

# Configure Multicast Over LISP Phase 1

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## Introduction

This document describes that in phase 1 of the multicast implementation over Locator/ID Separation Protocol (LISP), ingress replication is used. It means that unicast Routing Locator (RLOC) core is used to transport identity information (EID) multicast.

## Prerequisites

### Requirements

Cisco recommends that you have knowledge of LISP and multicast.

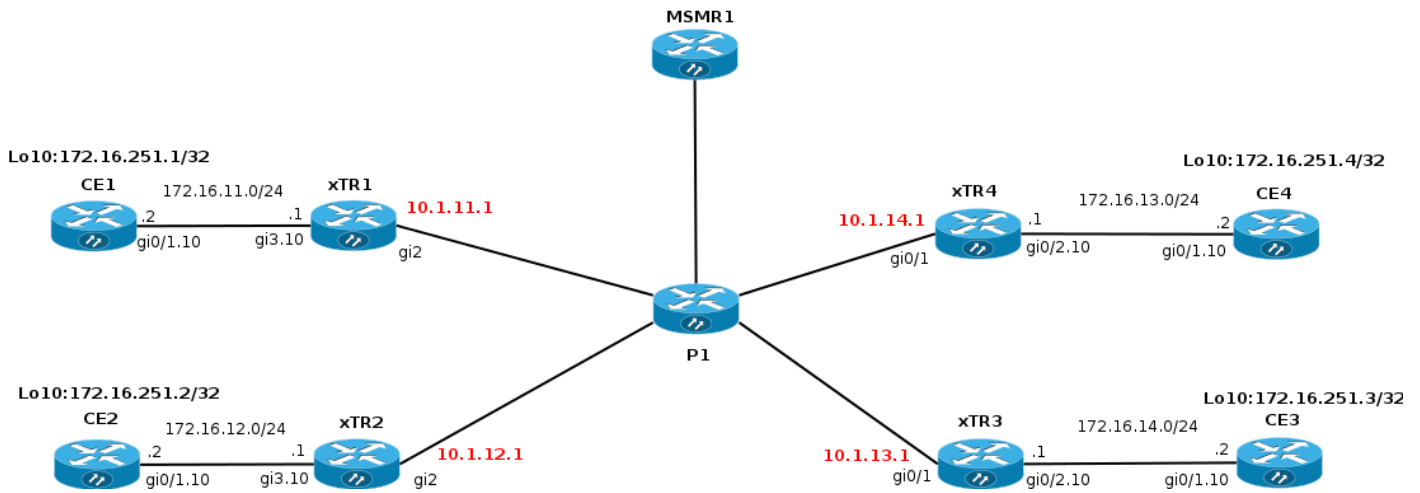
### Components Used

This document is not restricted to specific software and hardware versions.

The information in this document was created from the devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, make sure that you understand the potential impact of any command.

## Configure

## Network Diagram



## Configurations

Phase 1 supports unicast head-end replication of multicast packets.

- Phase 1 support begins in XE 3.13 and Cisco IOS® 15.4(2)T.
- Phase 1 supports IPv4 EIDs over IPv4 RLOCs (transport) begins in XE 3.13 and Cisco IOS® 15.4(2)T.
- Phase 1 supports IPv6 EIDs over IPv4 RLOCs (transport) begins in Polaris 16.6.1 in default vrf only for LISP with VXLAN encapsulation for Software-Defined Access (SDA).
- Phase 1 supports EID Virtual Routing and Forwarding (VRFs) (segmentation) with IIDs (via PIM VRF support).
- Phase 1 supports Any Source Multicast (ASM) and Source Specific Multicast (SSM) models.
- Phase 1 supports static Route Processor (RP) configuration only.
- Phase 1 does not support RP redundancy.
- Phase 1 supports various combinations of LISP and non-LISP capable source and receiver sites.
- LISP Multicast is NOT supported as a LISP Mobility Data Center Interconnect (DCI) solution.

It is assumed, that multicast is already configured on the network (pim sparse-mode/rp).

