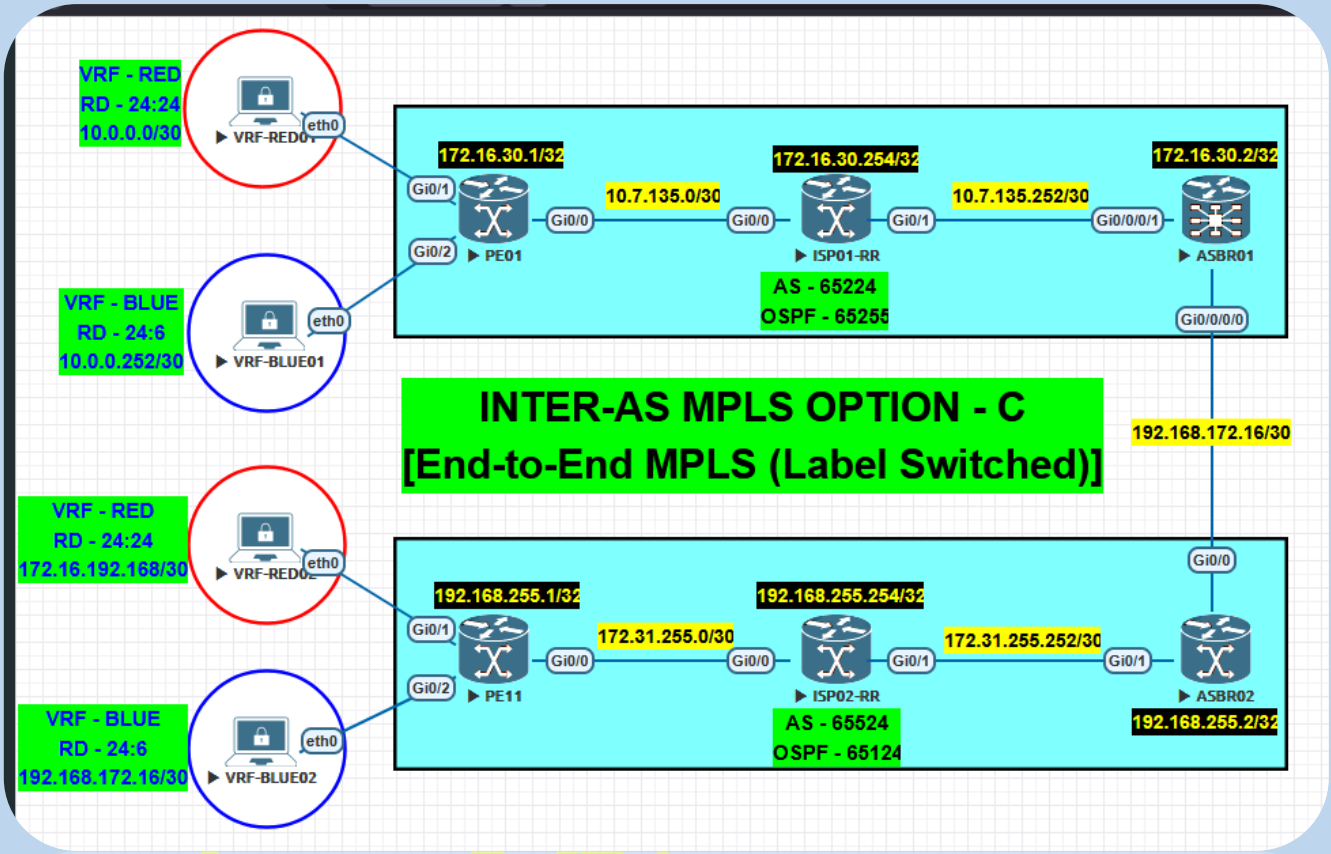
INTER–AS MPLS OPTION–C

[END–TO–END MPLS (Label–Switched)]



Lab Requirements

1. Configure MPLS L3VPN from **PE01(AS–65224)** to **PE11(AS–65524)** for vrf **RED** and vrf **BLUE** using **INTER–AS MPLS OPTION–C.**

