WHITE PAPER

# MULTI-VRF AND IP MULTICAST

## OVERVIEW

Multi-VRF Customer Edge (VRF-Lite) enables Multiple VPN routing instances on Customer Edge devices and supports Cisco IOS® IP Multicast. Since Multicast has become an integral part of many networks, it is critical that Cisco IOS Technologies support it.

## CONFIGURATION PROCESS

Once the unicast setup is complete, follow these steps to configure Multi-VRF and IP Multicast between the VPN provider and the customer.

### Enable IP Multicast over VPN (Service Providers)

1. Enable Multicast on the Provider and Provider Edge routers and interfaces

2. Enable VRFs for Multicast by assigning them default Multicast Diagnostic Toolset (MDT) groups and optionally data MDT groups

### Configure Multi-VRF to support IP Multicast (Customers)

3. Enable individual VRFs on the Multi-VRF Customer Edges for IP Multicast

4. Configure Rendezvous Points using either static Auto-Rendezvous Point or Boot Strap Router (BSR) within each VRF on the Provider Edge/Multi-VRF Customer Edge routers. When using Auto-Rendezvous Point, make sure all the participating interfaces are sparse-dense.

The Customer Edge portion of the configuration process illustrates that no special configuration is required to enable IP Multicast with Multi VRF. The configuration is VRF-specific.

**Figure 1**
Multi-VRF Topology

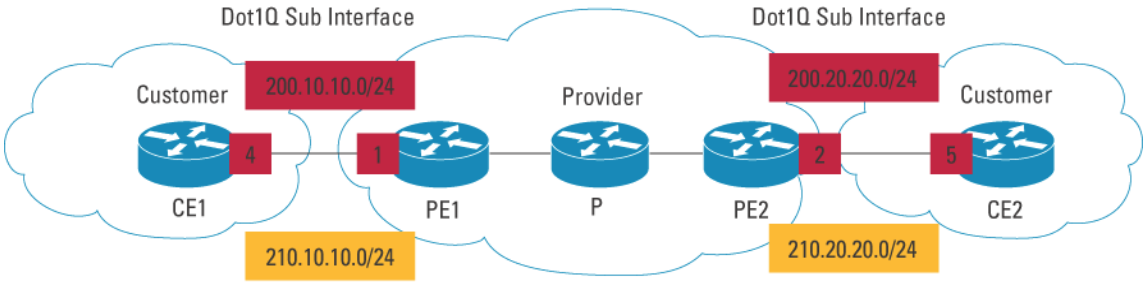


Figure 1 illustrates Multi-VRF deployment for a customer who requires two separate VPNs for its operations: finance (yellow) and engineering (red). This customer also has a VPN service from Provider and two sites connected to both VPNs.

A single physical interface uses sub-interfaces to carry per-VPN traffic between the Customer Edge and Provider Edge. Each VPN could also be assigned its own physical interface between the Customer Edge and Provider Edge; however, this option is more expensive.

The Multi-VRF Customer Edge provides the capability of supporting multiple VRFs on the Customer Edge.

Customer Edge1 and Customer Edge2 each support VPNs, Finance, and Engineering. Also, assume that the Rendezvous Point for Finance is Customer Edge2, and the Rendezvous Point for Engineering is Customer Edge1.

Following are the configurations that enable IP Multicast on Customer Edge1 and Customer Edge2:

**Customer Edge1**

```
ip multicast-routing vrf FINANCE

ip multicast-routing vrf ENG

! FINANCE is sub-intf 2

int Ethernet0/0.2

 descr Sub-interface to PE for the ENG VPN

 ip pim sparse-dense

!

! ENG is sub-intf 3

int Ethernet0/0.3

 descr Sub-interface to PE for the FINANCE VPN

 ip pim sparse-dense

!

ip pim vrf FINANCE rp-address <x.x.x.x>

ip pim vrf ENG rp-address <x.x.x.x>
```

## CONFIGURATION EXAMPLES

Complete Configuration from the network described above.

In the following configurations, the provider uses a default MDT over Source Specific Multicast (SSM) with a default SSM address. In the Customer Edge VRF the group range 228.0.0.0 is being used by both VRFs independently from each other. Static Rendezvous Points for Protocol Independent Multicast sparse mode (PIM SM) have been used this time; however, any PIM Mode is supported within the VRF.

