



Configuring Tenant Routed Multicast

- [Restrictions for Tenant Routed Multicast](#) , on page 1
- [Information about Tenant Routed Multicast](#), on page 2
- [How to Configure Tenant Routed Multicast](#), on page 6
- [Configuration Examples for Tenant Routed Multicast](#), on page 11
- [Verifying Tenant Routed Multicast](#), on page 24

Restrictions for Tenant Routed Multicast

- Only Layer 3 Tenant Routed Multicast (TRM) is supported.
- Layer 2 TRM is not supported.
- TRM works only on the Default Multicast Distribution Tree (MDT).
- In the underlay network, TRM is supported only in the PIM-SM mode.
- In the underlay network, the spine switch should be configured as the Rendezvous Point (RP).
- In the overlay network, TRM is supported in the PIM-SM and PIM-SSM mode.
- Only Layer 3 Tenant Routed Multicast (TRM) is supported.
- Layer 2 TRM is not supported.
- Layer 3 TRM is not supported for IPv6 traffic in the underlay networks.
In the overlay networks, Layer 3 TRM is supported for both IPv4 and IPv6 traffic.
- TRM works only on the Default Multicast Distribution Tree (MDT).
- In the underlay network, TRM is supported only in the PIM-SM mode. In the overlay network, it is supported in the PIM-SM with Distributed Anycast-RP mode, PIM-SM with External-RP mode, and PIM-SSM mode.
- In the underlay network, the spine switch should be configured as the Rendezvous Point (RP).
- In the overlay network, each of the VTEPs must be configured as the RP for TRM in Distributed Anycast-RP mode.
- For External RP with EVPN AnycastGW, separate register-source loopback is needed in FHR

- E-BGP and I-BGP are supported.
- BGP router-reflector is also supported.

Information about Tenant Routed Multicast

TRM enables multicast forwarding in a VXLAN fabric that uses a BGP-based EVPN control plane. TRM provides multi-tenancy aware multicast forwarding between senders and receivers within the same or different subnets local or across VTEPs.

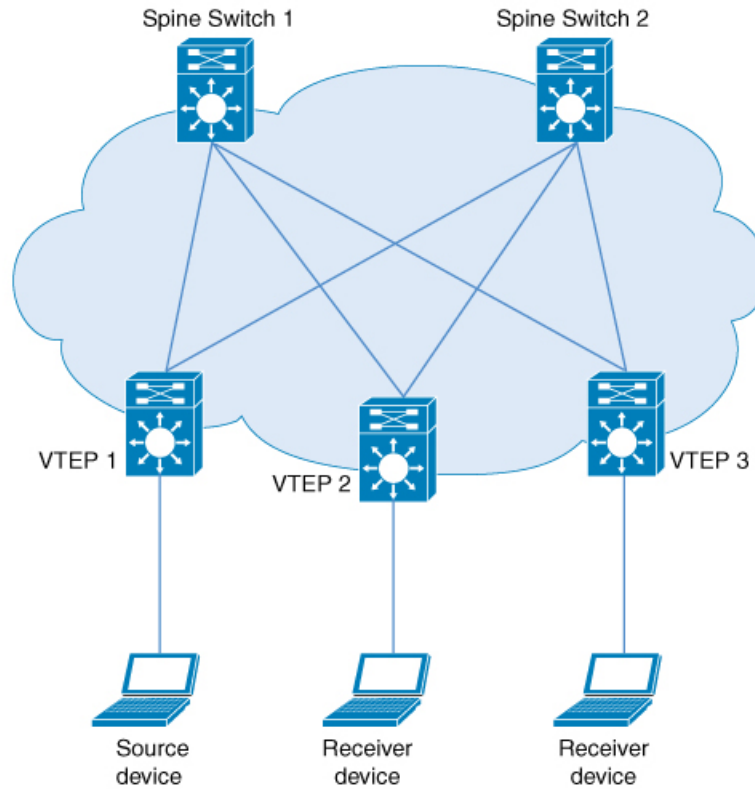
This feature brings the efficiency of multicast delivery to VXLAN overlay networks. TRM enables the delivery of a customer's IP multicast traffic in a multi-tenant fabric in an efficient and resilient manner. The delivery of TRM improves Layer-3 overlay multicast functionality in the networks.

With TRM enabled, multicast forwarding in the underlay is leveraged to replicate VXLAN-encapsulated routed multicast traffic. A default-MDT is built per-VRF. This is an addition to the existing multicast groups for broadcast and unknown unicast traffic in a Layer 2 Virtual Network Instance (VNI), and for Layer 2 multicast replication group. The individual multicast group addresses in the overlay are mapped to the respective underlay multicast address for replication and transport. The advantage of using a BGP-based approach is that it allows the BGP EVPN VXLAN fabric with TRM to operate as fully distributed Overlay Rendezvous-Point (RP), with the RP presence on every edge-device or VTEP.

A multicast-enabled data center fabric is typically part of an overall multicast network. Multicast sources, receivers, and multicast rendezvous points, might reside inside the data center but might also be inside the campus or externally reachable via the WAN. TRM allows a seamless integration with existing multicast networks.

For IPv4 and IPv6 multicast traffic, TRM uses BGP EVPN and MVPN routes to perform multicast routing.

Figure 1: Tenant Routed Multicast Topology



Source detection triggers advertising of EVPN route type 2 in the EVPN fabric. This EVPN route installed in Layer 3 RIB at a receiver VTEP is used as the RPF route towards the source. Thus, if the source is undetected, the RPF for the (S,G) entry is not found. In this case, either RPF remains NULL or a less specific route is installed if present in the RIB.