In order to enable multicast over LISP you have to add “ip pim sparse-mode” under a LISP0 or a LISP0.xx interface. By enabling PIM on a LISP interface, it is included in RPF. The RPF information for prefixes reachable via LISP sites consists of a LISP tunnel and a neighbor represented by a RLOC address of an upstream site.

Only join/prune messages are allowed to be sent over LISP tunnels. PIM Hello messages are not exchanged between sites. PIM join/prune messages are unicast-encapsulated to an upstream xTR (RP or Source). Join/prune messages are not seen by other xTRs/PxTRs. There is no analog of Default MDT in MVPN.

PIM must be enabled under a LISP tunnel interfaces for multicast processing.

EID virtualization uses LISP Instance-IDs in conjunction with EID VRFs. An interface LISP0.x where x=IID is created for each EID VRF/LISP Instance ID.

```
xTR1#sh run
!
interface LISP0
```

```

ip pim sparse-mode <<<< PIM under the LISP interface
!
interface LISP0.20
ip pim sparse-mode <<<< PIM under the LISP interface
end

```

**xTR1#sh ip pim int**

Address	Interface	Ver/ Mode	Nbr Count	Query Intvl	DR Prior	DR
172.16.11.1	GigabitEthernet3.10	v2/S	1	30	1	172.16.11.2
10.1.255.1	LISP0	v2/S	0	30	1	10.1.255.1

No neighbors via a LISP interface are seen because there are no active sources/receivers and PIM Hello's are not exchanged between peers.

**xTR1#sh ip pim nei**

PIM Neighbor Table

Mode: B - Bidir Capable, DR - Designated Router, N - Default DR Priority,  
P - Proxy Capable, S - State Refresh Capable, G - GenID Capable,  
L - DR Load-balancing Capable

Neighbor Address	Interface	Uptime/Expires	Ver	DR Prio/Mode
172.16.11.2	GigabitEthernet3.10	01:43:52/00:01:34	v2	1 / DR S P G

## SSM

Let's configure the interface lo10 on the CE2 to join a group. It triggers a (S,G) Join because a group and a source are specified.

**CE2#conf t**

Enter configuration commands, one per line. End with CNTL/Z.

**CE2(config)#int lo10**

**CE2(config-if)#ip igmp join-group 232.1.1.10 source 172.16.251.1**

```

*Nov 26 18:28:55.471: PIM(0): Insert (172.16.251.1,232.1.1.10) join in nbr 172.16.12.1's queue
*Nov 26 18:28:55.491: PIM(0): Building Join/Prune packet for nbr 172.16.12.1
*Nov 26 18:28:55.491: PIM(0): Adding v2 (172.16.251.1/32, 232.1.1.10), S-bit Join
*Nov 26 18:28:55.492: PIM(0): Send v2 join/prune to 172.16.12.1 (GigabitEthernet0/1.10)
*Nov 26 18:28:56.856: PIM(0): Send v2 join/prune to 172.16.12.1 (GigabitEthernet0/1.1

```

The (S,G) mroute is created on CE2.

**CE2#sh ip mro 232.1.1.10**

<...skip...>

```

(172.16.251.1, 232.1.1.10), 00:00:16/00:02:45, flags: sLTI
Incoming interface: GigabitEthernet0/1.10, RPF nbr 172.16.12.1
Outgoing interface list:
Loopback10, Forward/Sparse, 00:00:14/00:02:45

```

Let's check what happens on xTR2.

