# MVPN ingress replication over SRv6

This document describes MVPN Ingress Replication (IR) over SRv6.



# Feature Information for MVPN ingress replication over SRv6

The table below provides the feature history for MVPN ingress replication over SRv6.

***Table 1:***

| Feature | Release | Description |
|---|---|---|
| **MVPN Ingress Replication (IR) over SRv6** | Cisco IOS XE 17.18.1a | This feature enables the transport of IPv4 Multicast traffic across an SRv6 network. It simplifies multicast deployment by using the existing SRv6 unicast infrastructure as the underlay. With this feature, the ingress PE router receives multicast traffic and creates a separate unicast SRv6-encapsulated copy for each egress PE router in the multicast group. |

# MVPN Ingress Replication over SRv6

This document describes MVPN Ingress Replication (IR) over SRv6, a feature that

- enables the transport of IPv4 Multicast traffic across an SRv6 network,
- leverages the existing SRv6 unicast infrastructure
- simplifies multicast deployment by using SRv6 as the underlay transport.

The ingress PE router receives multicast traffic and creates a separate unicast SRv6-encapsulated copy for each egress PE router in the multicast group.

- Each packet is encapsulated using an SRv6 encapsulation that guides it to the intended egress PE.
- The core network simply forwards these SRv6 packets based on their segment routing headers; no multicast state is maintained in the core.
- The egress PE receives and decapsulates the outer SRv6 encapsulation, and then forwards the multicast data in corresponding VPN.

# How MVPN Ingress Replication over SRv6 works

This feature primarily supports IPv4 MVPN over an SRv6 network, specifically implementing the SRv6 End.DTMC4 behavior. Key capabilities and benefits include:

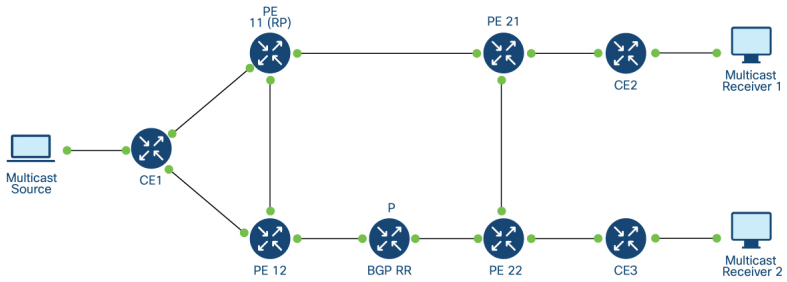
### Summary

The key components involved in the MVPN Ingress Replication over SRv6 process are:

- Ingress CE: The customer edge device that faces the multicast source.
- Ingress PE: The provider edge router that receives multicast traffic, performs replication, and encapsulates it.
- Core Network (P routers): The underlying SRv6 fabric that forwards encapsulated packets without maintaining multicast state.
- Egress PE: The provider edge router that receives and decapsulates multicast traffic for receivers.
- Egress CE: The customer edge device that faces the multicast receiver.

MVPN Ingress Replication over SRv6 describes the end-to-end flow of IPv4 multicast traffic from source to receiver using SRv6 as the underlay, leveraging ingress replication at the PE routers.

### Workflow




The MVPN Ingress Replication over SRv6 process involves the following stages:

1. The ingress CE faces the multicast source and forwards the multicast traffic to the Ingress PE. The Ingress PE performs replication based on learned multicast routes and encapsulates each replica in an IPv6 header. The Egress PE allocates a SID for MVPN per VRF, and the Ingress PE uses that SID for all multicast routes in the VRF for forwarding in the underlay. Each IPv6 packet is then forwarded to the appropriate Egress PE.
2. The Egress PE receives the unicast IPv6 packet destined for its locally allocated SRv6 SID, decapsulates the outer SRv6 header, and performs a multicast lookup in the associated VRF. The payload is then delivered to the Egress CE facing the multicast receiver.
3. The Provider Edge (PE) and Provider (P) routers form the SRv6 fabric, while PE devices act as SRv6 edge nodes.

# Partitioned MDT profiles

In a partitioned MDT profile, only those egress PE routers with interested receivers are associated with that ingress PE. By using Partitioned MDT we limit the replication state in the Ingress PE to only include Egress PEs that contain receivers.

When a Partitioned MDT profile is used in PE-PE IR, egress PEs may need to identify traffic from ingress PEs, which uses an internal RPF-ID.

# Configure MVPN ingress replication over SRv6

Enable MVPN Ingress Replication over SRv6 for the specified VRF, allowing multicast traffic transport over the SRv6 underlay.

SRv6 MVPN IR transports only IPv4 multicast traffic over an SRv6 network. Intra-as BGP auto-discovery for SRv6 and C-mroute overlay signalling are enabled by default. Strict RPF check is also enabled by default.

**Before you begin**

For more information on static RP and Auto RP configuration, refer Configuring Basic IP Multicast

Follow these steps to configure MVPN IR over SRv6.

**Procedure**

**Step 1** Access the VRF definition configuration mode.

**Example:**

```
vrf definition BLUE
```

**Step 2** Enter the address-family configuration mode for IPv4.

**Example:**

```
address-family ipv4
```

**Step 3** Configure SRv6 multicast ingress replication.

**Example:**

```
srv6-mcast ingress-replication partitioned [data]
```

- `partitioned`: Specifies partitioned MDT.
- `data`: Specifies data MDT.

MVPN Ingress Replication over SRv6 is configured for the specified VRF, enabling multicast traffic transport over the SRv6 underlay.

# Configure SRv6 MVPN multicast

To enable MVPN Ingress Replication over SRv6 for multicast traffic within a VRF.

Intra-as BGP auto-discovery for SRv6 and C-mroute overlay signaling are enabled by default. Strict RPF check is also enabled by default.

**Before you begin**

Follow these steps to enable MVPN Ingress Replication over SRv6 for multicast traffic within a VRF.

**Procedure**

**Step 1** Enter the global configuration mode and access the VRF definition:

**Example:**

```
vrf definition <vrf-name>
```

**Step 2** Configure the Route Distinguisher (RD) for the VRF.

**Example:**

```
rd <route-distinguisher>
```

**Step 3** For IPv4 multicast, enter the address-family.

**Example:**

```
address-family ipv4
```

**Step 4** Configure the route-target for the VRF's address-family.

**Example:**

```
route-target {import | export | both } <route-target-ext-community>
```

**Step 5** Enable SRv6 multicast ingress replication:

**Example:**

```
srv6-mcast ingress-replication partitioned [data]
```

**Step 6** Exit the IPv4 address-family configuration mode:

**Example:**

```
exit-address-family
```

The specified VRF is configured to use SRv6 for MVPN Ingress Replication.

# Configure BGP MVPNv4 neighbor encapsulation

To specify the encapsulation type for MVPNv4 updates advertised to a BGP neighbor.

**Before you begin**

Follow these steps to specify the encapsulation type for MVPNv4 updates advertised to a BGP neighbor.

**Procedure**

**Step 1** Enter the global configuration mode and access the BGP router configuration.

**Example:**

```
router bgp <autonomous-system-number>
```

**Step 2** Enter the IPv4 MVPN address-family configuration mode.

**Example:**

```
address-family ipv4 mvpn
```

**Step 3** Configure the encapsulation option for a specific neighbor.

**Example:**

```
address-family ipv4 mvpn
            neighbor <neighbor-address> activate
            neighbor <neighbor-address> send-community both
```

The BGP neighbor is configured to advertise MVPNv4 updates only for the specified encapsulation type.

## BGP SRv6 configuration

To illustrate a sample BGP configuration for SRv6 in a multicast environment.

This example displays a BGP configuration that

- includes SRv6 locator and
- allocation mode settings, which are utilized by Multicast.

```
router bgp <autonomous-system-number>
          neighbor <neighbor-address> remote-as <remote-as-number>
          neighbor <neighbor-address> update-source <interface-type-and-number>
          segment-routing srv6
          locator <locator-name>
          exit-srv6
          address-family vpnv4
          neighbor <neighbor-address> activate
          neighbor <neighbor-address> send-community both
          segment-routing srv6
```

```
locator <locator-name>
alloc-mode per-vrf
exit-srv6
address-family ipv4 vrf <vrf-name>
segment-routing srv6
locator <locator-name>
alloc-mode per-vrf
exit-srv6
address-family ipv4 mvpn
neighbor <neighbor-address> activate
neighbor <neighbor-address> send-community both
```

# Verify and monitor MVPN ingress replication over SRv6

To provide commands and examples for monitoring and verifying the operation of SRv6 MVPN.

