

Chapter 8

Multicast over Layer 3 VPNs

The JUNOS software provides support for multicast over Layer 3 virtual private networks (VPNs), as described in RFC 2547. The implementation is based on Section Two of the Internet Engineering Task Force (IETF) Internet draft *Multicast in MPLS/BGP VPNs* (draft-rosen-vpn-mcast-05.txt) and uses Protocol Independent Multicast (PIM) and Generalized Routing Encapsulation (GRE) tunneling. Initially, only PIM sparse mode was supported. In JUNOS Release 5.5, Layer 3 VPN multicast support is extended to include PIM dense mode.

This document assumes the reader is familiar with Layer 3 VPN operation on Juniper Networks routers, as well as standard PIM configurations. For more information on PIM and its usage in a Layer 3 VPN, see the *JUNOS 5.5 Internet Software Configuration Guide: Multicast*. For more information on Layer 3 VPN configuration, see the *JUNOS 5.5 Internet Software Configuration Guide: VPNs*. Both manuals are located at: <http://www.juniper.net/techpubs/software/junos/junos55>.

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Overview

In a unicast environment for Layer 3 VPNs, all VPN states are contained within the provider edge (PE) routers. With multicast over Layer 3 VPNs, two PIM adjacencies are established: one between the customer edge (CE) and PE routers through a VPN routing and forwarding (VRF) instance, the second between the master PIM instance (configured at the [edit protocols pim] hierarchy level) and the interior gateway protocol (IGP) neighbors of this PE. The set of these master PIM adjacencies throughout the service provider's network makes up the forwarding path, which will eventually be a rendezvous point (RP) tree. The tree is rooted at the RP contained within the service provider's network. Because of this, core provider transit routers within the service provider's network must maintain multicast state information for the VPNs.

For multicast in Layer 3 VPNs to work correctly, there must be two types of rendezvous points for each VPN. The VPN-RP is an RP that resides within the VPN, and the service provider rendezvous point (SP-RP) resides within the service provider network.



Note

A PE router can act as an SP-RP but cannot be the VPN-RP of a VPN. The VPN-RP must be located at a CE router or elsewhere within the VPN.

The operation of multicast within a Layer 3 VPN domain occurs in multiple stages, which are described on the following pages.

Figure 33: Multicast over Layer 3 VPNs Operation

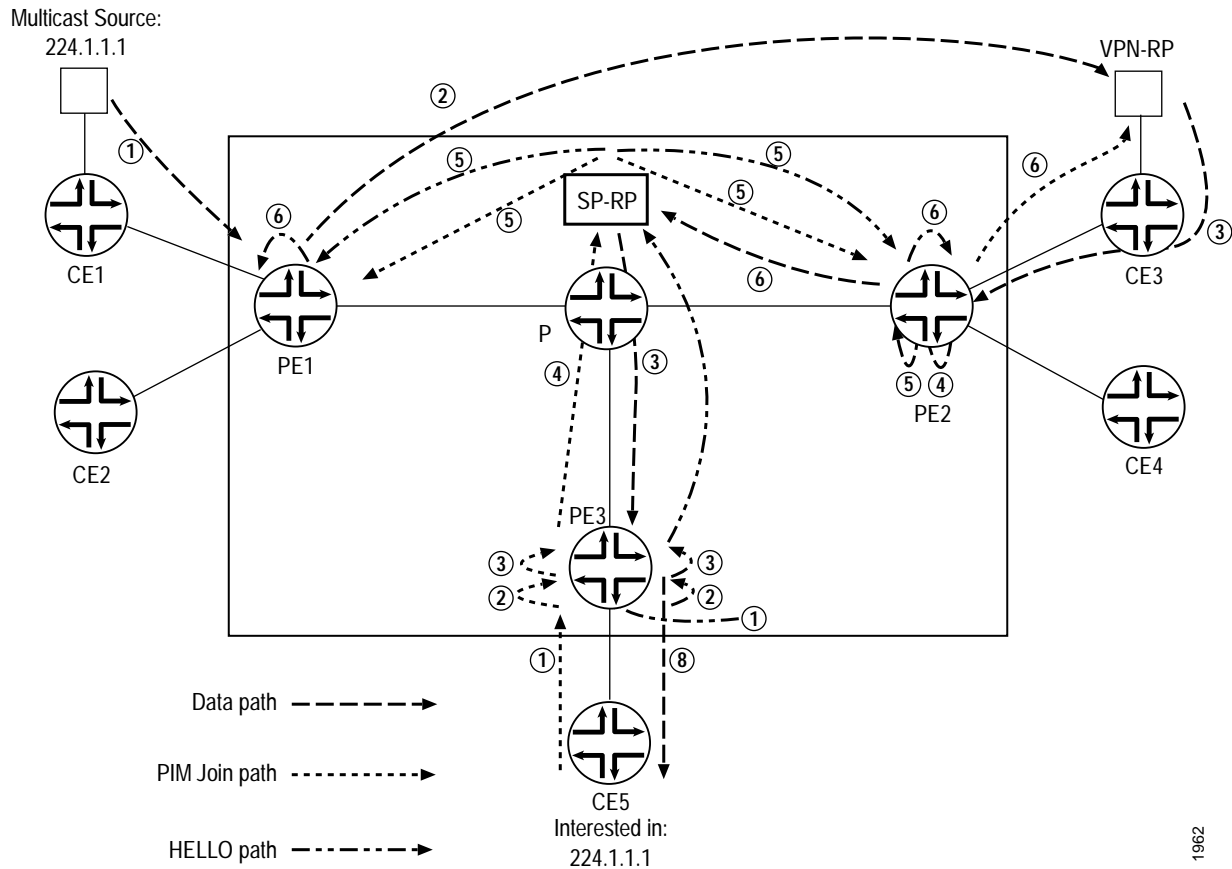


Figure 33 shows the various stages that multicast packets pass through in a Layer 3 VPN environment.

Stage 1: PIM HELLO

1. PIM is configured as part of a VPN routing instance and the configuration is committed. A virtual multicast tunnel interface (*mt-fpc/port.abcd*) is created if a Tunnel Services Physical Interface Card (PIC) exists on the router. This interface is used to communicate between the PIM instance within the VRF and the master PIM instance.
2. A PIM HELLO is sent from the VRF across the mt interface. When this happens, a GRE header is prepended to the PIM HELLO with fields containing the VPN group address and the loopback address of the PE router.
3. A PIM register header is prepended to the HELLO as the packet is looped through the pe (PIM Encapsulation) interface. This header contains the destination address of the SP-RP and the loopback address of the PE router.
4. The packet is sent to the SP-RP.

5. The SP-RP de-encapsulates the top header off the packet as it travels through the pd (PIM De-encapsulation) interface and sends the remaining GRE encapsulated HELLO to all of the PE routers.
6. The master PIM instance on the PE router handles the GRE encapsulated packet. Because the VPN group address is contained in the packet, the master instance de-encapsulates the packet and sends the HELLO over the mt interface to reach the desired VPN group address within the VRF.

