



Configuring EVPN VXLAN External Connectivity

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Restrictions for EVPN VXLAN External Connectivity

- External connectivity with VPLS networks is supported only when bridging is the mode of interworking between the two domains. Integrated routing and bridging (IRB) is not supported between a BGP EVPN VXLAN fabric and a VPLS network.
- External Connectivity with Layer 3 networks is supported only for IPv4 and IPv6 unicast traffic.
- External connectivity with an MVPN network is not supported for multicast traffic.
- Import of EVPN IP routes, which includes both route type 5 and route type 2 host routes, to global routing table is not supported.
- not support the following features:
 - MPLS Layer 3 VPN Border Leaf Handoff
 - MPLS Layer 3 VPN Border Spine Handoff
 - VPLS over MPLS Border Leaf Handoff
 - VPLS over MPLS Border Spine Handoff
 - Interworking of Layer 3 TRM with MVPN Networks for IPv4 Traffic

Information About EVPN VXLAN External Connectivity

External connectivity allows the movement of Layer 2 and Layer 3 traffic between an EVPN VXLAN network and an external network. It also enables the EVPN VXLAN network to exchange routes with the externally connected network. Routes within an EVPN VXLAN network are already shared between all the VTEPs or leaf switches. External connectivity uses the VTEPs on the periphery of the network to pass on these routes to an external Layer 2 or Layer 3 network. Similarly, the EVPN VXLAN network imports the reachability

routes from the external network. External connectivity extends the Layer 2 or Layer 3 overlay network outside the VXLAN network. The process of extending a Layer 2 or Layer 3 network outside the EVPN VXLAN network is also known as handoff.

Implementation of Border Nodes for EVPN VXLAN External Connectivity

Border nodes or border VTEPs are the devices through which you establish a connection between an EVPN VXLAN network and an external network. The border nodes sit on the periphery of the EVPN VXLAN network and remain a part of the BGP EVPN VXLAN fabric. To enable external connectivity, you can implement the border nodes of an EVPN VXLAN network as either border leaf or border spine switches.

Connectivity Through a Border Leaf Switch

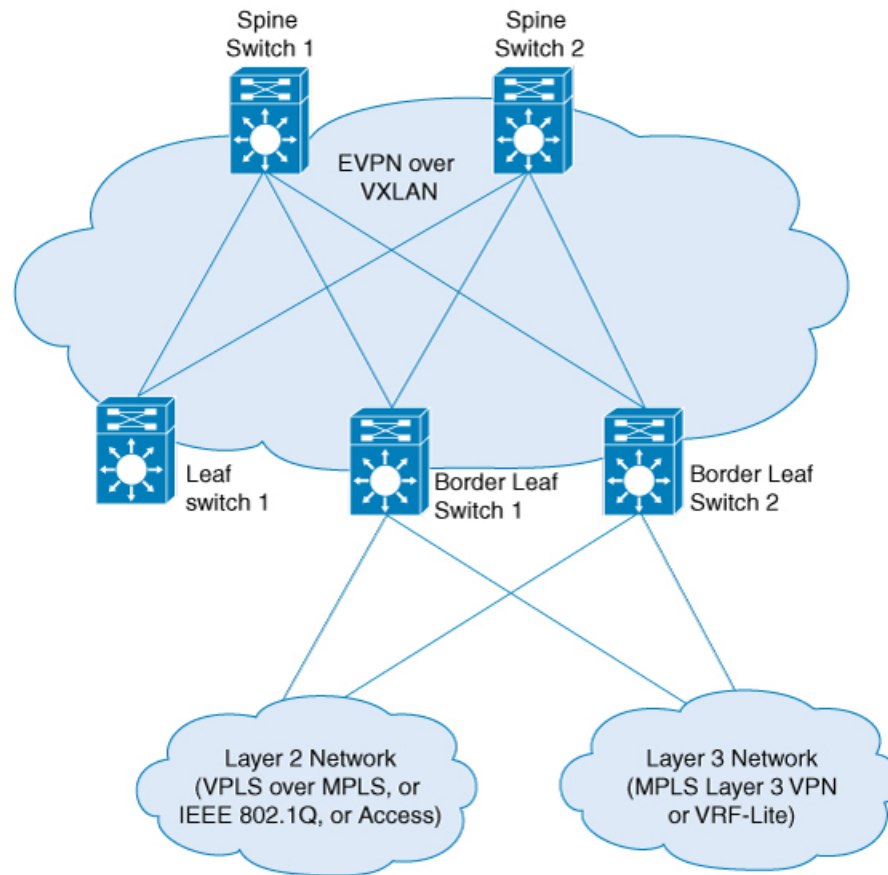
Leaf switches deployed as border nodes support the required control plane and data plane functionalities. Border leaf deployment ensures that the configuration on the spine switches is much simpler. Border leaf switches only allow communication between the external network and the VXLAN network, also known as north-south communication.



Note A border leaf switch can also be multiple switches functioning as a single logical system with Cisco StackWise Virtual configured.

The following figure shows border leaf external connectivity of an EVPN VXLAN network with external Layer 2 and Layer 3 networks:

Figure 1: EVPN VXLAN External Connectivity Through a Border Leaf Switch

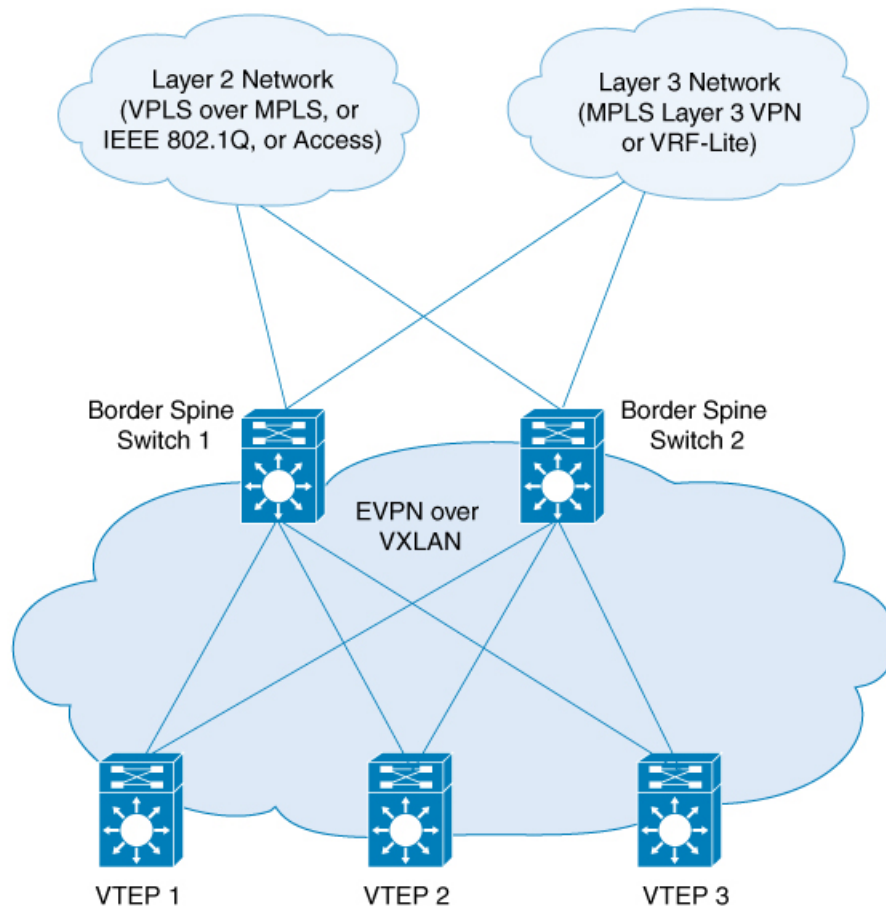


Connectivity Through a Border Spine Switch

Deploying spine switches as border nodes provides the advantage of optimizing the north-south communication with external resources. At the same time, border spine deployment allows the spine switches to support VXLAN control and data plane functionality. Border spine switches allow both north-south communication and east-west communication. East-west communication represents the communication within the nodes of the EVPN VXLAN network.

The following figure shows border spine external connectivity of an EVPN VXLAN network with external Layer 2 and Layer 3 networks.:

Figure 2: EVPN VXLAN External Connectivity Through a Border Spine Switch



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External Connectivity with Layer 3 Networks

Layer 3 external connectivity or handoff is established by connecting the border nodes of a BGP EVPN VXLAN fabric with an edge router from the external Layer 3 network. The border node acts as a VTEP to perform VXLAN encapsulation and decapsulation, but it also routes the traffic towards the edge routing device. The VXLAN-facing interface on the external Layer 3 network can be a switch virtual interface (SVI), or a Layer 3 interface, or a Layer 3 subinterface.

You can use Layer 3 external connectivity to achieve any of the following:

- Extend the logical isolation between VRFs or VLANs within the EVPN VXLAN network into the externally routed network. The external routed network can be a traditional non-VXLAN campus network, a datacenter, or a WAN.
- Provide shared access within the EVPN VXLAN network to a common external service such as the internet.

BGP EVPN VXLAN fabric supports Layer 3 external connectivity with VRF-Lite and MPLS Layer 3 VPN networks.

Layer 3 External Connectivity with VRF-Lite

Using VRF allows for the use of multiple routing tables that are independent and isolated. VRF-Lite is a mechanism to extend the tenant Layer 3 VRF information beyond the BGP EVPN VXLAN Fabric. External connectivity with VRF-Lite or VRF handoff involves a two-box approach where the border node and the edge router are physically independent devices. With VRF-Lite handoff, the BGP EVPN VXLAN fabric extends the connectivity for different tenants externally on a hop-by-hop basis.

Once the border node learns external routes from the edge router, it advertises the prefixes inside the BGP EVPN VXLAN fabric as EVPN type 5 routes. This information is distributed to all the other VTEPs in the network. The border node also advertises EVPN routes to the external edge router. It sends the EVPN routes learned from the Layer 2 VPN EVPN address family to the IPv4 or IPv6 unicast address family.

Layer 3 Multicast External Connectivity with MPLS Layer 3 VPN

Layer 3 external connectivity with an MPLS Layer 3 VPN network or MPLS handoff uses a single-box approach. The single-box approach combines the functionalities of an EVPN VXLAN border node and an MPLS PE router into a single physical device. The device is also known as a border PE node. The border PE node reoriginates IP prefixes from the EVPN address family of the BGP EVPN VXLAN fabric to the VPNv4 address family of the MPLS network. Likewise, the border PE node performs the corresponding function in the reverse direction. eBGP peering is necessary between the border PE node and the MPLS PE devices to ensure the connectivity.

MPLS handoff allows scalability for EVPN VXLAN networks that have a large number of tenants or VRFs. Scalability is not possible with VRF-Lite handoff.