These commands help you monitor and verify the operation of SRv6 MVPN.

- 

The following example shows the output of the **show ip mroute** command on an Ingress PE router to display the multicast routing table for a specific VRF and group address.

```
PE12#show ip mroute vrf vpn-11 239.1.1.2 verbose
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,
       e - encap-helper tunnel flag, l - LISP decap ref count contributor
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
                          t - LISP transit group
 Timers: Uptime/Expires
 Interface state: Interface, Next-Hop or VCD, State/Mode

(*, 239.1.1.2), 00:04:47/stopped, RP 11.11.11.11, flags: SP
  Incoming interface: Srvif1, RPF nbr A002::1
  Remote RD: 11:11  RPF-ID: 0xA002::1
  Outgoing interface list: Null

(11.1.0.2, 239.1.1.2), 00:04:47/00:02:07, flags: TyGq
  Incoming interface: GigabitEthernet2.11, RPF nbr 14.1.0.1
   MDT TX nr: 2097162  LSM-ID: 0x5E
  Outgoing interface list:
    Srvif1, LSM MDT: 5E (data), Forward/Sparse, 00:04:47/stopped, Pkts:0, flags:
```

The following output example displays multicast routing entry details and MVPN replication.

```
PE12#show ip mroute vrf vpn-11 239.1.1.2 11.1.0.2 verbose

(11.1.0.2, 239.1.1.2), 00:02:32/00:00:27, flags: TyGq
  Incoming interface: GigabitEthernet2.11, RPF nbr 14.1.0.1
```

```
   MDT TX nr: 2097162  LSM-ID: 0x5E
  Outgoing interface list:
    Srvif1, LSM MDT: 5E (data), Forward/Sparse, 00:02:32/00:00:27, Pkts:0, flags:
```

The following example shows the output of the **show ip mfib** command on an Ingress PE router, displaying the multicast forwarding information base (MFIB) for a specific VRF and group address.

```
PE12#show ip mfib vrf vpn-11 239.1.1.2
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,
                e   - Encap helper tunnel flag.
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 vpn-11
 (*,239.1.1.2) Flags: C HW
   SW Forwarding: 0/0/0/0, Other: 0/0/0
   HW Forwarding:   0/0/0/0, Other: 0/0/0
   Srvif1, SRV6 LSM/5D, RPF-ID: 0xA002::1, Flags: A
 (11.1.0.2,239.1.1.2) Flags: ET HW
   SW Forwarding: 0/0/0/0, Other: 0/0/0
   HW Forwarding:   607/2/200/3, Other: 27/27/0
   GigabitEthernet2.11 Flags: A
   Srvif1, SRV6 LSM/5E, RPF-ID: *, Flags: F
     Pkts: 0/0/0    Rate: 0 pps
```

The **show bgp ipv4 mvpn vrf vpn-11 detail** command displays detailed BGP MVPN routing table entries for VRF vpn-11.

```
PE12#show bgp ipv4 mvpn vrf vpn-11 detail

Route Distinguisher: 11:11 (default for vrf vpn-11)
BGP routing table entry for [1][11:11][A002::1]/24, version 3764603
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
  Local
    A002::1 (metric 20) from A005::1 (5.5.5.5)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:11:11
      Originator: 2.2.2.2, Cluster list: 5.5.5.5
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 7 2025 17:53:45 UTC
BGP routing table entry for [1][11:11][A003::1]/24, version 3764604
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
  Local
    A003::1 (metric 30) from A005::1 (5.5.5.5)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:11:11
      Originator: 3.3.3.3, Cluster list: 5.5.5.5
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 4 2025 05:52:41 UTC
BGP routing table entry for [1][11:11][A004::1]/24, version 3764605
```

```
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Advertised to update-groups:
     23
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (4.4.4.4)
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      Extended Community: RT:11:11
      rx pathid: 0, tx pathid: 0x0
      Updated on Jul 30 2025 04:45:12 UTC
BGP routing table entry for [1][11:11][A006::1]/24, version 3764606
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
  Local
    A006::1 (metric 30) from A005::1 (5.5.5.5)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:11:11
      Originator: 6.6.6.6, Cluster list: 5.5.5.5
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 4 2025 05:52:41 UTC
BGP routing table entry for [3][11:11][*][*][A002::1]/26, version 3764768
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
  Local
    A002::1 (metric 20) from A005::1 (5.5.5.5)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:11:11
      Originator: 2.2.2.2, Cluster list: 5.5.5.5
      PMSI Attribute: Flags: 0x1, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A002::1 >
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 7 2025 17:53:45 UTC
BGP routing table entry for [3][11:11][*][*][A003::1]/26, version 3764769
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
  Local
    A003::1 (metric 30) from A005::1 (5.5.5.5)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:11:11
      Originator: 3.3.3.3, Cluster list: 5.5.5.5
      PMSI Attribute: Flags: 0x1, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A003::1 >
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 4 2025 05:52:41 UTC
BGP routing table entry for [3][11:11][*][*][A004::1]/26, version 3764770
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Advertised to update-groups:
     23
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (4.4.4.4)
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      Extended Community: RT:11:11
      PMSI Attribute: Flags: 0x1, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A004::1 >
      rx pathid: 0, tx pathid: 0x0
      Updated on Jul 30 2025 04:45:12 UTC
BGP routing table entry for [3][11:11][*][*][A006::1]/26, version 3764771
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
```

```
  Local
    A006::1 (metric 30) from A005::1 (5.5.5.5)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:11:11
      Originator: 6.6.6.6, Cluster list: 5.5.5.5
      PMSI Attribute: Flags: 0x1, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A006::1 >
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 4 2025 05:52:41 UTC
BGP routing table entry for [3][11:11][*][224.0.1.39][A002::1]/30, version 3764772
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
  Local
    A002::1 (metric 20) from A005::1 (5.5.5.5)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:11:11
      Originator: 2.2.2.2, Cluster list: 5.5.5.5
      PMSI Attribute: Flags: 0x1, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A002::1 >
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 7 2025 17:53:45 UTC
BGP routing table entry for [3][11:11][*][224.0.1.40][A002::1]/30, version 3764773
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
  Local
    A002::1 (metric 20) from A005::1 (5.5.5.5)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:11:11
      Originator: 2.2.2.2, Cluster list: 5.5.5.5
      PMSI Attribute: Flags: 0x1, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A002::1 >
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 7 2025 17:53:45 UTC
BGP routing table entry for [3][11:11][11.1.0.2][239.1.1.2][A004::1]/34, version 3764774
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Advertised to update-groups:
     23
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (4.4.4.4)
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      Extended Community: RT:11:11
      PMSI Attribute: Flags: 0x1, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A004::1 >
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 7 2025 09:22:19 UTC
BGP routing table entry for [4]{[3][11:11][*][*][A002::1]/26}[A004::1]/44, version 3739440
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Advertised to update-groups:
     23
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (4.4.4.4)
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      IPv6-Extended Community: RT::A002::1:0
      PMSI Attribute: Flags: 0x0, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A004::1 >
      srv6 in-sid: F:F128:4:E000::
      rx pathid: 3, tx pathid: 0x0
      Updated on Aug 8 2025 01:30:45 UTC
BGP routing table entry for [4]{[3][11:11][*][224.0.1.39][A002::1]/30}[A004::1]/48, version
 3666900
```

```
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Advertised to update-groups:
     23
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (4.4.4.4)
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      IPv6-Extended Community: RT::A002::1:0
      PMSI Attribute: Flags: 0x0, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A004::1 >
      srv6 in-sid: F:F128:4:E000::
      rx pathid: 3, tx pathid: 0x0
      Updated on Aug 7 2025 17:53:45 UTC
BGP routing table entry for [4]{[3][11:11][*][224.0.1.40][A002::1]/30}[A004::1]/48, version
 3666901
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Advertised to update-groups:
     23
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (4.4.4.4)
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      IPv6-Extended Community: RT::A002::1:0
      PMSI Attribute: Flags: 0x0, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A004::1 >
      srv6 in-sid: F:F128:4:E000::
      rx pathid: 3, tx pathid: 0x0
      Updated on Aug 7 2025 17:53:45 UTC
BGP routing table entry for [5][11:11][11.1.0.2][239.1.1.2]/18, version 3598737
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Advertised to update-groups:
     23
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (4.4.4.4)
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      Extended Community: RT:11:11
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 7 2025 09:22:12 UTC
BGP routing table entry for [7][11:11][100][11.1.0.2/32][239.1.1.2/32]/22, version 3730109
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
  Local
    A006::1 (metric 30) from A005::1 (5.5.5.5)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:4.4.4.4:3
      Originator: 6.6.6.6, Cluster list: 5.5.5.5
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 8 2025 00:54:16 UTC
```