Stage 2: PIM Join message

1. Router CE5 is interested in receiving from multicast source 224.1.1.1, so a PIM Join message is sent from router CE5 to router PE3.
2. The PIM Join message is sent through the mt interface and a GRE header is prepended to it. The GRE header contains the VPN group ID and the loopback address of router PE3.
3. The PIM Join message is then sent through the pe interface and a register header is prepended to the packet. The data contained within the register header is the IP address of the SP-RP and the loopback address of router PE3.
4. The PIM Join message is sent to the SP-RP using unicast routing.
5. Upon arrival at the SP-RP, the register header is stripped off and the packet is sent (with the GRE header intact) to all the PE routers.
6. Router PE2 receives the packet. Because the VPN-RP is behind router PE2, router PE2 sends the packet through the mt interface, which strips off the GRE header.
7. The PIM Join message is now sent to the VPN-RP.

Stage 3: Multicast forwarding

1. The source behind router CE1 is sending to group 224.1.1.1. The designated router (DR) behind the CE router encapsulates this packet into a PIM register.
2. Because the packet already has the PIM register header, it is forwarded to the VPN-RP by unicast routing over the Layer 3 VPN.
3. The VPN-RP de-encapsulates the data packet and sends it out the downstream interfaces (which include the return path interface leading to router CE3). Router CE3 also forwards the packet to router PE3.
4. The data packet is sent through the mt interface on router PE2. In the process, the GRE header is prepended to the packet.
5. The packet is next sent through the pe interface where the register header is prepended to the data packet.
6. The packet is forwarded to the SP-RP, which removes the register from the packet.
7. The packet is sent to the PE routers with GRE header intact.
8. The “interested” PE routers strip the GRE header off the packet and forward it to the CE routers that requested the PIM Join. If there are no PIM-join messages for this group at this site, the PE router drops the packet.

When PIM is configured within a routing instance, two mt interfaces are created as follows:

mt-[xxxxx] (xxxxx range is 32768 through 49151) for mt-encap

mt-[yyyyy] (yyyyy range is 49152 through 65535) for mt-decap

PIM is run only on the mt-encap interface. The mt-decap interface is used to populate downstream interface information.

System Requirements

To implement multicast over Layer 3 VPNs, your system must meet these minimum requirements:

JUNOS Release 5.5 or later for PIM dense mode and logical loopback interfaces

JUNOS Release 5.3 or later for PIM sparse mode

Any hardware needed in your network to enable your Juniper Networks routers to act as PE routers

A Tunnel Services PIC for any provider core router acting as an RP

A Tunnel Services PIC for any PE router where GRE tunneling is needed

A Tunnel Services PIC for any CE router acting as a DR or VPN-RP

The Tunnel Services PIC is required for GRE tunneling, as specified in Section Two of the IETF Internet draft *Multicast in MPLS/BGP VPNs*.

Terms and Acronyms

Master PIM instance—The global instance of PIM that is configured at the [edit protocols pim] hierarchy level.

Multicast domain—The set of VPN Routing and Forwarding (VRF) instances associated with interfaces that can send multicast traffic to one another.

SP-RP—The rendezvous point (RP) for the service provider (this RP is not contained within the VPN).

VPN-RP—The RP for the VPN (this RP is contained within the VPN).

Configure Multicast for Layer 3 VPNs

The configuration syntax for PIM in a Layer 3 instance is available at the [edit routing-instances protocols pim] hierarchy level. It is similar to the global PIM configuration syntax found at the [edit protocols pim] hierarchy level.

The only new configuration command is `vpn-group-address`. This command is configured for PIM within the routing instance and specifies the multicast group address for a particular VPN. Only one `vpn-group-address` can be configured per VPN, and this address should be unique on a per-VPN basis. To review how the VPN group address is used within GRE packet headers, see “Stage 2: PIM Join message” on page 276.

Keep in mind that each PE router will contain two entries of PIM: one for the routing instance that connects to the CE router, and a second for master instance of PIM that connects through the service provider network. The RP listed within the routing instance is known as a VPN-RP, while the RP in the master instance is an SP-RP. Additionally, you must configure a unique loopback interface for the routing instance at the [edit interfaces lo0 unit] hierarchy level and include the loopback interface in the PIM-enabled VPN routing instance. The following sample configuration shows a PE router with PIM enabled for sparse-dense mode in the VPN instance and PIM sparse mode in the master instance:

```
[edit]
interfaces {
  lo0 {
    unit 1 {
      family inet {
        address 10.1.1.1;
      }
    }
  }
}
protocols {
  pim {
    rp {
      static {
        address 10.254.71.47;
      }
    }
    interface all {
      mode sparse;
      version 2;
    }
    interface fxp0.0 {
      disable;
    }
  }
}
```

```

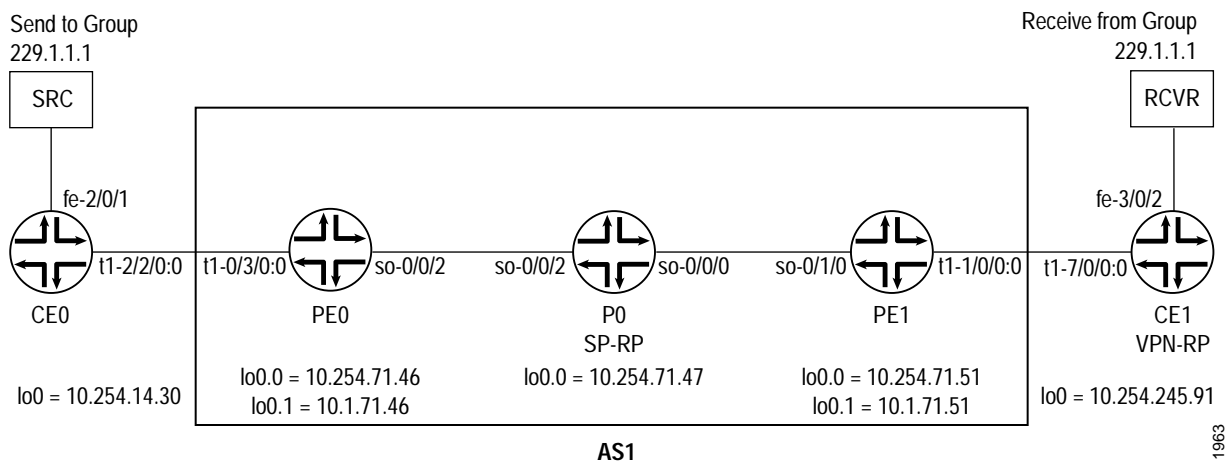
routing-instances {
  VPN-A {
    .....
    protocols {
      .....
      pim {
        vpn-group-address 239.1.1.1;
        rp {
          static {
            address 10.254.245.91;
          }
        }
        interface t1-1/0/0:0.0 {
          mode sparse-dense;
          version 2;
        }
        interface lo0.1 {
          mode sparse-dense;
          version 2;
        }
      }
    }
  }
}

```

Note In JUNOS software Release 5.5 and later, you can configure PIM dense mode with the dense statement at the [edit routing-instances pim mode] hierarchy level. Sparse mode is available at this same hierarchy level in JUNOS software Release 5.3 and later.

