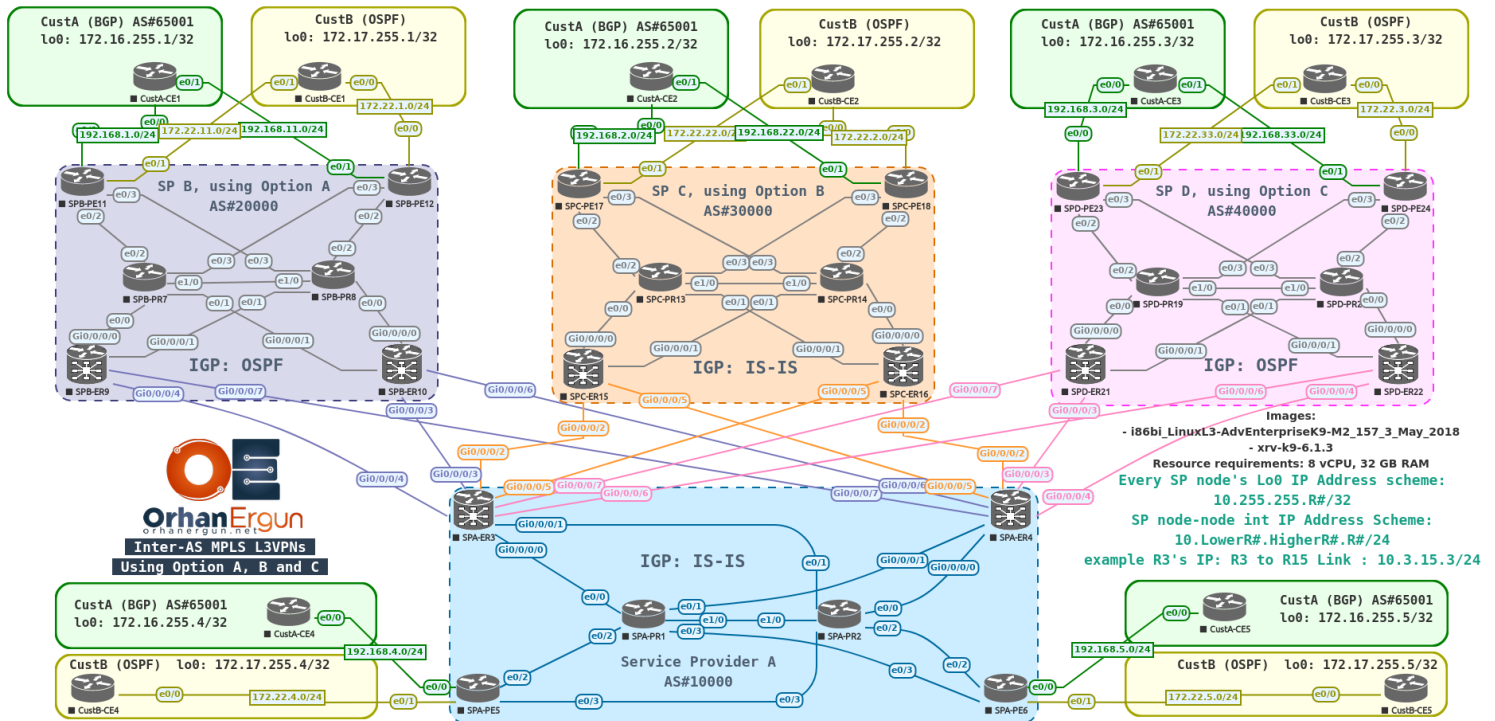


Inter-AS MPLS L3VPNs (All in One) Lab

IOS-XE, IOS-XR

Topology:



MP-BGP AF/SAF: VPNv4 Unicast, IPv4 Labeled-Unicast

PE-CE Routing Protocols:

- OSPF (Also includes Sham-link between PEs and VRF Aware OSPF process on CE5)
- BGP (Same Local AS for all Customer sites)



Task 01:

- Configure IGP based on the topology for all Service Providers
- Enable MPLS LDP on each SP network



Solution:

In this topology, There are four different Service Providers, If you take a look at the customer sites, you realize that each customer has a remote-site connected to these four service provider.

Service Provider A is going to be the Main SP (Or let's call it Top level SP), it is connected to the three Low Level SPs. We will implement Inter-AS L3VPNs option A, B and C at a single lab.

All the SPs are designed in a redundant way:

- Two PE devices
- Two Route Reflectors
- Two ASBRs

As an example in Service Provider B:

- SPB- PE11 and SPB-PE12 are PE devices
- SPB-PE11 and SPB-PE12 are Route-Reflectors (Inline Route Reflectors)
- SPB-PR7 and SPB-PR8 are P or Core devices
- SPB-ER9 and SPB-ER10 are ASBRs

In this lab we also configure the IOS-XR devices (XRv 6.1.3 Cisco VIRL emulator image).

Let's configure the IGP and enable MPLS LDP in each of the Service Provider network:

Service Provider A:

SPA-PR1:

```
router isis 10000
mpls ldp sync
mpls ldp autoconfig
net 47.0000.0000.0000.0001.00
is-type level-2-only
advertise passive-only
metric-style wide
log-adjacency-changes all
```

```
passive-interface Loopback0
!
mpls label range 10000 19999
mpls ldp session protection
mpls ldp router-id Loopback0
!
interface range e0/0-3, e1/0
 ip router isis 10000
!
```

SPA-PR2:

```
router isis 10000
 mpls ldp sync
 mpls ldp autoconfig
 net 47.0000.0000.0000.0002.00
 is-type level-2-only
 advertise passive-only
 metric-style wide
 log-adjacency-changes
 passive-interface Loopback0
!
mpls label range 20000 29999
mpls ldp session protection
mpls ldp router-id Loopback0
!
interface range e0/0-3, e1/0
 ip router isis 10000
!
```

SPA-PE5:

```
router isis 10000
 mpls ldp sync
 mpls ldp autoconfig
 net 47.0000.0000.0000.0005.00
 is-type level-2-only
```

```
advertise passive-only
metric-style wide
log-adjacency-changes all
passive-interface Loopback0
!
mpls label range 50000 59999
mpls ldp session protection
mpls ldp router-id Loopback0
!
interface range e0/2-3
 ip router isis 10000
!

SPA-PE6:
router isis 10000
 mpls ldp sync
 mpls ldp autoconfig
 net 47.0000.0000.0000.0006.00
 is-type level-2-only
 advertise passive-only
 metric-style wide
 log-adjacency-changes all
 passive-interface Loopback0
!
mpls label range 60000 69999
mpls ldp session protection
mpls ldp router-id Loopback0
!
interface range e0/2-3
 ip router isis 10000
!
```

There is no need for explanation about how to configure IGP (IS-IS in this SP) and enable MPLS LDP, you are already familiar with these type of simple configuration, If you need to read more about how to configure OSPF or IS-IS and MPLS LDP, please refer to the appropriate Workbook file for those technologies.

SPA-ER3:

```
router isis 10000
  is-type level-2-only
  net 47.0000.0000.0000.0003.00
  log adjacency changes
  address-family ipv4 unicast
  metric-style wide
  advertise passive-only
  redistribute bgp 10000 level-2 metric 100 route-policy PASS_ALL
  mpls ldp auto-config
!
interface Loopback0
  passive
  address-family ipv4 unicast
!
!
interface GigabitEthernet0/0/0/0
  address-family ipv4 unicast
  mpls ldp sync
!
!
interface GigabitEthernet0/0/0/1
  address-family ipv4 unicast
  mpls ldp sync
!
!
interface GigabitEthernet0/0/0/2
  passive
  address-family ipv4 unicast
!
!
interface GigabitEthernet0/0/0/5
  passive
  address-family ipv4 unicast
!
```

```
!  
!  
mpls ldp  
  router-id 10.255.255.3  
  session protection  
!  
mpls label range table 0 30000 39999  
!
```

SPA-ER4:

```
router isis 10000  
  is-type level-2-only  
  net 47.0000.0000.0000.0004.0  
  log adjacency changes  
  address-family ipv4 unicast  
  metric-style wide  
  advertise passive-only  
  redistribute bgp 10000 level-2 metric 100 route-policy PASS_ALL  
  mpls ldp auto-config  
!  
interface Loopback0  
  passive  
  address-family ipv4 unicast  
!  
!  
interface GigabitEthernet0/0/0/0  
  address-family ipv4 unicast  
  mpls ldp sync  
!  
!  
interface GigabitEthernet0/0/0/1  
  address-family ipv4 unicast  
  mpls ldp sync  
!  
!
```

```
interface GigabitEthernet0/0/0/2
  passive
  address-family ipv4 unicast
  !
!
interface GigabitEthernet0/0/0/5
  passive
  address-family ipv4 unicast
  !
!
!
mpls ldp
  router-id 10.255.255.4
  session protection
!
mpls label range table 0 40000 49999
!
```

Service Provider A IOS and IOS-XR basic configuration is done. Let's continue with other SP devices as well.