Use the **show mvpn ipv4 vrf vpn-11 auto-discovery detail** command to display a summary of the MVPN auto-discovery routes.

```
PE12#show mvpn ipv4 vrf vpn-11 auto-discovery detail
I-PMSI - Intra-AS Inclusive-PMSI, S-PMSI - Selective-PMSI
* - Indicates Wildcard source or group address

 [I-PMSI][11:11][A002::1], Joined
  Orig: Remote Uptime: 2w5d Type: NONE

 [I-PMSI][11:11][A003::1], Joined
  Orig: Remote Uptime: 18:31:19 Type: NONE
```

```
 [I-PMSI][11:11][A006::1], Joined
  Orig: Remote Uptime: 18:31:19 Type: NONE

 [S-PMSI][11:11][*][*][A002::1], Joined
  Orig: Remote Uptime: 6d00h Type: IR SRV6

 [S-PMSI][11:11][*][*][A003::1],
  Orig: Remote Uptime: 18:31:19 Type: IR SRV6

 [S-PMSI][11:11][*][*][A006::1],
  Orig: Remote Uptime: 18:31:19 Type: IR SRV6

 [S-PMSI][11:11][*][224.0.1.39][A002::1], Joined
  Orig: Remote Uptime: 6d00h Type: IR SRV6

 [S-PMSI][11:11][*][224.0.1.40][A002::1], Joined
  Orig: Remote Uptime: 6d00h Type: IR SRV6

 [I-PMSI][11:11][A004::1], Joined
  Orig: Local Uptime: 5d19h Type: NONE

 [S-PMSI][11:11][*][*][A004::1], Joined
  Orig: Local Uptime: 5d19h Type: IR SRV6

 [S-PMSI][11:11][11.1.0.2][239.1.1.2][A004::1], Joined
  Orig: Local Uptime: 00:01:04 Type: IR SRV6
```

Use the **show mvpn ipv4 vrf vpn-11 leaf-information detail** command to display a summary of the MVPN leaf-information details.

```
PE12#show mvpn ipv4 vrf vpn-11 leaf-information detail
Route-Type: 1 - Intra-AS Inclusive-PMSI, 3 - Selective-PMSI
* - Indicates Wildcard source or group address

 [3][11:11][*][*][A004::1], Joined
  Remote Orig: A003::1 UMH: 0.0.0.0 Uptime: 00:01:41 Type: IR SRV6
  Remote SID:{F:F128:3:E024::, pl:0 bl:32 nl:16 fl:16 al:0 st:0 bhv:76} IR-address: A003::1
 Replication-Id: 200000

 [3][11:11][*][*][A004::1], Joined
  Remote Orig: A006::1 UMH: 0.0.0.0 Uptime: 00:01:24 Type: IR SRV6
  Remote SID:{F:F128:6:E024::, pl:0 bl:32 nl:16 fl:16 al:0 st:0 bhv:76} IR-address: A006::1
 Replication-Id: 200000

 [3][11:11][11.1.0.2][239.1.1.2][A004::1], Joined
  Remote Orig: A003::1 UMH: 0.0.0.0 Uptime: 00:01:33 Type: IR SRV6
  Remote SID:{F:F128:3:E024::, pl:0 bl:32 nl:16 fl:16 al:0 st:0 bhv:76} IR-address: A003::1
 Replication-Id: 20000A

 [3][11:11][11.1.0.2][239.1.1.2][A004::1], Joined
  Remote Orig: A006::1 UMH: 0.0.0.0 Uptime: 00:01:24 Type: IR SRV6
  Remote SID:{F:F128:6:E024::, pl:0 bl:32 nl:16 fl:16 al:0 st:0 bhv:76} IR-address: A006::1
 Replication-Id: 20000A

 [3][11:11][*][*][A002::1], Joined
  Local Orig: A004::1 UMH: A002::1 Uptime: 00:01:41 Type: IR SRV6
  Local SID:{F:F128:4:E000::, pl:64 bl:32 nl:16 fl:16 al:0 st:0 bhv:76} IR-address: A004::1
 IR-Egress-PSM-Id: 41947810

 [3][11:11][*][224.0.1.39][A002::1], Joined
  Local Orig: A004::1 UMH: A002::1 Uptime: 5d19h Type: IR SRV6
  Local SID:{F:F128:4:E000::, pl:64 bl:32 nl:16 fl:16 al:0 st:0 bhv:76} IR-address: A004::1
 IR-Egress-PSM-Id: 41947810
```

```
 [3][11:11][*][224.0.1.40][A002::1], Joined
  Local Orig: A004::1 UMH: A002::1 Uptime: 5d19h Type: IR SRV6
  Local SID:{F:F128:4:E000::, pl:64 bl:32 nl:16 fl:16 al:0 st:0 bhv:76} IR-address: A004::1
 IR-Egress-PSM-Id: 41947810
```

To view information on the replication branches, including remote SIDs, for the specified multicast LSM ID use the command below.

**Note** The LSM MDT: <value> field from the above **show ip mroute** output, for instance 5E in this example, provides the LSM ID value of the below **show mvpn replication** command.

```
PE12#show mvpn replication lsm-id 5E

Repl ID : 20000A   LSM ID : 5E   Uptime : 00:03:03
  Path Set ID         : 2800FD6
  Replication branches: 2
   IR (A003::1)
      Uptime         : 00:03:03      Refcount  : 1
      Remote SID: F:F128:3:E024::
   IR (A006::1)
      Uptime         : 00:02:54      Refcount  : 1
      Remote SID: F:F128:6:E024::
```