**Customer Edge1**

```
hostname CE1

!

ip cef

ip vrf ENG

 rd 200:200
```

```
!
ip vrf FINANCE
 rd 300:300
!
ip multicast-routing vrf ENG
ip multicast-routing vrf FINANCE
!
interface Loopback1
 ip vrf forwarding ENG
 ip address 200.10.100.1 255.255.255.0
 no ip directed-broadcast
 ip pim sparse-dense-mode
!
interface Loopback2
 ip vrf forwarding FINANCE
 ip address 210.10.100.1 255.255.255.0
 no ip directed-broadcast
 ip pim sparse-dense-mode
!
interface Ethernet0/0
 description Link between routers CE1 PE1
 no ip address
 no ip directed-broadcast
 no cdp enable
!
interface Ethernet0/0.2
 encapsulation dot1Q 2
 ip vrf forwarding ENG
 ip address 200.10.10.4 255.255.255.0
 no ip directed-broadcast
 ip pim sparse-dense-mode
!
```

```
interface Ethernet0/0.3
 encapsulation dot1Q 3
 ip vrf forwarding FINANCE
 ip address 210.10.10.4 255.255.255.0
 no ip directed-broadcast
 ip pim sparse-dense-mode
!
router rip
 version 2
 !
 address-family ipv4 vrf FINANCE
 version 2
 network 210.10.10.0
 network 210.10.100.0
 no auto-summary
 exit-address-family
 !
 address-family ipv4 vrf ENG
 version 2
 network 200.10.10.0
 network 200.10.100.0
 no auto-summary
 exit-address-family
!
ip classless
!
ip pim vrf ENG rp-address 200.20.20.5 50
ip pim vrf FINANCE rp-address 210.10.10.4 50
!
access-list 50 permit 228.0.0.0 0.255.255.255
!
end
```

**Provider Edge1**

```
hostname PE1
!
ip cef
ip vrf ENG
 rd 200:200
 route-target export 200:200
 route-target import 200:200
 mdt default 232.1.1.1
!
ip vrf FINANCE
 rd 300:300
 route-target export 300:300
 route-target import 300:300
 mdt default 232.2.2.2
!
ip multicast-routing
ip multicast-routing vrf ENG
ip multicast-routing vrf FINANCE
!
interface Loopback0
 ip address 205.1.0.1 255.255.255.255
 no ip directed-broadcast
 ip pim sparse-dense-mode
!
interface Ethernet0/0
 description Link between routers CE1 PE1
 no ip address
 no ip directed-broadcast
 ip pim sparse-dense-mode
 no cdp enable
!
```

```
interface Ethernet0/0.2
 encapsulation dot1Q 2
 ip vrf forwarding ENG
 ip address 200.10.10.1 255.255.255.0
 no ip directed-broadcast
 ip pim sparse-dense-mode
!
interface Ethernet0/0.3
 encapsulation dot1Q 3
 ip vrf forwarding FINANCE
 ip address 210.10.10.1 255.255.255.0
 no ip directed-broadcast
 ip pim sparse-dense-mode
!
interface Ethernet1/0
 description Link between routers PE1 P
 ip address 10.10.10.1 255.255.255.0
 no ip directed-broadcast
 ip pim sparse-dense-mode
 tag-switching ip
 no cdp enable
!
router ospf 200
 log-adjacency-changes
 network 10.10.10.0 0.0.0.255 area 0
 network 205.1.0.1 0.0.0.0 area 0
!
router rip
 version 2
 !
 address-family ipv4 vrf FINANCE
 version 2
```

```
 redistribute bgp 200 metric 10
 network 210.10.10.0
 no auto-summary
 exit-address-family
 !
 address-family ipv4 vrf ENG
 version 2
 redistribute bgp 200 metric 10
 network 200.10.10.0
 no auto-summary
 exit-address-family
!
router bgp 200
 bgp log-neighbor-changes
 neighbor 205.2.0.2 remote-as 200
 neighbor 205.2.0.2 update-source Loopback0
 !
 address-family ipv4
 neighbor 205.2.0.2 activate
 no auto-summary
 no synchronization
 exit-address-family
 !
 address-family vpnv4
 neighbor 205.2.0.2 activate
 neighbor 205.2.0.2 send-community extended
 exit-address-family
 !
 address-family ipv4 vrf FINANCE
 redistribute rip metric 50
 no auto-summary
 no synchronization
```

```
 exit-address-family
 !
 address-family ipv4 vrf ENG
 redistribute rip metric 50
 no auto-summary
 no synchronization
 exit-address-family
!
ip classless
!
ip pim ssm default
ip pim vrf ENG rp-address 200.20.20.5 50
ip pim vrf FINANCE rp-address 210.10.10.4 50
!
access-list 50 permit 228.0.0.0 0.255.255.255
!
end
```