VRF Configuration

IOS XE

ip vrf **BLUE**

rd 24:6

```
 route-target both 24:6
 !
ip vrf RED
 rd 24:24
 route-target both 24:24
!
```

PE01

```
interface GigabitEthernet0/1
 ip vrf forwarding RED
 ip address 10.0.0.2 255.255.255.252
!
interface GigabitEthernet0/2
 ip vrf forwarding BLUE
 ip address 10.0.0.254 255.255.255.252
!
```

PE11

```
interface GigabitEthernet0/1
 ip vrf forwarding RED
 ip address 172.16.192.170 255.255.255.252
!
interface GigabitEthernet0/2
 ip vrf forwarding BLUE
```

```
 ip address 192.168.172.18 255.255.255.252
!
```

IGP: OSPF Configuration

hello interval is 3s, dead interval is 10s and network type is point-to-point

PE01

```
router ospf 65255
 router-id 172.16.30.1
 auto-cost reference-bandwidth 10000
 passive-interface default
 no passive-interface GigabitEthernet0/0
 network 10.7.135.1 0.0.0.0 area 0
 network 172.16.30.1 0.0.0.0 area 0
!
```

ISP01-RR

```
router ospf 65255
 router-id 172.16.30.254
 auto-cost reference-bandwidth 10000
 passive-interface default
 no passive-interface GigabitEthernet0/0
 no passive-interface GigabitEthernet0/1
 network 10.7.135.2 0.0.0.0 area 0
 network 10.7.135.253 0.0.0.0 area 0
```

```
 network 172.16.30.254 0.0.0.0 area 0
!
```

ASBR01

```
router ospf 65255
 router-id 172.16.30.2
 network point-to-point
 passive enable
 dead-interval 10
 hello-interval 3
 auto-cost reference-bandwidth 10000
 area 0
  interface Loopback2028
  !
  interface GigabitEthernet0/0/0/1
   passive disable
  !
```

PE11

```
router ospf 65124
 router-id 192.168.255.1
 auto-cost reference-bandwidth 10000
 passive-interface default
 no passive-interface GigabitEthernet0/0
```

```
 network 172.31.255.1 0.0.0.0 area 0
 network 192.168.255.1 0.0.0.0 area 0
!
```

ISP02-RR

```
router ospf 65124
 router-id 192.168.255.254
 auto-cost reference-bandwidth 10000
 passive-interface default
 no passive-interface GigabitEthernet0/0
 no passive-interface GigabitEthernet0/1
 network 172.31.255.2 0.0.0.0 area 0
 network 172.31.255.253 0.0.0.0 area 0
 network 192.168.255.254 0.0.0.0 area 0
!
```

ASBR02

```
router ospf 65124
 router-id 192.168.255.2
 auto-cost reference-bandwidth 10000
 passive-interface default
 no passive-interface GigabitEthernet0/1
 network 172.31.255.254 0.0.0.0 area 0
 network 192.168.255.2 0.0.0.0 area 0
```

Configure MPLS in Respective Interfaces

!

BGP Configuration

PE01

```
router bgp 65224
 bgp router-id 172.16.30.1
 neighbor 172.16.30.254 remote-as 65224
 neighbor 172.16.30.254 password kolwin!!!!
 neighbor 172.16.30.254 update-source Loopback2028
 !
 address-family ipv4
  neighbor 172.16.30.254 activate
 exit-address-family
 !
 address-family vpnv4
  neighbor 172.16.30.254 activate
  neighbor 172.16.30.254 send-community extended
 exit-address-family
 !
 address-family ipv4 vrf BLUE
  redistribute connected
 exit-address-family
```

```
!
 address-family ipv4 vrf RED
  redistribute connected
 exit-address-family
!
```