**Debug ip pim** is enabled on xTR2.

The (S,G) Join from CE2 is received.

```
CE2#sh ip mro 232.1.1.10
```

```
<...skip...>
```

```
(172.16.251.1, 232.1.1.10), 00:00:16/00:02:45, flags: sLTI  
Incoming interface: GigabitEthernet0/1.10, RPF nbr 172.16.12.1  
Outgoing interface list:  
Loopback10, Forward/Sparse, 00:00:14/00:02:45
```

172.16.251.1 is the EID from xTR1 and not present in the RIB yet. Because of that, the RPF lookup is failed for the source IP 172.16.251.1. It triggers the LISP lookup. So the RPF interface is the LISP tunnel.

```
*Nov 26 18:38:19.641: PIM(0): RPF Lookup failed for 172.16.251.1  
*Nov 26 18:38:19.643: PIM(0): Add GigabitEthernet3.10/172.16.12.2 to (172.16.251.1, 232.1.1.10),  
Forward state, by PIM SG Join  
*Nov 26 18:38:19.650: PIM(0): Insert (172.16.251.1,232.1.1.10) join in nbr 10.1.11.1's queue
```

```
xTR2#sh ip rpf 172.16.251.1
```

```
RPF information for ? (172.16.251.1)  
RPF interface: LISP0  
RPF neighbor: ? (10.1.11.1)  
RPF route/mask: 172.16.251.1/32  
RPF type: unicast ()  
Doing distance-preferred lookups across tables  
RPF topology: ipv4 multicast base
```

After that, a (S,G) Join is built and sent out via the LISP interface to the source via the RLOC 10.1.11.1.

```
*Nov 26 18:38:19.641: PIM(0): RPF Lookup failed for 172.16.251.1  
*Nov 26 18:38:19.643: PIM(0): Add GigabitEthernet3.10/172.16.12.2 to (172.16.251.1, 232.1.1.10),  
Forward state, by PIM SG Join  
*Nov 26 18:38:19.650: PIM(0): Insert (172.16.251.1,232.1.1.10) join in nbr 10.1.11.1's queue
```

```
xTR2#sh ip rpf 172.16.251.1
```

```
RPF information for ? (172.16.251.1)  
RPF interface: LISP0  
RPF neighbor: ? (10.1.11.1)  
RPF route/mask: 172.16.251.1/32  
RPF type: unicast ()  
Doing distance-preferred lookups across tables  
RPF topology: ipv4 multicast base
```

A Join is encapsulated into the unicast LISP header. The source IP of the encapsulated packet is a RLOC of the interface via which the packet is sent out. The destination IP is the RLOC address of the xTR which has reachability to the EID of the multicast source.

```
xTR2#sh ip lisp map-cache 172.16.251.1
```

```
LISP IPv4 Mapping Cache for EID-table default (IID 0), 4 entries
```

```
172.16.251.1/32, uptime: 02:18:16, expires: 21:41:44, via map-reply, complete
```

```
Sources: map-reply
```

```
State: complete, last modified: 02:18:16, map-source: 10.1.11.1
```

```
Idle, Packets out: 41(4838 bytes) (~ 01:21:15 ago)
```

```
Locator    Uptime    State    Pri/Wgt
```

```
10.1.11.1  02:18:16  up      100/100
```

```
Last up-down state change:      02:18:16, state change count: 1
```

```
Last route reachability change: 02:18:16, state change count: 1
```

```

Last priority / weight change:      never/never
RLOC-probing loc-status algorithm:
Last RLOC-probe sent:              never

```

In order to be able to send a Join you need to have a PIM neighbor. Once RPF information has been obtained, PIM explicitly creates a neighbor to the corresponding RLOC. The neighbor is not created in the usual way because PIM Hello's are not going through the LISP tunnel.

```
xTR2#sh ip pim nei
```

```
PIM Neighbor Table
```

```

Mode: B - Bidir Capable, DR - Designated Router, N - Default DR Priority,
      P - Proxy Capable, S - State Refresh Capable, G - GenID Capable,
      L - DR Load-balancing Capable

```

Neighbor Address	Interface	Uptime/Expires	Ver	DR Prio/Mode
172.16.12.2	GigabitEthernet3.10	01:57:04/00:01:30	v2	1 / DR S P G
10.1.11.1	LISP0	00:00:48/00:01:10	v2	0 /

A wireshark capture of the multicast packet is as shown in the image.