Example: Basic Multicast over a Layer 3 VPN Configuration

Figure 34: Basic Multicast over a Layer 3 VPN Topology Diagram



In Figure 34 on page 279, the multicast source sends to group 229.1.1.1, and the receiver listens to the same group address. The VPN-RP is located at router CE1, while the SP-RP is located at router PE0. The routing instances are named VPN-A on both routers PE0 and PE1.

```

CE0 [edit]
      protocols {
        pim {
          rp {
            dense-groups {
              229.0.0.0/8;
            }
            static {
              address 10.254.245.91;
            }
          }
          interface all {
            mode sparse-dense;
            version 2;
          }
          interface fxp0.0 {
            disable;
          }
        }
      }

```

In this example, the statement interface all is configured. If the topology requires only a few interfaces to be configured for PIM, then loopback interface lo0 must also be one of the configured interfaces.

```

PE0 [edit]
      protocols {
        pim {
          rp {
            static {
              address 10.254.71.47;
            }
          }
          interface all {
            mode sparse;
            version 2;
          }
          interface fxp0.0 {
            disable;
          }
        }
      }

```

Router PE0 also requires a standard VPN configuration, along with the PIM instance configuration. The `vpn-group-address` command is the only new PIM statement with PIM used exclusively with a routing instance multicast configuration.

```
[edit]
routing-instances {
  VPN-A {
    instance-type vrf;
    interface t1-0/3/0:0.0;
    interface lo0.1
    route-distinguisher 10.254.71.46:100;
    vrf-import VPN-A-import;
    vrf-export VPN-A-export;
    protocols {
      ospf {
        export bgp-to-ospf;
        area 0.0.0.0 {
          interface t1-0/3/0:0.0;
          interface lo0.1;
        }
      }
      pim {
        dense-groups {
          229.0.0.0/8;
        }
        vpn-group-address 239.1.1.1;
        rp {
          static {
            address 10.254.245.91;
          }
        }
        interface t1-0/3/0:0.0 {
          mode sparse-dense;
          version 2;
        }
        interface lo0.1 {
          mode sparse-dense;
          version 2;
        }
      }
    }
  }
}

```

```
P0 [edit]
protocols {
  pim {
    rp {
      local {
        address 10.254.71.47;
      }
    }
    interface all {
      mode sparse;
      version 2;
    }
    interface fxp0.0 {
      disable;
    }
  }
}

```

Again, if the configuration calls for specific interfaces to be configured for PIM, loopback interface lo0 must be included as one of the interfaces running PIM.

```

PE1 [edit]
  protocols {
    pim {
      rp {
        static {
          address 10.254.71.47;
        }
      }
      interface all {
        mode sparse;
        version 2;
      }
      interface fxp0.0 {
        disable;
      }
    }
  }
  routing-instances {
    VPN-A {
      instance-type vrf;
      interface t1-1/0/0:0.0;
      interface lo0.1;
      route-distinguisher 10.254.71.51:100;
      vrf-import VPN-A-import;
      vrf-export VPN-A-export;
      protocols {
        ospf {
          export bgp-to-ospf;
          area 0.0.0.0 {
            interface t1-1/0/0:0.0;
            interface lo0.1;
          }
        }
        pim {
          dense-groups {
            229.0.0.0/8;
          }
          vpn-group-address 239.1.1.1;
          rp {
            static {
              address 10.254.245.91;
            }
          }
          interface t1-1/0/0:0.0 {
            mode sparse-dense;
            version 2;
          }
          interface lo0.1 {
            mode sparse-dense;
            version 2;
          }
        }
      }
    }
  }
}

```

```

CE1 [edit]
  protocols {
    pim {
      dense-groups {
        229.0.0.0/8;
      }
      rp {
        local {
          address 10.254.245.91;
        }
      }
      interface all {
        mode sparse-dense;
        version 2;
      }
      interface fxp0.0 {
        disable;
      }
    }
  }

```

Check Your Work

To verify correct operation of basic multicast over a Layer 3 VPN, use the following commands:

```

show pim

show pim rps

show pim rps instance instance-name

show pim join

show pim join extensive

show pim join extensive instance instance-name

show multicast route extensive

show multicast next-hops

show interfaces mt-fpc/pic/port extensive

```

The following sections show the output of these commands used with the configuration example:

RP Information on page 284

PIM Information Prior to Multicast Transmission on page 284

Successful PIM Join Verification on page 286

RP Information

You can view master instance PIM information with the `show pim` command. You can see information on the PIM routing instance with the `show pim (rps | join extensive) instance instance-name` command. Output verifying the SP-RP (10.254.71.47) as well as the VPN-RP (10.254.245.91) follows:

```
user@PE0> show pim rps
Instance: PIM.master

Family: INET
RP address      Type      Holdtime Timeout Active groups Group prefixes
10.254.71.47    static    0        None      1 224.0.0.0/4

Family: INET6
RP address      Type      Holdtime Timeout Active groups Group prefixes

user@PE0> show pim rps instance VPN-A
Instance: PIM.VPN-A

Family: INET
RP address      Type      Holdtime Timeout Active groups Group prefixes
10.254.245.91  static    0        None      0 224.0.0.0/4

Family: INET6
RP address      Type      Holdtime Timeout Active groups Group prefixes
```

