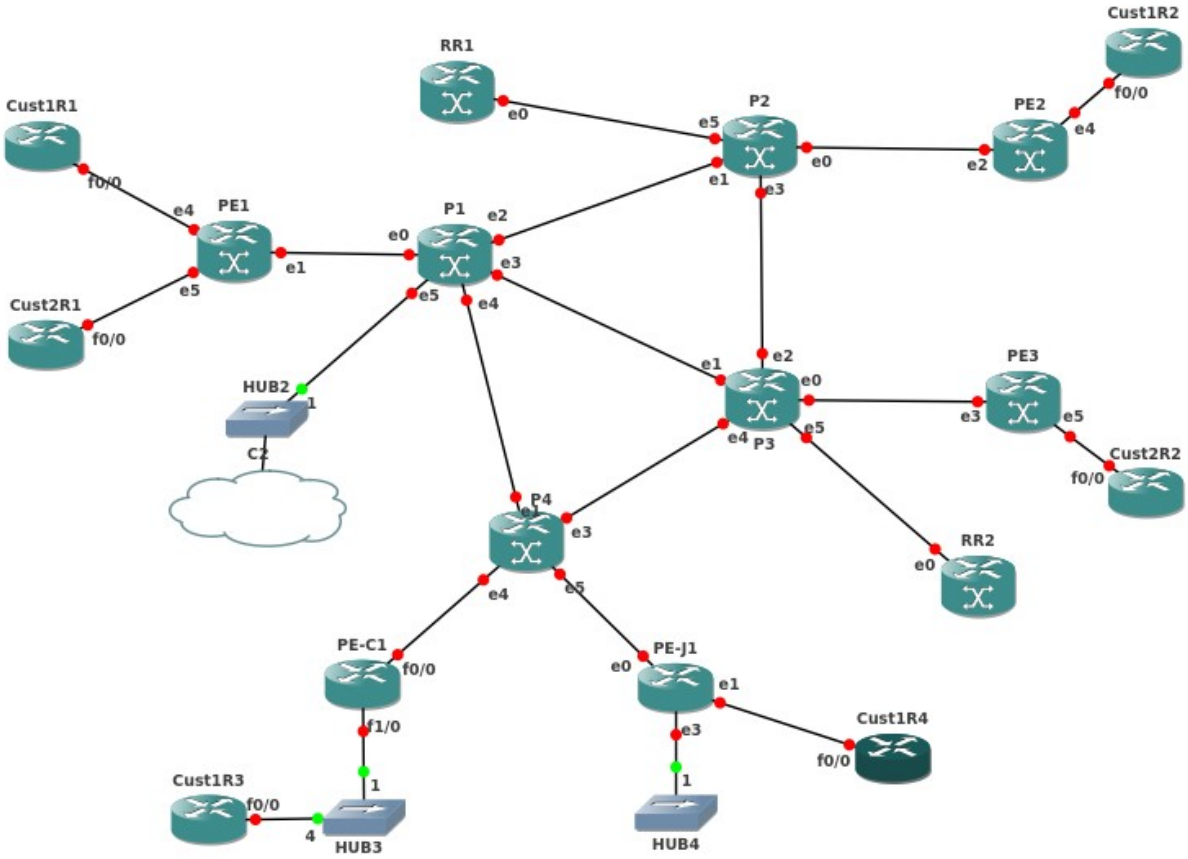
Multivendor MPLS L3VPN

Small MPLS Network, with P routers (Mikrotik), PE routers (Mikrotik, Cisco, Juniper) and a couple of RR for VPNv4 Address-Family (Mikrotik).



All P routers configuration are similar
All RR routers configuration are similar
All Mikrotik PE routers configuration are similar
PE-J1 is a Juniper PE
PE-C1 is a Cisco PE
PE-CE routing protocol is OSPF or BGP

Note: I found a litte bug in Mikrotik BGP-VPNv4. It's not a blocking problem, but it can create some mess ;)
Route-Distinguisher for VPNv4 routes is propagated in reverse order. Mikrotik PEs read it correctly, but Junipers and Ciscos read it reversed. Anyway, this is not a big problem, since the routes are imported and exported basing on route-target, that is correctly propagated.

Example: RD configured on PEs is 12.34.56.78:1

```
Cisco#sh ip bgp vpnv4 all
BGP table version is 1, local router ID is 10.1.1.1
[...]
   Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 12.34.56.78:1 (default for vrf vrf-Test1)
*  192.168.7.0      0.0.0.0                  0         32768 ?
Route Distinguisher: 78.56.34.12:1
* i192.168.7.0      10.2.2.2                      100      0 ?
```

Network design - AS65530:

Loopback addresses:

P routers: 10.0.1.x
RR routers: 10.0.2.x
PE routers – Mikrotik: 10.0.3.x
PE routers – Cisco: 10.0.4.x
PE routers – Juniper: 10.0.5.x

P-t-P links:

P1 – P2 : 10.1.12.0/24 *(last octet is router number. i.e. for router 2 10.1.12.2)*
P1 – P3 : 10.1.13.0/24
P1 – P4 : 10.1.14.0/24
P2 – P3 : 10.1.23.0/24
P3 – P4 : 10.1.34.0/24

P1 – PE1 : 10.2.1.0/24 *(.1 P , .2 PE)*
P2 – PE2 : 10.2.2.0/24
P3 – PE3 : 10.2.3.0/24
P4 – PE-C1 : 10.4.1.0/24
P4 – PE-J1 : 10.5.1.0/24

P2 – RR1 : 10.3.2.0/24
P3 – RR2 : 10.3.3.0/24

VRF:

vrf-Cust1 – RD 10.41.0.0:1 – RT (import, export) 10.41.0.0:1
Cust1R1 : (Lo: 192.168.0.1) 10.41.1.0/30
Cust1R2 : (Lo: 192.168.0.2) 10.41.2.0/30
Cust1R3 : (Lo: 192.168.0.3) 10.73.12.0/24
Cust1R4 (AS 65533) : (Lo: 192.168.0.4 + 10.141.41.1/24) 10.141.7.0/30

vrf-Cust2 – RD 10.42.0.0:2 – RT (import, export) 10.42.0.0:2
Cust2R1 : 10.42.1.0/30
Cust2R2 : 10.42.3.0/30

Configuration snipplets:

P routers (P2):

```
/routing ospf instance
     set [ find default=yes ] router-id=10.0.1.2
/ip address
     add address=10.1.12.2/24 interface=e1 network=10.1.12.0
     add address=10.0.1.2/32 interface=loopback0 network=10.0.1.2
     add address=10.1.23.2/24 interface=e3 network=10.1.23.0
     add address=10.2.2.1/24 interface=e0 network=10.2.2.0
     add address=10.3.2.1/24 interface=e5 network=10.3.2.0
     add address=192.0.2.2/30 interface=e2 network=192.0.2.0
/mpls ldp
     set enabled=yes lsr-id=10.0.1.2 transport-address=10.0.1.2
/mpls ldp interface
     add interface=e0
     add interface=e1
     add interface=e3
```

```
     add interface=e5
     add interface=loopback0
/routing ospf network
     add area=backbone network=10.0.1.2/32
     add area=backbone network=10.1.12.0/24
     add area=backbone network=10.1.23.0/24
     add area=backbone network=10.2.2.0/24
     add area=backbone network=10.3.2.0/24
/system identity
     set name=P2
```

RR routers (RR2):

```
/routing bgp instance
     set default router-id=10.0.2.2
/routing ospf instance
     set [ find default=yes ] router-id=10.0.2.2
/ip address
     add address=10.3.3.2/24 interface=e0 network=10.3.3.0
     add address=10.0.2.2/32 interface=loopback0 network=10.0.2.2
/mpls ldp
     set enabled=yes lsr-id=10.0.2.2 transport-address=10.0.2.2
/mpls ldp interface
     add interface=e0
     add interface=loopback0
/routing bgp peer
     add address-families=vpnv4 name=peer1 \
          nexthop-choice=force-self remote-address=10.0.2.1 \
          remote-as=65530 update-source=loopback0
     add address-families=vpnv4 name=peer2 \
          nexthop-choice=force-self remote-address=10.0.3.1 \
          remote-as=65530 route-reflect=yes update-source=loopback0
     add address-families=vpnv4 name=peer3 \
          nexthop-choice=force-self remote-address=10.0.3.2 \
          remote-as=65530 route-reflect=yes update-source=loopback0
     add address-families=vpnv4 name=peer4 \
          nexthop-choice=force-self remote-address=10.0.3.3 \
          remote-as=65530 route-reflect=yes update-source=loopback0
/routing ospf network
     add area=backbone network=10.0.2.2/32
     add area=backbone network=10.3.3.0/24
/system identity
     set name=RR2
```