No.	Time	Source	Destination	Protocol	Info
1433	2017-11-26 19:40:01.922318	10.1.11.1	10.1.255.41	TCP	[TCP Keep-Alive ACK] 38534 → 4342 [ACK] Se...
1434	2017-11-26 19:40:07.759677	10.1.11.10	224.0.0.5	OSPF	Hello Packet
1435	2017-11-26 19:40:10.230530	10.1.11.1	224.0.0.5	OSPF	Hello Packet
1436	2017-11-26 19:40:17.509349	10.1.11.10	224.0.0.5	OSPF	Hello Packet
1437	2017-11-26 19:40:18.428913	10.1.255.2	224.0.0.13	PIMv2	Join/Prune
1438	2017-11-26 19:40:20.006961	10.1.11.1	224.0.0.5	OSPF	Hello Packet
1439	2017-11-26 19:40:26.747812	10.1.11.10	224.0.0.5	OSPF	Hello Packet
1440	2017-11-26 19:40:29.176324	10.1.11.1	224.0.0.5	OSPF	Hello Packet
1441	2017-11-26 19:40:36.581463	10.1.11.10	224.0.0.5	OSPF	Hello Packet
1442	2017-11-26 19:40:38.535445	10.1.11.1	224.0.0.5	OSPF	Hello Packet
1443	2017-11-26 19:40:46.066010	10.1.11.10	224.0.0.5	OSPF	Hello Packet
1444	2017-11-26 19:40:47.743783	10.1.11.1	224.0.0.5	OSPF	Hello Packet
1445	2017-11-26 19:40:51.434533	fa:16:3e:5c:d9:c9	CDP/VTP/DTP/PAgP/UDLD	CDP	Device ID: P1 Port ID: GigabitEthernet0/1...

▶ Frame 1437: 114 bytes on wire (912 bits), 114 bytes captured (912 bits) on interface 0  
 ▶ Ethernet II, Src: fa:16:3e:5c:d9:c9 (fa:16:3e:5c:d9:c9), Dst: fa:16:3e:86:3f:35 (fa:16:3e:86:3f:35)  
 ▶ Internet Protocol Version 4, Src: 10.1.12.1, Dst: 10.1.11.1  
 ▶ User Datagram Protocol, Src Port: 30222 (30222), Dst Port: 4341 (4341)  
 ▶ Locator/ID Separation Protocol (Data)  
 ▶ Internet Protocol Version 4, Src: 10.1.255.2, Dst: 224.0.0.13  
 ▼ Protocol Independent Multicast  
   0010 .... = Version: 2  
   ... 0011 = Type: Join/Prune (3)  
   Reserved byte(s): 00  
   Checksum: 0x0e80 [correct]  
   PIM Options

The outer Source and Destination IP are local and remote RLOCs. It is expected as you use unicast replication.

The inner Source IP was taken from the LISP0 interface.

```
xTR2#sh int LISP0 | i unn
```

```
Interface is unnumbered. Using address of Loopback0 (10.1.255.2)
```

The inner destination IP is multicast address 224.0.0.13 which is used for PIM messages.

On xTR2 for the (172.16.251.1, 232.1.1.10) mroute an IIL is the LISP0 interface and an OIL points to CE2.

```
xTR2#show ip mroute
<...skip...>
(172.16.251.1, 232.1.1.10), 00:00:36/00:02:55, flags: sT
  Incoming interface: LISP0, RPF nbr 10.1.11.1
  Outgoing interface list:
    GigabitEthernet3.10, Forward/Sparse, 00:00:36/00:02:55
```

```
xTR2#sh ip mfib
<...skip...>
(172.16.251.1,232.1.1.10) Flags: HW
  SW Forwarding: 0/0/0/0, Other: 0/0/0
  HW Forwarding: 0/0/0/0, Other: 0/0/0
  LISP0 Flags: A
  GigabitEthernet3.10 Flags: F NS
  Pkts: 0/0
```