PIM Information Prior to Multicast Transmission

With the configuration properly set, the backbone PIM sessions should be established before any traffic is forwarded. In the output below, the routers were configured, but the traffic source was not transmitting and the receiver was not requesting to be part of a group. Notice that there is no PIM Join information for the routing instances yet.

```
user@PE0> show pim join extensive
Instance: PIM.master Family: INET
Group: 239.1.1.1
  Source: *
  RP: 10.254.71.47
  Flags: sparse,rptree,wildcard
  Upstream interface: so-0/0/2.0
  Upstream State: Join to RP
  Downstream Neighbors:
    Interface: mt-1/1/0.32769
      0.0.0.0 State: Join  Flags: SRW  Timeout: Infinity

Group: 239.1.1.1
  Source: 10.254.71.46
  Flags: sparse
  Upstream interface: local
  Upstream State: Local Source, Prune to RP
  Keepalive timeout: 166
  Downstream Neighbors:
    Interface: so-0/0/2.0
      192.168.296.70 State: Join  Flags: S    Timeout: 204
```

```

Group: 239.1.1.1
  Source: 10.254.71.51
  Flags: sparse,spt-pending
  Upstream interface: so-0/0/2.0
  Upstream State: Join to Source
  Keepalive timeout: 166
  Downstream Neighbors:
    Interface: mt-1/1/0.32769
      0.0.0.0 State: Join  Flags: S  Timeout: Infinity

user@PE0> show pim join extensive instance VPN-A
Instance: PIM.VPN-A Family: INET

user@P0> show pim join extensive
Instance: PIM.master Family: INET
Group: 239.1.1.1
  Source: *
  RP: 10.254.71.47
  Flags: sparse,rptree,wildcard
  Upstream interface: local
  Upstream State: Local RP
  Downstream Neighbors:
    Interface: so-0/0/0.0
      192.168.296.34 State: Join  Flags: SRW  Timeout: 186
    Interface: so-0/0/2.0
      192.168.296.69 State: Join  Flags: SRW  Timeout: 198

Group: 239.1.1.1
  Source: 10.254.71.46
  Flags: sparse,spt
  Upstream interface: so-0/0/2.0
  Upstream State: Local RP, Join to Source
  Keepalive timeout: 170
  Downstream Neighbors:
    Interface: so-0/0/0.0
      192.168.296.34 State: Join  Flags: S  Timeout: 186
    Interface: so-0/0/2.0
      192.168.296.69 State: Prune  Flags: SR  Timeout: 198

Group: 239.1.1.1
  Source: 10.254.71.51
  Flags: sparse,spt
  Upstream interface: so-0/0/0.0
  Upstream State: Local RP, Join to Source
  Keepalive timeout: 170
  Downstream Neighbors:
    Interface: so-0/0/0.0
      192.168.296.34 State: Prune  Flags: SR  Timeout: 186
    Interface: so-0/0/2.0
      192.168.296.69 State: Join  Flags: S  Timeout: 198

user@PE1> show pim join extensive
Instance: PIM.master Family: INET
Group: 239.1.1.1
  Source: *
  RP: 10.254.71.47
  Flags: sparse,rptree,wildcard
  Upstream interface: so-0/1/0.0
  Upstream State: Join to RP
  Downstream Neighbors:
    Interface: mt-1/1/0.32769
      0.0.0.0 State: Join  Flags: SRW  Timeout: Infinity

```

```

Group: 239.1.1.1
  Source: 10.254.71.46
  Flags: sparse,spt-pending
  Upstream interface: so-0/1/0.0
  Upstream State: Join to Source
  Keepalive timeout: 180
  Downstream Neighbors:
    Interface: mt-1/1/0.32769
      0.0.0.0 State: Join  Flags: S  Timeout: Infinity

Group: 239.1.1.1
  Source: 10.254.71.51
  Flags: sparse
  Upstream interface: local
  Upstream State: Local Source, Prune to RP
  Keepalive timeout: 180
  Downstream Neighbors:
    Interface: so-0/1/0.0
      192.168.296.33 State: Join  Flags: S  Timeout: 168

```

Successful PIM Join Verification

In the remaining output for this example, the `show pim join` output shows group participation. Also displayed is the output from the `show multicast route extensive` and `show multicast next-hop` commands. The join output for PIM within a VPN will reference the group 229.1.1.1, while the service provider side of the network will reference the join information for group 239.1.1.1 (which is the VPN group ID). In the `show multicast route extensive` output, you can view the group, sender, and upstream interface toward the sender.

```

CE0 user@CE0> show pim join
Instance: PIM.master Family: INET
Group: 229.1.1.1
  Source: 192.168.295.34
  Flags: dense
  Upstream interface: fe-2/0/1.0
Instance: PIM.master Family: INET6

user@CE0> show multicast route extensive

Family: INET
Group      Source prefix      Act Pru NHid  Packets  IfMismatch Timeout
229.1.1.1  192.168.295.34 /32 A  F  120    8010     0         360
  Upstream interface: fe-2/0/1.0
  Session name: Unknown
  Forwarding rate: 1 kBps (10 pps)

Family: INET6
Group      Source prefix      Act Pru NHid  Packets  IfMismatch Timeout

user@CE0> show multicast next-hops
Family: INET
ID      Refcount  KRefCount Downstream interface
120     2         1         t1-2/2/0:0.0

```

```

PE0 user@PE0> show pim join extensive
Instance: PIM.master Family: INET
Group: 239.1.1.1
  Source: *
  RP: 10.254.71.47
  Flags: sparse,rptree,wildcard
  Upstream interface: so-0/0/2.0
  Upstream State: Join to RP
  Downstream Neighbors:
    Interface: mt-1/1/0.32769
      10.1.71.46 State: Join  Flags: SRW  Timeout: Infinity

Group: 239.1.1.1
  Source: 10.254.71.46
  Flags: sparse
  Upstream interface: local
  Upstream State: Local Source, Prune to RP
  Keepalive timeout: 188
  Downstream Neighbors:
    Interface: so-0/0/2.0
      192.168.296.70 State: Join  Flags: S  Timeout: 180

Instance: PIM.master Family: INET6

user@PE0> show pim join extensive instance VPN-A
Instance: PIM.VPN-A Family: INET
Group: 229.1.1.1
  Source: 192.168.295.34
  Flags: dense
  Upstream interface: t1-0/3/0:0.0
  Downstream interfaces:
    mt-1/1/0.32769

Instance: PIM.VPN-A Family: INET6

user@PE0> show interfaces mt-1/1/0 extensive
Physical interface: mt-1/1/0, Enabled, Physical link is Up
  Interface index: 37, SNMP ifIndex: 45, Generation: 36
  Type: Multicast-GRE, Link-level type: GRE, MTU: Unlimited, Speed: 800mbps
  Hold-times      : Up 0 ms, Down 0 ms
  Device flags    : Present Running
  Interface flags: SNMP-Traps
  Statistics last cleared: Never
  Traffic statistics:
    Input bytes   :                2887970          0 bps
    Output bytes  :                   0          0 bps
    Input packets :                31896          0 pps
    Output packets:                   0          0 pps

Logical interface mt-1/1/0.32769 (Index 43) (SNMP ifIndex 0) (Generation 46)
  Flags: Point-To-Point SNMP-Traps
  IP-Header 239.1.1.1:10.254.71.46:47:df:64:0000000800000000
  Encapsulation: GRE-NULL
  Traffic statistics:
    Input bytes   :                   0
    Output bytes  :                2396
    Input packets :                   0
    Output packets:                34
  Local statistics:
    Input bytes   :                   0
    Output bytes  :                2396
    Input packets :                   0
    Output packets:                34

```

```

Transit statistics:
  Input bytes   :                0          0 bps
  Output bytes  :                0          0 bps
  Input packets:                0          0 pps
  Output packets:              0          0 pps
Protocol inet, MTU: 4446, Generation: 79, Route table: 3
  Flags: None

```

```

Logical interface mt-1/1/0.49154 (Index 44) (SNMP ifIndex 0) (Generation 47)
Flags: Point-To-Point SNMP-Traps Encapsulation: GRE-NULL