PE routers – Mikrotik (PE1):

```
/routing bgp instance
     set default router-id=10.0.3.1
/routing ospf instance
     set [ find default=yes ] router-id=10.0.3.1
     add name=vrf-Cust1 redistribute-bgp=as-type-1 \
          router-id=10.0.3.1 routing-table=vrf-Cust1
     add name=vrf-Cust2 redistribute-bgp=as-type-1 \
          router-id=10.0.3.1 routing-table=vrf-Cust2
/routing ospf area
```

```
     add instance=vrf-Cust1 name=vrf-Cust1-area0
     add instance=vrf-Cust2 name=vrf-Cust2-area0
/ip address
     add address=10.2.1.2/24 interface=e1 network=10.2.1.0
     add address=10.0.3.1/32 interface=loopback0 network=10.0.3.1
     add address=10.41.1.1/30 interface=e4 network=10.41.1.0
     add address=10.42.1.1/30 interface=e5 network=10.42.1.0
/ip route vrf
     add export-route-targets=10.41.0.0:1 \
          import-route-targets=10.41.0.0:1 interfaces=e4 \
          route-distinguisher=10.41.0.0:1 routing-mark=vrf-Cust1
     add export-route-targets=10.42.0.0:2 \
          import-route-targets=10.42.0.0:2 interfaces=e5 \
          route-distinguisher=10.42.0.0:2 routing-mark=vrf-Cust2
/mpls ldp
     set enabled=yes lsr-id=10.0.3.1 transport-address=10.0.3.1
/mpls ldp interface
     add interface=e1
     add interface=loopback0
/routing bgp instance vrf
     add redistribute-connected=yes redistribute-ospf=yes \
          routing-mark=vrf-Cust1
     add redistribute-connected=yes redistribute-ospf=yes \
          routing-mark=vrf-Cust2
/routing bgp peer
     add address-families=vpnv4 name=peer1 \
          nexthop-choice=force-self remote-address=10.0.2.1 \
          remote-as=65530 update-source=loopback0
     add address-families=vpnv4 name=peer2 \
          nexthop-choice=force-self remote-address=10.0.2.2 \
          remote-as=65530 update-source=loopback0
/routing ospf network
     add area=backbone network=10.2.1.0/24
     add area=backbone network=10.0.3.1/32
     add area=vrf-Cust1-area0 network=10.41.1.0/30
     add area=vrf-Cust2-area0 network=10.42.1.0/30
/system identity
     set name=PE1
```

PE routers – Cisco (PE-C1):

```
hostname PE-C1
!
ip cef
!
ip vrf vrf-Cust1
 rd 0.0.41.10:1      (just to be clear – see note on first pages)
 route-target export 10.41.0.0:1
 route-target import 10.41.0.0:1
!
mpls label protocol ldp
!
interface Loopback0
 ip address 10.0.4.1 255.255.255.255
!
```

```
interface Loopback101
 ip vrf forwarding vrf-Cust1
 ip address 192.168.101.1 255.255.255.255
!
interface FastEthernet0/0
 ip address 10.4.1.101 255.255.255.0
 mpls ip
!
interface FastEthernet1/0
 ip vrf forwarding vrf-Cust1
 ip address 10.73.12.1 255.255.255.0
!
router ospf 11 vrf vrf-Cust1
 redistribute bgp 65530 subnets
 network 10.73.12.0 0.0.0.255 area 0
 network 192.168.101.1 0.0.0.0 area 0
!
router ospf 1
 network 10.0.4.1 0.0.0.0 area 0
 network 10.4.1.0 0.0.0.255 area 0
!
router bgp 65530
 no bgp default ipv4-unicast
 bgp log-neighbor-changes
 neighbor 10.0.2.1 remote-as 65530
 neighbor 10.0.2.1 update-source Loopback0
 neighbor 10.0.2.2 remote-as 65530
 neighbor 10.0.2.2 update-source Loopback0
 !
 address-family vpnv4
 neighbor 10.0.2.1 activate
 neighbor 10.0.2.1 send-community extended
 neighbor 10.0.2.2 activate
 neighbor 10.0.2.2 send-community extended
 exit-address-family
 !
 address-family ipv4 vrf vrf-Cust1
 redistribute connected
 redistribute static
 redistribute ospf 11 vrf vrf-Cust1
 no synchronization
 exit-address-family
!
```

PE routers – Juniper (PE-J1):

```
system {
    host-name PE-J1;
}
interfaces {
    em0 {
        unit 0 {
            family inet {
                address 10.5.1.31/24;
            }
```

```
            family mpls;
        }
    }
    em1 {
        unit 0 {
            family inet {
                address 10.141.7.1/30;
            }
        }
    }
    em3 {
        vlan-tagging;
        unit 11 {
            vlan-id 11;
            family inet {
                address 10.90.11.1/24;
            }
        }
        unit 12 {
            vlan-id 12;
            family inet {
                address 10.90.12.1/24;
            }
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 10.0.5.1/32;
            }
        }
    }
}
routing-options {
    route-distinguisher-id 10.0.5.1;
    autonomous-system 65530;
}
protocols {
    mpls {
        traffic-engineering mpls-forwarding;
        interface em0.0;
    }
    bgp {
        group vpn {
            type internal;
            local-address 10.0.5.1;
            family inet-vpn {
                unicast;
            }
            neighbor 10.0.2.1;
            neighbor 10.0.2.2;
        }
    }
    ospf {
        traffic-engineering;
```

```
        area 0.0.0.0 {
            interface em0.0;
            interface lo0.0 {
                passive;
            }
        }
    }
    ldp {
        interface em0.0;
    }
}
routing-instances {
    vrf-Cust1 {
        instance-type vrf;
        interface em1.0;
        interface em3.11;
        interface em3.12;
        route-distinguisher 0.0.41.10:1;   ### as per PE-C1
        vrf-target target:10.41.0.0:1;
        vrf-table-label;
        routing-options {
            static {
                route 192.168.91.0/24 next-hop 10.90.12.91;
            }
        }
        protocols {
            bgp {
                group Cust1R4 {
                    neighbor 10.141.7.2 {
                        family inet {
                            unicast;
                        }
                        peer-as 65533;
                    }
                }
            }
        }
    }
}
```

