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N. B. MEHTA (V) SCIENCE COLLEGE

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DEPARTMENT OF INFORMATION TECHNOLOGY AND COMPUTER SCIENCE

Certificate

Class _____________ Year ____________

This is to certify that the work entered in this journal is the work of Shri/Kumari

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Of __________________Division____________________Roll No. _______________________

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Date : / / 2024

N.B. MEHTA (VALWADA) SCIENCE COLLEGE BORDI
DEPARTMENT OF COMPUTER SCIENCE

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Practical 1 : Configuring Trunks between switches and VTP Pruning .

Introduction

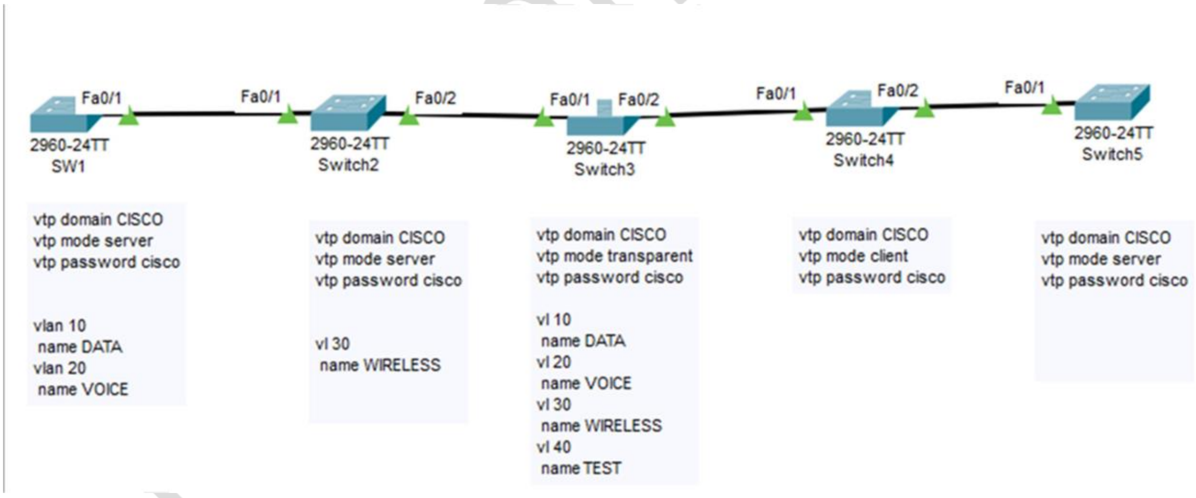
VTP Pruning is the key element of VTP (VLAN Turning Protocol). It help improves network performance and network bandwidth by decreasing unnecessary flooded traffic i.e. broadcast, multicast, unknown and flooded unicast packets. In normal operation, a switch needs to flood broadcast frames, multicast frames, or unicast frames where the destination MAC address is unknown to all its ports. If the neighboring switch doesn't have any active ports in the source VLAN, this broadcast is needless and excessive undesirable traffic may create problems on the network.

This is disabled by default in Cisco switches. VTP pruning Cisco helps to send broadcasts only to those trunk links that actually needs the information i.e. with VTP pruning enabled, when the destination MAC address is unknown, frames are forwarded over a trunk link only if the switch on the receiving end of the trunk link has ports in the source VLAN pruning. It should only be enabled on VTP servers, all the clients in the VTP domain will automatically enable VTP pruning. VLAN 1 can't be pruned because it's an administrative VLAN.

It can be pruned manually using **no vlan** command or automatically by enabling pruning using

vtp pruning command.

Step 1: Topology



Step 2:Basic and VLAN Configurations

Switch 1

Switch>en
Switch#conf t

Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname SW1
SW1(config)#int f0/1
SW1(config-if)#switchport mode trunk
SW1(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up

SW1(config-if)#exit
SW1(config)#vtp domain CISCO
Changing VTP domain name from NULL to CISCO
SW1(config)#vtp mode server
Device mode already VTP SERVER.
SW1(config)#vtp password cisco
Setting device VLAN database password to cisco
SW1(config)#

SW1 con0 is now available

Press RETURN to get started.

SW1>en
SW1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
SW1(config)#vlan 10
SW1(config-vlan)#name DATA
SW1(config-vlan)#exit
SW1(config)#vlan 20
SW1(config-vlan)#name VOICE
SW1(config-vlan)#exit
SW1(config)#exit
SW1#
%SYS-5-CONFIG_I: Configured from console by console

SW1#show vlan brief

VLAN Name Status Ports
----- -------------------------------- --------- -------------------------------
1 default active Fa0/2, Fa0/3, Fa0/4, Fa0/5
Fa0/6, Fa0/7, Fa0/8, Fa0/9
Fa0/10, Fa0/11, Fa0/12, Fa0/13
Fa0/14, Fa0/15, Fa0/16, Fa0/17
Fa0/18, Fa0/19, Fa0/20, Fa0/21
Fa0/22, Fa0/23, Fa0/24, Gig0/1

Gig0/2
10 DATA active
20 VOICE active
1002 fddi-default active
1003 token-ring-default active
1004 fddinet-default active
1005 trnet-default active
SW1#show vtp status
VTP Version : 2
Configuration Revision : 4
Maximum VLANs supported locally : 255
Number of existing VLANs : 7
VTP Operating Mode : Server
VTP Domain Name : CISCO
VTP Pruning Mode : Disabled
VTP V2 Mode : Disabled
VTP Traps Generation : Disabled
MD5 digest : 0x01 0x91 0x4A 0x4B 0xAC 0x86 0xB5 0x30
Configuration last modified by 0.0.0.0 at 3-1-93 00:16:12
Local updater ID is 0.0.0.0 (no valid interface found)
SW1#show interface trunk
Port Mode Encapsulation Status Native vlan
Fa0/1 on 802.1q trunking 1

Port Vlans allowed on trunk
Fa0/1 1-1005

Port Vlans allowed and active in management domain
Fa0/1 1,10,20

Port Vlans in spanning tree forwarding state and not pruned
Fa0/1 1,10,20

SW1#

SW1 con0 is now available
Press RETURN to get started.

SW1>en
SW1#show vtp status
VTP Version : 2
Configuration Revision : 6
Maximum VLANs supported locally : 255
Number of existing VLANs : 8
VTP Operating Mode : Server
VTP Domain Name : CISCO

VTP Pruning Mode : Disabled
VTP V2 Mode : Disabled
VTP Traps Generation : Disabled
MD5 digest : 0xE0 0x4A 0x58 0x3E 0x6F 0xDB 0x77 0x3F
Configuration last modified by 0.0.0.0 at 3-1-93 00:23:25
Local updater ID is 0.0.0.0 (no valid interface found)
SW1#show vlan brief

VLAN Name Status Ports
----- -------------------------------- --------- -------------------------------
1 default active Fa0/2, Fa0/3, Fa0/4, Fa0/5
Fa0/6, Fa0/7, Fa0/8, Fa0/9
Fa0/10, Fa0/11, Fa0/12, Fa0/13
Fa0/14, Fa0/15, Fa0/16, Fa0/17
Fa0/18, Fa0/19, Fa0/20, Fa0/21
Fa0/22, Fa0/23, Fa0/24, Gig0/1
Gig0/2
10 DATA active
20 VOICE active
30 WIRELESS active
1002 fddi-default active
1003 token-ring-default active
1004 fddinet-default active
1005 trnet-default active
SW1#

Switch 2

Switch>en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int f0/
Switch(config)#int f0/1
Switch(config-if)#switchport mode trunk
Switch(config-if)#exit
Switch(config)#int f0/2
Switch(config-if)#switchport mode trunk

Switch(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up

Switch(config-if)#exit
Switch(config)#vtp domain CISCO

Domain name already set to CISCO.
Switch(config)#vtp mode server
Device mode already VTP SERVER.
Switch(config)#vtp password cisco
Setting device VLAN database password to cisco
Switch(config)#

Switch con0 is now available
Press RETURN to get started.

Switch>en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#vlan 30
Switch(config-vlan)#name WIRELESS
Switch(config-vlan)#exit
Switch(config)#exit
Switch#
%SYS-5-CONFIG_I: Configured from console by console

Switch#show vlan brief

VLAN Name Status Ports
---- -------------------------------- --------- -------------------------------
1 default active Fa0/3, Fa0/4, Fa0/5, Fa0/6
Fa0/7, Fa0/8, Fa0/9, Fa0/10
Fa0/11, Fa0/12, Fa0/13, Fa0/14
Fa0/15, Fa0/16, Fa0/17, Fa0/18
Fa0/19, Fa0/20, Fa0/21, Fa0/22
Fa0/23, Fa0/24, Gig0/1, Gig0/2
10 DATA active
20 VOICE active
30 WIRELESS active
1002 fddi-default active
1003 token-ring-default active
1004 fddinet-default active
1005 trnet-default active
Switch#show vtp status
VTP Version : 2
Configuration Revision : 6
Maximum VLANs supported locally : 255
Number of existing VLANs : 8
VTP Operating Mode : Server
VTP Domain Name : CISCO
VTP Pruning Mode : Disabled
VTP V2 Mode : Disabled

VTP Traps Generation : Disabled
MD5 digest : 0xE0 0x4A 0x58 0x3E 0x6F 0xDB 0x77 0x3F
Configuration last modified by 0.0.0.0 at 3-1-93 00:23:25
Local updater ID is 0.0.0.0 (no valid interface found)
Switch#show interface trunk
Port Mode Encapsulation Status Native vlan
Fa0/1 on 802.1q trunking 1
Fa0/2 on 802.1q trunking 1

Port Vlans allowed on trunk
Fa0/1 1-1005
Fa0/2 1-1005

Port Vlans allowed and active in management domain
Fa0/1 1,10,20,30
Fa0/2 1,10,20,30

Port Vlans in spanning tree forwarding state and not pruned
Fa0/1 1,10,20,30
Fa0/2 1,10,20,30

Switch 3

Switch>en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int f0/1
Switch(config-if)#switchport mode trunk
Switch(config-if)#exit
Switch(config)#int f0/2
Switch(config-if)#switchport mode trunk

Switch(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up

Switch(config-if)#exit
Switch(config)#vtp domain CISCO
Domain name already set to CISCO.
Switch(config)#vtp mode transparent
Setting device to VTP TRANSPARENT mode.
Switch(config)#vtp password cisco
Setting device VLAN database password to cisco
Switch(config)#

Switch con0 is now available

Press RETURN to get started.

Switch>en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#vlan 10
Switch(config-vlan)#name DATA
Switch(config-vlan)#exit
Switch(config)#vlan 20
Switch(config-vlan)#name VOICE
Switch(config-vlan)#exit
Switch(config)#vlan 30
Switch(config-vlan)#name WIRELESS
Switch(config-vlan)#exit
Switch(config)#vlan 40
Switch(config-vlan)#name TEST
Switch(config-vlan)#exit
Switch(config)#exit
Switch#
%SYS-5-CONFIG_I: Configured from console by console

Switch#show vlan brief

VLAN Name Status Ports
----- -------------------------------- --------- -------------------------------
1 default active Fa0/3, Fa0/4, Fa0/5, Fa0/6
Fa0/7, Fa0/8, Fa0/9, Fa0/10
Fa0/11, Fa0/12, Fa0/13, Fa0/14
Fa0/15, Fa0/16, Fa0/17, Fa0/18
Fa0/19, Fa0/20, Fa0/21, Fa0/22
Fa0/23, Fa0/24, Gig0/1, Gig0/2
10 DATA active
20 VOICE active
30 WIRELESS active
40 TEST active
1002 fddi-default active
1003 token-ring-default active
1004 fddinet-default active
1005 trnet-default active
Switch#
Switch#show vtp status
VTP Version : 2
Configuration Revision : 0
Maximum VLANs supported locally : 255
Number of existing VLANs : 9
VTP Operating Mode : Transparent

VTP Domain Name : CISCO
VTP Pruning Mode : Disabled
VTP V2 Mode : Disabled
VTP Traps Generation : Disabled
MD5 digest : 0x68 0xDE 0x27 0x00 0xEB 0x43 0x67 0x3F
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00
Switch#
Switch#show interface trunk
Port Mode Encapsulation Status Native vlan
Fa0/1 on 802.1q trunking 1
Fa0/2 on 802.1q trunking 1

Port Vlans allowed on trunk
Fa0/1 1-1005
Fa0/2 1-1005

Port Vlans allowed and active in management domain
Fa0/1 1,10,20,30,40
Fa0/2 1,10,20,30,40

Port Vlans in spanning tree forwarding state and not pruned
Fa0/1 1,10,20,30,40
Fa0/2 1,10,20,30,40

Switch#
Switch con0 is now available
Press RETURN to get started.

Switch 4

Switch>en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int f0/1
Switch(config-if)#switchport mode trunk
Switch(config-if)#exit
Switch(config)#int f0/2
Switch(config-if)#switchport mode trunk

Switch(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up

Switch(config-if)#exit
Switch(config)#vtp domain CISCO
Domain name already set to CISCO.
Switch(config)#vtp mode client

Setting device to VTP CLIENT mode.
Switch(config)#vtp password cisco
Setting device VLAN database password to cisco
Switch(config)#exit
Switch#
%SYS-5-CONFIG_I: Configured from console by console

Switch#en
Switch#show vlan brief

VLAN Name Status Ports
----- -------------------------------- --------- -------------------------------
1 default active Fa0/3, Fa0/4, Fa0/5, Fa0/6
Fa0/7, Fa0/8, Fa0/9, Fa0/10
Fa0/11, Fa0/12, Fa0/13, Fa0/14
Fa0/15, Fa0/16, Fa0/17, Fa0/18
Fa0/19, Fa0/20, Fa0/21, Fa0/22
Fa0/23, Fa0/24, Gig0/1, Gig0/2
10 DATA active
20 VOICE active
30 WIRELESS active
1002 fddi-default active
1003 token-ring-default active
1004 fddinet-default active
1005 trnet-default active
Switch#show vtp status
VTP Version : 2
Configuration Revision : 6
Maximum VLANs supported locally : 255
Number of existing VLANs : 8
VTP Operating Mode : Client
VTP Domain Name : CISCO
VTP Pruning Mode : Disabled
VTP V2 Mode : Disabled
VTP Traps Generation : Disabled
MD5 digest : 0xE0 0x4A 0x58 0x3E 0x6F 0xDB 0x77 0x3F
Configuration last modified by 0.0.0.0 at 3-1-93 00:23:25
Switch#show interface trunk
Port Mode Encapsulation Status Native vlan
Fa0/1 on 802.1q trunking 1
Fa0/2 on 802.1q trunking 1

Port Vlans allowed on trunk
Fa0/1 1-1005
Fa0/2 1-1005

Port Vlans allowed and active in management domain
Fa0/1 1,10,20,30
Fa0/2 1,10,20,30

Port Vlans in spanning tree forwarding state and not pruned
Fa0/1 1,10,20,30
Fa0/2 1,10,20,30

Switch#
Switch con0 is now available
Press RETURN to get started.

Switch 5

Switch>en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname Switch5
Switch5(config)#int f0/1
Switch5(config-if)#switchport mode trunk
Switch5(config-if)#exit
Switch5(config)#vtp domain CISCO
Changing VTP domain name from NULL to CISCO
Switch5(config)#vtp mode server
Device mode already VTP SERVER.
Switch5(config)#vtp password cisco
Setting device VLAN database password to cisco
Switch5(config)#

Switch5 con0 is now available
Press RETURN to get started.

Switch5>en
Switch5#
Switch5 con0 is now available
Press RETURN to get started.

Switch5>en
Switch5#show vlan brief

VLAN Name Status Ports
----- -------------------------------- --------- -------------------------------
1 default active Fa0/2, Fa0/3, Fa0/4, Fa0/5
Fa0/6, Fa0/7, Fa0/8, Fa0/9
Fa0/10, Fa0/11, Fa0/12, Fa0/13

Fa0/14, Fa0/15, Fa0/16, Fa0/17
Fa0/18, Fa0/19, Fa0/20, Fa0/21
Fa0/22, Fa0/23, Fa0/24, Gig0/1
Gig0/2
10 DATA active
20 VOICE active
30 WIRELESS active
1002 fddi-default active
1003 token-ring-default active
1004 fddinet-default active
1005 trnet-default active
Switch5#show vtp status
VTP Version : 2
Configuration Revision : 6
Maximum VLANs supported locally : 255
Number of existing VLANs : 8
VTP Operating Mode : Server
VTP Domain Name : CISCO
VTP Pruning Mode : Disabled
VTP V2 Mode : Disabled
VTP Traps Generation : Disabled
MD5 digest : 0xE0 0x4A 0x58 0x3E 0x6F 0xDB 0x77 0x3F
Configuration last modified by 0.0.0.0 at 3-1-93 00:23:25
Local updater ID is 0.0.0.0 (no valid interface found)
Switch5#show interface trunk
Port Mode Encapsulation Status Native vlan
Fa0/1 on 802.1q trunking 1

Port Vlans allowed on trunk
Fa0/1 1-1005

Port Vlans allowed and active in management domain
Fa0/1 1,10,20,30

Port Vlans in spanning tree forwarding state and not pruned
Fa0/1 1,10,20,30

Switch5#

Switch5 con0 is now available
Press RETURN to get started.

Step 3: VTP Pruning On Switch 3

VLAN 10 VLAN 20 manual pruning

```
Switch#en
Switch#show interface trunk
Port Mode Encapsulation Status Native vlan
Fa0/1 on 802.1q trunking 1
Fa0/2 on 802.1q trunking 1

Port Vlans allowed on trunk
Fa0/1 1-1005
Fa0/2 1-1005

Port Vlans allowed and active in management domain
Fa0/1 1,10,20,30,40
Fa0/2 1,10,20,30,40

Port Vlans in spanning tree forwarding state and not pruned
Fa0/1 1,10,20,30,40
Fa0/2 1,10,20,30,40

Switch#show vlan brief

VLAN Name Status Ports
---- -------------------------------- --------- -------------------------------
1 default active Fa0/3, Fa0/4, Fa0/5, Fa0/6
Fa0/7, Fa0/8, Fa0/9, Fa0/10
Fa0/11, Fa0/12, Fa0/13, Fa0/14
Fa0/15, Fa0/16, Fa0/17, Fa0/18
Fa0/19, Fa0/20, Fa0/21, Fa0/22
Fa0/23, Fa0/24, Gig0/1, Gig0/2
10 DATA active
20 VOICE active
30 WIRELESS active
40 TEST active
1002 fddi-default active
1003 token-ring-default active
1004 fddinet-default active
1005 trnet-default active
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#exit
Switch#
%SYS-5-CONFIG_I: Configured from console by console

Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int range f0/1 -2
```

Switch(config-if-range)#vlan 10
Switch(config-vlan)#no vlan 10
Switch(config)#exit
Switch#show interface trunk
Port Mode Encapsulation Status Native vlan
Fa0/1 on 802.1q trunking 1
Fa0/2 on 802.1q trunking 1

Port Vlans allowed on trunk
Fa0/1 1-1005
Fa0/2 1-1005

Port Vlans allowed and active in management domain
Fa0/1 1,20,30,40
Fa0/2 1,20,30,40

Port Vlans in spanning tree forwarding state and not pruned
Fa0/1 1,20,30,40
Fa0/2 1,20,30,40

Switch#en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int range f0/1 -2
Switch(config-if-range)#vlan 20
Switch(config-vlan)#no vlan 20
Switch(config)#exit
Switch#show interface trunk
Port Mode Encapsulation Status Native vlan
Fa0/1 on 802.1q trunking 1
Fa0/2 on 802.1q trunking 1

Port Vlans allowed on trunk
Fa0/1 1-1005
Fa0/2 1-1005

Port Vlans allowed and active in management domain
Fa0/1 1,30,40
Fa0/2 1,30,40

Port Vlans in spanning tree forwarding state and not pruned
Fa0/1 1,30,40
Fa0/2 1,30,40

Practical 2: Configuring EtherChannels Suggested Topology

Introduction

EtherChannel is a port link aggregation technology in which multiple physical port links are grouped into one logical link. It is used to provide high-speed links and redundancy. A maximum of 8 links can be aggregated to form a single logical link.

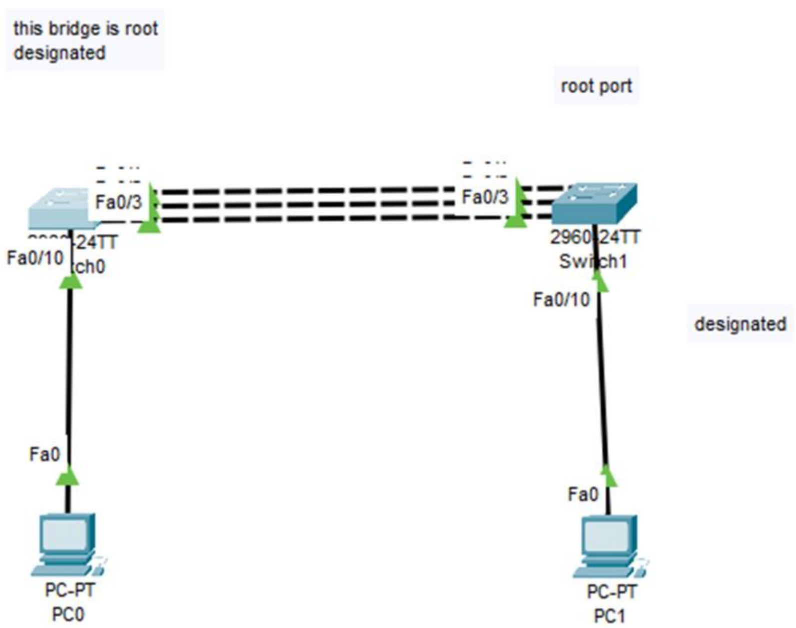
EtherChannel protocols – To form an EtherChannel, there are 2 protocols, port aggregation Protocol (PAgP) and link aggregation control protocol (LACP).

1. LACP - Link Aggregation Control Protocol

Link Aggregation Control Protocol is an IEEE protocol, originally defined in 802.3ad, used to form an EtherChannel. This protocol is almost similar to Cisco PAgP. There are different modes in which you can configure your interface. These are namely:

1. **ON**: In this mode, the interface will be a part of EtherChannel but no negotiation takes place
2. **Active**: In this mode, the interface will continuously attempt to convert the other side interface into an EtherChannel.
3. **Passive**: In this mode, the interface will become a part of EtherChannel if and only if it is requested by the opposite interface.
4. **Off:** No EtherChannel configured on the interface.

