

## Module 10a – MPLS P-to-P L3 VPN Configuration Lab

**Objective:** All the routers are pre-configured with basic interface, OSPF, BGP, MPLS Label Distribution Protocol (LDP) configuration according to the following topology diagram. Required LSPs are already built among the loopback interfaces of all the infrastructure routers. Need to configure MPLS L3 VPN from one side CPE routers to the other side CPE routers. This LAB module is using eBGP as PE-CE routing protocol and after finishing the MPLS L3VPN configuration you can be able do ping from one CE router to the other side CE router of the VPN tunnel. **Please notice CPE side LAN IP address and it has been changed from the previous lab exercises.**

**Prerequisites:** Knowledge of IGP, EGP, MPLS, LDP and MPLS L3 VPN are required.

The following will be the common topology and IP address plan used for the labs.

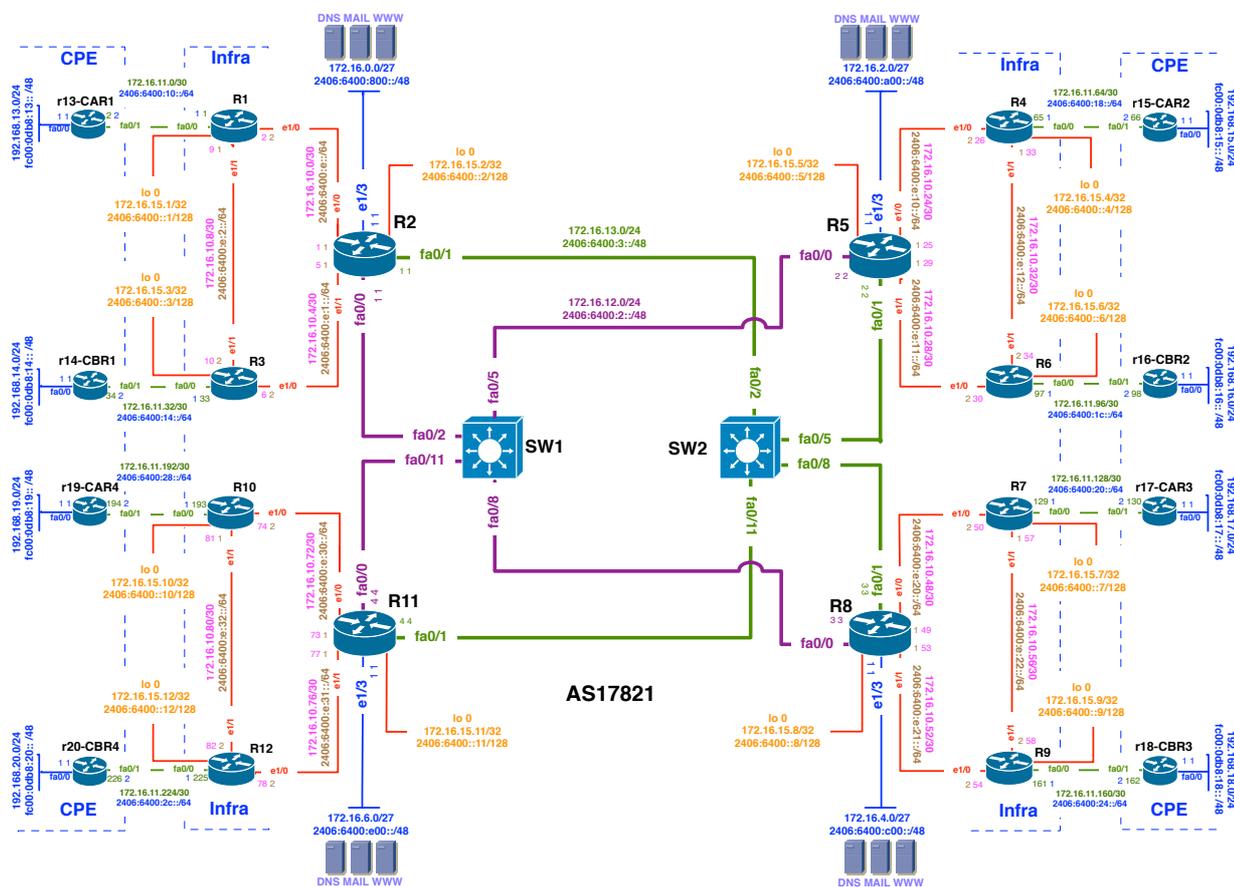


Figure 1 – ISP Lab Basic Configuration

### Lab Notes

On this module participants need to configure L3 VPN on following three scenario i.e.