Use the following command to display detailed BGP MVPN information for the specified VRF.

```
PE22#show bgp ipv4 mvpn vrf vpn-11 detail

Route Distinguisher: 11:11 (default for vrf vpn-11)
BGP routing table entry for [1][11:11][A002::1]/24, version 1865054
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
  Local
    A002::1 (metric 30) from A005::1 (5.5.5.5)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:11:11
      Originator: 2.2.2.2, Cluster list: 5.5.5.5
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 7 2025 17:53:45 UTC
BGP routing table entry for [1][11:11][A003::1]/24, version 1865055
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
  Local
    A003::1 (metric 20) from A005::1 (5.5.5.5)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:11:11
      Originator: 3.3.3.3, Cluster list: 5.5.5.5
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 4 2025 05:52:41 UTC
BGP routing table entry for [1][11:11][A004::1]/24, version 1865056
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
  Local
    A004::1 (metric 30) from A005::1 (5.5.5.5)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:11:11
      Originator: 4.4.4.4, Cluster list: 5.5.5.5
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 7 2025 17:53:45 UTC
```

```
BGP routing table entry for [1][11:11][A006::1]/24, version 1865057
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Advertised to update-groups:
     9
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (6.6.6.6)
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      Extended Community: RT:11:11
      rx pathid: 0, tx pathid: 0x0
      Updated on Jul 16 2025 15:42:02 UTC
BGP routing table entry for [3][11:11][*][*][A002::1]/26, version 1865219
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
  Local
    A002::1 (metric 30) from A005::1 (5.5.5.5)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:11:11
      Originator: 2.2.2.2, Cluster list: 5.5.5.5
      PMSI Attribute: Flags: 0x1, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A002::1 >
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 7 2025 17:53:45 UTC
BGP routing table entry for [3][11:11][*][*][A003::1]/26, version 1865220
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
  Local
    A003::1 (metric 20) from A005::1 (5.5.5.5)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:11:11
      Originator: 3.3.3.3, Cluster list: 5.5.5.5
      PMSI Attribute: Flags: 0x1, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A003::1 >
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 4 2025 05:52:41 UTC
BGP routing table entry for [3][11:11][*][*][A004::1]/26, version 1865221
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
  Local
    A004::1 (metric 30) from A005::1 (5.5.5.5)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:11:11
      Originator: 4.4.4.4, Cluster list: 5.5.5.5
      PMSI Attribute: Flags: 0x1, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A004::1 >
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 7 2025 17:53:45 UTC
BGP routing table entry for [3][11:11][*][*][A006::1]/26, version 1865222
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Advertised to update-groups:
     9
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (6.6.6.6)
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      Extended Community: RT:11:11
      PMSI Attribute: Flags: 0x1, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A006::1 >
      rx pathid: 0, tx pathid: 0x0
      Updated on Jul 16 2025 15:42:02 UTC
BGP routing table entry for [3][11:11][*][224.0.1.39][A002::1]/30, version 1865223
```

```
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
  Local
    A002::1 (metric 30) from A005::1 (5.5.5.5)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:11:11
      Originator: 2.2.2.2, Cluster list: 5.5.5.5
      PMSI Attribute: Flags: 0x1, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A002::1 >
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 7 2025 17:53:45 UTC
BGP routing table entry for [3][11:11][*][224.0.1.40][A002::1]/30, version 1865224
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
  Local
    A002::1 (metric 30) from A005::1 (5.5.5.5)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:11:11
      Originator: 2.2.2.2, Cluster list: 5.5.5.5
      PMSI Attribute: Flags: 0x1, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A002::1 >
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 7 2025 17:53:45 UTC
BGP routing table entry for [3][11:11][11.1.0.2][239.1.1.2][A004::1]/34, version 1865225
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
  Local
    A004::1 (metric 30) from A005::1 (5.5.5.5)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:11:11
      Originator: 4.4.4.4, Cluster list: 5.5.5.5
      PMSI Attribute: Flags: 0x1, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A004::1 >
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 7 2025 17:53:45 UTC
BGP routing table entry for [4]{[3][11:11][*][*][A002::1]/26}[A006::1]/44, version 1848708
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Advertised to update-groups:
     9
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (6.6.6.6)
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      IPv6-Extended Community: RT::A002::1:0
      PMSI Attribute: Flags: 0x0, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A006::1 >
      srv6 in-sid: F:F128:6:E024::
      rx pathid: 3, tx pathid: 0x0
      Updated on Aug 8 2025 00:54:16 UTC
BGP routing table entry for [4]{[3][11:11][*][*][A004::1]/26}[A006::1]/44, version 1848705
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Advertised to update-groups:
     9
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (6.6.6.6)
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      IPv6-Extended Community: RT::A004::1:0
      PMSI Attribute: Flags: 0x0, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A006::1 >
      srv6 in-sid: F:F128:6:E024::
```

```
      rx pathid: 3, tx pathid: 0x0
      Updated on Aug 8 2025 00:54:16 UTC
BGP routing table entry for [4]{[3][11:11][*][224.0.1.39][A002::1]/30}[A006::1]/48, version
 1822559
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Advertised to update-groups:
     9
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (6.6.6.6)
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      IPv6-Extended Community: RT::A002::1:0
      PMSI Attribute: Flags: 0x0, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A006::1 >
      srv6 in-sid: F:F128:6:E024::
      rx pathid: 3, tx pathid: 0x0
      Updated on Aug 7 2025 17:53:45 UTC
BGP routing table entry for [4]{[3][11:11][*][224.0.1.40][A002::1]/30}[A006::1]/48, version
 1822560
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Advertised to update-groups:
     9
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (6.6.6.6)
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      IPv6-Extended Community: RT::A002::1:0
      PMSI Attribute: Flags: 0x0, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A006::1 >
      srv6 in-sid: F:F128:6:E024::
      rx pathid: 3, tx pathid: 0x0
      Updated on Aug 7 2025 17:53:45 UTC
BGP routing table entry for [4]{[3][11:11][11.1.0.2][239.1.1.2][A004::1]/34}[A006::1]/52,
version 1848706
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Advertised to update-groups:
     9
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (6.6.6.6)
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      IPv6-Extended Community: RT::A004::1:0
      PMSI Attribute: Flags: 0x0, Tunnel type: IR, length 16, label:exp-null tunnel
identifier: < Tunnel Endpoint: A006::1 >
      srv6 in-sid: F:F128:6:E024::
      rx pathid: 3, tx pathid: 0x0
      Updated on Aug 8 2025 00:54:16 UTC
BGP routing table entry for [5][11:11][11.1.0.2][239.1.1.2]/18, version 1822081
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Flag: 0x100
  Not advertised to any peer
  Refresh Epoch 2
  Local
    A004::1 (metric 30) from A005::1 (5.5.5.5)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Extended Community: RT:11:11
      Originator: 4.4.4.4, Cluster list: 5.5.5.5
      rx pathid: 0, tx pathid: 0x0
      Updated on Aug 7 2025 17:53:45 UTC
BGP routing table entry for [6][11:11][100][11.11.11.11/32][239.1.1.2/32]/22, version 1848709

  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Advertised to update-groups:
     9
```

```
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (6.6.6.6)
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      Extended Community: RT:2.2.2.2:3
      rx pathid: 3, tx pathid: 0x0
      Updated on Aug 8 2025 00:54:16 UTC
BGP routing table entry for [7][11:11][100][11.1.0.2/32][239.1.1.2/32]/22, version 1848707
  Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Advertised to update-groups:
     9
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (6.6.6.6)
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      Extended Community: RT:4.4.4.4:3
      rx pathid: 3, tx pathid: 0x0
      Updated on Aug 8 2025 00:54:16 UTC
```

The following example shows the output of the **show ip rpf** command on an Egress PE router, displaying the RPF ID (strict RPF check) of multicast routing table for a specific VRF and multicast group address.

```
PE22#show ip rpf vrf vpn-11 11.1.0.2
RPF information for ? (11.1.0.2)
  RPF interface: Srvif1
  RPF neighbor: ? (A004::1)
  RPF route/mask: 11.1.0.0/16
  RPF type: unicast (bgp 100)
  Doing distance-preferred lookups across tables
  RPF topology: ipv4 multicast base, originated from ipv6 unicast base
```

The following example shows the output of the **show ip mfib** command on an Egress PE router, displaying multicast forwarding information for a specific VRF and multicast group address.

```
PE22#show ip mfib vrf vpn-11 239.1.1.2
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,
                e   - Encap helper tunnel flag.
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 vpn-11
 (*,239.1.1.2) Flags: C HW
   SW Forwarding: 0/0/0/0, Other: 0/0/0
   HW Forwarding:   0/0/0/0, Other: 0/0/0
   Srvif1, SRV6 LSM/0, RPF-ID: 0xA002::1, Flags: A
   GigabitEthernet3.11 Flags: F NS
     Pkts: 0/0/0    Rate: 0 pps
 (11.1.0.2,239.1.1.2) Flags: HW
   SW Forwarding: 0/0/0/0, Other: 0/0/0
   HW Forwarding:   654/2/200/3, Other: 0/0/0
   Srvif1, SRV6 LSM/0, RPF-ID: 0xA004::1, Flags: A
   GigabitEthernet3.11 Flags: F NS
     Pkts: 0/0/0    Rate: 0 pps
```

