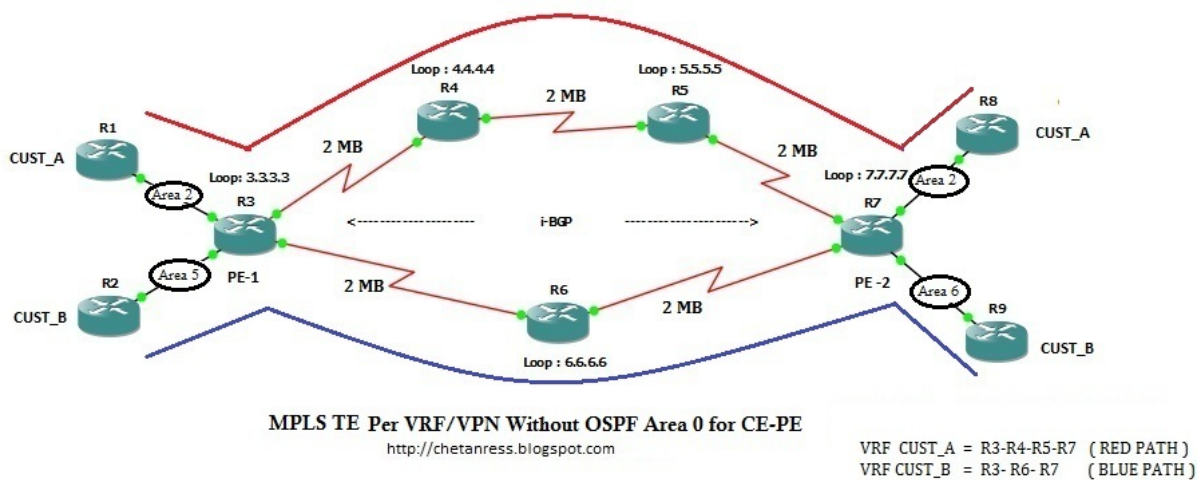


MPLS VPN OSPF CE-PE Protocol without Area 0

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MPLS VPN OSPF CE-PE Protocol without Area 0

Whereas migrating or enhancement of network we face some complexity with OSPF Area's. As we know that in OSPF Area 0 is an backbone area, So even if we plan to run OSPF as a CE-PE routing protocol we can run, But if we assume that in existing network we are already running OSPF & configured with Area 0, So in this case how we can run OSPF without Area 0 over MPLS Link.

The Solution is that we can run OSPF without Area 0 over MPLS link. Because as per hierarchy in OSPF we need Backbone Area 0 and other standard area i.e. Area 1, 2, 3 etc and in OSPF design the rule is that every standard area should have connectivity with OSPF Area 0 i.e. Backbone Area 0. So how we can run OSPF without Area 0 over MPLS Cloud as a CE-PE protocol.

MPLS VPN : The Core

Here is the explanation,

Till now we know that in OSPF we have Backbone Area, Standard Area, Stub Area, Total Stubby Area & NSSA Area. Now in MPLS while using OSPF as a CE-PE protocol the new Area has been define and that is known as **Super Backbone Area**.

Super backbone area is usually known as ISP Cloud and all PE router of ISP act as an ABR for all OSPF CE routers in same MPLS Domain and that Area of ISP is known as Super Backbone Area & the Super Backbone area override the standard rule of OSPF i.e. Every area should connect to Backbone area i.e. Area 0, But in OSPF instant of using Backbone area they have introduce new are i.e. OSPF Super backbone and Super back bone is not associate with any area like backbone area 0.

