

Routing
Switching
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MPLS



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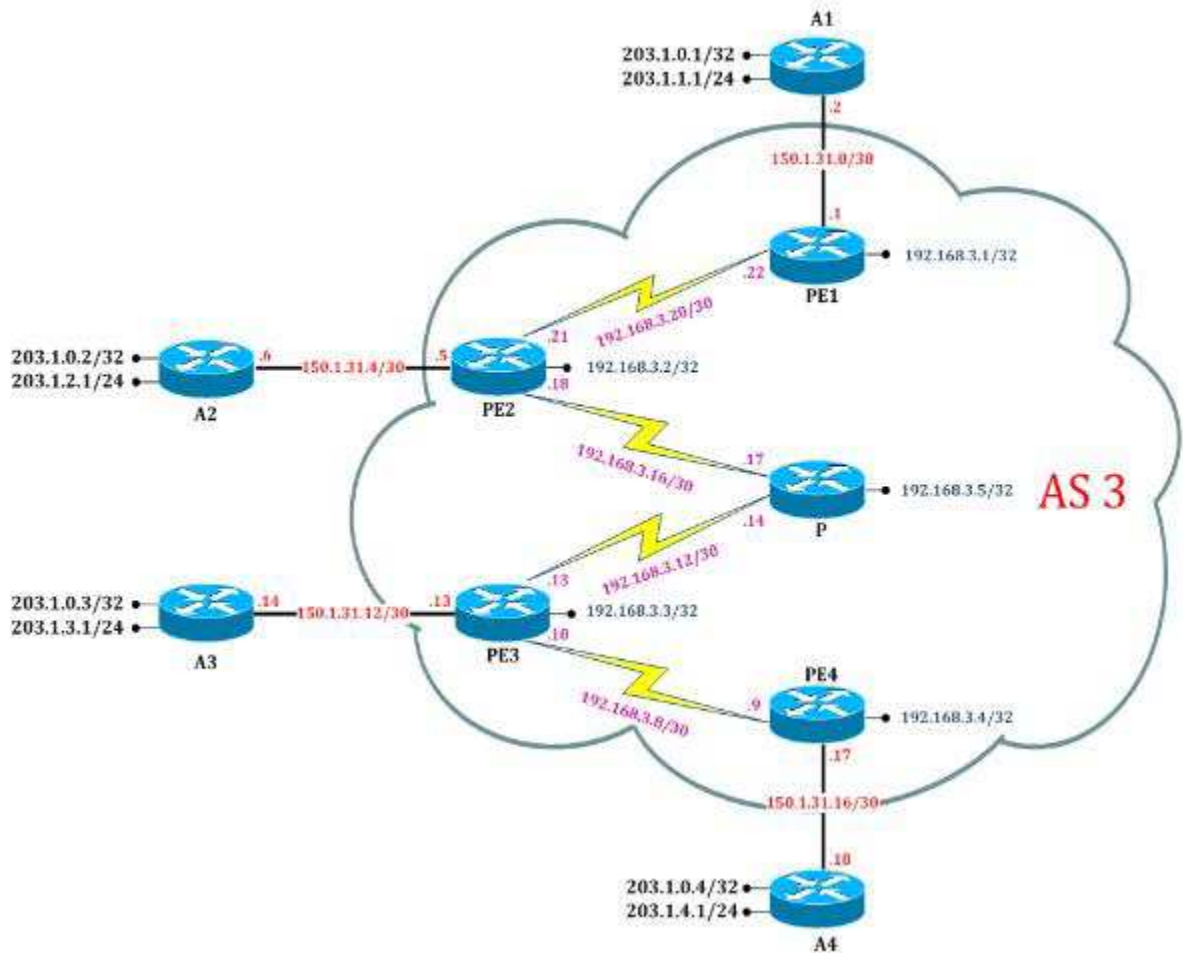
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Layer3 VPN with RIP protocol between CE-PE

Disclaimer

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IOS used: c7200-p-mz.120-32.S.bin



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Task 1: BASIC OSPF MPLS and BGP Setup

Configure OSPF, MPLS, BGP on all PE-routers and P-router

Step 1. Configure following on respective P and PE routers:

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```

PE1 Router Initial Config:
hostname PE1
!
ip cef
mpls label protocol ldp
mpls ldp router-id Loopback0
!
interface Loopback0
ip address 192.168.3.1 255.255.255.255
!
interface FastEthernet0/0
description *** Link to A1 ***
ip address 150.1.31.1 255.255.255.252
no shutdown
!
interface Serial2/0
description *** Link to PE2 ***
ip address 192.168.3.22 255.255.255.252
clock rate 64000
mpls ip
no shutdown
!
router ospf 1
Network 192.168.3.0 0.0.0.255 area 0
!
router bgp 3
no synchronization
no auto-summary
neighbor 192.168.3.2 remote-as 3
neighbor 192.168.3.2 update-source
Loopback0
network 192.168.3.1 mask 255.255.255.255
!
end

```

```

PE2 Router Initial Config:
hostname PE2
!
ip cef
mpls label protocol ldp
mpls ldp router-id Loopback0
!
interface Loopback0
ip address 192.168.3.2 255.255.255.255
!
interface FastEthernet0/0
description *** Link to A2 ***
ip address 150.1.31.5 255.255.255.252
no shutdown
!
interface Serial2/0
description *** Link to PE1 ***
ip address 192.168.3.21 255.255.255.252
mpls ip
no shutdown
!
interface Serial2/1
description *** Link to P ***
Ip address 192.168.3.18 255.255.255.252
mpls ip
no shutdown
!
router ospf 1
network 192.168.3.0 0.0.0.255 area 0
!
router bgp 3
no synchronization
no auto-summary
network 192.168.3.2 mask 255.255.255.255
neighbor 192.168.3.3 remote-as 3
neighbor 192.168.3.3 update-source
Loopback0
neighbor 192.168.3.1 remote-as 3
neighbor 192.168.3.1 update-source
Loopback0
neighbor 192.168.3.1 route-reflector-client
!
end

```

PE3 Router Initial Config:

```
hostname PE3
!
ip cef
mpls label protocol ldp
mpls ldp router-id Loopback0
!
interface Loopback0
ip address 192.168.3.3 255.255.255.255
!
interface FastEthernet0/0
description *** Link to A3 ***
ip address 150.1.31.13 255.255.255.252
no shutdown
!
interface Serial2/1
description *** Link to PE4 ***
ip address 192.168.3.10 255.255.255.252
mpls ip
no shutdown
!
interface Serial2/0
description *** Link to P ***
ip address 192.168.3.13 255.255.255.252
mpls ip
no shutdown
!
router ospf 1
network 192.168.3.0 0.0.0.255 area 0
!
router bgp 3
no synchronization
no auto-summary
network 192.168.3.3 mask 255.255.255.255
neighbor 192.168.3.2 remote-as 3
neighbor 192.168.3.2 update-source
Loopback0
neighbor 192.168.3.4 remote-as 3
neighbor 192.168.3.4 update-source
Loopback0
neighbor 192.168.3.4 route-reflector-client
!
end
```

PE4 Router Initial Config:

```
hostname PE4
!
ip cef
mpls label protocol ldp
mpls ldp router-id Loopback0
!
interface Loopback0
ip address 192.168.3.4 255.255.255.255
!
interface FastEthernet0/0
description *** Link to A4 ***
ip address 150.1.31.17 255.255.255.252
no shutdown
!
interface Serial2/1
description *** Link to PE3 ***
ip address 192.168.3.9 255.255.255.252
clock rate 64000
mpls ip
no shutdown
!
Router ospf 1
Network 192.168.3.0 0.0.0.255 area 0
!
router bgp 3
no synchronization
no auto-summary
neighbor 192.168.3.3 remote-as 3
neighbor 192.168.3.3 update-source
Loopback0
network 192.168.3.4 mask 255.255.255.255
!
end
```

P Router Config:

```
hostname P
!
ip cef
mpls label protocol ldp
mpls ldp router-id Loopback0
!
interface Loopback0
ip address 192.168.3.5 255.255.255.255
!
interface Serial2/0
description *** Link to PE3 ***
ip address 192.168.3.14 255.255.255.252
clock rate 64000
mpls ip
no shutdown
!
interface Serial2/1
description *** Link to PE2 ***
ip address 192.168.3.17 255.255.255.252
clock rate 64000
mpls ip
no shutdown
!
router ospf 1
network 192.168.3.0 0.0.0.255 area 0
!
end
```

Verification:

```
PE1#sh ip route
 150.1.0.0/30 is subnetted, 1 subnets
C    150.1.31.0 is directly connected, FastEthernet0/0
 192.168.3.0/24 is variably subnetted, 9 subnets, 2 masks
O    192.168.3.8/30 [110/256] via 192.168.3.21, 00:02:51, Serial1/0
O    192.168.3.12/30 [110/192] via 192.168.3.21, 00:02:51, Serial1/0
O    192.168.3.3/32 [110/193] via 192.168.3.21, 00:02:51, Serial1/0
O    192.168.3.2/32 [110/65] via 192.168.3.21, 00:02:51, Serial1/0
C    192.168.3.1/32 is directly connected, Loopback0
O    192.168.3.5/32 [110/129] via 192.168.3.21, 00:02:51, Serial1/0
O    192.168.3.4/32 [110/257] via 192.168.3.21, 00:02:51, Serial1/0
O    192.168.3.16/30 [110/128] via 192.168.3.21, 00:02:51, Serial1/0
C    192.168.3.20/30 is directly connected, Serial1/0
PE4#sh ip bgp
BGP table version is 5, local router ID is 192.168.3.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               S Stale
```

Origin codes: i - IGP, e - EGP, ? - incomplete

Network	Next Hop	Metric	LocPrf	Weight	Path
*>i192.168.3.1/32	192.168.3.1	0	100	0	i
*>i192.168.3.2/32	192.168.3.2	0	100	0	i
*>i192.168.3.3/32	192.168.3.3	0	100	0	i
*> 192.168.3.4/32	0.0.0.0	0		32768	i

A1 Router Initial Config:

```
hostname A1
!
interface Loopback0
ip address 203.1.0.1 255.255.255.255
!
interface Loopback1
ip address 203.1.1.1 255.255.255.0
!
interface FastEthernet0/0
description *** Link to PE1 ***
ip address 150.1.31.2 255.255.255.252
no shutdown
!
end
```

A2 Router Initial Config:

```
hostname A2
!
interface Loopback0
ip address 203.1.0.2 255.255.255.255
!
interface Loopback1
ip address 203.1.2.1 255.255.255.0
!
interface FastEthernet0/0
description *** Link to PE2 ***
ip address 150.1.31.6 255.255.255.252
no shutdown
!
end
```

A3 Router Initial Config:

```
hostname A3
!
interface Loopback0
ip address 203.1.0.3 255.255.255.255
!
interface Loopback1
ip address 203.1.3.1 255.255.255.0
!
interface FastEthernet0/0
description *** Link to PE3 ***
ip address 150.1.31.14 255.255.255.252
no shutdown
!
end
```

A4 Router Initial Config:

```
hostname A4
!
interface Loopback0
ip address 203.1.0.4 255.255.255.255
!
interface Loopback1
ip address 203.1.4.1 255.255.255.0
!
interface FastEthernet0/0
description *** Link to PE4 ***
ip address 150.1.31.18 255.255.255.252
no shutdown
!
end
```

Task 2: Configure Multiprotocol BGP

Configure multi-protocol BGP between provider-edge (PE) routers.

Step 1 Activate VPNv4 BGP sessions between all PE routers in your Service Provider backbone.

Step 2 On the PE routers acting as route reflectors, configure the route-reflector clients under the VPNv4 address family.

The following commands need to be entered on the PE-routers:

PE1 (config) #

```
router bgp 3
address-family vpnv4
  neighbor 192.168.3.2 activate
  no auto-summary
```

PE2 (config) #

```
router bgp 3
address-family vpnv4
  neighbor 192.168.3.1 activate
  neighbor 192.168.3.1 route-reflector-client
  neighbor 192.168.3.3 activate
  no auto-summary
```

PE3 (config) #

```
router bgp 3
address-family vpnv4
  neighbor 192.168.3.2 activate
  neighbor 192.168.3.4 activate
  neighbor 192.168.3.4 route-reflector-client
  no auto-summary
```

PE4 (config) #