Step 1 : Topology



Step2: Configurations On Switch 1 and Switch 0

Switch1

Switch>en
Switch#show spanning-tree
VLAN0001
Spanning tree enabled protocol ieee
Root ID Priority 32769
Address 0001.6421.6B73
Cost 19
Port 1(FastEthernet0/1)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32769 (priority 32768 sys-id-ext 1)
Address 00E0.F704.EB9A
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20

Interface Role Sts Cost Prio.Nbr Type
---------------- ----- ---- ---------- --------- ------------------------------------
Fa0/3 Altn BLK 19 128.3 P2p
Fa0/1 Root FWD 19 128.1 P2p
Fa0/2 Altn BLK 19 128.2 P2p
Fa0/10 Desg FWD 19 128.10 P2p

Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int range f0/1-3
Switch(config-if-range)#channel-group 2 mode active
Switch(config-if-range)#
Creating a port-channel interface Port-channel 2
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up

Switch(config-if-range)#
%LINK-5-CHANGED: Interface Port-channel2, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel2, changed state to up

Switch(config-if-range)#^Z
Switch#
%SYS-5-CONFIG_I: Configured from console by console

Switch#show spanning-tree

VLAN0001
Spanning tree enabled protocol ieee
Root ID Priority 32769
Address 0001.6421.6B73
Cost 8
Port 27(Port-channel2)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32769 (priority 32768 sys-id-ext 1)
Address 00E0.F704.EB9A
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20

Interface Role Sts Cost Prio.Nbr Type
------------------ ----- ---- ---------- --------- --------------------------------------
Po2 Root LRN 8 128.27 Shr
Fa0/10 Desg FWD 19 128.10 P2p

Switch#show etherchannel summary
Flags: D - down P - 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
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

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

Group Port-channel Protocol Ports
-------+--------------+------------+--

2 Po2(SU) LACP Fa0/1(P) Fa0/2(P) Fa0/3(P)
Switch#

Switch 0

Switch>en
Switch#show spanning-tree
VLAN0001
Spanning tree enabled protocol ieee
Root ID Priority 32769
Address 0001.6421.6B73
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 0001.6421.6B73
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20

Interface Role Sts Cost Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Fa0/2 Desg FWD 19 128.2 P2p
Fa0/10 Desg FWD 19 128.10 P2p
Fa0/1 Desg FWD 19 128.1 P2p
Fa0/3 Desg FWD 19 128.3 P2p

Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int range f0/1-3
Switch(config-if-range)#channel-protocol lacp
Switch(config-if-range)#channel-group 6 mode passive
Switch(config-if-range)#
Creating a port-channel interface Port-channel 6
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up

Switch(config-if-range)#
%LINK-5-CHANGED: Interface Port-channel6, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel6, changed state to up
Switch(config-if-range)#^Z
Switch#
%SYS-5-CONFIG_I: Configured from console by console

Switch#show spanning-tree
VLAN0001
Spanning tree enabled protocol ieee
Root ID Priority 32769
Address 0001.6421.6B73
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 0001.6421.6B73
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20

Interface Role Sts Cost Prio.Nbr Type
----------------- ----- --- ----------- --------- --------------------------------------
Po6 Desg FWD 8 128.27 Shr
Fa0/10 Desg FWD 19 128.10 P2p

Switch#show etherchannel summary
Flags: D - down P - 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
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

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

Group Port-channel Protocol Ports
-------+---------------+-------------+--

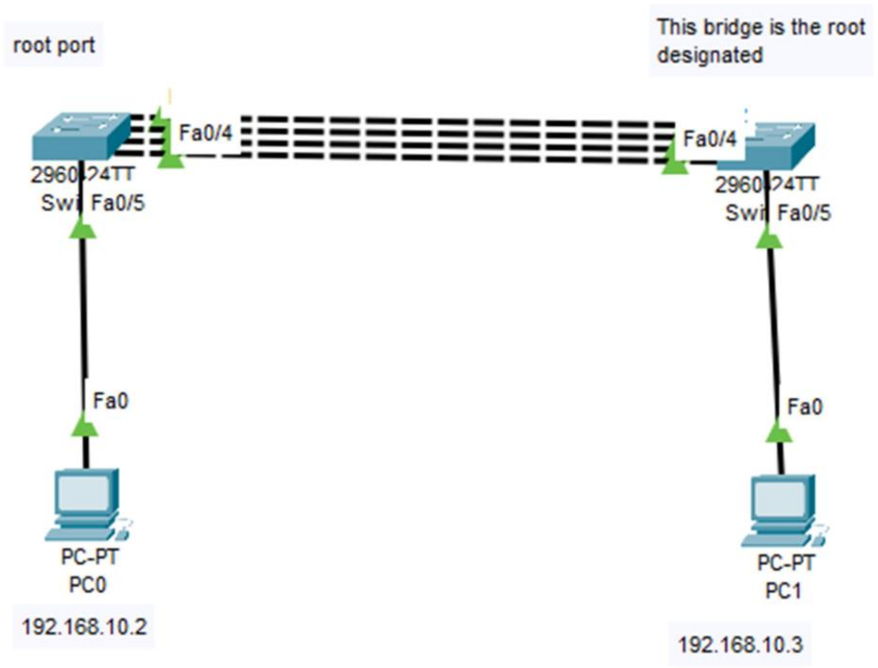
6 Po6(SU) LACP Fa0/1(P) Fa0/2(P) Fa0/3(P)
Switch#

2. PAgP - Port Aggregation Protocol

The Cisco proprietary protocol Port Aggregation Protocol (PAgP) is an EtherChannel technology. It's a type of data/traffic load balancing that involves the logical aggregation of Cisco Ethernet switch ports. A PAgP EtherChannel can merge up to eight physical links into one virtual link. LACP, or Link Aggregation Control Protocol, is an IEEE open standard. These are namely:

1. **ON:** In this mode, the interface will be a part of EtherChannel but no negotiation takes place.
2. **Desirable**: In this mode, the interface will continuously attempt to convert the other side interface into an EtherChannel.
3. **Auto:** In this mode, the interface will become a part of EtherChannel if and only if it is requested by the opposite interface.
4. **Off:** No EtherChannel configured on the interface.

Step1:Topology



Step2: Configurations On Switch 0 and Switch 1

Switch 0

Switch>en
Switch#show spanning-tree
VLAN0001
Spanning tree enabled protocol ieee
Root ID Priority 32769
Address 0002.1714.B9D8
Cost 19
Port 1(FastEthernet0/1)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32769 (priority 32768 sys-id-ext 1)
Address 00E0.F728.C001
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20

Interface Role Sts Cost Prio.Nbr Type
------------------ ----- ---- ---------- --------- -------------------------------------
Fa0/4 Altn BLK 19 128.4 P2p
Fa0/2 Altn BLK 19 128.2 P2p
Fa0/1 Root FWD 19 128.1 P2p
Fa0/3 Altn BLK 19 128.3 P2p
Fa0/5 Desg LRN 19 128.5 P2p

```
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int range f0/1-4
Switch(config-if-range)#channel-protocol pagp
Switch(config-if-range)#channel-group 1 mode desirable
Switch(config-if-range)#
Creating a port-channel interface Port-channel 1
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to up

Switch(config-if-range)#
%LINK-5-CHANGED: Interface Port-channel1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel1, changed state to up

Switch(config-if-range)#^Z
Switch#
%SYS-5-CONFIG_I: Configured from console by console

Switch#show etherchannel summary
Flags: D - down P - 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
u - unsuitable for bundling
w - waiting to be aggregated
d - default port


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

Group Port-channel Protocol Ports
-------+---------------+------------+--------------------------------------------------

1 Po1(SU) PAgP Fa0/1(P) Fa0/2(P) Fa0/3(P) Fa0/4(P)
Switch#
```

Switch1

Switch>en
Switch#show spanning-tree
VLAN0001
Spanning tree enabled protocol ieee
Root ID Priority 32769
Address 0002.1714.B9D8
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 0002.1714.B9D8
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20

Interface Role Sts Cost Prio.Nbr Type
------------------ ----- ---- ---------- --------- -------------------------------------
Fa0/2 Desg FWD 19 128.2 P2p
Fa0/5 Desg FWD 19 128.5 P2p
Fa0/1 Desg FWD 19 128.1 P2p
Fa0/3 Desg FWD 19 128.3 P2p
Fa0/4 Desg FWD 19 128.4 P2p

Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int range f0/1-4
Switch(config-if-range)#channel-protocol pagp
Switch(config-if-range)#channel-group 1 mode desirable
Switch(config-if-range)#
Creating a port-channel interface Port-channel 1

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to up
%LINK-5-CHANGED: Interface Port-channel1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel1, changed state to up

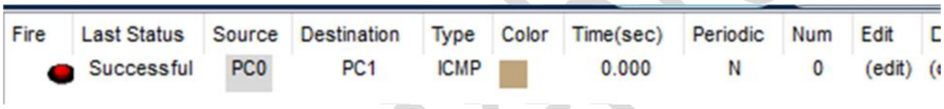
Switch(config-if-range)#^Z
Switch#
%SYS-5-CONFIG_I: Configured from console by console

Switch#show etherchannel summary
Flags: D - down P - 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
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

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

Group Port-channel Protocol Ports
-------+---------------+-------------+---

1 Po1(SU) PAgP Fa0/1(P) Fa0/2(P) Fa0/3(P) Fa0/4(P)
Switch#



Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	D
	Successful	PC0	PC1	ICMP		0.000	N	0	(edit)	(

Practical 3:

1. Implement BGP Path Manipulation

2. Implement BGP Communities

1. Implement BGP Path Manipulation

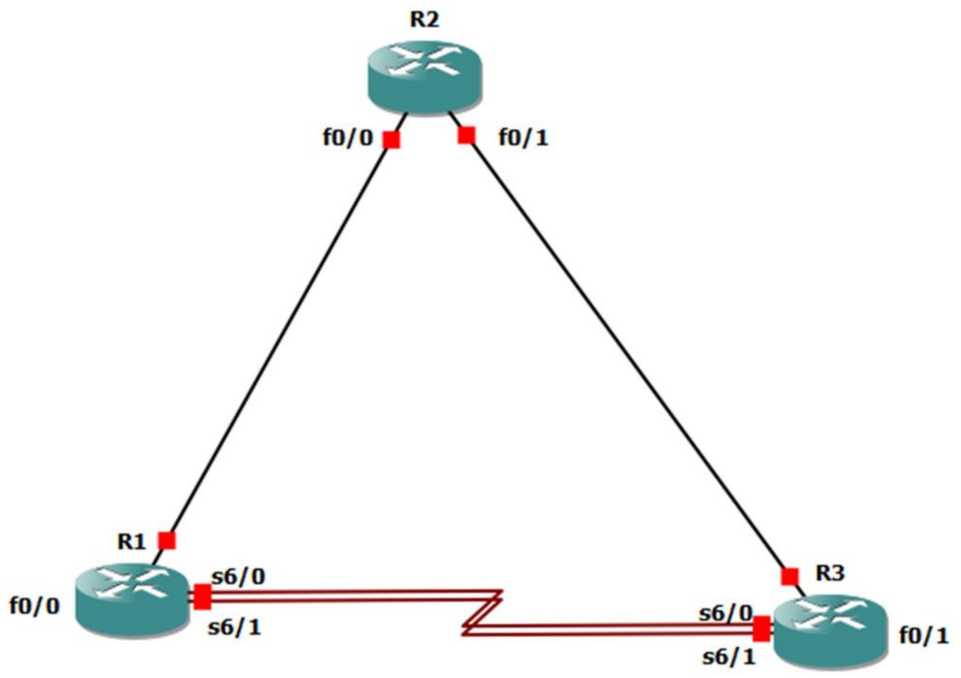
Instructions

Part 1: Build the Network and Configure Basic Device Settings and Interface Addressing

In Part 1, you will set up the network topology and configure basic settings and interface addressing on routers.

Step 1: Cable the network as shown in the topology.

Attach the devices as shown in the topology diagram, and cable as necessary.



Step 2: Configure basic settings for each router.

Console into each router, enter global configuration mode, and apply the basic settings and interface addressing. A command list for each router is listed below to perform initial configuration.

Router R1

```
no ip domain lookup
hostname R1
line con 0
 exec-timeout 0 0
 logging synchronous
banner motd # This is R1, BGP Path Manipulation Lab #
ipv6 unicast-routing

interface FastEthernet0/0
 ip address 10.1.2.1 255.255.255.0
 ipv6 address fe80::1:1 link-local
 ipv6 address 2001:db8:acad:1012::1/64
 no shutdown

interface s6/0
 ip address 10.1.3.1 255.255.255.128
 ipv6 address fe80::1:2 link-local
 ipv6 address 2001:db8:acad:1013::1/64
 no shutdown

interface s6/1
 ip address 10.1.3.129 255.255.255.128
 ipv6 address fe80::1:3 link-local
 ipv6 address 2001:db8:acad:1014::1/64
 no shutdown

interface loopback 0
 ip address 192.168.1.1 255.255.255.224
 ipv6 address fe80::1:4 link-local
 ipv6 address 2001:db8:acad:1000::1/64
 no shutdown

interface loopback 1
 ip address 192.168.1.65 255.255.255.192
 ipv6 address fe80::1:5 link-local
 ipv6 address 2001:db8:acad:1001::1/64
 no shutdown
```

Router R2

```
no ip domain lookup
hostname R2
line con 0
 exec-timeout 0 0
 logging synchronous
banner motd # This is R2, BGP Path Manipulation Lab #
ipv6 unicast-routing

interface FastEthernet0/0
 ip address 10.1.2.2 255.255.255.0
 ipv6 address fe80::2:1 link-local
 ipv6 address 2001:db8:acad:1012::2/64
 no shutdown

interface FastEthernet0/1
 ip address 10.2.3.2 255.255.255.0
 ipv6 address fe80::2:2 link-local
 ipv6 address 2001:db8:acad:1023::2/64
 no shutdown

interface loopback 0
 ip address 192.168.2.1 255.255.255.224
 ipv6 address fe80::2:3 link-local
 ipv6 address 2001:db8:acad:2000::1/64
 no shutdown

interface loopback 1
 ip address 192.168.2.65 255.255.255.192
 ipv6 address fe80::2:4 link-local
 ipv6 address 2001:db8:acad:2001::1/64
 no shutdown
```

Router R3

```
no ip domain lookup
hostname R3
line con 0
 exec-timeout 0 0
 logging synchronous
banner motd # This is R3, BGP Path Manipulation Lab #
ipv6 unicast-routing

interface FastEthernet0/1
 ip address 10.2.3.3 255.255.255.0
```

```
 ipv6 address fe80::3:1 link-local
 ipv6 address 2001:db8:acad:1023::3/64
 no shutdown
interface s6/0
 ip address 10.1.3.3 255.255.255.128
 ipv6 address fe80::3:2 link-local
 ipv6 address 2001:db8:acad:1013::3/64
 no shutdown

interface s6/1
 ip address 10.1.3.130 255.255.255.128
 ipv6 address fe80::3:3 link-local
 ipv6 address 2001:db8:acad:1014::3/64
 no shutdown

interface loopback 0
 ip address 192.168.3.1 255.255.255.224
 ipv6 address fe80::3:4 link-local
 ipv6 address 2001:db8:acad:3000::1/64
 no shutdown

interface loopback 1
 ip address 192.168.3.65 255.255.255.192
 ipv6 address fe80::3:5 link-local
 ipv6 address 2001:db8:acad:3001::1/64
 no shutdown
```

Set the clock on each router to UTC time.

Save the running configuration to startup-config.

Use the command copy running-config startup-config

Part 2: Configure and Verify Multi-Protocol BGP on all Routers

In Part 2, you will configure and verify Multi-Protocol BGP on all routers to achieve full connectivity between the routers. The text below provides you with the complete configuration for R1. You will use this to inform your configuration of R2 and R3. The configuration being used here is not meant to represent best practice, but to assess your ability to complete the required configurations.

Step 1: On R1, create the core BGP configuration.

- Enter BGP configuration mode from global configuration mode, specifying AS 6500.

  R1(config)# router bgp 6500

- Configure the BGP router-id for R1.

  R1(config-router)# bgp router-id 1.1.1.1

- Disable the default IPv4 unicast address family behavior.

R1(config-router)# no bgp default ipv4-unicast

- Based on the topology diagram, configure all the designated neighbors for R1.

R1(config-router)# neighbor 10.1.2.2 remote-as 500
R1(config-router)# neighbor 10.1.3.3 remote-as 300
R1(config-router)# neighbor 10.1.3.130 remote-as 300
R1(config-router)# neighbor 2001:db8:acad:1012::2 remote-as 500
R1(config-router)# neighbor 2001:db8:acad:1013::3 remote-as 300
R1(config-router)# neighbor 2001:db8:acad:1014::3 remote-as 300

Step 2: On R1, configure the IPv4 unicast address family.

Enter the IPv4 unicast address family configuration mode.

R1(config-router)# address-family ipv4 unicast

- Configure network statements for the IPv4 networks attached to interfaces loopback0 and loopback1. Remember that BGP does not work the same way that an IGP does, and that the network statement has no impact on neighbor adjacency; it is used solely for advertising purposes.

R1(config-router-af)# network 192.168.1.0 mask 255.255.255.224
R1(config-router-af)# network 192.168.1.64 mask 255.255.255.192

- Deactivate the IPv6 neighbors and activate the IPv4 neighbors.

R1(config-router-af)# no neighbor 2001:db8:acad:1012::2 activate
R1(config-router-af)# no neighbor 2001:db8:acad:1013::3 activate
R1(config-router-af)# no neighbor 2001:db8:acad:1014::3 activate
R1(config-router-af)# neighbor 10.1.2.2 activate
R1(config-router-af)# neighbor 10.1.3.3 activate
R1(config-router-af)# neighbor 10.1.3.130 activate

Step 3: On R1, configure the IPv6 unicast address family.

- Enter the IPv6 unicast address family configuration mode.

R1(config-router)# address-family ipv6 unicast

- Configure network statements for the IPv6 networks that are attached to interfaces loopback0 and loopback1. Remember that BGP does not work the same way that an IGP does; therefore, the network statement has no impact on neighbor adjacency; it is used solely for advertising purposes.

R1(config-router-af)# network 2001:db8:acad:1000::/64
R1(config-router-af)# network 2001:db8:acad:1001::/64

- Activate the IPv6 neighbors that are configured for BGP.

```
R1(config-router-af)# neighbor 2001:db8:acad:1012::2 activate
R1(config-router-af)# neighbor 2001:db8:acad:1013::3 activate
R1(config-router-af)# neighbor 2001:db8:acad:1014::3 activate
```

Step 4: Configure MP-BGP on R2 and R3 as you did in the previous step.

Step 5: Verify that MP-BGP is operational.

Use the **show bgp ipv4 unicast summary** and **show bgp ipv6 unicast summary** commands to verify that BGP has established three IPv4 and three IPv6 adjacencies and received four prefixes from each neighbor.

R1#**show bgp ipv4 unicast summary**

```
BGP router identifier 1.1.1.1, local AS number 6500
BGP table version is 7, main routing table version 7
6 network entries using 702 bytes of memory
14 path entries using 728 bytes of memory
6/3 BGP path/bestpath attribute entries using 744 bytes of memory
4 BGP AS-PATH entries using 96 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 2270 total bytes of memory
BGP activity 14/2 prefixes, 30/2 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
10.1.2.2        4   500      27      27        7    0    0 00:20:56        4
10.1.3.3        4   300      13      14        7    0    0 00:07:40        4
10.1.3.130      4   300      15      14        7    0    0 00:07:15        4
```

R1#**show bgp ipv6 unicast summary**

```
BGP router identifier 1.1.1.1, local AS number 6500
BGP table version is 7, main routing table version 7
6 network entries using 894 bytes of memory
14 path entries using 1064 bytes of memory
6/3 BGP path/bestpath attribute entries using 744 bytes of memory
4 BGP AS-PATH entries using 96 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 2798 total bytes of memory
BGP activity 14/2 prefixes, 30/2 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
```

```
2001:DB8:ACAD:1012::2
            4   500     23      23       7    0    0 00:16:56        4
2001:DB8:ACAD:1013::3
            4   300      9      10       7    0    0 00:03:39        4
2001:DB8:ACAD:1014::3
            4   300     11      10       7    0    0 00:03:25        4
```

b. Use the show bgp ipv4 unicast and show bgp ipv6 unicast commands to view the specified BGP tables. Note that R1 has multiple paths to each destination network. Take note of the next hop address for the destination networks marked with the “>” symbol.

```
R1# show bgp ipv4 unicast | begin Network
  Network          Next Hop            Metric LocPrf Weight Path
*> 192.168.1.0/27   0.0.0.0                  0         32768 i
*> 192.168.1.64/26  0.0.0.0                  0         32768 i
*  192.168.2.0/27   10.1.3.130                             0 300 500 i
*                   10.1.3.3                               0 300 500 i
*>                  10.1.2.2                 0             0 500 i
*  192.168.2.64/26  10.1.3.130                             0 300 500 i
*                   10.1.3.3                               0 300 500 i
*>                  10.1.2.2                 0             0 500 i
*  192.168.3.0/27   10.1.2.2                               0 500 300 i
*                   10.1.3.130               0             0 300 i
*>                  10.1.3.3                 0             0 300 i
*  192.168.3.64/26  10.1.2.2                               0 500 300 i
*                   10.1.3.130               0             0 300 i
*>                  10.1.3.3                 0             0 300 i
```

```
R1# show bgp ipv6 unicast | begin Network
  Network          Next Hop            Metric LocPrf Weight Path
*> 2001:DB8:ACAD:1000::/64
                    ::                       0         32768 i
*> 2001:DB8:ACAD:1001::/64
                    ::                       0         32768 i
*  2001:DB8:ACAD:2000::/64
                    2001:DB8:ACAD:1014::3
                                                           0 300 500 i
*                   2001:DB8:ACAD:1013::3
                                                           0 300 500 i
*>                  2001:DB8:ACAD:1012::2
                                             0             0 500 i
*  2001:DB8:ACAD:2001::/64
```

```
              2001:DB8:ACAD:1014::3
                                        0 300 500 i
*              2001:DB8:ACAD:1013::3
                                        0 300 500 i
*>              2001:DB8:ACAD:1012::2
                            0          0 500 i
*  2001:DB8:ACAD:3000::/64
              2001:DB8:ACAD:1012::2
                                        0 500 300 i
*              2001:DB8:ACAD:1014::3
```

c. Use the show ip route bgp and show ipv6 route bgp commands to view the routing tables. Note that there is only one route to each destination, and that the routes included in the routing table have the same next hop as those with the ">" symbol in the BGP tables.

R1#show bgp ipv6 unicast | begin Network

```
  Network         Next Hop          Metric LocPrf Weight Path
*> 2001:DB8:ACAD:1000::/64
               ::                  0       32768 i
*> 2001:DB8:ACAD:1001::/64
               ::                  0       32768 i
*  2001:DB8:ACAD:2000::/64
              2001:DB8:ACAD:1014::3
                                        0 300 500 i
*              2001:DB8:ACAD:1013::3
                                        0 300 500 i
*>              2001:DB8:ACAD:1012::2
                            0          0 500 i
*  2001:DB8:ACAD:2001::/64
              2001:DB8:ACAD:1014::3
                                        0 300 500 i
*              2001:DB8:ACAD:1013::3
                                        0 300 500 i
*>              2001:DB8:ACAD:1012::2
                            0          0 500 i
*  2001:DB8:ACAD:3000::/64
              2001:DB8:ACAD:1012::2
                                        0 500 300 i
*              2001:DB8:ACAD:1014::3
```

R1#show ipv6 route bgp

```
IPv6 Routing Table - 16 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
     U - Per-user Static route
     I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
```

```
   O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
   ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
B   2001:DB8:ACAD:2000::/64 [20/0]
     via FE80::2:1, FastEthernet0/0
B   2001:DB8:ACAD:2001::/64 [20/0]
     via FE80::2:1, FastEthernet0/0
B   2001:DB8:ACAD:3000::/64 [20/0]
     via FE80::3:2, Serial6/0
B   2001:DB8:ACAD:3001::/64 [20/0]
     via FE80::3:2, Serial6/0
```

Part 3: Configure and Verify BGP Path Manipulation Settings on all Routers

In Part 3, you will configure path manipulation tools for BGP. The way these tools are being used here is not meant to represent best practice, but to assess your ability to complete the required configurations.