Service Provider B:

```
SPB-PR7:
router ospf 20000
  mpls ldp autoconfig
  router-id 10.255.255.7
  prefix-suppression
  passive-interface default
  no passive-interface Ethernet0/0
  no passive-interface Ethernet0/1
  no passive-interface Ethernet0/2
  no passive-interface Ethernet0/3
  no passive-interface Ethernet1/0
  network 10.7.8.0 0.0.0.255 area 0
  network 10.7.9.0 0.0.0.255 area 0
  network 10.7.10.0 0.0.0.255 area 0
```

```
network 10.7.11.0 0.0.0.255 area 0
network 10.7.12.0 0.0.0.255 area 0
network 10.255.255.7 0.0.0.0 area 0
!
mpls label range 70000 79999
mpls ldp router-id Loopback0
!
```

SPB-PR8:

```
router ospf 20000
mpls ldp autoconfig
prefix-suppression
passive-interface default
no passive-interface Ethernet0/0
no passive-interface Ethernet0/1
no passive-interface Ethernet0/2
no passive-interface Ethernet0/3
no passive-interface Ethernet1/0
network 10.7.8.0 0.0.0.255 area 0
network 10.8.9.0 0.0.0.255 area 0
network 10.8.10.0 0.0.0.255 area 0
network 10.8.11.0 0.0.0.255 area 0
network 10.8.12.0 0.0.0.255 area 0
network 10.255.255.8 0.0.0.0 area 0
!
mpls label range 80000 89999
mpls ldp router-id Loopback0
!
```

SPB-PE11:

```
router ospf 20000
mpls ldp autoconfig
router-id 10.255.255.11
prefix-suppression
passive-interface default
```



```
no passive-interface Ethernet0/2
no passive-interface Ethernet0/3
network 10.7.11.0 0.0.0.255 area 0
network 10.8.11.0 0.0.0.255 area 0
network 10.255.255.11 0.0.0.0 area 0
!
mpls label range 110000 119999
mpls ldp router-id Loopback0
!
```

SPB-PE12:

```
router ospf 20000
mpls ldp autoconfig
prefix-suppression
passive-interface default
no passive-interface Ethernet0/2
no passive-interface Ethernet0/3
network 10.7.12.0 0.0.0.255 area 0
network 10.8.12.0 0.0.0.255 area 0
network 10.255.255.0 0.0.0.255 area 0
!
mpls label range 120000 129999
mpls ldp router-id Loopback0
!
```

SPB-ER9:

```
router ospf 20000
log adjacency changes detail
router-id 10.255.255.9
mpls ldp sync
mpls ldp auto-config
prefix-suppression
area 0
interface Loopback0
passive enable
```

```
!  
interface GigabitEthernet0/0/0/0  
!  
interface GigabitEthernet0/0/0/1  
!  
!  
!  
mpls ldp  
router-id 10.255.255.9  
session protection  
!  
mpls label range table 0 90000 99999  
!  
  
SPB-ER10:  
router ospf 20000  
log adjacency changes detail  
router-id 10.255.255.10  
mpls ldp auto-config  
prefix-suppression  
area 0  
interface Loopback0  
passive enable  
!  
interface GigabitEthernet0/0/0/0  
!  
interface GigabitEthernet0/0/0/1  
!  
!  
!  
mpls ldp  
router-id 10.255.255.10  
session protection  
!  
mpls label range table 0 100000 109999
```

Service Provider C:

SPC-PR13:

```
router isis 30000
 mpls ldp autoconfig
 net 47.0000.0000.0000.0013.00
 is-type level-2-only
 advertise passive-only
 metric-style wide
 log-adjacency-changes all
 passive-interface Loopback0
 !
 mpls label range 130000 139999
 mpls ldp router-id Loopback0
 !
 interface range e0/0-3, e1/0
 ip router isis 30000
 !
```

SPC-PR14:

```
router isis 30000
 mpls ldp autoconfig
 net 47.0000.0000.0000.0014.00
 is-type level-2-only
 advertise passive-only
 metric-style wide
 log-adjacency-changes all
 passive-interface Loopback0
 !
 mpls label range 140000 149999
 mpls ldp router-id Loopback0
 !
 interface range e0/0-3, e1/0
 ip router isis 30000
 !
```

SPC-PE17:

```
router isis 30000
mpls ldp autoconfig
net 47.0000.0000.0000.0017.00
is-type level-2-only
advertise passive-only
metric-style wide
log-adjacency-changes all
passive-interface Loopback0
!
mpls label range 170000 179999
mpls ldp router-id Loopback0
!
interface range e0/2-3
ip router isis 30000
!
```

SPC-PR18:

```
router isis 30000
mpls ldp autoconfig
net 47.0000.0000.0000.0018.00
is-type level-2-only
advertise passive-only
metric-style wide
log-adjacency-changes all
passive-interface Loopback0
!
mpls label range 180000 189999
mpls ldp router-id Loopback0
!
interface range e0/2-3
ip router isis 30000
!
```

SPC-ER15:

```
router isis 30000
  is-type level-2-only
  net 47.0000.0000.0000.0015.00
  log adjacency changes
  address-family ipv4 unicast
  metric-style wide
  advertise passive-only
  mpls ldp auto-config
!
interface Loopback0
  passive
  address-family ipv4 unicast
!
!
interface GigabitEthernet0/0/0/0
  address-family ipv4 unicast
  mpls ldp sync
!
!
interface GigabitEthernet0/0/0/1
  address-family ipv4 unicast
  mpls ldp sync
!
!
interface GigabitEthernet0/0/0/2
  passive
  address-family ipv4 unicast
!
!
interface GigabitEthernet0/0/0/5
  passive
  address-family ipv4 unicast
!
!
```

```
mpls ldp
  router-id 10.255.255.15
  session protection
!
mpls label range table 0 150000 159999
!
```

SPC-ER16:

```
router isis 30000
  is-type level-2-only
  net 47.0000.0000.0000.0016.00
  log adjacency changes
  address-family ipv4 unicast
    metric-style wide
  advertise passive-only
  mpls ldp auto-config
!
interface Loopback0
  passive
  address-family ipv4 unicast
!
!
interface GigabitEthernet0/0/0/0
  address-family ipv4 unicast
    mpls ldp sync
!
!
interface GigabitEthernet0/0/0/1
  address-family ipv4 unicast
    mpls ldp sync
!
!
interface GigabitEthernet0/0/0/2
  passive
  address-family ipv4 unicast
```

```
!  
!  
interface GigabitEthernet0/0/0/5  
  passive  
  address-family ipv4 unicast  
!  
!  
!  
mpls ldp  
  router-id 10.255.255.16  
  session protection  
!  
mpls label range table 0 160000 169999  
!
```

Service Provider D:

SPD-PR19:

```
router ospf 40000  
  mpls ldp autoconfig  
  router-id 10.255.255.19  
  log-adjacency-changes detail  
  prefix-suppression  
  passive-interface default  
  no passive-interface Ethernet0/0  
  no passive-interface Ethernet0/1  
  no passive-interface Ethernet0/2  
  no passive-interface Ethernet0/3  
  no passive-interface Ethernet1/0  
  network 10.19.20.0 0.0.0.255 area 0  
  network 10.19.21.0 0.0.0.255 area 0  
  network 10.19.22.0 0.0.0.255 area 0  
  network 10.19.23.0 0.0.0.255 area 0  
  network 10.19.24.0 0.0.0.255 area 0  
  network 10.255.255.19 0.0.0.0 area 0
```

```
mpls ldp router-id Loopback0
!

SPD-PR20:
router ospf 40000
mpls ldp autoconfig
router-id 10.255.255.20
log-adjacency-changes detail
prefix-suppression
passive-interface default
no passive-interface Ethernet0/0
no passive-interface Ethernet0/1
no passive-interface Ethernet0/2
no passive-interface Ethernet0/3
no passive-interface Ethernet1/0
network 10.19.20.0 0.0.0.255 area 0
network 10.20.21.0 0.0.0.255 area 0
network 10.20.22.0 0.0.0.255 area 0
network 10.20.23.0 0.0.0.255 area 0
network 10.20.24.0 0.0.0.255 area 0
network 10.255.255.20 0.0.0.0 area 0
!
mpls label range 200000 209999
mpls ldp router-id Loopback0
!

SPD-PE23:
router ospf 40000
mpls ldp autoconfig
router-id 10.255.255.23
log-adjacency-changes detail
prefix-suppression
passive-interface default
no passive-interface Ethernet0/2
no passive-interface Ethernet0/3
```



```
network 10.19.23.0 0.0.0.255 area 0
network 10.20.23.0 0.0.0.255 area 0
network 10.255.255.23 0.0.0.0 area 0
!
mpls label range 230000 239999
mpls ldp router-id Loopback0
!
```

SPD-PE24:

```
router ospf 40000
mpls ldp autoconfig
router-id 10.255.255.24
log-adjacency-changes detail
prefix-suppression
passive-interface default
no passive-interface Ethernet0/2
no passive-interface Ethernet0/3
network 10.19.24.0 0.0.0.255 area 0
network 10.20.24.0 0.0.0.255 area 0
network 10.255.255.24 0.0.0.0 area 0
!
mpls label range 240000 249999
mpls ldp router-id Loopback0
!
```

SPD-ER21:

```
router ospf 40000
log adjacency changes detail
router-id 10.255.255.21
mpls ldp sync
mpls ldp auto-config
prefix-suppression
redistribute bgp 40000 route-policy PASS_ALL
area 0
interface Loopback0
```

```
    passive enable
!
interface GigabitEthernet0/0/0/0
!
interface GigabitEthernet0/0/0/1
!
!
mpls ldp
router-id 10.255.255.21
session protection
!
mpls label range table 0 210000 219999
!
SPD-ER22:
router ospf 40000
log adjacency changes detail
router-id 10.255.255.22
mpls ldp sync
prefix-suppression
redistribute bgp 40000 route-policy PASS_ALL
area 0
mpls ldp auto-config
interface Loopback0
    passive enable
!
interface GigabitEthernet0/0/0/0
!
interface GigabitEthernet0/0/0/1
!
!
mpls ldp
router-id 10.255.255.22
session protection
!
mpls label range table 0 220000 229999
```



Task 02 and 03:

- Configure BGP on all SPs (Between PEs and ASBRs)
- In Service Provider A, SPA-PE5 and SPA-PE6 should be the RRs
- In Service Provider B, SPB-PE11 and SPB-PE12 should be the RRs
- In Service Provider C, SPC-PE17 and SPC-PE18 should be the RRs
- In Service Provider D, SPD-PE23 and SPD-PE24 should be the RRs
- Provide L3VPN service for the Customers (Configure PE-CE routing protocols according to the diagram)
- Customer CE devices should have L3 reachability between their sites (Intra AS only)



Solution:

It is obvious that we should configure MP-BGP VPNv4 Unicast neighborship between all PE devices and ASBRs in each Service Provider, This task also does not need any explanation, we have already discussed how to configure it in MPLS Lab 01 and MPLS Lab 02.