On xTR1, a Join from xTR2 was received and a (S,G) mroute was created.

```
*Nov 26 18:38:19.464: PIM(0): Received v2 Join/Prune on LISP0 from 10.1.255.2
*Nov 26 18:38:19.464: PIM(0): J/P Transport Attribute, Transport Type: Unicast, to us
*Nov 26 18:38:19.464: PIM(0): Join-list: (172.16.251.1/32, 232.1.1.10), S-bit set
*Nov 26 18:38:19.467: PIM(0): Add LISP0/10.1.12.1 to (172.16.251.1, 232.1.1.10), Forward state,
by PIM SG Join
*Nov 26 18:38:19.467: PIM(0): Insert (172.16.251.1,232.1.1.10) join in nbr 172.16.11.2's queue
*Nov 26 18:38:19.467: PIM(0): Building Join/Prune packet for nbr 172.16.11.2
*Nov 26 18:38:19.467: PIM(0): Adding v2 (172.16.251.1/32, 232.1.1.10), S-bit Join
*Nov 26 18:38:19.467: PIM(0): Send v2 join/prune to 172.16.11.2 (GigabitEthernet3.10)
```

```
xTR1#sh ip mroute
<...skip...>
(172.16.251.1, 232.1.1.10), 00:01:00/00:03:28, flags: sT
  Incoming interface: GigabitEthernet3.10, RPF nbr 172.16.11.2
  Outgoing interface list:
    LISP0, 10.1.12.1, Forward/Sparse, 00:01:00/00:03:28 <<<< LISP in OIL
```

Upstream xTR1 must track every downstream RLOC for which a Join message has been received.

The xTR must remember the set of RLOCs to replicate packets to.

An (EID<sub>s</sub>,G) entry at the upstream xTR therefore looks as follows for unicast encapsulation:

**(EID<sub>s</sub>, G)**

**A Eth0/0**

**F LISP0, nexthop = RLOC1**

**F LISP0, nexthop = RLOC2**

```
xTR1#sh ip mfib
<...skip...>
(172.16.251.1,232.1.1.10) Flags: HW
  SW Forwarding: 0/0/0/0, Other: 0/0/0
  HW Forwarding: 0/0/0/0, Other: 0/0/0
```

```
GigabitEthernet3.10 Flags: A
LISP0, 10.1.12.1 Flags: F NS <<<<
Pkts: 0/0
```

**Note:** xTR1 doesn't have a PIM neighbor via the interface LISP0.

```
xTR1# sh ip pim nei
```

```
PIM Neighbor Table
```

```
Mode: B - Bidir Capable, DR - Designated Router, N - Default DR Priority,
      P - Proxy Capable, S - State Refresh Capable, G - GenID Capable,
      L - DR Load-balancing Capable
```

Neighbor Address	Interface	Uptime/Expires	Ver	DR Prio/Mode
172.16.11.2	GigabitEthernet3.10	04:25:32/00:01:37	v2	1 / DR S P G

On CE1 a Join for a (S,G) was received and a mroute has been created.

```
CE1#sh ip mro
```

```
<...skip...>
```

```
(172.16.251.1, 232.1.1.10), 02:16:45/00:03:08, flags: sT
  Incoming interface: Loopback10, RPF nbr 0.0.0.0
  Outgoing interface list:
    GigabitEthernet0/1.10, Forward/Sparse, 02:16:45/00:03:08
```

Multicast traffic is flowing like expected.

```
CE1#ping 232.1.1.10 so lo10 rep 5
```

```
Type escape sequence to abort.
```

```
Sending 5, 100-byte ICMP Echos to 232.1.1.10, timeout is 2 seconds:
```

```
Packet sent with a source address of 172.16.251.1
```

```
Reply to request 0 from 172.16.251.2, 11 ms
Reply to request 0 from 172.16.251.2, 15 ms
Reply to request 1 from 172.16.251.2, 14 ms
Reply to request 1 from 172.16.251.2, 15 ms
Reply to request 2 from 172.16.251.2, 12 ms
Reply to request 2 from 172.16.251.2, 16 ms
Reply to request 3 from 172.16.251.2, 9 ms
Reply to request 3 from 172.16.251.2, 13 ms
Reply to request 4 from 172.16.251.2, 9 ms
Reply to request 4 from 172.16.251.2, 9 ms
```

Let's add one more receiver on CE3.