Step 1: Configure ACL-based route filtering.

In this step, you will configure R3 so that it only sends ASN300 networks to R1; it will not tell R1 that it knows about the networks in ASN200.

a. On R1, issue the command show bgp ipv4 unicast | i 300 to see what prefixes ASN300 is sharing via BGP. Take note of those prefixes that do not originate in ASN300.

```
R1# show bgp ipv4 unicast | i 300
*  192.168.2.0/27   10.1.3.130                 0 300 500 i
*                   10.1.3.3                   0 300 500 i
*  192.168.2.64/26  10.1.3.130                 0 300 500 i
*                   10.1.3.3                   0 300 500 i
*  192.168.3.0/27   10.1.2.2                   0 500 300 i
*                   10.1.3.130        0        0 300 i
*>                  10.1.3.3          0        0 300 i
*  192.168.3.64/26  10.1.2.2                   0 500 300 i
*                   10.1.3.130        0        0 300 i
*>                  10.1.3.3          0        0 300 i
```

b. On R3, configure an access list designed to match the source address and mask of the networks belonging to ASN300:

```
R3(config)# ip access-list extended ALLOWED_TO_R1
R3(config-ext-nacl)# permit ip 192.168.3.0 0.0.0.0 255.255.255.224
0.0.0.0
R3(config-ext-nacl)# permit ip 192.168.3.64 0.0.0.0 255.255.255.192
0.0.0.0
R3(config-ext-nacl)# exit
```

c. On R3, apply the ALLOWED_TO_R1 ACL as a distribute list to the IPv4 neighbor adjacencies with R1.

```
R3(config)# router bgp 300
R3(config-router)# address-family ipv4 unicast
```

```
R3(config-router-af)# neighbor 10.1.3.1 distribute-list ALLOWED_TO_R1
out
R3(config-router-af)# neighbor 10.1.3.129 distribute-list ALLOWED_TO_R1
out
R3(config-router-af)# end
```

Perform a reset of the IPv4 adjacency with R1 for the outbound traffic without tearing down the session.

```
R3# clear bgp ipv4 unicast 6500 out
```

d. On R1, issue the command show bgp ipv4 unicast | i 300 to see what prefixes routes ASN300 is now sharing via BGP. All of the prefixes should now originate in ASN300:

```
R1# show bgp ipv4 unicast | i 300

* 192.168.2.0/27   10.1.3.130                  0 300 500 i
*                  10.1.3.3                    0 300 500 i
* 192.168.2.64/26  10.1.3.130                  0 300 500 i
*                  10.1.3.3                    0 300 500 i
* 192.168.3.0/27   10.1.2.2                    0 500 300 i
*                  10.1.3.130       0          0 300 i
*>                 10.1.3.3         0          0 300 i
* 192.168.3.64/26  10.1.2.2                    0 500 300 i
*                  10.1.3.130       0          0 300 i
*>                 10.1.3.3         0          0 300 i
```

Step 2: Configure prefix-list-based route filtering.

In this step, you will configure R1 so that it only accepts ASN500 networks from R2; it will not accept information about ASN300 networks from R2.

a. On R1, issue the command show bgp ipv4 unicast | begin 192.168.3 to see what prefixes ASN500 is sharing via BGP. Take note of those prefixes that do not originate in ASN500.

```
R1# show bgp ipv4 unicast | begin 192.168.3
* 192.168.3.0/27   10.1.2.2                    0 500 300 i
*                  10.1.3.130       0          0 300 i
*>                 10.1.3.3         0          0 300 i
* 192.168.3.64/26  10.1.2.2                    0 500 300 i
*                  10.1.3.130       0          0 300 i
*>                 10.1.3.3         0          0 300 i
```

b. On R1, configure a prefix list designed to match the source address and mask of networks belonging to ASN500.

```
R1(config)# ip prefix-list ALLOWED_FROM_R2 seq 5 permit 192.168.2.0/24
le 27
```

Apply the ALLOWED_FROM_R2 prefix list to the IPv4 neighbor adjacencies for R2.

```
R1(config)# router bgp 6500
R1(config-router)# address-family ipv4 unicast
```

```
R1(config-router-af)# neighbor 10.1.2.2 prefix-list ALLOWED_FROM_R2 in
R1(config-router-af)# end
```

Perform a reset of the IPv4 adjacency with R2 for the inbound traffic without tearing down the session.

```
R1# clear bgp ipv4 unicast 500 in
```

c. On R1, issue the command show bgp ipv4 unicast | i 500 to see what prefixes routes ASN500 is now sharing via BGP. All of the prefixes should now originate in ASN500.

```
R1# show bgp ipv4 unicast | i 500
* 192.168.2.0/27   10.1.3.130                    0 300 500 i
*                  10.1.3.3                      0 300 500 i
*>                 10.1.2.2          0           0 500 i
* 192.168.2.64/26  10.1.3.130                    0 300 500 i
*                  10.1.3.3                      0 300 500 i
*>                 10.1.2.2          0           0 500 i
```

Step 3: Configure an AS-PATH ACL to filter routes being advertised.

In this step, you will configure R1 so that it only sends ASN100 networks to R2; it will not forward information about prefixes from any other ASN to ASN500.

a. On R2, issue the command show bgp ipv4 unicast | begin Network to see what prefixes ASN6500 is sharing via BGP. Take note of those prefixes that do not originate in ASN6500. Advertising these routes could set ASN6500 up as a transit AS, and that is not a desirable scenario.

```
R2# show bgp ipv4 unicast | begin Network
     Network          Next Hop            Metric LocPrf Weight Path
 *    192.168.1.0/27   10.2.3.3                               0 300 6500 i
 *>                    10.1.2.1                 0             0 6500 i
 *    192.168.1.64/26  10.2.3.3                               0 300 6500 i
 *>                    10.1.2.1                 0             0 6500 i
 *>   192.168.2.0/27   0.0.0.0                  0         32768 i
 *>   192.168.2.64/26  0.0.0.0                  0         32768 i
 *    192.168.3.0/27   10.1.2.1                               0 6500 300 i
 *>                    10.2.3.3                 0             0 300 i
 *    192.168.3.64/26  10.1.2.1                               0 6500 300 i
 *>                    10.2.3.3                 0             0 300 i
```

b. On R1, configure AS-PATH ACL to match the routes from the local ASN.

```
R1(config)# ip as-path access-list 1 permit ^$
```

c. On R1, apply the AS-PATH ACL as a filter-list on the adjacency configured with R2.

```
R1(config)# router bgp 6500
R1(config-router)# address-family ipv4 unicast
R1(config-router-af)# neighbor 10.1.2.2 filter-list 1 out
R1(config-router-af)# end
```

d. On R1, perform a reset of the IPv4 adjacency with R2 for the outbound traffic without tearing down the session.

```
R1# clear bgp ipv4 unicast 500 out
```

e. On R2, issue the command show bgp ipv4 unicast | i 6500 to see what prefixes routes ASN6500 is now sharing via BGP. All of the prefixes should now originate in ASN6500.

```
R2# show bgp ipv4 unicast | i 6500
 *    192.168.1.0/27   10.2.3.3                                      0 300 6500 i
 *>                    10.1.2.1                0                     0 6500 i
 *    192.168.1.64/26  10.2.3.3                                      0 300 6500 i
 *>                    10.1.2.1                0                     0 6500 i
```

Step 4: Configure IPv6 prefix-list-based route filtering.

In this step, you will configure R1 so that it only accepts ASN500 IPv6 networks from R2. It will not accept information about ASN300 IPv6 networks from R2.

a. On R1, issue the command show bgp ipv6 unicast neighbors 2001:db8:acad:1012::2 routes to see what IPv6 prefixes ASN500 is sharing via BGP. Take note of those IPv6 prefixes that do not originate in ASN500.

```
R1# show bgp ipv6 unicast neighbors 2001:db8:acad:1012::2 routes

BGP table version is 7, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 2001:DB8:ACAD:2000::/64
                    2001:DB8:ACAD:1012::2
                                             0             0 500 i
*> 2001:DB8:ACAD:2001::/64
                    2001:DB8:ACAD:1012::2
                                             0             0 500 i
*  2001:DB8:ACAD:3000::/64
                    2001:DB8:ACAD:1012::2
                                                           0 500 300 i
 *  2001:DB8:ACAD:3001::/64
                    2001:DB8:ACAD:1012::2
                                                           0 500 300 i

Total number of prefixes 4
```

b. On R1, configure an IPv6 prefix list designed to match the source address and mask of networks belonging to ASN500.

```
R1(config)# ipv6 prefix-list IPV6_ALLOWED_FROM_R2 seq 5 permit
2001:db8:acad:2000::/64
R1(config)# ipv6 prefix-list IPV6_ALLOWED_FROM_R2 seq 10 permit
2001:db8:acad:2001::/64
```

Apply the IPV6_ALLOWED_FROM_R2 prefix list to the IPv6 neighbor adjacencies for R2.

```
R1(config)# router bgp 6500
R1(config-router)# address-family ipv6 unicast
R1(config-router-af)# neighbor 2001:db8:acad:1012::2 prefix-list
IPV6_ALLOWED_FROM_R2 in
R1(config-router-af)# end
```

Perform a reset of the IPv6 adjacency with R2 for the inbound traffic without tearing down the session.

```
R1# clear bgp ipv6 unicast 500 in
```

c. On R1, issue the command show bgp ipv6 unicast neighbors 2001:db8:acad:1012::2 routes to see what IPv6 prefixes routes ASN500 is now sharing via BGP. All of the IPv6 prefixes should now originate in ASN500.

```
R1# show bgp ipv6 unicast neighbors 2001:db8:acad:1012::2 routes
BGP table version is 9, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
          r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 2001:DB8:ACAD:2000::/64
                    2001:DB8:ACAD:1012::2
                                             0             0 500 i
*> 2001:DB8:ACAD:2001::/64
                    2001:DB8:ACAD:1012::2
                                             0             0 500 i

Total number of prefixes 2
```

Configure and apply an IPv6 filter to do the same thing on the adjacency with ASN300.

Step 5: Configure BGP path attribute manipulation to effect routing.

In this step, you will configure R1 so that it prefers the next-hop address of 192.168.3.130 over 192.168.3.3, which would normally be the preferred path to ASN300 networks. You will do this by using a prefix list to identify the destination networks and then use a route map to match the prefix list and set the matched networks to have a local preference of 250.

a. On R1, issue the command show ip route bgp and take note of the next hop addresses for the 192.168.3.0/27 and 192.168.3.64/26 networks. Then issue the command show bpg ipv4 unicast and note that the 10.1.3.130 is a valid next hop (It's just not the *best* next hop, according to the BGP path selection algorithm.) Lastly, issue the command show bgp ipv4 unicast 192.168.3.0 to see details about all the paths available and which one was selected.

```
R1# show bgp ipv4 unicast 192.168.3.0
BGP routing table entry for 192.168.3.0/27, version 8
Paths: (2 available, best #1, table default)
```

```
Advertised to update-groups:
   1
Refresh Epoch 1
300
  10.1.3.3 from 10.1.3.3 (3.3.3.3)
    Origin IGP, metric 0, localpref 100, valid, external, best
    rx pathid: 0, tx pathid: 0x0
Refresh Epoch 1
300
  10.1.3.130 from 10.1.3.130 (3.3.3.3)
    Origin IGP, metric 0, localpref 100, valid, external
    rx pathid: 0, tx pathid: 0
```

b. On R1, configure a prefix list designed to match the source address and mask of networks belonging to ASN300.

```
R1(config)# ip prefix-list PREFERRED_IPV4_PATH seq 5 permit 192.168.3.0/24 le
27
```

c. Create a route-map named USE_THIS_PATH_FOR_IPV4 that matches on the prefix list you just created and sets the local preference to 250.

```
R1(config)# route-map USE_THIS_PATH_FOR_IPV4 permit 10
R1(config)# match ip address prefix-list PERFERRED_IPV4_PATH
R1(config)# set local-preference 250
```

Next, apply this route map to the BGP neighbor 10.1.3.130.

```
R1(config)# router bgp 6500
R1(config-router)# address-family ipv4 unicast
R1(config-router-af)# neighbor 10.1.3.130 route-map USE_THIS_PATH_FOR_IPV4
in
R1(config-router-af)#  end
```

Perform a reset of the IPv4 adjacency with R3 for the inbound traffic without tearing down the session.

```
R1# clear bgp ipv4 unicast 300 in
```

d. On R1, issue the command show ip route bgp and take note of the next hop addresses for the 192.168.3.0/27 and 192.168.3.64/26 networks; it should be 10.1.3.130 for both. Issue the command show bgp ipv4 unicast and you should see the local preference value in the appropriate column.

```
R1# show ip route bgp | begin Gateway
Gateway of last resort is not set

      192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
B        192.168.2.0/27 [20/0] via 10.1.2.2, 00:35:17
B        192.168.2.64/26 [20/0] via 10.1.2.2, 00:35:17
      192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
B        192.168.3.0/27 [20/0] via 10.1.3.130, 00:00:08
B        192.168.3.64/26 [20/0] via 10.1.3.130, 00:00:08

R1# show bgp ipv4 unicast | begin Network
```

```
    Network          Next Hop            Metric LocPrf Weight Path
*>   192.168.1.0/27   0.0.0.0                  0         32768 i
*>   192.168.1.64/26  0.0.0.0                  0         32768 i
*>   192.168.2.0/27   10.1.2.2                 0             0 500 i
*>   192.168.2.64/26  10.1.2.2                 0             0 500 i
*    192.168.3.0/27   10.1.3.3                 0             0 300 i
*>                    10.1.3.130               0    250      0 300 i
*    192.168.3.64/26  10.1.3.3                 0             0 300 i
*>                    10.1.3.130               0    250      0 300 i
```

Close configuration window

2. Implement BGP Communities

Part 1: Verify that MP-BGP is operational.

a. Use the show bgp ipv4 unicast summary and show bgp ipv6 unicast summary commands to verify that BGP has established adjacencies and received prefixes.
Open configuration window

R1# show bgp ipv4 unicast summary

BGP router identifier 1.1.1.1, local AS number 6500
BGP table version is 9, main routing table version 9
6 network entries using 1488 bytes of memory
14 path entries using 1904 bytes of memory
5/3 BGP path/bestpath attribute entries using 1400 bytes of memory
4 BGP AS-PATH entries using 128 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 4920 total bytes of memory
BGP activity 12/0 prefixes, 28/0 paths, scan interval 60 secs
Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down
State/PfxRcd
10.1.2.2 4 500 7 7 9 0 0 00:01:46 4
10.1.3.3 4 300 7 7 9 0 0 00:00:45 4
10.1.3.130 4 300 7 7 9 0 0 00:00:44 4

R1# show bgp ipv6 unicast summary

BGP router identifier 1.1.1.1, local AS number 6500
BGP table version is 9, main routing table version 9
6 network entries using 1632 bytes of memory
14 path entries using 2128 bytes of memory
5/3 BGP path/bestpath attribute entries using 1400 bytes of memory 4
BGP AS-PATH entries using 128 bytes of memory

0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 5288 total bytes of memory
BGP activity 12/0 prefixes, 28/0 paths, scan interval 60 secs
Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down
State/PfxRcd
2001:DB8:ACAD:1012::2
4 500 7 7 9 0 0 00:02:08 4
2001:DB8:ACAD:1013::3
4 300 8 7 9 0 0 00:01:09 4
2001:DB8:ACAD:1014::3
4 300 8 7 9 0 0 00:01:09 4

b. Use the show bgp ipv4 unicast and show bgp ipv6 unicast commands to view the specified BGP tables. Note that R1 has multiple paths to each destination network. Take note of the next hop address for the destination networks marked with the ">" symbol.

R1# show bgp ipv4 unicast

BGP table version is 9, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
x best-external, a additional-path, c RIB-compressed,
t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found
Network Next Hop Metric LocPrf Weight Path
*> 192.168.1.0/27 0.0.0.0 0 32768 i
*> 192.168.1.64/26 0.0.0.0 0 32768 i
* 192.168.2.0/27 10.1.3.3 0 300 500 i
* 10.1.3.130 0 300 500 i
*> 10.1.2.2 0 0 500 i
* 192.168.2.64/26 10.1.3.3 0 300 500 i
* 10.1.3.130 0 300 500 i
*> 10.1.2.2 0 0 500 i
* 192.168.3.0/27 10.1.2.2 0 500 300 i
*> 10.1.3.3 0 0 300 i
* 10.1.3.130 0 0 300 i
* 192.168.3.64/26 10.1.2.2 0 500 300 i
*> 10.1.3.3 0 0 300 i
* 10.1.3.130 0 0 300 i

R1# show bgp ipv6 unicast

BGP table version is 9, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
 r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
 x best-external, a additional-path, c RIB-compressed,
 t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found
Network Next Hop Metric LocPrf Weight Path
*> 2001:DB8:ACAD:1000::/64 :: 0 32768 i
*> 2001:DB8:ACAD:1001::/64 :: 0 32768 i
* 2001:DB8:ACAD:2000::/64
 2001:DB8:ACAD:1014::3 0 300 500 i
* 2001:DB8:ACAD:1013::3 0 300 500 i
*> 2001:DB8:ACAD:1012::2 0 0 500 i
* 2001:DB8:ACAD:2001::/64
 2001:DB8:ACAD:1014::3 0 300 500 i
* 2001:DB8:ACAD:1013::3 0 300 500 i
*> 2001:DB8:ACAD:1012::2 0 0 500 i
* 2001:DB8:ACAD:3000::/64
 2001:DB8:ACAD:1012::2 0 500 300 i
* 2001:DB8:ACAD:1014::3 0 0 300 i
*> 2001:DB8:ACAD:1013::3 0 0 300 i
* 2001:DB8:ACAD:3001::/64
 2001:DB8:ACAD:1012::2 0 500 300 i
* 2001:DB8:ACAD:1014::3 0 0 300 i
*> 2001:DB8:ACAD:1013::3 0 0 300 i

c. Use the show ip route bgp and show ipv6 route bgp commands to view the routing tables. Note that there is only one route to each destination, and that the routes included in the routing table have the same next hop as those with the ">" symbol in the BGP tables.

R1# show ip route bgp | begin Gateway

Gateway of last resort is not set

 192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
B 192.168.2.0/27 [20/0] via 10.1.2.2, 00:06:20
B 192.168.2.64/26 [20/0] via 10.1.2.2, 00:06:20
 192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
B 192.168.3.0/27 [20/0] via 10.1.3.3, 00:06:19
B 192.168.3.64/26 [20/0] via 10.1.3.3, 00:06:19
R1# show ipv6 route bgp
IPv6 Routing Table - default - 15 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
 B - BGP, R - RIP, H - NHRP, I1 - ISIS L1

```
 I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
 EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE - Destination
 NDr - Redirect, RL - RPL, O - OSPF Intra, OI - OSPF Inter
 OE1 - OSPF ext 1, OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1
 ON2 - OSPF NSSA ext 2, a - Application
B 2001:DB8:ACAD:2000::/64 [20/0]
 via FE80::2, GigabitEthernet0/0/0
B 2001:DB8:ACAD:2001::/64 [20/0]
 via FE80::2, GigabitEthernet0/0/0
B 2001:DB8:ACAD:3000::/64 [20/0]
 via FE80::3:2, Serial0/1/0
B 2001:DB8:ACAD:3001::/64 [20/0]
 via FE80::3:2, Serial0/1/0
```

Part 2: Configure and Verify BGP Communities on all Routers

In Part 2, you will configure BGP communities and various community attributes to see their effect on routing decisions.

Step 1: Configure all routers to send community information.

In this step, you will configure all of the routers to support the new-format for exchanging community information and enable sending community information to all neighbors on all routers. A BGP community is a 32-bit number that can be included as a flag or tag in a route. The BGP community can be configured and displayed as two 16 bit numbers AA:NN commonly referred to as new-format. To configure and display using the AA:NN, issue the ip bgp-community new-format command. The first part of the AA:NN represents the AS number and the second part represents a 2-byte number.

The configuration for R1 is shown below. Use this as an example and complete the configuration on R2 and R3 on your own.

a. Issue the global configuration command that enables configuration and display of community information using the AA:NN format.

Open configuration window

R1(config)# ip bgp-community new-format

b. Add a neighbor statement for each neighbor with the send community parameter.

```
R1(config)# router bgp 6500
R1(config-router)# address-family ipv4 unicast
R1(config-router-af)# neighbor 10.1.2.2 send-community
R1(config-router-af)# neighbor 10.1.3.3 send-community
R1(config-router-af)# neighbor 10.1.3.130 send-community
R1(config-router-af)# address-family ipv6 unicast
R1(config-router-af)# neighbor 2001:db8:acad:1012::2 send-community
R1(config-router-af)# neighbor 2001:db8:acad:1013::3 send-community
```

R1(config-router-af)# neighbor 2001:db8:acad:1014::3 send-community
R1(config-router-af)# exit

c. At this point, the routers are ready to send community information, but there is no community information available.

On R2, issue the command show bgp ipv4 unicast 192.168.2.0/27, and you will see there is no community information listed.
Close configuration window

Step 2: Configure and verify the effect of the no-export community.

In this step, you will configure R3 so that it sets the well-known no-export community value on the updates
describing its local networks that are being sent to R1. The effect of this is that R1 will not pass along information about these paths to other eBGP neighbors.

a. On R2, issue the command show bgp ipv4 unicast 192.168.3.0/27 to see to the available BGP paths to 192.168.3.0/27 from R2.

Open configuration window

R2# show bgp ipv4 unicast 192.168.3.0/27

BGP routing table entry for 192.168.3.0/27, version 6
Paths: (2 available, best #2, table default)
Advertised to update-groups:
2
Refresh Epoch 1
6500 300
10.1.2.1 from 10.1.2.1 (1.1.1.1)
Origin IGP, localpref 100, valid, external
rx pathid: 0, tx pathid: 0
Refresh Epoch 1
300
10.2.3.3 from 10.2.3.3 (3.3.3.3)
Origin IGP, metric 0, localpref 100, valid, external, best
rx pathid: 0, tx pathid: 0x0
Close configuration window

b. In this case, note that there are two paths, one directly from R3/ASN300 and the other from R1/ASN6500.

This might not be desirable, because it sets ASN6500 up as a transit network. To fix this issue, a prefix list on R3 can be created to match the source address and mask of networks belonging to ASN300.
Open configuration window

R3(config)# ip prefix-list LOCAL_NETWORK_COMMSET seq 5 permit 192.168.3.0/24 le 27
R3(config)# ipv6 prefix-list LOCAL_6_NETWORK_COMMSET seq 5 permit

2001:db8:acad:3000::/64
R3(config)# ipv6 prefix-list LOCAL_6_NETWORK_COMMSET seq 10 permit
2001:db8:acad:3001::/64

c. Next, build a route map for IPv4 and IPv6 on R3 that uses the prefix list to set the no-export additive community on networks matching the prefix list, and the internet additive community on networks that do not match the prefix list. By default, when setting a community, any existing communities are over-written, but can be preserved using the optional additive keyword.

R3(config)# route-map COMMSET permit 10
R3(config-route-map)# match ip address prefix-list LOCAL_NETWORK_COMMSET
R3(config-route-map)# set community no-export additive
R3(config-route-map)# exit
R3(config)# route-map COMMSET permit 20
R3(config-route-map)# set community internet additive
R3(config-route-map)# exit
R3(config)# route-map COMMSET_6 permit 10
R3(config-route-map)# match ipv6 address prefix-list LOCAL_6_NETWORK_COMMSET
R3(config-route-map)# set community no-export additive
R3(config-route-map)# exit
R3(config)# route-map COMMSET_6 permit 20
R3(config-route-map)# set community internet additive

d. Next, apply these route maps to the neighbor statements associated with R1.