- a. Point-to-point VPN
- b. Mull Mesh VPN
- c. Hub and Spoke

## Lab Exercise Scenario A : Point-to-point VPN

MPLS L3 point to point VPN tunnel will be created between CPE routers:

1. r13-CAR1 ⇔ r15-CAR2 [Traffic from R13 fa0/0 to R15 fa0/0, Capture R1 fa0/0 & R4 fa0/0]
2. r14-CBR1 ⇔ r16-CBR2 [Traffic from R14 fa0/0 to R16 fa0/0, Capture R3 fa0/0 & R6 fa0/0]
3. r19-CAR4 ⇔ r17-CAR3 [Traffic from R19 fa0/0 to R17 fa0/0, Capture R10 fa0/0 & R7 fa0/0]
4. r20-CBR4 ⇔ r18-CBR3 [Traffic from R20 fa0/0 to R18 fa0/0, Capture R12 fa0/0 & R9 fa0/0]

Please spend some time to be familiar with the network topology and addressing plan

### Lab Exercise

To configure this module exercises we need to configure routers with following 4 steps:

1. VRF configuration on the PE routers
2. Adding PE-CE eBGP neighbour on the PE router VRF context of BGP
3. Activate VPNv4 address family on PE routers to send MPLS L3 VPN signalling to other P and PE routers.
4. After the PE routers configuration we need to configure CE router regular eBGP configuration with the PE router.

#### 1. VRF configuration on the PE routers:

Here is an example VRF configuration for router R10:

```
config t
vrf definition BLUE-VPN-R19
```

VRF definition command is use to create a VRF instance within the physical routers which support dual stack (IPv4&IPv6) on PE-CE link.

```
rd 192.168.19.1:1
```

Assign this Route Distinguisher (RD) value for the prefixes of this VRF.

```
route-target export 192.168.19.1:1
```

All route going out from this VRF will have a tag 192.168.19.1:1

```
route-target import 192.168.17.1:1
```

All route will be included into this VRF if the tag is 192.168.17.1:1 [Other side of the VPN]

```
address-family ipv4
```

This VRF will support IPv4 address family

```
exit
```

```
exit
```

```
interface fa0/0
```

Going to the relevant interface connecting to the site of this VPN

```
vrf forwarding BLUE-VPN-R19
```

This interface now belong to this VRF. Please note this command will remove all IP related (IPv4 & IPv6) configuration from this interface. Need to configure IP (IPv4 & IPv6) address again.

```
ip address 172.16.11.193 255.255.255.252
```

Configuring IP address on this interface again.

```
exit
exit
wr
```

## 2. Adding PE-CE eBGP neighbour in VRF context of BGP:

Here is an example VRF configuration for router R9:

```
config t
router bgp 17821
address-family ipv4 vrf BLACK-VPN-R18
```

New VRF context of IPv4 address family for VRF name BLACK-VPN-R18. This will create a separate BGP table for this VRF.

```
neighbor 172.16.11.162 remote-as 65004
```

This is a new neighbour only created in the VRF context.

```
neighbor 172.16.11.162 activate
neighbor 172.16.11.162 as-override
```

Since both side of the VPN customer will use the same AS number, this VRF will not accept this AS path because its own AS number already on the path. This command will overwrite 65004 with AS17821 so AS65004 can accept this.

```
exit
exit
exit
wr
```

## 3. Activate VPNv4 address family on PE routers: Please note this configuration step need to apply on all PE as well as P routers.

