Lab 2

MPLS L3 VPNv4 and VPNv6 models

991451344

Timothy Pang

Professor: Felix Carapaica

Introduction:

This lab tests your knowledge of Layer 3 VPN both IPv4 and IPv6. It contains the majority of the PE-CE relationships that can be encountered in any job situation. Even though its full implementation of 22 routers demands computer resources.

Objectives:

- View relationships between VPNs
- Solve a situation between R17 and R22

R16# show ip bgp vpnv6 unicast vrf VPN-A

```
R16#sh bgp vpnv6 unicast vrf VPN-A
BGP table version is 6, local router ID is 10.16.16.16
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 144:65021 (default for vrf VPN-A)
 *>i 2001:1111::/120  ::FFFF:10.4.4.4          0    100      0 65001 i
 *>  2001:2121::/120  FC00:1621::              0             0 65021 i
 *>i 2001:2222::/120  ::FFFF:10.5.5.5          0    100      0 65002 i
```

Figure 1.

R21# show ipv6 route

```
R21#sh ipv6 route
IPv6 Routing Table - default - 7 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE - Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, l - LISP
B   2001:1111::/120 [20/0]
     via FE80::C810:15FF:FE50:1C, FastEthernet1/0
C   2001:2121::/120 [0/0]
     via FastEthernet0/0, directly connected
L   2001:2121::1/128 [0/0]
     via FastEthernet0/0, receive
B   2001:2222::/120 [20/0]
     via FE80::C810:15FF:FE50:1C, FastEthernet1/0
C   FC00:1621::/127 [0/0]
     via FastEthernet1/0, directly connected
L   FC00:1621::/128 [0/0]
     via FastEthernet1/0, receive
L   FF00::/8 [0/0]
     via Null0, receive
R21#
```

Figure 2.

R3# show running

```
!
interface Loopback0
 ip address 10.3.3.3 255.255.255.255
!
interface Tunnel0
 ip address 10.0.36.1 255.255.255.0
 no ip redirects
 ip nhrp authentication vrfVPNB
 ip nhrp network-id 1
 ip nhrp redirect
 ip ospf network point-to-multipoint
 tunnel source FastEthernet1/0
 tunnel mode gre multipoint
!
interface FastEthernet0/0
 ip address 192.168.3.1 255.255.255.0
 duplex full
!
interface FastEthernet1/0
 ip address 10.0.34.1 255.255.255.252
 speed auto
 duplex auto
!
interface FastEthernet1/1
 no ip address
 shutdown
 speed auto
 duplex auto
!
router ospf 3
 router-id 10.3.3.3
 network 10.0.36.0 0.0.0.255 area 3
 network 10.3.3.3 0.0.0.0 area 3
 network 192.168.3.1 0.0.0.0 area 3
!
ip forward-protocol nd
!
!
no ip http server
no ip http secure-server
!
```

Figure 3.

R9# show ip bgp vpnv4 vrf VPN-C

```
R9#sh ip bgp vpnv4 vrf VPN-C
BGP table version is 22, local router ID is 10.9.9.9
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 144:9 (default for vrf VPN-C)
 * i 192.168.7.0      10.17.17.17             10    100      0 ?
 *>                   10.0.79.1               20         32768 ?
 *>i 192.168.11.0     10.17.17.17             10    100      0 ?
 * i                  10.10.10.10             20    100      0 ?
 *>i 192.168.23.0     10.17.17.17             20    100      0 ?
R9#
```

Figure 4.