Objective:

Configure MPLS VPNs with the Traffic Engineering feature on R3 & R7 in such a way that VRF CUST_A traffic should pass through RED PATH (I.e. R3-R4-R5-R7) & VRF CUST_B should pass through BLUE PATH (i.e. R3-R6-R7)

Direction:

1. Create a basic topology.
2. Between CE-PE OSPF routing protocol has been configured
3. We are using default scenario of MPLS VPN - Traffic Engineering with Per VRF.
4. ***Below configuration for MPLS VPN – OSPF as CE-PE without Area 0

Configuration for MPLS VPN OSPF as CE-PE Protocol without Area 0

R1 – Router

```
!  
interface Loopback1  
ip address 10.1.1.1 255.255.255.252  
!  
interface Loopback2  
ip address 10.2.1.1 255.255.255.255  
!  
interface Loopback3  
ip address 10.3.1.1 255.255.255.255  
!  
interface FastEthernet0/0  
description ***** Connected to PE1 Router *****  
ip address 10.250.10.1 255.255.255.252  
duplex auto  
speed auto  
!  
!  
router ospf 1  
log-adjacency-changes  
network 10.1.1.1 0.0.0.0 area 2  
network 10.2.1.1 0.0.0.0 area 2  
network 10.3.1.1 0.0.0.0 area 2  
network 10.250.10.0 0.0.0.3 area 2  
!
```

R2 – Router

```
!  
interface Loopback1  
ip address 20.1.1.1 255.255.255.255  
!  
interface Loopback2  
ip address 20.2.1.1 255.255.255.255  
!  
interface Loopback3  
ip address 20.3.1.1 255.255.255.255  
!  
interface FastEthernet1/0  
description ***** Connected to PE-2 *****  
ip address 10.250.20.1 255.255.255.252  
duplex auto  
speed auto  
!  
!
```

```
router ospf 2  
log-adjacency-changes
```

```
network 10.250.20.0 0.0.0.3 area 5
network 20.1.1.1 0.0.0.0 area 5
network 20.2.1.1 0.0.0.0 area 5
network 20.3.1.1 0.0.0.0 area 5
!!
```