In every VRF on a border VTEP, there are two sets of manually configured import and export route targets. The first set of import and export route targets is associated with the BGP neighbor in the BGP EVPN VXLAN fabric. This BGP neighbor uses the EVPN address family to exchange Layer 3 information. The second set of import and export route targets is associated with the BGP neighbor in the Layer 3 VPN network. This BGP neighbor uses either VPNv4 or VPNv6 unicast address families to exchange Layer 3 information. The separation of route targets allows you to configure both sets of route targets independently. In this way, a border VTEP in an EVPN VXLAN network effectively stitches the two sets of route targets. The route targets associated with the BGP neighbor in the Layer 3 VPN network are known as normal route targets. The route targets associated with the BGP neighbor in the BGP EVPN VXLAN fabric are known as stitching route targets.

External Connectivity with Layer 2 Networks

Layer 2 external connectivity or handoff for an EVPN VXLAN network extends the Layer 2 domain outside of the network. BGP EVPN VXLAN fabric supports Layer 2 external connectivity with IEEE 802.1Q, access, and VPLS over MPLS networks.

Layer 2 External connectivity with IEEE 802.1Q or Access Networks

Layer 2 handoff to IEEE 802.1Q networks is achieved through a regular IEEE 802.1Q Trunk port configuration on the Switchport interfaces on the border nodes. You can also connect EVPN VXLAN networks to external access networks.

The commonly deployed scenario has EVPN enabled at the distribution layer and has the access layer switches connected with IEEE 802.1Q Trunk encapsulation. The IEEE 802.1Q Layer 2 traffic that comes from the access layer switches is mapped to the corresponding VLAN. The border node then bridges the traffic towards the destination with VXLAN encapsulation. The inner packet does not carry the IEEE 802.1Q tag. Instead, the VXLAN network identifier (VNI), which is the Layer 2 VNI in the VXLAN header, represents the broadcast

domain. Similarly, the border nodes decapsulate the traffic from the BGP EVPN VXLAN fabric and bridge it with the corresponding IEEE 802.1Q tag to the access switches. The interface on the border VTEP that faces the external interface can be either an access or a Trunk port. The external interface can belong to either a Layer 2 switch or a firewall.



Note If you connect the network to an external Layer 2 switch through two border VTEPs, it represents a dual connection. In such cases, STP does not propagate over the BGP EVPN VXLAN fabric by default.

Layer 2 External connectivity with VPLS over MPLS Network

External connectivity with VPLS networks or VPLS handoff is achieved when a border VTEP or multiple border VTEPs establish a connection with the VPLS network. The border nodes act as the provider edge (PE) devices in the VPLS network and as VTEPs in the EVPN VXLAN network.

BGP EVPN VXLAN supports VPLS handoff in the form of VPLS stitching through either an access VFI or an access pseudowire on the VLAN on the border VTEP.

The access pseudowires and the pseudowires in the access VFI function as the access ports in the EVPN VXLAN network. The BGP EVPN VXLAN fabric treats the MAC addresses learned on the pseudowires as locally learned MAC addresses. It advertises these MAC addresses within the fabric as EVPN type 2 routes. The pseudowires are in a different split horizon group compared to the EVPN VXLAN network. Therefore, BUM traffic floods between both the EVPN VXLAN and VPLS networks.

Route Leaking between EVPN-enabled VRF and Global Routing Tables

The route leaking feature provides the import and export of routes between an EVPN-enabled Virtual Routing and Forwarding (VRF) Table and the Global Routing Table (GRT). By enabling the import or export of the EVPN learned routes into the GRT, the border node provides access to services such as DNS or DHCP to the hosts in the fabric. Routes that are imported from GRT to VRF can subsequently be imported to EVPN using the **import {ipv4|ipv6} unicast map allow-evpn** command. Routes that are imported from EVPN to IP VRF can subsequently be exported to GRT using the **export {ipv4|ipv6} unicast map allow-evpn** command.

You can further filter the imported routes using route-maps. A route-map contains the match conditions that define which of the routes from the import or export tables are allowed into the target routing table. This reduces the risk of unintended import or export of routes between the tables and helps contain the table sizes and advertisements.

How to Configure EVPN VXLAN External Connectivity

This section provides information about how to configure external connectivity between an EVPN VXLAN network and an external Layer 2 or Layer 3 network.

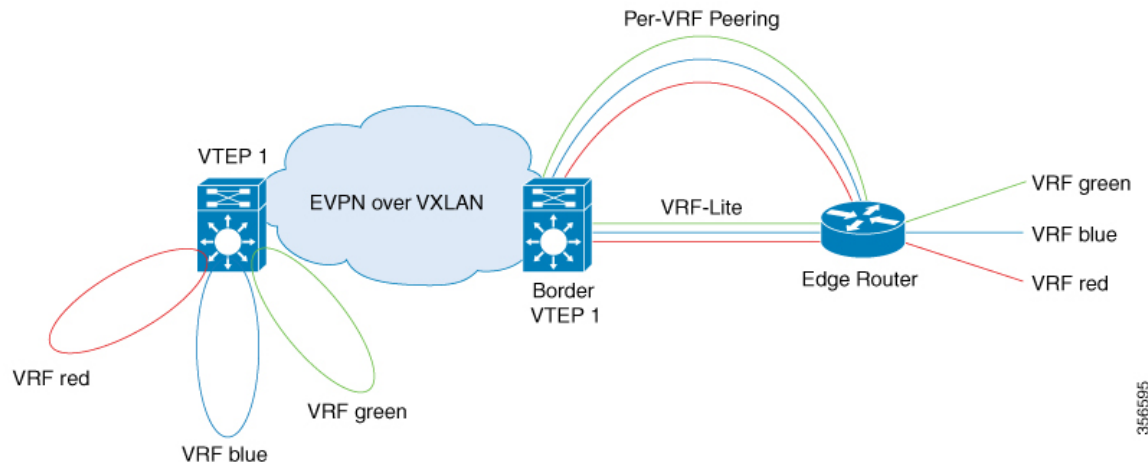


Note You must configure EVPN VXLAN Layer 2 and Layer 3 overlay networks before you configure external connectivity. See [Configuring EVPN VXLAN Integrated Routing and Bridging](#) for detailed steps.

Enabling Layer 3 External Connectivity with VRF-Lite

The following figure shows a sample topology that illustrates Layer 3 external connectivity with VRF-Lite:

Figure 3: Layer 3 External Connectivity with VRF-Lite



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To configure Layer 3 external connectivity with VRF-Lite, perform the following set of procedures:

- Configure the VRF on the border VTEP interface that faces the external router.
- Ensure that Layer 2 VPN EVPN is advertised as part of the BGP VRF configuration. See [Configuring BGP with EVPN and VRF Address Families on a VTEP](#) for detailed steps.



Note Redistribution of the respective interior gateway protocol (IGP) is required in the BGP VRF address family to distribute the external prefixes into the BGP EVPN VXLAN fabric.

For more information about VRF-Lite, see *Contents* → *IP Routing Configuration Guide* → *Configuring VRF-lite* in the software configuration guide for the applicable release.

Configuring the VRF on the Border VTEP Interface that Faces the External Router

To configure the VRF on the border VTEP interface that faces the external router, perform these steps:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. Enter your password, if prompted.

	Command or Action	Purpose
Step 2	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 3	interface <i>interface-id</i> Example: Device(config)# <code>interface GigabitEthernet1/0/30</code>	Enters the interface configuration mode for the specified interface.
Step 4	vrf forwarding <i>vrf-name</i> Example: Device(config-if)# <code>vrf forwarding green</code>	Associates the VRF with the interface. Note The interface must be associated with the same VRF for which the Layer 3 VNI has been configured for the EVPN VXLAN network.
Step 5	ip address <i>ip-address</i> Example: Device(config-if)# <code>ip address 192.168.3.203 255.255.255.0</code>	Configures the IP address for the interface.
Step 6	end Example: Device(config-if)# <code>end</code>	Returns to privileged EXEC mode.

Enabling Route Leaking between EVPN-enabled VRF and Global Routing Table

Route Leaking between an EVPN-enabled VRF and the Global Routing Table (GRT) is required to access shared services such as DNS or DHCP, which are reachable through the global routing table.

To configure route leaking on a leaf node, perform the following steps.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> <code>enable</code>	Enters privileged EXEC mode. Enter password, if prompted.
Step 2	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.

	Command or Action	Purpose
Step 3	vrf definition <i>vrf-name</i> Example: Device(config)# vrf definition green	Creates a VRF instance.
Step 4	address-family { ipv4 ipv6 } Example: Device(config-vrf)# address-family ipv4	Configures the IPv4 or IPv6 address family and enters the VRF address family configuration mode. <ul style="list-style-type: none"> • Use the ipv4 keyword to configure IPv4 address family. • Use the ipv6 keyword to configure IPv6 address family.
Step 5	import { ipv4 ipv6 } unicast map <i>import-route-map allow-evpn</i> Example: Device(config-vrf-af)# import ipv4 unicast map RM-GL-TO-EVPN allow-evpn	Specifies an import map to import IPv4 or IPv6 prefixes from the global routing table to a VRF table. Specify ipv4 or ipv6 , which you specified in Step 4. The map <i>import-route-map</i> keyword specifies the route-map that defines the prefixes to import. In the example, RM-GL-TO-EVPN is the name of the route-map that defines the conditions and the IPv4 prefixes to import.
Step 6	export { ipv4 ipv6 } unicast map <i>export-route-map allow-evpn</i> Example: Device(config-vrf-af)# export ipv4 unicast map RM-EVPN-TO-GL allow-evpn	Specifies a route map to export IPv4 or IPv6 prefixes to the global routing table. Specify ipv4 or ipv6 , which you specified in Step 4. The map <i>export-route-map</i> keyword specifies the route-map that defines the prefixes to export. In the example, RM-EVPN-TO-GL is the name of the route-map that defines the conditions and the IPv4 prefixes to export.
Step 7	exit-address-family Example: Device(config-vrf-af)# exit-address-family	Exits VRF address family configuration mode and returns to VRF configuration mode.