Here is an example configuration for router R3 & R2:

R3

```
config t
router bgp 17821
address-family vpnv4
```

Going to VPNv4 address family of router MP-BGP protocol.

```
neighbor 172.16.15.2 activate
```

This neighbour is already created under IPv4 address family. So we simply need to activate it from VPNv4 address family.

```
neighbor 172.16.15.2 send-community both
```

Since RTs are sent as extended BGP community attribute so need to configure this.

```
exit
exit
exit
wr
```

## R2

```
config t
router bgp 17821
address-family vpnv4
neighbor 172.16.15.1 activate
neighbor 172.16.15.3 activate
neighbor IPV4-iBGP-REG1 send-community both
```

We have started the lab with pre-configured iBGP with peer-group. So need to add send-community command under respective peer-group. Please find the existing peer-group name from the running config to configure this command.

```
neighbor 172.16.15.5 activate
neighbor 172.16.15.8 activate
neighbor 172.16.15.11 activate
neighbor IPV4-iBGP-TRCORE send-community both
```

Please find the existing peer-group name from the running config to configure this command.

```
exit
exit
exit
wr
```

**Since R2 is acting as Route Reflector for both router R1 & R3 so need to configure those router as RR client for VPNv4 address family as well.**

Here is RR configuration example for R2:

```
config t
router bgp 17821
address-family vpnv4
neighbor IPV4-iBGP-REG1 route-reflector-client
```

Please find the existing peer-group name from the running config to configure this command.

```
exit
exit
exit
wr
```

#### 4. Configure CE router regular eBGP configuration with the PE router:

Here is an example configuration for router R13:

```
config t
router bgp 65001
no bgp default ipv4-unicast
address-family ipv4
neighbor 172.16.11.1 remote-as 17821
neighbor 172.16.11.1 activate
network 192.168.13.0 mask 255.255.255.0
exit
exit
ip route 192.168.13.0 255.255.255.0 null 0 permanent
exit
wr
```



## 5. Verify your MPLS L3 VPN Configuration:

Check VRF routing table:

```
sh bgp vpnv4 unicast vrf RED-VPN-R13 summary
sh bgp vpnv4 unicast vrf RED-VPN-R13
```

Check iBGP VPN-V4 routes:

```
sh bgp vpnv4 unicast all
```

Check VPN labels:

```
sh bgp vpnv4 unicast al labels
```

## **Lab Exercise Scenario B: Full Mesh VPN**

On this scenario no configuration template will be given. Participants need to build their own configuration based on their understanding of RT manipulation so solve any given task. Try to build your configuration based on following requirement specification:

1. Change the VPN membership and required RT import statement so that all CE routers can access to all other CE routers.
2. Notice the traffic flow between CE routers to the other CE routers. Sometime the traffic do not need to go even via the core routers.

## **Lab Exercise Scenario C: Hub and Spoke**

On this scenario customer requirement is to forward any traffic between CE routers via the central site router. In real life example a bank would like to control its inter branch communication via the head office router to make sure all the required policy has been enforced.

In this lab module there will be two central site configuration as follows:

1. Central site 1:
  - a. Hub Router: R13
  - b. Spoke Routers: R14, R15, R16
2. Central site 2:
  - a. Hub Router: R17
  - b. Spoke Router: R18, R19, R20

Before you start configuring any RT import statement on each VRF please remove any existing RT import and come up with a brand new RT import strategy.

Hints: Two way this requirement can be achieve:

1. Central site will advertise a summarize route.
2. Central site will advertise a default route.

In this lab we will use a summarize route.

Central site R1 will use a summarize route 192.168.13

## Workshop templates for reference purpose only:

### R1:

#### VRF

```
config t
vrf definition RED-VPN-R13
rd 192.168.13.1:1
route-target export 192.168.13.1:1
route-target import 192.168.15.1:1
address-family ipv4
exit
exit
interface fa0/0
vrf forwarding RED-VPN-R13
ip address 172.16.11.1 255.255.255.252
exit
exit
wr
```

#### Add Neighbour in VRF

```
config t
router bgp 17821
address-family ipv4 vrf RED-VPN-R13
neighbor 172.16.11.2 remote-as 65001
neighbor 172.16.11.2 activate
neighbor 172.16.11.2 as-override
exit
exit
exit
wr
```