ISP01-RR

```
router bgp 65224
 bgp router-id 172.16.30.254
 neighbor 172.16.30.1 remote-as 65224
 neighbor 172.16.30.1 password kolwin!!!!
 neighbor 172.16.30.1 update-source Loopback2028
 neighbor 172.16.30.2 remote-as 65224
 neighbor 172.16.30.2 password kolwin!!!!
 neighbor 172.16.30.2 update-source Loopback2028
 !
 address-family ipv4
  neighbor 172.16.30.1 activate
  neighbor 172.16.30.1 route-reflector-client
  neighbor 172.16.30.2 activate
  neighbor 172.16.30.2 route-reflector-client
 exit-address-family
 !
```

```
 address-family vpnv4
  neighbor 172.16.30.1 activate
  neighbor 172.16.30.1 send-community extended
  neighbor 172.16.30.1 route-reflector-client
  neighbor 172.16.30.2 activate
  neighbor 172.16.30.2 send-community extended
  neighbor 172.16.30.2 route-reflector-client
 exit-address-family
```

PE11

```
router bgp 65524
 bgp router-id 192.168.255.1
 neighbor 192.168.255.254 remote-as 65524
 neighbor 192.168.255.254 password kolwin!!!!
 neighbor 192.168.255.254 update-source Loopback2028
 !
 address-family ipv4
  neighbor 192.168.255.254 activate
 exit-address-family
 !
 address-family vpnv4
  neighbor 192.168.255.254 activate
  neighbor 192.168.255.254 send-community extended
```

```
 exit-address-family
 !
 address-family ipv4 vrf BLUE
  redistribute connected
 exit-address-family
 !
 address-family ipv4 vrf RED
  redistribute connected
 exit-address-family
!
```

ISP02-RR

```
router bgp 65524
 bgp router-id 192.168.255.254
 neighbor 192.168.255.1 remote-as 65524
 neighbor 192.168.255.1 password kolwin!!!!
 neighbor 192.168.255.1 update-source Loopback2028
 neighbor 192.168.255.2 remote-as 65524
 neighbor 192.168.255.2 password kolwin!!!!
 neighbor 192.168.255.2 update-source Loopback2028
 !
 address-family ipv4
  neighbor 192.168.255.1 activate
```

```
 neighbor 192.168.255.1 route-reflector-client
 neighbor 192.168.255.2 activate
 neighbor 192.168.255.2 route-reflector-client
exit-address-family
!
address-family vpnv4
 neighbor 192.168.255.1 activate
 neighbor 192.168.255.1 send-community extended
 neighbor 192.168.255.1 route-reflector-client
 neighbor 192.168.255.2 activate
 neighbor 192.168.255.2 send-community extended
 neighbor 192.168.255.2 route-reflector-client
exit-address-family
!
```

Redistribution Required Loopbacks at ASBRs

ASBR01

```
prefix-set AS-IN {Required Loopbacks of Remote AS}
  192.168.255.1/32,
  192.168.255.2/32,
  192.168.255.254/32
end-set
!
```

route-policy **INTO-OSPF**

if destination in **AS-IN** then

pass

endif

end-policy

!

route-policy **PASSTOPASS**

pass

end-policy

!

router ospf 65255

redistribute bgp 65224 metric 110 route-policy **INTO-OSPF**

!

router bgp 65224

address-family ipv4 unicast

network 172.16.30.1/32 *{Redistribution Required Loopbacks of Local AS into BGP}*

network 172.16.30.2/32

network 172.16.30.254/32

!

ASBR02

ip prefix-list **AS-IN** seq 5 permit 172.16.30.1/32

ip prefix-list **AS-IN** seq 10 permit 172.16.30.2/32

ip prefix-list **AS-IN** seq 15 permit 172.16.30.254/32

! *{Required Loopback of Remote AS}*

route-map **INTO-OSPF** permit 10

match ip address prefix-list **AS-IN**

route-map **INTO-OSPF** permit 2028

!

router ospf 65124

redistribute bgp 65524 subnets route-map **INTO-OSPF**

!