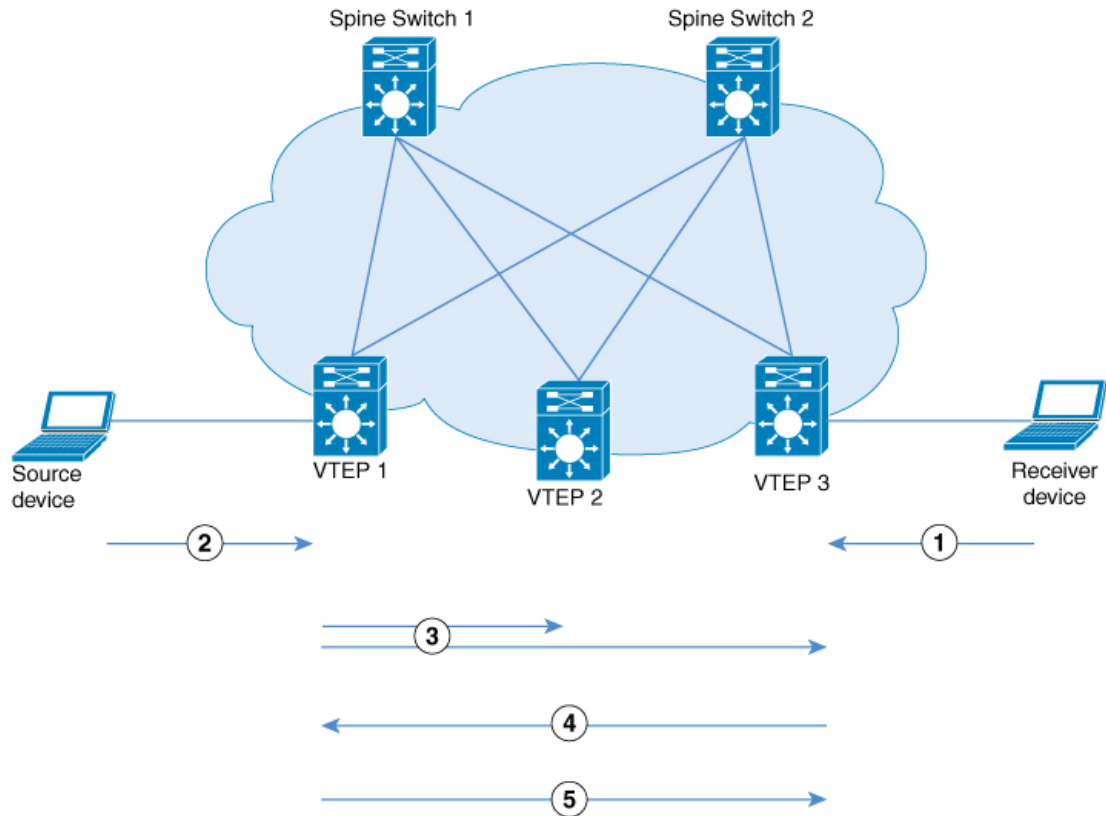
In EVPN-VXLAN network, TRM is supported in the overlay network in PIM-SM and PIM-SSM modes.

PIM-SM with Distributed Anycast-RP Mode

In PIM-SM with Distributed Anycast-RP Mode, each of the VTEPs must be the RP in the overlay network for their respective groups. The rendezvous points in the underlay network must be configured on the spine switches. All the VTEPs do not need to be BGP peers. There can be BGP peering between the VTEPs and the spine switches with the spine switches acting as route reflectors.

When a VTEP discovers a source device, it sends Source A-D Routes (MVPN Route Type 5) to all the other VTEPs. Based on these Source A-D routes, the other VTEPs send (S,G) join requests as MVPN route type 7 to the source VTEP.

Figure 2: PIM-SM with Distributed Anycast-RP Mode



356532

1. IGMP Join for (*,G) from Receiver Device to VTEP 3.
2. Data Traffic from Source Device to VTEP 1.
3. Source A-D Route for (S,G) from VTEP 1 to VTEP 2 and VTEP 3.
4. MVPN route type 7 from VTEP 3 to VTEP 1.
5. Data Traffic from VTEP 1 to VTEP 3.

In PIM-SM with Distributed Anycast-RP Mode, the following sequence of events occurs:

1. Receiver sends (*,G) IGMP Join to VTEP 3. Since VTEP 3 is an RP, (*,G) is created at VTEP 3.
2. The source device starts streaming data and (S,G) is created on VTEP 1.



Note When PIM-SM with Distributed Anycast-RP Mode is enabled, the first packet is dropped.

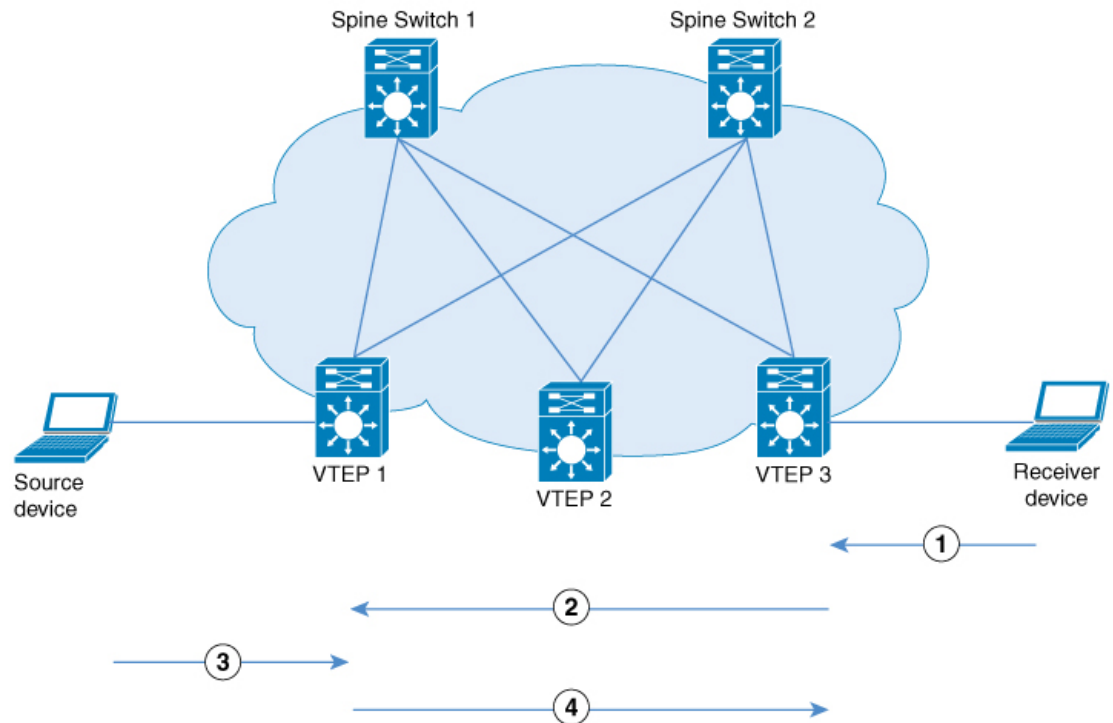
3. VTEP 1 performs self-source-registration since it is also an RP.
4. The source VTEP (VTEP 1) advertises Source A-D Routes (also called MVPN route type 5) for (S,G) to all the other VTEPs which are BGP peers in the MVPN address family.
5. VTEP 2 and VTEP 3 receive and install the Source A-D Routes for (S,G).

6. (S,G) is created at VTEP 3. VTEP 3 now has an overlay route for (S,G) and also has a unicast route to the source device from the EVPN Control plane. It then sends an MVPN route type 7 (S,G) BGP join to VTEP 1 and starts accepting traffic.
7. VTEP 1 receives and installs MVPN route type 7 from VTEP 3. It uses the Layer 3 VNI's SVI as the forwarding interface for (S,G) and starts forwarding traffic.

PIM-SSM Mode

In PIM-SSM Mode, the Source A-D route (MVPN route type 5) is not needed for the multicast convergence to happen. The receiver VTEP does not wait to receive the Source A-D route to send the MVPN route type 7.

Figure 3: PIM-SSM Mode



1. IGMP Join for (S,G) from Receiver Device to VTEP 3.
2. MVPN route type 7.
3. Data Traffic for (S,G) from Source Device to VTEP 1.
4. Data Traffic from VTEP 1 to VTEP 3.