The following example output displays detailed SID multicast information.

```
PE22# show segment-routing srv6 sid F:F128:6:E024:: detail

SID: F:F128:6:E024::     Type: DYNAMIC
 Behavior: End.DTMC4 (76)
 Context:
    interface: (not-set)
    vrf: (not-set), v4-topo-id: 0xFFFF, v6-topo-id: 0xFFFF
    next-hop: (not-set)
    policy: (not-set)
    distinguisher: (not-set)
    protected: n/a
    MCAST Instance: 1
      vrf v4: vpn-11, topo-id: 0x3
      ps_fwd_id: 41943073
 Stats:
    Packets: 12392565   Bytes: 2471022400
 User:
    User:Refcount                       Locator:Refcount
    -------------                       ----------------
    bgp-mvpn(2):1                       F128:1
 User Event history:
    Timestamp                  Client                         Event type
    ---------                  ------                         ----------
    07-16 15:41:51.677         bgp-mvpn(2)                    ALLOC
```

# Appendix: configuration reference

## SRv6 configuration for PE11

This section details the configuration of PE11, a Provider Edge router, focusing on its role in an SRv6 enabled network with advanced traffic engineering and VPN services

```
hostname PE11

vrf definition vpn-11
 rd 11:11
 route-target export 11:11
 route-target import 11:11
 !
 address-family ipv4
  srv6-mcast ingress-replication partitioned data
  route-target export 11:11
  route-target import 11:11
 exit-address-family
 !
 address-family ipv6
  route-target export 11:11
  route-target import 11:11
 exit-address-family
!
ip multicast-routing vrf vpn-11 distributed

bfd-template single-hop bfd_tmp
 interval microseconds min-tx 7000 min-rx 7000 multiplier 3
!
!
!
```

```
!
!
!
crypto ikev2 keyring gre_key
 peer gre
  address ::/0
  pre-shared-key cisco123
 !
!
!
crypto ikev2 profile gre_profile
 match identity remote address ::/0
 authentication remote pre-share
 authentication local pre-share
 keyring local gre_key
!
!
crypto ipsec transform-set gre_transet esp-aes esp-sha-hmac
 mode transport
!
!
crypto ipsec profile gre_profile
 set transform-set gre_transet
 set ikev2-profile gre_profile
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 2.2.2.2 255.255.255.255
 ip router isis 1
 ipv6 address A002::1/128
 ipv6 router isis 1
!
interface Loopback11
 vrf forwarding vpn-11
 ip address 11.11.11.11 255.255.255.255
 ip pim sparse-mode
!
interface Tunnel231
 description pe11_pe21_tunnel1
 ip address 23.11.0.2 255.255.0.0
 ip router isis 1
 ipv6 address 2311::2/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 tunnel source GigabitEthernet3.1
 tunnel mode gre ipv6
 tunnel destination 2301::3
 tunnel path-mtu-discovery
 isis bfd
 isis ipv6 bfd
!
interface Tunnel232
 description pe11_p21_tunnel2
 ip address 23.12.0.2 255.255.0.0
 ip router isis 1
 ipv6 address 2312::2/64
 ipv6 router isis 1
```

```
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 tunnel source GigabitEthernet3.2
 tunnel mode gre ipv6
 tunnel destination 2302::3
 tunnel path-mtu-discovery
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-128
  !
!
interface Tunnel233
 description pe11_p21_tunnel3
 ip address 23.13.0.2 255.255.0.0
 ip router isis 1
 ipv6 address 2313::2/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 tunnel source GigabitEthernet3.3
 tunnel mode gre ipv6
 tunnel destination 2303::3
 tunnel path-mtu-discovery
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-129
  !
!
interface Tunnel234
 description pe11_p21_tunnel4
 ip address 23.14.0.2 255.255.0.0
 ip router isis 1
 ipv6 address 2314::2/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 tunnel source GigabitEthernet3.4
 tunnel mode gre ipv6
 tunnel destination 2304::3
 tunnel path-mtu-discovery
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-130
  !
!
interface Tunnel235
 description pe11_p21_tunnel5
 ip address 23.15.0.2 255.255.0.0
 ip router isis 1
 ipv6 address 2315::2/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 tunnel source GigabitEthernet3.5
 tunnel mode gre ipv6
 tunnel destination 2305::3
 tunnel path-mtu-discovery
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-131
```

```
  !
!
interface Tunnel236
 description pe11_p21_tunnel6
 ip address 23.16.0.2 255.255.0.0
 ip router isis 1
 ipv6 address 2316::2/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 tunnel source GigabitEthernet3.6
 tunnel mode gre ipv6
 tunnel destination 2306::3
 tunnel path-mtu-discovery
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-132
  !
!
interface Tunnel237
 description pe11_p21_tunnel7
 ip address 23.17.0.2 255.255.0.0
 ip router isis 1
 ipv6 address 2317::2/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 tunnel source GigabitEthernet3.7
 tunnel mode gre ipv6
 tunnel destination 2307::3
 tunnel path-mtu-discovery
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-133
  !
!
interface Tunnel238
 description pe11_p21_tunnel8
 ip address 23.18.0.2 255.255.0.0
 ip router isis 1
 ipv6 address 2318::2/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 tunnel source GigabitEthernet3.8
 tunnel mode gre ipv6
 tunnel destination 2308::3
 tunnel path-mtu-discovery
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-134
  !
!
interface Tunnel239
 description pe11_p21_tunnel9
 ip address 23.19.0.2 255.255.0.0
 ip router isis 1
 ipv6 address 2319::2/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
```

```
 tunnel source GigabitEthernet3.9
 tunnel mode gre ipv6
 tunnel destination 2309::3
 tunnel path-mtu-discovery
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-135
  !
!
interface GigabitEthernet2.11
 encapsulation dot1Q 11
 vrf forwarding vpn-11
 ip address 12.1.0.2 255.255.0.0
 ip pim sparse-mode
!
interface GigabitEthernet3
 description pe11_pe21
 no ip address
 negotiation auto
!
interface GigabitEthernet3.1
 description pe11_pe21_subintf1
 encapsulation dot1Q 4001
 ip address 23.1.0.2 255.255.0.0
 ipv6 address 2301::2/64
!
interface GigabitEthernet3.2
 description pe11_pe21_subintf2
 encapsulation dot1Q 4002
 ip address 23.2.0.2 255.255.0.0
 ipv6 address 2302::2/64
!
interface GigabitEthernet3.3
 description pe11_pe21_subintf3
 encapsulation dot1Q 4003
 ip address 23.3.0.2 255.255.0.0
 ipv6 address 2303::2/64
!
interface GigabitEthernet3.4
 description pe11_pe21_subintf4
 encapsulation dot1Q 4004
 ip address 23.4.0.2 255.255.0.0
 ipv6 address 2304::2/64
!
interface GigabitEthernet3.5
 description pe11_pe21_subintf5
 encapsulation dot1Q 4005
 ip address 23.5.0.2 255.255.0.0
 ipv6 address 2305::2/64
!
interface GigabitEthernet3.6
 description pe11_pe21_subintf6
 encapsulation dot1Q 4006
 ip address 23.6.0.2 255.255.0.0
 ipv6 address 2306::2/64
!
interface GigabitEthernet3.7
 description pe11_pe21_subintf7
 encapsulation dot1Q 4007
 ip address 23.7.0.2 255.255.0.0
 ipv6 address 2307::2/64
!
interface GigabitEthernet3.8
```

```
 description pe11_pe21_subintf8
 encapsulation dot1Q 4008
 ip address 23.8.0.2 255.255.0.0
 ipv6 address 2308::2/64
!
interface GigabitEthernet3.9
 description pe11_pe21_subintf9
 encapsulation dot1Q 4009
 ip address 23.9.0.2 255.255.0.0
 ipv6 address 2309::2/64
!
interface GigabitEthernet4
 no ip address
 negotiation auto
!
interface GigabitEthernet5
 no ip address
 negotiation auto
!
interface GigabitEthernet6
 no ip address
 speed 1000
 no negotiation auto
!
interface GigabitEthernet7
 description pe11_pe12
 no ip address
 speed 1000
 no negotiation auto
!
interface GigabitEthernet7.1
 description pe11_pe12_subintf1
 encapsulation dot1Q 4011
 ip address 24.1.0.2 255.255.0.0
 ip router isis 1
 ipv6 address 2401::2/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 isis network point-to-point
 isis metric 10 level-1
 isis metric 10 level-2
 isis bfd
 isis ipv6 metric 10
 isis ipv6 bfd
!
interface GigabitEthernet7.2