```
router bgp 3
address-family vpnv4
  neighbor 192.168.3.3 activate
  no auto-summary
```

Task 3: Configure VRF Tables

The following commands need to be entered on PE router:

PE1 (config) #

```
ip vrf vpna
  rd 3:10
  route-target both 3:10
!
interface FastEthernet0/0
description *** Link to A1 ***
ip vrf forwarding vpna
ip address 150.1.31.1 255.255.255.252
```

Note: "ip vrf forwarding vpna" will remove IP address, so IP address need to be reconfigured

PE2 (config) #

```
ip vrf vpna
  rd 3:10
```

```

route-target both 3:10
!
interface FastEthernet0/0
description *** Link to A2 ***
ip vrf forwarding vpna
ip address 150.1.31.5 255.255.255.252

PE3(config)#
ip vrf vpna
rd 3:10
route-target both 3:10
!
interface fastEthernet0/0
description *** Link to A3 ***
ip vrf forwarding vpna
ip address 150.1.31.13 255.255.255.252

```

```

PE4(config)#
ip vrf vpna
rd 3:10
route-target both 3:10
!
interface FastEthernet0/0
description *** Link to A4 ***
ip vrf forwarding vpna
ip address 150.1.31.17 255.255.255.252

```

Verification:

```

PE3#show ip vrf
Name      Default RD   Interfaces
vpna      3:10        FastEthernet0/0

```

Task 3: Configure PE-CE Routing

Configure RIP Routing Protocol between PE and CE router.

Step 1 Configure RIP on all PE routers to learn routes from respective CE routers.

Step 2 Configure IPv4 BGP instance for customer VRF VPNA on PE routers

Step 3 Redistribute between RIP and BGP on PE routers

The following commands need to be entered on all PE router:

```

router rip
version 2
address-family ipv4 vrf vpna
redistribute bgp 3 metric transparent
network 150.1.0.0
!
router bgp 3
address-family ipv4 vrf vpna
redistribute rip

```

Step 4: Configure RIP on all CE routers

The following commands need to be entered on CE router:

```

A1(config)#
router rip
version 2
network 150.1.0.0

```



```
network 203.1.0.0
network 203.1.1.0
no auto-summary
```

A2 (config) #

```
router rip
version 2
network 150.1.0.0
network 203.1.0.0
network 203.1.2.0
no auto-summary
```

A3 (config) #

```
router rip
version 2
network 150.1.0.0
network 203.1.0.0
network 203.1.3.0
no auto-summary
```

A4 (config) #

```
router rip
version 2
network 150.1.0.0
network 203.1.0.0
network 203.1.4.0
no auto-summary
```

Verification:

Step 5 To check status of link between PE and CE use **VRF Ping**. Normal ping will not work as your PE – CE link and interface is not part of global routing table, it is now part of VRF table.

A sample VRF Ping printout is shown below:

```
PE1#ping 150.1.31.2
```

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 150.1.31.2, timeout is 2 seconds:

.....

Success rate is 0 percent (0/5)

```
PE1#ping vrf vpna 150.1.31.2
```

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 150.1.31.2, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 32/47/68 ms

Step 6 A sample VRF Telnet printout is shown below:

```
PE1#telnet 150.1.31.2 /vrf vpna
```

Trying 150.1.31.2 ... Open

User Access Verification

Password:

Step 7 To check VRF table for VPNA give following command on PE1 router

```
PE1#show ip route vrf vpna
```

Routing Table: vpna

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, 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

Gateway of last resort is not set