In PIM-SSM Mode, the following sequence of events occurs:

1. When the source device sends a unicast packet, VTEP 1 sends out EVPN routes to all the other VTEPs, letting them know that the packet is from the source device.
2. The receiver sends an (S,G) IGMP join towards VTEP 3 and an (S,G) entry is created.

3. VTEP 3 performs an RPF lookup for the source device. If the SVI of the Layer 3 VNI is found to be the RPF interface, VTEP 3 sends MVPN route type 7 towards VTEP 1.
4. VTEP 1 receives and installs the MVPN route type 7. VTEP 1 creates an (S,G) entry, using the Layer 3 VNI's SVI as the forwarding interface for (S,G).
5. The source device sends (S,G) data to VTEP 1 which starts forwarding the traffic to VTEP 3.

How to Configure Tenant Routed Multicast

Prerequisites to Configuring TRM

Before configuring TRM, ensure that EVPN VXLAN Layer 2 and Layer 3 Overlay networks have been configured. See [How to Configure EVPN VXLAN Integrated Routing and Bridging](#) for detailed steps to configure Layer 2 and Layer 3 overlay networks.

Perform the following set of procedures to configure TRM in an EVPN VXLAN network:

Configuring the Default Multicast Distribution Tree in the VRF

To configure the default MDT for TRM, perform the following steps:

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	vrf definition <i>vrf-name</i> Example: Device(config)# vrf definition green	Names the VRF and enters VRF configuration mode.
Step 4	mdt default vxlan <i>group-address</i> Example: Device(config-vrf)# mdt default vxlan 225.2.2.2	Configures the multicast group address range for data MDT groups for a VRF in a VXLAN. <ul style="list-style-type: none"> • This command creates a tunnel interface. • By default, the destination address of the tunnel header is the <i>group-address</i> argument.
Step 5	mdt auto-discovery vxlan Example:	Enables VXLAN with BGP auto-discovery.

	Command or Action	Purpose
	<code>Device(config-vrf) # mdt auto-discovery vxlan</code>	
Step 6	mdt overlay use-bgp spt-only Example: <code>Device(config-vrf) # mdt overlay use-bgp spt-only</code>	Specifies BGP as the overlay protocol.
Step 7	end Example: <code>Device(config-vrf) # end</code>	Returns to privileged EXEC mode.

Configuring Multicast Routing on the Overlay VRF

To enable multicast routing on the overlay VRF, perform the following steps:

Procedure

	Command or Action	Purpose
Step 1	enable Example: <code>Device> enable</code>	Enables privileged EXEC mode. Enter your password, if prompted.
Step 2	configure terminal Example: <code>Device# configure terminal</code>	Enters global configuration mode.
Step 3	ip multicast-routing vrf vrf-name Example: <code>Device(config)# ip multicast-routing vrf green</code>	Enables IP multicast forwarding on the overlay VRF.
Step 4	end Example: <code>Device(config)# end</code>	Returns to privileged EXEC mode.

Configuring Multicast on Switch Virtual Interfaces for the Core-facing and Access-facing VLANs

To configure multicast on SVIs for the core-facing and access-facing VLANs on the VTEP, perform the following steps:

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 vlan <i>core-facing-vlan-id</i> Example: Device(config)# interface vlan 200	Enters interface configuration mode for the specified VLAN.
Step 4	ip pim sparse-mode Example: Device(config-if) # ip pim sparse-mode	Enables multicast on the core-facing SVI.
Step 5	exit Example: Device(config-if) # end	Returns to privileged EXEC mode.
Step 6	interface vlan <i>access-facing-vlan-id</i> Example: Device(config)# interface vlan 202	Enters interface configuration mode for the specified VLAN.
Step 7	ip pim sparse-mode Example: Device(config-if) # ip pim sparse-mode	Enables multicast on the access-facing SVI where sources or receivers are connected. Repeat this step for all the access-facing SVIs that are part of the Layer 2 VNI where sources and receivers are connected.
Step 8	end Example: Device(config-if) # end	Returns to privileged EXEC mode.

Configuring BGP with MVPN Address Family on VTEP

To configure BGP on a VTEP with MVPN address family, perform the following steps:

Procedure

	Command or Action	Purpose
Step 1	enable	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: Device> enable	Enter your password, if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
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	address-family ipv4 mvpn Example: Device(config-router)# address-family ipv4 mvpn	Specifies the MVPN address family and enters address family configuration mode.
Step 5	neighbor <i>ip-address</i> activate Example: Device(config-router-af) # neighbor 10.2.2.20 activate	Enables the exchange of information with a BGP neighbor. Use the IP address of the spine switch as the neighbor IP address.
Step 6	neighbor <i>ip-address</i> send-community extended Example: Device(config-router-af) # neighbor 10.2.2.20 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.
Step 7	neighbor <i>ip-address</i> advertisement-interval <i>seconds</i> Example: Device(config-router-af) # neighbor 10.2.2.20 advertisement-interval 10	(Optional) Sets the minimum route advertisement interval (RAI) between the sending of BGP routing updates.
Step 8	exit-address-family Example: Device(config-router-af) # exit-address-family	Exits address family configuration mode and returns to router configuration mode.
Step 9	end Example: Device(config-router) # end	Returns to privileged EXEC mode.

Configuring RP for Underlay Network

To configure RP for the underlay network, perform the following steps:

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	ip pim rp-address <i>ip-address-of-rp</i> Example: Device (config)# ip pim rp-address <rp-ip-address>	Configures the RP in the underlay network. For information about RP redundancy, see to <i>IP Multicast Routing Configuration Guide</i> .
Step 4	end Example: Device (config)# end	Returns to privileged EXEC mode.

Configuring RP and SSM for Overlay Network

To configure RP and SSM for the overlay network, perform the following steps:

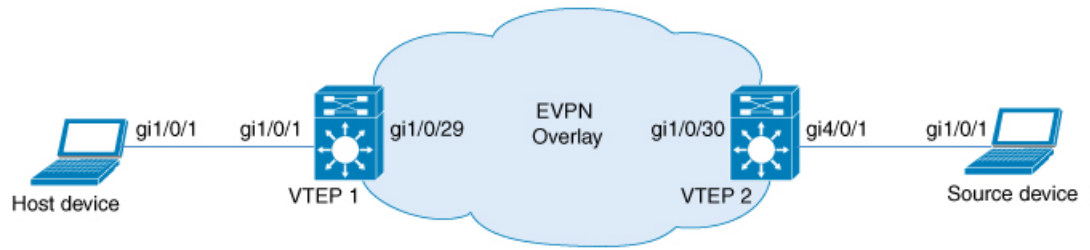
Procedure

	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 <i>loopback-interface</i> Example: Device (config)# interface Loopback 13	Enters interface configuration mode for the specified Loopback interface.
Step 4	vrf forwarding <i>vrf-name</i> Example: Device (config-if)# vrf forwarding green	Configures forwarding table for the Loopback interface.
Step 5	ip-address <i>ip-address subnet-mask</i> Example:	Configures the IP address for the Loopback interface.

