

Configuring Seamless Integration of EVPN with L3VPN (MPLS SR)

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Information About Configuring Seamless Integration of EVPN with L3VPN (MPLS SR)

Data Center (DC) deployments have adopted VXLAN EVPN for its benefits such as EVPN control-plane learning, multi-tenancy, seamless mobility, redundancy, and easier horizontal scaling. Similarly, the Core network transitions to different technologies with their respective capabilities. MPLS with Label Distribution Protocol (LDP) and Layer-3 VPN (L3VPN) is present in many Core networks interconnecting Data Centers. With the technology evolution, a transformation from the traditional MPLS L3VPN with LDP-based underlay to MPLS-based Segment Routing (SR) with L3VPN became available. Segment Routing is adopted for its benefits such as:

- Unified IGP and MPLS control planes
- Simpler traffic engineering methods

With the Data Center (DC) established on VXLAN EVPN and the Core network requiring multi-tenant capable transport, there is a natural necessity for seamless integration. To provide this integration between different control-plane protocols and encapsulations—from VXLAN to an MPLS-based Core network—the Cisco Nexus 9000 Series Switch provides the Border Provider Edge (Border PE) capability by interfacing the Data Center and the Core routers (Provider Routers or Provider Edge-Routers).

Deployment Scenarios and Integration Details

There are multiple deployment scenarios for integrating VXLAN EVPN Data Center fabrics with MPLS-based Segment Routing (SR) Core networks. The following sections describe typical topologies and operational details.

In the following scenario, a single Data Center Fabric running VXLAN EVPN is depicted. The VRFs (VRF_A, VRF_B) present in the Data Center require to be extended over a WAN/Core running MPLS-based Segment Routing (MPLS-SR). The Data Center Fabric's Border switches act as Border Provider Edge (Border PE1, Border PE2) interconnecting VXLAN BGP EVPN with MPLS-SR with L3VPN (VPNv4/VPNv6). The BPEs are interconnected with the Provider Router (P-Router) via eBGP using the IPv4 Labeled-Unicast as well as the VPNv4/VPNv6 Address-Family (AF). The P-Router acts as BGP Route-Reflector for the mentioned AF and relays the necessary routes to the MPLS-SR Provider Edge (PE3, PE4) via iBGP. Beyond the usage of BGP as the control plane, the MPLS-SR nodes within the same Autonomous System (AS) use an IGP (OSPF or ISIS) for label distribution. From the PEs shown in the above figure (PE3, PE4), Inter-AS Option A can be used to extend the Data Center or Core network VRFs to another external network. Even though this diagram shows only one Data Center, the MPLS-SR network can interconnect multiple Data Center Fabrics.