```
B 203.1.4.0/24 [200/1] via 192.168.3.4, 00:37:06
B 203.1.3.0/24 [200/1] via 192.168.3.3, 00:37:21
B 203.1.2.0/24 [200/1] via 192.168.3.2, 00:37:36
R 203.1.1.0/24 [120/1] via 150.1.31.2, 00:00:10, FastEthernet0/0
  203.1.0.0/32 is subnetted, 4 subnets
B 203.1.0.2 [200/1] via 192.168.3.2, 00:37:36
B 203.1.0.3 [200/1] via 192.168.3.3, 00:37:21
R 203.1.0.1 [120/1] via 150.1.31.2, 00:00:10, FastEthernet0/0
B 203.1.0.4 [200/1] via 192.168.3.4, 00:37:06
  150.1.0.0/30 is subnetted, 4 subnets
B 150.1.31.12 [200/0] via 192.168.3.3, 00:37:36
C 150.1.31.0 is directly connected, FastEthernet0/0
B 150.1.31.4 [200/0] via 192.168.3.2, 00:37:52
B 150.1.31.16 [200/0] via 192.168.3.4, 00:37:37
PE1#
```

Step 8 To check BGP table for VRF VPNA give following command on PE1 router

PE1#show ip bgp vpnv4 vrf vpna

BGP table version is 25, local router ID is 192.168.3.1
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
Route Distinguisher: 3:10 (default for vrf vpna)					
*> 150.1.31.0/30	0.0.0.0	0		32768	?
*>i150.1.31.4/30	192.168.3.2	0	100	0	?
*>i150.1.31.12/30	192.168.3.3	0	100	0	?
*>i150.1.31.16/30	192.168.3.4	0	100	0	?
*> 203.1.0.1/32	150.1.31.2	1		32768	?
*>i203.1.0.2/32	192.168.3.2	1	100	0	?
*>i203.1.0.3/32	192.168.3.3	1	100	0	?
*>i203.1.0.4/32	192.168.3.4	1	100	0	?
*> 203.1.1.0	150.1.31.2	1		32768	?
*>i203.1.2.0	192.168.3.2	1	100	0	?
*>i203.1.3.0	192.168.3.3	1	100	0	?
*>i203.1.4.0	192.168.3.4	1	100	0	?

PE1#

Step 9 To check CE Routing table give following command on A1 router

A1#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, 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

Gateway of last resort is not set

```
R 203.1.4.0/24 [120/2] via 150.1.31.1, 00:00:26, FastEthernet0/0
R 203.1.3.0/24 [120/2] via 150.1.31.1, 00:00:26, FastEthernet0/0
R 203.1.2.0/24 [120/2] via 150.1.31.1, 00:00:26, FastEthernet0/0
C 203.1.1.0/24 is directly connected, Loopback1
  203.1.0.0/32 is subnetted, 4 subnets
```

```

R      203.1.0.2 [120/2] via 150.1.31.1, 00:00:26, FastEthernet0/0
R      203.1.0.3 [120/2] via 150.1.31.1, 00:00:26, FastEthernet0/0
C      203.1.0.1 is directly connected, Loopback0
R      203.1.0.4 [120/2] via 150.1.31.1, 00:00:26, FastEthernet0/0
150.1.0.0/30 is subnetted, 4 subnets
R      150.1.31.12 [120/1] via 150.1.31.1, 00:00:26, FastEthernet0/0
C      150.1.31.0 is directly connected, FastEthernet0/0
R      150.1.31.4 [120/1] via 150.1.31.1, 00:00:26, FastEthernet0/0
R      150.1.31.16 [120/1] via 150.1.31.1, 00:00:28, FastEthernet0/0
A1#

```

Step 10 To check CE Routing table give following command on A4 router

A4#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, 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

```

Gateway of last resort is not set

```

C      203.1.4.0/24 is directly connected, Loopback1
R      203.1.3.0/24 [120/2] via 150.1.31.17, 00:00:14, FastEthernet0/0
R      203.1.2.0/24 [120/2] via 150.1.31.17, 00:00:14, FastEthernet0/0
R      203.1.1.0/24 [120/2] via 150.1.31.17, 00:00:14, FastEthernet0/0
203.1.0.0/32 is subnetted, 4 subnets
R      203.1.0.2 [120/2] via 150.1.31.17, 00:00:14, FastEthernet0/0
R      203.1.0.3 [120/2] via 150.1.31.17, 00:00:14, FastEthernet0/0
R      203.1.0.1 [120/2] via 150.1.31.17, 00:00:14, FastEthernet0/0
C      203.1.0.4 is directly connected, Loopback0
150.1.0.0/30 is subnetted, 4 subnets
R      150.1.31.12 [120/1] via 150.1.31.17, 00:00:14, FastEthernet0/0
R      150.1.31.0 [120/1] via 150.1.31.17, 00:00:14, FastEthernet0/0
R      150.1.31.4 [120/1] via 150.1.31.17, 00:00:14, FastEthernet0/0
C      150.1.31.16 is directly connected, FastEthernet0/0

```

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