	Command or Action	Purpose
	Device(config-if)# ip address 10.1.13.13 255.255.255.255	
Step 6	ip pim sparse-mode Example: Device(config-if)# ip pim sparse-mode	Enables PIM sparse mode on the Loopback interface. Note Enable PIM sparse mode only if EVPN VXLAN Layer 2 overlay network is also configured on the VTEP with underlay multicast as the mechanism for forwarding BUM traffic.
Step 7	exit Example: Device(config-if)# exit	Returns to global configuration mode.
Step 8	ip pim [vrf vrf-name] ssm {default range access-list } Example: Device(config)# ip pim vrf green ssm default	Configures an SSM range for TRM. The default keyword defines the SSM range access list as 232/8. The range keyword specifies the standard IP access list number or name that defines the SSM range.
Step 9	ip pim vrf vrf-name rp-address loopback-address-of-vtep Example: Device(config)# ip pim vrf green rp-address 10.1.13.13	Configures the address of the loopback interface of the local VTEP as the PIM RP for the multicast group in PIM-SM with Distributed Anycast RP mode. Note The loopback interface specified must be part of the same VRF.
Step 10	end Example: Device(config)# end	Returns to privileged EXEC mode.

Configuration Examples for Tenant Routed Multicast

This section provides an example for TRM configuration. The following example shows a sample configuration for a VXLAN network with a receiver device and a source device connected to VTEP 1 and VTEP 2 respectively, with TRM enabled.



356534

Table 1: Configuration Example for a VXLAN Network with the Source Device and Host Device connected to two VTEPs with TRM Enabled

VTEP 1	VTEP 2
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VTEP 1	VTEP 2
<pre> VTEP1# show running-config ! hostname VTEP1 ! vrf definition green rd 103:2 ! address-family ipv4 mdt auto-discovery vxlan mdt default vxlan 239.1.1.1 mdt overlay use-bgp spt-only route-target export 103:2 route-target import 104:2 route-target export 103:2 stitching route-target import 104:2 stitching exit-address-family ! ! ip routing ip multicast-routing ip multicast-routing vrf green ! ! l2vpn evpn replication-type static router-id Loopback0 default-gateway advertise ! l2vpn evpn instance 1 vlan-based encapsulation vxlan route-target export 103:1 route-target import 104:1 ! l2vpn evpn instance 2 vlan-based encapsulation vxlan ! ! system mtu 9150 ! vlan configuration 200 member vni 5000 vlan configuration 201 member evpn-instance 1 vni 6000 vlan configuration 202 member evpn-instance 2 vni 7000 ! ! interface Loopback0 ip address 10.1.1.10 255.255.255.255 ip pim sparse-mode ! interface Loopback13 vrf forwarding green ip address 10.1.13.13 255.255.255.0 ip pim sparse-mode ipv6 enable ! ! interface GigabitEthernet1/0/1 description access interface switchport mode trunk ! </pre>	<pre> VTEP2# show running-config ! hostname VTEP2 ! vrf definition green rd 104:2 ! address-family ipv4 mdt auto-discovery vxlan mdt default vxlan 239.1.1.1 mdt overlay use-bgp spt-only route-target export 104:2 route-target import 103:2 route-target export 104:2 stitching route-target import 103:2 stitching exit-address-family ! ! ip routing ip multicast-routing ip multicast-routing vrf green ! ! l2vpn evpn replication-type static router-id Loopback0 default-gateway advertise ! l2vpn evpn instance 1 vlan-based encapsulation vxlan route-target export 104:1 route-target import 103:1 ! l2vpn evpn instance 2 vlan-based encapsulation vxlan ! ! system mtu 9150 ! vlan configuration 200 member vni 5000 vlan configuration 201 member evpn-instance 1 vni 6000 vlan configuration 202 member evpn-instance 2 vni 7000 ! ! interface Loopback0 ip address 10.2.2.20 255.255.255.255 ip pim sparse-mode ! interface Loopback14 vrf forwarding green ip address 10.1.14.14 255.255.255.0 ip pim sparse-mode ipv6 address 2001:200::14:14/128 ipv6 enable ! ! interface GigabitEthernet4/0/1 description access interface switchport mode trunk ! </pre>

VTEP 1	VTEP 2
<pre> interface GigabitEthernet1/0/29 description core-underlay-interface no switchport ip address 172.16.1.29 255.255.255.0 ip pim sparse-mode ! interface Vlan200 description core svi for l3vni vrf forwarding green ip unnumbered Loopback0 ip pim sparse-mode ipv6 enable no autostate ! interface Vlan201 description vni 6000 default-gateway vrf forwarding green ip address 192.168.1.201 255.255.255.0 ip pim sparse-mode ipv6 enable ! interface Vlan202 description vni 7000 default-gateway vrf forwarding green ip address 192.168.2.202 255.255.255.0 ip pim sparse-mode ! ! interface nve10 no ip address source-interface Loopback0 host-reachability protocol bgp member vni 6000 mcast-group 231.1.1.1 member vni 7000 mcast-group 231.1.1.1 member vni 5000 vrf green ! router ospf 1 router-id 10.1.1.10 network 10.1.1.0 0.0.0.255 area 0 network 172.16.1.0 0.0.0.255 area 0 ! router bgp 10 bgp router-id interface Loopback0 bgp log-neighbor-changes bgp update-delay 1 no bgp default ipv4-unicast neighbor 10.2.2.20 remote-as 10 neighbor 10.2.2.20 update-source Loopback0 ! address-family ipv4 exit-address-family ! address-family ipv4 mvpn neighbor 10.2.2.20 activate neighbor 10.2.2.20 send-community both exit-address-family ! address-family l2vpn evpn neighbor 10.2.2.20 activate neighbor 10.2.2.20 send-community both exit-address-family ! </pre>	<pre> interface GigabitEthernet1/0/30 description core-underlay-interface no switchport ip address 172.16.1.30 255.255.255.0 ip pim sparse-mode ! interface Vlan200 description core svi for l3vni vrf forwarding green ip unnumbered Loopback0 ip pim sparse-mode ipv6 enable no autostate ! interface Vlan201 vrf forwarding green ip address 192.168.1.201 255.255.255.0 ip pim sparse-mode ipv6 address 2001:DB8:201::201/64 ipv6 enable ! interface Vlan202 description vni 7000 default-gateway vrf forwarding green ip address 192.168.2.202 255.255.255.0 ip pim sparse-mode ! ! interface nve10 no ip address source-interface Loopback0 host-reachability protocol bgp member vni 6000 mcast-group 231.1.1.1 member vni 7000 mcast-group 231.1.1.1 member vni 5000 vrf green ! router ospf 1 router-id 10.2.2.20 network 10.2.2.0 0.0.0.255 area 0 network 172.16.1.0 0.0.0.255 area 0 ! router bgp 10 bgp router-id interface Loopback0 bgp log-neighbor-changes bgp update-delay 1 no bgp default ipv4-unicast neighbor 10.1.1.10 remote-as 10 neighbor 10.1.1.10 update-source Loopback0 ! address-family ipv4 exit-address-family ! address-family ipv4 mvpn neighbor 10.1.1.10 activate neighbor 10.1.1.10 send-community both exit-address-family ! address-family l2vpn evpn neighbor 10.1.1.10 activate neighbor 10.1.1.10 send-community both exit-address-family ! </pre>