We can merge Task 02 and 03, They are simple PE-CE connectivity and SP core VPNv4 neighborships:

SPA-PE5:

```
vrf definition CustA
  rd 10000:1
  !
  address-family ipv4
    route-target export 10000:1
    route-target import 10000:1
  exit-address-family
  !
  !
interface Ethernet0/0
  vrf forwarding CustA
  ip address 192.168.4.5 255.255.255.0
  duplex auto
  !
vrf definition CustB
  rd 10000:2
  !
```

```
address-family ipv4
  route-target export 10000:2
  route-target import 10000:2
exit-address-family
!
!
interface Ethernet0/1
  vrf forwarding CustB
  ip address 172.22.4.5 255.255.255.0
  duplex auto
!
router bgp 10000
  bgp router-id 10.255.255.5
  bgp cluster-id 10.255.255.5
  bgp log-neighbor-changes
  no bgp default ipv4-unicast
  neighbor 10.255.255.3 remote-as 10000
  neighbor 10.255.255.3 update-source Loopback0
  neighbor 10.255.255.4 remote-as 10000
  neighbor 10.255.255.4 update-source Loopback0
  neighbor 10.255.255.6 remote-as 10000
  neighbor 10.255.255.6 update-source Loopback0
  neighbor 10.255.255.23 remote-as 40000
  neighbor 10.255.255.23 ebgp-multihop 255
  neighbor 10.255.255.23 update-source Loopback0
  neighbor 10.255.255.24 remote-as 40000
  neighbor 10.255.255.24 ebgp-multihop 255
  neighbor 10.255.255.24 update-source Loopback0
!
address-family ipv4
exit-address-family
!
address-family vpnv4
  neighbor 10.255.255.3 activate
  neighbor 10.255.255.3 send-community extended
```

```
neighbor 10.255.255.3 route-reflector-client
neighbor 10.255.255.4 activate
neighbor 10.255.255.4 send-community extended
neighbor 10.255.255.4 route-reflector-client
neighbor 10.255.255.6 activate
neighbor 10.255.255.6 send-community extended
neighbor 10.255.255.23 activate
neighbor 10.255.255.23 send-community extended
neighbor 10.255.255.23 next-hop-unchanged
neighbor 10.255.255.24 activate
neighbor 10.255.255.24 send-community extended
neighbor 10.255.255.24 next-hop-unchanged
exit-address-family
!
router bgp 10000
!
address-family ipv4 vrf CustA
  redistribute connected
  neighbor 192.168.4.4 remote-as 65001
  neighbor 192.168.4.4 activate
  neighbor 192.168.4.4 remove-private-as all replace-as
exit-address-family
!
router ospf 10002 vrf CustB
router-id 172.22.4.5
domain-id type 0005 value 000000000002
redistribute bgp 10000 subnets
passive-interface default
no passive-interface Ethernet0/1
network 172.22.4.0 0.0.0.255 area 0
!
!
router bgp 10000
!
address-family ipv4 vrf CustB
```

```
redistribute connected
redistribute ospf 10002 match internal external 1 external 2
exit-address-family
!
```

SPA-PE6:

```
router bgp 10000
  bgp router-id 10.255.255.6
  bgp cluster-id 10.255.255.6
  bgp log-neighbor-changes
  no bgp default ipv4-unicast
  neighbor 10.255.255.3 remote-as 10000
  neighbor 10.255.255.3 update-source Loopback0
  neighbor 10.255.255.4 remote-as 10000
  neighbor 10.255.255.4 update-source Loopback0
  neighbor 10.255.255.5 remote-as 10000
  neighbor 10.255.255.5 update-source Loopback0
  neighbor 10.255.255.23 remote-as 40000
  neighbor 10.255.255.23 ebgp-multihop 255
  neighbor 10.255.255.23 update-source Loopback0
  neighbor 10.255.255.24 remote-as 40000
  neighbor 10.255.255.24 ebgp-multihop 255
  neighbor 10.255.255.24 update-source Loopback0
  neighbor 192.168.5.5 remote-as 65001
!
address-family ipv4
exit-address-family
!
address-family vpnv4
  neighbor 10.255.255.3 activate
  neighbor 10.255.255.3 send-community extended
  neighbor 10.255.255.3 route-reflector-client
  neighbor 10.255.255.4 activate
  neighbor 10.255.255.4 send-community extended
  neighbor 10.255.255.4 route-reflector-client
```

```
neighbor 10.255.255.5 activate
neighbor 10.255.255.5 send-community extended
neighbor 10.255.255.23 activate
neighbor 10.255.255.23 send-community extended
neighbor 10.255.255.23 next-hop-unchanged
neighbor 10.255.255.24 activate
neighbor 10.255.255.24 send-community extended
neighbor 10.255.255.24 next-hop-unchanged
exit-address-family
!
vrf definition CustA
rd 10000:1
!
address-family ipv4
route-target export 10000:1
route-target import 10000:1
exit-address-family
!
!
interface Ethernet0/0
vrf forwarding CustA
ip address 192.168.5.6 255.255.255.0
duplex auto
!
router bgp 10000
!
address-family ipv4 vrf CustA
redistribute connected
neighbor 192.168.5.5 remote-as 65001
neighbor 192.168.5.5 activate
neighbor 192.168.5.5 remove-private-as all replace-as
exit-address-family
!
vrf definition CustB
rd 10000:2
```

```
!  
address-family ipv4  
  route-target export 10000:2  
  route-target import 10000:2  
exit-address-family  
!  
!  
interface Ethernet0/1  
  vrf forwarding CustB  
  ip address 172.22.5.6 255.255.255.0  
  duplex auto  
!  
router ospf 10002 vrf CustB  
  router-id 172.22.5.6  
  domain-id type 0005 value 000000000002  
  redistribute bgp 10000 subnets  
  passive-interface default  
  no passive-interface Ethernet0/1  
  network 172.22.5.0 0.0.0.255 area 0  
!  
!  
router bgp 10000  
  !  
  address-family ipv4 vrf CustB  
    redistribute connected  
    redistribute ospf 10002 match internal external 1 external 2  
  exit-address-family  
!  
  
SPA-ER3:  
router bgp 10000  
  bgp router-id 10.255.255.3  
  bgp log neighbor changes detail  
  address-family vpv4 unicast  
  neighbor 10.255.255.4
```



```
remote-as 10000
update-source Loopback0
address-family ipv4 unicast
!
address-family vpnv4 unicast
!
!
neighbor 10.255.255.5
remote-as 10000
update-source Loopback0
address-family vpnv4 unicast
!
!
neighbor 10.255.255.6
remote-as 10000
update-source Loopback0
address-family vpnv4 unicast
!
!
```

SPA-ER4:

```
router bgp 10000
bgp router-id 10.255.255.4
bgp log neighbor changes detail
address-family vpnv4 unicast
neighbor 10.255.255.3
remote-as 10000
update-source Loopback0
!
address-family vpnv4 unicast
!
!
neighbor 10.255.255.5
remote-as 10000
```

```
update-source Loopback0
address-family vpnv4 unicast
  next-hop-self
!
!
neighbor 10.255.255.6
  remote-as 10000
  update-source Loopback0
  address-family vpnv4 unicast
    next-hop-self
!
!
```

Service Provider A, PE, RR and ASBRs configuration are done.

Service Provider B:

SPB-PE11:

```
router bgp 20000
  bgp router-id 10.255.255.11
  bgp cluster-id 10.255.255.11
  bgp log-neighbor-changes
  no bgp default ipv4-unicast
  neighbor 10.255.255.9 remote-as 20000
  neighbor 10.255.255.9 update-source Loopback0
  neighbor 10.255.255.10 remote-as 20000
  neighbor 10.255.255.10 update-source Loopback0
  neighbor 10.255.255.12 remote-as 20000
  neighbor 10.255.255.12 update-source Loopback0
!
address-family ipv4
  exit-address-family
!
address-family vpnv4
  neighbor 10.255.255.9 activate
  neighbor 10.255.255.9 send-community extended
  neighbor 10.255.255.9 route-reflector-client
```

```
neighbor 10.255.255.10 activate
neighbor 10.255.255.10 send-community extended
neighbor 10.255.255.10 route-reflector-client
neighbor 10.255.255.12 activate
neighbor 10.255.255.12 send-community extended
exit-address-family
!
vrf definition CustA
rd 20000:1
!
address-family ipv4
route-target export 20000:1
route-target import 20000:1
exit-address-family
!
!
interface Ethernet0/0
vrf forwarding CustA
ip address 192.168.1.11 255.255.255.0
duplex auto
!
router bgp 20000
!
address-family ipv4 vrf CustA
redistribute connected
neighbor 192.168.1.1 remote-as 65001
neighbor 192.168.1.1 activate
neighbor 192.168.1.1 remove-private-as all replace-as
neighbor 192.168.1.1 soo 20000:1
exit-address-family
!
vrf definition CustB
rd 20000:2
!
address-family ipv4
```

```
route-target export 20000:2
route-target import 20000:2
exit-address-family
!
!
interface Ethernet0/1
 vrf forwarding CustB
 ip address 172.22.11.11 255.255.255.0
 duplex auto
!
router ospf 20002 vrf CustB
 router-id 172.22.11.11
 domain-id type 0005 value 000000000002
 redistribute bgp 20000 subnets
 passive-interface default
 no passive-interface Ethernet0/1
 network 172.22.11.0 0.0.0.255 area 0
!
!
router bgp 20000
!
 address-family ipv4 vrf CustB
  redistribute connected
  redistribute ospf 20002 match internal external 1 external 2
 exit-address-family
!
```