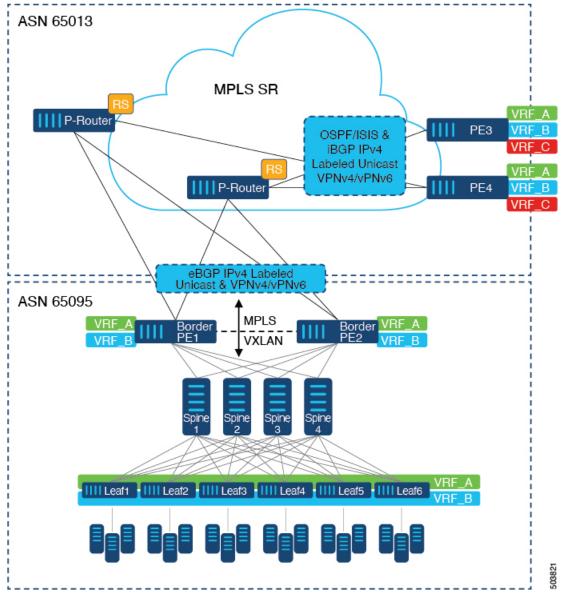


Figure 1: Topology with DC to Core Network Domain Separation

An alternative deployment scenario is when the Core network is separated into multiple Administrative Domains or Autonomous Systems (AS). In the above figure, a single Data Center Fabric running VXLAN EVPN is depicted. The VRFs (VRF_A, VRF_B) present in the Data Center require to be extended over a WAN/Core running MPLS-based Segment Routing (MPLS-SR). The Data Center Fabric's Border switches act as Border Provider Edge (Border PE1, Border PE2) interconnecting VXLAN BGP EVPN with MPLS-SR with L3VPN (VPNv4/VPNv6). The BPEs are interconnected with the Provider Router (P-Router) via eBGP using the IPv4 Labeled-Unicast as well as the VPNv4/VPNv6 Address-Family (AF). The P-Router acts as BGP Route Server for the mentioned AF and relays the necessary routes to the MPLS-SR Provider Edge (PE3, PE4) via eBGP; no other control-plane protocol is used between the MPLS-SR nodes. Similar to the previous scenario, the PEs (PE3, PE4) can operate with Inter-AS Option A to extend the Data Center or Core network VRFs to an external network. Even though this diagram shows only one Data Center, the MPLS-SR network can interconnect multiple Data Center Fabrics.

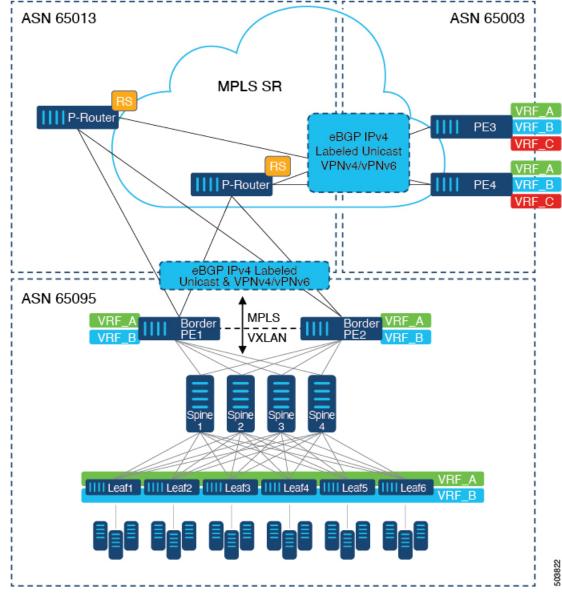


Figure 2: Multiple Administrative Domains within the Core Network

For additional information on MPLS SR, see the Cisco Nexus 9000 Series NX-OS Label Switching Configuration Guide.

Guidelines and Limitations for Configuring Seamless Integration of EVPN with L3VPN (MPLS SR)

Supported Features and Platforms

The following Cisco Nexus platform switches support seamless integration of EVPN with L3VPN (MPLS SR):

- 9336C-FX2 switches
- 93240YC-FX2 switches
- 9300-FX3 platform switches
- 9300-GX platform switches
- 9504 and 9508 platform switches with 96136YC-R and 9636C-RX line cards (The 9636C-R and 9636Q-R line cards are not supported.)

The following features are supported with seamless integration of EVPN with L3VPN (MPLS SR):

- Host Facing (Downlinks towards)
 - Individual Layer-3 interfaces (orphan ports)
 - Layer-3 Port-Channel
 - Layer-3 Sub-interfaces
 - Inter-AS Option A (often also called VRF-lite)
- Core Facing (Uplinks towards VXLAN)
 - Individual Layer-3 interfaces
 - Layer-3 Port-Channel
- Core Facing (Uplinks towards MPLS SR)
 - Individual Layer-3 interface
 - · Per-VRF labels
 - · VPN label statistics
- End-to-EndTime to Live (TTL) and Explicit Congestion Notification (ECN) with pipe-mode only.
- MPLS SegmentRouting and MPLS LDP cannot be configured at the same time on a Cisco Nexus 9504 and 9508 platform switches with Cisco Nexus 96136YC-R and Cisco Nexus 9636C-RX line cards.

Feature	Cisco Nexus 9300-FX2, FX3, GX, GX2 Platform Switches	Cisco Nexus 9504 and 9508 switches with -R Line Cards	Comments
VXLAN EVPN to SR-L3VPN	Yes	Yes	Extend Layer 3 connectivity between different DC pods Underlay IGP/BGP with SR extensions.
VXLAN EVPN to SR-L3VPN	Yes	Yes	Extend Layer 3 connectivity between DC POD running VXLAN and any domain (DC or CORE) running SR.