Example: Enable Route Leaking Between EVPN and Global Routing Table

The following snippet shows a sample configuration for route leaking on a Leaf VTEP.

```

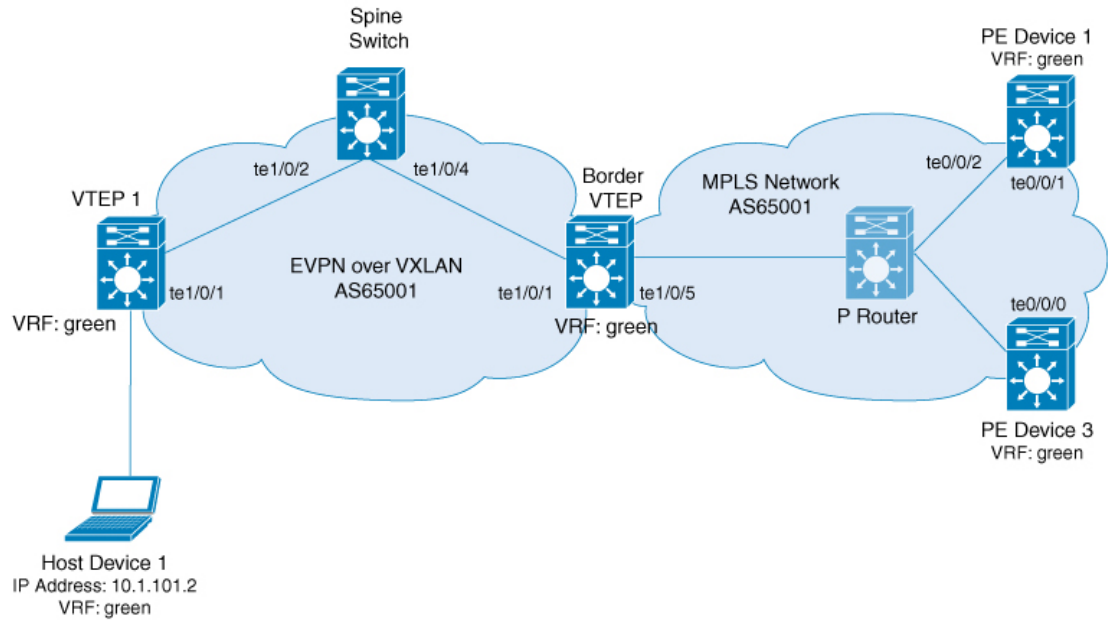
Leaf-01#
!
ip prefix-list EVPN-TO-GL seq 5 permit 10.1.101.0/24 le 32
ip prefix-list EVPN-TO-GL seq 10 permit 10.1.102.0/24 le 32
!
ip prefix-list GL-TO-EVPN seq 5 permit 192.168.255.0/24 le 32
!
route-map RM-GL-TO-EVPN permit 10
 match ip address prefix-list GL-TO-EVPN
!
route-map RM-EVPN-TO-GL permit 10
 match ip address prefix-list EVPN-TO-GL
!
vrf definition green
 description green VRF definition
 rd 1:1
!
 address-family ipv4
  import ipv4 unicast map RM-GL-TO-EVPN allow-evpn
  export ipv4 unicast map RM-EVPN-TO-GL allow-evpn
  route-target export 1:1
  route-target import 1:1
  route-target export 1:1 stitching
  route-target import 1:1 stitching
 exit-address-family
!
!
interface Loopback100
 ip address 192.168.255.1 255.255.255.255
 ip ospf 1 area 0
!
interface Vlan101
 vrf forwarding green
 ip address 10.1.101.1 255.255.255.0
!
interface Vlan102
 vrf forwarding green
 ip address 10.1.102.1 255.255.255.0
!

```

Enabling Layer 3 External Connectivity with MPLS Layer 3 VPN

The following figure shows a sample topology that illustrates Layer 3 external connectivity with an MPLS Layer 3 VPN network:

Figure 4: Layer 3 External Connectivity with MPLS Layer 3 VPN



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To enable EVPN VLAN Layer 3 external connectivity with MPLS Layer 3 VPN networks, perform the following set of procedures:

- Run the **mpls label mode all-vrfs protocol all-afs per-vrf** command in global configuration mode on the border VTEP.
- Configure BGP with reorigination of routes with a new route type for Layer 2 VPN, VPNv4, VPNv6 address families on the border VTEP.

Configuring BGP on a Border VTEP for External Connectivity with MPLS Layer 3 VPN

To configure BGP on a border VTEP to establish external connectivity with an MPLS Layer 3 VPN network, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. Enter your password, if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 3	router bgp <i>autonomous-system-number</i> Example: Device (config) # router bgp 1	Enables a BGP routing process, assigns it an autonomous system number, and enters router configuration mode.
Step 4	bgp log-neighbor-changes Example: Device (config-router) # bgp log-neighbor-changes	(Optional) Enables the generation of logging messages when the status of a BGP neighbor changes. For more information, see Configuring BGP section of the <i>IP Routing Configuration Guide</i> .
Step 5	bgp update-delay <i>time-period</i> Example: Device (config-router) # bgp update-delay 1	(Optional) Sets the maximum initial delay period before sending the first update. For more information, see Configuring BGP section of the <i>IP Routing Configuration Guide</i> .
Step 6	bgp graceful-restart Example: Device (config-router) # bgp graceful-restart	(Optional) Enables the BGP graceful restart capability for all BGP neighbors. For more information, see Configuring BGP section of the <i>IP Routing Configuration Guide</i> .
Step 7	no bgp default ipv4-unicast Example: Device (config-router) # no bgp default ipv4-unicast	(Optional) Disables default IPv4 unicast address family for BGP peering session establishment. For more information, see Configuring BGP section of the <i>IP Routing Configuration Guide</i> .
Step 8	neighbor <i>spine-ip-address</i> remote-as <i>number</i> Example: Device (config-router) # neighbor 172.16.255.1 remote-as 1	Defines multiprotocol-BGP neighbors in the EVPN network. Use the IP address of the spine switch as the neighbor IP address. This configures the spine switch as a BGP neighbor.
Step 9	neighbor <i>mpls-peer-ip-address</i> remote-as <i>number</i> Example: Device (config-router) # neighbor 172.16.255.103 remote-as 1	Defines multiprotocol-BGP neighbors in the external MPLS network. Use the IP address of the external MPLS network peer as the neighbor IP address. This configures the external MPLS network peer as a BGP neighbor.
Step 10	neighbor { <i>ip-address</i> <i>group-name</i> } update-source <i>interface</i> Example: Device (config-router) # neighbor 172.16.255.1 update-source Loopback0	Configures update source. Update source can be configured per neighbor or per peer-group. Use the IP address of the spine switch as the neighbor IP address.

	Command or Action	Purpose
Step 11	address-family l2vpn evpn Example: Device(config-router)# address-family l2vpn evpn	Specifies the L2VPN address family and enters address family configuration mode.
Step 12	import vpnv4 unicast re-originate Example: Device(config-router-af)# import vpnv4 unicast re-originate	Reoriginates the VPNv4 routes imported from the external peer into the EVPN address family as EVPN routes, and distributes within the EVPN fabric.
Step 13	import vpnv6 unicast re-originate Example: Device(config-router-af)# import vpnv6 unicast re-originate	Reoriginates the VPNv6 routes imported from the external peer into the EVPN address family as EVPN routes, and distributes within the EVPN fabric.
Step 14	neighbor ip-address activate Example: Device(config-router-af)# neighbor 10.11.11.11 activate	<p>Enables the exchange information from a BGP neighbor.</p> <p>Use the IP address of the spine switch as the neighbor IP address.</p>
Step 15	neighbor ip-address send-community [both extended standard] Example: Device(config-router-af)# neighbor 10.11.11.11 send-community both	<p>Specifies the communities attribute sent to a BGP neighbor.</p> <p>Use the IP address of the spine switch as the neighbor IP address.</p> <p>Note Use either of extended or both keywords. External connectivity cannot be established when you use the standard keyword.</p>
Step 16	neighbor {ip-address peer-group-name} next-hop-self [all] Example: Device(config-router-af)# neighbor ip-address next-hop-self all	<p>Configures the router as the next hop for a BGP-speaking neighbor or peer group.</p> <p>The all keyword is mandatory when implementing external connectivity through iBGP, where the EVPN fabric and the MPLS network are in the same BGP autonomous system number.</p> <p>The all keyword is optional when implementing external connectivity through eBGP, where the EVPN fabric and the MPLS network are in different BGP autonomous system numbers.</p>
Step 17	exit-address-family Example: Device(config-router-af)# exit-address-family	Exits address family configuration mode and returns to router configuration mode.

	Command or Action	Purpose
Step 18	address-family vpnv4 Example: Device(config-router)# address-family vpnv4	Specifies the VPNv4 address family and enters address family configuration mode.
Step 19	import l2vpn evpn re-originate Example: Device(config-router-af)# import l2vpn evpn re-originate	Reoriginates the EVPN routes imported from the EVPN fabric into the VPNv4 address family as VPNv4 routes and distributes them to the external network.
Step 20	neighbor ip-address activate Example: Device(config-router-af)# neighbor 172.16.255.103 activate	Enables the exchange information from a BGP neighbor. Use the IP address of the external MPLS network router as the neighbor IP address.
Step 21	neighbor ip-address send-community [both extended standard] Example: Device(config-router-af)# neighbor 172.16.255.103 send-community both	Specifies the communities attribute sent to a BGP neighbor. Use the IP address of the external MPLS network router as the neighbor IP address. Note Use either of extended or both keywords. External connectivity cannot be established when you use the standard keyword.
Step 22	neighbor {ip-address peer-group-name} next-hop-self [all] Example: Device(config-router-af)# neighbor ip-address next-hop-self all	Configures the router as the next hop for a BGP-speaking neighbor or peer group. The all keyword is mandatory when implementing external connectivity through iBGP, where the EVPN fabric and the MPLS network are in the same BGP autonomous system number. The all keyword is optional when implementing external connectivity through eBGP, where the EVPN fabric and the MPLS network are in different BGP autonomous system numbers.
Step 23	exit-address-family Example: Device(config-router-af)# exit-address-family	Exits address family configuration mode and returns to router configuration mode.
Step 24	address-family vpnv6 Example: Device(config-router)# address-family vpnv6	Specifies the VPNv6 address family and enters address family configuration mode.

	Command or Action	Purpose
Step 25	import l2vpn evpn re-originate Example: Device(config-router-af)# import l2vpn evpn re-originate	Reoriginates the EVPN routes imported from the EVPN fabric into the VPNv6 address family as VPNv6 routes and distributes them to the external network.
Step 26	neighbor ip-address activate Example: Device(config-router-af)# neighbor 172.16.255.103 activate	Enables the exchange information from a BGP neighbor. Use the IP address of the spine switch as the neighbor IP address.
Step 27	neighbor ip-address send-community [both extended standard] Example: Device(config-router-af)# neighbor 172.16.255.103 send-community both	Specifies the communities attribute sent to a BGP neighbor. Use the IP address of the spine switch as the neighbor IP address. Note Use either of extended or both keywords. External connectivity cannot be established when you use the standard keyword.
Step 28	neighbor {ip-address peer-group-name} next-hop-self [all] Example: Device(config-router-af)# neighbor ip-address next-hop-self all	Configures the router as the next hop for a BGP-speaking neighbor or peer group. The all keyword is mandatory when implementing external connectivity through iBGP, where the EVPN fabric and the MPLS network are in the same BGP autonomous system number. The all keyword is optional when implementing external connectivity through eBGP, where the EVPN fabric and the MPLS network are in different BGP autonomous system numbers.
Step 29	exit-address-family Example: Device(config-router-af)# exit-address-family	Exits address family configuration mode and returns to router configuration mode.
Step 30	end Example: Device(config-router)# end	Returns to privileged EXEC mode.