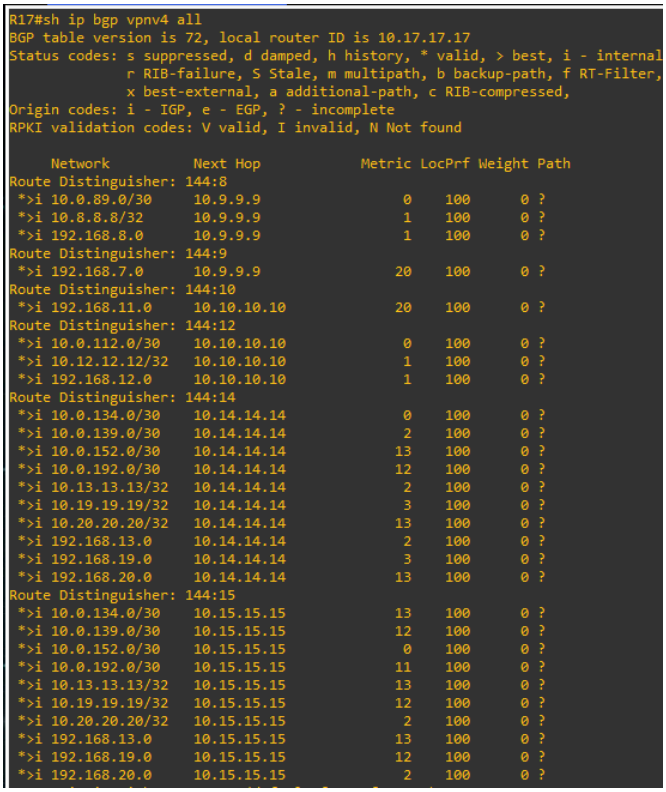
R9# show ip bgp vpnv4 vrf VPN-D

```
R9#sh ip bgp vpnv4 vrf VPN-D
BGP table version is 22, local router ID is 10.9.9.9
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 144:8 (default for vrf VPN-D)
 *>  10.0.89.0/30     0.0.0.0                  0         32768 ?
 *>i 10.0.112.0/30    10.10.10.10              0    100      0 ?
 *>i 10.3.172.0/24    10.17.17.17              0    100      0 ?
 *>  10.8.8.8/32      10.0.89.1                1         32768 ?
 *>i 10.12.12.12/32   10.10.10.10              1    100      0 ?
 *>  192.168.8.0      10.0.89.1                1         32768 ?
 *>i 192.168.12.0     10.10.10.10              1    100      0 ?
 *>i 192.168.24.0     10.17.17.17              1    100      0 ?
R9#
```

Figure 5.

R17# show ip bgp vpnv4 all



```
R17#sh ip bgp vpnv4 all
BGP table version is 72, local router ID is 10.17.17.17
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 144:8
 *>i 10.0.89.0/30     10.9.9.9                 0    100      0 ?
 *>i 10.8.8.8/32      10.9.9.9                 1    100      0 ?
 *>i 192.168.8.0      10.9.9.9                 1    100      0 ?
Route Distinguisher: 144:9
 *>i 192.168.7.0      10.9.9.9                20    100      0 ?
Route Distinguisher: 144:10
 *>i 192.168.11.0     10.10.10.10             20    100      0 ?
Route Distinguisher: 144:12
 *>i 10.0.112.0/30    10.10.10.10              0    100      0 ?
 *>i 10.12.12.12/32   10.10.10.10              1    100      0 ?
 *>i 192.168.12.0     10.10.10.10              1    100      0 ?
Route Distinguisher: 144:14
 *>i 10.0.134.0/30    10.14.14.14              0    100      0 ?
 *>i 10.0.139.0/30    10.14.14.14              2    100      0 ?
 *>i 10.0.152.0/30    10.14.14.14             13    100      0 ?
 *>i 10.0.192.0/30    10.14.14.14             12    100      0 ?
 *>i 10.13.13.13/32   10.14.14.14              2    100      0 ?
 *>i 10.19.19.19/32   10.14.14.14              3    100      0 ?
 *>i 10.20.20.20/32   10.14.14.14             13    100      0 ?
 *>i 192.168.13.0     10.14.14.14              2    100      0 ?
 *>i 192.168.19.0     10.14.14.14              3    100      0 ?
 *>i 192.168.20.0     10.14.14.14             13    100      0 ?
Route Distinguisher: 144:15
 *>i 10.0.134.0/30    10.15.15.15             13    100      0 ?
 *>i 10.0.139.0/30    10.15.15.15             12    100      0 ?
 *>i 10.0.152.0/30    10.15.15.15              0    100      0 ?
 *>i 10.0.192.0/30    10.15.15.15             11    100      0 ?
 *>i 10.13.13.13/32   10.15.15.15             13    100      0 ?
 *>i 10.19.19.19/32   10.15.15.15             12    100      0 ?
 *>i 10.20.20.20/32   10.15.15.15              2    100      0 ?
 *>i 192.168.13.0     10.15.15.15             13    100      0 ?
 *>i 192.168.19.0     10.15.15.15             12    100      0 ?
 *>i 192.168.20.0     10.15.15.15              2    100      0 ?
```