**Provider**

```
hostname P
!
ip cef
ip multicast-routing
!
interface Ethernet1/0
 description Link between routers PE1 P
 ip address 10.10.10.3 255.255.255.0
 no ip directed-broadcast
 ip pim sparse-dense-mode
 tag-switching ip
 no cdp enable
!
interface Ethernet2/0
```

```
 description Link between routers P PE2
 ip address 10.10.20.3 255.255.255.0
 no ip directed-broadcast
 ip pim sparse-dense-mode
 tag-switching ip
 no cdp enable
!
router ospf 200
 log-adjacency-changes
 network 10.10.10.0 0.0.0.255 area 0
 network 10.10.20.0 0.0.0.255 area 0
!
ip classless
!
ip pim ssm default
!
end
```

**Provider Edge2**

```
hostname PE2
!
ip cef
ip vrf ENG
 rd 200:200
 route-target export 200:200
 route-target import 200:200
 mdt default 232.1.1.1
!
ip vrf FINANCE
 rd 300:300
 route-target export 300:300
 route-target import 300:300
 mdt default 232.2.2.2
```

```
!
ip multicast-routing
ip multicast-routing vrf ENG
ip multicast-routing vrf FINANCE
!
interface Loopback0
 ip address 205.2.0.2 255.255.255.255
 no ip directed-broadcast
 ip pim sparse-dense-mode
!
interface Ethernet2/0
 description Link between routers P PE2
 ip address 10.10.20.2 255.255.255.0
 no ip directed-broadcast
 ip pim sparse-dense-mode
 tag-switching ip
 no cdp enable
!
interface Ethernet3/0
 description Link between routers PE2 CE2
 no ip address
 no ip directed-broadcast
 no cdp enable
!
interface Ethernet3/0.2
 encapsulation dot1Q 2
 ip vrf forwarding ENG
 ip address 200.20.20.2 255.255.255.0
 no ip directed-broadcast
 ip pim sparse-dense-mode
!
interface Ethernet3/0.3
```

```
 encapsulation dot1Q 3
 ip vrf forwarding FINANCE
 ip address 210.20.20.2 255.255.255.0
 no ip directed-broadcast
 ip pim sparse-dense-mode
!
router ospf 200
 log-adjacency-changes
 network 10.10.20.0 0.0.0.255 area 0
 network 205.2.0.2 0.0.0.0 area 0
!
router rip
 version 2
 !
 address-family ipv4 vrf FINANCE
 version 2
 redistribute bgp 200 metric 10
 network 210.20.20.0
 no auto-summary
 exit-address-family
 !
 address-family ipv4 vrf ENG
 version 2
 redistribute bgp 200 metric 10
 network 200.20.20.0
 no auto-summary
 exit-address-family
!
router bgp 200
 bgp log-neighbor-changes
 neighbor 205.1.0.1 remote-as 200
 neighbor 205.1.0.1 update-source Loopback0
```

```
 !
 address-family ipv4
 neighbor 205.1.0.1 activate
 no auto-summary
 no synchronization
 exit-address-family
 !
 address-family vpnv4
 neighbor 205.1.0.1 activate
 neighbor 205.1.0.1 send-community extended
 exit-address-family
 !
 address-family ipv4 vrf FINANCE
 redistribute rip metric 50
 no auto-summary
 no synchronization
 exit-address-family
 !
 address-family ipv4 vrf ENG
 redistribute rip metric 50
 no auto-summary
 no synchronization
 exit-address-family
!
ip classless
!
ip pim ssm default
ip pim vrf ENG rp-address 200.20.20.5 50
ip pim vrf FINANCE rp-address 210.10.10.4 50
!
access-list 50 permit 228.0.0.0 0.255.255.255
!
```

```
end
```