R3 --Router

```
!
!
ip vrf CUST_A
 rd 65:1
 route-target export 65:1
 route-target import 65:1
 bgp next-hop Loopback100
!
ip vrf CUST_B
 rd 65:2
 route-target export 65:2
 route-target import 65:2
 bgp next-hop Loopback200
!
mpls traffic-eng tunnels
!
!
interface Loopback10
 ip address 3.3.3.3 255.255.255.255
!
interface Loopback100
 ***** BGP NEXT-HOP FOR CUST_A *****
 ip address 100.100.100.100 255.255.255.255
!
interface Loopback200
 ***** BGP NEXT_HOP FOR CUST_B *****
 ip address 50.50.50.50 255.255.255.255
!
interface Tunnel10
 ***** MPLS TE FOR CUST_B *****
 ip unnumbered Loopback10
 mpls ip
 tunnel destination 7.7.7.7
 tunnel mode mpls traffic-eng
 tunnel mpls traffic-eng priority 1 1
 tunnel mpls traffic-eng bandwidth 2000
 tunnel mpls traffic-eng path-option 1 dynamic
 no routing dynamic
!
interface Tunnel20
 ***** MPLS TE FOR CUST_A *****
 ip unnumbered Loopback10
 mpls ip
 tunnel destination 7.7.7.7
 tunnel mode mpls traffic-eng
 tunnel mpls traffic-eng priority 1 1
 tunnel mpls traffic-eng bandwidth 2000
```

```
tunnel mpls traffic-eng path-option 1 explicit name R3-R4-R5-R7
no routing dynamic
```

```
!
```

```
interface FastEthernet0/0
description ***** Connected to R1 *****
ip vrf forwarding CUST_A
ip address 10.250.10.2 255.255.255.252
duplex auto
speed auto
```

```
!
```

```
interface FastEthernet1/0
description ***** Connected to R2 *****
ip vrf forwarding CUST_B
ip address 10.250.20.2 255.255.255.252
duplex auto
speed auto
```

```
!
```

```
interface Serial3/0
description *****Connected to P2_CORE *****
bandwidth 2000
ip address 15.1.1.1 255.255.255.252
encapsulation ppp
mpls label protocol ldp
mpls ip
mpls traffic-eng tunnels
serial restart-delay 0
ip rsvp bandwidth 2000 2000
```

```
!
```

```
interface Serial3/1
description *****Connected to P1_CORE*****
bandwidth 2000
ip address 15.3.1.1 255.255.255.252
encapsulation ppp
mpls label protocol ldp
mpls ip
mpls traffic-eng tunnels
serial restart-delay 0
ip rsvp bandwidth 2000 2000
```

```
!
```

```
!
```

```
router ospf 1 vrf CUST_A
log-adjacency-changes
redistribute bgp 65000 subnets
network 10.250.10.0 0.0.0.3 area 2
```

```
!
```

```
router ospf 2 vrf CUST_B
log-adjacency-changes
redistribute bgp 65000 subnets
network 10.250.20.0 0.0.0.3 area 5
```

```
!
```

```
router ospf 10
mpls traffic-eng router-id Loopback10
mpls traffic-eng area 0
router-id 3.3.3.3
log-adjacency-changes
no auto-cost
```

```
network 3.3.3.3 0.0.0.0 area 0
network 15.1.1.0 0.0.0.3 area 0
network 15.3.1.0 0.0.0.3 area 0
!
router bgp 65000
  bgp log-neighbor-changes
  neighbor 7.7.7.7 remote-as 65000
  neighbor 7.7.7.7 update-source Loopback10
!
  address-family ipv4
    neighbor 7.7.7.7 activate
    no auto-summary
    no synchronization
    exit-address-family
  !
  address-family vpnv4
    neighbor 7.7.7.7 activate
    neighbor 7.7.7.7 send-community extended
    exit-address-family
  !
  !
  address-family ipv4 vrf CUST_B
    redistribute ospf 2 vrf CUST_B
    no synchronization
    exit-address-family
  !
  address-family ipv4 vrf CUST_A
    redistribute ospf 1 vrf CUST_A
    no synchronization
    exit-address-family
  !
  ip route 60.60.60.60 255.255.255.255 Tunnel10
  ip route 200.200.200.200 255.255.255.255 Tunnel20
  !
  no ip http server
  no ip http secure-server
  !
  !
  ip explicit-path name R3-R4-R5-R7 enable
  next-address 15.1.1.2
  next-address 15.2.1.2
  next-address 15.5.1.2
  next-address 7.7.7.7
  !
  mpls ldp router-id Loopback10
  !
```

R4 - Router

```
!
mpls traffic-eng tunnels
!
!
interface Loopback10
  ip address 4.4.4.4 255.255.255.255
!
!
```

```
interface Serial3/0
description *****Connected to PE1_ROUTER *****
bandwidth 2000
ip address 15.1.1.2 255.255.255.252
encapsulation ppp
mpls label protocol ldp
mpls ip
mpls traffic-eng tunnels
serial restart-delay 0
ip rsvp bandwidth 2000 2000
!
interface Serial3/1
description *****Connected to P3_CORE *****
bandwidth 2000
ip address 15.2.1.1 255.255.255.252
encapsulation ppp
mpls label protocol ldp
mpls ip
mpls traffic-eng tunnels
serial restart-delay 0
ip rsvp bandwidth 2000 2000
!
!
router ospf 10
mpls traffic-eng router-id Loopback10
mpls traffic-eng area 0
router-id 4.4.4.4
log-adjacency-changes
no auto-cost
network 4.4.4.4 0.0.0.0 area 0
network 15.1.1.0 0.0.0.3 area 0
network 15.2.1.0 0.0.0.3 area 0
!
mpls ldp router-id Loopback10
!
```