Figure 6.

```
Route Distinguisher: 144:17 (default for vrf VPN-E)
 *>i 10.0.134.0/30    10.14.14.14              0    100      0 ?
 * i                  10.15.15.15             13    100      0 ?
 *>i 10.0.139.0/30    10.14.14.14              2    100      0 ?
 * i                  10.15.15.15             12    100      0 ?
 * i 10.0.152.0/30    10.14.14.14             13    100      0 ?
 *>i                  10.15.15.15              0    100      0 ?
 *>  10.0.178.0/30    0.0.0.0                  0         32768 ?
 * i 10.0.192.0/30    10.14.14.14             12    100      0 ?
 *>i                  10.15.15.15             11    100      0 ?
 *>i 10.13.13.13/32   10.14.14.14              2    100      0 ?
 * i                  10.15.15.15             13    100      0 ?
 *>  10.18.18.18/32   10.0.178.1               2         32768 ?
 *>i 10.19.19.19/32   10.14.14.14              3    100      0 ?
 * i                  10.15.15.15             12    100      0 ?
 * i 10.20.20.20/32   10.14.14.14             13    100      0 ?
 *>i                  10.15.15.15              2    100      0 ?
 *>i 192.168.13.0     10.14.14.14              2    100      0 ?
 * i                  10.15.15.15             13    100      0 ?
 *>  192.168.18.0     10.0.178.1               2         32768 ?
 *>i 192.168.19.0     10.14.14.14              3    100      0 ?
 * i                  10.15.15.15             12    100      0 ?
 * i 192.168.20.0     10.14.14.14             13    100      0 ?
 *>i                  10.15.15.15              2    100      0 ?
Route Distinguisher: 144:172 (default for vrf VPN-C)
 r>i 10.2.172.0/24    10.2.172.1               0    100      0 ?
 *>  192.168.7.0      10.2.172.1              10         32768 ?
 * i                  10.9.9.9                20    100      0 ?
 *>  192.168.11.0     10.2.172.1              10         32768 ?
 * i                  10.10.10.10             20    100      0 ?
 * i 192.168.23.0     10.2.172.1               0    100      0 ?
 *>                   10.2.172.1              20         32768 ?
Route Distinguisher: 144:173 (default for vrf VPN-D)
 * i 10.0.89.0/30     10.3.172.1               1    100      0 ?
 *>i                  10.9.9.9                 0    100      0 ?
 * i 10.0.112.0/30    10.3.172.1               1    100      0 ?
 *>i                  10.10.10.10              0    100      0 ?
 * i 10.3.172.0/24    10.3.172.1               0    100      0 ?
 *>                   0.0.0.0                  0         32768 ?
 * i 10.8.8.8/32      10.3.172.1               2    100      0 ?
 *>i                  10.9.9.9                 1    100      0 ?
 * i 10.12.12.12/32   10.3.172.1               2    100      0 ?
 *>i                  10.10.10.10              1    100      0 ?
 * i 192.168.8.0      10.3.172.1               2    100      0 ?
 *>i                  10.9.9.9                 1    100      0 ?
 * i 192.168.12.0     10.3.172.1               2    100      0 ?
 *>i                  10.10.10.10              1    100      0 ?
 * i 192.168.24.0     10.3.172.1               0    100      0 ?
 *>                   10.3.172.1               1         32768 ?
R17#
```

Figure 7.