R3(config)# router bgp 300
R3(config-router)# address-family ipv4 unicast
R3(config-router-af)# neighbor 10.1.3.1 route-map COMMSET out
R3(config-router-af)# neighbor 10.1.3.129 route-map COMMSET out
R3(config-router-af)# address-family ipv6 unicast
R3(config-router-af)# neighbor 2001:db8:acad:1013::1 route-map COMMSET_6 out
R3(config-router-af)# neighbor 2001:db8:acad:1014::1 route-map COMMSET_6 out

e. Perform a reset of the adjacencies with the outbound traffic to R1 without tearing down the session.

R3# clear bgp ipv4 unicast 6500 out
R3# clear bgp ipv6 unicast 6500 out
Close configuration window

f. On R2, issue the command show bgp ipv4 unicast 192.168.3.0/27 to see to the available BGP paths to 192.168.3.0/27 from R2. This time, you should not see a path to 192.168.3.0/27 via the next-hop 10.1.2.1.

If you use the command show bgp ipv6 unicast 2001:db8:acad:3000::/64, you will see only one nexthop address, and that is 2001:db8:acad:1023::3.

Open configuration window

R2# show bgp ipv4 unicast 192.168.3.0/27

BGP routing table entry for 192.168.3.0/27, version 6
Paths: (1 available, best #1, table default)
 Advertised to update-groups:
 2
 Refresh Epoch 1
 300
 10.2.3.3 from 10.2.3.3 (3.3.3.3)
 Origin IGP, metric 0, localpref 100, valid, external, best
 rx pathid: 0, tx pathid: 0x0

R2# show bgp ipv6 unicast 2001:db8:acad:3000::/64

BGP routing table entry for 2001:DB8:ACAD:3000::/64, version 8
Paths: (1 available, best #1, table default)
 Advertised to update-groups:
 2
 Refresh Epoch 2
 300
 2001:DB8:ACAD:1023::3 (FE80::3:1) from 2001:DB8:ACAD:1023::3 (3.3.3.3)
 Origin IGP, metric 0, localpref 100, valid, external, best
 rx pathid: 0, tx pathid: 0x0
Close configuration window

Step 3: Add private community information to routes advertised by R1.

In this step, you will configure R1 so that it adds custom community strings to IPv4 and IPv6 routes that it advertises to R2/ASN500.

a. On R1, create two route maps. One route map will add the community 650:400 to all IPv4 routes advertised to R2/ASN500, and the second route map adds the community 650:600 to all IPv6 routes advertised to R2/ASN500.
Open configuration window

R1(config)# route-map ADDCOMM permit 10
R1(config-route-map)# set community 650:400 additive
R1(config-route-map)# exit
R1(config)# route-map ADDCOMM_6 permit 10
R1(config-route-map)# set community 650:600 additive
R1(config-route-map)# exit
b. On R1, apply the appropriate route map to the appropriate R2 neighbor statement.

R1(config)# router bgp 6500
R1(config-router)# address-family ipv4 unicast
R1(config-router-af)# neighbor 10.1.2.2 route-map ADDCOMM out
R1(config-router-af)# address-family ipv6 unicast

R1(config-router-af)# neighbor 2001:db8:acad:1012::2 route-map ADDCOMM_6 out
R1(config-router-af)# end

c. On R1, perform a reset of the adjacencies with the outbound traffic to R2 without tearing down the session.

R1# clear bgp ipv4 unicast 500 out

R1# clear bgp ipv6 unicast 500 out
Close configuration window

e. On R2, verify the community tags are present by issuing the commands show bgp ipv4 unicast 192.168.1.0/27 | i Community and show bgp ipv6 unicast 2001:db8:acad:1000::/64 | i Community.

Open configuration window
R2# show bgp ipv4 unicast 192.168.1.0/27 | i Community
Community: 650:400
R2# show bgp ipv6 unicast 2001:db8:acad:1000::/64 | i Community
Community: 650:600
Close configuration window

If you run those same commands on R3, you will see that the community tags are present there as well. Because Community is an optional transitive attribute, it is passed on to eBGP neighbors by default.

Step 4: Configure community-based route filtering and manipulation.

In this step, you will configure R3 so that it drops all routes coming from R2 with the 650:400 community attribute. Then configure R3 so that it sets a higher local preference for all routes coming from R2 with the
650:600 community attribute.

a. On R3, create two community lists; one that matches the 650:400 attribute and another that matches the
650:600 attribute.

Open configuration window
R3(config)# ip community-list 100 permit 650:400
R3(config)# ip community-list 101 permit 650:600

b. On R3, create a pair of route maps that use the newly created community lists. The first route map will drop routes with the 650:400 community set and permit all others. The second route map will match the community 650:600 and set the local preference value to 250. Routes not matching the community 650:600 will not be modified.

R3(config)# route-map COMMCHECK_4 deny 10
R3(config-route-map)# match community 100
R3(config-route-map)# route-map COMMCHECK_4 permit 20
R3(config-route-map)# exit
R3(config)# route-map COMMCHECK_6 permit 10
R3(config-route-map)# match community 101

R3(config-route-map)# set local-preference 250
R3(config-route-map)# route-map COMMCHECK_6 permit 20
R3(config-route-map)# exit

c. On R3, apply the appropriate route map to the appropriate R2 neighbor statement.

R3(config)# router bgp 300
R3(config-router)# address-family ipv4 unicast
R3(config-router-af)# neighbor 10.2.3.2 route-map COMMCHECK_4 in
R3(config-router-af)# address-family ipv6 unicast
R3(config-router-af)# neighbor 2001:db8:acad:1023::2 route-map COMMCHECK_6 in
R3(config-router-af)# end

d. Perform a reset of the adjacencies with the inbound traffic to R2 without tearing down the session.

R3# clear bgp ipv4 unicast 500 in
R3# clear bgp ipv6 unicast 500 in

e. On R3, verify the IPv4 policy is working. Issue the command show bgp ipv4 unicast 192.168.1.0/27 | I Community and you will see that there is no output. Follow this with the show bgp ipv4 unicast command and you will see that there are no paths to the ASN6500 networks via R2. They have all been filtered.

R3# show bgp ipv4 unicast 192.168.1.0/27 | i Community
R3# show bgp ipv4 unicast
BGP table version is 9, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
x best-external, a additional-path, c RIB-compressed,
t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found
BGP Lab 4 - Implement BGP Communities

Network Next Hop Metric LocPrf Weight Path
*> 192.168.1.0/27 10.1.3.1 0 0 6500 i
* 10.1.3.129 0 0 6500 i
*> 192.168.1.64/26 10.1.3.1 0 0 6500 i
* 10.1.3.129 0 0 6500 i
* 192.168.2.0/27 10.1.3.1 0 6500 500 i
* 10.1.3.129 0 6500 500 i
*> 10.2.3.2 0 0 500 i
* 192.168.2.64/26 10.1.3.1 0 6500 500 i
* 10.1.3.129 0 6500 500 i
*> 10.2.3.2 0 0 500 i

*> 192.168.3.0/27 0.0.0.0 0 32768 i
*> 192.168.3.64/26 0.0.0.0 0 32768 i

f. On R3, verify the IPv6 policy is working. Issue the command show bgp ipv6 unicast and note the local preference has been assigned to the ASN500 routes advertised from R2.

R3# show bgp ipv6 unicast

BGP table version is 11, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
 r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
 x best-external, a additional-path, c RIB-compressed,
 t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found
 Network Next Hop Metric LocPrf Weight Path
*> 2001:DB8:ACAD:1000::/64
 2001:DB8:ACAD:1023::2 250 0 500 6500 i
* 2001:DB8:ACAD:1014::1 0 0 6500 i
* 2001:DB8:ACAD:1013::1 0 0 6500 i
*> 2001:DB8:ACAD:1001::/64
 2001:DB8:ACAD:1023::2 250 0 500 6500 i
* 2001:DB8:ACAD:1014::1 0 0 6500 i
* 2001:DB8:ACAD:1013::1
 Network Next Hop Metric LocPrf Weight Path 0 0 6500 i
* 2001:DB8:ACAD:2000::/64
 2001:DB8:ACAD:1014::1 0 6500 500 i
* 2001:DB8:ACAD:1013::1 0 6500 500 i
*> 2001:DB8:ACAD:1023::2 0 0 500 i
* 2001:DB8:ACAD:2001::/64
 2001:DB8:ACAD:1014::1 0 6500 500 i
* 2001:DB8:ACAD:1013::1 0 6500 500 i
*> 2001:DB8:ACAD:1023::2 0 0 500 i
*> 2001:DB8:ACAD:3000::/64:: 0 32768 i
*> 2001:DB8:ACAD:3001::/64 :: 0 32768 i

Practical 4: Control Routing Updates and Path Control Using PBR

Objectives

Part 1: Build the Network and Configure Basic Device Settings
Part 2: Configure and Verify Routing
Part 3: Configure PBR to Provide Path Control
Part 4: Configure Local PBR to Provide Path Control

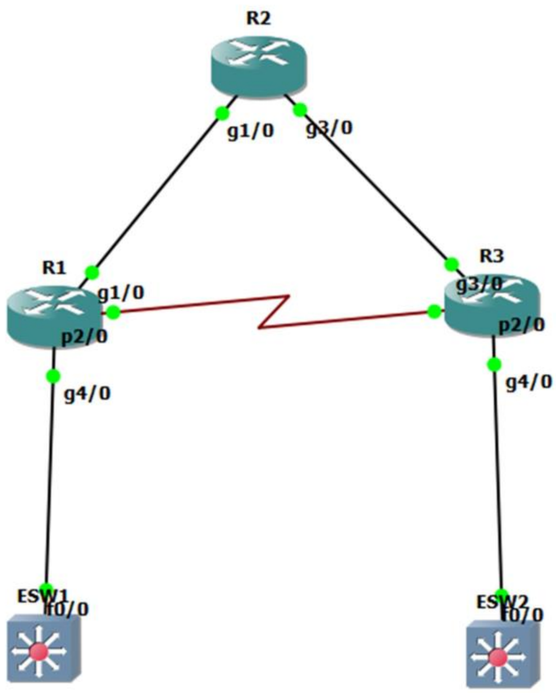
Background / Scenario

In this scenario, you want to experiment with policy-based routing (PBR) to see how it is implemented and study how it could be used to influence path selection.

Your task is to connect and configure a 3 router and 2 Layer 3 switch OSPF routing domain and verify normal path selection. You will alter the traffic flow for PC2 going to PC3 using PBR. You will also use Cisco IOS IP SLA with PBR to achieve dynamic path control. Finally, you will configure PBR for traffic originating locally on router R1.

Part 1:Build the Network and Configure Basic Device Settings

In Part 1, you will set up the network topology and configure basic settings and interface addressing on routers.



Step 1:Cable the network as shown in the topology.

Attach the devices as shown in the topology diagram, and cable as necessary.

Step 2:Configure basic settings for each device.

Console into each device, enter global configuration mode, and apply the basic settings. The startup configurations for each device are provided below

Router R1

```
R1#
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#hostname R1
R1(config)#no ip domain lookup
R1(config)#line con 0
R1(config-line)#logging sync
R1(config-line)#exec-time 0 0
R1(config-line)#exit
R1(config)#banner motd # This is R1, Path Control Using PBR #
R1(config)#int g1/0
R1(config-if)#description Connection to R2
R1(config-if)#ip add 172.16.0.2 255.255.255.252
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#int p
*Nov 29 10:28:35.795: %LINK-3-UPDOWN: Interface GigabitEthernet1/0, changed state to up
*Nov 29 10:28:36.795: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0,
changed state to up
R1(config)#int p2/0
R1(config-if)#description Serial Connection to R3
R1(config-if)#ip add 172.16.2.1 255.255.255.252
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#
*Nov 29 10:29:01.855: %LINK-3-UPDOWN: Interface POS2/0, changed state to up
R1(config)#
*Nov 29 10:29:02.863: %LINEPROTO-5-UPDOWN: Line protocol on Interface POS2/0, changed state to
up
R1(config)#int g4/0
*Nov 29 10:29:26.967: %LINEPROTO-5-UPDOWN: Line protocol on Interface POS2/0, changed state to
down
R1(config-if)#description Connection to D1
R1(config-if)#ip add 10.10.0.1 255.255.255.252
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#
*Nov 29 10:29:35.043: %LINK-3-UPDOWN: Interface GigabitEthernet4/0, changed state to up
*Nov 29 10:29:36.043: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet4/0,
changed state to up
```

R1(config)#
*Nov 29 10:32:16.967: %LINEPROTO-5-UPDOWN: Line protocol on Interface POS2/0, changed state to up
R1(config)#exit
R1#
*Nov 29 10:36:14.367: %SYS-5-CONFIG_I: Configured from console by console
R1#copy running-config startup-config
Destination filename [startup-config]?
Warning: Attempting to overwrite an NVRAM configuration previously written
by a different version of the system image.
Overwrite the previous NVRAM configuration?[confirm]
Building configuration...
[OK]

Router R2

R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#hostname R2
R2(config)#no ip domain lookup
R2(config)#line con 0
R2(config-line)#logging sync
R2(config-line)#exec-time 0 0
R2(config-line)#exit
R2(config)#banner motd # This is R2, Path Control Using PBR #
R2(config)#int g1/0
R2(config-if)#description Connection to R1
R2(config-if)#ip add 172.16.0.1 255.255.255.252
R2(config-if)#no shutdown
R2(config-if)#exit
*Nov 29 10:30:27.927: %LINK-3-UPDOWN: Interface GigabitEthernet1/0, changed state to up
*Nov 29 10:30:28.927: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0, changed state to up
R2(config-if)#exit
R2(config)#int g3/0
R2(config-if)#description Connection to R3
R2(config-if)#ip address 172.16.1.1 255.255.255.252
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#
*Nov 29 10:30:55.203: %LINK-3-UPDOWN: Interface GigabitEthernet3/0, changed state to up
*Nov 29 10:30:56.203: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet3/0, changed state to up
R2(config)#do copy running-config startup-config
Destination filename [startup-config]?
Warning: Attempting to overwrite an NVRAM configuration previously written
by a different version of the system image.

```
Overwrite the previous NVRAM configuration?[confirm]
Building configuration...
[OK]
R2(config)#do copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
```

Router R3

```
R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#hostname R3
R3(config)#no ip domain lookup
R3(config)#line con 0
R3(config-line)#logging sync
R3(config-line)#exec-time 0 0
R3(config-line)#exit
R3(config)#banner motd # This is R3, Path Control Using PBR #
R3(config)#int g3/0
R3(config-if)#description Connection to R2
R3(config-if)#ip add 172.16.1.2 255.255.255.252
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#
*Nov 29 10:31:51.171: %LINK-3-UPDOWN: Interface GigabitEthernet3/0, changed state to up
*Nov 29 10:31:52.171: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet3/0,
changed state to up
R3(config)#int  p2/0
R3(config-if)#description Serial Connection to R1
R3(config-if)#ip add 172.16.2.2 255.255.255.252
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#
*Nov 29 10:32:06.571: %LINK-3-UPDOWN: Interface POS2/0, changed state to up
*Nov 29 10:32:07.571: %LINEPROTO-5-UPDOWN: Line protocol on Interface POS2/0, changed state to
up
R3(config)#int  g4/0
R3(config-if)#description Connection to D2
R3(config-if)#ip add 192.168.0.1 255.255.255.252
R3(config-if)#no shut
R3(config-if)#exit
```

Switch1 D1

```
ESW1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
```

ESW1(config)#hostname D1
D1(config)#no ip domain lookup
D1(config)#line con 0
D1(config-line)#exec-timeout 0 0
D1(config-line)#logging synchronous
D1(config-line)#exit
D1(config)#banner motd # This is D1, Path Control Using PBR #
D1(config)#int f0/0
D1(config-if)#description Connects to R1
D1(config-if)#ip address 10.10.0.2 255.255.255.252
D1(config-if)#no shut
D1(config-if)#exit
D1(config)#interface Loopback 1
D1(config-if)#description Interface simulates network
D1(config-if)#ip ospf network point-to-point
D1(config-if)#ip address 10.10.1.1 255.255.255.0
D1(config-if)#exit
D1(config)#interface Loopback 2
D1(config-if)#description Interface simulates network
D1(config-if)#ip ospf network point-to-point
D1(config-if)#ip address 10.10.2.1 255.255.255.0
D1(config-if)#exit
*Mar 1 00:05:43.443: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
*Mar 1 00:05:43.499: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback2, changed state to up
D1(config-if)#exit
*Mar 1 00:05:44.391: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:05:45.391: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
D1(config-if)#exit
D1(config)#do copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]

Switch2 D2

SW2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
ESW2(config)#hostname D2
D2(config)#no ip domain lookup
D2(config)#line con 0
D2(config-line)#logging sync

D2(config-line)#exec-time 0 0
D2(config-line)#exit
D2(config)#banner motd # This is D2, Path Control Using PBR #
D2(config)#int f0/0
D2(config-if)#description Connects to R3
D2(config-if)#ip address 192.168.0.2 255.255.255.252
D2(config-if)#no shut
D2(config-if)#exit
D2(config)#interface Loopback 1
D2(config-if)#description Interface simulates network
D2(config-if)#ip ospf network point-to-point
D2(config-if)#ip address 192.168.1.1 255.255.255.0
D2(config-if)#exit
*Mar 1 00:08:03.811: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
D2(config-if)#exit
*Mar 1 00:08:04.759: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:08:05.759: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
D2(config-if)#exit
D2(config)#exit
D2#conf t

Part 2:Configure and Verify Routing

In Part 2, you will implement OSPF routing for the routing domain and verify end to end routing.

Step 1:Configure Routing.

In this step, you will configure OSPF.

1.On D1, advertise the connected networks using OSPF process ID 123. Also assign D1 the router ID of 1.1.1.2 and set the reference bandwidth to recognize Gigabit Ethernet interfaces.

Open configuration window

D1(config)#
D1(config)#ip routing
D1(config)#router ospf 123
D1(config-router)#router-id 1.1.1.2
D1(config-router)# auto-cost reference-bandwidth 1000
% OSPF: Reference bandwidth is changed.
Please ensure reference bandwidth is consistent across all routers.
D1(config-router)# network 10.10.0.0 0.0.0.3 area 0
D1(config-router)# network 10.10.1.0 0.0.0.255 area 0
D1(config-router)#network 10.10.2.0 0.0.0.255 area 0

D1(config-router)#end
D1#
*Mar 1 00:11:30.655: %SYS-5-CONFIG_I: Configured from console by console
D1#
*Mar 1 00:12:22.995: %OSPF-5-ADJCHG: Process 123, Nbr 1.1.1.1 on FastEthernet0/0 from LOADING to FULL, Loading Done
Close configuration window

2. On R1, advertise the connected networks using OSPF process ID 123. Also assign R1 the router ID of 1.1.1.1 and set the reference bandwidth to recognize Gigabit Ethernet interfaces.

Open configuration window

R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)# router ospf 123
R1(config-router)#router-id 1.1.1.1
R1(config-router)# auto-cost reference-bandwidth 1000
% OSPF: Reference bandwidth is changed.
Please ensure reference bandwidth is consistent across all routers.
R1(config-router)#network 10.10.0.0 0.0.0.3 area 0
R1(config-router)# network 172.16.0.0 0.0.0.3 area 0
R1(config-router)#
*Nov 29 10:39:52.079: %OSPF-5-ADJCHG: Process 123, Nbr 1.1.1.2 on GigabitEthernet4/0 from LOADING to FULL, Loading Done
R1(config-router)# network 172.16.2.0 0.0.0.3 area 0
R1(config-router)#end
R1#
*Nov 29 10:40:03.795: %SYS-5-CONFIG_I: Configured from console by console
R1#
*Nov 29 10:41:17.399: %OSPF-5-ADJCHG: Process 123, Nbr 2.2.2.1 on GigabitEthernet1/0 from LOADING to FULL, Loading Done
R1#
*Nov 29 10:42:52.783: %OSPF-5-ADJCHG: Process 123, Nbr 3.3.3.1 on POS2/0 from LOADING to FULL, Loading Done
Close configuration window

3. On R2, advertise the connected networks using OSPF process ID 123. Also assign R2 the router ID of 2.2.2.1 and set the reference bandwidth to recognize Gigabit Ethernet interfaces.

Open configuration window

R2(config)#router ospf 123
R2(config-router)#router-id 2.2.2.1
R2(config-router)#auto-cost reference-bandwidth 1000

% OSPF: Reference bandwidth is changed.
Please ensure reference bandwidth is consistent across all routers.
R2(config-router)#auto-cost reference-bandwidth 1000
R2(config-router)#network 172.16.0.0 0.0.0.3 area 0
R2(config-router)#
*Nov 29 10:41:18.355: %OSPF-5-ADJCHG: Process 123, Nbr 1.1.1.1 on GigabitEthernet1/0 from LOADING to FULL, Loading Done
R2(config-router)#network 172.16.1.0 0.0.0.3 area 0
R2(config-router)#end
R2#
*Nov 29 10:41:42.547: %SYS-5-CONFIG_I: Configured from console by console
R2#
*Nov 29 10:42:49.363: %OSPF-5-ADJCHG: Process 123, Nbr 3.3.3.1 on GigabitEthernet3/0 from LOADING to FULL, Loading Done
Close configuration window

4. On R3, advertise the connected networks using OSPF process ID 123. Also assign R3 the router ID of 3.3.3.1 and set the reference bandwidth to recognize Gigabit Ethernet interfaces.
Open configuration window

R3(config)# router ospf 123
R3(config-router)# router-id 3.3.3.1
R3(config-router)# auto-cost reference-bandwidth 1000
% OSPF: Reference bandwidth is changed.
Please ensure reference bandwidth is consistent across all routers.
R3(config-router)# network 192.168.0.0 0.0.0.3 area 0
R3(config-router)# network 172.16.1.0 0.0.0.3 area 0
R3(config-router)# network 172.16.2.0 0.0.0.3 area 0
R3(config-router)# end
R3#
*Nov 29 17:03:56.362: %OSPF-5-ADJCHG: Process 123, Nbr 1.1.1.1 on p2/0 from LOADING to FULL, Loading Done

R3#
*Nov 29 17:09:38.978: %OSPF-5-ADJCHG: Process 123, Nbr 2.2.2.1 on G1/0 from LOADING to FULL, Loading Done
Close configuration window
5. On D2, advertise the connected networks using OSPF process ID 123. Also assign D2 the router ID of 3.3.3.2 and set the reference bandwidth to recognize Gigabit Ethernet interfaces.
Open configuration window

D2(config)# ip routing
D2(config)# router ospf 123
D2(config-router)# router-id 3.3.3.2
D2(config-router)# auto-cost reference-bandwidth 1000
% OSPF: Reference bandwidth is changed.
Please ensure reference bandwidth is consistent across all routers.