```

```

Traffic statistics:
  Input bytes   :            1550
  Output bytes  :                0
  Input packets:             33
  Output packets:              0
Local statistics:
  Input bytes   :            1550
  Output bytes  :                0
  Input packets:             33
  Output packets:              0
Transit statistics:
  Input bytes   :                0          0 bps
  Output bytes  :                0          0 bps
  Input packets:                0          0 pps
  Output packets:              0          0 pps
Protocol inet, MTU: Unlimited, Generation: 80, Route table: 3
  Flags: None

```

```

user@PE0> show pim join
Instance: PIM.master Family: INET
Group: 239.1.1.1
  Source: *
  RP: 10.254.71.47
  Flags: sparse,rptree,wildcard
  Upstream interface: so-0/0/2.0

```

```

Group: 239.1.1.1
  Source: 10.254.71.46
  Flags: sparse
  Upstream interface: local

```

```

Instance: PIM.master Family: INET6

```

```

user@PE0> show pim join instance VPN-A
Instance: PIM.VPN-A Family: INET
Group: 229.1.1.1
  Source: 192.168.295.34
  Flags: dense
  Upstream interface: t1-0/3/0:0.0
Instance: PIM.VPN-A Family: INET6

```

```
user@PE0> show multicast route extensive
```

```
Family: INET
Group          Source prefix      Act Pru NHid  Packets  IfMismatch Timeout
239.1.1.1      10.254.71.46 /32 A  F 86    9174     0         360
  Upstream interface: local
  Session name: Administratively Scoped
  Forwarding rate: 1 kBps (10 pps)
239.1.1.1      10.254.71.51 /32 A  F 96     36       0         360
  Upstream interface: so-0/0/2.0
  Session name: Administratively Scoped
  Forwarding rate: 0 kBps (0 pps)
```

```
Family: INET6
Group          Source prefix      Act Pru NHid  Packets  IfMismatch Timeout
```

```
user@PE0> show multicast route extensive instance VPN-A
```

```
Family: INET
Group          Source prefix      Act Pru NHid  Packets  IfMismatch Timeout
229.1.1.1      192.168.295.34 /32 A  F 85    9408     0         360
  Upstream interface: t1-0/3/0:0.0
  Session name: Unknown
  Forwarding rate: 1 kBps (10 pps)
```

```
Family: INET6
Group          Source prefix      Act Pru NHid  Packets  IfMismatch Timeout
```

```
user@PE0> show multicast next-hops
```

```
Family: INET
ID      Refcount  KRefCount  Downstream interface
86      2         1          so-0/0/2.0
85      2         1          mt-1/1/0.32769
96      2         1          mt-1/1/0.49154
```

```
Family: INET6
```

```
P0 user@P0> show pim join
```

```
Instance: PIM.master Family: INET
Group: 239.1.1.1
  Source: *
  RP: 10.254.71.47
  Flags: sparse,rptree,wildcard
  Upstream interface: local

Group: 239.1.1.1
  Source: 10.254.71.46
  Flags: sparse,spt
  Upstream interface: so-0/0/2.0

Group: 239.1.1.1
  Source: 10.254.71.51
  Flags: sparse,spt
  Upstream interface: so-0/0/0.0

Instance: PIM.master Family: INET6
```

```

user@P0> show multicast route extensive

Family: INET
Group          Source prefix      Act Pru NHid  Packets   IfMismatch Timeout
239.1.1.1      10.254.71.46      /32 A  F  127   9906      195       360
  Upstream interface: so-0/0/2.0
  Session name: Administratively Scoped
  Forwarding rate: 1 kBps (10 pps)
239.1.1.1      10.254.71.51      /32 A  F  126   135       23        359
  Upstream interface: so-0/0/0.0
  Session name: Administratively Scoped
  Forwarding rate: 0 kBps (0 pps)

```

```

Family: INET6
Group          Source prefix      Act Pru NHid  Packets   IfMismatch Timeout

```

```

user@P0> show multicast next-hops
Family: INET
ID      Refcount  KRefcount Downstream interface
127     2         1         so-0/0/0.0
126     2         1         so-0/0/2.0

```

```

Family: INET6

```

```

PE1 user@PE1> show pim join extensive
Instance: PIM.master Family: INET
Group: 239.1.1.1
  Source: *
  RP: 10.254.71.47
  Flags: sparse,rptree,wildcard
  Upstream interface: so-0/1/0.0
  Upstream State: Join to RP
  Downstream Neighbors:
    Interface: mt-1/1/0.32769
    10.1.71.51 State: Join  Flags: SRW  Timeout: Infinity

Group: 239.1.1.1
  Source: 10.254.71.46
  Flags: sparse,spt-pending
  Upstream interface: so-0/1/0.0
  Upstream State: Join to Source
  Keepalive timeout: 199
  Downstream Neighbors:
    Interface: mt-1/1/0.32769
    10.1.71.51 State: Join  Flags: S    Timeout: Infinity

Group: 239.1.1.1
  Source: 10.254.71.51
  Flags: sparse
  Upstream interface: local
  Upstream State: Local Source, Prune to RP
  Keepalive timeout: 79
  Downstream Neighbors:
    Interface: so-0/1/0.0
    192.168.296.33 State: Join  Flags: S    Timeout: 174
    Interface: register to RP 10.254.71.47 on pe-1/1/0.32769

Instance: PIM.master Family: INET6

```

```
user@PE1> show pim join extensive instance VPN-A
```

```
Instance: PIM.VPN-A Family: INET
Group: 229.1.1.1
Source: 192.168.295.34
Flags: dense
Upstream interface: mt-1/1/0.32769
Downstream interfaces:
    t1-1/0/0:0.0
```

```
Instance: PIM.VPN-A Family: INET6
```

```
user@PE1> show interfaces mt-1/1/0 extensive
```

```
Physical interface: mt-1/1/0, Enabled, Physical link is Up
Interface index: 38, SNMP ifIndex: 45, Generation: 37
Type: Multicast-GRE, Link-level type: GRE, MTU: Unlimited, Speed: 800mbps
Hold-times      : Up 0 ms, Down 0 ms
Device flags    : Present Running
Interface flags: SNMP-Traps
Statistics last cleared: Never
Traffic statistics:
Input bytes  :                2265256                7568 bps
Output bytes :                   0                   0 bps
Input packets:                24981                10 pps
Output packets:                   0                   0 pps
```

```
Logical interface mt-1/1/0.32769 (Index 45) (SNMP ifIndex 0) (Generation 46)
```

```
Flags: Point-To-Point SNMP-Traps
IP-Header 239.1.1.1:10.254.71.51:47:df:64:0000000800000000
Encapsulation: GRE-NULL
Traffic statistics:
Input bytes  :                   0
Output bytes :                10934
Input packets:                   0
Output packets:                153
Local statistics:
Input bytes  :                   0
Output bytes :                10934
Input packets:                   0
Output packets:                153
Transit statistics:
Input bytes  :                   0                0 bps
Output bytes :                   0                0 bps
Input packets:                   0                0 pps
Output packets:                   0                0 pps
```

```
Protocol inet, MTU: 4418, Generation: 77, Route table: 1
Flags: None
```

```
Logical interface mt-1/1/0.49154 (Index 46) (SNMP ifIndex 0) (Generation 47)
```

```
Flags: Point-To-Point SNMP-Traps Encapsulation: GRE-NULL
Traffic statistics:
Input bytes  :                1820512
Output bytes :                   0
Input packets:                19848
Output packets:                   0
Local statistics:
Input bytes  :                   5536
Output bytes :                   0
Input packets:                120
Output packets:                   0
```

```

Transit statistics:
  Input bytes :          1814976          7568 bps
  Output bytes :           0           0 bps
  Input packets:          19728          10 pps
  Output packets:         0           0 pps
Protocol inet, MTU: Unlimited, Generation: 78, Route table: 1
Flags: None