VTEP 1	VTEP 2
<pre> address-family ipv4 vrf green advertise l2vpn evpn redistribute connected redistribute static exit-address-family ! ! ip pim rp-address 10.1.1.10 ip pim vrf green rp-address 10.1.13.13 ! ! end </pre>	<pre> address-family ipv4 vrf green advertise l2vpn evpn redistribute connected redistribute static exit-address-family ! ! ip pim rp-address 10.1.1.10 ip pim vrf green rp-address 10.1.14.14 ! ! end </pre>

The following examples provide outputs for **show** commands on VTEP 1 and VTEP 2 in the topology configured above.

- [show nve peers, on page 16](#)
- [show l2vpn evpn peers vxlan, on page 17](#)
- [show ip igmp vrf green groups, on page 17](#)
- [show bgp ipv4 mvpn all, on page 17](#)
- [show ip mroute vrf green, on page 18](#)
- [show ip mfib vrf green, on page 19](#)
- [show ip mroute, on page 21](#)
- [show ip mfib, on page 22](#)

show nve peers

VTEP 1

The following example shows the output for the **show nve peers** command on VTEP 1:

```

VTEP1# show nve peers
Interface VNI      Type Peer-IP          RMAC/Num_RTs  eVNI      state flags UP time
nve10    5000    L3CP 10.1.1.10      380e.4d9b.6a4a 5000      UP   A/-/4 03:22:40
nve10    6000    L2CP 10.2.2.20        14         6000      UP   N/A   03:22:19
nve10    7000    L2CP 10.2.2.20        6         7000      UP   N/A   03:22:19

```

VTEP 2

The following example shows the output for the **show nve peers** command on VTEP 2:

```

VTEP2# show nve peers
Interface VNI      Type Peer-IP          RMAC/Num_RTs  eVNI      state flags UP time
nve10    5000    L3CP 10.1.1.10      a0f8.4910.bce2 5000      UP   A/M/4 03:22:27
nve10    6000    L2CP 10.1.1.10        6         6000      UP   N/A   03:22:27
nve10    7000    L2CP 10.1.1.10        4         7000      UP   N/A   03:22:27

```


show l2vpn evpn peers vxlan**VTEP 1**

The following example shows the output for the **show l2vpn evpn peers vxlan** command on VTEP 1:

```
VTEP1# show l2vpn evpn peers vxlan
Interface VNI      Peer-IP              Num routes eVNI      UP time
-----
nve10      6000      10.2.2.20           5          6000     01:34:50
nve10      7000      10.2.2.20           6          7000     01:34:50
```

VTEP 2

The following example shows the output for the **show l2vpn evpn peers vxlan** command on VTEP 2:

```
VTEP2# show l2vpn evpn peers vxlan
Interface VNI      Peer-IP              Num routes
eVNI      UP time
-----
nve10      6000      10.1.1.10           7          6000     01:35:23
nve10      7000      10.1.1.10           6          7000     01:35:23
```

show ip igmp vrf green groups**VTEP 1**

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

```
VTEP1# show ip igmp vrf green groups
IGMP Connected Group Membership
Group Address  Interface          Uptime    Expires    Last Reporter  Group Accounted
229.1.1.1     Vlan201           04:08:35  00:02:16  192.168.1.81
224.0.1.40    Loopback13        06:35:55  00:02:05  10.1.13.13
```

VTEP 2

The following example shows the output for the **show ip igmp vrf green groups** command on VTEP 2:

```
VTEP2# show ip igmp vrf green groups
IGMP Connected Group Membership
Group Address  Interface          Uptime    Expires    Last Reporter  Group Accounted
224.0.1.40    Loopback14        05:11:42  00:02:18  10.1.14.14
```

show bgp ipv4 mvpn all**VTEP 1**

The following example shows the output for the **show bgp ipv4 mvpn all** command on VTEP 1:

```
VTEP1# show bgp ipv4 mvpn all
BGP table version is 22, local router ID is 10.1.1.10
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
               t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found
   Network          Next Hop          Metric LocPrf Weight Path
Route Distinguisher: 103:2 (default for vrf green)
*>i  [5][103:2][192.168.2.88][229.1.1.1]/18
      10.2.2.20                0    100    0 ?
Route Distinguisher: 104:2
*>i  [5][104:2][192.168.2.88][229.1.1.1]/18
      10.2.2.20                0    100    0 ?
Route Distinguisher: 10.2.2.20:2
*>  [7][10.2.2.20:2][10][192.168.2.88/32][229.1.1.1/32]/22
      0.0.0.0                    32768 ?
```

VTEP 2

The following example shows the output for the **show bgp ipv4 mvpn all** command on VTEP 2:

```
VTEP2# show bgp ipv4 mvpn all
BGP table version is 24, local router ID is 10.2.2.20
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
               t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found
   Network          Next Hop          Metric LocPrf Weight Path
Route Distinguisher: 104:2 (default for vrf green)
*>  [5][104:2][192.168.2.88][229.1.1.1]/18
      0.0.0.0                    32768 ?
*>i  [7][104:2][10][192.168.2.88/32][229.1.1.1/32]/22
      10.1.1.10                0    100    0 ?
Route Distinguisher: 10.2.2.20:2
*>i  [7][10.2.2.20:2][10][192.168.2.88/32][229.1.1.1/32]/22
      10.1.1.10                0    100    0 ?
```

show ip mroute vrf green

VTEP 1

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

```
VTEP1# show ip mroute vrf green IP Multicast Routing Table
Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C - Connected,
       L - Local, P - Pruned, R - RP-bit set, F - Register flag,
       T - SPT-bit set, J - Join SPT, M - MSDP created entry, E - Extranet,
       X - Proxy Join Timer Running, A - Candidate for MSDP Advertisement,
       U - URD, I - Received Source Specific Host Report,
       Z - Multicast Tunnel, z - MDT-data group sender,
       Y - Joined MDT-data group, y - Sending to MDT-data group,
       G - Received BGP C-Mroute, g - Sent BGP C-Mroute,
       N - Received BGP Shared-Tree Prune, n - BGP C-Mroute suppressed,
       Q - Received BGP S-A Route, q - Sent BGP S-A Route,
       V - RD & Vector, v - Vector, p - PIM Joins on route,
       x - VxLAN group, c - PFP-SA cache created entry,
```

```

* - determined by Assert, # - iif-starg configured on rpf intf
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode
(*, 229.1.1.1), 04:11:11/stopped, RP 10.1.13.13, flags: SJC
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:
    Vlan201, Forward/Sparse, 04:11:11/00:02:40
(192.168.2.88, 229.1.1.1), 00:02:42/00:00:17, flags: gQ
  Incoming interface: Vlan200, RPF nbr 10.2.2.20
  Outgoing interface list:
    Vlan201, Forward/Sparse, 00:02:42/00:02:40
(*, 224.0.1.40), 04:44:21/00:02:34, RP 10.1.13.13, flags: SJCL
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:
    Loopback13, Forward/Sparse, 04:44:21/00:02:34