Enabling EVPN VXLAN Layer 3 TRM Interworking with MVPN Networks

To configure interworking of Layer 3 TRM with MVPN networks, perform the following steps:

- Configure Layer 3 TRM in the BGP EVPN VXLAN fabric before you enable Layer 3 TRM interworking with MVPN. See [Configuring Layer 3 Tenant Routed Multicast](#) for detailed steps.
- Configure the MVPN network for the VPNv4 address family. See *Configuring Multicast Virtual Private Network* module of the *IP Multicast Routing Configuration Guide*.



Note Configure MVPN Profile 11 for EVPN VXLAN Layer 3 TRM interworking. For information on how to configure MVPN profiles, refer to [Configure mVPN Profiles Within Cisco IOS](#).

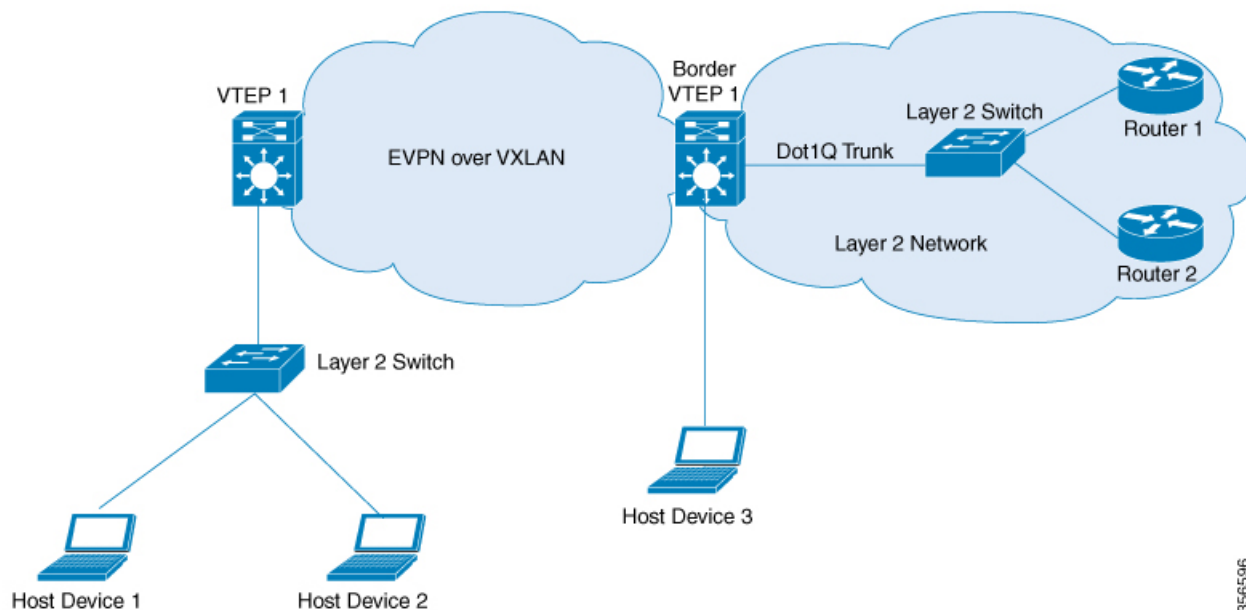
- If internal Border Gateway Protocol (iBGP) is used for peering between the two networks, run the **mdt auto-discovery interworking vxlan-pim** in VRF configuration mode on the border VTEP.

If external Border Gateway Protocol (eBGP) is used for peering between the two networks, run the **mdt auto-discovery interworking vxlan-pim inter-as** in VRF configuration mode on the border VTEP.

Enabling Layer 2 External Connectivity with IEEE 802.1Q Networks

The following image shows a sample topology that illustrates Layer 2 external connectivity with an IEEE 802.1Q network:

Figure 5: Layer 2 External Connectivity with IEEE 802.1Q Networks



You can also connect the EVPN VXLAN network to a firewall in place of the Layer 2 switch in the above image. To configure Layer 2 external connectivity with an IEEE 802.1Q network, perform the following steps on the external Layer 2 switch:

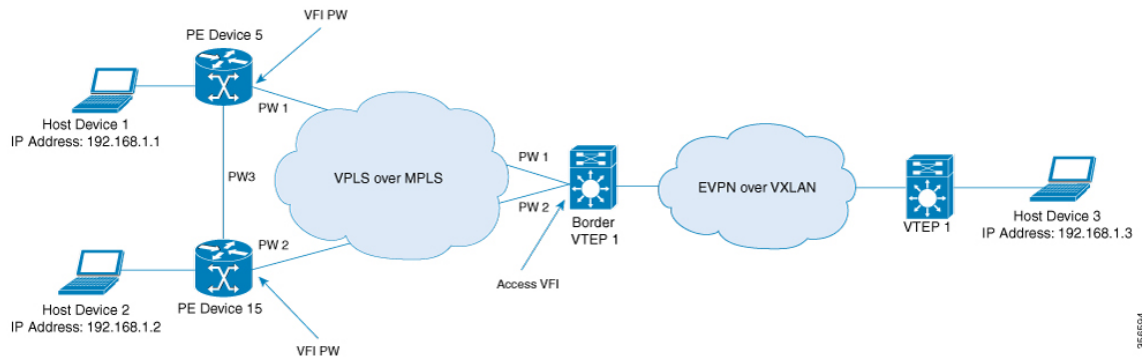
Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. Enter your password, if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	interface interface-id Example: Device(config)# interface GigabitEthernet4/0/1	Enters interface configuration mode for the specified interface. The specified interface must be the interface on the Layer 2 switch through which the EVPN VXLAN network communicates with the IEEE 802.1Q network.
Step 4	switchport mode trunk Example: Device(config-if)# switchport mode trunk	Configures the interface as a trunking VLAN Layer 2 interface.
Step 5	switchport trunk allowed vlan vlan-list Example: Device(config-if)# switchport trunk allowed vlan 201,202	Sets the list of VLANs that are allowed to transmit traffic from this interface in tagged format when the interface is in trunking mode.
Step 6	end Example: Device(config-if)# end	Returns to privileged EXEC mode.

Enabling Layer 2 External Connectivity with a VPLS Network Through an Access VFI

The following illustration shows a single-homed VXLAN network connected to a VPLS over MPLS network through the access VFIs on the border VTEP:

Figure 6: Layer 2 External Connectivity with a VPLS Network Through an Access VFI



Note We recommend you to use Cisco Catalyst 9500 Series - High Performance switches or Cisco Catalyst 9600 Series switches as border VTEPs when you configure Layer 2 external connectivity with a VPLS network. We recommend you to configure Cisco StackWise Virtual on the border VTEPs in order to achieve physical redundancy when you configure Layer 2 external connectivity with a VPLS network.

Perform the following set of procedures to enable Layer 2 external connectivity with VPLS networks through an access VFI interface:

1. Define the access VFI for the VTEPs.
2. Configure the access VFI as a member of the VLAN on the VTEPs.
3. Configure the EVPN instance as a member of the VLAN on the VTEPs.
4. Configure VPLS on the border VTEP.

Defining an Access VFI on a Border VTEP

To configure an access facing VFI on the VLAN of a border VTEP, perform the following steps:

For more information on configuring VFIs, in the software configuration guide for the required release, go to *Contents* → *Multiprotocol Label Switching (MPLS) Configuration Guide* → *Configuring Virtual Private LAN Service (VPLS) and VPLS BGP-Based Autodiscovery*.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enters privileged EXEC mode. Enter password, if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 3	l2vpn vfi context <i>vfi-name</i> Example: Device(config) # l2vpn vfi context myVFI	Establishes an Layer 2 VPN VFI between two or more separate networks, and enters VFI configuration mode.
Step 4	vpn id <i>vpn-id</i> Example: Device(config-vfi) # vpn id 1	Configures the VPN ID for the VFI.
Step 5	member ip-address encapsulation mpls Example: Device(config-vfi) # member 10.12.12.5 encapsulation mpls	Specifies the device that forms a point-to-point Layer 2 VPN VFI connection.
Step 6	Repeat step 5 for all devices that form a point-to-point Layer 2 VPN VFI connection.	
Step 7	end Example: Device(config-vfi) # end	Exits VFI configuration mode and enters privileged EXEC mode.

Adding an Access VFI and an EVPN Instance as Members of the VLAN of a Border VTEP

To add an access VFI and an EVPN instance as members of the VLAN of a border VTEP, perform the following steps:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enters privileged EXEC mode. Enter password, if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	vlan configuration <i>vlan-number</i> Example: Device(config) # vlan configuration 11	Enters VLAN feature configuration mode for the specified VLAN interface. Enter the VLAN number that is associated with the Layer 2 VNI configured in the EVPN VXLAN network.
Step 4	member access-vfi <i>vfi-name</i> Example:	Adds the access VFI as a member of the VLAN configuration.

	Command or Action	Purpose
	<code>Device(config-vlan)# member access-vfi myVFI</code>	
Step 5	member evpn-instance <i>evpn-instance-number</i> vni <i>l2-vni-number</i> Example: <code>Device(config-vlan)# member evpn-instance 1 vni 6000</code>	Adds the EVPN instance as a member of the VLAN configuration.
Step 6	end Example: <code>Device(config-vlan)# end</code>	Exits VLAN configuration mode and enters privileged EXEC mode.

Configuring VPLS on a Border VTEP

To configure VPLS on a border VTEP, in the software configuration guide for the required release, see *Contents* → *Multiprotocol Label Switching (MPLS) Configuration Guide* → *Configuring Virtual Private LAN Service (VPLS) and VPLS BGP-Based Autodiscovery*.