CE routers – (OSPF as PE-CE)(Cust1R3):

```
hostname Cust1R3
!
ip cef
!
interface Loopback0
 ip address 192.168.0.3 255.255.255.255
!
interface FastEthernet0/0
 ip address 10.73.12.133 255.255.255.0
!
router ospf 1
 network 10.73.12.0 0.0.0.255 area 0
 network 192.168.0.3 0.0.0.0 area 0
```

```
!
```

CE routers – (BGP as PE-CE)(Cust1R4):

```
!
hostname Cust1R4
!
ip cef
!
interface Loopback0
 ip address 192.168.0.4 255.255.255.255
!
interface Loopback1
 ip address 10.141.41.1 255.255.255.255
!
interface FastEthernet0/0
 ip address 10.141.7.2 255.255.255.252
!
router bgp 65533
 no synchronization
 bgp log-neighbor-changes
 network 10.141.41.0 mask 255.255.255.0
 network 192.168.0.4 mask 255.255.255.255
 neighbor 10.141.7.1 remote-as 65530
 no auto-summary
!
ip route 10.141.41.0 255.255.255.0 Null0
!
```

Some command output:

(MPLS LDP test)

```
PE-C1#traceroute 10.0.2.1

Type escape sequence to abort.
Tracing the route to 10.0.2.1

  1 10.4.1.4 [MPLS: Label 29 Exp 0] 8 msec 4 msec 12 msec
  2 10.1.14.1 [MPLS: Label 29 Exp 0] 12 msec 12 msec 8 msec
  3 10.1.12.2 [MPLS: Label 29 Exp 0] 12 msec 12 msec 12 msec
  4 10.0.2.1 8 msec 4 msec 8 msec


root@PE-J1> traceroute 10.0.2.1
traceroute to 10.0.2.1 (10.0.2.1), 30 hops max, 40 byte packets
 1  10.5.1.4 (10.5.1.4)  5.713 ms  1.643 ms  1.716 ms
     MPLS Label=30 CoS=0 TTL=1 S=1
 2  10.1.34.3 (10.1.34.3)  2.631 ms  1.962 ms  2.306 ms
     MPLS Label=29 CoS=0 TTL=1 S=1
 3  10.1.23.2 (10.1.23.2)  1.683 ms  2.075 ms  1.686 ms
     MPLS Label=30 CoS=0 TTL=1 S=1
 4  10.0.2.1 (10.0.2.1)  2.840 ms  2.680 ms  2.035 ms


[admin@P3] > /mpls ldp neighbor print
Flags: X - disabled, D - dynamic, O - operational, T - sending-targeted-hello,
V - vpls
```

```
 #      TRANSPORT       LOCAL-TRANSPORT PEER                        SEN
 0 DO   10.0.1.4        10.0.1.3        10.0.1.4:0                  no
 1 DO   10.0.1.1        10.0.1.3        10.0.1.1:0                  no
 2 DO   10.0.1.2        10.0.1.3        10.0.1.2:0                  no
 3 DO   10.0.2.2        10.0.1.3        10.0.2.2:0                  no
 4 DO   10.0.3.3        10.0.1.3        10.0.3.3:0                  no


[admin@P3] > /mpls forwarding-table print
Flags: L - ldp, V - vpls, T - traffic-eng
 #   IN-LABEL      OUT-LABELS  DESTINATION                    I NEXTHOP
 0   expl-null
 1 L 16                        10.3.2.0/24                    e 10.1.23.2
 2 L 17                        192.168.222.0/30               e 10.1.13.1
 3 L 18                        10.0.1.2/32                    e 10.1.23.2
 4 L 19                        10.0.1.1/32                    e 10.1.13.1
 5 L 20                        10.2.1.0/24                    e 10.1.13.1
 6 L 21                        10.1.12.0/24                   e 10.1.23.2
 7 L 22                        10.1.14.0/24                   e 10.1.13.1
 8 L 23                        10.2.2.0/24                    e 10.1.23.2
 9 L 24                        10.0.1.4/32                    e 10.1.34.4
10 L 25                        10.4.1.0/24                    e 10.1.34.4
11 L 26                        10.5.1.0/24                    e 10.1.34.4
12 L 27                        10.0.2.2/32                    e 10.3.3.2
13 L 28            28          10.0.3.1/32                    e 10.1.13.1
14 L 29            30          10.0.2.1/32                    e 10.1.23.2
15 L 30            31          10.0.3.2/32                    e 10.1.23.2
16 L 31                        10.0.3.3/32                    e 10.2.3.2
17 L 32            33          10.0.5.1/32                    e 10.1.34.4
18 L 33            34          10.0.4.1/32                    e 10.1.34.4


root@PE-J1> show ldp route
Destination          Next-hop intf/lsp               Next-hop address
 10.0.1.1/32         em0.0                           10.5.1.4
 10.0.1.2/32         em0.0                           10.5.1.4
 10.0.1.3/32         em0.0                           10.5.1.4
 10.0.1.4/32         em0.0                           10.5.1.4
 10.0.2.1/32         em0.0                           10.5.1.4
 10.0.2.2/32         em0.0                           10.5.1.4
 10.0.4.1/32         em0.0                           10.5.1.4
 10.0.5.1/32         lo0.0
 10.1.12.0/24        em0.0                           10.5.1.4
 10.1.13.0/24        em0.0                           10.5.1.4
 10.1.14.0/24        em0.0                           10.5.1.4
 10.1.23.0/24        em0.0                           10.5.1.4
 10.1.34.0/24        em0.0                           10.5.1.4
 10.2.1.0/24         em0.0                           10.5.1.4