```

VTEP 2

The following example shows the output for the **show ip mroute vrf green** command on VTEP 2:

```

VTEP2# show ip mroute vrf green
IP Multicast Routing Table
Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C - Connected,
       L - Local, P - Pruned, R - RP-bit set, F - Register flag,
       T - SPT-bit set, J - Join SPT, M - MSDP created entry, E - Extranet,
       X - Proxy Join Timer Running, A - Candidate for MSDP Advertisement,
       U - URD, I - Received Source Specific Host Report,
       Z - Multicast Tunnel, z - MDT-data group sender,
       Y - Joined MDT-data group, y - Sending to MDT-data group,
       G - Received BGP C-Mroute, g - Sent BGP C-Mroute,
       N - Received BGP Shared-Tree Prune, n - BGP C-Mroute suppressed,
       Q - Received BGP S-A Route, q - Sent BGP S-A Route,
       V - RD & Vector, v - Vector, p - PIM Joins on route,
       x - VxLAN group, c - PFP-SA cache created entry,
       * - determined by Assert, # - iif-starg configured on rpf intf
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode
(*, 229.1.1.1), 00:53:58/stopped, RP 10.1.14.14, flags: SPF
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list: Null
(192.168.2.88, 229.1.1.1), 00:53:58/00:01:56, flags: FTGqx
  Incoming interface: Vlan202, RPF nbr 0.0.0.0
  Outgoing interface list:
    Vlan200, Forward/Sparse, 00:03:06/stopped
(*, 224.0.1.40), 04:46:21/00:02:48, RP 10.1.14.14, flags: SJCL
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:
    Loopback14, Forward/Sparse, 04:46:21/00:02:48

```

show ip mrib vrf green

VTEP 1

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

```

VTEP1# show ip mrib vrf green
Entry Flags:      C - Directly Connected, S - Signal, IA - Inherit A flag,
                  ET - Data Rate Exceeds Threshold, K - Keepalive

```

```

DDE - Data Driven Event, HW - Hardware Installed
ME - MoFRR ECMP entry, MNE - MoFRR Non-ECMP entry, MP - MFIB
MoFRR Primary, RP - MRIB MoFRR Primary, P - MoFRR Primary
MS - MoFRR Entry in Sync, MC - MoFRR entry in MoFRR Client.
I/O Item Flags: IC - Internal Copy, NP - Not platform switched,
NS - Negate Signalling, SP - Signal Present,
A - Accept, F - Forward, RA - MRIB Accept, RF - MRIB Forward,
MA - MFIB Accept, A2 - Accept backup,
RA2 - MRIB Accept backup, MA2 - MFIB Accept backup
Forwarding Counts: Pkt Count/Pkts per second/Avg Pkt Size/Kbits per second
Other counts:      Total/RPF failed/Other drops
I/O Item Counts:  HW Pkt Count/FS Pkt Count/PS Pkt Count   Egress Rate in pps
VRF green
(*,224.0.0.0/4) Flags: C HW
  SW Forwarding: 0/0/0/0, Other: 0/0/0
  HW Forwarding: 0/0/0/0, Other: 0/0/0
(*,224.0.1.40) Flags: C HW
  SW Forwarding: 0/0/0/0, Other: 0/0/0
  HW Forwarding: 0/0/0/0, Other: 0/0/0
  Tunnel9 Flags: A
  Loopback13 Flags: F IC NS
  Pkts: 0/0/0 Rate: 0 pps
(*,229.1.1.1) Flags: C HW
  SW Forwarding: 0/0/0/0, Other: 0/0/0
  HW Forwarding: 0/0/0/0, Other: 0/0/0
  Tunnel9 Flags: A
  Vlan201 Flags: F NS
  Pkts: 0/0/0 Rate: 0 pps
(192.168.2.88,229.1.1.1) Flags: HW
  SW Forwarding: 0/0/0/0, Other: 0/0/0
  HW Forwarding: 117/0/126/0, Other: 0/0/0
  Tunnel9 Flags: A
  Vlan200, VXLAN Decap Flags: NS
  Vlan201 Flags: F NS
  Pkts: 0/0/0 Rate: 0 pps

```

VTEP 2

The following example shows the output for the **show ip mfib vrf green** command on VTEP 2:

```

VTEP2# show ip mfib vrf green
Entry Flags: C - Directly Connected, S - Signal, IA - Inherit A flag,
ET - Data Rate Exceeds Threshold, K - Keepalive
DDE - Data Driven Event, HW - Hardware Installed
ME - MoFRR ECMP entry, MNE - MoFRR Non-ECMP entry, MP - MFIB
MoFRR Primary, RP - MRIB MoFRR Primary, P - MoFRR Primary
MS - MoFRR Entry in Sync, MC - MoFRR entry in MoFRR Client.
I/O Item Flags: IC - Internal Copy, NP - Not platform switched,
NS - Negate Signalling, SP - Signal Present,
A - Accept, F - Forward, RA - MRIB Accept, RF - MRIB Forward,
MA - MFIB Accept, A2 - Accept backup,
RA2 - MRIB Accept backup, MA2 - MFIB Accept backup
Forwarding Counts: Pkt Count/Pkts per second/Avg Pkt Size/Kbits per second
Other counts:      Total/RPF failed/Other drops
I/O Item Counts:  HW Pkt Count/FS Pkt Count/PS Pkt Count   Egress Rate in pps
VRF green
(*,224.0.0.0/4) Flags: C HW
  SW Forwarding: 0/0/0/0, Other: 0/0/0
  HW Forwarding: 0/0/0/0, Other: 0/0/0
(*,224.0.1.40) Flags: C HW
  SW Forwarding: 0/0/0/0, Other: 0/0/0
  HW Forwarding: 0/0/0/0, Other: 0/0/0

```

```

Tunnel5 Flags: A
Loopback14 Flags: F IC NS
  Pkts: 0/0/0 Rate: 0 pps
(*,229.1.1.1) Flags: C HW
SW Forwarding: 0/0/0/0, Other: 0/0/0
HW Forwarding: 0/0/0/0, Other: 0/0/0
Tunnel5 Flags: A
(192.168.2.88,229.1.1.1) Flags: HW
SW Forwarding: 56/0/100/0, Other: 1715/1699/16
HW Forwarding: 2306/0/122/0, Other: 0/0/0
Vlan202 Flags: A
Vlan200, VXLAN v4 Encap (5000, 239.1.1.1) Flags: F
  Pkts: 0/0/0 Rate: 0 pps