D2(config-router)# network 192.168.0.0 0.0.0.3 area 0
D2(config-router)# network 192.168.1.0 0.0.0.255 area 0
D2(config-router)# end
D2#
*Nov 29 17:29:46.627: %OSPF-5-ADJCHG: Process 123, Nbr 3.3.3.1 on f0/0 from LOADING to FULL, Loading Done
Close configuration window

Step 2:Verify OSPF routing

Before configuring PBR, verify the current routing table on all devices. All routing tables look accurate.
Open configuration window

D1#show ip route ospf | begin Gateway

```
   172.16.0.0/30 is subnetted, 3 subnets
O      172.16.0.0 [110/11] via 10.10.0.1, 00:00:26, FastEthernet0/0
O      172.16.1.0 [110/12] via 10.10.0.1, 00:00:26, FastEthernet0/0
O      172.16.2.0 [110/16] via 10.10.0.1, 00:00:26, FastEthernet0/0
   192.168.0.0/30 is subnetted, 1 subnets
O      192.168.0.0 [110/13] via 10.10.0.1, 00:00:26, FastEthernet0/0
O   192.168.1.0/24 [110/14] via 10.10.0.1, 00:00:26, FastEthernet0/0
```

D2# show ip route ospf | begin Gateway

```
Gateway of last resort is not set
10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
O10.10.0.0/30 [110/4] via 192.168.0.1, 00:03:55, GigabitEthernet1/0/11
O10.10.1.0/24 [110/5] via 192.168.0.1, 00:03:55, GigabitEthernet1/0/11
O10.10.2.0/24 [110/5] via 192.168.0.1, 00:03:55, GigabitEthernet1/0/11
172.16.0.0/30 is subnetted, 3 subnets
O172.16.0.0 [110/3] via 192.168.0.1, 00:03:55, GigabitEthernet1/0/11
O172.16.1.0 [110/2] via 192.168.0.1, 00:03:55, GigabitEthernet1/0/11
O172.16.2.0 [110/499] via 192.168.0.1, 00:03:55, GigabitEthernet1/0/1
```

R1#show ip route ospf | begin Gateway

```
Gateway of last resort is not set
     10.0.0.0/8 is variably subnetted, 4 subnets, 3 masks
O       10.10.1.0/24 [110/2] via 10.10.0.2, 00:05:13, GigabitEthernet4/0
O       10.10.2.0/24 [110/2] via 10.10.0.2, 00:05:13, GigabitEthernet4/0
     172.16.0.0/16 is variably subnetted, 5 subnets, 2 masks
O       172.16.1.0/30 [110/2] via 172.16.0.1, 00:03:35, GigabitEthernet1/0
     192.168.0.0/30 is subnetted, 1 subnets
O       192.168.0.0 [110/3] via 172.16.0.1, 00:02:17, GigabitEthernet1/0
O    192.168.1.0/24 [110/4] via 172.16.0.1, 00:00:59, GigabitEthernet1/0
```

R2#show ip route ospf | begin Gateway

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
O 10.10.0.0/30 [110/2] via 172.16.0.2, 00:04:14, GigabitEthernet1/0 O
10.10.1.0/24 [110/3] via 172.16.0.2, 00:04:14, GigabitEthernet1/0 O
10.10.2.0/24 [110/3] via 172.16.0.2, 00:04:14, GigabitEthernet1/0
172.16.0.0/16 is variably subnetted, 5 subnets, 2 masks
O 172.16.2.0/30 [110/7] via 172.16.1.2, 00:02:31, GigabitEthernet3/0
[110/7] via 172.16.0.2, 00:04:14, GigabitEthernet1/0
192.168.0.0/30 is subnetted, 1 subnets
O 192.168.0.0 [110/2] via 172.16.1.2, 00:02:41, GigabitEthernet3/0
O 192.168.1.0/24 [110/3] via 172.16.1.2, 00:01:23, GigabitEthernet3/0
R2#
R3# show ip route ospf | begin Gateway
Gateway of last resort is not set
10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
O10.10.0.0/30 [110/3] via 172.16.1.1, 00:12:56, GigabitEthernet1/0
O10.10.1.0/24 [110/13] via 172.16.1.1, 00:12:56, GigabitEthernet1/0
O10.10.2.0/24 [110/13] via 172.16.1.1, 00:12:56, GigabitEthernet1/0
172.16.0.0/16 is variably subnetted, 5 subnets, 2 masks
O172.16.0.0/30 [110/2] via 172.16.1.1, 00:12:56, GigabitEthernet1/0
O192.168.1.0/24 [110/11] via 192.168.0.2, 00:12:44, GigabitEthernet4/1

Step 3:Verify end-to-end connectivity and path taken

1. From any device, verify connectivity to all configured destinations using the following TCL script. All pings should be successful. Troubleshoot if necessary.

```
tclsh
foreach address {
10.10.0.1
10.10.0.2
10.10.1.1
10.10.2.1
172.16.0.1
172.16.0.2
172.16.1.1
172.16.1.2
172.16.2.1
172.16.2.2
192.168.0.1
192.168.0.2
192.168.1.1
} { ping $address }
```

close configuration window

2. On D1, ping the D2 Loopback interface 192.168.1.1 address from the Lo1 interface as shown. The pings should be successful.
Open configuration window

D1#ping 192.168.1.1 source 10.10.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
Packet sent with a source address of 10.10.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 152/232/284 ms

3. Next, identify the path taken to D2 Lo1 interface using the traceroute command as shown. Notice that the path taken for the packets sourced from the D1 Lo1 LAN is going through R1 –> R2 –> R3 –> D2.

D1#traceroute 192.168.1.1 source 10.10.1.1
Type escape sequence to abort.
Tracing the route to 192.168.1.1
1 10.10.0.1 64 msec 56 msec 60 msec
2 172.16.0.1 136 msec 128 msec 164 msec
3 172.16.1.2 188 msec 204 msec 184 msec
4 192.168.0.2 300 msec 284 msec 276 msec
Because the serial interfaces between routers R1 and R3 are using a slower serial link, giving it a higher metric. All other interfaces are faster Gigabit Ethernet producing lower (and preferred) metrics.

4. Now ping and traceroute the D2 Lo1 interface from the D1 Loopback 2 interface as shown. It is also taking the same path.

D1#ping 192.168.1.1 source lo 2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
Packet sent with a source address of 10.10.2.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 196/204/220 ms
D1#traceroute 192.168.1.1 source lo 2
Type escape sequence to abort.
Tracing the route to 192.168.1.1
1 10.10.0.1 40 msec 36 msec 40 msec
2 172.16.0.1 40 msec 80 msec 52 msec
3 172.16.1.2 108 msec 136 msec 144 msec
4 192.168.0.2 204 msec 204 msec 200 msec
D1#

5. Display the OSPF routes in the routing table of R1. R1 forwards all packets destined to the 192.168.1.0/24 network out of its G0/0/0 interface to R2.

D1# traceroute 192.168.1.1 source lo 2
Type escape sequence to abort.
Tracing the route to 192.168.1.1
VRF info: (vrf in name/id, vrf out name/id)
1 10.10.0.1 2 msec 2 msec 1 msec
2 172.16.0.1 1 msec 2 msec 1 msec
3 172.16.1.2 2 msec 2 msec 2 msec
4 192.168.0.2 3 msec *3 msec
Close configuration window

6. Display the OSPF routes in the routing table of R1. R1 forwards all packets destined to the 192.168.1.0/24 network out of its G0/0/0 interface to R2.
Open configuration window

R1# show ip route ospf | begin Gateway

Gateway of last resort is not set
10.0.0.0/8 is variably subnetted, 4 subnets, 3 masks
O10.10.1.0/24 [110/2] via 10.10.0.2, 00:19:56, GigabitEthernet0/0/1
O10.10.2.0/24 [110/2] via 10.10.0.2, 00:19:56, GigabitEthernet0/0/1
172.16.0.0/16 is variably subnetted, 5 subnets, 2 masks
O172.16.1.0/30 [110/2] via 172.16.0.1, 00:18:50, GigabitEthernet0/0/0
192.168.0.0/30 is subnetted, 1 subnets
O192.168.0.0 [110/3] via 172.16.0.1, 00:18:37, GigabitEthernet0/0/0
O192.168.1.0/24 [110/4] via 172.16.0.1, 00:18:33, GigabitEthernet0/0/0

Display how R1 learned about the 192.168.1.0 network. R1 learned of the network from R2 (i.e., 172.16.0.1) who originally learned it from D2 (i.e., 3.3.3.2).
R1# show ip route 192.168.1.0
Routing entry for 192.168.1.0/24
Known via “ospf 123“, distance 110, metric 4, type intra area
Last update from 172.16.0.1 on GigabitEthernet0/0/0, 00:20:27 ago
Routing Descriptor Blocks:
* 172.16.0.1, from 3.3.3.2, 00:20:27 ago, via GigabitEthernet0/0/0
Route metric is 4, traffic share count is 1

Part 3:Configure PBR to Provide Path Control

Recall that route maps can be used for:

Redistribution – Route maps provide more options and flexibility to the redistribute command.

Policy-based routing (PBR) – PBR allows an administrator to define routing policy other than basic destination-based routing using the routing table. The route map is applied to an interface using the ip policy route-map interface configuration command.

BGP – Route maps are the primary tools for implementing BGP policy and allows an administrator to do path control and provide sophisticated manipulation of BGP path attributes. The route map is applied using the BGP neighbor router configuration command.

In this part, you will use PBR to configure source-based IP routing. Specifically, you will override the default IP routing decision based on the OSPF-acquired routing information for selected IP source-to-destination flows and apply a different next-hop router.

Recall that routers normally forward packets to destination addresses based on information in their routing table. By using PBR, you can implement policies that selectively cause packets to take different paths based on source address, protocol type, or application type. Therefore, PBR overrides the router's normal routing behavior.

Configuring PBR involves configuring a route map with match and set commands and then applying the route map to the interface.

The steps required to implement path control include the following:

1. Choose the path control tool to use. Path control tools manipulate or bypass the IP routing table. For PBR, route-map commands are used.
2. Implement the traffic-matching configuration, specifying which traffic will be manipulated. The match commands are used within route maps.
3. Define the action for the matched traffic using set commands within route maps.
4. Apply the route map to incoming traffic.

Step 1:Configure PBR on R1.

As a test, you will configure the following policy on router R1:

- All traffic sourced from D1 Lo1 LAN must take the R1 –> R2 –> R3 –> D2 path.
- All traffic sourced from D1 Lo2 LAN must take the R1 –> R3 –> D2 path.

1. On R1, create a standard named ACL called Lo2-ACL to identify the D1 Loopback 2 (i.e., 10.10.2.0/24) LAN.

Open configuration window

```
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#ip access-list standard Lo2-ACL
R1(config-std-nacl)#remark ACL matches D1 Lo2 traffic
R1(config-std-nacl)# permit 10.10.2.0 0.0.0.255
R1(config-std-nacl)#exit
```

2. Create a route map called R1-to-R3 that matches Lo2-ACL and sets the next-hop interface to the R3 serial 0/1/0 interface.

```
R1(config)# route-map R1-to-R3 permit
R1(config)#
```

R1(config)#route-map R1-to-R3 permit
R1(config-route-map)#description RM to forward Lo2 traffic to R3
R1(config-route-map)#match ip address Lo2-ACL
R1(config-route-map)#set ip next-hop 172.16.2.2
R1(config-route-map)#exit

3. Apply the R1-to-R3 route map to the G0/0/1 interface using the ip policy route-map command.

R1(config)#
R1(config)#int g4/0
R1(config-if)#ip policy route-map R1-to-R3
R1(config-if)#end
R1#
*Nov 29 10:54:52.687: %SYS-5-CONFIG_I: Configured from console by console

4. On R1, display the policy and matches using the show route-map command.

R1# show route-map
R1#show route-map
route-map R1-to-R3, permit, sequence 10
 Match clauses:
  ip address (access-lists): Lo2-ACL
 Set clauses:
  ip next-hop 172.16.2.2
 Policy routing matches: 0 packets, 0 bytes

5. On R1, verify that the R1-to-R3 route map has been applied to the Gi4/0 interface.

Step 2:Test the policy.

Now you are ready to test the policy configured on R1.

1. From D1, test the policy with the traceroute command, using D1 Lo1 interface as the source network.

Open configuration window

D1#traceroute 192.168.1.1 source lo 1
Type escape sequence to abort.
Tracing the route to 192.168.1.1
 1 10.10.0.1 56 msec 48 msec 36 msec
 2 172.16.0.1 92 msec 120 msec 132 msec
 3 172.16.1.2 148 msec 196 msec 192 msec
 4 192.168.0.2 176 msec 168 msec 152 msec
Notice the path taken for the packet sourced from D1 Lo 1 LAN A is still going through R1 –> R2 –> R3 –> D2.

It does not take the PBR-specified path because LAN A does not meet the criteria specified in the Lo1-ACL access list.

Now test the policy with the traceroute command, using D1 Lo2 interface as the source network. Now the path taken for the packet sourced from D1 Lo 2 LAN is R1 –> R3 –> D2, as expected.

D1#

D1#traceroute 192.168.1.1 source lo 2

Type escape sequence to abort.
Tracing the route to 192.168.1.1
1 10.10.0.1 36 msec 56 msec 40 msec
2 172.16.2.2 184 msec 160 msec 176 msec
3 192.168.0.2 228 msec 236 msec 212 msec
D1#
Close configuration window

2. **On R1, display the policy and matches using the show route-map command.**

Note: There are now matches to the policy because packets matching the ACL have passed through R1 G0/0/1 interface. The number of packet and bytes may differ in your implementation.

Open configuration window

```
R1
R1#show route-map
route-map R1-to-R3, permit, sequence 10
  Match clauses:
    ip address (access-lists): Lo2-ACL
  Set clauses:
    ip next-hop 172.16.2.2
  Policy routing matches: 9 packets, 540 bytes
R1#
```

Part 4:Configure Local PBR to Provide Path Control

Local PBR is a feature to policy route locally generated traffic. Local PBR policies are applied to the router with the ip local policy route-map global config command.

In this part, you will configure R1 to policy route all router generated traffic over the R1 to R3 link.

Step 1:Configure Local PBR on R1.

Verify the path that R1 currently takes without local PBR configured. R1 sends traffic to R2 then R3 and finally D2 as expected.

Open configuration window Local path

R1#

R1#traceroute 192.168.1.1

Type escape sequence to abort.

Tracing the route to 192.168.1.1
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.0.1 24 msec 52 msec 92 msec
  2 172.16.1.2 100 msec 128 msec 160 msec
  3 192.168.0.2 172 msec 172 msec 212 msec

1. On R1, create a named extended ACL called R1-TRAFFIC which matches all IP generated packets from R1 and destined to the D2 192.162.1.0/24 network.

R1#
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#ip access-list extended R1-TRAFFIC
R1(config-ext-nacl)# permit ip any 192.168.1.0 0.0.0.255
R1(config-ext-nacl)#exit

2. On R1, create a route map called LOCAL-PBR that permits traffic matching the R1-TRAFFIC ACL and redirects it to the R3 172.16.2.2 interface.

R1(config)# route-map LOCAL-PBR permit
R1(config-route-map)#match ip address R1-TRAFFIC
R1(config-route-map)#set ip next-hop 172.16.2.2
R1(config-route-map)#exit

3. Create a local PBR policy that matches the LOCAL-PBR route map

R1(config)#ip local policy route-map LOCAL-PBR
R1(config)#exit
R1#
*Nov 29 10:59:30.179: %SYS-5-CONFIG_I: Configured from console by console

Step 2:Test Local PBR on R1.

1. Verify the path taken by R1 to reach the 192.168.1.0/24 LAN. The traffic generated by R1 and going to 192.168.1.0/24 is now policy routed directly to R3 (i.e., 172.16.2.2).

R1#traceroute 192.168.1.1

Type escape sequence to abort.
Tracing the route to 192.168.1.1
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.2.2 68 msec 92 msec 48 msec
  2 192.168.0.2 124 msec 160 msec 160 msec

2. Verify the path taken by R1 to reach other networks. The traffic takes the normal OSPF generated path and is not policy routed.R1#

R1#traceroute 192.168.0.2

Type escape sequence to abort.
Tracing the route to 192.168.0.2

```
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.0.1 56 msec 68 msec 68 msec
  2 172.16.1.2 84 msec 116 msec 120 msec
  3 192.168.0.2 128 msec 132 msec 128 msec
```

3. Verify the route-map counters. The local PBR policy has matched packets.

Note: The number of packets and bytes may differ in your implementation.

```
R1#
R1#show route-map
route-map R1-to-R3, permit, sequence 10
  Match clauses:
    ip address (access-lists): Lo2-ACL
  Set clauses:
    ip next-hop 172.16.2.2
  Policy routing matches: 9 packets, 540 bytes
route-map LOCAL-PBR, permit, sequence 10
Match clauses:
    ip address (access-lists): R1-TRAFFIC
  Set clauses:
    ip next-hop 172.16.2.2
  Policy routing matches: 6 packets, 452 bytes
R1#
```

Practical 5:

1. Implement Route Redistribution Between Multiple Protocols

2. Configure Route Redistribution Within the Same Interior Gateway Protocol

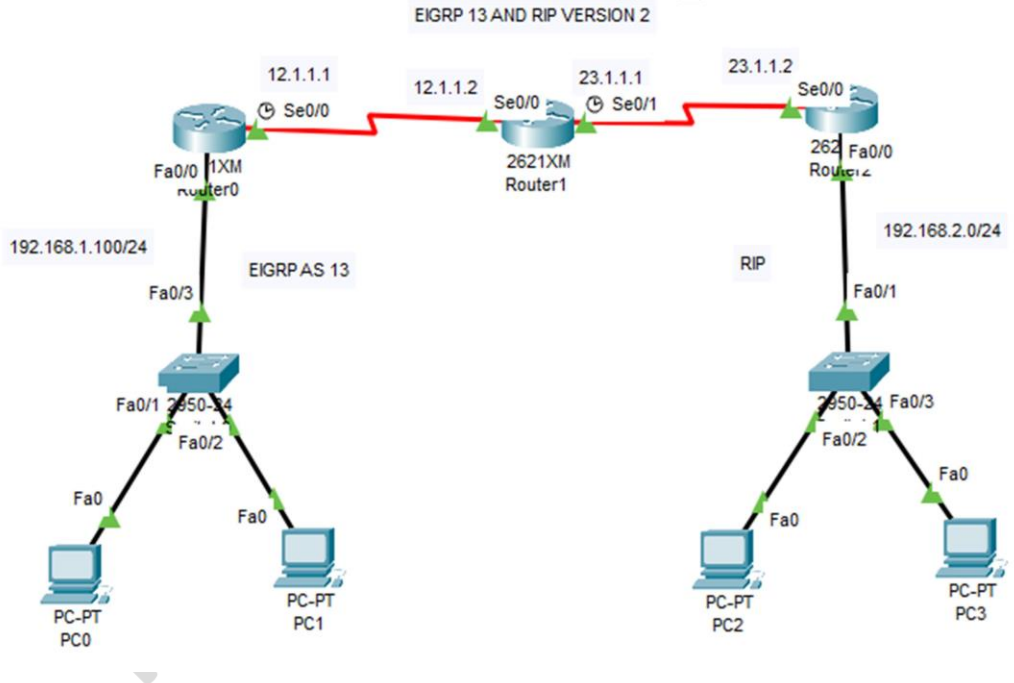
Introduction

Often, using a single routing protocol in an organisation is preferred but there are some conditions in which we have to use multi protocol routing. These conditions include multiple administrator running multiple protocols, company mergers or usage of multi-vendors devices. Therefore, we have to advertise a route learned through a routing protocol or by any other means (like static route or directly connected route) in different routing protocol. This process is called redistribution.

Redistribution –

It is a process of advertising a route learned by method of static routing, directly connected route or a dynamic routing protocol into another routing protocol.

1. Implement Route Redistribution Between Multiple Protocols



Step 1: Topology

Step 2: Basic Configurations
Router 0

Router>en

Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#in f0/0
Router(config-if)#ip address 192.168.1.100 255.255.255.0
Router(config-if)#no shutdown

Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
Router(config-if)#end
Router#%SYS-5-CONFIG_I: Configured from console by console
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#ip dhcp pool abc
Router(dhcp-config)#default-router 192.168.1.100
Router(dhcp-config)#network 192.168.1.0 255.255.255.0
Router(dhcp-config)#int s0/0
Router(config-if)#ip address 12.1.1.1 255.0.0.0
Router(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/0, changed state to down
Router(config-if)#
Router(config-if)#

Router(config-if)#clock rate 64000
Router(config-if)#
Router(config-if)#

Router 1

Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int s0/0
Router(config-if)#ip address 12.1.1.2 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface Serial0/0, changed state to up
Router(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up

Router(config-if)#int s0/1
Router(config-if)#ip address 23.1.1.1 255.0.0.0
Router(config-if)#no shutdown
%LINK-5-CHANGED: Interface Serial0/1, changed state to down
Router(config-if)#
Router(config-if)#end

Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#show ip int brief
Interface IP-Address OK? Method Status Protocol
FastEthernet0/0 unassigned YES unset administratively down down
FastEthernet0/1 unassigned YES unset administratively down down
Serial0/0 12.1.1.2 YES manual up up
Serial0/1 23.1.1.1 YES manual down down
Router#

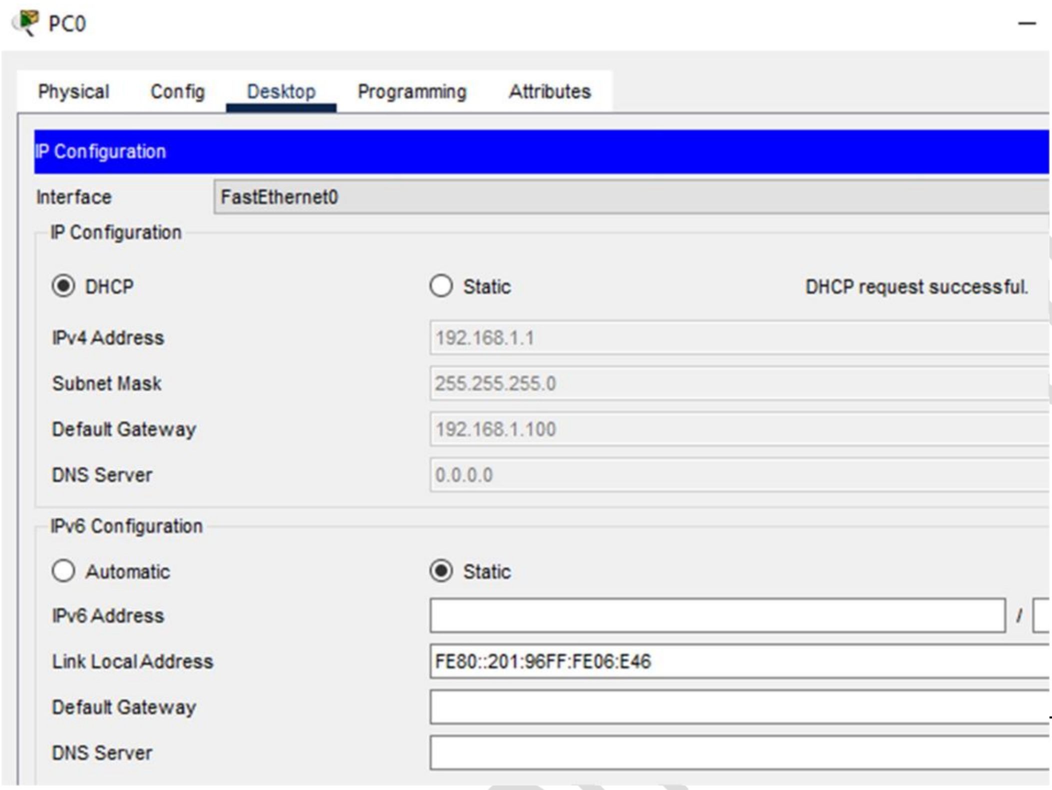
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface Serial0/0
Router(config-if)#clock rate 64000
This command applies only to DCE interfaces
Router(config-if)#