SPB-PE12:

```
router bgp 20000
 bgp router-id 10.255.255.12
 bgp cluster-id 10.255.255.12
 bgp log-neighbor-changes
 no bgp default ipv4-unicast
 neighbor 10.255.255.9 remote-as 20000
 neighbor 10.255.255.9 update-source Loopback0
```

```
neighbor 10.255.255.10 remote-as 20000
neighbor 10.255.255.10 update-source Loopback0
neighbor 10.255.255.11 remote-as 20000
neighbor 10.255.255.11 update-source Loopback0
!
address-family vpnv4
  neighbor 10.255.255.9 activate
  neighbor 10.255.255.9 send-community extended
  neighbor 10.255.255.9 route-reflector-client
  neighbor 10.255.255.10 activate
  neighbor 10.255.255.10 send-community extended
  neighbor 10.255.255.10 route-reflector-client
  neighbor 10.255.255.11 activate
  neighbor 10.255.255.11 send-community extended
exit-address-family
!
vrf definition CustA
  rd 20000:1
  !
  address-family ipv4
    route-target export 20000:1
    route-target import 20000:1
  exit-address-family
  !
  !
interface Ethernet0/1
  vrf forwarding CustA
  ip address 192.168.11.12 255.255.255.0
  duplex auto
  !
router bgp 20000
  !
  address-family ipv4 vrf CustA
    redistribute connected
    neighbor 192.168.11.1 remote-as 65001
```

```

neighbor 192.168.11.1 activate
neighbor 192.168.11.1 remove-private-as all replace-as
neighbor 192.168.11.1 soo 20000:1
exit-address-family
!
vrf definition CustB
rd 20000:2
!
address-family ipv4
route-target export 20000:2
route-target import 20000:2
exit-address-family
!
!
interface Ethernet0/0
vrf forwarding CustB
ip address 172.22.1.12 255.255.255.0
duplex auto
!
router ospf 20002 vrf CustB
router-id 172.22.1.12
domain-id type 0005 value 000000000002
redistribute bgp 20000 subnets
passive-interface default
no passive-interface Ethernet0/0
network 172.22.1.0 0.0.0.255 area 0
!
!
router bgp 20000
!
address-family ipv4 vrf CustB
redistribute connected
redistribute ospf 20002 match internal external 1 external 2
exit-address-family
    
```

SPB-ER9:

```
router bgp 20000
  bgp router-id 10.255.255.9
  bgp log neighbor changes detail
  address-family vpnv4 unicast
  !
  neighbor 10.255.255.11
    remote-as 20000
    update-source Loopback0
    address-family vpnv4 unicast
  !
  !
  neighbor 10.255.255.12
    remote-as 20000
    update-source Loopback0
    address-family vpnv4 unicast
  !
  !
  !
```

SPB-ER10:

```
router bgp 20000
  bgp router-id 10.255.255.10
  bgp log neighbor changes detail
  address-family vpnv4 unicast
  !
  neighbor 10.255.255.11
    remote-as 20000
    update-source Loopback0
    address-family vpnv4 unicast
  !
  !
  neighbor 10.255.255.12
    remote-as 20000
    update-source Loopback0
```

```
address-family vpnv4 unicast
!
!
```

Service Provider C:

SPC-PE17:

```
router bgp 30000
  bgp router-id 10.255.255.17
  bgp cluster-id 10.255.255.17
  bgp log-neighbor-changes
  no bgp default ipv4-unicast
  neighbor 10.255.255.15 remote-as 30000
  neighbor 10.255.255.15 update-source Loopback0
  neighbor 10.255.255.16 remote-as 30000
  neighbor 10.255.255.16 update-source Loopback0
  neighbor 10.255.255.18 remote-as 30000
  neighbor 10.255.255.18 update-source Loopback0
!
address-family vpnv4
  neighbor 10.255.255.15 activate
  neighbor 10.255.255.15 send-community extended
  neighbor 10.255.255.15 route-reflector-client
  neighbor 10.255.255.16 activate
  neighbor 10.255.255.16 send-community extended
  neighbor 10.255.255.16 route-reflector-client
  neighbor 10.255.255.18 activate
  neighbor 10.255.255.18 send-community extended
exit-address-family
!
vrf definition CustA
  rd 30000:1
!
address-family ipv4
  route-target export 10000:1
```



```
route-target import 10000:1
exit-address-family
!
!
interface Ethernet0/0
vrf forwarding CustA
ip address 192.168.2.17 255.255.255.0
duplex auto
!
router bgp 30000
!
address-family ipv4 vrf CustA
redistribute connected
neighbor 192.168.2.2 remote-as 65001
neighbor 192.168.2.2 activate
neighbor 192.168.2.2 remove-private-as all replace-as
neighbor 192.168.2.2 soo 30000:1
exit-address-family
!
vrf definition CustB
rd 30000:2
!
address-family ipv4
route-target export 10000:2
route-target import 10000:2
exit-address-family
!
!
interface Ethernet0/1
vrf forwarding CustB
ip address 172.22.22.17 255.255.255.0
duplex auto
!
router ospf 30002 vrf CustB
```

```
router-id 172.22.22.17
domain-id type 0005 value 000000000002
redistribute bgp 30000 subnets
passive-interface default
no passive-interface Ethernet0/1
network 172.22.22.0 0.0.0.255 area 0
!
!
router bgp 30000
!
address-family ipv4 vrf CustB
  redistribute connected
  redistribute ospf 30002 match internal external 1 external 2
exit-address-family
!
```

SPC-PE18:

```
router bgp 30000
  bgp router-id 10.255.255.18
  bgp cluster-id 10.255.255.18
  bgp log-neighbor-changes
  no bgp default ipv4-unicast
  neighbor 10.255.255.15 remote-as 30000
  neighbor 10.255.255.15 update-source Loopback0
  neighbor 10.255.255.16 remote-as 30000
  neighbor 10.255.255.16 update-source Loopback0
  neighbor 10.255.255.17 remote-as 30000
  neighbor 10.255.255.17 update-source Loopback0
!
address-family ipv4
exit-address-family
!
address-family vpnv4
  neighbor 10.255.255.15 activate
```

```
neighbor 10.255.255.15 send-community extended
neighbor 10.255.255.15 route-reflector-client
neighbor 10.255.255.16 activate
neighbor 10.255.255.16 send-community extended
neighbor 10.255.255.16 route-reflector-client
neighbor 10.255.255.17 activate
neighbor 10.255.255.17 send-community extended
exit-address-family
!
vrf definition CustA
rd 30000:1
!
address-family ipv4
route-target export 10000:1
route-target import 10000:1
exit-address-family
!
!
interface Ethernet0/1
vrf forwarding CustA
ip address 192.168.22.18 255.255.255.0
duplex auto
!
router bgp 30000
!
address-family ipv4 vrf CustA
redistribute connected
neighbor 192.168.22.2 remote-as 65001
neighbor 192.168.22.2 activate
neighbor 192.168.22.2 remove-private-as all replace-as
neighbor 192.168.22.2 soo 30000:1
exit-address-family
!
vrf definition CustB
rd 30000:2
```

```
!  
address-family ipv4  
  route-target export 10000:2  
  route-target import 10000:2  
exit-address-family  
!  
!  
interface Ethernet0/0  
  vrf forwarding CustB  
  ip address 172.22.2.18 255.255.255.0  
  duplex auto  
!  
router ospf 30002 vrf CustB  
  domain-id type 0005 value 000000000002  
  redistribute bgp 30000 subnets  
  passive-interface default  
  no passive-interface Ethernet0/0  
  network 192.168.22.0 0.0.0.255 area 0  
!  
!  
router bgp 30000  
  !  
  address-family ipv4 vrf CustB  
    redistribute connected  
    redistribute ospf 30002 match internal external 1 external 2  
  exit-address-family  
!  
  
SPC-ER15:  
router bgp 30000  
  bgp router-id 10.255.255.15  
  bgp log neighbor changes detail  
  address-family vpnv4 unicast  
  !
```

```
!  
neighbor 10.255.255.17  
  remote-as 30000  
  update-source Loopback0  
  address-family vpnv4 unicast  
!  
!  
neighbor 10.255.255.18  
  remote-as 30000  
  update-source Loopback0  
  address-family vpnv4 unicast  
!  
!  
!
```

SPC-ER16:

```
router bgp 30000  
  bgp router-id 10.255.255.16  
  bgp log neighbor changes detail  
  address-family vpnv4 unicast  
!  
neighbor 10.255.255.17  
  remote-as 30000  
  update-source Loopback0  
  address-family vpnv4 unicast  
!  
!  
neighbor 10.255.255.18  
  remote-as 30000  
  update-source Loopback0  
  address-family vpnv4 unicast  
!  
!  
!
```

Service Provider D:

SPD-PE23:

```
router bgp 40000
  bgp router-id 10.255.255.23
  bgp cluster-id 10.255.255.23
  bgp log-neighbor-changes
  no bgp default ipv4-unicast
  neighbor 10.255.255.24 remote-as 40000
  neighbor 10.255.255.24 update-source Loopback0
!
address-family ipv4
  exit-address-family
!
address-family vpv4
  neighbor 10.255.255.24 activate
  neighbor 10.255.255.24 send-community extended
  exit-address-family
!
vrf definition CustA
  rd 40000:1
!
  address-family ipv4
    route-target export 10000:1
    route-target import 10000:1
  exit-address-family
!
!
interface Ethernet0/0
  vrf forwarding CustA
  ip address 192.168.3.23 255.255.255.0
  duplex auto
!
router bgp 40000
!
  address-family ipv4 vrf CustA
```

```
redistribute connected metric 10
neighbor 192.168.3.3 remote-as 65001
neighbor 192.168.3.3 activate
neighbor 192.168.3.3 as-override
neighbor 192.168.3.3 soo 40000:1
exit-address-family
!
vrf definition CustB
rd 40000:2
!
address-family ipv4
route-target export 10000:2
route-target import 10000:2
exit-address-family
!
!
interface Ethernet0/1
vrf forwarding CustB
ip address 172.22.33.23 255.255.255.0
duplex auto
!
router ospf 40002 vrf CustB
domain-id type 0005 value 000000000002
redistribute bgp 40000 subnets
passive-interface default
no passive-interface Ethernet0/1
network 172.22.33.0 0.0.0.255 area 0
!
!
router bgp 40000
!
address-family ipv4 vrf CustB
redistribute connected
redistribute ospf 40002 match internal external 1 external 2
exit-address-family
```