 10.2.2.0/24         em0.0                           10.5.1.4
 10.2.3.0/24         em0.0                           10.5.1.4
 10.3.2.0/24         em0.0                           10.5.1.4
 10.3.3.0/24         em0.0                           10.5.1.4
 10.4.1.0/24         em0.0                           10.5.1.4
 10.5.1.0/24         em0.0
 10.5.1.31/32
 192.168.222.0/30    em0.0                           10.5.1.4
 224.0.0.5/32


root@PE-J1> show route table inet.0

inet.0: 23 destinations, 42 routes (23 active, 0 holddown, 0 hidden)
@ = Routing Use Only, # = Forwarding Use Only
+ = Active Route, - = Last Active, * = Both

10.0.1.1/32         @[OSPF/10] 00:21:43, metric 21
```

```
                    > to 10.5.1.4 via em0.0
                   #[LDP/9] 00:21:43, metric 1
                    > to 10.5.1.4 via em0.0, Push 23
10.0.1.2/32        @[OSPF/10] 00:21:43, metric 31
                    > to 10.5.1.4 via em0.0
                   #[LDP/9] 00:21:43, metric 1
                    > to 10.5.1.4 via em0.0, Push 21
10.0.1.3/32        @[OSPF/10] 00:21:43, metric 21
                    > to 10.5.1.4 via em0.0
                   #[LDP/9] 00:21:43, metric 1
                    > to 10.5.1.4 via em0.0, Push 22
10.0.1.4/32        @[OSPF/10] 00:21:43, metric 11
                    > to 10.5.1.4 via em0.0
                   #[LDP/9] 00:21:43, metric 1
                    > to 10.5.1.4 via em0.0
10.0.2.1/32        @[OSPF/10] 00:21:43, metric 41
                    > to 10.5.1.4 via em0.0
                   #[LDP/9] 00:21:43, metric 1
                    > to 10.5.1.4 via em0.0, Push 30
10.0.2.2/32        @[OSPF/10] 00:21:43, metric 31
                    > to 10.5.1.4 via em0.0
                   #[LDP/9] 00:21:43, metric 1
                    > to 10.5.1.4 via em0.0, Push 28
10.0.4.1/32        @[OSPF/10] 00:21:43, metric 12
                    > to 10.5.1.4 via em0.0
                   #[LDP/9] 00:21:43, metric 1
                    > to 10.5.1.4 via em0.0, Push 34
10.0.5.1/32        *[Direct/0] 00:22:08
                    > via lo0.0
10.1.12.0/24       @[OSPF/10] 00:21:43, metric 21
                    > to 10.5.1.4 via em0.0
                   #[LDP/9] 00:21:43, metric 1
                    > to 10.5.1.4 via em0.0, Push 24
10.1.13.0/24       @[OSPF/10] 00:21:43, metric 21
                    > to 10.5.1.4 via em0.0
                   #[LDP/9] 00:21:43, metric 1
                    > to 10.5.1.4 via em0.0, Push 18
10.1.14.0/24       @[OSPF/10] 00:21:43, metric 11
                    > to 10.5.1.4 via em0.0
                   #[LDP/9] 00:21:43, metric 1
                    > to 10.5.1.4 via em0.0
10.1.23.0/24       @[OSPF/10] 00:21:43, metric 21
                    > to 10.5.1.4 via em0.0
                   #[LDP/9] 00:21:43, metric 1
                    > to 10.5.1.4 via em0.0, Push 17
10.1.34.0/24       @[OSPF/10] 00:21:43, metric 11
                    > to 10.5.1.4 via em0.0
                   #[LDP/9] 00:21:43, metric 1
                    > to 10.5.1.4 via em0.0
10.2.1.0/24        @[OSPF/10] 00:21:43, metric 21
                    > to 10.5.1.4 via em0.0
                   #[LDP/9] 00:21:43, metric 1
                    > to 10.5.1.4 via em0.0, Push 19
10.2.2.0/24        @[OSPF/10] 00:21:43, metric 31
                    > to 10.5.1.4 via em0.0
                   #[LDP/9] 00:21:43, metric 1
                    > to 10.5.1.4 via em0.0, Push 27
10.2.3.0/24        @[OSPF/10] 00:21:43, metric 21
                    > to 10.5.1.4 via em0.0
                   #[LDP/9] 00:21:43, metric 1
                    > to 10.5.1.4 via em0.0, Push 25
10.3.2.0/24        @[OSPF/10] 00:21:43, metric 31
                    > to 10.5.1.4 via em0.0
                   #[LDP/9] 00:21:43, metric 1
                    > to 10.5.1.4 via em0.0, Push 16
10.3.3.0/24        @[OSPF/10] 00:21:43, metric 21
```

```
                     > to 10.5.1.4 via em0.0
                    #[LDP/9] 00:21:43, metric 1
                     > to 10.5.1.4 via em0.0, Push 26
10.4.1.0/24         @[OSPF/10] 00:21:43, metric 11
                     > to 10.5.1.4 via em0.0
                    #[LDP/9] 00:21:43, metric 1
                     > to 10.5.1.4 via em0.0
10.5.1.0/24         *[Direct/0] 00:22:08
                     > via em0.0
10.5.1.31/32        *[Local/0] 00:22:08
                       Local via em0.0
192.168.222.0/30    @[OSPF/10] 00:21:43, metric 21
                     > to 10.5.1.4 via em0.0
                    #[LDP/9] 00:21:43, metric 1
                     > to 10.5.1.4 via em0.0, Push 20
224.0.0.5/32        *[OSPF/10] 00:22:22, metric 1
                       MultiRecv
```