```

```
user@PE1> show multicast route extensive
```

```

Family: INET
Group      Source prefix      Act Pru NHid  Packets  IfMismatch Timeout
239.1.1.1  10.254.71.46 /32 A  F 76  11014    0         360
  Upstream interface: so-0/1/0.0
  Session name: Administratively Scoped
  Forwarding rate: 1 kBps (10 pps)
239.1.1.1  10.254.71.51 /32 A  F 103  1        0         360
  Upstream interface: local
  Session name: Administratively Scoped
  Forwarding rate: 0 kBps (0 pps)

```

```

Family: INET6
Group      Source prefix      Act Pru NHid  Packets  IfMismatch Timeout

```

```
user@PE1> show multicast route extensive instance VPN-A
```

```

Family: INET
Group      Source prefix      Act Pru NHid  Packets  IfMismatch Timeout
229.1.1.1  192.168.295.34 /32 A  F 99  10976    4         360
  Upstream interface: mt-1/1/0.49154
  Session name: Unknown
  Forwarding rate: 1 kBps (10 pps)

```

```

Family: INET6
Group      Source prefix      Act Pru NHid  Packets  IfMismatch Timeout

```

```
user@PE1> show multicast next-hops
```

```

Family: INET
ID      Refcount  KRefCount  Downstream interface
75      2         1          so-0/1/0.0
99      2         1          t1-1/0/0:0.0
76      2         1          mt-1/1/0.49154

```

```
Family: INET6
```

```

CE1 user@CE1> show pim join
Instance: PIM.master Family: INET
Group: 229.1.1.1
  Source: 192.168.295.34
  Flags: dense
  Upstream interface: t1-7/0/0:0.0
Instance: PIM.master Family: INET6

```

```

user@CE1> show multicast route extensive

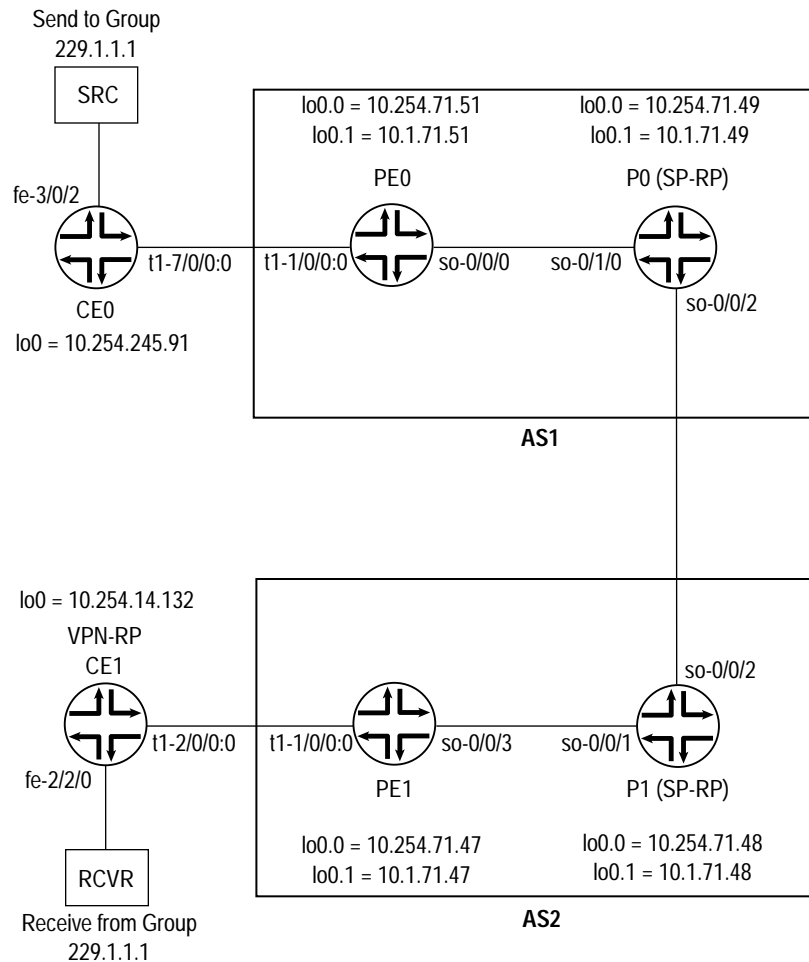
Family: INET
Group          Source prefix      Act Pru NHid  Packets   IfMismatch Timeout
229.1.1.1     192.168.295.34 /32 A  F  120    8010      0         360
  Upstream interface: t1-7/0/0:0.0
  Session name: Unknown
  Forwarding rate: 1 kBps (10 pps)

Family: INET6
Group          Source prefix      Act Pru NHid  Packets   IfMismatch Timeout

user@CE1> show multicast next-hops
Family: INET
ID      Refcount  KRefCount Downstream interface
120    2         1         1 fe-3/0/2.0
    
```

Example: Multicast with Interprovider VPNs

Figure 35: Multicast with Interprovider VPNs Topology Diagram



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Interprovider VPNs are also mentioned in RFC 2547. An example is shown in Figure 35. The topology is slightly different; the main difference is the addition of Multicast Source Discovery Protocol (MSDP) between two provider core transit (P) routers. In this limited topology, each P router is an SP-RP for the local autonomous system (AS), and router CE1 is the VPN-RP. VPN-A is the name of the routing instance on routers PE0 and PE1.

```

CEO [edit]
  protocols {
    pim {
      dense-groups {
        229.0.0.0/8;
      }
      rp {
        static {
          address 10.254.14.132;
        }
      }
      interface all {
        mode sparse-dense;
        version 2;
      }
      interface fxp0.0 {
        disable;
      }
    }
  }

PE0 [edit]
  protocols {
    pim {
      rp {
        static {
          address 10.254.71.49;
        }
      }
      interface all {
        mode sparse;
        version 2;
      }
      interface fxp0.0 {
        disable;
      }
    }
  }

