-HSRP-routers_01	Broadcast	ARP	60 Gratuitous ARP for 172.16.10.254 (Reply)
54	14.508997	All-HSRP-routers_01	STP-UplinkFast	ARP	60 Gratuitous ARP for 172.16.10.254 (Reply)
63	17.485151	All-HSRP-routers_01	Broadcast	ARP	60 Gratuitous ARP for 172.16.10.254 (Reply)
199	58.378328	All-HSRP-routers_01	Broadcast	ARP	60 Gratuitous ARP for 172.16.10.254 (Reply)
200	58.383524	All-HSRP-routers_01	STP-UplinkFast	ARP	60 Gratuitous ARP for 172.16.10.254 (Reply)
210	61.369427	All-HSRP-routers_01	Broadcast	ARP	60 Gratuitous ARP for 172.16.10.254 (Reply)

The Gratuitous ARP is sent as a broadcast, as a way for a node to announce or update its IP to MAC mapping to the entire network.

HSRPv1 HSRP Packet {Default Config}

| 1191 354.647700 | 172.16.40.2 | 224.0.0.2 | HSRP | 66 Hello (state Active) |

```
> Frame 52: 62 bytes on wire (496 bits), 62 bytes captured (496 bits) on interface 0
> Ethernet II, Src: aa:bb:cc:00:11:10 (aa:bb:cc:00:11:10), Dst: IPv4mcast_02 (01:00:5e:00:00:02)
> Internet Protocol Version 4, Src: 172.16.10.2, Dst: 224.0.0.2
> User Datagram Protocol, Src Port: 1985, Dst Port: 1985
∨ Cisco Hot Standby Router Protocol
    Version: 0
    Op Code: Hello (0)
    State: Speak (4)
    Hellotime: Default (3)
    Holdtime: Default (10)
    Priority: 100
    Group: 1
    Reserved: 0
    Authentication Data: Default (cisco)
    Virtual IP Address: 172.16.10.254
```

LAB #14 CONFIGURE – OSPFv2
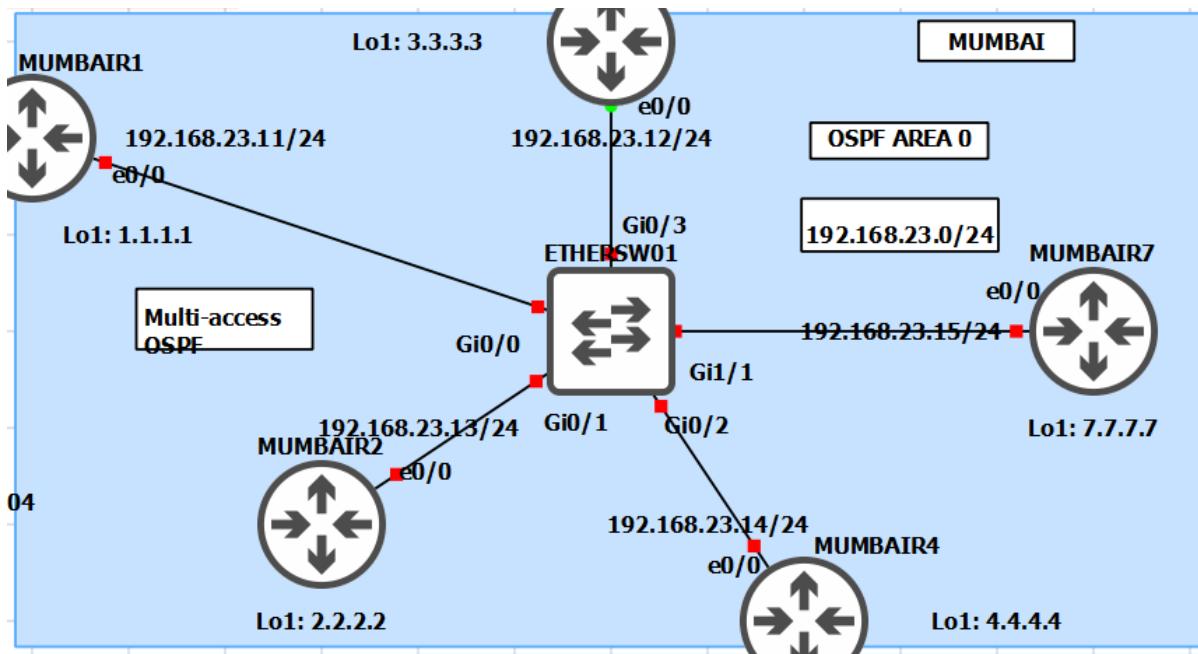
Objectives: Configure on MUMBAIR1, MUMBAIR2, MUMBAIR3, MUMBAIR4, MUMBAIR7 as following:

1. Prepare the Initial Configs interface IP address, Loopback IP address on MUMBAIR1, MUMBAIR2, MUMBAIR3, MUMBAIR4 and MUMBAIR7
2. Configure OSPF (single-area)
3. MANIPULATE DR/BDR ELECTION
4. MANIPULATE ROUTER-ID ELECTION
5. MANIPULATE HELLO/HOLD TIMER
6. CHANGE AREA ID
7. OSPF AUTHENTICATIION
8. OSPF AREA TYPE
9. OSPF MTU MISMATCH
10. VERIFY OSPF MUTLICAST ADDRESS 224.0.0.6 and 224.0.0.5

CONFIGURATION TASK #1: Initial Configs

MUMBAIR1(config)#
hostname MUMBAIR1
int loopback 1
ip address 1.1.1.1 255.255.255.0
no shut
int e0/0
ip add 192.168.23.11 255.255.255.0
no shut

MUMBAIR2(config)#
hostname MUMBAIR2
int loopback 1
ip address 2.2.2.2 255.255.255.0
no shut
int e0/0
ip add 192.168.23.13 255.255.255.0
no shut

MUMBAIR3(config)#
hostname MUMBAIR3
int loopback 1
ip address 3.3.3.3 255.255.255.0
no shut
int e0/0
ip add 192.168.23.12 255.255.255.0
no shut

MUMBAIR4
hostname MUMBAIR4
int loopback 1
ip address 4.4.4.4 255.255.255.0
no shut
int e0/0
ip add 192.168.23.14 255.255.255.0
no shut

MUMBAIR7
hostname MUMBAIR7
int loopback 1
ip address 7.7.7.7 255.255.255.0
no shut
int e0/0
ip add 192.168.23.15 255.255.255.0
no shut

CONFIGURATION TASK #2: Configure OSPF (single-area)

MUMBAIR1(config)# #global way
router ospf 100
network 192.168.23.0 0.0.0.255 area 0
network 1.1.1.1 0.0.0.255 area 0

MUMBAIR2(config)# #global way
router ospf 100
network 192.168.23.0 0.0.0.255 area 0
network 2.2.2.2 0.0.0.255 area 0

MUMBAIR3(config)# #global way
router ospf 100
network 192.168.23.0 0.0.0.255 area 0
network 3.3.3.3 0.0.0.255 area 0

MUMBAIR4(config)# #interface way
Interface e0/0
Ip ospf 1 area 0

MUMBAIR7(config)# #interface way
Interface e0/0
Ip ospf 1 area 0

By default, any router can become DR, BDR, DROTHERS as per the configurations are done.
To make the rightful Router as DR and BDR based out of known formulae, DR = Priority+R-ID
Make use of CLI command "clear ip ospf process" → Reloads the ospf process so that re-election happens.

MUMBAIR1#, MUMBAIR2#, MUMBAIR3#, MUMBAIR4#, MUMBAIR7#
clear ip ospf process
Reset ALL OSPF processes? [no]: yes

You can also enable the "debug" commands to see the packet captures:

DEBUG OSPF

MUMBAIR1#debug ip ospf packet
OSPF packet debugging is on
MUMBAIR1#debug ip ospf adj
OSPF adjacency debugging is on

VERIFICATION TASKS#2

MUMBAIR1#show ip ospf neighbor

```
Neighbor ID   Pri  State        Dead Time   Address       Interface
2.2.2.2        1   FULL/DROTHER  00:00:30    192.168.23.13  Ethernet0/0
3.3.3.3        1   FULL/DR       00:00:32    192.168.23.12  Ethernet0/0
MUMBAIR1#
```