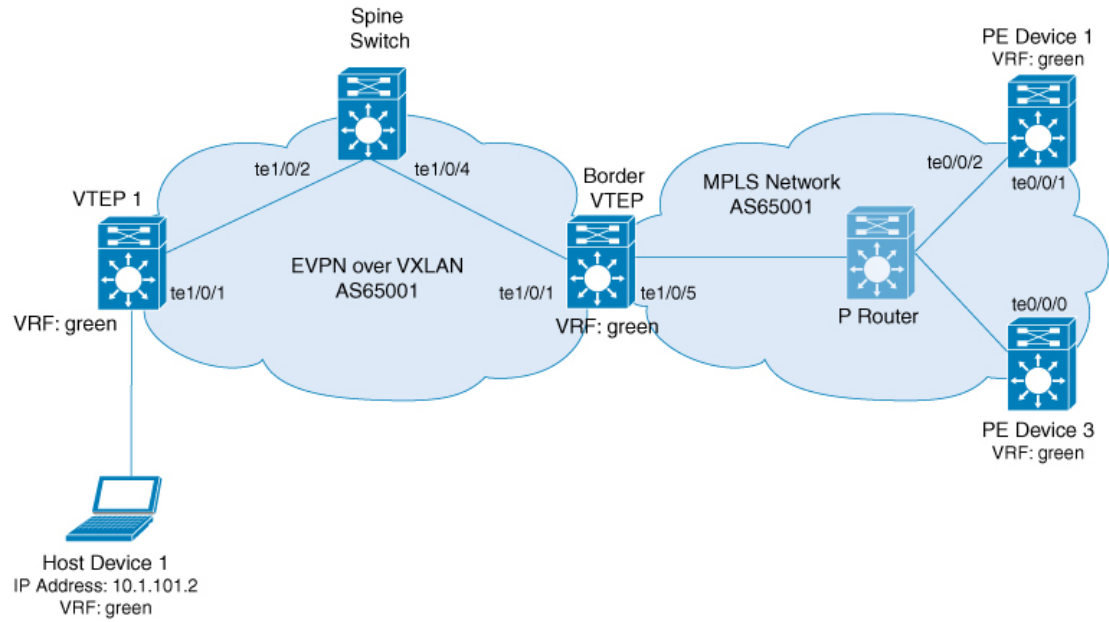
Configuration Examples for EVPN VXLAN External Connectivity

The following section shows the configuration examples for EVPN VXLAN external connectivity to other technologies:

Example: Enabling Layer 3 External Connectivity with MPLS Layer 3 VPN through iBGP

This section provides an example to show how Layer 3 external connectivity with MPLS Layer 3 VPN is enabled for a BGP EVPN VXLAN fabric through iBGP. The example shows how to configure and verify Layer 3 external connectivity with MPLS Layer 3 VPN for the topology shown below:

Figure 7: Layer 3 External Connectivity with MPLS Layer 3 VPN through iBGP



The topology shows an EVPN VXLAN network with two VTEPS, VTEP 1 and border VTEP. Border VTEP is connected to an external PE device that belongs to an MPLS network. The BGP EVPN VXLAN fabric and the MPLS network are in the autonomous system number 65001. All the VTEPs, PE devices and, host devices are part of the VRF green. The following tables provide sample configurations for the devices in the topology above.

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Table 1: Configuring Spine Switch, Border VTEP and PE Device 1 for Enabling Layer 3 External Connectivity with MPLS Layer 3 VPN through iBGP

Spine Switch	Border VTEP	PE Device 1
<pre> Spine_switch# show running-config hostname Spine_switch ! interface Loopback0 ip address 172.16.255.1 255.255.255.255 ip ospf 1 area 0 ip pim sparse-mode ! interface Loopback1 ip address 172.16.254.1 255.255.255.255 ip pim sparse-mode ip ospf 1 area 0 ! interface Loopback2 ip address 172.16.255.255 255.255.255.255 ip pim sparse-mode ip ospf 1 area 0 ! interface TenGigabitEthernet1/0/2 no switchport ip address 172.16.14.1 255.255.255.0 ip pim sparse-mode ip ospf network point-to-point ip ospf 1 area 0 ! interface TenGigabitEthernet1/0/4 no switchport ip address 172.16.16.1 255.255.255.0 ip pim sparse-mode ip ospf network point-to-point ip ospf 1 area 0 ! router ospf 1 router-id 172.16.255.1 ! router bgp 65001 template peer-policy RR-PP route-reflector-client send-community both exit-peer-policy ! template peer-session RR-PS remote-as 65001 update-source Loopback0 exit-peer-session ! bgp router-id 172.16.255.1 bgp log-neighbor-changes no bgp default ipv4-unicast neighbor 172.16.255.4 inherit peer-session RR-PS neighbor 172.16.255.6 inherit peer-session RR-PS ! ! ! </pre>	<pre> Border_VTEP# show running-config hostname Border_VTEP !vrf definition green rd 1:1 ! address-family ipv4 route-target export 1:1 route-target import 1:1 route-target export 1:1 stitching route-target import 1:1 stitching exit-address-family ! address-family ipv6 route-target export 1:1 route-target import 1:1 route-target export 1:1 stitching route-target import 1:1 stitching exit-address-family ! mpls label mode all-vrfs protocol all-afs per-vrf ! l2vpn evpn replication-type static router-id Loopback1 default-gateway advertise ! l2vpn evpn instance 101 vlan-based encapsulation vxlan ! l2vpn evpn instance 102 vlan-based encapsulation vxlan replication-type ingress ! vlan configuration 101 member evpn-instance 101 vni 10101 vlan configuration 102 member evpn-instance 102 vni 10102 vlan configuration 901 member vni 50901 ! interface Loopback0 ip address 172.16.255.6 255.255.255.255 ip pim sparse-mode ip ospf 1 area 0 ! interface Loopback1 ip address 172.16.254.6 255.255.255.255 ip pim sparse-mode ip ospf 1 area 0 ! interface TenGigabitEthernet1/0/1 no switchport ip address 172.16.16.6 255.255.255.0 ip pim sparse-mode ip ospf network point-to-point ip ospf 1 area 0 </pre>	<pre> PE_device_1# show running-config hostname PE_device_1 ! vrf definition green rd 1:1 ! address-family ipv4 route-target export 1:1 route-target import 1:1 exit-address-family ! address-family ipv6 route-target export 1:1 route-target import 1:1 exit-address-family ! interface Loopback0 ip address 172.16.255.101 255.255.255.255 ! interface Loopback1 vrf forwarding green ip address 10.1.255.101 255.255.255.255 ! interface TenGigabitEthernet0/0/1 ip address 172.16.111.101 255.255.255.0 ip router isis cdp enable mpls ip isis network point-to-point ! interface TenGigabitEthernet0/0/2 ip address 172.16.106.101 255.255.255.0 ip router isis negotiation auto cdp enable mpls ip isis network point-to-point ! router isis net 49.0001.1720.1625.5101.00 is-type level-2-only metric-style wide passive-interface Loopback0 ! router bgp 65001 bgp log-neighbor-changes no bgp default ipv4-unicast neighbor 172.16.255.103 remote-as 65001 neighbor 172.16.255.103 update-source Loopback0 ! address-family ipv4 exit-address-family ! </pre>

Table 2: Configuring VTEP 1 and PE Device 3 for Enabling Layer 3 External Connectivity with MPLS Layer 3 VPN through iBGP

VTEP 1	PE Device 3
<pre>VTEP_1# show running-config hostname VTEP_1 ! vrf definition green rd 1:1 ! address-family ipv4 route-target export 1:1 route-target import 1:1 route-target export 1:1 stitching route-target import 1:1 stitching exit-address-family ! address-family ipv6 route-target export 1:1 route-target import 1:1 route-target export 1:1 stitching route-target import 1:1 stitching exit-address-family ! l2vpn evpn replication-type static router-id Loopback1 default-gateway advertise ! l2vpn evpn instance 101 vlan-based encapsulation vxlan ! l2vpn evpn instance 102 vlan-based encapsulation vxlan replication-type ingress ! vlan configuration 101 member evpn-instance 101 vni 10101 vlan configuration 102 member evpn-instance 102 vni 10102 vlan configuration 901 member vni 50901 ! interface Loopback0 ip address 172.16.255.4 255.255.255.255 ip pim sparse-mode ip ospf 1 area 0 ! interface Loopback1 ip address 172.16.254.4 255.255.255.255 ip pim sparse-mode ip ospf 1 area 0 ! interface TenGigabitEthernet1/0/1 no switchport ip address 172.16.14.4 255.255.255.0 ip pim sparse-mode ip ospf network point-to-point ip ospf 1 area 0 ! interface Vlan101 vrf forwarding green ip address 10.1.101.1 255.255.255.0</pre>	<pre>PE_device_3# show running-config hostname PE_device_3 ! vrf definition green rd 1:1 ! address-family ipv4 route-target export 1:1 route-target import 1:1 exit-address-family ! address-family ipv6 route-target export 1:1 route-target import 1:1 exit-address-family ! interface Loopback0 ip address 172.16.255.103 255.255.255.255 ! interface Loopback1 vrf forwarding green ip address 10.1.255.103 255.255.255.255 ! interface TenGigabitEthernet0/0/0 ip address 172.16.111.103 255.255.255.0 ip router isis cdp enable mpls ip isis network point-to-point ! router isis net 49.0001.1720.1625.5103.00 is-type level-2-only metric-style wide passive-interface Loopback0 ! router bgp 65001 template peer-policy RR-PP route-reflector-client send-community both exit-peer-policy ! template peer-session RR-PS remote-as 65001 update-source Loopback0 exit-peer-session ! bgp log-neighbor-changes no bgp default ipv4-unicast neighbor 172.16.255.6 inherit peer-session RR-PS neighbor 172.16.255.101 inherit peer-session RR-PS ! address-family ipv4 exit-address-family ! ! ! ! !</pre>

The following examples provide sample outputs for **show** commands on VTEP 1 and border VTEP to verify external connectivity for the topology configured above:

VTEP 1

The following example shows the output for the **show bgp l2vpn evpn route-type** command for route type 5 on VTEP 1:

```
VTEP_1# show bgp l2vpn evpn route-type 5 0 10.1.255.103 32
BGP routing table entry for [5][1:1][0][32][10.1.255.103]/17, version 12
Paths: (1 available, best #1, table EVPN-BGP-Table)
  Flag: 0x100
  Not advertised to any peer
  Refresh Epoch 1
  Local
    172.16.254.6 (metric 3) (via default) from 172.16.255.1 (172.16.255.1)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      EVPN ESI: 00000000000000000000, Gateway Address: 0.0.0.0, VNI Label 50901, MPLS VPN
Label 0
  Extended Community: RT:1:1 ENCAP:8 Router MAC:0C75.BD67.EF48
  Originator: 172.16.255.103, Cluster list: 172.16.255.1, 172.16.255.6
  rx pathid: 0, tx pathid: 0x0
  net: 0x7F84B914EF38, path: 0x7F84BAFD0E30, pathext: 0x7F84BB42E698
  flags: net: 0x100, path: 0x3, pathext: 0xA1
  Updated on May 20 2020 19:31:08 UTC
```