#### Activate VPNv4 address-family

```
config t
router bgp 17821
address-family vpnv4
neighbor 172.16.15.2 activate
neighbor IPV4-iBGP-REG1 send-community both
exit
```

```
exit  
exit  
wr
```

## **R2:**

### **Activate VPNv4 address-family**

```
config t  
router bgp 17821  
address-family vpnv4  
neighbor 172.16.15.1 activate  
neighbor 172.16.15.3 activate  
neighbor IPV4-iBGP-REG1 send-community both  
neighbor 172.16.15.5 activate  
neighbor 172.16.15.8 activate  
neighbor 172.16.15.11 activate  
neighbor IPV4-iBGP-TRCORE send-community both  
exit  
exit  
exit  
wr
```

### **Configure RR for vpnv4 prefixes**

```
config t  
router bgp 17821  
address-family vpnv4  
neighbor IPV4-iBGP-REG1 route-reflector-client  
exit  
exit  
exit  
wr
```

## **R3:**

### **VRF**

```
config t  
vrf definition GREEN-VPN-R14  
rd 192.168.14.1:1  
route-target export 192.168.14.1:1  
route-target import 192.168.16.1:1  
address-family ipv4  
exit  
exit
```



```
interface fa0/0
vrf forwarding GREEN-VPN-R14
ip address 172.16.11.33 255.255.255.252
exit
exit
wr
```

### Add Neighbour in VRF

```
config t
router bgp 17821
address-family ipv4 vrf GREEN-VPN-R14
neighbor 172.16.11.34 remote-as 65002
neighbor 172.16.11.34 activate
neighbor 172.16.11.34 as-override
exit
exit
exit
wr
```

### Activate VPNv4 address-family

```
config t
router bgp 17821
address-family vpnv4
neighbor 172.16.15.2 activate
neighbor IPV4-iBGP-REG1 send-community both
exit
exit
exit
wr
```

### **R4:**

#### VRF

```
config t
vrf definition RED-VPN-R15
rd 192.168.15.1:1
route-target export 192.168.15.1:1
route-target import 192.168.13.1:1
address-family ipv4
exit
exit
interface fa0/0
vrf forwarding RED-VPN-R15
ip address 172.16.11.65 255.255.255.252
exit
exit
wr
```

### **Add Neighbour in VRF**

```
config t
router bgp 17821
address-family ipv4 vrf RED-VPN-R15
neighbor 172.16.11.66 remote-as 65001
neighbor 172.16.11.66 activate
neighbor 172.16.11.66 as-override
exit
exit
exit
wr
```

### **Activate VPNv4 address-family**

```
config t
router bgp 17821
address-family vpnv4
neighbor 172.16.15.5 activate
neighbor IPV4-iBGP-REG2 send-community both
exit
exit
exit
wr
```

### **R5:**

### **Activate VPNv4 address-family**

```
config t
router bgp 17821
address-family vpnv4
neighbor 172.16.15.4 activate
neighbor 172.16.15.6 activate
neighbor IPV4-iBGP-REG2 send-community both
neighbor 172.16.15.2 activate
neighbor 172.16.15.8 activate
neighbor 172.16.15.11 activate
neighbor IPV4-iBGP-TRCORE send-community both
exit
exit
exit
```

```
wr
```

### Configure RR for VPNv4 prefixes

```
config t
router bgp 17821
address-family vpnv4
neighbor IPV4-iBGP-REG2 route-reflector-client
exit
exit
exit
wr
```

### R6:

#### VRF

```
config t
vrf definition GREEN-VPN-R16
rd 192.168.16.1:1
route-target export 192.168.16.1:1
route-target import 192.168.14.1:1
address-family ipv4
exit
exit
interface fa0/0
vrf forwarding GREEN-VPN-R16
ip address 172.16.11.97 255.255.255.252
exit
exit
wr
```

#### Add Neighbour in VRF

```
config t
router bgp 17821
address-family ipv4 vrf GREEN-VPN-R16
neighbor 172.16.11.98 remote-as 65002
neighbor 172.16.11.98 activate
neighbor 172.16.11.98 as-override
exit
exit
exit
wr
```