```

show ip mroute

VTEP 1

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

```

VTEP1# show ip mroute
IP Multicast Routing Table
Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C - Connected,
       L - Local, P - Pruned, R - RP-bit set, F - Register flag,
       T - SPT-bit set, J - Join SPT, M - MSDP created entry, E - Extranet,
       X - Proxy Join Timer Running, A - Candidate for MSDP Advertisement,
       U - URD, I - Received Source Specific Host Report,
       Z - Multicast Tunnel, z - MDT-data group sender,
       Y - Joined MDT-data group, y - Sending to MDT-data group,
       G - Received BGP C-Mroute, g - Sent BGP C-Mroute,
       N - Received BGP Shared-Tree Prune, n - BGP C-Mroute suppressed,
       Q - Received BGP S-A Route, q - Sent BGP S-A Route,
       V - RD & Vector, v - Vector, p - PIM Joins on route,
       x - VxLAN group, c - PFP-SA cache created entry,
       * - determined by Assert, # - iif-starg configured on rpf intf
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode
(*, 239.1.1.1), 00:57:25/00:03:16, RP 10.1.1.10, flags: SJCx
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:
    GigabitEthernet1/0/29, Forward/Sparse, 00:57:17/00:03:16
    Tunnel0, Forward/Sparse, 00:57:25/stopped
(10.2.2.20, 239.1.1.1), 00:04:25/00:02:37, flags: Tx
  Incoming interface: GigabitEthernet1/0/29, RPF nbr 172.16.1.30
  Outgoing interface list:
    Tunnel0, Forward/Sparse, 00:04:25/00:01:33
(*, 231.1.1.1), 00:57:25/00:03:02, RP 10.1.1.10, flags: SJCFx
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:
    GigabitEthernet1/0/29, Forward/Sparse, 00:56:28/00:03:02
    Tunnel0, Forward/Sparse, 00:57:25/stopped
(10.2.2.20, 231.1.1.1), 00:56:26/00:02:55, flags: JTx
  Incoming interface: GigabitEthernet1/0/29, RPF nbr 172.16.1.30
  Outgoing interface list:
    Tunnel0, Forward/Sparse, 00:56:26/00:00:33
(10.1.1.10, 231.1.1.1), 00:57:23/00:03:03, flags: FTx
  Incoming interface: Loopback0, RPF nbr 0.0.0.0
  Outgoing interface list:
    GigabitEthernet1/0/29, Forward/Sparse, 00:56:53/00:03:02
(*, 224.0.1.40), 00:57:25/00:02:46, RP 10.1.1.10, flags: SJCL
  Incoming interface: Null, RPF nbr 0.0.0.0

```

```

Outgoing interface list:
  GigabitEthernet1/0/29, Forward/Sparse, 00:56:43/00:02:46
  Loopback0, Forward/Sparse, 00:57:25/00:02:44

```

VTEP 2

The following example shows the output for the **show ip mroute** command on VTEP 2:

```

VTEP2# show ip mroute
IP Multicast Routing Table
Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C - Connected,
       L - Local, P - Pruned, R - RP-bit set, F - Register flag,
       T - SPT-bit set, J - Join SPT, M - MSDP created entry, E - Extranet,
       X - Proxy Join Timer Running, A - Candidate for MSDP Advertisement,
       U - URD, I - Received Source Specific Host Report,
       Z - Multicast Tunnel, z - MDT-data group sender,
       Y - Joined MDT-data group, y - Sending to MDT-data group,
       G - Received BGP C-Mroute, g - Sent BGP C-Mroute,
       N - Received BGP Shared-Tree Prune, n - BGP C-Mroute suppressed,
       Q - Received BGP S-A Route, q - Sent BGP S-A Route,
       V - RD & Vector, v - Vector, p - PIM Joins on route,
       x - VxLAN group, c - PFP-SA cache created entry,
       * - determined by Assert, # - iif-starg configured on rpf intf
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode
(*, 239.1.1.1), 04:50:56/stopped, RP 10.1.1.10, flags: SJCFx
  Incoming interface: GigabitEthernet1/0/30, RPF nbr 172.16.1.29
  Outgoing interface list:
    Tunnel0, Forward/Sparse, 04:50:56/00:02:03
  (10.2.2.20, 239.1.1.1), 00:04:51/00:02:44, flags: FTx
    Incoming interface: Loopback0, RPF nbr 0.0.0.0
    Outgoing interface list:
      GigabitEthernet1/0/30, Forward/Sparse, 00:04:49/00:02:37
  (*, 231.1.1.1), 00:58:51/stopped, RP 10.1.1.10, flags: SJCFx
    Incoming interface: GigabitEthernet1/0/30, RPF nbr 172.16.1.29
    Outgoing interface list:
      Tunnel0, Forward/Sparse, 00:58:51/00:01:08
  (10.1.1.10, 231.1.1.1), 00:58:16/00:01:05, flags: JTx
    Incoming interface: GigabitEthernet1/0/30, RPF nbr 172.16.1.29
    Outgoing interface list:
      Tunnel0, Forward/Sparse, 00:58:16/00:01:43
  (10.2.2.20, 231.1.1.1), 00:58:49/00:02:58, flags: FTx
    Incoming interface: Loopback0, RPF nbr 0.0.0.0
    Outgoing interface list:
      GigabitEthernet1/0/30, Forward/Sparse, 00:58:49/00:02:46
  (*, 224.0.1.40), 05:14:59/00:02:03, RP 10.1.1.10, flags: SJCL
    Incoming interface: GigabitEthernet1/0/30, RPF nbr 172.16.1.29
    Outgoing interface list:
      Loopback0, Forward/Sparse, 05:14:58/00:02:03

```

show ip mfib

VTEP 1

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

```

VTEP1# show ip mfib
Entry Flags:      C - Directly Connected, S - Signal, IA - Inherit A flag,
                  ET - Data Rate Exceeds Threshold, K - Keepalive