router bgp 65524

address-family ipv4

network 192.168.255.1 mask 255.255.255.255

network 192.168.255.2 mask 255.255.255.255

network 192.168.255.254 mask 255.255.255.255

! *{Redistribution Required Loopbacks of Local AS into BGP}*

BGP Peering at ASBRs for Label Sending

ASBR01

router bgp 65224

address-family ipv4 unicast

allocate-label all

!

neighbor 192.168.172.18

```
 remote-as 65524
 password kolwin!!!!
 address-family ipv4 unicast
  route-policy PASSTOPASS in
  route-policy PASSTOPASS out
 !
 address-family ipv4 labeled-unicast
  route-policy PASSTOPASS in
  route-policy PASSTOPASS out
 !
router static
 address-family ipv4 unicast
  192.168.172.18/32 GigabitEthernet0/0/0/0
!
```

{"BGP can form without a /32 route, but MPLS forwarding cannot — because BGP allocates labels only to /32 peer routes, and without an explicit /32 in the RIB, labeled traffic will fail."}

```
!
mpls ldp
interface GigabitEthernet0/0/0/0
 !
```

```
RP/0/0/CPU0:ASBR01#sh mpls forwarding | in 192.168.172.18/32
Thu Dec 25 21:48:14.154 UTC
24003  Pop         192.168.172.18/32  Gi0/0/0/0    192.168.172.18  419527
```

ASBR02

interface GigabitEthernet0/0

mpls bgp forwarding

mpls ip

!

router bgp 65524

neighbor 192.168.172.17 remote-as 65224

neighbor 192.168.172.17 password kolwin!!!!

address-family ipv4

neighbor 192.168.172.17 activate

neighbor 192.168.172.17 send-label

!

Complete BGP Configuration at ASBRs *{for Full Setup of BGP at ASBRs}*

ASBR01

router bgp 65224

bgp router-id 172.16.30.2

address-family ipv4 unicast

network 172.16.30.1/32

network 172.16.30.2/32

network 172.16.30.254/32

allocate-label all

!

address-family vpnv4 unicast

!

neighbor 172.16.30.254

 remote-as 65224

 password kolwin!!!!

 update-source Loopback2028

 address-family ipv4 unicast

  next-hop-self

 !

 address-family vpnv4 unicast

  next-hop-self

 !

!

neighbor 192.168.172.18

 remote-as 65524

 password kolwin!!!!

 address-family ipv4 unicast

  route-policy PASSTOPASS in

  route-policy PASSTOPASS out

 !

 address-family ipv4 labeled-unicast

  route-policy PASSTOPASS in

route-policy PASSTOPASS out

!

ASBR02

```
router bgp 65524
 bgp router-id 192.168.255.2
 neighbor 192.168.172.17 remote-as 65224
 neighbor 192.168.172.17 password kolwin!!!!
 neighbor 192.168.255.254 remote-as 65524
 neighbor 192.168.255.254 password kolwin!!!!
 neighbor 192.168.255.254 update-source Loopback2028
 !
 address-family ipv4
  network 192.168.255.1 mask 255.255.255.255
  network 192.168.255.2 mask 255.255.255.255
  network 192.168.255.254 mask 255.255.255.255
  neighbor 192.168.172.17 activate
  neighbor 192.168.172.17 send-label
  neighbor 192.168.255.254 activate
  neighbor 192.168.255.254 next-hop-self all
 exit-address-family
 !
 address-family vpnv4
```

```
  neighbor 192.168.255.254 activate
  neighbor 192.168.255.254 send-community extended
  neighbor 192.168.255.254 next-hop-self all
 exit-address-family
!
```

VPNv4 Peering of Route-Reflectors of Each AS

ISP01-RR

```
router bgp 65224
 neighbor 192.168.255.254 remote-as 65524
 neighbor 192.168.255.254 ebgp-multihop
 neighbor 192.168.255.254 password kolwin!!!!
 neighbor 192.168.255.254 update-source Loopback2028
!
address-family vpnv4
  neighbor 192.168.255.254 activate
  neighbor 192.168.255.254 send-community extended
  neighbor 192.168.255.254 next-hop-unchanged
!
```