An additional entry in an OIL for the new RLOC is added in a MRIB and a MFIB.

```
xTR1#sh ip mro 232.1.1.10
```

```
<...skip...>
```

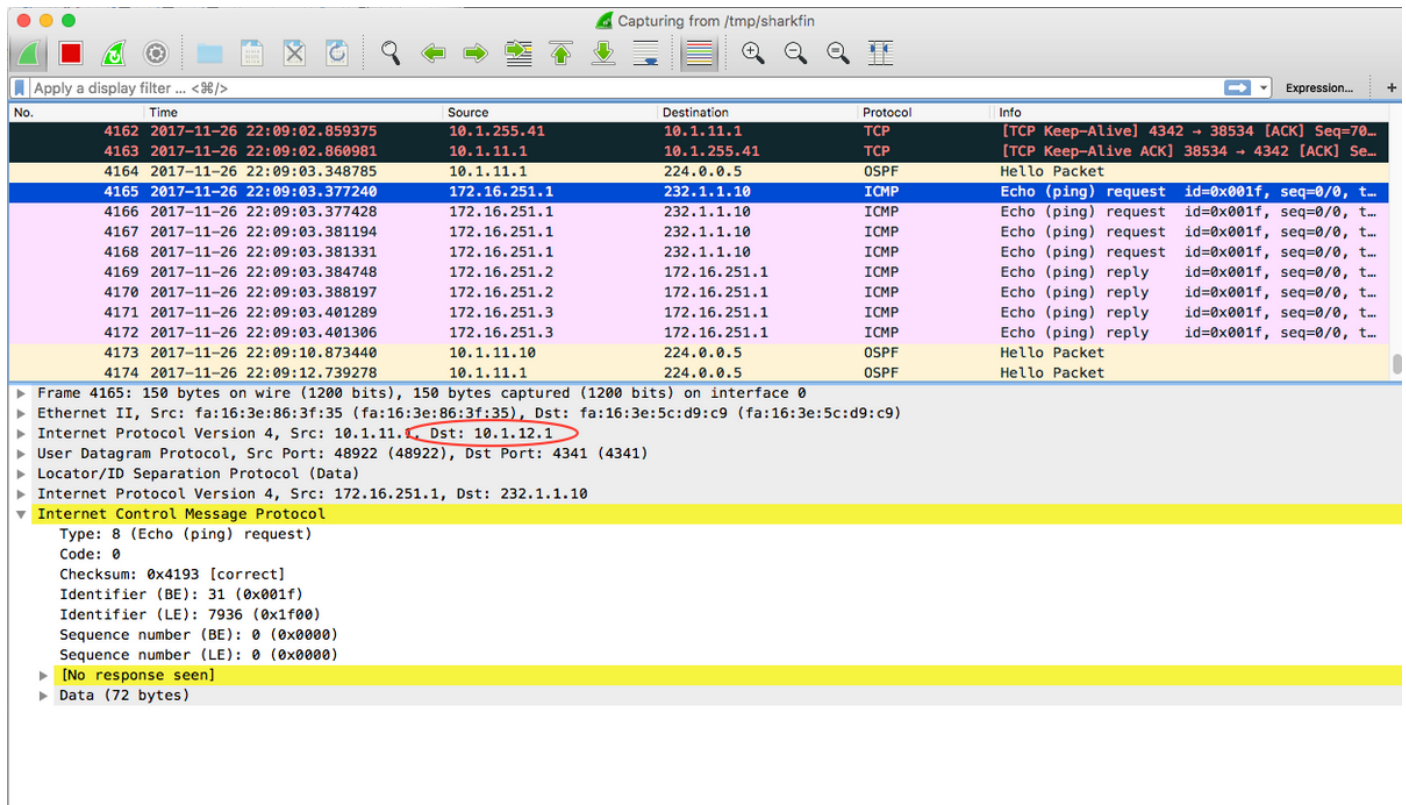
```
(172.16.251.1, 232.1.1.10), 02:28:36/00:03:25, flags: sT
  Incoming interface: GigabitEthernet3.10, RPF nbr 172.16.11.2
  Outgoing interface list:
    LISP0, 10.1.13.1, Forward/Sparse, 00:01:34/00:02:57
    LISP0, 10.1.12.1, Forward/Sparse, 02:28:36/00:03:25
```

```
xTR1#sh ip mfib 232.1.1.10
```

```
<...skip...>
```

```
(172.16.251.1,232.1.1.10) Flags: HW  
SW Forwarding: 0/0/0/0, Other: 0/0/0  
HW Forwarding: 10/0/118/0, Other: 0/0/0  
GigabitEthernet3.10 Flags: A  
LISP0, 10.1.13.1 Flags: F NS  
Pkts: 0/0  
LISP0, 10.1.12.1 Flags: F NS  
Pkts: 0/0
```