```

```

routing-instances {
  VPN-A {
    protocols {
      pim {
        dense-groups {
          229.0.0.0/8;
        }
        vpn-group-address 239.1.1.1;
        rp {
          static {
            address 10.254.14.132;
          }
        }
        interface t1-1/0/0:0.0 {
          mode sparse-dense;
          version 2;
        }
        interface lo0.1 {
          mode sparse-dense;
          version 2;
        }
      }
    }
  }
}

```

```

P0 [edit]
  protocols {
    ...
    msdp {
      peer 10.254.71.48 {
        local-address 10.254.71.49;
      }
    }
    ...
    pim {
      rp {
        local {
          address 10.254.71.49;
        }
      }
      interface all {
        mode sparse;
        version 2;
      }
      interface fxp0.0 {
        disable;
      }
    }
  }
}

```

```

P1 [edit]
  protocols {
    ...
    msdp {
      peer 10.254.71.49 {
        local-address 10.254.71.48;
      }
    }
    ...
  }
}

```

```

    pim {
      rp {
        local {
          address 10.254.71.48;
        }
      }
      interface all {
        mode sparse;
        version 2;
      }
      interface fxp0.0 {
        disable;
      }
    }
  }
}

PE1 [edit]
protocols {
  pim {
    rp {
      static {
        address 10.254.71.48;
      }
    }
    interface all {
      mode sparse;
      version 2;
    }
    interface fxp0.0 {
      disable;
    }
  }
}

routing-instances {
  VPN-A {
    protocols {
      pim {
        dense-groups {
          229.0.0.0/8;
        }
        vpn-group-address 239.1.1.1;
        rp {
          static {
            address 10.254.14.132;
          }
        }
      }
      interface t1-1/0/0:0.0 {
        mode sparse-dense;
        version 2;
      }
      interface lo0.1 {
        mode sparse-dense;
        version 2;
      }
    }
  }
}
}
}

```

```
CE1 [edit]
    protocols {
    pim {
        dense-groups {
            229.0.0.0/8;
        }
        rp {
            local {
                address 10.254.14.132;
            }
        }
        interface all {
            mode sparse-dense;
            version 2;
        }
        interface fxp0.0 {
            disable;
        }
    }
}
```

Check Your Work

The show commands used to verify proper functionality of multicast in an interprovider environment are the same ones used with the first Layer 3 VPN multicast example (see “Check Your Work” on page 283).

The following output provides details for RP and the PIM Join information:

CE0 Status on page 298

PE0 Status on page 298

P0 Status on page 300

P1 Status on page 301

PE1 Status on page 302

CE1 Status on page 304

CE0 Status

```

user@CE0> show pim rps extensive
Instance: PIM.master

Family: INET
RP: 10.254.14.132
Learned via: static configuration
Time Active: 00:21:35
Holdtime: 0
Device Index: 119
Subunit: 32769
Interface: pe-6/0/0.32769
Group Ranges:
    224.0.0.0/4
Active groups using RP:

Register State for RP:

Group          Source          FirstHop        RP Address      State    Timeout
-----
Family: INET6

user@CE0> show pim join extensive
Instance: PIM.master Family: INET
Group: 229.1.1.1
    Source: 192.168.295.38
    Flags: dense
    Upstream interface: fe-3/0/2.0
    Downstream interfaces:
        t1-7/0/0:0.0

Instance: PIM.master Family: INET6

```

PE0 Status

```

user@PE0> show pim rps extensive
Instance: PIM.master

Family: INET
RP: 10.254.71.49
Learned via: static configuration
Time Active: 00:22:07
Holdtime: 0
Device Index: 34
Subunit: 32769
Interface: pe-1/1/0.32769
Group Ranges:
    224.0.0.0/4
Active groups using RP:
    239.1.1.1

    total 1 groups active

Register State for RP:

Group          Source          FirstHop        RP Address      State    Timeout
-----
239.1.1.1      10.254.71.51   10.254.71.51   10.254.71.49   Suppress  20

Family: INET6

```

```

user@PE0> show pim rps extensive instance VPN-A
Instance: PIM.VPN-A

Family: INET
RP: 10.254.14.132
Learned via: static configuration
Time Active: 00:22:22
Holdtime: 0
Device Index: 34
Subunit: 32771
Interface: pe-1/1/0.32771
Group Ranges:
    224.0.0.0/4
Active groups using RP:

Register State for RP:

Group          Source          FirstHop        RP Address      State    Timeout

Family: INET6

user@PE0> show pim join extensive
Instance: PIM.master Family: INET
Group: 239.1.1.1
  Source: *
  RP: 10.254.71.49
  Flags: sparse,rptree,wildcard
  Upstream interface: so-0/0/0.0
  Upstream State: Join to RP
  Downstream Neighbors:
    Interface: mt-1/1/0.32769
      0.0.0.0 State: Join  Flags: SRW  Timeout: Infinity

Group: 239.1.1.1
  Source: 10.254.71.47
  Flags: sparse,spt-pending
  Upstream interface: so-0/0/0.0
  Upstream State: Join to Source
  Keepalive timeout: 198
  Downstream Neighbors:
    Interface: mt-1/1/0.32769
      0.0.0.0 State: Join  Flags: S    Timeout: Infinity

Group: 239.1.1.1
  Source: 10.254.71.51
  Flags: sparse
  Upstream interface: local
  Upstream State: Local Source, Prune to RP
  Keepalive timeout: 198
  Downstream Neighbors:
    Interface: so-0/0/0.0
      192.168.296.42 State: Join  Flags: S    Timeout: 176

Instance: PIM.master Family: INET6

```

```

user@PE0> show pim join extensive instance VPN-A
Instance: PIM.VPN-A Family: INET
Group: 229.1.1.1
  Source: 192.168.295.38
  Flags: dense
  Upstream interface: t1-1/0/0:0.0
  Downstream interfaces:
    mt-1/1/0.32769

Instance: PIM.VPN-A Family: INET6

```

P0 Status

```

user@P0> show pim rps extensive
Instance: PIM.master

Family: INET
RP: 10.254.71.49
Learned via: static configuration
Time Active: 00:30:43
Holdtime: 0
Device Index: 33
Subunit: 32768
Interface: pd-1/1/0.32768
Group Ranges:
  224.0.0.0/4
Active groups using RP:
  239.1.1.1

      total 1 groups active

Register State for RP:

Group          Source          FirstHop        RP Address      State    Timeout
239.1.1.1      10.254.71.51   10.254.71.51   10.254.71.49   Receive

Family: INET6

user@P0> show pim join extensive
Instance: PIM.master Family: INET
Group: 239.1.1.1
  Source: *
  RP: 10.254.71.49
  Flags: sparse,rptree,wildcard
  Upstream interface: local
  Upstream State: Local RP
  Downstream Neighbors:
    Interface: so-0/1/0.0
      192.168.296.41 State: Join  Flags: SRW  Timeout: 184

Group: 239.1.1.1
  Source: 10.254.71.47
  Flags: sparse,spt-pending
  Upstream interface: so-0/0/2.0
  Upstream State: Local RP, Join to Source
  Keepalive timeout: 207
  Downstream Neighbors:
    Interface: so-0/1/0.0
      192.168.296.41 State: Join  Flags: S    Timeout: 184