Router2

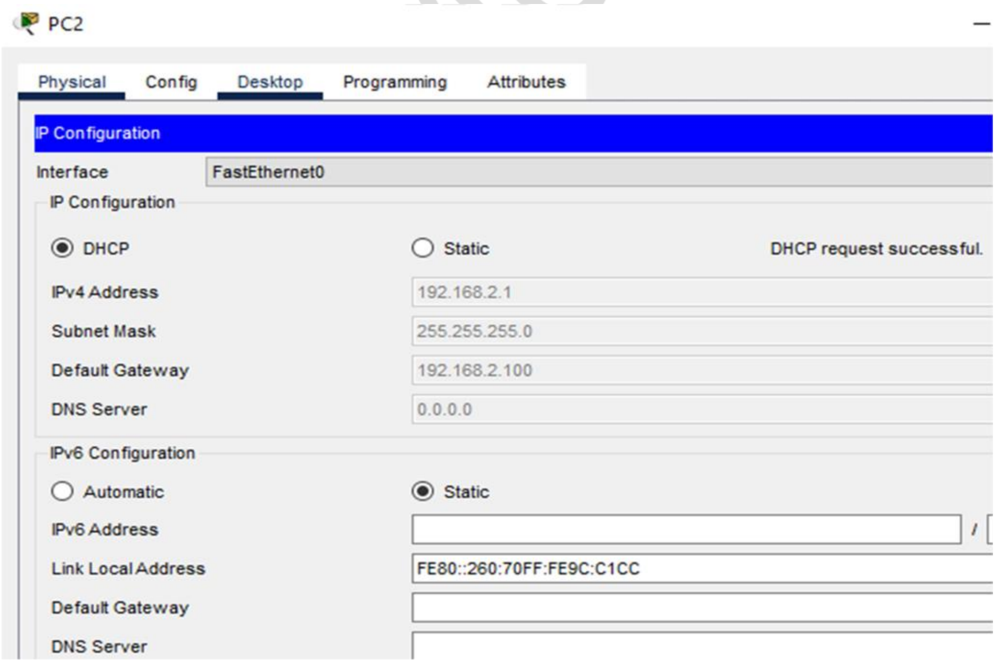
Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int s0/0
Router(config-if)#ip address 23.1.1.2 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface Serial0/0, changed state to up
Router(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
Router(config-if)#clock rate 64000
This command applies only to DCE interfaces
Router(config-if)#exit
Router(config)#interface FastEthernet0/0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
ip address 192.168.2.100 255.255.255.0
Router(config-if)#ip address 192.168.2.100 255.255.255.0
Router(config-if)#

Router(config-if)#exit
Router(config)#ip dhcp pool abc
Router(dhcp-config)#default-router 192.168.2.100
Router(dhcp-config)#network 192.168.2.0 255.255.255.0

similarly on pc 1



similarly on pc 3



Router 0 is aware of only directly connected network and cannot connect to router 2 pcs pc 2and pc 3

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

Gateway of last resort is not set

C 12.0.0.0/8 is directly connected, Serial0/0
C 192.168.1.0/24 is directly connected, FastEthernet0/0

Router#

Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router eigrp 13
Router(config-router)#network 192.168.1.0

Router(config-router)#no auto-summary
Router(config-router)#network 12.0.0.0

Router(config-router)#do show ip route

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

Gateway of last resort is not set

C 12.0.0.0/8 is directly connected, Serial0/0
C 192.168.1.0/24 is directly connected, FastEthernet0/0

Router(config-router)#no auto-summary
Router(config-router)#

Router 1

Configure EIGRP Protocol on Router1

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

Gateway of last resort is not set

C 12.0.0.0/8 is directly connected, Serial0/0
C 23.0.0.0/8 is directly connected, Serial0/1

Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router eigrp 13
Router(config-router)#network 12.0.0.0
Router(config-router)#
%DUAL-5-NBRCHANGE: IP-EIGRP 13: Neighbor 12.1.1.1 (Serial0/0) is up: new adjacency

Router(config-router)#no auto-summary
Router(config-router)#
%DUAL-5-NBRCHANGE: IP-EIGRP 13: Neighbor 12.1.1.1 (Serial0/0) resync: summary configured

Router(config-router)#end
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#show ip eigrp neighbors
IP-EIGRP neighbors for process 13
H Address Interface Hold Uptime SRTT RTO Q Seq
(sec) (ms) Cnt Num
0 12.1.1.1 Se0/0 12 00:00:51 40 1000 0 2

Router#ping 12.1.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/19/44 ms

RIP On Router1

Router# en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router rip
Router(config-router)#version 2
Router(config-router)#no auto-summary
Router(config-router)#network 23.0.0.0
Router(config-router)#end
Router#
%SYS-5-CONFIG_I: Configured from console by console

To See The Protocols Running On Router1 RIP AND EIGRP

Router#show ip protocols

Routing Protocol is "eigrp 13 "
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set
Default networks flagged in outgoing updates
Default networks accepted from incoming updates
EIGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
EIGRP maximum hopcount 100
EIGRP maximum metric variance 1
Redistributing: eigrp 13
Automatic network summarization is not in effect
Maximum path: 4
Routing for Networks:
12.0.0.0
Routing Information Sources:
Gateway Distance Last Update
12.1.1.1 90 2978725
Distance: internal 90 external 170

Routing Protocol is "rip"
Sending updates every 30 seconds, next due in 12 seconds
Invalid after 180 seconds, hold down 180, flushed after 240
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set
Redistributing: rip
Default version control: send version 2, receive 2
Interface Send Recv Triggered RIP Key-chain
Serial0/1 22
Automatic network summarization is not in effect
Maximum path: 4

Routing for Networks:
23.0.0.0
Passive Interface(s):
Routing Information Sources:
Gateway Distance Last Update
Distance: (default is 120)
Router#
Router#

Router 2

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

Gateway of last resort is not set

C 23.0.0.0/8 is directly connected, Serial0/0
C 192.168.2.0/24 is directly connected, FastEthernet0/0

Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router rip
Router(config-router)#version 2
Router(config-router)#no auto-summary
Router(config-router)#network 23.0.0.0
Router(config-router)#network 192.168.2.0
Router(config-router)#end
Router#
%SYS-5-CONFIG_I: Configured from console by console

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

Gateway of last resort is not set

C 23.0.0.0/8 is directly connected, Serial0/0
C 192.168.2.0/24 is directly connected, FastEthernet0/0

Router#

On Router 1 RIP AND EIGRP

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

Gateway of last resort is not set

C 12.0.0.0/8 is directly connected, Serial0/0
C 23.0.0.0/8 is directly connected, Serial0/1
D 192.168.1.0/24 [90/2172416] via 12.1.1.1, 00:11:58, Serial0/0
R 192.168.2.0/24 [120/1] via 23.1.1.2, 00:00:13, Serial0/1

Router#

On Router 0

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

Gateway of last resort is not set

C 12.0.0.0/8 is directly connected, Serial0/0
C 192.168.1.0/24 is directly connected, FastEthernet0/0

On Router 1 Redistribute RIP IN EIGRP

Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router eigrp 13
Router(config-router)#redistribute rip metric 1 1 255 255 1
Router(config-router)#exit

On Router 0 check ex occurs means RIP is install in EIGRP on router 0
170 means rip routes is learned in eigrp routes else it is 90

Router#show ip protocols

Routing Protocol is "eigrp 13 "
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set
Default networks flagged in outgoing updates
Default networks accepted from incoming updates
EIGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
EIGRP maximum hopcount 100
EIGRP maximum metric variance 1
Redistributing: eigrp 13
Automatic network summarization is not in effect
Maximum path: 4
Routing for Networks:
192.168.1.0
12.0.0.0
Routing Information Sources:
Gateway Distance Last Update
12.1.1.2 90 3003639
Distance: internal 90 external 170

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

Gateway of last resort is not set

C 12.0.0.0/8 is directly connected, Serial0/0
D EX 23.0.0.0/8 [170/2560512256] via 12.1.1.2, 00:01:46, Serial0/0
C 192.168.1.0/24 is directly connected, FastEthernet0/0
D EX 192.168.2.0/24 [170/2560512256] via 12.1.1.2, 00:01:46, Serial0/0

Router#

On router 1 redistribute eigrp in rip

Udp port 520 rip

Router(config)#router rip
Router(config-router)#redistribute eigrp 13 metric 1
Router(config-router)#exit
Router(config)#

Check on Router 2

Metric 1 indicates other network is only 1 router away 120/1

Router>en

Router#show ip protocols
Routing Protocol is "rip"
Sending updates every 30 seconds, next due in 21 seconds
Invalid after 180 seconds, hold down 180, flushed after 240
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set
Redistributing: rip
Default version control: send version 2, receive 2
Interface Send Recv Triggered RIP Key-chain
FastEthernet0/0 22
Serial0/0 22
Automatic network summarization is not in effect
Maximum path: 4
Routing for Networks:
23.0.0.0
192.168.2.0
Passive Interface(s):
Routing Information Sources:
Gateway Distance Last Update
23.1.1.1 120 00:00:29
Distance: (default is 120)

Router#show ip route

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR

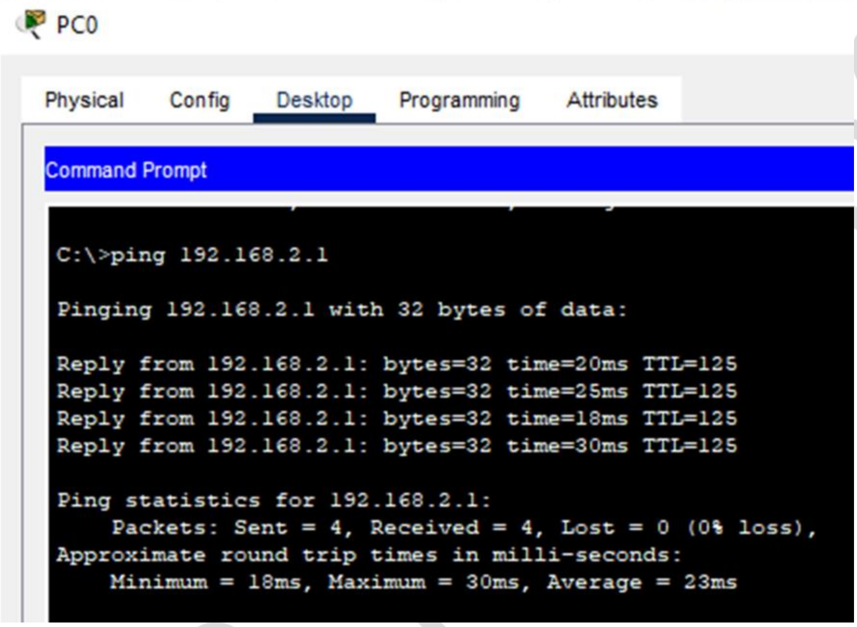
P - periodic downloaded static route

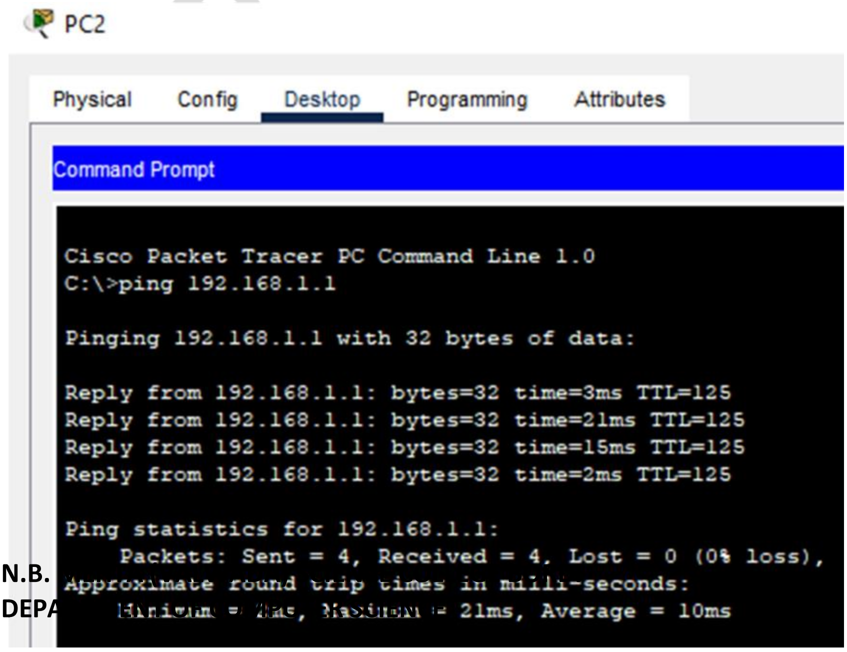
Gateway of last resort is not set

R 12.0.0.0/8 [120/1] via 23.1.1.1, 00:00:12, Serial0/0
C 23.0.0.0/8 is directly connected, Serial0/0
R 192.168.1.0/24 [120/1] via 23.1.1.1, 00:00:12, Serial0/0
C 192.168.2.0/24 is directly connected, FastEthernet0/0

Router#

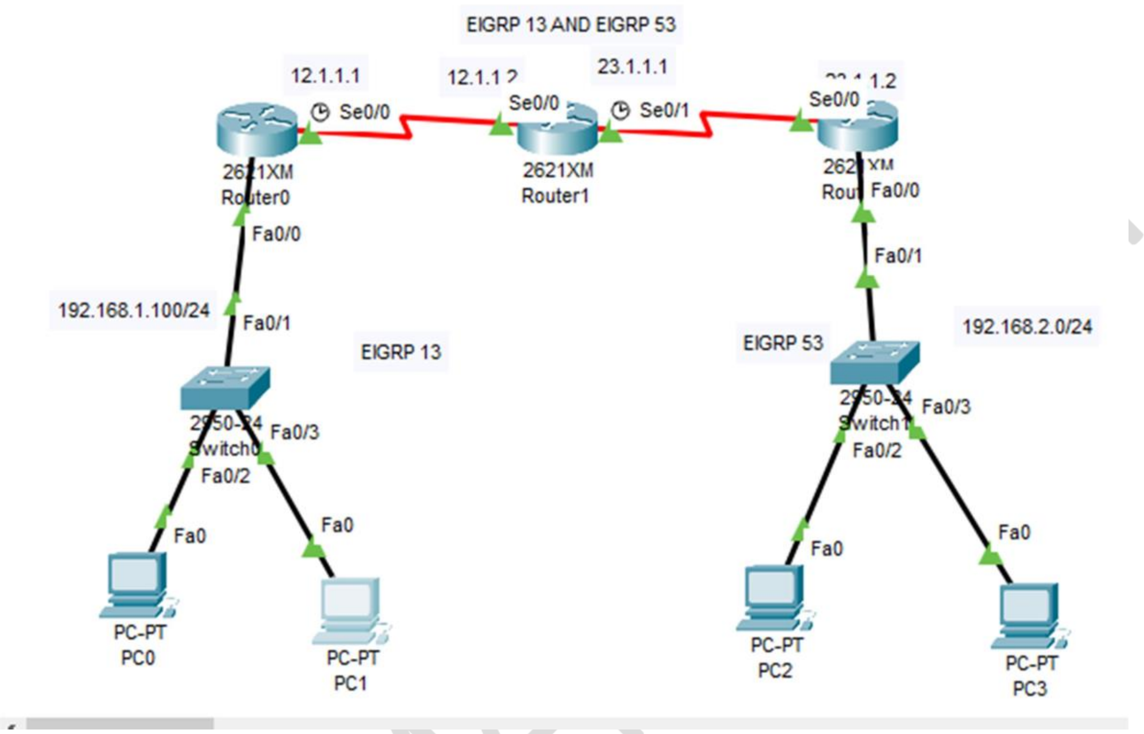
Pinging EIGRP FROM RIP AND RIP FROM EIGRP





2. Configure Route Redistribution Within the Same Interior Gateway Protocol

Step 1: Topology



Step 2: Basic configurations

Router 0

Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int f0/0
Router(config-if)#ip address 192.168.1.100 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
Router(config-if)#end
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#ip dhcp pool abc
Router(dhcp-config)#default-router 192.168.1.100

```
Router(dhcp-config)#network 192.168.1.0 255.255.255.0
Router(dhcp-config)#int s0/0
Router(config-if)#ip address 12.1.1.1 255.0.0.0
Router(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/0, changed state to down
Router(config-if)#
Router(config-if)#clock rate 64000
Router(config-if)#

Router#show ip int brief
Interface IP-Address OK? Method Status Protocol
FastEthernet0/0 192.168.1.100 YES manual up up
FastEthernet0/1 unassigned YES unset administratively down down
Serial0/0 12.1.1.1 YES manual up up
Serial0/1 unassigned YES unset administratively down down
Router#
```

Router 1

```
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface Serial0/0
Router(config-if)#ip address 12.1.1.2 255.0.0.0
Router(config-if)#ip address 12.1.1.2 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface Serial0/0, changed state to up

Router(config-if)#exit
Router(config)#interface Serial0/1
Router(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
no ip address
Router(config-if)#ip address 23.1.1.1 255.0.0.0
Router(config-if)#ip address 23.1.1.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#
Router(config-if)#exit
Router(config)#interface Serial0/0
Router(config-if)#clock rate 64000
This command applies only to DCE interfaces

Router#show ip int brief
Interface IP-Address OK? Method Status Protocol
FastEthernet0/0 unassigned YES unset administratively down down
```

FastEthernet0/1 unassigned YES unset administratively down down
Serial0/0 12.1.1.2 YES manual up up
Serial0/1 23.1.1.1 YES manual down down

Router 2

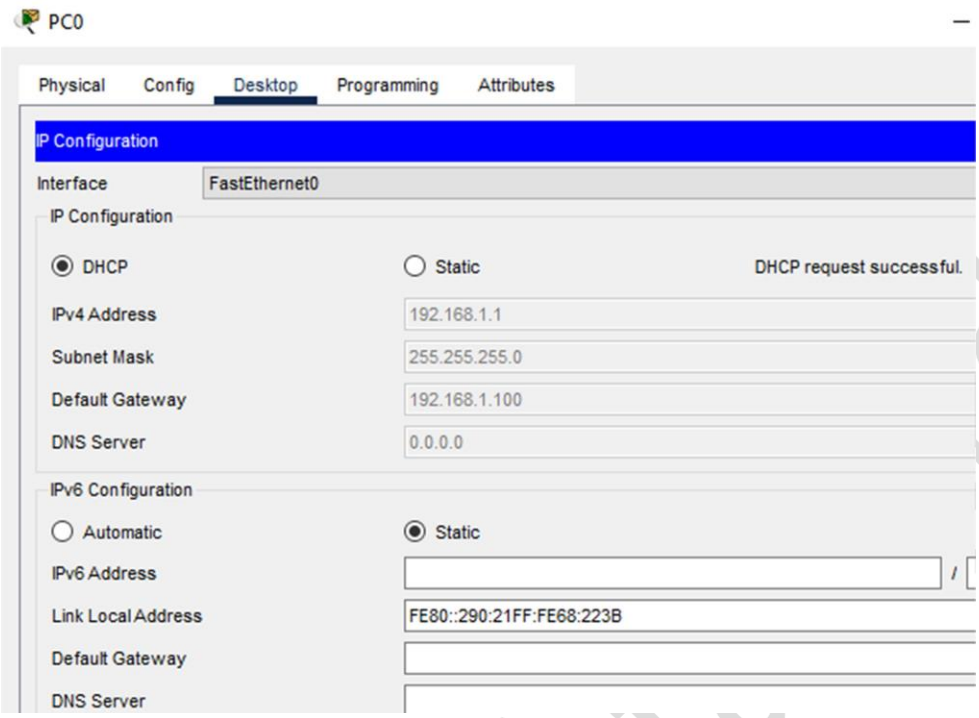
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface Serial0/0
Router(config-if)#ip address 23.1.1.2 255.0.0.0
Router(config-if)#ip address 23.1.1.2 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface Serial0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
clock rate 64000
This command applies only to DCE interfaces
Router(config-if)#
Router(config-if)#exit
Router(config)#interface FastEthernet0/0
Router(config-if)#ip address 192.168.2.100 255.255.255.0
Router(config-if)#ip address 192.168.2.100 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up

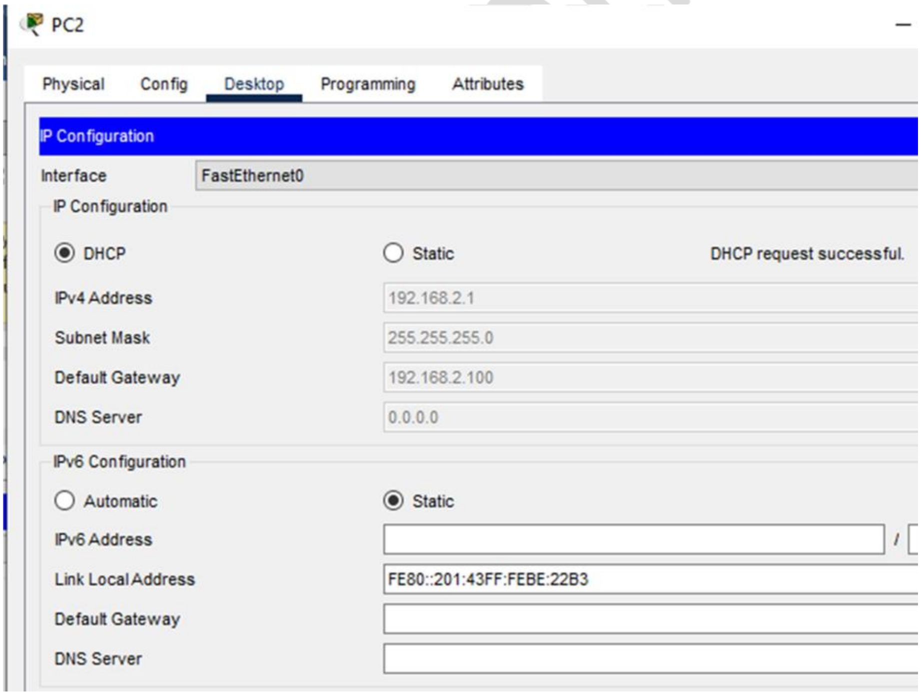
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up

Router(config-if)#exit
Router(config)#ip dhcp pool abc
Router(dhcp-config)#default-router 192.168.2.100
Router(dhcp-config)#network 192.168.2.0 255.255.255.0
Router(dhcp-config)#

Similarly on PC1



Similarly on PC3



EIGRP 13 On Router 0

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

Gateway of last resort is not set

C 12.0.0.0/8 is directly connected, Serial0/0
C 192.168.1.0/24 is directly connected, FastEthernet0/0

Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router eigrp 13
Router(config-router)#network 192.168.1.0
Router(config-router)#no auto-summary
Router(config-router)#network 12.0.0.0
Router(config-router)#no auto-summary

EIGRP 13 on Router 1

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

Gateway of last resort is not set

C 12.0.0.0/8 is directly connected, Serial0/0
C 23.0.0.0/8 is directly connected, Serial0/1

Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router eigrp 13
Router(config-router)#network 12.0.0.0
Router(config-router)#
%DUAL-5-NBRCHANGE: IP-EIGRP 13: Neighbor 12.1.1.1 (Serial0/0) is up: new adjacency