### **Activate VPNv4 address-family**

```
config t
router bgp 17821
address-family vpnv4
neighbor 172.16.15.5 activate
neighbor IPV4-iBGP-REG2 send-community both
exit
exit
exit
wr
```

### **R7:**

### **VRF**

```
config t
vrf definition BLUE-VPN-R17
rd 192.168.17.1:1
route-target export 192.168.17.1:1
route-target import 192.168.19.1:1
address-family ipv4
exit
exit
interface fa0/0
vrf forwarding BLUE-VPN-R17
ip address 172.16.11.129 255.255.255.252
exit
exit
wr
```

### **Add Neighbour in VRF**

```
config t
router bgp 17821
address-family ipv4 vrf BLUE-VPN-R17
neighbor 172.16.11.130 remote-as 65003
neighbor 172.16.11.130 activate
neighbor 172.16.11.130 as-override
exit
exit
exit
```



wr

### Activate VPNv4 address-family

```
config t
router bgp 17821
address-family vpnv4
neighbor 172.16.15.8 activate
neighbor IPV4-iBGP-REG3 send-community both
exit
exit
exit
wr
```

### R8:

### Activate VPNv4 address-family

```
config t
router bgp 17821
address-family vpnv4
neighbor 172.16.15.7 activate
neighbor 172.16.15.9 activate
neighbor IPV4-iBGP-REG3 send-community both
neighbor 172.16.15.2 activate
neighbor 172.16.15.5 activate
neighbor 172.16.15.11 activate
neighbor IPV4-iBGP-TRCORE send-community both
exit
exit
exit
wr
```

### Configure RR for VPNv4 prefixes

```
config t
router bgp 17821
address-family vpnv4
neighbor IPV4-iBGP-REG3 route-reflector-client
exit
exit
exit
wr
```

## **R9:**

### **VRF**

```
config t
vrf definition BLACK-VPN-R18
rd 192.168.18.1:1
route-target export 192.168.18.1:1
route-target import 192.168.20.1:1
address-family ipv4
exit
exit
interface fa0/0
vrf forwarding BLACK-VPN-R18
ip address 172.16.11.161 255.255.255.252
exit
exit
wr
```

### **Add Neighbour in VRF**

```
config t
router bgp 17821
address-family ipv4 vrf BLACK-VPN-R18
neighbor 172.16.11.162 remote-as 65004
neighbor 172.16.11.162 activate
neighbor 172.16.11.162 as-override
exit
exit
exit
wr
```

### **Activate VPNv4 address-family**

```
config t
router bgp 17821
address-family vpnv4
neighbor 172.16.15.8 activate
neighbor IPV4-iBGP-REG3 send-community both
exit
exit
exit
wr
```

**R10:****VRF**

```
config t
vrf definition BLUE-VPN-R19
rd 192.168.19.1:1
route-target export 192.168.19.1:1
route-target import 192.168.17.1:1
address-family ipv4
exit
exit
interface fa0/0
vrf forwarding BLUE-VPN-R19
ip address 172.16.11.193 255.255.255.252
exit
exit
wr
```

**Add Neighbour in VRF**

```
config t
router bgp 17821
address-family ipv4 vrf BLUE-VPN-R19
neighbor 172.16.11.194 remote-as 65003
neighbor 172.16.11.194 activate
neighbor 172.16.11.194 as-override
exit
exit
exit
wr
```

**Activate VPNv4 address-family**

```
config t
router bgp 17821
address-family vpnv4
neighbor 172.16.15.11 activate
neighbor IPV4-iBGP-REG4 send-community both
exit
exit
exit
wr
```

## **R11:**

### **Activate VPNv4 address-family**

```
config t
router bgp 17821
address-family vpnv4
neighbor 172.16.15.10 activate
neighbor 172.16.15.12 activate
neighbor IPV4-iBGP-REG4 send-community both
neighbor 172.16.15.2 activate
neighbor 172.16.15.5 activate
neighbor 172.16.15.8 activate
neighbor IPV4-iBGP-TRCORE send-community both
exit
exit
exit
wr
```

### **Configure RR for VPNv4 prefixes**

```
config t
router bgp 17821
address-family vpnv4
neighbor IPV4-iBGP-REG4 route-reflector-client
exit
exit
exit
wr
```