 description pe11_pe12_subintf2
 encapsulation dot1Q 4012
 ip address 24.2.0.2 255.255.0.0
 ip router isis 1
 ipv6 address 2402::2/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 isis network point-to-point
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-128
  !
!
interface GigabitEthernet7.3
 description pe11_pe12_subintf3
```

```
 encapsulation dot1Q 4013
 ip address 24.3.0.2 255.255.0.0
 ip router isis 1
 ipv6 address 2403::2/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 isis network point-to-point
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-129
  !
!
interface GigabitEthernet7.4
 description pe11_pe12_subintf4
 encapsulation dot1Q 4014
 ip address 24.4.0.2 255.255.0.0
 ip router isis 1
 ipv6 address 2404::2/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 isis network point-to-point
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-130
  !
!
interface GigabitEthernet7.5
 description pe11_pe12_subintf5
 encapsulation dot1Q 4015
 ip address 24.5.0.2 255.255.0.0
 ip router isis 1
 ipv6 address 2405::2/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 isis network point-to-point
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-131
  !
!
interface GigabitEthernet7.6
 description pe11_pe12_subintf6
 encapsulation dot1Q 4016
 ip address 24.6.0.2 255.255.0.0
 ip router isis 1
 ipv6 address 2406::2/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 isis network point-to-point
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-132
  !
!
interface GigabitEthernet7.7
 description pe11_pe12_subintf7
```

```
 encapsulation dot1Q 4017
 ip address 24.7.0.2 255.255.0.0
 ip router isis 1
 ipv6 address 2407::2/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 isis network point-to-point
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-133
  !
!
interface GigabitEthernet7.8
 description pe11_pe12_subintf8
 encapsulation dot1Q 4018
 ip address 24.8.0.2 255.255.0.0
 ip router isis 1
 ipv6 address 2408::2/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 isis network point-to-point
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-134
  !
!
interface GigabitEthernet7.9
 description pe11_pe12_subintf9
 encapsulation dot1Q 4019
 ip address 24.9.0.2 255.255.0.0
 ip router isis 1
 ipv6 address 2409::2/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 isis network point-to-point
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-135
  !
!
segment-routing srv6
 sid holdtime 0
 encapsulation
  hop-limit propagate
  traffic-class propagate
 locators
  locator loc1-pe11
   prefix F:1:2::/48
   format usid-f3216
  locator F128
   prefix F:F128:2::/48
   format usid-f3216
   algorithm 128
  locator F129
   prefix F:F129:2::/48
   format usid-f3216
   algorithm 129
  locator F130
```

```
   prefix F:F130:2::/48
   format usid-f3216
   algorithm 130
  locator F131
   prefix F:F131:2::/48
   format usid-f3216
   algorithm 131
  locator F132
   prefix F:F132:2::/48
   format usid-f3216
   algorithm 132
  locator F133
   prefix F:F133:2::/48
   format usid-f3216
   algorithm 133
  locator F134
   prefix F:F134:2::/48
   format usid-f3216
   algorithm 134
  locator F135
   prefix F:F135:2::/48
   format usid-f3216
   algorithm 135
!
router isis 1
 net 49.0001.0000.0000.0002.00
 is-type level-2-only
 router-id Loopback0
 metric-style wide
 log-adjacency-changes
 lsp-mtu 1418
 nsf ietf
 distribute link-state level-2
 segment-routing mpls
 segment-routing prefix-sid-map advertise-local
 fast-reroute per-prefix level-2 all
 fast-reroute remote-lfa level-2 mpls-ldp
 fast-reroute ti-lfa level-2
 microloop avoidance rib-update-delay 15000
 affinity-map flexalgo-128 bit-position 128
 affinity-map flexalgo-129 bit-position 129
 affinity-map flexalgo-130 bit-position 130
 affinity-map flexalgo-131 bit-position 131
 affinity-map flexalgo-132 bit-position 132
 affinity-map flexalgo-133 bit-position 133
 affinity-map flexalgo-134 bit-position 134
 affinity-map flexalgo-135 bit-position 135
 flex-algo 128
  advertise-definition
  metric-type delay
  priority 100
  affinity
   include-any
    name flexalgo-128
    exit-fa-affinity-attr
   !
 !
 flex-algo 129
  advertise-definition
  metric-type delay
  priority 100
  affinity
   include-any
    name flexalgo-129
```

```
   exit-fa-affinity-attr
  !
!
flex-algo 130
 advertise-definition
 metric-type delay
 priority 100
 affinity
  include-any
   name flexalgo-130
   exit-fa-affinity-attr
  !
!
flex-algo 131
 advertise-definition
 metric-type delay
 priority 100
 affinity
  include-any
   name flexalgo-131
   exit-fa-affinity-attr
  !
!
flex-algo 132
 advertise-definition
 metric-type delay
 priority 100
 affinity
  include-any
   name flexalgo-132
   exit-fa-affinity-attr
  !
!
flex-algo 133
 advertise-definition
 metric-type delay
 priority 100
 affinity
  include-any
   name flexalgo-133
   exit-fa-affinity-attr
  !
!
flex-algo 134
 advertise-definition
 metric-type delay
 priority 100
 affinity
  include-any
   name flexalgo-134
   exit-fa-affinity-attr
  !
!
flex-algo 135
 advertise-definition
 metric-type delay
 priority 100
 affinity
  include-any
   name flexalgo-135
   exit-fa-affinity-attr
  !
!
bfd all-interfaces
```

```
 !
 address-family ipv6
  bfd all-interfaces
  segment-routing srv6
   locator loc1-pe11
   locator F128
   locator F129
   locator F130
   locator F131
   locator F132
   locator F133
   locator F134
   locator F135
  fast-reroute per-prefix level-2 all
  fast-reroute ti-lfa level-2
  microloop avoidance segment-routing
  microloop avoidance rib-update-delay 15000
 exit-address-family
 mpls traffic-eng router-id Loopback0
 mpls traffic-eng level-2
!
router bgp 100
 bgp router-id interface Loopback0
 bgp log-neighbor-changes
 bgp graceful-restart
 no bgp default ipv4-unicast
 neighbor A005::1 remote-as 100
 neighbor A005::1 update-source Loopback0
 !
 address-family ipv4
 exit-address-family
 !
 address-family ipv4 mvpn
  neighbor A005::1 activate
  neighbor A005::1 send-community extended
 exit-address-family
 !
 address-family vpnv4
  neighbor A005::1 activate
  neighbor A005::1 send-community both
 exit-address-family
 !
 address-family ipv4 vrf vpn-11
  redistribute connected
  redistribute static
  !
  segment-routing srv6
   locator F128
   alloc-mode per-vrf
  exit-srv6
  !
 exit-address-family
 !
!
ip pim vrf vpn-11 autorp listener
ip pim vrf vpn-11 send-rp-announce Loopback11 scope 10
ip pim vrf vpn-11 send-rp-discovery Loopback11 scope 10
ip pim vrf vpn-11 ssm default


ip route vrf vpn-11 11.1.0.0 255.255.0.0 GigabitEthernet2.11 12.1.0.1

performance-measurement
 interface GigabitEthernet7.1
```

```
 delay-measurement
  advertise-delay 10
interface GigabitEthernet7.2
 delay-measurement
  advertise-delay 10
interface GigabitEthernet7.3
 delay-measurement
  advertise-delay 10
interface GigabitEthernet7.4
 delay-measurement
  advertise-delay 10
interface GigabitEthernet7.5
 delay-measurement
  advertise-delay 10
interface GigabitEthernet7.6
 delay-measurement
  advertise-delay 10
interface GigabitEthernet7.7
 delay-measurement
  advertise-delay 10
interface GigabitEthernet7.8
 delay-measurement
  advertise-delay 10
interface GigabitEthernet7.9
 delay-measurement
  advertise-delay 10
interface Tunnel231
 delay-measurement
  advertise-delay 10
interface Tunnel232
 delay-measurement
  advertise-delay 10
interface Tunnel233
 delay-measurement
  advertise-delay 10
interface Tunnel234
 delay-measurement
  advertise-delay 10
interface Tunnel235
 delay-measurement
  advertise-delay 10
interface Tunnel236
 delay-measurement
  advertise-delay 10
interface Tunnel237
 delay-measurement
  advertise-delay 10
interface Tunnel238
 delay-measurement
  advertise-delay 10
interface Tunnel239
 delay-measurement
  advertise-delay 10
!
```