(MPLS VPNv4 test)

```
[admin@RR2] > /routing bgp vpnv4-route print
Flags: L - label-present
 #   ROUTE-DISTINGUISHER  DST-ADDRESS        GATEWAY     IN-LABEL  OUT-LABEL
 0 L 10.41.0.0:1          10.41.2.0/30       10.0.3.2       16         16
 1 L 10.41.0.0:1          10.90.11.0/24      10.0.5.1       16         16
 2 L 10.41.0.0:1          10.90.12.0/24      10.0.5.1       16         16
 3 L 10.41.0.0:1          10.141.7.0/30      10.0.5.1       16         16
 4 L 10.41.0.0:1          192.168.91.0/24    10.0.5.1       16         16
 5 L 10.41.0.0:1          10.41.1.0/30       10.0.3.1       16         16
 6 L 10.42.0.0:2          10.42.1.0/30       10.0.3.1       17         17
 7 L 10.41.0.0:1          10.41.2.0/30       10.0.3.2       16         16
 8 L 10.42.0.0:2          10.42.3.0/30       10.0.3.3       16         16
 9 L 10.41.0.0:1          10.73.12.0/24      10.0.4.1       38         38
10 L 10.41.0.0:1          192.168.101.1/32   10.0.4.1       39         39
11 L 10.41.0.0:1          10.90.11.0/24      10.0.5.1       16         16
12 L 10.41.0.0:1          10.90.12.0/24      10.0.5.1       16         16
13 L 10.41.0.0:1          10.141.7.0/30      10.0.5.1       16         16
14 L 10.41.0.0:1          192.168.91.0/24    10.0.5.1       16         16
[......-cut-......]
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Cust1R3#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

O E2 192.168.91.0/24 [110/1] via 10.73.12.1, 00:02:00, FastEthernet0/0
     10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
O E2    10.41.2.0/30 [110/1] via 10.73.12.1, 00:02:00, FastEthernet0/0
O E2    10.41.1.0/30 [110/1] via 10.73.12.1, 00:02:00, FastEthernet0/0
C       10.73.12.0/24 is directly connected, FastEthernet0/0
O E2    10.90.11.0/24 [110/1] via 10.73.12.1, 00:02:00, FastEthernet0/0
O E2    10.90.12.0/24 [110/1] via 10.73.12.1, 00:02:00, FastEthernet0/0
O E2    10.141.7.0/30 [110/1] via 10.73.12.1, 00:02:01, FastEthernet0/0
O E2    10.141.41.0/24 [110/1] via 10.73.12.1, 00:01:27, FastEthernet0/0
     192.168.0.0/32 is subnetted, 4 subnets
O E2    192.168.0.1 [110/12] via 10.73.12.1, 00:01:57, FastEthernet0/0
O E2    192.168.0.2 [110/12] via 10.73.12.1, 00:01:57, FastEthernet0/0
C       192.168.0.3 is directly connected, Loopback0
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O E2    192.168.0.4 [110/1] via 10.73.12.1, 00:01:28, FastEthernet0/0
     192.168.101.0/32 is subnetted, 1 subnets
O       192.168.101.1 [110/2] via 10.73.12.1, 00:02:03, FastEthernet0/0


Cust1R4#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

     10.0.0.0/8 is variably subnetted, 6 subnets, 3 masks
B       10.41.2.0/30 [20/0] via 10.141.7.1, 00:02:40
B       10.41.1.0/30 [20/0] via 10.141.7.1, 00:02:40
B       10.73.12.0/24 [20/0] via 10.141.7.1, 00:02:40
C       10.141.7.0/30 is directly connected, FastEthernet0/0
S       10.141.41.0/24 is directly connected, Null0
C       10.141.41.1/32 is directly connected, Loopback1
     192.168.0.0/32 is subnetted, 4 subnets
B       192.168.0.1 [20/0] via 10.141.7.1, 00:02:40
B       192.168.0.2 [20/0] via 10.141.7.1, 00:02:42
B       192.168.0.3 [20/0] via 10.141.7.1, 00:02:42
C       192.168.0.4 is directly connected, Loopback0
     192.168.101.0/32 is subnetted, 1 subnets
B       192.168.101.1 [20/0] via 10.141.7.1, 00:02:42


[admin@PE2] > /ip route print where routing-mark=vrf-Cust1
Flags: X - disabled, A - active, D - dynamic,
C - connect, S - static, r - rip, b - bgp, o - ospf, m - mme,
B - blackhole, U - unreachable, P - prohibit
 #      DST-ADDRESS        PREF-SRC        GATEWAY            DISTANCE
 0 ADb  10.41.1.0/30                       10.0.3.1                200
 1 ADC  10.41.2.0/30       10.41.2.1       e4                        0