R12# show running

Figure 8.

R14# show ip bgp vpnv4 vrf VPN-E

```
R14#sh ip bgp vpnv4 vrf VPN-E
BGP table version is 31, local router ID is 10.14.14.14
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 144:14 (default for vrf VPN-E)
 * i 10.0.134.0/30    10.15.15.15              4    100      0 ?
 *>                   0.0.0.0                  0         32768 ?
 * i 10.0.139.0/30    10.15.15.15              3    100      0 ?
 *>                   10.0.134.1               2         32768 ?
 *>i 10.0.152.0/30    10.15.15.15              0    100      0 ?
 *>i 10.0.178.0/30    10.17.17.17              0    100      0 ?
 *>i 10.0.192.0/30    10.15.15.15              2    100      0 ?
 * i 10.13.13.13/32   10.15.15.15              4    100      0 ?
 *>                   10.0.134.1               2         32768 ?
 *>i 10.18.18.18/32   10.17.17.17              2    100      0 ?
 *>i 10.19.19.19/32   10.15.15.15              3    100      0 ?
 *>i 10.20.20.20/32   10.15.15.15              2    100      0 ?
 * i 192.168.13.0     10.15.15.15              4    100      0 ?
 *>                   10.0.134.1               2         32768 ?
 *>i 192.168.18.0     10.17.17.17              2    100      0 ?
 *>i 192.168.19.0     10.15.15.15              3    100      0 ?
 *>i 192.168.20.0     10.15.15.15              2    100      0 ?
R14#
```

Figure 9.

R19# show ip route

```
R19#sh ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
C        10.0.139.0/30 is directly connected, FastEthernet1/0
L        10.0.139.2/32 is directly connected, FastEthernet1/0
C        10.0.192.0/30 is directly connected, FastEthernet1/1
L        10.0.192.1/32 is directly connected, FastEthernet1/1
C        10.19.19.19/32 is directly connected, Loopback0
      192.168.19.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.19.0/24 is directly connected, FastEthernet0/0
L        192.168.19.1/32 is directly connected, FastEthernet0/0
R19#
```

Figure 10.

R15# show running

```
ip vrf VPN-E
 rd 144:15
 route-target export 144:15
 route-target import 144:14
 route-target import 144:17
!
```

Figure 11.

```
interface Loopback0
 ip address 10.15.15.15 255.255.255.255
!
interface FastEthernet0/0
 ip address 172.16.1.15 255.255.255.0
 duplex full
 mpls ip
!
interface FastEthernet1/0
 ip vrf forwarding VPN-E
 ip address 10.0.152.2 255.255.255.252
 speed auto
 duplex auto
!
interface FastEthernet1/1
 no ip address
 shutdown
 speed auto
 duplex auto
!
router ospf 1 vrf VPN-E
 router-id 10.15.15.1
 redistribute bgp 144 subnets
 network 10.0.152.2 0.0.0.0 area 0
!
router ospf 2
 router-id 10.15.15.15
 network 10.15.15.15 0.0.0.0 area 2
 network 172.16.1.15 0.0.0.0 area 2
!
router bgp 144
 bgp log-neighbor-changes
 no bgp default ipv4-unicast
 neighbor 10.14.14.14 remote-as 144
 neighbor 10.14.14.14 update-source Loopback0
 neighbor 10.17.17.17 remote-as 144
 neighbor 10.17.17.17 update-source Loopback0
 !
 address-family ipv4
 exit-address-family
 !
 address-family vpnv4
  neighbor 10.14.14.14 activate
  neighbor 10.14.14.14 send-community extended
  neighbor 10.17.17.17 activate
  neighbor 10.17.17.17 send-community both
 exit-address-family
 !
 address-family ipv4 vrf VPN-E
  redistribute ospf 1 match internal external 1 external 2
 exit-address-family
!
ip forward-protocol nd
!
```

Figure 12.