The following example shows the output for the **show bgp l2vpn evpn route-type** command for route type 2 on VTEP 1:

```
VTEP_1# show bgp l2vpn evpn route-type 2 0 44d3ca286cc1 10.1.101.2
BGP routing table entry for [2][172.16.254.4:101][0][48][44D3CA286CC1][32][10.1.101.2]/24,
  version 17
Paths: (1 available, best #1, table evi_101)
  Advertised to update-groups:
    1
  Refresh Epoch 1
  Local
    :: (via default) from 0.0.0.0 (172.16.255.4)
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      EVPN ESI: 00000000000000000000, Label1 10101, Label2 50901
      Extended Community: RT:1:1 RT:65001:101 ENCAP:8
        Router MAC:7C21.0DBD.9548
      Local irb vxlan vtep:
        vrf:green, l3-vni:50901
        local router mac:7C21.0DBD.9548
        core-irb interface:Vlan901
        vtep-ip:172.16.254.4
      rx pathid: 0, tx pathid: 0x0
      net: 0x7F84B914E858, path: 0x7F84BAFD09F8, pathext: 0x7F84BB42E4B8
      flags: net: 0x0, path: 0x4000028000003, pathext: 0x81
      Updated on May 20 2020 19:31:30 UTC
```

The following example shows the output for the **show ip route vrf** command on VTEP 1:

```
VTEP_1# show ip route vrf green

Routing Table: green
```

Example: Enabling Layer 3 External Connectivity with MPLS Layer 3 VPN through iBGP

```

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, m - OMP
       n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
       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
       H - NHRP, G - NHRP registered, g - NHRP registration summary
       o - ODR, P - periodic downloaded static route, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR

```

Gateway of last resort is not set

```

      10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C       10.1.101.0/24 is directly connected, Vlan101
L       10.1.101.1/32 is directly connected, Vlan101
C       10.1.102.0/24 is directly connected, Vlan102
L       10.1.102.1/32 is directly connected, Vlan102
B       10.1.255.101/32 [200/0] via 172.16.254.6, 00:21:47, Vlan901
B       10.1.255.103/32 [200/0] via 172.16.254.6, 00:21:47, Vlan901

```

Border VTEP

The following example shows the output for the **show mpls ldp neighbor** command on border VTEP:

```

Border_VTEP# show mpls ldp neighbor
Peer LDP Ident: 172.16.111.101:0; Local LDP Ident 172.16.106.6:0
TCP connection: 172.16.111.101.26371 - 172.16.106.6.646
State: Oper; Msgs sent/rcvd: 86/69; Downstream
Up time: 00:32:14
LDP discovery sources:
  TenGigabitEthernet1/0/5, Src IP addr: 172.16.106.101
Addresses bound to peer LDP Ident:
  172.16.111.101 172.16.106.101 172.16.255.101

```

The following example shows the output for the **show bgp l2vpn evpn route-type** command for route type 5 on border VTEP:

```

Border_VTEP# show bgp l2vpn evpn route-type 5 0 10.1.255.103 32
BGP routing table entry for [5][1:1][0][32][10.1.255.103]/17, version 7
Paths: (1 available, best #1, table EVPN-BGP-Table)
Flag: 0x100
Advertised to update-groups:
  1
Refresh Epoch 1
Local, (Received from a RR-client), imported path from base
  172.16.255.103 (metric 20) (via default) from 172.16.255.103 (172.16.255.103)
  Origin incomplete, metric 0, localpref 100, valid, internal, best
  EVPN ESI: 00000000000000000000, Gateway Address: 0.0.0.0, local vtep: 172.16.254.6,
VNI Label 50901, MPLS VPN Label 23
  Extended Community: RT:1:1 ENCAP:8 Router MAC:0C75.BD67.EF48
  rx pathid: 0, tx pathid: 0x0
  net: 0x7FED6F808948, path: 0x7FED6D7EDA68, pathext: 0x7FED6D80DE40, exp_net:
0x7FED6F9BF070
  flags: net: 0x100, path: 0x7, pathext: 0xA1
  Updated on May 20 2020 19:22:47 UTC

```

The following example shows the output for the **show bgp vpv4 unicast all** command on border VTEP for the IP address of host device 1:

```
Border_VTEP# show bgp vpv4 unicast all 10.1.101.2
BGP routing table entry for 1:1:10.1.101.2/32, version 10
Paths: (1 available, best #1, table green)
  Advertised to update-groups:
    3
  Refresh Epoch 1
  Local, (Received from a RR-client), imported path from
[2][172.16.254.4:101][0][48][44D3CA286CC1][32][10.1.101.2]/24 (global)
  172.16.254.4 (metric 3) (via default) from 172.16.255.1 (172.16.255.1)
  Origin incomplete, metric 0, localpref 100, valid, internal, best
  Extended Community: RT:1:1 ENCAP:8 Router MAC:7C21.0DBD.9548
  Originator: 172.16.255.4, Cluster list: 172.16.255.1
  Local vxlan vtep:
    vrf:green, vni:50901
    local router mac:0C75.BD67.EF48
    encap:8
    vtep-ip:172.16.254.6
    bdi:Vlan901
  Remote VxLAN:
    Topoid 0x4(vrf green)
    Remote Router MAC:7C21.0DBD.9548
    Encap 8
    Egress VNI 50901
    RTEP 172.16.254.4
  mpls labels in/out IPv4 VRF Aggr:34/nolabel
  rx pathid: 0, tx pathid: 0x0
  Updated on May 20 2020 19:23:11 UTC
```

Spine Switch

The following example shows the output for the **show bgp l2vpn evpn route-type** command for route type 5 on spine switch:

```
Spine_switch# show bgp l2vpn evpn route-type 5 0 10.1.255.103 32
BGP routing table entry for [5][1:1][0][32][10.1.255.103]/17, version 12
Paths: (1 available, best #1, table EVPN-BGP-Table)
  Advertised to update-groups:
    1
  Refresh Epoch 1
  Local, (Received from a RR-client)
    172.16.254.6 (metric 2) (via default) from 172.16.255.6 (172.16.255.6)
    Origin incomplete, metric 0, localpref 100, valid, internal, best
    EVPN ESI: 00000000000000000000, Gateway Address: 0.0.0.0, VNI Label 50901, MPLS VPN
Label 0
  Extended Community: RT:1:1 ENCAP:8 Router MAC:0C75.BD67.EF48
  Originator: 172.16.255.103, Cluster list: 172.16.255.6
  rx pathid: 0, tx pathid: 0x0
  net: 0x7F54CC99CEF8, path: 0x7F54CC9AD310, pathext: 0x7F54CC9C6998
  flags: net: 0x0, path: 0x3, pathext: 0x81
  Updated on May 20 2020 19:28:59 UTC
```

The following example shows the output for the **show bgp l2vpn evpn route-type** command for route type 2 on spine switch:

Example: Enabling Layer 3 External Connectivity with MPLS Layer 3 VPN through iBGP

```
Spine_switch# show bgp l2vpn evpn route-type 2 0 44d3ca286cc1 10.1.101.2
BGP routing table entry for [2][172.16.254.4:101][0][48][44D3CA286CC1][32][10.1.101.2]/24,
version 14
Paths: (1 available, best #1, table EVPN-BGP-Table)
  Advertised to update-groups:
    1
  Refresh Epoch 1
  Local, (Received from a RR-client)
    172.16.254.4 (metric 2) (via default) from 172.16.255.4 (172.16.255.4)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      EVPN ESI: 00000000000000000000, Label1 10101, Label2 50901
      Extended Community: RT:1:1 RT:65001:101 ENCAP:8
      Router MAC:7C21.0DBD.9548
      rx pathid: 0, tx pathid: 0x0
      net: 0x7F54CC99CAD8, path: 0x7F54CC9AD088, pathext: 0x7F54CC9C68D8
      flags: net: 0x0, path: 0x3, pathext: 0x81
      Updated on May 20 2020 19:29:22 UTC
```

PE Device 3

The following example shows the output for the **show bgp vpnv4 unicast all** command on PE device 3 for the IP address of host device 1:

```
PE_device_3# show bgp vpnv4 unicast all 10.1.101.2
BGP routing table entry for 1:1:10.1.101.2/32, version 14
Paths: (1 available, best #1, table green)
  Advertised to update-groups:
    3
  Refresh Epoch 1
  Local, (Received from a RR-client)
    172.16.255.6 (metric 20) (via default) from 172.16.255.6 (172.16.255.6)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:1:1 ENCAP:8 Router MAC:7C21.0DBD.9548
      Originator: 172.16.255.4, Cluster list: 172.16.255.6, 172.16.255.1
      mpls labels in/out nolabel/34
      rx pathid: 0, tx pathid: 0x0
      Updated on May 20 2020 11:27:25 UTC
```

The following example shows the output for the **show ip route vrf green** command on PE device 3:

```
PE_device_3# show ip route vrf green

Routing Table: green
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, m - OMP
       n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
       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
       H - NHRP, G - NHRP registered, g - NHRP registration summary
       o - ODR, P - periodic downloaded static route, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
```

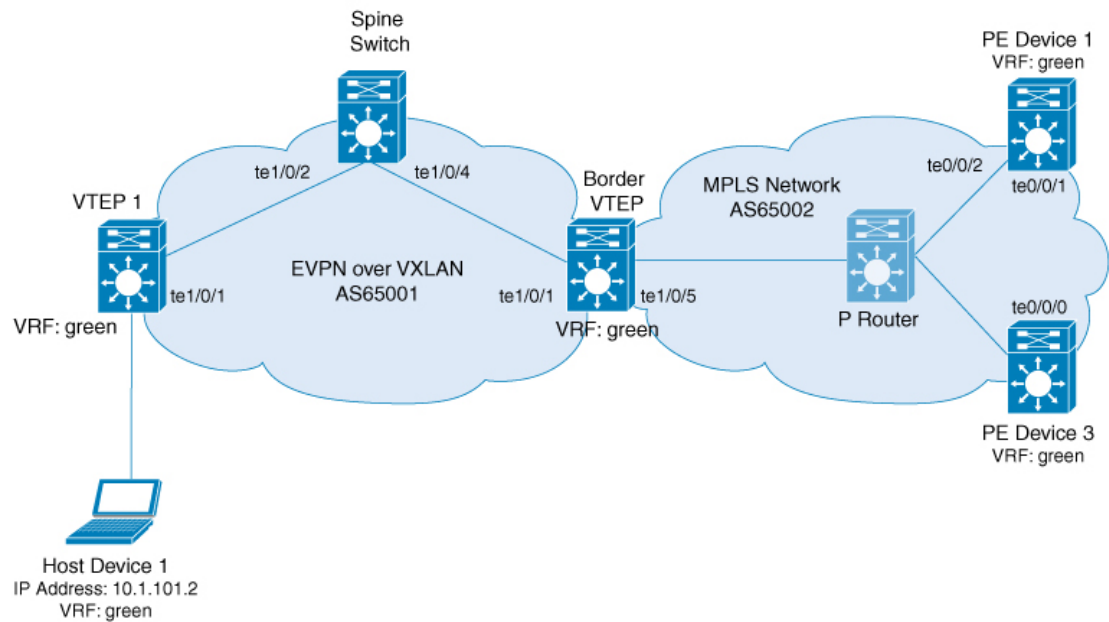
```

B      10.1.101.0/24 [200/0] via 172.16.255.6, 00:28:12
B      10.1.101.1/32 [200/0] via 172.16.255.6, 00:28:10
B      10.1.101.2/32 [200/0] via 172.16.255.6, 00:27:48
B      10.1.102.0/24 [200/0] via 172.16.255.6, 00:28:12
B      10.1.102.1/32 [200/0] via 172.16.255.6, 00:28:10
B      10.1.255.101/32 [200/0] via 172.16.255.101, 00:28:09
C      10.1.255.103/32 is directly connected, Loopback1
    
```

Example: Enabling Layer 3 External Connectivity with MPLS Layer 3 VPN through eBGP

This section provides an example to show how Layer 3 external connectivity with MPLS Layer 3 VPN is enabled for a BGP EVPN VXLAN fabric through eBGP. The example shows how to configure and verify Layer 3 external connectivity with MPLS Layer 3 VPN for the topology shown below:

Figure 8: Layer 3 External Connectivity with MPLS Layer 3 VPN through eBGP



The topology shows an EVPN VXLAN network with two VTEPs, VTEP 1 and border VTEP. Border VTEP is connected to an external PE device that belongs to an MPLS network. The BGP EVPN VXLAN fabric is in the autonomous system number 65001. The MPLS network is in the autonomous system number 65002. All the VTEPs, PE devices, and host devices are part of the VRF green. The following tables provide sample configurations for the devices in the topology above.