SPD-PE24:

```
router bgp 40000
  bgp router-id 10.255.255.24
  bgp cluster-id 10.255.255.24
  bgp log-neighbor-changes
  no bgp default ipv4-unicast
  neighbor 10.255.255.23 remote-as 40000
  neighbor 10.255.255.23 update-source Loopback0
!
address-family ipv4
  exit-address-family
!
address-family vpv4
  neighbor 10.255.255.23 activate
  neighbor 10.255.255.23 send-community extended
  exit-address-family
vrf definition CustA
  rd 40000:1
!
address-family ipv4
  route-target export 10000:1
  route-target import 10000:1
  exit-address-family
!
!
interface Ethernet0/1
  vrf forwarding CustA
  ip address 192.168.33.24 255.255.255.0
  duplex auto
!
router bgp 40000
!
address-family ipv4 vrf CustA
  redistribute connected metric 10
  neighbor 192.168.33.3 remote-as 65001
```



```
neighbor 192.168.33.3 activate
neighbor 192.168.33.3 as-override
neighbor 192.168.33.3 soo 40000:1
exit-address-family
!
vrf definition CustB
rd 40000:2
!
address-family ipv4
route-target export 10000:2
route-target import 10000:2
exit-address-family
!
!
interface Ethernet0/0
vrf forwarding CustB
ip address 172.22.3.23 255.255.255.0
duplex auto
!
router ospf 40002 vrf CustB
domain-id type 0005 value 000000000002
redistribute bgp 40000 subnets
passive-interface default
no passive-interface Ethernet0/0
network 172.22.3.0 0.0.0.255 area 0
!
!
router bgp 40000
!
address-family ipv4 vrf CustB
redistribute connected
redistribute ospf 40002 match internal external 1 external 2
exit-address-family
!
```



Task 04:

- Configure Inter-AS L3VPN between SP A and SP B (Use Option A)



Solution:

If you have not completed the Inter-AS MPLS VPNs Using Option A Lab, please go back to that lab and complete all the tasks, otherwise you may be confused with this part.

We have explained all the necessary steps for configuring Inter-AS MPLS VPNs using Option A in that lab.

The difference between this lab (All in One) and the individual Options lab is:

- We are now using IOS-XR as the ASBR devices
- ASBRs are redundant (It seems much more complicated, but it is not!)

As a reminder: in Inter-AS MPLS VPNs using Option A, we need to create a separate sub-interfaces between two ASBRs for each customer (We could also use separate physical interfaces for each of the Customers, but that type of implementation is not common).

Then, we need to configure eBGP IPv4 unicast neighborship under each VRF (Or we could use any IGP between ASBRs for each VRF, but it overcomplicates the implementation because of using many routing protocols and they need redistribution).

ASBRs already have MP-BGP VPNv4 Unicast neighborship with the PEs (inline RRs).

Let's configure the ASBRs:

```
SPA-ER3:
vrf CustA
  address-family ipv4 unicast
    import route-target
      10000:1
    !
  export route-target
    10000:1
  !
  !
  !
vrf CustB
  address-family ipv4 unicast
```

```
import route-target
10000:2
!
export route-target
10000:2
!
!
!
route-policy PASS_ALL
pass
end-policy
interface GigabitEthernet0/0/0/3.10
vrf CustA
ipv4 address 10.3.10.3 255.255.255.0
encapsulation dot1q 10
!
interface GigabitEthernet0/0/0/3.20
vrf CustB
ipv4 address 10.30.10.3 255.255.255.0
encapsulation dot1q 20
!
interface GigabitEthernet0/0/0/4.10
vrf CustA
ipv4 address 10.3.9.3 255.255.255.0
encapsulation dot1q 10
!
interface GigabitEthernet0/0/0/4.20
vrf CustB
ipv4 address 10.30.9.3 255.255.255.0
encapsulation dot1q 20
!
router bgp 10000
bgp router-id 10.255.255.3
bgp log neighbor changes detail
address-family ipv4 unicast
```

```
!  
vrf CustA  
  rd 10000:1  
  address-family ipv4 unicast  
  !  
  neighbor 10.3.9.9  
  remote-as 20000  
  address-family ipv4 unicast  
    route-policy PASS_ALL in  
    route-policy PASS_ALL out  
  !  
  !  
  neighbor 10.3.10.10  
  remote-as 20000  
  address-family ipv4 unicast  
    route-policy PASS_ALL in  
    route-policy PASS_ALL out  
  !  
  !  
  !  
vrf CustB  
  rd 10000:2  
  address-family ipv4 unicast  
  !  
  neighbor 10.30.9.9  
  remote-as 20000  
  address-family ipv4 unicast  
    route-policy PASS_ALL in  
    route-policy PASS_ALL out  
  !  
  !  
  neighbor 10.30.10.10  
  remote-as 20000  
  address-family ipv4 unicast
```

```
route-policy PASS_ALL in
route-policy PASS_ALL out
!
!
!
!
```

The only step that you may not know about it is:

Route-Policy and applying it to each of the eBGP neighbors. IOS-XR by default does not send any route to the neighbor and it does not accept any route from eBGP neighbor. In order to force it to do so, we must define a route-policy and selectively allow incoming and outgoing routes. In order to keep it simple we have just defined a simple PASS ALL policy (Accepts everything) and apply it to the neighbors in inbound and outbound direction.

You have realized that the configuration steps are the same as IOS or IOS-XE configuration but in different language (IOS-XR CLI).

Let's configure all the other ASBRs:

```
SPA-ER4:
vrf CustA
  address-family ipv4 unicast
    import route-target
      10000:1
    !
  export route-target
    10000:1
  !
!
!
vrf CustB
  address-family ipv4 unicast
    import route-target
      10000:2
    !
  export route-target
    10000:2
  !
```

```
!  
!  
interface GigabitEthernet0/0/0/6.10  
  vrf CustA  
  ipv4 address 10.4.10.4 255.255.255.0  
  encapsulation dot1q 10  
!  
interface GigabitEthernet0/0/0/6.20  
  vrf CustB  
  ipv4 address 10.40.10.4 255.255.255.0  
  encapsulation dot1q 20  
!  
interface GigabitEthernet0/0/0/7.10  
  vrf CustA  
  ipv4 address 10.4.9.4 255.255.255.0  
  encapsulation dot1q 10  
!  
interface GigabitEthernet0/0/0/7.20  
  vrf CustB  
  ipv4 address 10.40.9.4 255.255.255.0  
  encapsulation dot1q 20  
!  
route-policy PASS_ALL  
  pass  
end-policy  
!  
router bgp 10000  
  vrf CustA  
  rd 10000:1  
  address-family ipv4 unicast  
  !  
  neighbor 10.4.9.9  
  remote-as 20000  
  address-family ipv4 unicast  
  route-policy PASS_ALL in
```

```
route-policy PASS_ALL out
!
!
neighbor 10.4.10.10
remote-as 20000
address-family ipv4 unicast
route-policy PASS_ALL in
route-policy PASS_ALL out
!
!
!
!
vrf CustB
rd 10000:2
address-family ipv4 unicast
!
neighbor 10.40.9.9
remote-as 20000
address-family ipv4 unicast
route-policy PASS_ALL in
route-policy PASS_ALL out
!
!
neighbor 10.40.10.10
remote-as 20000
address-family ipv4 unicast
route-policy PASS_ALL in
route-policy PASS_ALL out
!
!
!
!
```