MUMBAIR1#show ip ospf database

```
          OSPF Router with ID (1.1.1.1) (Process ID 100)

          Router Link States (Area 0)

Link ID       ADV Router    Age      Seq#       Checksum Link count
1.1.1.1       1.1.1.1       1474     0x80000005 0x0035BB 2
2.2.2.2       2.2.2.2       365      0x8000000B 0x0033A9 2
3.3.3.3       3.3.3.3       1475     0x80000006 0x00F8DD 2

          Net Link States (Area 0)

Link ID       ADV Router    Age      Seq#       Checksum
192.168.23.12 3.3.3.3       365      0x80000007 0x003649
MUMBAIR1#
```

MUMBAIR1#show ip route
<!-output omitted-!>

Gateway of last resort is not set

```
    1.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C     1.1.1.0/24 is directly connected, Loopback1
L     1.1.1.1/32 is directly connected, Loopback1
    2.0.0.0/32 is subnetted, 1 subnets
O     2.2.2.2 [110/11] via 192.168.23.13, 00:05:59, Ethernet0/0
    3.0.0.0/32 is subnetted, 1 subnets
O     3.3.3.3 [110/11] via 192.168.23.12, 00:24:39, Ethernet0/0
    192.168.23.0/24 is variably subnetted, 2 subnets, 2 masks
C     192.168.23.0/24 is directly connected, Ethernet0/0
L     192.168.23.11/32 is directly connected, Ethernet0/0
```

MUMBAIR3#show ip ospf interface ethernet0/0
```
Ethernet0/0 is up, line protocol is up
  Internet Address 192.168.23.12/24, Area 0, Attached via Network Statement
  Process ID 100, Router ID 3.3.3.3, Network Type BROADCAST, Cost: 10
  Topology-MTID  Cost  Disabled  Shutdown  Topology Name
     0           10    no        no        Base
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 3.3.3.3, Interface address 192.168.23.12
  Backup Designated router (ID) 2.2.2.2, Interface address 192.168.23.13
```

Timer intervals configured, <mark>Hello 10, Dead 40</mark>, Wait 40, Retransmit 5
 oob-resync timeout 40
 Hello due in 00:00:04
Supports Link-local Signaling (LLS)
Cisco NSF helper support enabled
IETF NSF helper support enabled
Index 1/1, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 3
Last flood scan time is 0 msec, maximum is 1 msec
Neighbor Count is 2, Adjacent neighbor count is 1
 Adjacent with neighbor 2.2.2.2 (Backup Designated Router)
Suppress hello for 0 neighbor(s)
MUMBAIR3#

As we know:
DR/BDR = PRIORITY (DEFAULT=1) + ROUTER-ID (elected in 2-Way state)
MASTER/SLAVE = HIGHEST ROUTER-ID (elected in Extract state)

TROUBLESHOOTING OSPF:

CONFIGURATION TASK #3: **MANIPULATE DR/BDR ELECTION**

Make OSPF PRIORITY=0 for MUMBAIR3
Don't let MUMBAIR3 participate in DR/BDR election

MUMBAIR3(config)#
interface e0/0
ip ospf priority 0

VERIFICATION TASK #3:

MUMBAIR2#
3.3.3.3   0 FULL/DROTHER   00:00:36   192.168.23.12 Ethernet0/0

3.3.3.3 is now acting as DROTHER with OSPF Priority = 0

MUMBAIR3#show ip ospf interface e0/0
Ethernet0/0 is up, line protocol is up
  Internet Address 192.168.23.12/24, Area 0, Attached via Network Statement
  Process ID 100, Router ID 3.3.3.3, Network Type BROADCAST, Cost: 10
  Topology-MTID   Cost   Disabled   Shutdown   Topology Name
        0   10   no   no   Base
  Transmit Delay is 1 sec, State DROTHER, Priority 0
  Designated Router (ID) 2.2.2.2, Interface address 192.168.23.13
  Backup Designated router (ID) 1.1.1.1, Interface address 192.168.23.11
  Old designated Router (ID) 3.3.3.3, Interface address 192.168.23.12

CONFIGURATION TASK #4: **MANIPULATE ROUTER-ID ELECTION**

MUMBAIR1#(config)
router ospf 1
router-id 11.11.11.11
MUMBAIR2#(config)
router ospf 1
router-id 22.22.22.22
MUMBAIR3#(config)
router ospf 1
router-id 33.33.33.33

clear ip ospf process *
[yes]

This will re-elect the DR and BDR on updated Router-ID.