R5 - Router

```
!
mpls traffic-eng tunnels
!
!
interface Loopback10
ip address 5.5.5.5 255.255.255.255
!
!
interface Serial3/1
description *****Connected to P2_CORE*****
bandwidth 2000
ip address 15.2.1.2 255.255.255.252
encapsulation ppp
mpls label protocol ldp
mpls ip
mpls traffic-eng tunnels
serial restart-delay 0
ip rsvp bandwidth 2000 2000
!
```

```
interface Serial3/2
description ***** Connected to PE2_ROUTER *****
bandwidth 2000
ip address 15.5.1.1 255.255.255.252
encapsulation ppp
mpls label protocol ldp
mpls ip
mpls traffic-eng tunnels
serial restart-delay 0
ip rsvp bandwidth 2000 2000
!
router ospf 10
mpls traffic-eng area 0
router-id 5.5.5.5
log-adjacency-changes
no auto-cost
network 5.5.5.5 0.0.0.0 area 0
network 15.2.1.0 0.0.0.3 area 0
network 15.5.1.0 0.0.0.3 area 0
!
!
mpls ldp router-id Loopback10
```

R6 - Router

```
!
mpls traffic-eng tunnels
!
interface Loopback10
ip address 6.6.6.6 255.255.255.255
!
!
interface Serial3/0
description ***** Connected to PE2_ROUTER *****
bandwidth 2000
ip address 15.4.1.1 255.255.255.252
encapsulation ppp
mpls label protocol ldp
mpls ip
mpls traffic-eng tunnels
serial restart-delay 0
ip rsvp bandwidth 2000 2000
!
interface Serial3/1
description *****Connected to PE1_ROUETR *****
bandwidth 2000
ip address 15.3.1.2 255.255.255.252
encapsulation ppp
mpls label protocol ldp
mpls ip
mpls traffic-eng tunnels
serial restart-delay 0
ip rsvp bandwidth 2000 2000
!
!
router ospf 10
```



```
mpls traffic-eng router-id Loopback10
mpls traffic-eng area 0
router-id 6.6.6.6
log-adjacency-changes
no auto-cost
network 6.6.6.6 0.0.0.0 area 0
network 15.3.1.0 0.0.0.3 area 0
network 15.4.1.0 0.0.0.3 area 0
!
mpls ldp router-id Loopback10
!
```