SPB-ER9:

```
vrf CustA
  address-family ipv4 unicast
    import route-target
      20000:1
    !
  export route-target
    20000:1
  !
!
vrf CustB
  address-family ipv4 unicast
    import route-target
      20000:2
    !
  export route-target
    20000:2
  !
!
route-policy PASS_ALL
  pass
end-policy
!
interface GigabitEthernet0/0/0/4.10
  vrf CustA
  ipv4 address 10.3.9.9 255.255.255.0
  encapsulation dot1q 10
!
interface GigabitEthernet0/0/0/4.20
  vrf CustB
  ipv4 address 10.30.9.9 255.255.255.0
  encapsulation dot1q 20
!
```



```
interface GigabitEthernet0/0/0/7.10
  vrf CustA
  ipv4 address 10.4.9.9 255.255.255.0
  encapsulation dot1q 10
!
interface GigabitEthernet0/0/0/7.20
  vrf CustB
  ipv4 address 10.40.9.9 255.255.255.0
  encapsulation dot1q 20
!
router bgp 20000
  bgp router-id 10.255.255.9
  bgp log neighbor changes detail
  vrf CustA
    rd 20000:1
    address-family ipv4 unicast
  !
  neighbor 10.3.9.3
    remote-as 10000
    address-family ipv4 unicast
      route-policy PASS_ALL in
      route-policy PASS_ALL out
  !
  !
  neighbor 10.4.9.4
    remote-as 10000
    address-family ipv4 unicast
      route-policy PASS_ALL in
      route-policy PASS_ALL out
  !
  !
  !
  vrf CustB
    rd 20000:2
    address-family ipv4 unicast
```

```
!  
neighbor 10.30.9.3  
  remote-as 10000  
  address-family ipv4 unicast  
    route-policy PASS_ALL in  
    route-policy PASS_ALL out  
!  
!  
neighbor 10.40.9.4  
  remote-as 10000  
  address-family ipv4 unicast  
    route-policy PASS_ALL in  
    route-policy PASS_ALL out  
!  
!  
!  
!  
  
SPB-ER10:  
vrf CustA  
  address-family ipv4 unicast  
    import route-target  
      20000:1  
  !  
  export route-target  
    20000:1  
  !  
  !  
  !  
vrf CustB  
  address-family ipv4 unicast  
    import route-target  
      20000:2  
  !
```

```
export route-target
 20000:2
!
!
!
route-policy PASS_ALL
  pass
end-policy
!
interface GigabitEthernet0/0/0/3.10
 vrf CustA
 ipv4 address 10.3.10.10 255.255.255.0
 encapsulation dot1q 10
!
interface GigabitEthernet0/0/0/3.20
 vrf CustB
 ipv4 address 10.30.10.10 255.255.255.0
 encapsulation dot1q 20
!
interface GigabitEthernet0/0/0/6.10
 vrf CustA
 ipv4 address 10.4.10.10 255.255.255.0
 encapsulation dot1q 10
!
interface GigabitEthernet0/0/0/6.20
 vrf CustB
 ipv4 address 10.40.10.10 255.255.255.0
 encapsulation dot1q 20
!
router bgp 20000
 vrf CustA
  rd 20000:1
  address-family ipv4 unicast
  !
  neighbor 10.3.10.3
```

```
remote-as 10000
address-family ipv4 unicast
  route-policy PASS_ALL in
  route-policy PASS_ALL out
!
!
neighbor 10.4.10.4
  remote-as 10000
  address-family ipv4 unicast
    route-policy PASS_ALL in
    route-policy PASS_ALL out
  !
!
!
vrf CustB
  rd 20000:2
  address-family ipv4 unicast
  !
  neighbor 10.30.10.3
    remote-as 10000
    address-family ipv4 unicast
      route-policy PASS_ALL in
      route-policy PASS_ALL out
    !
  !
  neighbor 10.40.10.4
    remote-as 10000
    address-family ipv4 unicast
      route-policy PASS_ALL in
      route-policy PASS_ALL out
    !
  !
  !
  !
```

All the configurations are done. We can verify the Customer sites connectivity.

Verification:

```
RP/0/0/CPU0:SPB-ER10#show bgp vrf all summary | begin Neighbor
Fri Apr 16 22:45:14.366 UTC
Neighbor      Spk    AS MsgRcvd MsgSent   TblVer  InQ OutQ  Up/Down  St/PfxRcd
10.3.10.3     0 10000   423    415     103    0   0 06:44:44    10
10.4.10.4     0 10000   423    415     103    0   0 06:44:41    10
--More--
```

```
CustA-CE1#trace 172.16.255.4 source lo 0
Type escape sequence to abort.
Tracing the route to 172.16.255.4
VRF info: (vrf in name/id, vrf out name/id)
 1 192.168.1.11 0 msec
   192.168.11.12 [AS 20000] 1 msec
   192.168.1.11 0 msec
 2 10.7.12.7 [MPLS: Labels 70005/90006 Exp 0] 34 msec
   10.7.11.7 [MPLS: Labels 70005/90006 Exp 0] 4 msec
   10.7.12.7 [MPLS: Labels 70005/90006 Exp 0] 4 msec
 3 10.7.9.9 [MPLS: Label 90006 Exp 0] 5 msec 3 msec 2 msec
 4 10.3.9.3 4 msec 3 msec 3 msec
 5 10.1.3.1 [MPLS: Labels 10002/50003 Exp 0] 6 msec 5 msec 5 msec
 6 192.168.4.5 [AS 10000] [MPLS: Label 50003 Exp 0] 5 msec 4 msec 5 msec
 7 192.168.4.4 [AS 10000] 6 msec 5 msec 5 msec
```

```
CustB-CE1#trace 172.17.255.5 source lo 0
Type escape sequence to abort.
Tracing the route to 172.17.255.5
VRF info: (vrf in name/id, vrf out name/id)
 1 172.22.1.12 1 msec
   172.22.11.11 1 msec
   172.22.1.12 1 msec
 2 10.8.11.8 [MPLS: Labels 80004/90014 Exp 0] 5 msec
```

```
10.7.12.7 [MPLS: Labels 70005/90014 Exp 0] 4 msec
10.8.11.8 [MPLS: Labels 80004/90014 Exp 0] 5 msec
3 10.7.9.9 [MPLS: Label 90014 Exp 0] 8 msec
10.8.9.9 [MPLS: Label 90014 Exp 0] 4 msec
10.7.9.9 [MPLS: Label 90014 Exp 0] 4 msec
4 10.30.9.3 5 msec 4 msec 4 msec
5 10.2.3.2 [MPLS: Labels 20001/60005 Exp 0] 7 msec 6 msec 8 msec
6 172.22.5.6 [MPLS: Label 60005 Exp 0] 6 msec 5 msec 4 msec
7 172.22.5.5 6 msec 5 msec 4 msec
```



Task 05:

- Configure Inter-AS L3VPN between SP A and SP C (Use Option B)



Solution:

Before you continue with this task, if you are not familiar with how to configure Inter-AS MPLS VPNs using Option B, please go back to the individual workbook part and complete those tasks first.

Reminder: In Option B, ASBRs need to form MP-BGP VPNv4 Unicast neighborship, there is no need to define any VRFs for each of the customers. The MP-BGP neighborship is going to use Global Routing Table IP forwarding (no VRF), and ASBRs are not Route-Reflectors, so they will ignore and drop the VPNv4 routes by default (They are not also PEs, so no need for Route-Target values, and they simply drop all the routes), we need to handle that situation on IOS-XR.

Packet needs to be label switched between two Autonomous Systems, The configuration of MPLS BGP Forwarding is a little bit different than IOS-XE, we will take a look at the configuration of that part also (It will be highlighted in the below configuration section:

SPA-ER3:

```
router bgp 10000
  address-family ipv4 unicast
    allocate-label all
  address-family vpnv4 unicast
    retain route-target all
!
neighbor 10.3.15.15
  remote-as 30000
  address-family vpnv4 unicast
    route-policy PASS_ALL in
    route-policy PASS_ALL out
!
neighbor 10.3.16.16
  remote-as 30000
  address-family vpnv4 unicast
    route-policy PASS_ALL in
```

```
route-policy PASS_ALL out
!
!
!
router static
address-family ipv4 unicast
10.3.15.15/32 GigabitEthernet0/0/0/2
10.3.16.16/32 GigabitEthernet0/0/0/5
!
!
```

What does highlighted command mean:

retain route-target all: DO NOT drop any VPNv4 route that has any RT value that you are not using at the moment (The router does not have any CE devices connected to the ASBR, also The ASBR is not an RR, so it will not keep all the routes).

```
router static
address-family ipv4 unicast
10.3.15.15/32 GigabitEthernet0/0/0/2
10.3.16.16/32 GigabitEthernet0/0/0/5
```

!

Enable MPLS BGP Forwarding on those interfaces for that neighbor (I know this is odd! But that is the way you need to do on IOS-XR device). On the other hand, on IOS-XE devices we form a labeled unicast neighborhood with the ASBR and MPLS BGP FORWARDING command will be put automatically for the interface.

allocate-label all: Allocate a label for all of the IPv4 Unicast prefixes. (It is not needed in this task, but required in the next task (Option C)).

Let's configure the rest of the routers:

```
SPA-ER4:
router bgp 10000
address-family ipv4 unicast
allocate-label all
!
address-family vpnv4 unicast
retain route-target all
!
neighbor 10.4.15.15
```



```
remote-as 30000
address-family vpnv4 unicast
  route-policy PASS_ALL in
  route-policy PASS_ALL out
!
!
neighbor 10.4.16.16
  remote-as 30000
  address-family vpnv4 unicast
    route-policy PASS_ALL in
    route-policy PASS_ALL out
!
!
router static
address-family ipv4 unicast
  10.4.15.15/32 GigabitEthernet0/0/0/5
  10.4.16.16/32 GigabitEthernet0/0/0/2
!
!
```

SPC-ER15:

```
router bgp 30000
  bgp router-id 10.255.255.15
  bgp log neighbor changes detail
  address-family vpnv4 unicast
    retain route-target all
!
neighbor 10.3.15.3
  remote-as 10000
  address-family vpnv4 unicast
    route-policy PASS_ALL in
    route-policy PASS_ALL out
!
!
neighbor 10.4.15.4
```

```
remote-as 10000
address-family vpnv4 unicast
  route-policy PASS_ALL in
  route-policy PASS_ALL out
!
!
router static
address-family ipv4 unicast
  10.3.15.3/32 GigabitEthernet0/0/0/2
  10.4.15.4/32 GigabitEthernet0/0/0/5
!
!
```

SPC-PE-16:

```
router bgp 30000
  bgp router-id 10.255.255.16
  bgp log neighbor changes detail
  address-family vpnv4 unicast
    retain route-target all
  !
  neighbor 10.3.16.3
    remote-as 10000
    address-family vpnv4 unicast
      route-policy PASS_ALL in
      route-policy PASS_ALL out
    !
  !
  neighbor 10.4.16.4
    remote-as 10000
    address-family vpnv4 unicast
      route-policy PASS_ALL in
      route-policy PASS_ALL out
    !
  !
```

```

router static
address-family ipv4 unicast
  10.3.16.3/32 GigabitEthernet0/0/0/5
  10.4.16.4/32 GigabitEthernet0/0/0/2
!
!
    
```