Feature	Cisco Nexus 9300-FX2, FX3, GX, GX2 Platform Switches	Cisco Nexus 9504 and 9508 switches with -R Line Cards	Comments
VXLAN EVPN to MPLS L3VPN (LDP)	No	Yes	Underlay is LDP.

• Beginning with Cisco NX-OS Release 10.2(3)F, the seamless integration of EVPN with L3VPN (MPLS SR) is supported on Cisco Nexus 9300-GX2 platform switches.

Platform Limitations and Unsupported Features

The following features are not supported with seamless integration of EVPN with L3VPN (MPLS SR):

- Distributed Anycast Gateway or First-Hop Redundancy Protocol like HSRP, VRRP or GLBP.
- vPC for redundant Host or Network Service attachment.
- SVI/Sub-interfaces for Core facing uplinks (MPLS or VXLAN).
- SVI/Sub-interfaces with configured MAC addresses.
- MPLS Segment Routing and Border Gateway (BGW for VXLAN Multi-Site) cannot be configured at the same time.
- Layer-2 for stretched Subnet across the MPLS-SR domain
- No-drop for VXLAN/SR and SR/VXLAN handoff, for Cisco Nexus 9336C-FX2, 93240YC-FX2, and 9300-FX3 platform switches
- Statistics, for Cisco Nexus 9504 and 9508 platform switches with 96136YC-R and 9636C-RX line cards
- Priority flow control (PFC), for Cisco Nexus 9336C-FX2, 93240YC-FX2, 9300-FX3, and 9300-GX platform switches
- When using MPLS Segment Routing (SR) L2VPN, packets with an inner destination MAC address that begins with 4 or 6 are dropped. This is a platform limitation. Ensure inner destination MAC addresses do not start with 4 or 6 to avoid packet drops.

VXLAN-to-SR Handoff QoS Value Preservation

The VXLAN-to-SR handoff QoS value is preserved during handoff and propagated from VXLAN tunnel packets to SR-tunneled packets for Cisco Nexus 9336C-FX2, 93240YC-FX2, 9300-FX3, and 9300-GX platform switches.

 Beginning with Cisco NX-OS Release 10.2(3)F, the VXLAN-to-SR handoff QoS value is preserved during handoff and propagated from VXLAN tunnel packets to SR-tunneled packets on Cisco Nexus 9300-GX2 platform switches.

Feature-Specific Guidelines and Limitations

Configuring Seamless Integration of EVPN with L3VPN (MPLS SR)

The following procedure for Border Provider Edge (Border PE) imports and reoriginates the routes from the VXLAN domain to the MPLS domain and in the other direction.

Procedure

Step 1 configure terminal

Example:

switch# configure terminal

Enters global configuration mode.

Step 2 Enable platform features

a) feature-set mpls

Example:

```
switch(config)# feature-set mpls
```

Enables the MPLS feature set.

b) nv overlay evpn

Example:

```
switch(config) # nv overlay evpn
```

Enables VXLAN.

c) feature bgp

Example:

```
switch(config) # feature bgp
```

Enables BGP.

d) feature mpls 13vpn

Example:

```
switch(config)# feature mpls 13vpn
```

Enables Layer 3 VPN.

Note

Feature mpls 13vpn requires feature mpls segment-routing.

e) feature mpls segment-routing

Example:

```
switch(config) # feature mpls segment-routing
```

Enables Segment Routing.

f) feature interface-vlan

Example:

```
switch(config)# feature interface-vlan
```

Enables the interface VLAN.

g) feature vn-segment-vlan-based

Example:

```
switch(config)# feature vn-segment-vlan-based
```

Enables the VLAN-based VN segment.

h) feature nv overlay

Example:

```
switch(config)# feature nv overlay
```

Enables VXLAN.

Step 3 Configure BGP for MPLS domain

a) router bgp autonomous-system-number

Example:

```
switch(config)# router bgp 65095
```

Configures BGP. The value of autonomous-system-number is from 1 to 4294967295.

b) address-family ipv4 unicast

Example:

```
switch(config-router)# address-family ipv4 unicast
```

Configures the address family for IPv4.

c) network address

Example:

```
switch(config-router-af)# network 10.51.0.51/32
```

Injects prefixes into BGP for the MPLS-SR domain.