```

```

Group: 239.1.1.1
Source: 10.254.71.51
Flags: sparse,spt
Upstream interface: so-0/1/0.0
Upstream State: Local RP, Join to Source
Keepalive timeout: 207
Downstream Neighbors:
  Interface: so-0/0/2.0
    192.168.296.73 State: Join  Flags: S  Timeout: 186
  Interface: so-0/1/0.0
    192.168.296.41 State: Prune  Flags: SR  Timeout: 184
Instance: PIM.master Family: INET6

```

P1 Status

```

user@P1> show pim rps extensive
Instance: PIM.master

Family: INET
RP: 10.254.71.48
Learned via: static configuration
Time Active: 06:26:56
Holdtime: 0
Device Index: 32
Subunit: 32768
Interface: pd-1/1/0.32768
Group Ranges:
  224.0.0.0/4
Active groups using RP:
  239.1.1.1

      total 1 groups active

Register State for RP:

Group          Source          FirstHop        RP Address      State    Timeout
239.1.1.1      10.254.71.47   10.254.71.47   10.254.71.48   Receive  0

Family: INET6

user@P1> show pim join extensive
Instance: PIM.master Family: INET
Group: 239.1.1.1
Source: *
RP: 10.254.71.48
Flags: sparse,rptree,wildcard
Upstream interface: local
Upstream State: Local RP
Downstream Neighbors:
  Interface: so-0/0/1.0
    192.168.296.50 State: Join  Flags: SRW  Timeout: 174

```

```

Group: 239.1.1.1
  Source: 10.254.71.47
  Flags: sparse,spt
  Upstream interface: so-0/0/1.0
  Upstream State: Local RP, Join to Source
  Keepalive timeout: 196
  Downstream Neighbors:
    Interface: so-0/0/1.0          (pruned)
      192.168.296.50 State: Prune  Flags: SR  Timeout: 174
    Interface: so-0/0/2.0
      192.168.296.74 State: Join   Flags: S   Timeout: 178

Group: 239.1.1.1
  Source: 10.254.71.51
  Flags: sparse,spt-pending
  Upstream interface: so-0/0/2.0
  Upstream State: Local RP, Join to Source
  Keepalive timeout: 196
  Downstream Neighbors:
    Interface: so-0/0/1.0
      192.168.296.50 State: Join   Flags: S   Timeout: 174

Instance: PIM.master Family: INET6
    
```

PE1 Status

```

user@PE1> show pim rps extensive
Instance: PIM.master

Family: INET
RP: 10.254.71.48
Learned via: static configuration
Time Active: 00:25:13
Holdtime: 0
Device Index: 34
Subunit: 32770
Interface: pe-1/1/0.32770
Group Ranges:
  224.0.0.0/4
Active groups using RP:
  239.1.1.1

      total 1 groups active

Register State for RP:

Group          Source          FirstHop        RP Address      State    Timeout
239.1.1.1      10.254.71.47   10.254.71.47   10.254.71.48   Suppress 42

Family: INET6
    
```

```

user@PE1> show pim rps extensive instance VPN-A
Instance: PIM.VPN-A

Family: INET
RP: 10.254.14.132
Learned via: static configuration
Time Active: 00:25:17
Holdtime: 0
Device Index: 34
Subunit: 32771
Interface: pe-1/1/0.32771
Group Ranges:
    224.0.0.0/4
Active groups using RP:

Register State for RP:

Group          Source          FirstHop        RP Address      State      Timeout

Family: INET6

user@PE1> show pim join extensive
Instance: PIM.master Family: INET
Group: 239.1.1.1
  Source: *
  RP: 10.254.71.48
  Flags: sparse,rptree,wildcard
  Upstream interface: so-0/0/3.0
  Upstream State: Join to RP
  Downstream Neighbors:
    Interface: mt-1/1/0.32769
      0.0.0.0 State: Join  Flags: SRW  Timeout: Infinity

Group: 239.1.1.1
  Source: 10.254.71.47
  Flags: sparse
  Upstream interface: local
  Upstream State: Local Source, Prune to RP
  Keepalive timeout: 173
  Downstream Neighbors:
    Interface: so-0/0/3.0
      192.168.296.49 State: Join  Flags: S    Timeout: 199

Group: 239.1.1.1
  Source: 10.254.71.51
  Flags: sparse,spt-pending
  Upstream interface: so-0/0/3.0
  Upstream State: Join to Source
  Keepalive timeout: 173
  Downstream Neighbors:
    Interface: mt-1/1/0.32769
      0.0.0.0 State: Join  Flags: S    Timeout: Infinity

Instance: PIM.master Family: INET6

```

```

user@PE1> show pim join extensive instance VPN-A
Instance: PIM.VPN-A Family: INET
Group: 229.1.1.1
  Source: 192.168.295.38
  Flags: dense
  Upstream interface: mt-1/1/0.32769
  Downstream interfaces:
    t1-1/0/0:0.0

Instance: PIM.VPN-A Family: INET6

```

CE1 Status

```

user@CE1> show pim rps extensive
Instance: PIM.master

Family: INET
RP: 10.254.14.132
Learned via: static configuration
Time Active: 00:28:22
Holdtime: 0
Device Index: 69
Subunit: 32768
Interface: pd-3/1/0.32768
Group Ranges:
  224.0.0.0/4
Active groups using RP:

Register State for RP:

Group           Source           FirstHop         RP Address       State      Timeout

Family: INET6

user@CE1> show pim join extensive
Instance: PIM.master Family: INET
Group: 229.1.1.1
  Source: 192.168.295.38
  Flags: dense
  Upstream interface: t1-2/0/0:0.0
  Downstream interfaces:
    fe-2/2/0.0

Instance: PIM.master Family: INET6

```

For More Information

For additional information on multicast over Layer 3 VPNs, see the following resources:

JUNOS Internet Software Configuration Guide: Multicast

JUNOS Internet Software Configuration Guide: VPNs

E. Rosen and Y. Rekhter, "BGP/MPLS VPNs," RFC 2547, March 1999

E. Rosen, et. al., "Multicast in MPLS/BGP VPNs," IETF Internet draft, draft-rosen-vpn-mcast-05.txt, April 2003

Revision History

30 June 2003—6.0R1 Release. Richard Hendricks.

2 April 2003—5.7R1 Release. Richard Hendricks.

27 December 2002—5.6R1 Release. Richard Hendricks.

30 September 2002—5.5R1 Release. Richard Hendricks.

27 August 2002—Reformatted the document in Feature Guide style. Richard Hendricks.

22 August 2002—Added PIM dense mode information. Bill Nowak.

8 February 2002—Initial 5.3 Quick Start Guide document. Bill Nowak.