 2 ADb  10.73.12.0/24                      10.0.4.1                200
 3 ADb  10.90.11.0/24                      10.0.5.1                200
 4 ADb  10.90.12.0/24                      10.0.5.1                200
 5 ADb  10.141.7.0/30                      10.0.5.1                200
 6 ADb  10.141.41.0/24                     10.0.5.1                200
 7 ADb  192.168.0.1/32                     10.0.3.1                200
 8 ADo  192.168.0.2/32                     10.41.2.2               110
 9 ADb  192.168.0.3/32                     10.0.4.1                200
10 ADb  192.168.0.4/32                     10.0.5.1                200
11 ADb  192.168.91.0/24                    10.0.5.1                200
12 ADb  192.168.101.1/32                   10.0.4.1                200


PE-C1#sh ip route vrf vrf-Cust1

Routing Table: vrf-Cust1
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

B    192.168.91.0/24 [200/0] via 10.0.5.1, 00:14:17
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     10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
B       10.41.2.0/30 [200/0] via 10.0.3.2, 00:14:17
B       10.41.1.0/30 [200/0] via 10.0.3.1, 00:14:17
C       10.73.12.0/24 is directly connected, FastEthernet1/0
B       10.90.11.0/24 [200/0] via 10.0.5.1, 00:14:17
B       10.90.12.0/24 [200/0] via 10.0.5.1, 00:14:17
B       10.141.7.0/30 [200/0] via 10.0.5.1, 00:14:17
B       10.141.41.0/24 [200/0] via 10.0.5.1, 00:04:17
     192.168.0.0/32 is subnetted, 4 subnets
B       192.168.0.1 [200/12] via 10.0.3.1, 00:05:17
B       192.168.0.2 [200/12] via 10.0.3.2, 00:05:18
O       192.168.0.3 [110/2] via 10.73.12.133, 00:05:18, FastEthernet1/0
B       192.168.0.4 [200/0] via 10.0.5.1, 00:04:18
     192.168.101.0/32 is subnetted, 1 subnets
C       192.168.101.1 is directly connected, Loopback101


PE-C1#show ip bgp vpnv4 all
BGP table version is 91, local router ID is 10.0.4.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 0.0.41.10:1 (default for vrf vrf-Cust1)
*>i10.41.1.0/30     10.0.3.1                 100      0 ?
* i                 10.0.3.1                 100      0 ?
* i10.41.2.0/30     10.0.3.2                 100      0 ?
*>i                 10.0.3.2                 100      0 ?
*> 10.73.12.0/24    0.0.0.0                  0         32768 ?
* i10.90.11.0/24    10.0.5.1                 100      0 i
*>i                 10.0.5.1                 100      0 i
* i10.90.12.0/24    10.0.5.1                 100      0 i
*>i                 10.0.5.1                 100      0 i
* i10.141.7.0/30    10.0.5.1                 100      0 i
*>i                 10.0.5.1                 100      0 i
*>i10.141.41.0/24   10.0.5.1                  0    100      0 65533 i
* i                 10.0.5.1                  0    100      0 65533 i
* i192.168.0.1/32   10.0.3.1                 12    100      0 i
*>i                 10.0.3.1                 12    100      0 i
* i192.168.0.2/32   10.0.3.2                 12    100      0 i
*>i                 10.0.3.2                 12    100      0 i
*> 192.168.0.3/32   10.73.12.133              2         32768 ?
*>i192.168.0.4/32   10.0.5.1                  0    100      0 65533 i
* i                 10.0.5.1                  0    100      0 65533 i
* i192.168.91.0     10.0.5.1                 100      0 i
*>i                 10.0.5.1                 100      0 i
*> 192.168.101.1/32 0.0.0.0                  0         32768 ?


root@PE-J1> show route table vrf-Cust1.inet.0

vrf-Cust1.inet.0: 16 destinations, 29 routes (16 active, 0 holddown, 6 hidden)
+ = Active Route, - = Last Active, * = Both

10.41.1.0/30       *[BGP/170] 00:16:53, localpref 100, from 10.0.2.2
                      AS path: ?
                    > to 10.5.1.4 via em0.0, Push 16, Push 29(top)
                    [BGP/170] 00:16:58, localpref 100, from 10.0.2.1