Note

All viable next-hops for MPLS-SR tunnel deposition on the Border PE must be advertised via the network statement (/32 only).

d) allocate-label all

Example:

```
switch(config-router-af)# allocate-label all
```

Configures label allocation for every prefix injected via the network statement.

e) exit

Example:

```
switch(config-router-af)# exit
```

Exits command mode.

Step 4 Configure iBGP neighbor (Route Reflector)

a) neighbor address remote-as number

Example:

```
switch(config-router)# neighbor 10.95.0.95 remote-as 65095
```

Defines the iBGP neighbor IPv4 address and remote Autonomous-System (AS) number towards the Route-Reflector.

b) update-source type/id

Example:

```
switch(config-router)# update-source loopback0
```

Defines the interface for eBGP peering.

c) address-family l2vpn evpn

Example:

```
switch (config-router) # address-family 12vpn evpn
```

Configures the L2VPN EVPN address family.

d) send-community both

Example:

```
switch(config-router-af)# send-community both
```

Configures the community for BGP neighbors.

e) import vpn unicast reoriginate

Example:

```
switch(config-router-af)# import vpn unicast reoriginate
```

Reoriginates the route with a new Route-Target. It can be extended to use an optional route-map.

f) exit

Example:

```
switch(config-router-af)# exit
```

Exits command mode.

Step 5 Configure eBGP neighbor (P-Router)

a) neighbor address remote-as number

Example:

```
switch(config-router)# neighbor 10.51.131.131 remote-as 65013
```

Defines the eBGP neighbor IPv4 address and remote Autonomous-System (AS) number towards the P-Router.

b) **update-source** *type/id*

Example:

```
switch(config-router)# update-source Ethernet1/1
```

Defines the interface for eBGP peering.

c) address-family ipv4 labeled-unicast

Example:

```
switch(config-router) # address-family ipv4 labeled-unicast
```

Configures the address family for IPv4 labeled-unicast.

d) send-community both

Example:

```
switch(config-router-af)# send-community both
```

Configures the community for BGP neighbors.

e) exit

Example:

```
switch(config-router-af)# exit
```

Exits command mode.

Step 6 Configure eBGP neighbor (remote AS)

a) neighbor address remote-as number

Example:

```
switch(config-router)# neighbor 10.131.0.131 remote-as 65013
```

Defines the eBGP neighbor IPv4 address and remote Autonomous-System (AS) number.

b) **update-source** *type/id*

Example:

```
switch(config-router)# update-source loopback0
```

Defines the interface for eBGP peering.

c) **ebgp-multihop** *number*

Example:

```
switch(config-router)# ebgp-multihop 5
```

Specifies multihop TTL for the remote peer. The range of *number* is from 2 to 255.

d) address-family vpnv4 unicast

Example:

```
switch(config-router)# address-family vpnv4 unicast
```

Configures the address family for VPNv4 or VPNv6.

e) send-community both

Example:

```
switch(config-router-af)# send-community both
```

Configures the community for BGP neighbors.

f) import l2vpn evpn reoriginate

Example:

```
switch(config-router-af)# import 12vpn evpn reoriginate
```

Reoriginates the route with a new Route-Target. It can be extended to use an optional route-map.

g) exit

Example:

switch(config-router-af)# exit

Exits command mode.

Example Configuration for Configuring Seamless Integration of EVPN with L3VPN (MPLS SR)

This reference provides sample CLI configurations for scenarios involving route import and reorigination between VXLAN and MPLS domains, including both DC-to-Core and Core network domain separation topologies.

Scenario 1: DC to Core Network Domain Separation and IGP within MPLS-SR network

Scenario - 1 with DC to Core Network Domain Separation and IGP within MPLS-SR network.