CONFIGURATION TASK #5: MANIPULATE HELLO/HOLD TIMER

MUMBAIR1#(config)
interface e0/0
ip ospf hello-timer 5

CONFIGURATION TASK #6: CHANGE AREA ID

MUMBAIR1#(config)
router ospf 100
network 192.168.23.0 0.0.0.255 area 2 **or** network 192.168.23.0 0.0.0.255 area 0.0.0.2

Reference: https://www.browserling.com/tools/dec-to-ip

AREA MISMATCH OSPF MESSAGE:
*May 14 15:42:19.645: %OSPF-4-ERRRCV: Received invalid packet: mismatched area ID from backbone area from 192.168.23.0, Ethernet0/0

CONFIGURATION TASK #7: OSPF AUTHENTICATIION

TWO WAYS TO CONFIGURE AUTHENTICATION - PLAIN & MD5
PLAIN TEXT METHOD:
2 Ways:
1. Global
2. Interface

1. Global way for PLAIN TEXT
MUMBAIR1(config)#
router ospf 100
area 0 authentication

int e0/0
ip ospf authentication-key 0 cisco

2. Interface way for PLAIN TEXT
MUMBAIR1(config)#
interface e0/0
ip ospf authentication
ip ospf authentication-key 0 cisco

Verification:
show ip ospf inter e0/0

MD5 METHOD
----
2 Ways:
1. Global

2. Interface

1.Global way for MD5
MUMBAIR1(config)#
router ospf 1
area 0.0.0.0 authentication message-digest

interface e0/0
ip ospf message-digest-key 1 md5 cisco

2. Interface way for MD5
MUMBAIR1(config)#
interface e0/0
ip ospf authentication message-digest
ip ospf message-digest-key 1 md5 0 cisco

CONFIGURATION TASK #8: OSPF AREA TYPE

MUMBAIR1(config)#
area 40 stub
or
MUMBAIR1(config)#
area 40 nssa

CONFIGURATION TASK #9: OSPF MTU MISMATCH

MTU MISTMATCH (Stuck in Extract/Exchange State)

MUMBAIR2(config)#
int e0/0
ip mtu 1000
shutdown
no shutdown

VERIFICATION TASK #9: OSPF MTU MISMATCH

MUMBAIR2#

Neighbor ID	Pri	State	Dead Time	Address	Interface
1.1.1.1	1	EXSTART/BDR	00:00:39	192.168.23.11	Ethernet0/0
3.3.3.3	1	EXSTART/DR	00:00:39	192.168.23.12	Ethernet0/0

MUMBAIR1#

Neighbor ID	Pri	State	Dead Time	Address	Interface
2.2.2.2	1	EXCHANGE/DROTHER	00:00:38	192.168.23.13	Ethernet0/0
3.3.3.3	1	FULL/DR	00:00:37	192.168.23.12	Ethernet0/0

There are two ways to fix MTU MISMATCH issue in OSPF
FIX1: (#temp fix)
MUMBAIR2(config)#