```

```

DDE - Data Driven Event, HW - Hardware Installed
ME - MoFRR ECMP entry, MNE - MoFRR Non-ECMP entry, MP - MFIB
MoFRR Primary, RP - MRIB MoFRR Primary, P - MoFRR Primary
MS - MoFRR Entry in Sync, MC - MoFRR entry in MoFRR Client.
I/O Item Flags: IC - Internal Copy, NP - Not platform switched,
NS - Negate Signalling, SP - Signal Present,
A - Accept, F - Forward, RA - MRIB Accept, RF - MRIB Forward,
MA - MFIB Accept, A2 - Accept backup,
RA2 - MRIB Accept backup, MA2 - MFIB Accept backup
Forwarding Counts: Pkt Count/Pkts per second/Avg Pkt Size/Kbits per second
Other counts:      Total/RPF failed/Other drops
I/O Item Counts:  HW Pkt Count/FS Pkt Count/PS Pkt Count   Egress Rate in pps
Default
(*,224.0.0.0/4) Flags: C HW
  SW Forwarding: 0/0/0/0, Other: 0/0/0
  HW Forwarding:  0/0/0/0, Other: 0/0/0
(*,224.0.1.40) Flags: C HW
  SW Forwarding: 0/0/0/0, Other: 0/0/0
  HW Forwarding:  0/0/0/0, Other: 0/0/0
  Tunnel8 Flags: A
  GigabitEthernet1/0/29 Flags: F NS
    Pkts: 0/0/0 Rate: 0 pps
  Loopback0 Flags: F IC NS
    Pkts: 0/0/0 Rate: 0 pps
(*,231.1.1.1) Flags: C HW
  SW Forwarding: 1/0/206/0, Other: 4/4/0
  HW Forwarding:  0/0/0/0, Other: 0/0/0
  Tunnel8 Flags: A
  GigabitEthernet1/0/29 Flags: F NS
    Pkts: 0/0/0 Rate: 0 pps
(10.1.1.10,231.1.1.1) Flags: HW
  SW Forwarding: 1/0/128/0, Other: 0/0/0
  HW Forwarding:  192/0/144/0, Other: 0/0/0
  Null0 Flags: A
  GigabitEthernet1/0/29 Flags: F NS
    Pkts: 0/0/0 Rate: 0 pps
(10.2.2.20,231.1.1.1) Flags: HW
  SW Forwarding: 0/0/0/0, Other: 0/0/0
  HW Forwarding:  386/0/186/0, Other: 0/0/0
  GigabitEthernet1/0/29 Flags: A
  Tunnel0, VXLAN Decap Flags: F NS
    Pkts: 0/0/0 Rate: 0 pps
(*,239.1.1.1) Flags: C HW
  SW Forwarding: 26/0/150/0, Other: 0/0/0
  HW Forwarding:  0/0/0/0, Other: 0/0/0
  Tunnel8 Flags: A
  GigabitEthernet1/0/29 Flags: F NS
    Pkts: 0/0/22 Rate: 0 pps
(10.2.2.20,239.1.1.1) Flags: HW
  SW Forwarding: 1/0/150/0, Other: 0/0/0
  HW Forwarding:  162/0/168/0, Other: 0/0/0
  GigabitEthernet1/0/29 Flags: A
  Tunnel0, VXLAN Decap Flags: F NS
    Pkts: 0/0/1 Rate: 0 pps

```

VTEP 2

The following example shows the output for the **show ip mfib** command on VTEP 2:

```

VTEP2# show ip mfib
Entry Flags:      C - Directly Connected, S - Signal, IA - Inherit A flag,
                  ET - Data Rate Exceeds Threshold, K - Keepalive

```

```

DDE - Data Driven Event, HW - Hardware Installed
ME - MoFRR ECMP entry, MNE - MoFRR Non-ECMP entry, MP - MFIB
MoFRR Primary, RP - MRIB MoFRR Primary, P - MoFRR Primary
MS - MoFRR Entry in Sync, MC - MoFRR entry in MoFRR Client.
I/O Item Flags: IC - Internal Copy, NP - Not platform switched,
NS - Negate Signalling, SP - Signal Present,
A - Accept, F - Forward, RA - MRIB Accept, RF - MRIB Forward,
MA - MFIB Accept, A2 - Accept backup,
RA2 - MRIB Accept backup, MA2 - MFIB Accept backup
Forwarding Counts: Pkt Count/Pkts per second/Avg Pkt Size/Kbits per second
Other counts:      Total/RPF failed/Other drops
I/O Item Counts:  HW Pkt Count/FS Pkt Count/PS Pkt Count   Egress Rate in pps
Default
(*,224.0.0.0/4) Flags: C HW
  SW Forwarding: 0/0/0/0, Other: 0/0/0
  HW Forwarding:  0/0/0/0, Other: 0/0/0
(*,224.0.1.40) Flags: C HW
  SW Forwarding: 0/0/0/0, Other: 0/0/0
  HW Forwarding:  0/0/0/0, Other: 0/0/0
  GigabitEthernet1/0/30 Flags: A NS
  Loopback0 Flags: F IC NS
  Pkts: 0/0/0 Rate: 0 pps
(*,231.1.1.1) Flags: C HW
  SW Forwarding: 0/0/0/0, Other: 0/0/0
  HW Forwarding:  1/0/146/0, Other: 0/0/0
  GigabitEthernet1/0/30 Flags: A NS
  Tunnel0, VXLAN Decap Flags: F NS
  Pkts: 0/0/0 Rate: 0 pps
(10.1.1.10,231.1.1.1) Flags: HW
  SW Forwarding: 1/0/128/0, Other: 0/0/0
  HW Forwarding:  192/0/156/0, Other: 0/0/0
  GigabitEthernet1/0/30 Flags: A
  Tunnel0, VXLAN Decap Flags: F NS
  Pkts: 0/0/1 Rate: 0 pps
(10.2.2.20,231.1.1.1) Flags: HW
  SW Forwarding: 3/0/194/0, Other: 1/1/0
  HW Forwarding:  397/0/174/0, Other: 0/0/0
  Null0 Flags: A
  GigabitEthernet1/0/30 Flags: F NS
  Pkts: 0/0/2 Rate: 0 pps
(*,239.1.1.1) Flags: C HW
  SW Forwarding: 0/0/0/0, Other: 0/0/0
  HW Forwarding:  0/0/0/0, Other: 0/0/0
  GigabitEthernet1/0/30 Flags: A NS
  Tunnel0, VXLAN Decap Flags: F NS
  Pkts: 0/0/0 Rate: 0 pps
(10.2.2.20,239.1.1.1) Flags: HW
  SW Forwarding: 3/0/150/0, Other: 1/1/0
  HW Forwarding:  160/0/156/0, Other: 0/0/0
  Null0 Flags: A
  GigabitEthernet1/0/30 Flags: F NS
  Pkts: 0/0/2 Rate: 0 pps

```

Verifying Tenant Routed Multicast

The following table lists the **show** commands that are used to verify TRM:

Command	Purpose
show nve peers	Displays NVE interface state information for peer leaf switches.
show l2vpn evpn peers vxlan	Displays Layer 2 EVPN peer route counts in the VXLAN and up time.
show ip igmp vrf green groups	Displays the multicast groups with receivers that are directly connected to the router pertaining to the specific Multicast Virtual Routing and Forwarding (MVRF) instance and that were learned through IGMP.
show bgp ipv4 mvpn all	Displays the MVPN options for BGP MVPN C-route signaling.
show ip mroute vrf green	Displays the contents of the mroute table that pertain to a specific MVRF instance.
show ip mfib vrf green	Displays forwarding entries and interfaces in the IPv4 Multicast Forwarding Information Base (MFIB) associated with MVRF instances.
show ip mroute	Displays multicast routing table information.
show ip mfib	Displays the forwarding entries and interfaces in the IPv4 MFIB.