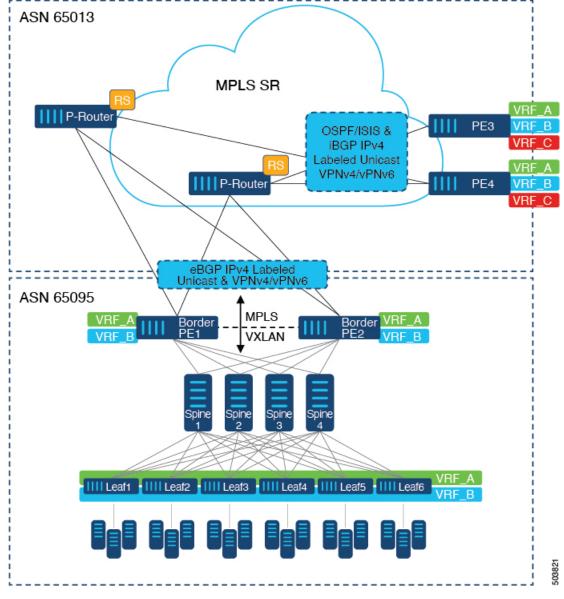


Figure 3: Topology with DC to Core Network Domain Separation

The following is a sample CLI configuration that is required to import and reoriginate the routes from the VXLAN domain to the MPLS domain and in the reverse direction. The sample CLI configuration represents only the necessary configuration for the respective roles.

Border PE

```
hostname BL51-N9336FX2
install feature-set mpls
feature-set mpls
feature bgp
feature mpls 13vpn
feature mpls segment-routing
```

```
feature ospf
feature interface-vlan
feature vn-segment-vlan-based
feature nv overlay
nv overlay evpn
mpls label range 16000 23999 static 6000 8000
segment-routing
 mpls
   connected-prefix-sid-map
      address-family ipv4
        10.51.0.51/32 index 51
vlan 2000
  vn-segment 50000
vrf context VRF A
 vni 50000
  rd auto
  address-family ipv4 unicast
    route-target both auto
   route-target both auto evpn
   route-target import 50000:50000
   route-target export 50000:50000
  address-family ipv6 unicast
   route-target both auto
    route-target both auto evpn
   route-target import 50000:50000
   route-target export 50000:50000
interface Vlan2000
  no shutdown
 vrf member VRF A
 no ip redirects
 ip forward
 ipv6 address use-link-local-only
  no ipv6 redirects
interface nve1
  no shutdown
  host-reachability protocol bgp
  source-interface loopback1
  member vni 50000 associate-vrf
interface Ethernet1/1
  description TO P-ROUTER
  ip address 10.51.131.51/24
  mpls ip forwarding
 no shutdown
interface Ethernet1/36
  description TO SPINE
  ip address 10.95.51.51/24
  ip router ospf 10 area 0.0.0.0
 no shutdown
interface loopback0
  description ROUTER-ID & SR-LOOPBACK
  ip address 10.51.0.51/32
  ip router ospf UNDERLAY area 0.0.0.0
interface loopback1
```

```
description NVE-LOOPBACK
  ip address 10.51.1.51/32
  ip router ospf UNDERLAY area 0.0.0.0
router ospf UNDERLAY
  router-id 10.51.0.51
router bgp 65095
  address-family ipv4 unicast
   network 10.51.0.51/32
   allocate-label all
  neighbor 10.95.0.95
   remote-as 65095
   update-source loopback0
   address-family 12vpn evpn
      send-community
      send-community extended
      import vpn unicast reoriginate
  neighbor 10.51.131.131
   remote-as 65013
    update-source Ethernet1/1
   address-family ipv4 labeled-unicast
     send-community
      send-community extended
  neighbor 10.131.0.131
   remote-as 65013
   update-source loopback0
   ebgp-multihop 5
   address-family vpnv4 unicast
     send-community
      send-community extended
     import 12vpn evpn reoriginate
    address-family vpnv6 unicast
      send-community
      send-community extended
      import 12vpn evpn reoriginate
  vrf VRF A
    address-family ipv4 unicast
      redistribute direct route-map fabric-rmap-redist-subnet
P-Router
hostname P131-N9336FX2
install feature-set mpls
feature-set mpls
feature bgp
feature isis
feature mpls 13vpn
feature mpls segment-routing
mpls label range 16000 23999 static 6000 8000
segment-routing
 mpls
    connected-prefix-sid-map
      address-family ipv4
        10.131.0.131/32 index 131
```

```
route-map RM NH UNCH permit 10
 set ip next-hop unchanged
interface Ethernet1/1
 description TO BORDER-PE
  ip address 10.51.131.131/24
 ip router isis 10
 mpls ip forwarding
 no shutdown
interface Ethernet1/11
 description TO PE
 ip address 10.52.131.131/24
 ip router isis 10
 mpls ip forwarding
 no shutdown
interface loopback0
 description ROUTER-ID & SR-LOOPBACK
 ip address 10.131.0.131/32
 ip router isis 10
router isis 10
 net 49.0000.0000.0131.00
 is-type level-2
 address-family ipv4 unicast
   segment-routing mpls
router bgp 65013
 event-history detail
  address-family ipv4 unicast
   allocate-label all
  neighbor 10.51.131.51
   remote-as 65095
   update-source Ethernet1/1
   address-family ipv4 labeled-unicast
     send-community
     send-community extended
 neighbor 10.51.0.51
   remote-as 65095
   update-source loopback0
   ebgp-multihop 5
   address-family vpnv4 unicast
     send-community
     send-community extended
     route-map RM NH UNCH out
   address-family vpnv6 unicast
     send-community
      send-community extended
     route-map RM NH UNCH out
!
 neighbor 10.52.131.52
   remote-as 65013
    update-source Ethernet1/11
   address-family ipv4 labeled-unicast
     send-community
     send-community extended
 neighbor 10.52.0.52
   remote-as 65013
   update-source loopback0
   address-family vpnv4 unicast
```

```
send-community
send-community extended
route-reflector-client
route-map RM_NH_UNCH out
address-family vpnv6 unicast
send-community
send-community extended
route-reflector-client
route-map RM NH UNCH out
```