                      AS path: ?
                    > to 10.5.1.4 via em0.0, Push 16, Push 29(top)
10.41.2.0/30       *[BGP/170] 00:16:58, localpref 100, from 10.0.2.1
                      AS path: ?
                    > to 10.5.1.4 via em0.0, Push 16, Push 31(top)
                    [BGP/170] 00:16:53, localpref 100, from 10.0.2.2
                      AS path: ?
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                     > to 10.5.1.4 via em0.0, Push 16, Push 31(top)
10.73.12.0/24      *[BGP/170] 00:15:41, MED 0, localpref 100, from 10.0.2.2
                       AS path: ?
                     > to 10.5.1.4 via em0.0, Push 38, Push 34(top)
                     [BGP/170] 00:15:40, MED 0, localpref 100, from 10.0.2.1
                       AS path: ?
                     > to 10.5.1.4 via em0.0, Push 38, Push 34(top)
10.90.11.0/24      *[Direct/0] 00:17:21
                     > via em3.11
10.90.11.1/32      *[Local/0] 00:17:27
                       Local via em3.11
10.90.12.0/24      *[Direct/0] 00:17:21
                     > via em3.12
10.90.12.1/32      *[Local/0] 00:17:27
                       Local via em3.12
10.141.7.0/30      *[Direct/0] 00:17:27
                     > via em1.0
10.141.7.1/32      *[Local/0] 00:17:27
                       Local via em1.0
10.141.41.0/24     *[BGP/170] 00:06:36, MED 0, localpref 100
                       AS path: 65533 I
                     > to 10.141.7.2 via em1.0
192.168.0.1/32     *[BGP/170] 00:06:57, MED 12, localpref 100, from 10.0.2.2
                       AS path: I
                     > to 10.5.1.4 via em0.0, Push 40, Push 29(top)
                     [BGP/170] 00:06:59, MED 12, localpref 100, from 10.0.2.1
                       AS path: I
                     > to 10.5.1.4 via em0.0, Push 40, Push 29(top)
192.168.0.2/32     *[BGP/170] 00:06:59, MED 12, localpref 100, from 10.0.2.1
                       AS path: I
                     > to 10.5.1.4 via em0.0, Push 39, Push 31(top)
                     [BGP/170] 00:06:57, MED 12, localpref 100, from 10.0.2.2
                       AS path: I
                     > to 10.5.1.4 via em0.0, Push 39, Push 31(top)
192.168.0.3/32     *[BGP/170] 00:06:00, MED 2, localpref 100, from 10.0.2.1
                       AS path: ?
                     > to 10.5.1.4 via em0.0, Push 40, Push 34(top)
                     [BGP/170] 00:05:57, MED 2, localpref 100, from 10.0.2.2
                       AS path: ?
                     > to 10.5.1.4 via em0.0, Push 40, Push 34(top)
192.168.0.4/32     *[BGP/170] 00:06:36, MED 0, localpref 100
                       AS path: 65533 I
                     > to 10.141.7.2 via em1.0
192.168.91.0/24    *[Static/5] 00:17:21
                     > to 10.90.12.91 via em3.12
192.168.101.1/32   *[BGP/170] 00:15:41, MED 0, localpref 100, from 10.0.2.2
                       AS path: ?
                     > to 10.5.1.4 via em0.0, Push 39, Push 34(top)
                     [BGP/170] 00:15:40, MED 0, localpref 100, from 10.0.2.1
                       AS path: ?
                     > to 10.5.1.4 via em0.0, Push 39, Push 34(top)


Cust1R2>ping 192.168.0.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 72/368/1194 ms


Cust1R2>ping 192.168.0.3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 64/246/597 ms
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```
root@PE-J1> ping 192.168.0.3 routing-instance vrf-Cust1 count 2
PING 192.168.0.3 (192.168.0.3): 56 data bytes
64 bytes from 192.168.0.3: icmp_seq=0 ttl=254 time=25.027 ms
64 bytes from 192.168.0.3: icmp_seq=1 ttl=254 time=24.466 ms

--- 192.168.0.3 ping statistics ---
2 packets transmitted, 2 packets received, 0% packet loss
round-trip min/avg/max/stddev = 24.466/24.747/25.027/0.281 ms
```