Verification:

```

RP/0/0/CPU0:SPC-ER16#show bgp vpnv4 uni summary | begin Neigh
Fri Apr 16 23:16:52.353 UTC
Neighbor      Spk    AS MsgRcvd MsgSent   TblVer  InQ OutQ  Up/Down  St/PfxRcd
10.3.16.3     0 10000    459    462     133    0    0 07:16:26    20
10.4.16.4     0 10000    461    462     133    0    0 07:16:19    20
10.255.255.17 0 30000    514    472     133    0    0 07:21:43    26
10.255.255.18 0 30000    511    473     133    0    0 07:21:45    26

CustA-CE2#trace 172.16.255.4 source lo 0
Type escape sequence to abort.
Tracing the route to 172.16.255.4
VRF info: (vrf in name/id, vrf out name/id)
 1 192.168.2.17 1 msec
   192.168.22.18 [AS 30000] 0 msec
   192.168.2.17 0 msec
 2 10.14.18.14 [MPLS: Labels 140003/150016 Exp 0] 7 msec
   10.13.17.13 [MPLS: Labels 130003/150016 Exp 0] 6 msec
   10.14.18.14 [MPLS: Labels 140003/150016 Exp 0] 5 msec
 3 10.13.15.15 [MPLS: Label 150016 Exp 0] 9 msec
   10.14.15.15 [MPLS: Label 150016 Exp 0] 8 msec
   10.13.15.15 [MPLS: Label 150016 Exp 0] 7 msec
 4 10.3.15.3 [MPLS: Label 30014 Exp 0] 9 msec 5 msec 6 msec
 5 10.1.3.1 [MPLS: Labels 10002/50003 Exp 0] 5 msec 6 msec 4 msec
 6 192.168.4.5 [AS 10000] [MPLS: Label 50003 Exp 0] 5 msec 4 msec 5 msec
 7 192.168.4.4 [AS 10000] 5 msec 5 msec 6 msec
    
```



Task 06:

- Configure Inter-AS L3VPN between SP A and SP D (Use Option C)



Solution:

If you have not completed the individual workbook part of Inter-AS MPLS L3VPNs using Option C, Please go back to that section and complete the tasks, otherwise you may not understand what is happening in this Option.

Reminder: In Option C, We need to configure IPv4 Labeled Unicast neighborship between the ASBRs (Packets needs to be label switched between two Autonomous Systems), also we need to advertise PE and RR Loopback IP addresses (/32 Host routes) to the neighboring Autonomous System). The final step is to configure MP-BGP VPNv4 Unicast neighborship between The two Autonomous Systems Route-Reflectors (DO NOT forget to use next-hop-unchanged).

SPA-ER3:

```
router bgp 10000
  bgp router-id 10.255.255.3
  bgp log neighbor changes detail
  address-family ipv4 unicast
    network 10.255.255.3/32
    network 10.255.255.4/32
    network 10.255.255.5/32
    network 10.255.255.6/32
  allocate-label all
!
neighbor 10.3.21.21
  remote-as 40000
  address-family ipv4 labeled-unicast
    route-policy PASS_ALL in
    route-policy PASS_ALL out
!
neighbor 10.3.22.22
  remote-as 40000
  address-family ipv4 labeled-unicast
```

```
route-policy PASS_ALL in
route-policy PASS_ALL out
!
!
router static
address-family ipv4 unicast
 10.3.21.21/32 GigabitEthernet0/0/0/7
 10.3.22.22/32 GigabitEthernet0/0/0/6
!
!
```

SPA-ER4:

```
router bgp 10000
  bgp router-id 10.255.255.4
  bgp log neighbor changes detail
  address-family ipv4 unicast
    network 10.255.255.3/32
    network 10.255.255.4/32
    network 10.255.255.5/32
    network 10.255.255.6/32
    allocate-label all
  !
  neighbor 10.4.15.15
    remote-as 30000
    address-family vpnv4 unicast
      route-policy PASS_ALL in
      route-policy PASS_ALL out
    !
  !
  neighbor 10.4.22.22
    remote-as 40000
    address-family ipv4 labeled-unicast
      route-policy PASS_ALL in
      route-policy PASS_ALL out
    !
  !
```

```
router static
  address-family ipv4 unicast
    10.4.21.21/32 GigabitEthernet0/0/0/3
    10.4.22.22/32 GigabitEthernet0/0/0/4
  !
!
```

SPD-ER21:

```
router bgp 40000
  bgp router-id 10.255.255.21
  bgp log neighbor changes detail
  address-family ipv4 unicast
    network 10.255.255.23/32
    network 10.255.255.24/32
    allocate-label all
  !
  neighbor 10.3.21.3
    remote-as 10000
    address-family ipv4 labeled-unicast
      route-policy PASS_ALL in
      route-policy PASS_ALL out
    !
  !
  neighbor 10.4.21.4
    remote-as 10000
    address-family ipv4 labeled-unicast
      route-policy PASS_ALL in
      route-policy PASS_ALL out
    !
  !
router static
  address-family ipv4 unicast
    10.3.21.3/32 GigabitEthernet0/0/0/7
    10.4.21.4/32 GigabitEthernet0/0/0/3
  !
!
```

SPD-ER22:

```

router bgp 40000
  bgp router-id 10.255.255.22
  bgp log neighbor changes detail
  address-family ipv4 unicast
    network 10.255.255.23/32
    network 10.255.255.24/32
    allocate-label all
  !
  neighbor 10.3.22.3
    remote-as 10000
    address-family ipv4 labeled-unicast
      route-policy PASS_ALL in
      route-policy PASS_ALL out
    !
  !
  neighbor 10.4.22.4
    remote-as 10000
    address-family ipv4 labeled-unicast
      route-policy PASS_ALL in
      route-policy PASS_ALL out
    !
  !
  !
router static
  address-family ipv4 unicast
    10.3.22.3/32 GigabitEthernet0/0/0/6
    10.4.22.4/32 GigabitEthernet0/0/0/4
  !
  !

```

Now, All PEs and RRs should have the end to end reachability (Label switches) or loopback to loopback LSPs.

The next step is to configure VPNv4 unicast neighborship between the RRs of two Autonomous Systems (next-hop-unchanged command should be used for the neighbors):

SPD-PE-23:

```
router bgp 40000
  neighbor 10.255.255.5 remote-as 10000
  neighbor 10.255.255.5 ebgp-multihop 255
  neighbor 10.255.255.5 update-source Loopback0
  neighbor 10.255.255.6 remote-as 10000
  neighbor 10.255.255.6 ebgp-multihop 255
  neighbor 10.255.255.6 update-source Loopback0
!
address-family ipv4
exit-address-family
!
address-family vpnv4
  neighbor 10.255.255.5 activate
  neighbor 10.255.255.5 send-community both
  neighbor 10.255.255.5 next-hop-unchanged
  neighbor 10.255.255.6 activate
  neighbor 10.255.255.6 send-community extended
  neighbor 10.255.255.6 next-hop-unchanged
exit-address-family
!
```

SPD-PE24:

```
router bgp 40000
  neighbor 10.255.255.5 remote-as 10000
  neighbor 10.255.255.5 ebgp-multihop 255
  neighbor 10.255.255.5 update-source Loopback0
  neighbor 10.255.255.6 remote-as 10000
  neighbor 10.255.255.6 ebgp-multihop 255
  neighbor 10.255.255.6 update-source Loopback0
!
address-family vpnv4
  neighbor 10.255.255.5 activate
  neighbor 10.255.255.5 send-community both
  neighbor 10.255.255.5 next-hop-unchanged
```



```
neighbor 10.255.255.6 activate
neighbor 10.255.255.6 send-community extended
neighbor 10.255.255.6 next-hop-unchanged
exit-address-family
!
```

SPA-PE5:

```
router bgp 10000
neighbor 10.255.255.23 remote-as 40000
neighbor 10.255.255.23 ebgp-multihop 255
neighbor 10.255.255.23 update-source Loopback0
neighbor 10.255.255.24 remote-as 40000
neighbor 10.255.255.24 ebgp-multihop 255
neighbor 10.255.255.24 update-source Loopback0
!
address-family vpnv4
neighbor 10.255.255.23 activate
neighbor 10.255.255.23 send-community extended
neighbor 10.255.255.23 next-hop-unchanged
neighbor 10.255.255.24 activate
neighbor 10.255.255.24 send-community extended
neighbor 10.255.255.24 next-hop-unchanged
exit-address-family
!
```

SPA-PE6:

```
router bgp 10000
neighbor 10.255.255.23 remote-as 40000
neighbor 10.255.255.23 ebgp-multihop 255
neighbor 10.255.255.23 update-source Loopback0
neighbor 10.255.255.24 remote-as 40000
neighbor 10.255.255.24 ebgp-multihop 255
neighbor 10.255.255.24 update-source Loopback0
!
address-family vpnv4
```

```

neighbor 10.255.255.23 activate
neighbor 10.255.255.23 send-community extended
neighbor 10.255.255.23 next-hop-unchanged
neighbor 10.255.255.24 activate
neighbor 10.255.255.24 send-community extended
neighbor 10.255.255.24 next-hop-unchanged
exit-address-family
    
```

Verification:

```
SPA-PE6#show bgp vpnv4 uni all summary | begin Neigh
```

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
10.255.255.3	4	10000	478	547	63	0	0	07:45:50	12
10.255.255.4	4	10000	474	543	63	0	0	07:45:43	12
10.255.255.5	4	10000	1439	1438	63	0	0	21:26:50	22
10.255.255.23	4	40000	533	535	63	0	0	07:42:52	6
10.255.255.24	4	40000	521	532	63	0	0	07:43:00	6
192.168.5.5	4	65001	1420	1427	63	0	0	21:27:08	2

```
SPA-PE6#show bgp vpnv4 uni all | include 10.255.255.23|10.255.255.24
```

```

*> 172.16.255.3/32 10.255.255.24 0 40000 65001 i
*> 192.168.3.0 10.255.255.23 0 40000 ?
*> 192.168.33.0 10.255.255.24 0 40000 ?
*> 172.17.255.3/32 10.255.255.24 11 0 40000 ?
*> 172.22.3.0/24 10.255.255.24 0 0 40000 ?
*> 172.22.33.0/24 10.255.255.23 0 0 40000 ?
* 172.16.255.3/32 10.255.255.23 0 40000 65001 i
* i 10.255.255.23 0 100 0 40000 65001 i
*> 10.255.255.24 0 40000 65001 i
* 192.168.3.0 10.255.255.23 10 0 40000 ?
* i 10.255.255.23 0 100 0 40000 ?
*> 10.255.255.23 0 40000 ?
*> 192.168.33.0 10.255.255.24 0 40000 ?
* i 10.255.255.24 0 100 0 40000 ?
* 10.255.255.24 10 0 40000 ?
    
```

```

* 172.17.255.3/32 10.255.255.23 11 0 40000 ?
* i 10.255.255.23 11 100 0 40000 ?
*> 10.255.255.24 11 0 40000 ?
* 172.22.3.0/24 10.255.255.23 20 0 40000 ?
* i 10.255.255.24 0 100 0 40000 ?
*> 10.255.255.24 0 0 40000 ?
*> 172.22.33.0/24 10.255.255.23 0 0 40000 ?
* i 10.255.255.23 0 100 0 40000 ?
* 10.255.255.24 20 0 40000 ?
    
```

CustA-CE3#trace 172.16.255.4 source lo 0

Type escape sequence to abort.