R7 - Router

```
!
ip vrf CUST_A
rd 65:1
route-target export 65:1
route-target import 65:1
bgp next-hop Loopback100
!
ip vrf CUST_B
rd 65:2
route-target export 65:2
route-target import 65:2
bgp next-hop Loopback60
!
mpls traffic-eng tunnels
!
!
interface Loopback10
ip address 7.7.7.7 255.255.255.255
!
interface Loopback60
***** BGP NEXT-HOP FOR CUST_B *****
ip address 60.60.60.60 255.255.255.255
!
interface Loopback100
***** BGP NEXT-HOP FOR CUST_A *****
ip address 200.200.200.200 255.255.255.255
!
!
interface Tunnel10
***** MPLS TE For CUST_B *****
ip unnumbered Loopback10
mpls ip
tunnel destination 3.3.3.3
tunnel mode mpls traffic-eng
tunnel mpls traffic-eng priority 1 1
tunnel mpls traffic-eng bandwidth 2000
tunnel mpls traffic-eng path-option 1 dynamic
no routing dynamic
!
interface Tunnel20
***** MPLS TE For CUST_A *****
ip unnumbered Loopback10
mpls ip
```

```
tunnel destination 3.3.3.3
tunnel mode mpls traffic-eng
tunnel mpls traffic-eng priority 1 1
tunnel mpls traffic-eng bandwidth 2000
tunnel mpls traffic-eng path-option 1 explicit name R7-R5-R4-R3
no routing dynamic
!
interface FastEthernet0/0
description ***** Connected to R8 *****
ip vrf forwarding CUST_A
ip address 10.250.80.2 255.255.255.252
duplex auto
speed auto
!
!
interface FastEthernet1/0
description ***** Connected to R9 *****
ip vrf forwarding CUST_B
ip address 10.250.90.2 255.255.255.252
duplex auto
speed auto
!
!
interface Serial3/0
description ***** Connected to P1_CORE *****
bandwidth 2000
ip address 15.4.1.2 255.255.255.252
encapsulation ppp
mpls label protocol ldp
mpls ip
mpls traffic-eng tunnels
serial restart-delay 0
ip rsvp bandwidth 2000 2000
!
!
interface Serial3/2
description ***** Connected to P3_CORE *****
bandwidth 2000
ip address 15.5.1.2 255.255.255.252
encapsulation ppp
mpls label protocol ldp
mpls ip
mpls traffic-eng tunnels
serial restart-delay 0
ip rsvp bandwidth 2000 2000
!
router ospf 1 vrf CUST_A
log-adjacency-changes
redistribute bgp 65000 subnets
network 10.250.80.0 0.0.0.3 area 2
!
router ospf 2 vrf CUST_B
log-adjacency-changes
redistribute bgp 65000 subnets
network 10.250.90.0 0.0.0.3 area 6
!
!
```

```
router ospf 10
mpls traffic-eng router-id Loopback10
mpls traffic-eng area 0
log-adjacency-changes
network 7.7.7.7 0.0.0.0 area 0
network 15.4.1.0 0.0.0.3 area 0
network 15.5.1.0 0.0.0.3 area 0
!
router bgp 65000
bgp log-neighbor-changes
neighbor 3.3.3.3 remote-as 65000
neighbor 3.3.3.3 update-source Loopback10
!
address-family ipv4
neighbor 3.3.3.3 activate
no auto-summary
no synchronization
exit-address-family
!
address-family vpnv4
neighbor 3.3.3.3 activate
neighbor 3.3.3.3 send-community extended
exit-address-family
!
address-family ipv4 vrf CUST_B
redistribute ospf 2 vrf CUST_B
no synchronization
exit-address-family
!
address-family ipv4 vrf CUST_A
redistribute ospf 1 vrf CUST_A
no synchronization
exit-address-family
!
ip route 50.50.50.50 255.255.255.255 Tunnel10
ip route 100.100.100.100 255.255.255.255 Tunnel20
!
ip explicit-path name R7-R5-R4-R3 enable
next-address 15.5.1.1
next-address 15.2.1.1
next-address 15.1.1.1
next-address 3.3.3.3
!
mpls ldp router-id Loopback10
!
```

R8 - Router

```
!
interface Loopback1
ip address 80.1.1.1 255.255.255.255
!
interface Loopback2
ip address 80.2.1.1 255.255.255.255
!
interface Loopback3
ip address 80.3.1.1 255.255.255.255
!
```

```
interface FastEthernet0/0
description ***** Connected to PE-2 *****
ip address 10.250.80.1 255.255.255.252
duplex auto
speed auto
!
!
!
router ospf 1
log-adjacency-changes
network 10.250.80.0 0.0.0.3 area 2
network 80.1.1.1 0.0.0.0 area 2
network 80.2.1.1 0.0.0.0 area 2
network 80.3.1.1 0.0.0.0 area 2
!
```

R9 - Router

```
!
interface Loopback1
ip address 90.1.1.1 255.255.255.255
!
interface Loopback2
ip address 90.2.1.1 255.255.255.255
!
interface Loopback3
ip address 90.3.1.1 255.255.255.255
!
interface FastEthernet1/0
description ***** Connected to PE-2 *****
ip address 10.250.90.1 255.255.255.252
duplex auto
speed auto
!
!
!
router ospf 2
log-adjacency-changes
network 10.250.90.0 0.0.0.3 area 6
network 90.1.1.1 0.0.0.0 area 6
network 90.2.1.1 0.0.0.0 area 6
network 90.3.1.1 0.0.0.0 area 6
!
```