int e0/0
ip ospf mtu-ignore

FIX2: (#permanent fix)
MUMBAIR2(config)#
int e0/0
ip mtu 1500
shut
no shutdown

CONFIGURATION TASK #10: VERIFY OSPF MUTLICAST ADDRESS 224.0.0.6 and 224.0.0.5

MUMBAIR2(config)#
int loopback1
shutdown

>>Take Wireshark capture on MUMBAIR2 Router interface
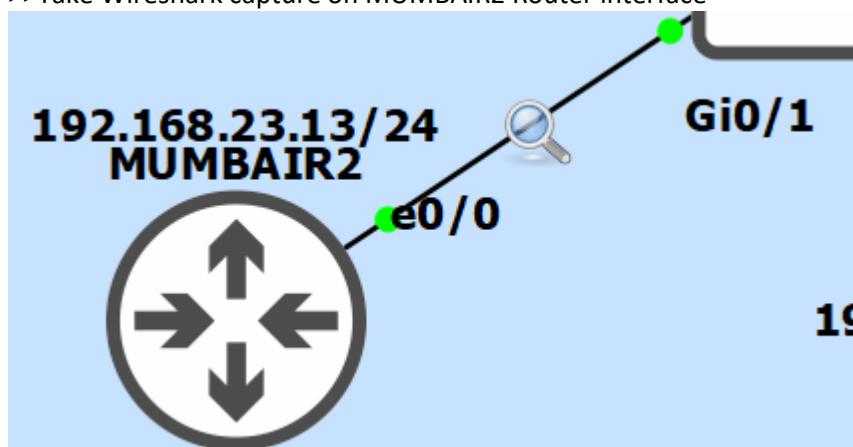
Remember!!!
DROTHERS --> DR,BDR = 224.0.0.6 and
(only)DR -> BDR and DR -> DROTHER = 224.0.0.5

VERIFICATIONS TASK#10

MUMBAIR7# show ip interface ethernet0/0 ←DR
<!-output omitted-!>
  Multicast reserved groups joined: 224.0.0.251 224.0.0.5 224.0.0.6
<!-output omitted-!>

MUMBAIR4# show ip interface ethernet0/0 ←BDR
<!-output omitted-!>
  Multicast reserved groups joined: 224.0.0.251 224.0.0.5 224.0.0.6
<!-output omitted-!>

MUMBAIR3# show ip interface ethernet0/0 ←DROTHER

<!-output omitted-!>
  Multicast reserved groups joined: 224.0.0.251 224.0.0.5
<!-output omitted-!>

LAB #15 CONFIGURE – OSPFv2 ADVANCE TOPICS
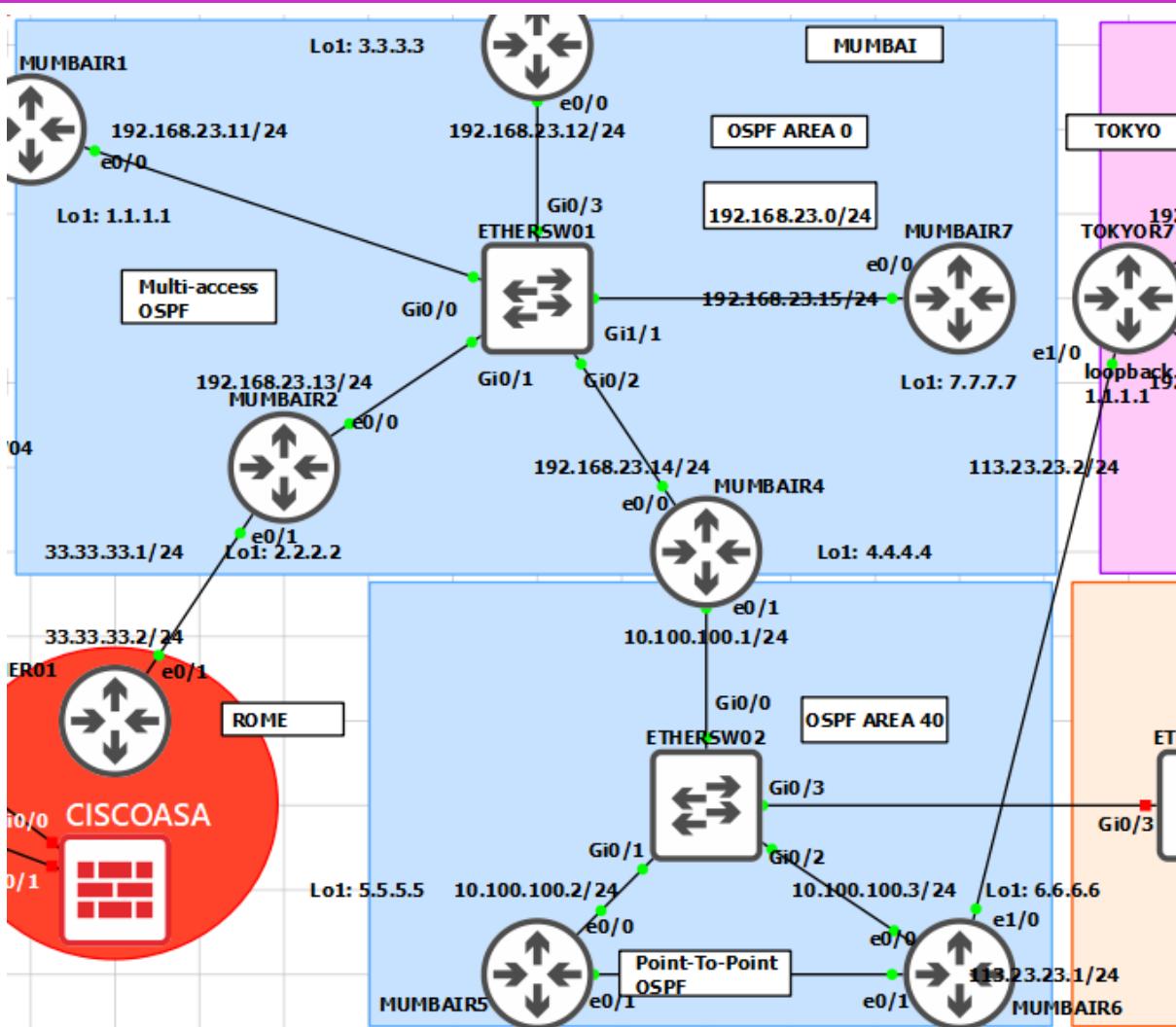
CONFIGURATION TASK #1: INITIAL CONFIGS