# SRv6 configuration for PE12

This section details the configuration of PE12, a Provider Edge router, focusing on its role in an SRv6 enabled network with advanced traffic engineering and VPN services.

```
version 17.19
hostname PE12
```

```
vrf definition vpn-11
 rd 11:11
 route-target export 11:11
 route-target import 11:11
 !
 address-family ipv4
  srv6-mcast ingress-replication partitioned data
  route-target export 11:11
  route-target import 11:11
 exit-address-family
 !
 address-family ipv6
  route-target export 11:11
  route-target import 11:11
 exit-address-family
!
ip multicast-routing vrf vpn-11 distributed

bfd-template single-hop bfd_tmp
 interval microseconds min-tx 7000 min-rx 7000 multiplier 3
!
crypto ikev2 keyring gre_key
 peer gre
  address ::/0
  pre-shared-key cisco123
 !
!
!
crypto ikev2 profile gre_profile
 match identity remote address ::/0
 authentication remote pre-share
 authentication local pre-share
 keyring local gre_key

crypto ipsec transform-set gre_transet esp-aes esp-sha-hmac
 mode transport
!
!
crypto ipsec profile gre_profile
 set transform-set gre_transet
 set ikev2-profile gre_profile
!
interface Loopback0
 ip address 4.4.4.4 255.255.255.255
 ip router isis 1
 ipv6 address A004::1/128
 ipv6 router isis 1
!
interface Tunnel451
 ip address 45.11.0.4 255.255.0.0
 ip router isis 1
 ipv6 address 4511::4/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 tunnel source GigabitEthernet3.1
 tunnel mode gre ipv6
 tunnel destination 4501::5
 tunnel path-mtu-discovery
 isis bfd
 isis ipv6 bfd
!
interface Tunnel452
```

```
 description pe12_p_tunnel2
 ip address 45.12.0.4 255.255.0.0
 ip router isis 1
 ipv6 address 4512::4/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 tunnel source GigabitEthernet3.2
 tunnel mode gre ipv6
 tunnel destination 4502::5
 tunnel path-mtu-discovery
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-128
  !
!
interface Tunnel453
 description pe12_p_tunnel3
 ip address 45.13.0.4 255.255.0.0
 ip router isis 1
 ipv6 address 4513::4/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 tunnel source GigabitEthernet3.3
 tunnel mode gre ipv6
 tunnel destination 4503::5
 tunnel path-mtu-discovery
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-129
  !
!
interface Tunnel454
 description pe12_p_tunnel4
 ip address 45.14.0.4 255.255.0.0
 ip router isis 1
 ipv6 address 4514::4/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 tunnel source GigabitEthernet3.4
 tunnel mode gre ipv6
 tunnel destination 4504::5
 tunnel path-mtu-discovery
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-130
  !
!
interface Tunnel455
 description pe12_p_tunnel5
 ip address 45.15.0.4 255.255.0.0
 ip router isis 1
 ipv6 address 4515::4/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 tunnel source GigabitEthernet3.5
 tunnel mode gre ipv6
 tunnel destination 4505::5
```

```
 tunnel path-mtu-discovery
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-131
  !
!
interface Tunnel456
 description pe12_p_tunnel6
 ip address 45.16.0.4 255.255.0.0
 ip router isis 1
 ipv6 address 4516::4/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 tunnel source GigabitEthernet3.6
 tunnel mode gre ipv6
 tunnel destination 4506::5
 tunnel path-mtu-discovery
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-132
  !
!
interface Tunnel457
 description pe12_p_tunnel7
 ip address 45.17.0.4 255.255.0.0
 ip router isis 1
 ipv6 address 4517::4/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 tunnel source GigabitEthernet3.7
 tunnel mode gre ipv6
 tunnel destination 4507::5
 tunnel path-mtu-discovery
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-133
  !
!
interface Tunnel458
 description pe12_p_tunnel8
 ip address 45.18.0.4 255.255.0.0
 ip router isis 1
 ipv6 address 4518::4/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 tunnel source GigabitEthernet3.8
 tunnel mode gre ipv6
 tunnel destination 4508::5
 tunnel path-mtu-discovery
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-134
  !
!
interface Tunnel459
 description pe12_p_tunnel9
 ip address 45.19.0.4 255.255.0.0
```

```
 ip router isis 1
 ipv6 address 4519::4/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 tunnel source GigabitEthernet3.9
 tunnel mode gre ipv6
 tunnel destination 4509::5
 tunnel path-mtu-discovery
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-135
  !
!
interface GigabitEthernet2
 description pe12_fhr
 vrf forwarding red
 ip address 14.1.0.4 255.255.0.0
 ip pim sparse-mode
 negotiation auto
!
interface GigabitEthernet2.11
 encapsulation dot1Q 11
 vrf forwarding vpn-11
 ip address 14.1.0.4 255.255.0.0
 ip pim sparse-mode
!
interface GigabitEthernet3
 description pe12_p
 no ip address
 negotiation auto
!
interface GigabitEthernet3.1
 description pe12_p_subintf1
 encapsulation dot1Q 4031
 ip address 45.1.0.4 255.255.0.0
 ipv6 address 4501::4/64
!
interface GigabitEthernet3.2
 description pe12_p_subintf2
 encapsulation dot1Q 4032
 ip address 45.2.0.4 255.255.0.0
 ipv6 address 4502::4/64
!
interface GigabitEthernet3.3
 description pe12_p_subintf3
 encapsulation dot1Q 4033
 ip address 45.3.0.4 255.255.0.0
 ipv6 address 4503::4/64
!
interface GigabitEthernet3.4
 description pe12_p_subintf4
 encapsulation dot1Q 4034
 ip address 45.4.0.4 255.255.0.0
 ipv6 address 4504::4/64
!
interface GigabitEthernet3.5
 description pe12_p_subintf5
 encapsulation dot1Q 4035
 ip address 45.5.0.4 255.255.0.0
 ipv6 address 4505::4/64
!
interface GigabitEthernet3.6
```

```
 description pe12_p_subintf6
 encapsulation dot1Q 4036
 ip address 45.6.0.4 255.255.0.0
 ipv6 address 4506::4/64
!
interface GigabitEthernet3.7
 description pe12_p_subintf7
 encapsulation dot1Q 4037
 ip address 45.7.0.4 255.255.0.0
 ipv6 address 4507::4/64
!
interface GigabitEthernet3.8
 description pe12_p_subintf8
 encapsulation dot1Q 4038
 ip address 45.8.0.4 255.255.0.0
 ipv6 address 4508::4/64
!
interface GigabitEthernet3.9
 description pe12_p_subintf9
 encapsulation dot1Q 4039
 ip address 45.9.0.4 255.255.0.0
 ipv6 address 4509::4/64
!
interface GigabitEthernet5
 description pe12_p11
 no ip address
 speed 1000
 no negotiation auto
!
interface GigabitEthernet5.1
 description pe12_p11_subintf1
 encapsulation dot1Q 4011
 ip address 24.1.0.4 255.255.0.0
 ip router isis 1
 ipv6 address 2401::4/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 isis network point-to-point
 isis bfd
 isis ipv6 bfd
!
interface GigabitEthernet5.2
 description pe12_p11_subintf2
 encapsulation dot1Q 4012
 ip address 24.2.0.4 255.255.0.0
 ip router isis 1
 ipv6 address 2402::4/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 isis network point-to-point
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-128
  !
!
interface GigabitEthernet5.3
 description pe12_p11_subintf3
 encapsulation dot1Q 4013
 ip address 24.3.0.4 255.255.0.0
 ip router isis 1
 ipv6 address 2403::4/64
```

```
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 isis network point-to-point
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-129
  !
!
interface GigabitEthernet5.4
 description pe12_p11_subintf4
 encapsulation dot1Q 4014
 ip address 24.4.0.4 255.255.0.0
 ip router isis 1