Verification :

CUST A - R8- Router

```
Dynamips(8): R8, Console port

CUST_A#sh ip rou
CUST_A#sh ip route
Codes: 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

Gateway of last resort is not set

      80.0.0.0/32 is subnetted, 3 subnets
C       80.1.1.1 is directly connected, Loopback1
C       80.2.1.1 is directly connected, Loopback2
C       80.3.1.1 is directly connected, Loopback3
      10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
O IA    10.2.1.1/32 [110/3] via 10.250.80.2, 01:11:29, FastEthernet0/0
O IA    10.3.1.1/32 [110/3] via 10.250.80.2, 01:11:29, FastEthernet0/0
O IA    10.1.1.1/32 [110/3] via 10.250.80.2, 01:11:29, FastEthernet0/0
C       10.250.80.0/30 is directly connected, FastEthernet0/0
O IA    10.250.10.0/30 [110/2] via 10.250.80.2, 01:11:29, FastEthernet0/0
CUST_A#
```

CUST B - R9 Router

```
Dynamips(0): R9, Console port

CUST_B#sh ip rou
CUST_B#sh ip route
Codes: 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

Gateway of last resort is not set

      20.0.0.0/32 is subnetted, 3 subnets
O IA    20.1.1.1 [110/3] via 10.250.90.2, 01:12:24, FastEthernet1/0
O IA    20.2.1.1 [110/3] via 10.250.90.2, 01:12:24, FastEthernet1/0
O IA    20.3.1.1 [110/3] via 10.250.90.2, 01:12:24, FastEthernet1/0
      10.0.0.0/30 is subnetted, 2 subnets
C       10.250.90.0 is directly connected, FastEthernet1/0
O IA    10.250.20.0 [110/2] via 10.250.90.2, 01:12:24, FastEthernet1/0
      90.0.0.0/32 is subnetted, 3 subnets
C       90.2.1.1 is directly connected, Loopback2
C       90.3.1.1 is directly connected, Loopback3
C       90.1.1.1 is directly connected, Loopback1
CUST_B#
```

R-3 Router - PE-1

```
Dynamips(4): R3, Console port

LSP Tunnels Process:      running
RSVP Process:             running
Forwarding:               enabled
Periodic reoptimization:  every 3600 seconds, next in 342 seconds
Periodic auto-bw collection: disabled

TUNNEL NAME      DESTINATION  UP IF    DOWN IF    STATE/PROT
PE1_ROUTER_t10   7.7.7.7      -        Se3/1      up/up
PE1_ROUTER_t20   7.7.7.7      -        Se3/0      up/up
PE2_ROUTER_t10   3.3.3.3      Se3/1    -          up/up
PE2_ROUTER_t20   3.3.3.3      Se3/0    -          up/up
Displayed 2 (of 2) heads, 0 (of 0) midpoints, 2 (of 2) tails
PE1_ROUTER#
```

R-7 Router - PE-2

```
Dynamips(7): R7, Console port

Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Connected to MPLS VPN Superbackbone, VRF CUST A
It is an area border and autonomous system boundary router
Redistributing External Routes from,
    bgp 65000, includes subnets in redistribution
Router is not originating router-LSAs with maximum metric
Initial SPF schedule delay 5000 msec
Minimum hold time between two consecutive SPF's 10000 msec
Maximum wait time between two consecutive SPF's 10000 msec
Incremental-SPF disabled

Dynamips(7): R7, Console port

Routing Process "ospf 2" with ID 10.250.90.2
  Domain ID type 0x0005, value 0.0.0.2
Start time: 00:00:40.452, Time elapsed: 01:16:17.104
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Connected to MPLS VPN Superbackbone, VRF CUST B
It is an area border and autonomous system boundary router
Redistributing External Routes from,
    bgp 65000, includes subnets in redistribution
Router is not originating router-LSAs with maximum metric
```