INITIAL CONFIG
MUMBAIR4(config)

interface e0/1
ip address 10.100.100.1 255.255.255.0
no shutdown

MUMBAIR5(config)
hostname MUMBAIR5
interface e0/0
ip address 10.100.100.2 255.255.255.0
no shutdown
interface e0/1
ip address 172.16.23.1 255.255.255.252
no shutdown
interface loopback1
ip address 5.5.5.5 255.255.255.0
no shutdown

MUMBAIR6(config)
hostname MUMBAIR6
interface e0/0
ip address 10.100.100.3 255.255.255.0
no shutdown
interface e0/1
ip address 172.16.23.2 255.255.255.252
no shutdown
interface loopback1
ip add 6.6.6.6 255.255.255.0
no shut
interface e1/0
ip add 113.23.23.1 255.255.255.0
no shut

MUMBAIR2(config)
interface e0/1
ip address 33.33.33.1 255.255.255.0
no shutdown

TOKYOR7
interface e1/0
ip address 113.23.23.2 255.255.255.0
no shut
interface loopback 10
ip add 114.114.114.1 255.255.255.0
no shut

ROMER01
hostname ROMER01
interface e0/1
no shut
ip add 33.33.33.2 255.255.255.0

TRAINER: SAGAR | www.NetworkJourney.com | www.youtube.com/c/NetworkJourney | CCNP Enterprise

CONFIGURATION TASK #2: CONFIGURE OSPF (Multi-area) VIA "INTERFACE" METHOD

MUMBAIR4(config)# #interface way
interface e0/1
ip ospf 1 area 40

MUMBAIR5(config)# #interface way
interface e0/0
ip ospf 1 area 40
interface e0/1
ip ospf 1 area 40
interface loopback 1
ip ospf 1 area 40

MUMBAIR6(config)# #interface way
interface e0/0
ip ospf 1 area 40
interface e0/1
ip ospf 1 area 40
interface loopback 1
ip ospf 1 area 40

VERIFICATION TASK #2:

TOKYOR7
router eigrp 100
network 113.0.0.0
network 114.0.0.0