ISP02-RR

```
router bgp 65524
 neighbor 172.16.30.254 remote-as 65224
 neighbor 172.16.30.254 ebgp-multihop 255
```

```
 neighbor 172.16.30.254 password kolwin!!!!
 neighbor 172.16.30.254 update-source Loopback2028
!
address-family vpnv4
  neighbor 172.16.30.254 activate
  neighbor 172.16.30.254 send-community extended
  neighbor 172.16.30.254 next-hop-unchanged
!
```

Verification

ASBR01

show bgp summary

```
Neighbor        Spk    AS MsgRcvd MsgSent   TblVer  InQ OutQ  Up/Down  St/PfxRcd
172.16.30.254     0 65224      91       85       30    0    0 01:10:42        0
192.168.172.18    0 65524      83       79       30    0    0 01:10:45        0
```

show bgp

```
*> 172.16.30.1/32     10.7.135.253             21         32768 i
*> 172.16.30.2/32     0.0.0.0                   0         32768 i
*> 172.16.30.254/32   10.7.135.253             11         32768 i
*> 192.168.255.1/32   192.168.172.18           21             0 65524 i
*> 192.168.255.2/32   192.168.172.18            0             0 65524 i
*> 192.168.255.254/32 192.168.172.18           11             0 65524 i
```

ASBR02

show ip bgp summary

```
Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
192.168.172.17  4        65224      81       85       10    0    0 01:12:47        3
192.168.255.254 4        65524     100       93       10    0    0 01:12:35        0
ASBR02#
```

show ip bgp

```
     Network          Next Hop            Metric LocPrf Weight Path
 *>  172.16.30.1/32   192.168.172.17          21             0 65224 i
 *>  172.16.30.2/32   192.168.172.17           0             0 65224 i
 *>  172.16.30.254/32 192.168.172.17          11             0 65224 i
 *>  192.168.255.1/32 172.31.255.253          21         32768 i
 *>  192.168.255.2/32 0.0.0.0                  0         32768 i
 *>  192.168.255.254/32
                      172.31.255.253          11         32768 i
```

ISP01-RR

show ip route ospf

```
      172.16.0.0/32 is subnetted, 3 subnets
O        172.16.30.1 [110/11] via 10.7.135.1, 01:02:56, GigabitEthernet0/0
O        172.16.30.2 [110/11] via 10.7.135.254, 01:02:56, GigabitEthernet0/1
      192.168.255.0/32 is subnetted, 3 subnets
O E2     192.168.255.1
           [110/110] via 10.7.135.254, 01:01:48, GigabitEthernet0/1
O E2     192.168.255.2
           [110/110] via 10.7.135.254, 01:01:48, GigabitEthernet0/1
O E2     192.168.255.254
           [110/110] via 10.7.135.254, 01:01:48, GigabitEthernet0/1
```

show ip bgp vpnv4 all summary

```
Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
172.16.30.1     4        65224      77      87        7    0    0 01:05:21        2
172.16.30.2     4        65224      80      86        7    0    0 01:05:22        0
192.168.255.254 4        65524      75      75        7    0    0 01:03:31        2
ISP01-RR#
```

show ip bgp vpnv4 all

```
     Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 24:6
 *>i 10.0.0.252/30    172.16.30.1              0    100      0 ?
 *>  192.168.172.16/30
                      192.168.255.1                         0 65524 ?
Route Distinguisher: 24:24
 *>i 10.0.0.0/30      172.16.30.1              0    100      0 ?
 *>  172.16.192.168/30
                      192.168.255.1                         0 65524 ?
```