Tracing the route to 172.16.255.4

VRF info: (vrf in name/id, vrf out name/id)

```

 1 192.168.3.23 [AS 40000] 1 msec
    192.168.33.24 [AS 40000] 1 msec
    192.168.3.23 [AS 40000] 1 msec
 2 10.19.24.19 [MPLS: Labels 190007/50003 Exp 0] 11 msec
    10.19.23.19 [MPLS: Labels 190007/50003 Exp 0] 9 msec
    10.19.24.19 [MPLS: Labels 190007/50003 Exp 0] 8 msec
 3 10.19.22.22 [MPLS: Labels 220009/50003 Exp 0] 11 msec 8 msec 7 msec
 4 10.3.22.3 [MPLS: Labels 30003/50003 Exp 0] 9 msec 8 msec 10 msec
 5 10.1.3.1 [MPLS: Labels 10002/50003 Exp 0] 9 msec 9 msec 7 msec
 6 192.168.4.5 [AS 10000] [MPLS: Label 50003 Exp 0] 8 msec 8 msec 9 msec
 7 192.168.4.4 [AS 10000] 8 msec 8 msec 8 msec
    
```



Task 07:

- All Customer sites should have reachability (from any SPs to All other SPs)



Verification:

If you have configured all the tasks properly, all customers sites should have End-To-End IP reachability:

```
CustA-CE3#show ip bgp | begin Net
```

	Network	Next Hop	Metric	LocPrf	Weight	Path
*m	172.16.255.1/32	192.168.33.24				0 40000 10000 20000 40000 i
*>		192.168.3.23				0 40000 10000 20000 40000 i
*m	172.16.255.2/32	192.168.33.24				0 40000 10000 30000 40000 i
*>		192.168.3.23				0 40000 10000 30000 40000 i
*>	172.16.255.3/32	0.0.0.0	0		32768	i
*m	172.16.255.4/32	192.168.33.24				0 40000 10000 40000 i
*>		192.168.3.23				0 40000 10000 40000 i
*m	172.16.255.5/32	192.168.33.24				0 40000 10000 40000 i
*>		192.168.3.23				0 40000 10000 40000 i
*m	192.168.1.0	192.168.33.24				0 40000 10000 20000 ?
*>		192.168.3.23				0 40000 10000 20000 ?
*m	192.168.2.0	192.168.33.24				0 40000 10000 30000 ?
	Network	Next Hop	Metric	LocPrf	Weight	Path
*>		192.168.3.23				0 40000 10000 30000 ?
r>	192.168.3.0	192.168.33.24				0 40000 ?
r		192.168.3.23	10			0 40000 ?
*m	192.168.4.0	192.168.33.24				0 40000 10000 ?
*>		192.168.3.23				0 40000 10000 ?
*m	192.168.5.0	192.168.33.24				0 40000 10000 ?
*>		192.168.3.23				0 40000 10000 ?
*m	192.168.11.0	192.168.33.24				0 40000 10000 20000 ?
*>		192.168.3.23				0 40000 10000 20000 ?
*m	192.168.22.0	192.168.33.24				0 40000 10000 30000 ?
*>		192.168.3.23				0 40000 10000 30000 ?
r>	192.168.33.0	192.168.3.23				0 40000 ?
r		192.168.33.24	10			0 40000 ?

```
CustA-CE3#trace 172.16.255.1 source lo 0
Type escape sequence to abort.
Tracing the route to 172.16.255.1
VRF info: (vrf in name/id, vrf out name/id)
  1 192.168.33.24 [AS 40000] 1 msec
    192.168.3.23 [AS 40000] 1 msec
    192.168.33.24 [AS 40000] 1 msec
  2 10.20.23.20 [MPLS: Labels 200006/30013 Exp 0] 8 msec
    10.19.24.19 [MPLS: Labels 190005/30013 Exp 0] 9 msec
    10.20.23.20 [MPLS: Labels 200006/30013 Exp 0] 7 msec
  3 10.19.22.22 [MPLS: Labels 220007/30013 Exp 0] 15 msec
    10.20.22.22 [MPLS: Labels 220007/30013 Exp 0] 8 msec
    10.19.22.22 [MPLS: Labels 220007/30013 Exp 0] 8 msec
  4 10.3.22.3 [MPLS: Label 30013 Exp 0] 8 msec 8 msec 8 msec
  5 10.3.9.9 9 msec 9 msec 9 msec
  6 10.8.9.8 [MPLS: Labels 80002/110003 Exp 0] 13 msec 14 msec 12 msec
  7 192.168.1.11 [AS 20000] [MPLS: Label 110003 Exp 0] 11 msec 12 msec 11 msec
  8 192.168.1.1 [AS 20000] 11 msec 12 msec 13 msec
```

```
CustA-CE3#trace 172.16.255.2 source lo 0
Type escape sequence to abort.
Tracing the route to 172.16.255.2
VRF info: (vrf in name/id, vrf out name/id)
  1 192.168.33.24 [AS 40000] 1 msec
    192.168.3.23 [AS 40000] 1 msec
    192.168.33.24 [AS 40000] 0 msec
  2 10.20.23.20 [MPLS: Labels 200006/30027 Exp 0] 9 msec
    10.20.24.20 [MPLS: Labels 200006/30027 Exp 0] 9 msec
    10.20.23.20 [MPLS: Labels 200006/30027 Exp 0] 9 msec
  3 10.20.22.22 [MPLS: Labels 220007/30027 Exp 0] 9 msec 9 msec 10 msec
  4 10.3.22.3 [MPLS: Label 30027 Exp 0] 8 msec 10 msec 8 msec
  5 10.3.15.15 [MPLS: Label 150009 Exp 0] 8 msec 9 msec 8 msec
  6 10.14.15.14 [MPLS: Labels 140002/170003 Exp 0] 7 msec 8 msec 8 msec
  7 192.168.2.17 [AS 30000] [MPLS: Label 170003 Exp 0] 8 msec 10 msec 9 msec
  8 192.168.2.2 [AS 30000] 10 msec 9 msec 10 msec
```

```
CustA-CE2#trace 172.16.255.1 source lo 0
Type escape sequence to abort.
Tracing the route to 172.16.255.1
VRF info: (vrf in name/id, vrf out name/id)
  1 192.168.22.18 [AS 30000] 1 msec
    192.168.2.17 0 msec
    192.168.22.18 [AS 30000] 0 msec
  2 10.14.17.14 [MPLS: Labels 140003/150015 Exp 0] 7 msec
    10.14.18.14 [MPLS: Labels 140003/150015 Exp 0] 6 msec
    10.14.17.14 [MPLS: Labels 140003/150015 Exp 0] 5 msec
  3 10.14.15.15 [MPLS: Label 150015 Exp 0] 11 msec 7 msec 8 msec
  4 10.3.15.3 [MPLS: Label 30013 Exp 0] 7 msec 7 msec 9 msec
  5 10.3.9.9 10 msec 8 msec 7 msec
  6 10.8.9.8 [MPLS: Labels 80002/110003 Exp 0] 12 msec 12 msec 13 msec
  7 192.168.1.11 [AS 20000] [MPLS: Label 110003 Exp 0] 12 msec 11 msec 11 msec
  8 192.168.1.1 [AS 20000] 12 msec 12 msec 13 msec
```

```
CustA-CE2#trace 172.16.255.3 source lo 0
Type escape sequence to abort.
Tracing the route to 172.16.255.3
VRF info: (vrf in name/id, vrf out name/id)
  1 192.168.22.18 [AS 30000] 1 msec
    192.168.2.17 0 msec
    192.168.22.18 [AS 30000] 1 msec
  2 10.14.17.14 [MPLS: Labels 140003/150030 Exp 0] 9 msec
    10.14.18.14 [MPLS: Labels 140003/150030 Exp 0] 8 msec
    10.14.17.14 [MPLS: Labels 140003/150030 Exp 0] 8 msec
  3 10.14.15.15 [MPLS: Label 150030 Exp 0] 11 msec 16 msec 8 msec
  4 10.3.15.3 [MPLS: Label 30033 Exp 0] 9 msec 9 msec 11 msec
  5 10.3.21.21 [MPLS: Labels 210003/230003 Exp 0] 13 msec 9 msec 7 msec
  6 10.19.21.19 [MPLS: Labels 190000/230003 Exp 0] 8 msec 8 msec 9 msec
  7 192.168.3.23 [AS 40000] [MPLS: Label 230003 Exp 0] 9 msec 10 msec 9 msec
  8 192.168.3.3 [AS 40000] 12 msec 9 msec 9 msec
```