Provider Edge (PE)

```
hostname L52-N93240FX2
install feature-set mpls
feature-set mpls
feature bgp
feature isis
feature mpls 13vpn
feature mpls segment-routing
mpls label range 16000 23999 static 6000 8000
segment-routing
 mpls
   connected-prefix-sid-map
      address-family ipv4
        10.52.0.52/32 index 52
vrf context VRF A
  rd auto
  address-family ipv4 unicast
   route-target import 50000:50000
   route-target export 50000:50000
  address-family ipv6 unicast
   route-target import 50000:50000
   route-target export 50000:50000
interface Ethernet1/49
  description TO P-ROUTER
  ip address 10.52.131.52/24
  ip router isis 10
 mpls ip forwarding
  no shutdown
interface loopback0
 description ROUTER-ID & SR-LOOPBACK
  ip address 10.52.0.52/32
  ip router isis 10
router isis 10
 net 49.0000.0000.0052.00
  is-type level-2
  address-family ipv4 unicast
   segment-routing mpls
router bgp 65013
  address-family ipv4 unicast
   network 10.52.0.52/32
    allocate-label all
  neighbor 10.52.131.131
   remote-as 65013
   update-source Ethernet1/49
```

```
address-family ipv4 labeled-unicast
     send-community
     send-community extended
!
 neighbor 10.131.0.131
   remote-as 65013
   update-source loopback0
   address-family vpnv4 unicast
     send-community
     send-community extended
   address-family vpnv6 unicast
     send-community
     send-community extended
  vrf VRF_A
   address-family ipv4 unicast
     redistribute direct route-map fabric-rmap-redist-subnet
```

Scenario 2: DC to Core and within Core Network Domain Separation (eBGP within MPLS-SR network)

Scenario - 2 with DC to Core and within Core Network Domain Separation (eBGP within MPLS-SR network).