Table 3: Configuring Spine Switch, Border VTEP and PE Device 1 for Enabling Layer 3 External Connectivity with MPLS Layer 3 VPN through eBGP

Spine Switch	Border VTEP	PE Device 1
<pre> Spine_switch# show running-config hostname Spine_switch ! interface Loopback0 ip address 172.16.255.1 255.255.255.255 ip ospf 1 area 0 ip pim sparse-mode ! interface Loopback1 ip address 172.16.254.1 255.255.255.255 ip pim sparse-mode ip ospf 1 area 0 ! interface Loopback2 ip address 172.16.255.255 255.255.255.255 ip pim sparse-mode ip ospf 1 area 0 ! interface TenGigabitEthernet1/0/2 no switchport ip address 172.16.14.1 255.255.255.0 ip pim sparse-mode ip ospf network point-to-point ip ospf 1 area 0 ! interface TenGigabitEthernet1/0/4 no switchport ip address 172.16.16.1 255.255.255.0 ip pim sparse-mode ip ospf network point-to-point ip ospf 1 area 0 ! router ospf 1 router-id 172.16.255.1 ! router bgp 65001 template peer-policy RR-PP route-reflector-client send-community both exit-peer-policy ! template peer-session RR-PS remote-as 65001 update-source Loopback0 exit-peer-session ! bgp router-id 172.16.255.1 bgp log-neighbor-changes no bgp default ipv4-unicast neighbor 172.16.255.4 inherit peer-session RR-PS neighbor 172.16.255.6 inherit peer-session RR-PS ! address-family ipv4 exit-address-family ! </pre>	<pre> Border_VTEP# show running-config hostname Border_VTEP ! vrf definition green rd 1:1 ! address-family ipv4 route-target export 1:1 route-target import 1:1 route-target export 1:1 stitching route-target import 1:1 stitching exit-address-family ! address-family ipv6 route-target export 1:1 route-target import 1:1 route-target export 1:1 stitching route-target import 1:1 stitching exit-address-family ! mpls label mode all-vrfs protocol all-afs per-vrf ! l2vpn evpn replication-type static router-id Loopback1 default-gateway advertise ! l2vpn evpn instance 101 vlan-based encapsulation vxlan ! l2vpn evpn instance 102 vlan-based encapsulation vxlan replication-type ingress ! vlan configuration 101 member evpn-instance 101 vni 10101 vlan configuration 102 member evpn-instance 102 vni 10102 vlan configuration 901 member vni 50901 ! interface Loopback0 ip address 172.16.255.6 255.255.255.255 ip pim sparse-mode ip ospf 1 area 0 ! interface Loopback1 ip address 172.16.254.6 255.255.255.255 ip pim sparse-mode ip ospf 1 area 0 ! interface TenGigabitEthernet1/0/1 no switchport ip address 172.16.16.6 255.255.255.0 ip pim sparse-mode ip ospf network point-to-point ip ospf 1 area 0 </pre>	<pre> PE_device_1# show running-config hostname PE_device_1 ! vrf definition green rd 1:1 ! address-family ipv4 route-target export 1:1 route-target import 1:1 exit-address-family ! address-family ipv6 route-target export 1:1 route-target import 1:1 exit-address-family ! interface Loopback0 ip address 172.16.255.101 255.255.255.255 ! interface Loopback1 vrf forwarding green ip address 10.1.255.101 255.255.255.255 ! interface TenGigabitEthernet0/0/1 ip address 172.16.111.101 255.255.255.0 ip router isis cdp enable mpls ip isis network point-to-point ! interface TenGigabitEthernet0/0/2 ip address 172.16.106.101 255.255.255.0 negotiation auto cdp enable mpls bgp forwarding ! router isis net 49.0001.1720.1625.5101.00 is-type level-2-only metric-style wide passive-interface Loopback0 ! router bgp 65002 bgp log-neighbor-changes no bgp default ipv4-unicas no bgp default route-target filter neighbor 172.16.106.6 remote-as 65001 neighbor 172.16.255.6 remote-as 65001 neighbor 172.16.255.6 ebgp-multihop 255 neighbor 172.16.255.6 update-source Loopback0 neighbor 172.16.255.103 remote-as 65002 neighbor 172.16.255.103 update-source Loopback0 </pre>

Table 4: Configuring VTEP 1 and PE Device 3 for Enabling Layer 3 External Connectivity with MPLS Layer 3 VPN through eBGP

VTEP 1	PE Device 3
<pre>VTEP_1# show running-config hostname VTEP_1! ! vrf definition green rd 1:1 ! address-family ipv4 route-target export 1:1 route-target import 1:1 route-target export 1:1 stitching route-target import 1:1 stitching exit-address-family ! address-family ipv6 route-target export 1:1 route-target import 1:1 route-target export 1:1 stitching route-target import 1:1 stitching exit-address-family ! l2vpn evpn replication-type static router-id Loopback1 default-gateway advertise ! l2vpn evpn instance 101 vlan-based encapsulation vxlan ! l2vpn evpn instance 102 vlan-based encapsulation vxlan replication-type ingress ! vlan configuration 101 member evpn-instance 101 vni 10101 vlan configuration 102 member evpn-instance 102 vni 10102 vlan configuration 901 member vni 50901 ! interface Loopback0 ip address 172.16.255.4 255.255.255.255 ip pim sparse-mode ip ospf 1 area 0 ! interface Loopback1 ip address 172.16.254.4 255.255.255.255 ip pim sparse-mode ip ospf 1 area 0 ! interface TenGigabitEthernet1/0/1 no switchport ip address 172.16.14.4 255.255.255.0 ip pim sparse-mode ip ospf network point-to-point ip ospf 1 area 0 !</pre>	<pre>PE_device_3# show running-config hostname PE_device_3 ! vrf definition green rd 1:1 ! address-family ipv4 route-target export 1:1 route-target import 1:1 exit-address-family ! address-family ipv6 route-target export 1:1 route-target import 1:1 exit-address-family ! interface Loopback0 ip address 172.16.255.103 255.255.255.255 ! interface Loopback1 vrf forwarding green ip address 10.1.255.103 255.255.255.255 ! interface TenGigabitEthernet0/0/0 ip address 172.16.111.103 255.255.255.0 ip router isis cdp enable mpls ip isis network point-to-point ! router isis net 49.0001.1720.1625.5103.00 is-type level-2-only metric-style wide passive-interface Loopback0 ! router bgp 65002 template peer-policy RR-PP route-reflector-client send-community both exit-peer-policy ! template peer-session RR-PS remote-as 65002 update-source Loopback0 exit-peer-session ! bgp log-neighbor-changes no bgp default ipv4-unicast neighbor 172.16.255.101 inherit peer-session RR-PS ! address-family ipv4 exit-address-family ! ! !</pre>

The following examples provide sample outputs for **show** commands on the devices to verify external connectivity for the topology configured above:

VTEP 1

The following example shows the output for the **show bgp l2vpn evpn route-type** command for route type 5 on VTEP 1:

```
VTEP_1# show bgp l2vpn evpn route-type 5 0 10.1.255.103 32
BGP routing table entry for [5][1:1][0][32][10.1.255.103]/17, version 36
Paths: (1 available, best #1, table EVPN-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 1
  65002
    172.16.254.6 (metric 3) (via default) from 172.16.255.1 (172.16.255.1)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      EVPN ESI: 00000000000000000000, Gateway Address: 0.0.0.0, VNI Label 50901, MPLS VPN
Label 0
  Extended Community: RT:1:1 ENCAP:8 Router MAC:0C75.BD67.EF48
  Originator: 172.16.255.6, Cluster list: 172.16.255.1
  rx pathid: 0, tx pathid: 0x0
  net: 0x7F84BB35A5C8, path: 0x7F84B913E010, pathext: 0x7F84BB54A8A8
  flags: net: 0x0, path: 0x3, pathext: 0x81
  Updated on May 21 2020 13:56:28 UTC
```

The following example shows the output for the **show bgp l2vpn evpn route-type** command for route type 2 on VTEP 1:

```
VTEP_1# show bgp l2vpn evpn route-type 2 0 44d3ca286cc1 10.1.101.2
BGP routing table entry for [2][172.16.254.4:101][0][48][44D3CA286CC1][32][10.1.101.2]/24,
version 37
Paths: (1 available, best #1, table evi_101)
  Advertised to update-groups:
    1
  Refresh Epoch 1
  Local
    :: (via default) from 0.0.0.0 (172.16.255.4)
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      EVPN ESI: 00000000000000000000, Label1 10101, Label2 50901
      Extended Community: RT:1:1 RT:65001:101 ENCAP:8
      Router MAC:7C21.0DBD.9548
      Local irb vxlan vtep:
        vrf:green, l3-vni:50901
        local router mac:7C21.0DBD.9548
        core-irb interface:Vlan901
        vtep-ip:172.16.254.4
      rx pathid: 0, tx pathid: 0x0
      net: 0x7F84BB35A468, path: 0x7F84B913DF38, pathext: 0x7F84BB54A848
      flags: net: 0x0, path: 0x4000028000003, pathext: 0x81
      Updated on May 21 2020 14:00:49 UTC
```