ISP02–RR

show ip route ospf

```
      172.16.0.0/32 is subnetted, 3 subnets
O E2     172.16.30.1 [110/1] via 172.31.255.254, 01:06:43, GigabitEthernet0/1
O E2     172.16.30.2 [110/1] via 172.31.255.254, 01:06:43, GigabitEthernet0/1
O E2     172.16.30.254
           [110/1] via 172.31.255.254, 01:06:43, GigabitEthernet0/1
      192.168.255.0/32 is subnetted, 3 subnets
O        192.168.255.1 [110/11] via 172.31.255.1, 01:07:52, GigabitEthernet0/0
O        192.168.255.2
           [110/11] via 172.31.255.254, 01:07:42, GigabitEthernet0/1
```

show ip bgp vpnv4 all summary

```
Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
172.16.30.254   4        65224      79      79        7    0    0 01:06:57        2
192.168.255.1   4        65524      81      96        7    0    0 01:08:50        2
192.168.255.2   4        65524      88      95        7    0    0 01:08:40        0
ISP02-RR#
```

show ip bgp vpnv4 all

```
     Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 24:6
 *>  10.0.0.252/30    172.16.30.1                            0 65224 ?
 *>i 192.168.172.16/30
                      192.168.255.1            0    100      0 ?
Route Distinguisher: 24:24
 *>  10.0.0.0/30      172.16.30.1                            0 65224 ?
 *>i 172.16.192.168/30
                      192.168.255.1            0    100      0 ?
```

PE01

show ip bgp vpnv4 all

```
     Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 24:6 (default for vrf BLUE)
 *>  10.0.0.252/30    0.0.0.0                  0         32768 ?
 *>i 192.168.172.16/30
                      192.168.255.1            0    100      0 65524 ?
Route Distinguisher: 24:24 (default for vrf RED)
 *>  10.0.0.0/30      0.0.0.0                  0         32768 ?
 *>i 172.16.192.168/30
                      192.168.255.1            0    100      0 65524 ?
```

show ip route vrf RED bgp

```
      172.16.0.0/30 is subnetted, 1 subnets
B        172.16.192.168 [200/0] via 192.168.255.1, 01:13:42
```

show ip route vrf BLUE bgp

```
      192.168.172.0/30 is subnetted, 1 subnets
B        192.168.172.16 [200/0] via 192.168.255.1, 01:13:54
```

PE11

show ip bgp vpnv4 all

```
Route Distinguisher: 24:6 (default for vrf BLUE)
 *>i 10.0.0.252/30    172.16.30.1              0    100      0 65224 ?
 *>  192.168.172.16/30
                      0.0.0.0                  0         32768 ?
Route Distinguisher: 24:24 (default for vrf RED)
 *>i 10.0.0.0/30      172.16.30.1              0    100      0 65224 ?
 *>  172.16.192.168/30
                      0.0.0.0                  0         32768 ?
```

show ip route vrf RED bgp

```
      10.0.0.0/30 is subnetted, 1 subnets
B        10.0.0.0 [200/0] via 172.16.30.1, 01:16:31
```

show ip route vrf BLUE bgp

```
      10.0.0.0/30 is subnetted, 1 subnets
B        10.0.0.252 [200/0] via 172.16.30.1, 01:16:36
```

REDPC01

```
REDPC01> ping 172.16.192.169

84 bytes from 172.16.192.169 icmp_seq=1 ttl=58 time=11.861 ms
84 bytes from 172.16.192.169 icmp_seq=2 ttl=58 time=6.166 ms
84 bytes from 172.16.192.169 icmp_seq=3 ttl=58 time=5.824 ms
84 bytes from 172.16.192.169 icmp_seq=4 ttl=58 time=5.903 ms
84 bytes from 172.16.192.169 icmp_seq=5 ttl=58 time=6.087 ms
```

BLUEPC02

```
BLUEPC01> ping 192.168.172.17

84 bytes from 192.168.172.17 icmp_seq=1 ttl=58 time=8.727 ms
84 bytes from 192.168.172.17 icmp_seq=2 ttl=58 time=6.073 ms
84 bytes from 192.168.172.17 icmp_seq=3 ttl=58 time=5.670 ms
84 bytes from 192.168.172.17 icmp_seq=4 ttl=58 time=6.068 ms
84 bytes from 192.168.172.17 icmp_seq=5 ttl=58 time=6.480 ms
```

Ko Lwin (Network)