**Customer Edge2**

```
hostname CE2
!
ip cef
ip vrf ENG
 rd 200:200
!
ip vrf FINANCE
 rd 300:300
!
ip multicast-routing vrf ENG
ip multicast-routing vrf FINANCE
!
interface Loopback1
 ip vrf forwarding ENG
 ip address 200.20.200.1 255.255.255.0
 no ip directed-broadcast
 ip pim sparse-dense-mode
!
interface Loopback2
 ip vrf forwarding FINANCE
 ip address 210.20.200.1 255.255.255.0
 no ip directed-broadcast
 ip pim sparse-dense-mode
!
interface Ethernet3/0
 description Link between routers PE2 CE2
 no ip address
 no ip directed-broadcast
 no cdp enable
!
```

```
interface Ethernet3/0.2
 encapsulation dot1Q 2
 ip vrf forwarding ENG
 ip address 200.20.20.5 255.255.255.0
 no ip directed-broadcast
 ip pim sparse-dense-mode
!
interface Ethernet3/0.3
 encapsulation dot1Q 3
 ip vrf forwarding FINANCE
 ip address 210.20.20.5 255.255.255.0
 no ip directed-broadcast
 ip pim sparse-dense-mode
!
router rip
 version 2
 !
 address-family ipv4 vrf FINANCE
 version 2
 network 210.20.20.0
 network 210.20.200.0
 no auto-summary
 exit-address-family
 !
 address-family ipv4 vrf ENG
 version 2
 network 200.20.20.0
 network 200.20.200.0
 no auto-summary
 exit-address-family
!
ip classless
```

```
!
ip pim vrf ENG rp-address 200.20.20.5 50
ip pim vrf FINANCE rp-address 210.10.10.4 50
!
access-list 50 permit 228.0.0.0 0.255.255.255
!
end
```

### VERIFYING IP MULTICAST ROUTE INFORMATION

Since IP Multicast relies on Unicast routing or performs it RPF check, its status has to be always checked before verifying the IP Multicast route information.

**Output from Customer Edge1**

```
CE1#sh ip route vrf ENG

Routing Table: ENG

Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       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

Gateway of last resort is not set

R    200.20.200.0/24 [120/10] via 200.10.10.1, 00:00:10, Ethernet0/0.2

R    200.20.20.0/24 [120/10] via 200.10.10.1, 00:00:10, Ethernet0/0.2

C    200.10.100.0/24 is directly connected, Loopback1

C    200.10.10.0/24 is directly connected, Ethernet0/0.2

CE1#sh ip pim vrf ENG int cou

State: * - Fast Switched, D - Distributed Fast Switched
       H - Hardware Switching Enabled

Address          Interface                FS  Mpackets In/Out

200.10.100.1     Loopback1                *   42/0

200.10.10.4      Ethernet0/0.2            *   0/0

CE1#sh ip vrf
```

```
  Name                             Default RD          Interfaces
  ENG                              200:200             Loopback1
                                                       Ethernet0/0.2
  green                            300:300             Loopback2
                                                       Ethernet0/0.3
```

The VRF for a specific group command, SH IP MROUTE, matches the access list on the Provider Edge for the ENG VRF. The incoming interface from Provider Edge neighbor is the address of the Provider Edge interface. The Rendezvous Point is the address of the remote Customer Edge.

```
CE1#sh ip mroute vrf ENG 228.1.1.1
IP Multicast Routing Table
Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C - Connected,
       L - Local, P - Pruned, R - RP-bit set, F - Register flag,
       T - SPT-bit set, J - Join SPT, M - MSDP created entry,
       X - Proxy Join Timer Running, A - Candidate for MSDP Advertisement,
       U - URD, I - Received Source Specific Host Report, Z - Multicast Tunnel,
       Y - Joined MDT-data group, y - Sending to MDT-data group
Outgoing interface flags: H - Hardware switched, A - Assert winner
 Timers: Uptime/Expires
 Interface state: Interface, Next-Hop or VCD, State/Mode

(*, 228.1.1.1), 00:00:12/00:02:49, RP 200.20.20.5, flags: SJCL
  Incoming interface: Ethernet0/0.2, RPF nbr 200.10.10.1
  Outgoing interface list:
    Loopback1, Forward/Sparse-Dense, 00:00:12/00:02:49
```

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