The following example shows the output for the **show ip route vrf** command on VTEP 1:

```
VTEP_1# show ip route vrf green

Routing Table: green
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, m - OMP
```

Example: Enabling Layer 3 External Connectivity with MPLS Layer 3 VPN through eBGP

```

n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
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
H - NHRP, G - NHRP registered, g - NHRP registration summary
o - ODR, P - periodic downloaded static route, l - LISP
a - application route
+ - replicated route, % - next hop override, p - overrides from PFR

```

Gateway of last resort is not set

```

10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C    10.1.101.0/24 is directly connected, Vlan101
L    10.1.101.1/32 is directly connected, Vlan101
C    10.1.102.0/24 is directly connected, Vlan102
L    10.1.102.1/32 is directly connected, Vlan102
B    10.1.255.101/32 [200/0] via 172.16.254.6, 00:06:25, Vlan901
B    10.1.255.103/32 [200/0] via 172.16.254.6, 00:05:54, Vlan901

```

Border VTEP

The following example shows the output for the **show bgp vpnv4 unicast all** command on border VTEP for the IP address of the external device:

```

Border_VTEP# show bgp vpnv4 uni all 10.1.255.103/32
BGP routing table entry for 1:1:10.1.255.103/32, version 9
Paths: (1 available, best #1, table green)
  Not advertised to any peer
  Refresh Epoch 1
  65002
    172.16.255.101 (via default) from 172.16.255.101 (172.16.255.101)
      Origin incomplete, localpref 100, valid, external, best
      Extended Community: RT:1:1
      Local vxlan vtep:
        vrf:green, vni:50901
        local router mac:0C75.BD67.EF48
        encaps:8
        vtep-ip:172.16.254.6
        bdi:Vlan901
      mpls labels in/out nolabel/16
      rx pathid: 0, tx pathid: 0x0
      Updated on May 21 2020 13:48:09 UTC

```

The following example shows the output for the **show bgp l2vpn evpn route-type** command for route type 5 on border VTEP:

```

Border_VTEP# show bgp l2vpn evpn route-type 5 0 10.1.255.103 32
BGP routing table entry for [5][1:1][0][32][10.1.255.103]/17, version 32
Paths: (1 available, best #1, table EVPN-BGP-Table)
  Advertised to update-groups:
    1
  Refresh Epoch 1
  65002, imported path from base
    172.16.255.101 (via default) from 172.16.255.101 (172.16.255.101)
      Origin incomplete, localpref 100, valid, external, best
      EVPN ESI: 00000000000000000000, Gateway Address: 0.0.0.0, local vtep: 172.16.254.6,
VNI Label 50901, MPLS VPN Label 16
      Extended Community: RT:1:1 ENCAP:8 Router MAC:0C75.BD67.EF48
      rx pathid: 0, tx pathid: 0x0
      net: 0x7FED704944D0, path: 0x7FED704A4CA0, pathext: 0x7FED6DA6E250, exp_net:
0x7FED6F812678

```

```
flags: net: 0x0, path: 0x7, pathext: 0x81
Updated on May 21 2020 13:48:09 UTC
```

The following example shows the output for the **show mpls forwarding-table** command on border VTEP:

```
Border_VTEP# show mpls forwarding-table
Local   Outgoing  Prefix          Bytes Label  Outgoing  Next Hop
Label   Label     or Tunnel Id   Switched     interface
16      No Label  IPv4 VRF[V]    156          aggregate/green
17      Pop Label  172.16.106.101/32 \
                                     228          Te1/0/5     172.16.106.101
18      Pop Label  172.16.255.101/32 \
                                     0            Te1/0/5     172.16.106.101
```

The following example shows the output for the **show bgp vpnv4 unicast all** command on border VTEP for the IP address of host device 1:

```
Border_VTEP# show bgp vpnv4 uni all 10.1.101.2/32
BGP routing table entry for 1:1:10.1.101.2/32, version 10
Paths: (1 available, best #1, table green)
  Advertised to update-groups:
    1
  Refresh Epoch 4
  Local, imported path from [2][172.16.254.4:101][0][48][44D3CA286CC1][32][10.1.101.2]/24
(global)
  172.16.254.4 (metric 3) (via default) from 172.16.255.1 (172.16.255.1)
  Origin incomplete, metric 0, localpref 100, valid, internal, best
  Extended Community: RT:1:1 ENCAP:8 Router MAC:7C21.0DBD.9548
  Originator: 172.16.255.4, Cluster list: 172.16.255.1
  Local vxlan vtep:
    vrf:green, vni:50901
    local router mac:0C75.BD67.EF48
    encap:8
    vtep-ip:172.16.254.6
    bdi:Vlan901
  Remote VxLAN:
    Topoid 0x9(vrf green)
    Remote Router MAC:7C21.0DBD.9548
    Encap 8
    Egress VNI 50901
    RTEP 172.16.254.4
  mpls labels in/out IPv4 VRF Aggr:16/nolabel
  rx pathid: 0, tx pathid: 0x0
  Updated on May 21 2020 13:52:30 UTC
```

Spine Switch

The following example shows the output for the **show bgp l2vpn evpn route-type** command for route type 5 on spine switch:

```
Spine_switch# show bgp l2vpn evpn route-type 5 0 10.1.255.103 32
BGP routing table entry for [5][1:1][0][32][10.1.255.103]/17, version 23
Paths: (1 available, best #1, table EVPN-BGP-Table)
  Advertised to update-groups:
    1
  Refresh Epoch 1
  65002, (Received from a RR-client)
    172.16.254.6 (metric 2) (via default) from 172.16.255.6 (172.16.255.6)
```

Example: Enabling Layer 3 External Connectivity with MPLS Layer 3 VPN through eBGP

```

Origin incomplete, metric 0, localpref 100, valid, internal, best
EVPN ESI: 00000000000000000000, Gateway Address: 0.0.0.0, VNI Label 50901, MPLS VPN
Label 0
Extended Community: RT:1:1 ENCAP:8 Router MAC:0C75.BD67.EF48
rx pathid: 0, tx pathid: 0x0
net: 0x7F54CC95FAB8, path: 0x7F54CCA542F8, pathext: 0x7F54CC9707B0
flags: net: 0x0, path: 0x3, pathext: 0x81
Updated on May 21 2020 13:54:20 UTC

```

The following example shows the output for the **show bgp l2vpn evpn route-type** command for route type 2 on spine switch:

```

Spine_switch# show bgp l2vpn evpn route-type 2 0 44d3ca286cc1 10.1.101.2
BGP routing table entry for [2][172.16.254.4:101][0][48][44D3CA286CC1][32][10.1.101.2]/24,
version 24
Paths: (1 available, best #1, table EVPN-BGP-Table)
  Advertised to update-groups:
    1
  Refresh Epoch 1
  Local, (Received from a RR-client)
    172.16.254.4 (metric 2) (via default) from 172.16.255.4 (172.16.255.4)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      EVPN ESI: 00000000000000000000, Label1 10101, Label2 50901
      Extended Community: RT:1:1 RT:65001:101 ENCAP:8
        Router MAC:7C21.0DBD.9548
        rx pathid: 0, tx pathid: 0x0
        net: 0x7F54CC95F958, path: 0x7F54CCA54220, pathext: 0x7F54CC970750
        flags: net: 0x0, path: 0x3, pathext: 0x81
        Updated on May 21 2020 13:58:41 UTC

```

PE Device 1

The following example shows the output for the **show bgp vpnv4 unicast all** command on PE device 1 for the IP address of host device 1:

```

PE_device_1# show bgp vpnv4 unicast all 10.1.255.103/32
BGP routing table entry for 1:1:10.1.101.2/32, version 14
Paths: (1 available, best #1, table green)
  Advertised to update-groups:
    1
  Refresh Epoch 1
  65001
    172.16.255.6 (via default) from 172.16.255.6 (172.16.255.6)
      Origin incomplete, localpref 100, valid, external, best
      Extended Community: RT:1:1 ENCAP:8 Router MAC:7C21.0DBD.9548
      mpls labels in/out 22/16
      rx pathid: 0, tx pathid: 0x0
      Updated on May 21 2020 05:57:06 UTC

```

The following example shows the output for the **show ip route vrf** command on PE device 1:

```

PE_device_1# show ip route vrf green

Routing Table: green
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, m - OMP
n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
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
H - NHRP, G - NHRP registered, g - NHRP registration summary
o - ODR, P - periodic downloaded static route, l - LISP
a - application route
+ - replicated route, % - next hop override, p - overrides from PfR

```

Gateway of last resort is not set

```

10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
B    10.1.101.0/24 [20/0] via 172.16.255.6, 00:28:09
B    10.1.101.1/32 [20/0] via 172.16.255.6, 00:28:09
B    10.1.101.2/32 [20/0] via 172.16.255.6, 00:23:17
B    10.1.102.0/24 [20/0] via 172.16.255.6, 00:28:09
B    10.1.102.1/32 [20/0] via 172.16.255.6, 00:28:09
C    10.1.255.101/32 is directly connected, Loopback1
B    10.1.255.103/32 [200/0] via 172.16.255.103, 00:28:09

```

PE Device 3

The following example shows the output for the **show bgp vpnv4 unicast all** command on PE device 3 for the IP address of host device 1:

```

PE_device_3# show bgp vpnv4 unicast all 10.1.101.2/32
BGP routing table entry for 1:1:10.1.101.2/32, version 14
Paths: (1 available, best #1, table green)
  Not advertised to any peer
  Refresh Epoch 1
  65001, (Received from a RR-client)
    172.16.255.101 (metric 10) (via default) from 172.16.255.101 (172.16.255.101)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:1:1 ENCAP:8 Router MAC:7C21.0DBD.9548
      mpls labels in/out nolabel/22
      rx pathid: 0, tx pathid: 0x0
      Updated on May 21 2020 05:56:46 UTC

```

The following example shows the output for the **show ip route vrf** command on PE device 3:

```

PE_device_3# show ip route vrf green

Routing Table: green
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, m - OMP
       n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
       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
       H - NHRP, G - NHRP registered, g - NHRP registration summary
       o - ODR, P - periodic downloaded static route, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR

```

Gateway of last resort is not set

```

10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks

```

Example: Enabling Layer 3 External Connectivity with MPLS Layer 3 VPN through eBGP

```
B      10.1.101.0/24 [200/0] via 172.16.255.101, 00:29:09
B      10.1.101.1/32 [200/0] via 172.16.255.101, 00:29:09
B      10.1.101.2/32 [200/0] via 172.16.255.101, 00:24:17
B      10.1.102.0/24 [200/0] via 172.16.255.101, 00:29:09
B      10.1.102.1/32 [200/0] via 172.16.255.101, 00:29:09
B      10.1.255.101/32 [200/0] via 172.16.255.101, 00:29:09
C      10.1.255.103/32 is directly connected, Loopback1
```