## **R12:**

### **VRF**

```
config t
vrf definition BLACK-VPN-R20
rd 192.168.20.1:1
route-target export 192.168.20.1:1
route-target import 192.168.18.1:1
address-family ipv4
exit
exit
```



```
interface fa0/0
vrf forwarding BLACK-VPN-R20
ip address 172.16.11.225 255.255.255.252
exit
exit
wr
```

### Add Neighbour in VRF

```
config t
router bgp 17821
address-family ipv4 vrf BLACK-VPN-R20
neighbor 172.16.11.226 remote-as 65004
neighbor 172.16.11.226 activate
neighbor 172.16.11.226 as-override
exit
exit
exit
wr
```

### Activate VPNv4 address-family

```
config t
router bgp 17821
address-family vpnv4
neighbor 172.16.15.11 activate
neighbor IPV4-iBGP-REG4 send-community both
exit
exit
exit
wr
```

## R13:

### Regular BGP Configuration

```
config t
router bgp 65001
no bgp default ipv4-unicast
address-family ipv4
neighbor 172.16.11.1 remote-as 17821
neighbor 172.16.11.1 activate
network 192.168.13.0 mask 255.255.255.0
exit
exit
ip route 192.168.13.0 255.255.255.0 null 0 permanent
exit
wr
```

## **R14:**

### **Regular BGP Configuration**

```
config t
router bgp 65002
no bgp default ipv4-unicast
address-family ipv4
neighbor 172.16.11.33 remote-as 17821
neighbor 172.16.11.33 activate
network 192.168.14.0 mask 255.255.255.0
exit
exit
ip route 192.168.14.0 255.255.255.0 null 0 permanent
exit
wr
```

## **R15:**

### **Regular BGP Configuration**

```
config t
router bgp 65001
no bgp default ipv4-unicast
address-family ipv4
neighbor 172.16.11.65 remote-as 17821
neighbor 172.16.11.65 activate
network 192.168.15.0 mask 255.255.255.0
exit
exit
ip route 192.168.15.0 255.255.255.0 null 0 permanent
exit
wr
```

## **R16:**

### **Regular BGP Configuration**

```
config t
router bgp 65002
no bgp default ipv4-unicast
address-family ipv4
```



```
neighbor 172.16.11.97 remote-as 17821
neighbor 172.16.11.97 activate
network 192.168.16.0 mask 255.255.255.0
exit
exit
ip route 192.168.16.0 255.255.255.0 null 0 permanent
exit
wr
```

### **R17:**

#### **Regular BGP Configuration**

```
config t
router bgp 65003
no bgp default ipv4-unicast
address-family ipv4
neighbor 172.16.11.129 remote-as 17821
neighbor 172.16.11.129 activate
network 192.168.17.0 mask 255.255.255.0
exit
exit
ip route 192.168.17.0 255.255.255.0 null 0 permanent
exit
wr
```

### **R18:**

#### **Regular BGP Configuration**

```
config t
router bgp 65004
no bgp default ipv4-unicast
address-family ipv4
neighbor 172.16.11.161 remote-as 17821
neighbor 172.16.11.161 activate
network 192.168.18.0 mask 255.255.255.0
exit
exit
ip route 192.168.18.0 255.255.255.0 null 0 permanent
exit
wr
```

### **R19:**

#### **Regular BGP Configuration**

```
config t
router bgp 65003
no bgp default ipv4-unicast
address-family ipv4
```

```
neighbor 172.16.11.193 remote-as 17821
neighbor 172.16.11.193 activate
network 192.168.19.0 mask 255.255.255.0
exit
exit
ip route 192.168.19.0 255.255.255.0 null 0 permanent
exit
wr
```

## **R20:**

### **Regular BGP Configuration**

```
config t
router bgp 65004
no bgp default ipv4-unicast
address-family ipv4
neighbor 172.16.11.225 remote-as 17821
neighbor 172.16.11.225 activate
network 192.168.20.0 mask 255.255.255.0
exit
exit
ip route 192.168.20.0 255.255.255.0 null 0 permanent
exit
wr
```