Router(config-router)#no auto-summary
Router(config-router)#
%DUAL-5-NBRCHANGE: IP-EIGRP 13: Neighbor 12.1.1.1 (Serial0/0) resync: summary configured

Router(config-router)#end
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#show ip eigrp neighbors
IP-EIGRP neighbors for process 13
H Address Interface Hold Uptime SRTT RTO Q Seq
(sec) (ms) Cnt Num
0 12.1.1.1 Se0/0 13 00:00:39 40 1000 0 2

Router#ping 12.1.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 12/23/62 ms

Router#

EIGRP 53 On Router 1

Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router eigrp 53
Router(config-router)#network 23.0.0.0
Router(config-router)#no auto-summary
Router(config-router)#end
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#show ip protocols

Routing Protocol is "eigrp 13 "
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set
Default networks flagged in outgoing updates
Default networks accepted from incoming updates
EIGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
EIGRP maximum hopcount 100
EIGRP maximum metric variance 1
Redistributing: eigrp 13

Automatic network summarization is not in effect
Maximum path: 4
Routing for Networks:
12.0.0.0
Routing Information Sources:
Gateway Distance Last Update
12.1.1.1 90 1278352
Distance: internal 90 external 170

Routing Protocol is "eigrp 53 "
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set

Router#

EIGRP 53 On Router 2

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

Gateway of last resort is not set

C 23.0.0.0/8 is directly connected, Serial0/0
C 192.168.2.0/24 is directly connected, FastEthernet0/0

Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router eigrp 53
Router(config-router)#no auto-summary
Router(config-router)#network 23.0.0.0
Router(config-router)#
%DUAL-5-NBRCHANGE: IP-EIGRP 53: Neighbor 23.1.1.1 (Serial0/0) is up: new adjacency

Router(config-router)#network 192.168.2.0
Router(config-router)#end
Router#
%SYS-5-CONFIG_I: Configured from console by console

On Router 1 Redistribute EIGRP 13 AND EIGRP 53

Router#show ip eigrp neighbors
IP-EIGRP neighbors for process 13
H Address Interface Hold Uptime SRTT RTO Q Seq
(sec) (ms) Cnt Num
0 12.1.1.1 Se0/0 11 00:05:34 40 1000 0 2

IP-EIGRP neighbors for process 53
H Address Interface Hold Uptime SRTT RTO Q Seq
(sec) (ms) Cnt Num
0 23.1.1.2 Se0/1 10 00:01:26 40 1000 0 2

1. EIGRP 53 IN EIGRP 13 On R1

Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router eigrp 13
Router(config-router)#redistribute eigrp 53 metric 1 1 255 255 1
Router(config-router)#exit
Router(config)#

Check on Router 0

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

Gateway of last resort is not set

C 12.0.0.0/8 is directly connected, Serial0/0
D EX 23.0.0.0/8 [170/2560514560] via 12.1.1.2, 00:01:29, Serial0/0
C 192.168.1.0/24 is directly connected, FastEthernet0/0
D EX 192.168.2.0/24 [170/2560514560] via 12.1.1.2, 00:01:29, Serial0/0

Router#

2. EIGRP 13 IN EIGRP 53 On R1

Router(config)#router eigrp 53
Router(config-router)#redistribute eigrp 13 metric 1 1 255 255 1
Router(config-router)#exit
Router(config)#

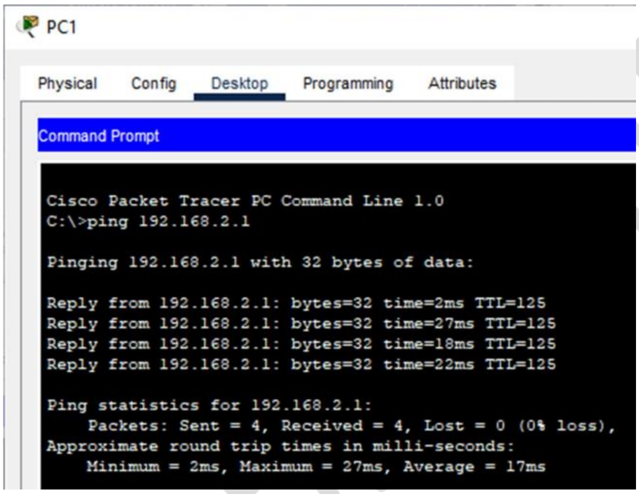
Check On R2

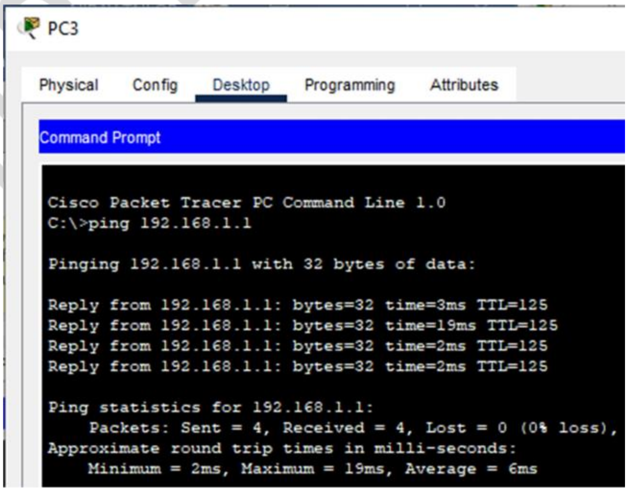
Router#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS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

Gateway of last resort is not set

D EX 12.0.0.0/8 [170/2560514560] via 23.1.1.1, 00:01:15, Serial0/0
C 23.0.0.0/8 is directly connected, Serial0/0
D EX 192.168.1.0/24 [170/2560514560] via 23.1.1.1, 00:01:15, Serial0/0
C 192.168.2.0/24 is directly connected, FastEthernet0/0

Ping and check connection

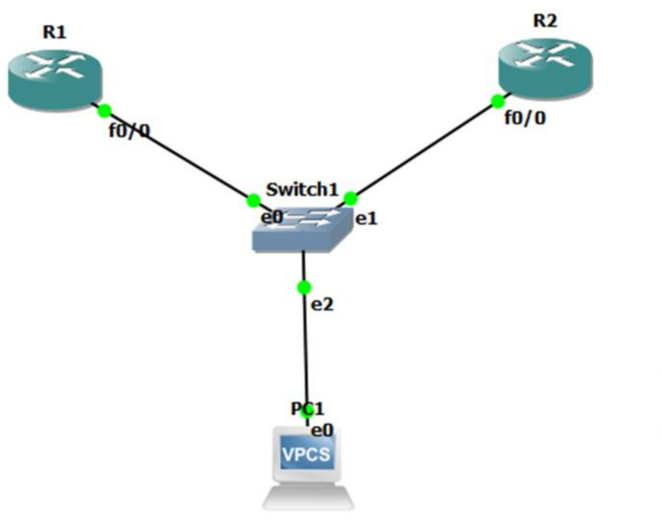




Practical 6

1. **Implement VRRP**
2. **Implement HSRP**
3. **Implement GLBP**

Step 1: Topology



BASIC CONFIGURATIONS FOR ROUTERS

Consider above given topology. There are 2 routers named R1 and R2. IP address of R1 (f 0/0) is 10.1.1.1/24 and R2 (f 0/0) is 10.1.1.2/24.

1. Assigning IP address to router R1.

R1(config)# int fa0/0
R1(config-if)# ip add 10.1.1.1 255.255.255.0
R2(config-if)#no shutdown
R2(config-if)#exit

2. Assigning IP address to router R2.

R2(config)# int fa0/0
R2(config-if)# ip address 10.1.1.2 255.255.255.0
R2(config-if)#no shutdown
R2(config-if)#exit

1. Implement VRRP

VRRP is an open standard protocol, which is used to provide redundancy in a network. It is a network layer protocol (protocol number-112). The number of routers (group members) in a group acts as a virtual logical router which will be the default gateway of all the local hosts. If one router goes down, one of the other group members can take place for responsibility for forwarding the traffic.

1. Now, let's provide a virtual IP address(10.1.1.100), group name *VRRP_TEST*, group number 10 and priority 110. Also, here preempt has been enabled by default i.e. if the master router goes down then the backup router automatically becomes the master router.

```
R1#

R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#int f0/0
R1(config-if)#vrrp 10 ip 10.1.1.100
R1(config-if)#
*Mar  1 00:03:01.775: %VRRP-6-STATECHANGE: Fa0/0 Grp 10 state Init -> Backup

*Mar  1 00:03:05.387: %VRRP-6-STATECHANGE: Fa0/0 Grp 10 state Backup -> Master
R1(config-if)#vrrp 10 priority 110
R1(config-if)#exit
R1(config)#exit
R1#
*Mar  1 00:08:41.703: %SYS-5-CONFIG_I: Configured from console by console


R1# show vrrp brief

Interface          Grp Pri Time  Own Pre State   Master addr      Group addr
Fa0/0              10  110 3570      Y  Master  10.1.1.1        10.1.1.100
```

R2

2. Now, provide the virtual IP address(10.1.1.100), group name VRRP_TEST, and priority 100. Also, group number 10 is assigned.

```
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#int f0/0
R2(config-if)#vrrp 10 ip 10.1.1.100
*Mar  1 00:04:14.483: %VRRP-6-STATECHANGE: Fa0/0 Grp 10 state Init -> Backup
R2(config-if)#vrrp 10 priority 100
R2(config-if)#exit
R2(config)#exit
R2#s
*Mar  1 00:10:18.479: %SYS-5-CONFIG_I: Configured from console by console
```

As provided priority 110 to r1, therefore, it will become the master router.

R2#show vrrp brief
Interface Grp Pri Time Own Pre State Master addr Group addr
Fa0/0 10 100 3609 Y Backup 10.1.1.1 10.1.1.100
R2#

3. TEST
Pc
PC1> ip 10.1.1.128 10.1.1.100
Checking for duplicate address...
PC1 : 10.1.1.128 255.255.255.0 gateway 10.1.1.100

PC1> ping 10.1.1.100
84 bytes from 10.1.1.100 icmp_seq=1 ttl=255 time=15.803 ms
84 bytes from 10.1.1.100 icmp_seq=2 ttl=255 time=15.773 ms
84 bytes from 10.1.1.100 icmp_seq=3 ttl=255 time=15.735 ms
84 bytes from 10.1.1.100 icmp_seq=4 ttl=255 time=15.777 ms
84 bytes from 10.1.1.100 icmp_seq=5 ttl=255 time=15.782 ms

PC1> trace 10.1.1.100
trace to 10.1.1.100, 8 hops max, press Ctrl+C to stop
1 *10.1.1.1 15.821 ms (ICMP type:3, code:3, Destination port unreachable)

2. Implement HSRP

Hot Standby Router Protocol (HSRP) is a CISCO proprietary protocol, which provides redundancy for a local subnet. In HSRP, two or more routers gives an illusion of a virtual router.
HSRP allows you to configure two or more routers as standby routers and only a single router as an active router at a time. All the routers in a single HSRP group shares a single MAC address and IP address, which acts as a default gateway to the local network. The *Active router* is responsible for forwarding the traffic. If it fails, the *Standby router* takes up all the responsibilities of the active router and forwards the traffic.

1. Now, Let's provide virtual IP address (10.1.1.100), group name *HSRP_TEST*, group number 1and priority 110. Also, preempt has been enabled i.e. if the active router goes down then the standby router automatically becomes the active router.
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int f0/0
R1(config-if)#standby 1 ip 10.1.1.100
R1(config-if)#standby 1 name HSRP_TEST
R1(config-if)#standby 1
*Mar 1 00:05:56.447: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Speak ->
Standby

*Mar 1 00:05:56.947: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Standby -
> Active
R1(config-if)#standby 1 priority 110
R1(config-if)#standby 1 preempt
R1(config-if)#exit
R1(config)#exit
R1#

```
R1#show standby brief
               P indicates configured to preempt.
               |
Interface   Grp Prio P State   Active          Standby        Virtual IP
Fa0/0       1   110  P Active  local           10.1.1.2       10.1.1.100
```

2. Now, we will provide virtual IP address (10.1.1.100), group name *HSRP_TEST* and priority 100. Also, group number 1 and preempt has been enabled.

R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int f0/0
R2(config-if)#standby 1 ip 10.1.1.100
R2(config-if)#standby 1 name HSRP_TEST
R2(config-if)#standby 1 priority
*Mar 1 00:07:53.899: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Speak ->
Standby
R2(config-if)#standby 1 priority 100
R2(config-if)#standby 1 preempt
R2(config-if)#exit
R2(config)#exit
*Mar 1 00:12:29.087: %SYS-5-CONFIG_I: Configured from console by console

As we have provided priority 110 to r1, therefore it will become the active router.

```
R2#show standby brief
               P indicates configured to preempt.
               |
Interface    Grp Prio P State    Active        Standby        Virtual IP
Fa0/0        1   100  P Standby  10.1.1.1      local          10.1.1.100
R2#
```

3.Test

PC1> ping 10.1.1.100
84 bytes from 10.1.1.100 icmp_seq=1 ttl=255 time=15.819 ms

84 bytes from 10.1.1.100 icmp_seq=2 ttl=255 time=15.730 ms
84 bytes from 10.1.1.100 icmp_seq=3 ttl=255 time=15.698 ms
84 bytes from 10.1.1.100 icmp_seq=4 ttl=255 time=15.741 ms
84 bytes from 10.1.1.100 icmp_seq=5 ttl=255 time=15.787 ms

PC1> trace 10.1.1.100 -P 6
trace to 10.1.1.100, 8 hops max (TCP), press Ctrl+C to stop
 1 10.1.1.100 15.819 ms 15.745 ms 15.451 ms

PC1>

3. Implement GLBP

Gateway Load Balancing Protocol (GLBP) is one of First Hop Redundancy Protocol (FHRP) which provides redundancy like other First Hop Redundancy Protocol, also provides load Balancing. It is a Cisco proprietary protocol which can perform both functions. It provides load Balancing over multiple routers using single virtual IP address and multiple virtual Mac address.

1. **Now, configure virtual IP, GLBP priority, preemption and type of load Balancing.**
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int f0/0
R1(config-if)#glbp 1 ip 10.1.1.100
R1(config-if)#glbp 1 priority 120
R1(config-if)#glbp 1 preem
*Mar 1 00:03:46.559: %GLBP-6-STATECHANGE: FastEthernet0/0 Grp 1 state Standby -
> Active
R1(config-if)#glbp 1 preempt
R1(config-if)#glbp 1 load-
*Mar 1 00:03:56.559: %GLBP-6-FWDSTATECHANGE: FastEthernet0/0 Grp 1 Fwd 1 state
Listen -> Active
R1(config-if)#glbp 1 load-balancing round-robin
R1(config-if)#exit
R1#
*Mar 1 00:06:08.675: %SYS-5-CONFIG_I: Configured from console by console

R1#show glbp brief

Interface	Grp	Fwd	Pri	State	Address	Active router	Standby router
Fa0/0	1	-	120	Active	10.1.1.100	local	10.1.1.2
Fa0/0	1	1	-	Active	0007.b400.0101	local	-
Fa0/0	1	2	-	Listen	0007.b400.0102	10.1.1.2	-

2. Here, assign the virtual IP as 10.1.1.100 from the local subnet and priority(assign R1 with higher priority as we want this router to become AVG). Also, preempt has been enabled and load Balancing of type round-robin. Now, configure same GLBP for r2.

```
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#int f0/0
R2(config-if)#glbp 1 ip 10.1.1.100
R2(config-if)#glbp 1 priority 100
R2(config-if)#glbp 1 preempt
*Mar  1 00:05:43.371: %GLBP-6-FWDSTATECHANGE: FastEthernet0/0 Grp 1 Fwd 2 state
Listen -> Active
R2(config-if)#glbp 1 load-balancing round-robin
R2(config-if)#exit
R2(config)#exit
R2#
R2#sho
*Mar  1 00:06:25.099: %SYS-5-CONFIG_I: Configured from console by console


R2#show glbp brief

Interface  Grp  Fwd Pri State   Address         Active router   Standby router
Fa0/0      1   -   100 Standby 10.1.1.100      10.1.1.1        local
Fa0/0      1   1   -   Listen  0007.b400.0101  10.1.1.1        -
Fa0/0      1   2   -   Active  0007.b400.0102  local           -
```

3.Test

```
PC1> ping 10.1.1.100
84 bytes from 10.1.1.100 icmp_seq=1 ttl=255 time=15.477 ms
84 bytes from 10.1.1.100 icmp_seq=2 ttl=255 time=15.897 ms
84 bytes from 10.1.1.100 icmp_seq=3 ttl=255 time=15.769 ms
84 bytes from 10.1.1.100 icmp_seq=4 ttl=255 time=15.729 ms
84 bytes from 10.1.1.100 icmp_seq=5 ttl=255 time=15.854 ms

PC1> trace 10.1.1.100 -P 6
trace to 10.1.1.100, 8 hops max (TCP), press Ctrl+C to stop
 1   10.1.1.100   15.892 ms  15.483 ms  15.520 ms
```

Practical 7:

Implement MPLS

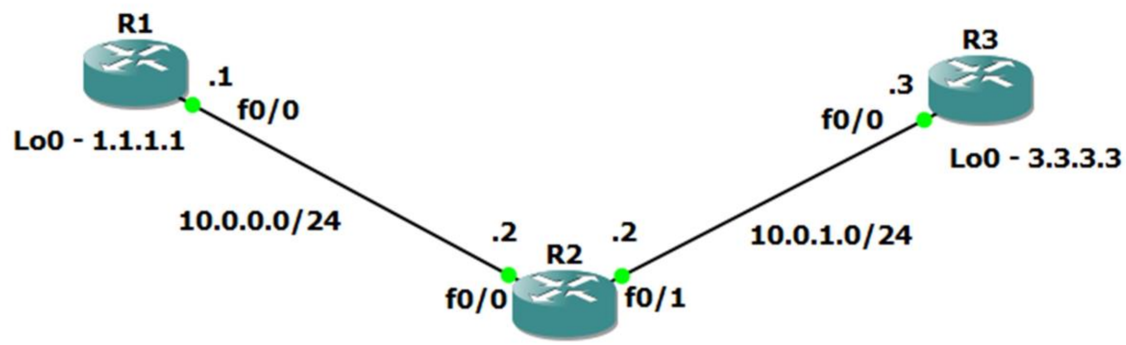
Introduction

Multiprotocol Label Switching (MPLS) is a way of routing traffic within a telecommunications network that directs data from one node to the next based path labels rather than long network addresses, It also allows the sharing of address space for clients as it is labels that are being routed not prefixes.

No, MPLS is a method to route networks across a service provider network, routing protocols like OSPF and BGP are used to make MPLS work. MPLS operates using BGP and typically uses OSPF to exchange routes with the customer.

MPLS was designed to work in a multiple protocol environment. Today, MPLS is used to support metro-Ethernet services & mobile communications back-haul it's main benefit is the ability to have two clients using the same address space and routing over the service provider network as they are routing using labels and not prefixes.

Topology



Step 1 – IP addressing of MPLS Core and OSPF

1. First bring 3 routers into your topology R1, R2, R3 position them as below. We are going to address the routers and configure ospf to ensure loopback to loopback connectivity between R1 and R3

R1

```
hostname R1
int lo0
ip add 1.1.1.1 255.255.255.255
ip ospf 1 area 0

int f0/0
ip add 10.0.0.1 255.255.255.0
```

no shut
ip ospf 1 area 0

R2
hostname R2
int lo0
ip add 2.2.2.2 255.255.255.255
ip ospf 1 are 0

int f0/0
ip add 10.0.0.2 255.255.255.0
no shut
ip ospf 1 area 0

int f0/1
ip add 10.0.1.2 255.255.255.0
no shut
ip ospf 1 area 0

R3
hostname R3
int lo0
ip add 3.3.3.3 255.255.255.255
ip ospf 1 are 0

int f0/0
ip add 10.0.1.3 255.255.255.0
no shut
ip ospf 1 area 0

2. You should now have full ip connectivity between R1, R2, R3 to verify this we need to see if we can ping between the loopbacks of R1 and R3

R1#ping 3.3.3.3 source lo0

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
Packet sent with a source address of 1.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 40/52/64 ms

Step 2 – Configure LDP on all the interfaces in the MPLS Core

1. In order to run MPLS you need to enable it, there are two ways to do this.

At each interface enter the mpls ip command Under the ospf process use the mpls ldp autoconfig using the second option, so go int the ospf process and enter mpls ldp autoconfig – this will enable mpls label distribution protocol on every interface running ospf under that specific process.

R1
router ospf 1
mpls ldp autoconfig

R2
router ospf 1
mpls ldp autoconfig

R3
router ospf 1
mpls ldp autoconfig
You should see log messages coming up showing the LDP neighbors are up.
R2#
*Mar 1 00:31:53.643: %SYS-5-CONFIG_I: Configured from console
*Mar 1 00:31:54.423: %LDP-5-NBRCHG: LDP Neighbor 1.1.1.1:0 (1) is UP
R2#
*Mar 1 00:36:09.951: %LDP-5-NBRCHG: LDP Neighbor 3.3.3.3:0 (2) is UP

2. To verify the mpls interfaces the command is very simple – sh mpls interface
This is done on R2 and you can see that both interfaces are running mpls and using LDP

R2#sh mpls interface

Interface	IP	Tunnel	Operational
FastEthernet0/0	Yes (ldp)	No	Yes
FastEthernet0/1	Yes (ldp)	No	Yes

You can also verify the LDP neighbors with the sh mpls ldp neighbors command.

R2#sh mpls ldp neigh

```
  Peer LDP Ident: 1.1.1.1:0; Local LDP Ident 2.2.2.2:0
    TCP connection: 1.1.1.1.646 - 2.2.2.2.37909
    State: Oper; Msgs sent/rcvd: 16/17; Downstream
    Up time: 00:07:46
    LDP discovery sources:
    FastEthernet0/0, Src IP addr: 10.0.0.1
    Addresses bound to peer LDP Ident:
      10.0.0.1       1.1.1.1
  Peer LDP Ident: 3.3.3.3:0; Local LDP Ident 2.2.2.2:0
    TCP connection: 3.3.3.3.22155 - 2.2.2.2.646
    State: Oper; Msgs sent/rcvd: 12/11; Downstream
    Up time: 00:03:30
    LDP discovery sources:
```

```
  FastEthernet0/1, Src IP addr: 10.0.1.3
 Addresses bound to peer LDP Ident:
  10.0.1.3        3.3.3.3
```

3. One more verification to confirm LDP is running ok is to do a trace between R1 and R3 and verify if you get MPLS Labels show up in the trace.

```
R1#trace 3.3.3.3

Type escape sequence to abort.
Tracing the route to 3.3.3.3

  1 10.0.0.2 [MPLS: Label 17 Exp 0] 84 msec 72 msec 44 msec
  2 10.0.1.3 68 msec 60 msec *
```

4. As you can see the trace to R2 used an MPLS Label in the path, as this is a very small MPLS core only one label was used as R3 was the final hop.