 ipv6 address 2404::4/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 isis network point-to-point
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-130
  !
!
interface GigabitEthernet5.5
 description pe12_p11_subintf5
 encapsulation dot1Q 4015
 ip address 24.5.0.4 255.255.0.0
 ip router isis 1
 ipv6 address 2405::4/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 isis network point-to-point
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-131
  !
!
interface GigabitEthernet5.6
 description pe12_p11_subintf6
 encapsulation dot1Q 4016
 ip address 24.6.0.4 255.255.0.0
 ip router isis 1
 ipv6 address 2406::4/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 isis network point-to-point
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-132
  !
!
interface GigabitEthernet5.7
 description pe12_p11_subintf7
 encapsulation dot1Q 4017
 ip address 24.7.0.4 255.255.0.0
 ip router isis 1
 ipv6 address 2407::4/64
```

```
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 isis network point-to-point
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-133
  !
!
interface GigabitEthernet5.8
 description pe12_p11_subintf8
 encapsulation dot1Q 4018
 ip address 24.8.0.4 255.255.0.0
 ip router isis 1
 ipv6 address 2408::4/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 isis network point-to-point
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-134
  !
!
interface GigabitEthernet5.9
 description pe12_p11_subintf9
 encapsulation dot1Q 4019
 ip address 24.9.0.4 255.255.0.0
 ip router isis 1
 ipv6 address 2409::4/64
 ipv6 router isis 1
 mpls traffic-eng tunnels
 bfd template bfd_tmp
 isis network point-to-point
 isis bfd
 isis ipv6 bfd
 isis affinity flex-algo
  name flexalgo-135
  !
!
segment-routing srv6
 sid holdtime 0
 encapsulation
  hop-limit propagate
  traffic-class propagate
 locators
  locator loc1-pe12
   prefix F:1:4::/48
   format usid-f3216
  locator F128
   prefix F:F128:4::/48
   format usid-f3216
   algorithm 128
  locator F129
   prefix F:F129:4::/48
   format usid-f3216
   algorithm 129
  locator F130
   prefix F:F130:4::/48
   format usid-f3216
   algorithm 130
  locator F131
```

```
   prefix F:F131:4::/48
   format usid-f3216
   algorithm 131
  locator F132
   prefix F:F132:4::/48
   format usid-f3216
   algorithm 132
  locator F133
   prefix F:F133:4::/48
   format usid-f3216
   algorithm 133
  locator F134
   prefix F:F134:4::/48
   format usid-f3216
   algorithm 134
  locator F135
   prefix F:F135:4::/48
   format usid-f3216
   algorithm 135
!
router isis 1
 net 49.0001.0000.0000.0004.00
 is-type level-2-only
 router-id Loopback0
 metric-style wide
 log-adjacency-changes
 lsp-mtu 1418
 nsf ietf
 distribute link-state level-2
 segment-routing mpls
 segment-routing prefix-sid-map advertise-local
 fast-reroute per-prefix level-2 all
 fast-reroute remote-lfa level-2 mpls-ldp
 fast-reroute ti-lfa level-2
 microloop avoidance rib-update-delay 15000
 affinity-map flexalgo-128 bit-position 128
 affinity-map flexalgo-129 bit-position 129
 affinity-map flexalgo-130 bit-position 130
 affinity-map flexalgo-131 bit-position 131
 affinity-map flexalgo-132 bit-position 132
 affinity-map flexalgo-133 bit-position 133
 affinity-map flexalgo-134 bit-position 134
 affinity-map flexalgo-135 bit-position 135
 flex-algo 128
  advertise-definition
  metric-type delay
  priority 100
  affinity
   include-any
    name flexalgo-128
    exit-fa-affinity-attr
   !
 !
 flex-algo 129
  advertise-definition
  metric-type delay
  priority 100
  affinity
   include-any
    name flexalgo-129
    exit-fa-affinity-attr
   !
 !
 flex-algo 130
```

```
 advertise-definition
 metric-type delay
 priority 100
 affinity
  include-any
   name flexalgo-130
   exit-fa-affinity-attr
  !
!
flex-algo 131
 advertise-definition
 metric-type delay
 priority 100
 affinity
  include-any
   name flexalgo-131
   exit-fa-affinity-attr
  !
!
flex-algo 132
 advertise-definition
 metric-type delay
 priority 100
 affinity
  include-any
   name flexalgo-132
   exit-fa-affinity-attr
  !
!
flex-algo 133
 advertise-definition
 metric-type delay
 priority 100
 affinity
  include-any
   name flexalgo-133
   exit-fa-affinity-attr
  !
!
flex-algo 134
 advertise-definition
 metric-type delay
 priority 100
 affinity
  include-any
   name flexalgo-134
   exit-fa-affinity-attr
  !
!
flex-algo 135
 advertise-definition
 metric-type delay
 priority 100
 affinity
  include-any
   name flexalgo-135
   exit-fa-affinity-attr
  !
!
bfd all-interfaces
!
address-family ipv6
 bfd all-interfaces
 segment-routing srv6
```

```
   locator loc1-pe12
   locator F128
   locator F129
   locator F130
   locator F131
   locator F132
   locator F133
   locator F134
   locator F135
  fast-reroute per-prefix level-2 all
  fast-reroute ti-lfa level-2
  microloop avoidance segment-routing
  microloop avoidance rib-update-delay 15000
 exit-address-family
 mpls traffic-eng router-id Loopback0
 mpls traffic-eng level-2
!
router bgp 100
 bgp router-id interface Loopback0
 bgp log-neighbor-changes
 bgp graceful-restart
 no bgp default ipv4-unicast
 neighbor A005::1 remote-as 100
 neighbor A005::1 update-source Loopback0
 !
 address-family ipv4
 exit-address-family
 !
 address-family ipv4 mvpn
  neighbor A005::1 activate
  neighbor A005::1 send-community extended
 exit-address-family
 !
 address-family vpnv4
  neighbor A005::1 activate
  neighbor A005::1 send-community both
 exit-address-family
 !
 address-family ipv4 vrf red
  redistribute connected
  redistribute static
  !
  segment-routing srv6
   locator loc1-pe12
   alloc-mode per-vrf
  exit-srv6
  !
 exit-address-family
 !
 address-family ipv4 vrf vpn-11
  redistribute connected
  redistribute static
  !
  segment-routing srv6
   locator F128
   alloc-mode per-vrf
  exit-srv6
  !
 exit-address-family
 !
ip pim vrf vpn-11 autorp listener
ip pim vrf vpn-11 ssm default

ip route vrf vpn-11 11.1.0.0 255.255.0.0 GigabitEthernet2.11 14.1.0.1
```

```
performance-measurement
 interface GigabitEthernet5.1
  delay-measurement
   advertise-delay 10
 interface GigabitEthernet5.2
  delay-measurement
   advertise-delay 10
 interface GigabitEthernet5.3
  delay-measurement
   advertise-delay 10
 interface GigabitEthernet5.4
  delay-measurement
   advertise-delay 10
 interface GigabitEthernet5.5
  delay-measurement
   advertise-delay 10
 interface GigabitEthernet5.6
  delay-measurement
   advertise-delay 10
 interface GigabitEthernet5.7
  delay-measurement
   advertise-delay 10
 interface GigabitEthernet5.8
  delay-measurement
   advertise-delay 10
 interface GigabitEthernet5.9
  delay-measurement
   advertise-delay 10
 interface Tunnel451
  delay-measurement
   advertise-delay 10
 interface Tunnel452
  delay-measurement
   advertise-delay 10
 interface Tunnel453
  delay-measurement
   advertise-delay 10
 interface Tunnel454
  delay-measurement
   advertise-delay 10
 interface Tunnel455
  delay-measurement
   advertise-delay 10
 interface Tunnel456
  delay-measurement
   advertise-delay 10
 interface Tunnel457
  delay-measurement
   advertise-delay 10
 interface Tunnel458
  delay-measurement
   advertise-delay 10
 interface Tunnel459
  delay-measurement
   advertise-delay 10
```