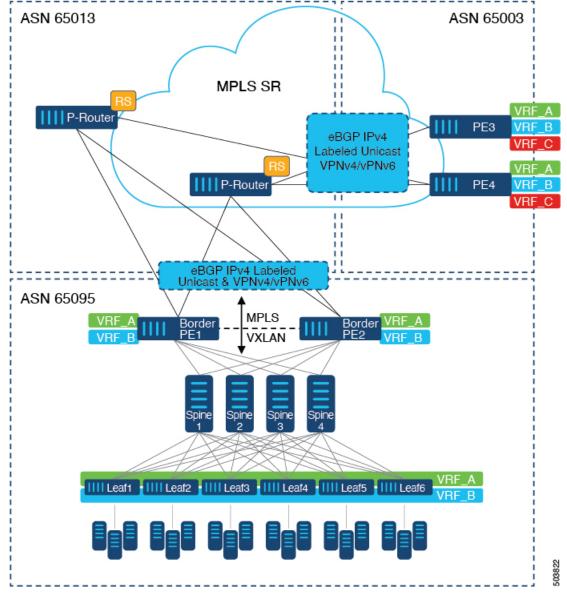


Figure 4: Multiple Administrative Domains within the Core network

The following is a sample CLI configuration that is required to import and reoriginate the routes from the VXLAN domain to the MPLS domain and in the reverse direction. The sample CLI configuration represents only the nodes that are different from Scenario #1, which are the P-Router and the Provider Edge (PE) roles. The Border PE remains the same for both scenarios.

P-Router

```
hostname P131-N9336FX2
install feature-set mpls
feature-set mpls
feature bgp
feature mpls 13vpn
feature mpls segment-routing
```

```
mpls label range 16000 23999 static 6000 8000
segment-routing
 mpls
   connected-prefix-sid-map
      address-family ipv4
        10.131.0.131/32 index 131
route-map RM_NH_UNCH permit 10
  set ip next-hop unchanged
interface Ethernet1/1
  description TO BORDER-PE
  ip address 10.51.131.131/24
 mpls ip forwarding
  no shutdown
interface Ethernet1/11
  description TO PE
  ip address 10.52.131.131/24
 mpls ip forwarding
  no shutdown
interface loopback0
  description ROUTER-ID & SR-LOOPBACK
  ip address 10.131.0.131/32
  ip router isis 10
router bgp 65013
  event-history detail
  address-family ipv4 unicast
   network 10.131.0.131/32
    allocate-label all
  address-family vpnv4 unicast
    retain route-target all
  address-family vpnv6 unicast
   retain route-target all
 neighbor 10.51.131.51
   remote-as 65095
   update-source Ethernet1/1
   address-family ipv4 labeled-unicast
      send-community
      send-community extended
  neighbor 10.51.0.51
   remote-as 65095
    update-source loopback0
    ebgp-multihop 5
   address-family vpnv4 unicast
      send-community
      send-community extended
      route-map RM NH UNCH out
    address-family vpnv6 unicast
      send-community
      send-community extended
      route-map RM NH UNCH out
  neighbor 10.52.131.52
    remote-as 65003
    update-source Ethernet1/11
    address-family ipv4 labeled-unicast
```

```
send-community
send-community extended

neighbor 10.52.0.52
remote-as 65003
update-source loopback0
ebgp-multihop 5
address-family vpnv4 unicast
send-community
send-community
send-community extended
route-map RM_NH_UNCH out
address-family vpnv6 unicast
send-community
send-community
send-community
```

Provider Edge (PE)

```
hostname L52-N93240FX2
install feature-set mpls
feature-set mpls
feature bgp
feature mpls 13vpn
feature mpls segment-routing
mpls label range 16000 23999 static 6000 8000
segment-routing
 mpls
   connected-prefix-sid-map
     address-family ipv4
        10.52.0.52/32 index 52
vrf context VRF A
 rd auto
  address-family ipv4 unicast
   route-target import 50000:50000
    route-target export 50000:50000
  address-family ipv6 unicast
   route-target import 50000:50000
   route-target export 50000:50000
interface Ethernet1/49
  description TO P-ROUTER
  ip address 10.52.131.52/24
 mpls ip forwarding
 no shutdown
interface loopback0
  description ROUTER-ID & SR-LOOPBACK
  ip address 10.52.0.52/32
  ip router isis 10
router bgp 65003
  address-family ipv4 unicast
   network 10.52.0.52/32
    allocate-label all
  neighbor 10.52.131.131
    remote-as 65013
    update-source Ethernet1/49
   address-family ipv4 labeled-unicast
      send-community
```

```
send-community extended

!

neighbor 10.131.0.131
  remote-as 65013
  update-source loopback0
  ebgp-multihop 5
  address-family vpnv4 unicast
    send-community
  send-community extended
  address-family vpnv6 unicast
    send-community
    send-community
    send-community
    send-community
    send-community
    redistribute direct route-map fabric-rmap-redist-subnet
```

Example Configuration for Configuring Seamless Integration of EVPN with L3VPN (MPLS SR)