So to review we have now configured IP addresses on the MPLS core, enabled OSPF and full IP connectivity between all routers and finally enabled mpls on all the interfaces in the core and have established ldp neighbors between all routers.
The next step is to configure MP-BGP between R1 and R3
This is when you start to see the layer 3 vpn configuration come to life

Step 3 – MPLS BGP Configuration between R1 and R3

We need to establish a Multi Protocol BGP session between R1 and R3 this is done by configuring the vpnv4 address family as below

```
R1#
router bgp 1
 neighbor 3.3.3.3 remote-as 1
 neighbor 3.3.3.3 update-source Loopback0
 no auto-summary
 !
 address-family vpnv4
  neighbor 3.3.3.3 activate

R3#
router bgp 1
 neighbor 1.1.1.1 remote-as 1
 neighbor 1.1.1.1 update-source Loopback0
 no auto-summary
 !
 address-family vpnv4
  neighbor 1.1.1.1 activate

*Mar  1 00:45:01.047: %BGP-5-ADJCHANGE: neighbor 1.1.1.1 Up
```

You should see log messages showing the BGP sessions coming up.

To verify the BGP session between R1 and R3 issue the command sh bgp vpnv4 unicast all summary

R1#sh bgp vpnv4 unicast all summary

BGP router identifier 1.1.1.1, local AS number 1
BGP table version is 1, main routing table version 1

Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
4 1 218 218 1 0 0 03:17:48 0

You can see here that we do have a bgp vpnv4 peering to R3 – looking at the PfxRcd you can see it says 0 this is because we have not got any routes in BGP. We are now going to add two more routers to the topology. These will be the customer sites connected to R1 and R3. We will then create a VRF on each router and put the interfaces connected to each site router into that VRF.

Step 4 – Add two more routers, create VRFs

1. We will add two more routers into the topology so it now looks like the final topology
Router 4 will peer OSPF using process number 2 to a VRF configured on R1. It will use the local site addressing of 192.168.1.0/24.

R4
int lo0
ip add 4.4.4.4 255.255.255.255
ip ospf 2 area 2
int f0/0
ip add 192.168.1.4 255.255.255.0
ip ospf 2 area 2
no shut

R1
int f0/1
no shut
ip add 192.168.1.1 255.255.255.0

Now at this point we have R4 peering to R1 but in the global routing table of R1 which is not what we want.

Using VRF's
Virtual routing and forwarding (VRF) is a technology included in IP (Internet Protocol) that allows multiple instances of a routing table to co-exist in a router and work together but not interfere with each other.. This increases functionality by allowing network paths to be segmented without using multiple devices.

As an example if R1 was a PE Provider Edge router of an ISP and it had two customers that were both addressed locally with the 192.168.1.0/24 address space it could accommodate both their routing tables in different VRFs – it distinguishes between the two of them using a Route Distinguisher
So back to the topology – we now need to create a VRF on R1
For this mpls tutorial I will be using VRF RED

R1
ip vrf RED
rd 4:4
route-target both 4:4
The RD and route-target do not need to be the same – and for a full explanation please read this post on Route Distinguishers

So now we have configured the VRF on R1 we need to move the interface F0/1 into that VRF
R1
int f0/1
ip vrf forwarding RED
Now notice what happens when you do that – the IP address is removed
R1(config-if)#ip vrf fo
R1(config-if)#ip vrf forwarding RED
% Interface FastEthernet0/1 IP address 192.168.1.1 removed due to enabling VRF RED

You just need to re-apply it
R1
int f0/1
ip address 192.168.1.1 255.255.255.0

Now if we view the config on R1 int f0/1 you can see the VRF configured.
R1
R1#sh run int f0/1
Building configuration...

Current configuration : 119 bytes
!
interface FastEthernet0/1
 ip vrf forwarding RED
 ip address 192.168.1.1 255.255.255.0
 duplex auto
speed auto
end

R1#
Now we can start to look int VRF's and how they operate – you need to understand now that there are 2 routing tables within R1

- The Global Routing Table
- The Routing Table for VRF RED

If you issue the command sh ip route this shows the routes in the global table and you will notice that you do not see 192.168.1.0/24

```
R1#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
 D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
 N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
 E1 - OSPF external type 1, E2 - OSPF external type 2
 i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
 ia - IS-IS inter area, * - candidate default, U - per-user static route
 o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

1.0.0.0/32 is subnetted, 1 subnets
C 1.1.1.1 is directly connected, Loopback0
 2.0.0.0/32 is subnetted, 1 subnets
O 2.2.2.2 [110/11] via 10.0.0.2, 01:03:48, FastEthernet0/0
 3.0.0.0/32 is subnetted, 1 subnets
O 3.3.3.3 [110/21] via 10.0.0.2, 01:02:29, FastEthernet0/0
 10.0.0.0/24 is subnetted, 2 subnets
C 10.0.0.0 is directly connected, FastEthernet0/0
O 10.0.1.0 [110/20] via 10.0.0.2, 01:02:39, FastEthernet0/0

R1#
```

If you now issue the command sh ip route vrf red – this will show the routes in the routing table for VRF RED

```
R1#sh ip route vrf red

% IP routing table red does not exist
```

NOTE: The VRF name is case sensitive!

```
R1#sh ip route vrf RED

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

Gateway of last resort is not set

C 192.168.1.0/24 is directly connected, FastEthernet0/1
R1#
```

We just need to enable OSPF on this interface and get the loopback address for R4 in the VRF RED routing table before proceeding.

R1
int f0/1
ip ospf 2 area 2

You should see a log message showing the OSPF neighbor come up

R1(config-if)#
*Mar 1 01:12:54.323: %OSPF-5-ADJCHG: Process 2, Nbr 4.4.4.4
on FastEthernet0/1 from LOADING to FULL, Loading Done

If we now check the routes in the VRF RED routing table you should see 4.4.4.4 in there as well.

R1#sh ip route vrf RED

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

Gateway of last resort is not set

4.0.0.0/32 is subnetted, 1 subnets
O 4.4.4.4 [110/11] via 192.168.1.4, 00:00:22, FastEthernet0/1
C 192.168.1.0/24 is directly connected, FastEthernet0/1
R1#

We now need to repeat this process for R3 & R6

Router 6 will peer OSPF using process number 2 to a VRF configured on R3. It will use the local site addressing of 192.168.2.0/24.

R6
int lo0
ip add 6.6.6.6 255.255.255.255
ip ospf 2 area 2
int f0/0
ip add 192.168.2.6 255.255.255.0
ip ospf 2 area 2
no shut

R3
int f0/1
no shut
ip add 192.168.2.3 255.255.255.0

We also need to configure a VRF onto R3 as well.

R3
ip vrf RED
rd 4:4

route-target both 4:4
So now we have configured the VRF on R3 we need to move the interface F0/1 into that VRF
R3
int f0/1
ip vrf forwarding RED
Now notice what happens when you do that – the IP address is removed
R3(config-if)#ip vrf forwarding RED
% Interface FastEthernet0/1 IP address 192.168.2.1 removed due to enabling VRF RED
You just need to re-apply it
R3
int f0/1
ip address 192.168.2.1 255.255.255.0
Now if we view the config on R3 int f0/1 you can see the VRF configured.
R3
R3#sh run int f0/1
Building configuration...

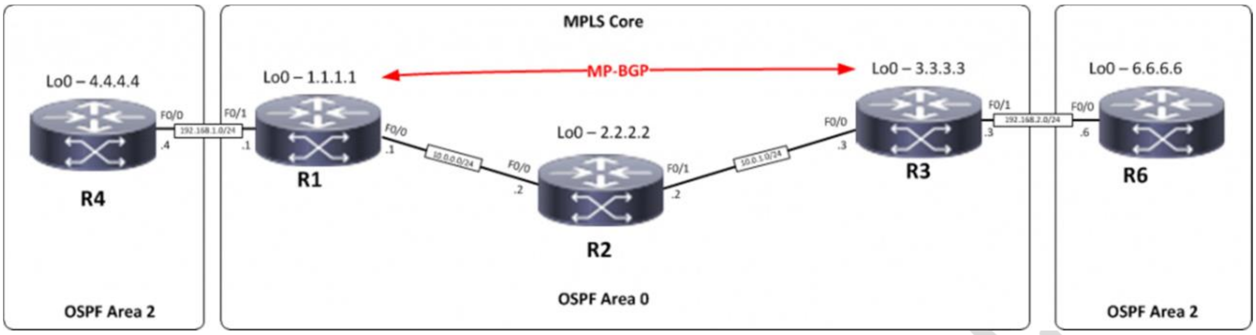
Current configuration : 119 bytes
!
interface FastEthernet0/1
ip vrf forwarding RED
ip address 192.168.2.1 255.255.255.0
duplex auto
speed auto
end
Finally we just need to enable OSPF on that interface and verify the routes are in the RED routing table.
R3
int f0/1
ip ospf 2 area 2
Check the routes in vrf RED
R3
R3#sh ip route vrf RED

Routing Table: RED
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP

Gateway of last resort is not set

6.0.0.0/32 is subnetted, 1 subnets
O 6.6.6.6 [110/11] via 192.168.2.6, 00:02:44, FastEthernet0/1
C 192.168.2.0/24 is directly connected, FastEthernet0/1

R3#
Ok so we have come a long way now let’s review the current situation. We now have this setup



R1,R2,R3 form the MPLS Core and are running OSPF with all loopbacks running a /32 address and all have full connectivity. R1 and R3 are peering with MP-BGP. LDP is enabled on all the internal interfaces. The external interfaces of the MPLS core have been placed into a VRF called RED and then a site router has been joined to that VRF on each side of the MPLS core – (These represent a small office)
The final step to get full connectivity across the MPLS core is to redistribute the routes in OSPF on R1 and R3 into MP-BGP and MP-BGP into OSPF, this is what we are going to do now.
We need to redistribute the OSPF routes from R4 into BGP in the VRF on R1, the OSPF routes from R6 into MP-BGP in the VRF on R3 and then the routes in MP-BGP in R1 and R3 back out to OSPF
Before we start lets do some verifications
Check the routes on R4

R4#sh ip route

4.0.0.0/32 is subnetted, 1 subnets
C 4.4.4.4 is directly connected, Loopback0
C 192.168.1.0/24 is directly connected, FastEthernet0/0
As expected we have the local interface and the loopback address.
When we are done we want to see 6.6.6.6 in there so we can ping across the MPLS
Check the routes on R1

R1#sh ip route

1.0.0.0/32 is subnetted, 1 subnets
C 1.1.1.1 is directly connected, Loopback0
2.0.0.0/32 is subnetted, 1 subnets
O 2.2.2.2 [110/11] via 10.0.0.2, 00:01:04, FastEthernet0/0
3.0.0.0/32 is subnetted, 1 subnets
O 3.3.3.3 [110/21] via 10.0.0.2, 00:00:54, FastEthernet0/0
10.0.0.0/24 is subnetted, 2 subnets
C 10.0.0.0 is directly connected, FastEthernet0/0
O 10.0.1.0 [110/20] via 10.0.0.2, 00:00:54, FastEthernet0/0
Remember we have a VRF configured on this router so this command will show routes in the global routing table (the MPLS Core) and it will not show the 192.168.1.0/24 route as that is in VRF RED – to see that we run the following command
R1#sh ip route vrf RED

Routing Table: RED

4.0.0.0/32 is subnetted, 1 subnets
O 4.4.4.4 [110/11] via 192.168.1.4, 00:02:32, FastEthernet0/1
C 192.168.1.0/24 is directly connected, FastEthernet0/1
Here you can see Routing Table: RED is shown and the routes to R4 are now visible with 4.4.4.4 being in OSPF.

So we need to do the following;

Redistribute OSPF into MP-BGP on R1
Redistribute MP-BGP into OSPF on R1
Redistribute OSPF into MP-BGP on R3
Redistribute MP-BGP into OSPF on R3
Redistribute OSPF into MP-BGP on R1
R1
router bgp 1
address-family ipv4 vrf RED
redistribute ospf 2
Redistribute OSPF into MP-BGP on R3

R3
router bgp 1
address-family ipv4 vrf RED
redistribute ospf 2

This has enabled redistribution of the OSPF routes into BGP. We can check the routes from R4 and R6 are now showing in the BGP table for their VRF with this command

R1#sh ip bgp vpnv4 vrf RED
BGP table version is 9, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best,
r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

Network Next Hop Metric LocPrf Weight Path
Route Distinguisher: 4:4 (default for vrf RED)
*> 4.4.4.4/32 192.168.1.4 11 32768 ?
*>i6.6.6.6/32 3.3.3.3 11 100 0 ?
*> 192.168.1.0 0.0.0.0 0 32768 ?
*>i192.168.2.0 3.3.3.3 0 100 0 ?

Here we can see that 4.4.4.4 is now in the BGP table in VRF RED on R1 with a next hop of 192.168.1.4 (R4) and also 6.6.6.6 is in there as well with a next hop of 3.3.3.3 (which is the loopback of R3 – showing that it is going over the MPLS and R1 is not in the picture)
The same should be true on R3

R3#sh ip bgp vpnv4 vrf RED

BGP table version is 9, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

Network Next Hop Metric LocPrf Weight Path
Route Distinguisher: 4:4 (default for vrf RED)
*>i4.4.4.4/32 1.1.1.1 11 100 0 ?
*> 6.6.6.6/32 192.168.2.6 11 32768 ?
*>i192.168.1.0 1.1.1.1 0 100 0 ?
*> 192.168.2.0 0.0.0.0 0 32768 ?

Which it is! 6.6.6.6 is now in the BGP table in VRF RED on R3 with a next hop of 192.168.2.6 (R6) and also 4.4.4 is in there as well with a next hop of 1.1.1.1 (which is the loopback of R1 – showing that it is going over the MPLS and R2 is not in the picture)
The final step is to get the routes that have come across the MPLS back into OSPF and then we can get end to end connectivity

R1
router ospf 2
redistribute bgp 1 subnets

R3
router ospf 2
redistribute bgp 1 subnets
If all has worked we should be now able to ping 6.6.6.6 from R4
Before we do let's see what the routing table looks like on R4

R4#sh ip route

4.0.0.0/32 is subnetted, 1 subnets
C 4.4.4.4 is directly connected, Loopback0
6.0.0.0/32 is subnetted, 1 subnets
O IA 6.6.6.6 [110/21] via 192.168.1.1, 00:01:31, FastEthernet0/0
C 192.168.1.0/24 is directly connected, FastEthernet0/0
O E2 192.168.2.0/24 [110/1] via 192.168.1.1, 00:01:31, FastEthernet0/0
Great we have 6.6.6.6 in there
Also check the routing table on R6

R6#sh ip route

4.0.0.0/32 is subnetted, 1 subnets
O IA 4.4.4.4 [110/21] via 192.168.2.1, 00:01:22, FastEthernet0/0
6.0.0.0/32 is subnetted, 1 subnets
C 6.6.6.6 is directly connected, Loopback0

O IA 192.168.1.0/24 [110/11] via 192.168.2.1,00:01:22,FastEthernet0/0
C 192.168.2.0/24 is directly connected, FastEthernet0/0
Brilliant we have 4.4.4.4 in there so we should be able to ping across the MPLS

R4#ping 6.6.6.6
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 6.6.6.6, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max= 40/48/52ms
Which we can – to prove this is going over the MPLS and be label switched and not routed, lets do a trace

R4#trace 6.6.6.6

Type escape sequence to abort.
Tracing the route to 6.6.6.6

1 192.168.1.1 20 msec 8 msec 8 msec
2 10.0.0.2 [MPLS: Labels 17/20 Exp 0] 36 msec 40 msec 36 msec
3 192.168.2.1 [MPLS: Label 20 Exp 0] 16 msec 40 msec 16 msec
4 192.168.2.6 44 msec 40 msec 56 msec
R4#

PRACTICAL 8

Aim :- Create and manage the inter connectivity of Virtual Machine on

- Vmware Esxi
- Citrix Xen
- Microsoft Hyper-V

Introduction

VMware ESXi is available to download in the official VMware site. You can download it from the account linked with the registered product.

The base ESXi installation image does not contain all the necessary software packages/drivers required for all the hardware devices. There are cases where you may require additional drivers/software. Installing these required items post-installation might be quite challenging as it involves too many processes. You can avoid such complications by building a custom ESXi installation image. This can be performed through the GUI & command-line interface.

Prerequisites

- Windows-based PC with VMware PowerCLI Installed. You can download here
- ESXi Base offline bundle. You can download here
- Driver or software you need to add to custom ISO. You can download from VMware/Product Site

Before starting to build the custom ESXi image, you need to be familiar with the following terms:

VIB – VIB stands for vSphere Installation Bundle. At a conceptual level, a VIB is like a tarball or ZIP archive in that it is a collection of files packaged into a single archive to facilitate distribution. This software packaging format is used by VMware and other 3rd party vendors to provide the required software for ESXi.

Image Profile – An Image Profile defines the set of VIBs that an ESXi installation or update process uses.

Software Depot – The ESXi software depot contains the image profiles and software packages (VIBs) that are used to run ESXi

creating a custom ESXi image using VMware PowerCLI.

Step 1: Download all required files

In our scenario, we are using ESXi 6.5 offline bundle and net-tulip legacy driver to build a custom ESXi 6.5 Installation image.

Step 2: Import the software depots

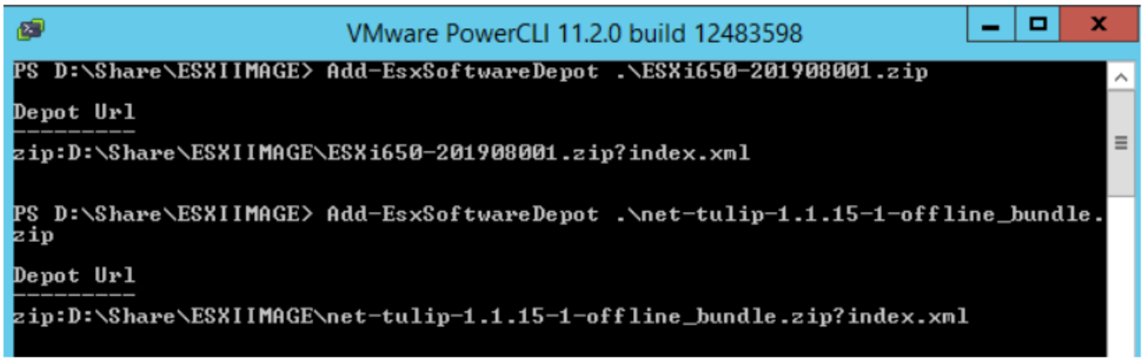
Start the PowerCLI session from the windows machine and import the software depots. You can use “Add-EsxSoftwareDepot” cmdlet to import the VMware offline bundle you have downloaded.

```
Add-EsxSoftwareDepot “VMware ESXi Offline File with path”

Add-EsxSoftwareDepot .\ESXi-6.5.0-201908001-depot.zip

Add-EsxSoftwareDepot “Driver or any other management pack file with path”

Add-EsxSoftwareDepot .\net-tulip-1.1.15-1.offline.bundle.zip
```



1. VMware ESXi:

Requirements:

- Compatible server hardware.
- VMware ESXi ISO image.

Installation Steps:

1. Insert bootable USB/CD with ESXi ISO.
2. Boot the server and follow on-screen instructions.
3. Accept EULA, select destination disk.
4. Set root password, configure management network.
5. Confirm and complete installation.
6. Remove installation media, reboot server.
7. Access ESXi using vSphere Client or Web Client.

2. Citrix XenServer:

Requirements:

- Compatible server hardware.
- Citrix Hypervisor ISO image.

Installation Steps:

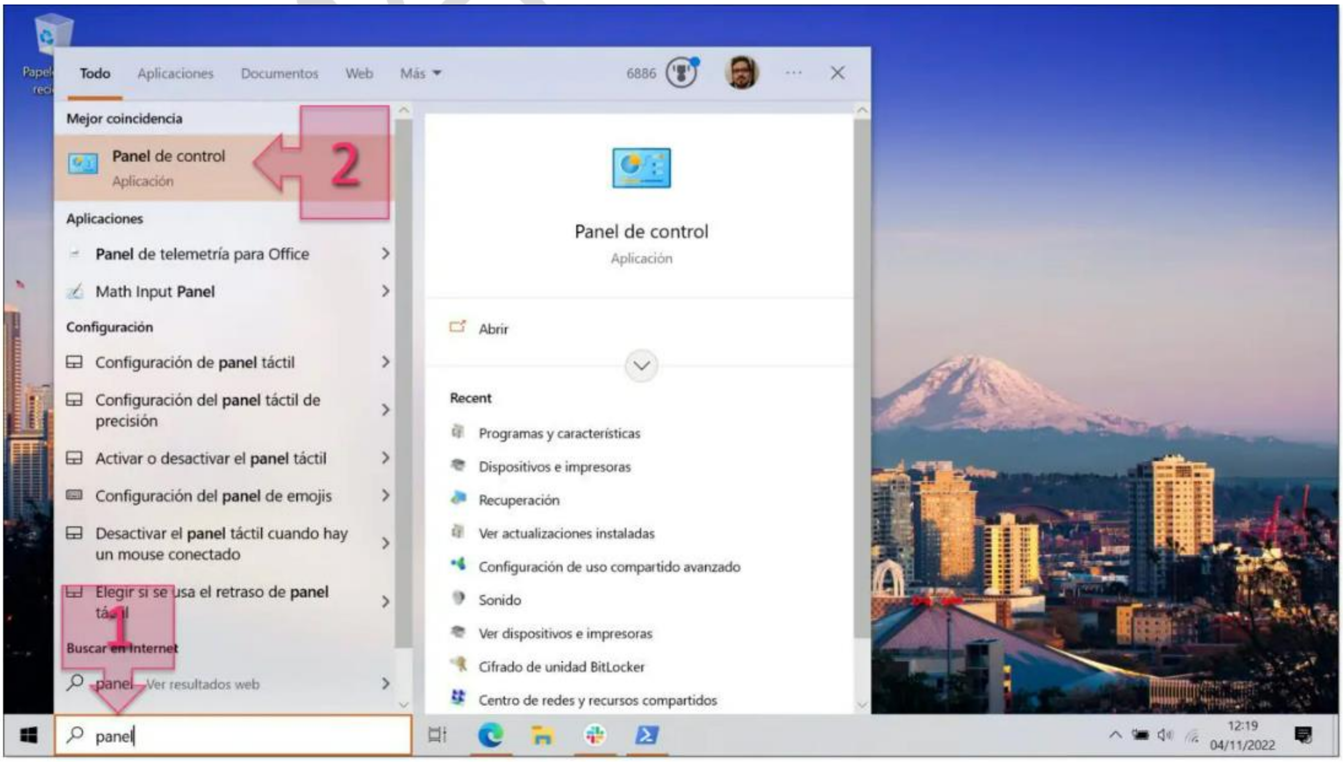
1. Insert bootable USB/CD with XenServer ISO.
2. Boot the server and follow on-screen instructions.
3. Select destination disk, set root password, configure networking.
4. Confirm and complete installation.
5. Remove installation media, reboot server.
6. Access XenServer using the web-based management interface.

2. Microsoft Hyper-V:

Option 1 – Installing Hyper-V on Windows 10 Using the Graphic Interface

NOTE: *As we just mentioned, you cannot install Hyper-V on Windows 10 Home Edition.*

First, go to the **search bar and type "Control Panel"** (1). Then, **double-click on Control Panel** (2).



Option 1 – Open the Control Panel

Requirements:

- Windows Server installed with Hyper-V role.
- Windows Server ISO image.

Installation Steps:

1. Install Windows Server with Hyper-V role.
2. Open Server Manager, select "Add roles and features."
3. Choose Hyper-V role, follow on-screen instructions.

4. Open Hyper-V Manager, create virtual switch if needed.
5. Start creating and managing virtual machines.

These are condensed steps; refer to each platform's documentation for more detailed instructions and considerations. Always ensure your hardware is compatible and meets the necessary requirements before installation.