If you start to send traffic to the 232.1.1.10 on the core interface as shown in the image.



The destination of the encapsulated packet is the RLOC for xTR2 as shown in the image.



Capturing from /tmp/sharkfin

Apply a display filter ... <%%>

No.	Time	Source	Destination	Protocol	Info
4162	2017-11-26 22:09:02.859375	10.1.255.41	10.1.11.1	TCP	[TCP Keep-Alive] 4342 → 38534 [ACK] Seq=70...
4163	2017-11-26 22:09:02.860981	10.1.11.1	10.1.255.41	TCP	[TCP Keep-Alive ACK] 38534 → 4342 [ACK] Se...
4164	2017-11-26 22:09:03.348785	10.1.11.1	224.0.0.5	OSPF	Hello Packet
4165	2017-11-26 22:09:03.377240	172.16.251.1	232.1.1.10	ICMP	Echo (ping) request id=0x001f, seq=0/0, t...
4166	2017-11-26 22:09:03.377428	172.16.251.1	232.1.1.10	ICMP	Echo (ping) request id=0x001f, seq=0/0, t...
4167	2017-11-26 22:09:03.381194	172.16.251.1	232.1.1.10	ICMP	Echo (ping) request id=0x001f, seq=0/0, t...
4168	2017-11-26 22:09:03.381331	172.16.251.1	232.1.1.10	ICMP	Echo (ping) request id=0x001f, seq=0/0, t...
4169	2017-11-26 22:09:03.384748	172.16.251.2	172.16.251.1	ICMP	Echo (ping) reply id=0x001f, seq=0/0, t...
4170	2017-11-26 22:09:03.388197	172.16.251.2	172.16.251.1	ICMP	Echo (ping) reply id=0x001f, seq=0/0, t...
4171	2017-11-26 22:09:03.401289	172.16.251.3	172.16.251.1	ICMP	Echo (ping) reply id=0x001f, seq=0/0, t...
4172	2017-11-26 22:09:03.401306	172.16.251.3	172.16.251.1	ICMP	Echo (ping) reply id=0x001f, seq=0/0, t...
4173	2017-11-26 22:09:10.873440	10.1.11.10	224.0.0.5	OSPF	Hello Packet
4174	2017-11-26 22:09:12.739278	10.1.11.1	224.0.0.5	OSPF	Hello Packet

▶ Frame 4166: 150 bytes on wire (1200 bits), 150 bytes captured (1200 bits) on interface 0

▶ Ethernet II, Src: fa:16:3e:86:3f:35 (fa:16:3e:86:3f:35), Dst: fa:16:3e:5c:d9:c9 (fa:16:3e:5c:d9:c9)

▶ Internet Protocol Version 4, Src: 10.1.11.1, Dst: 10.1.13.1

▶ User Datagram Protocol, Src Port: 48922, Dst Port: 4341 (4341)

▶ Locator/ID Separation Protocol (Data)

▶ Internet Protocol Version 4, Src: 172.16.251.1, Dst: 232.1.1.10

▼ **Internet Control Message Protocol**

Type: 8 (Echo (ping) request)

Code: 0

Checksum: 0x4193 [correct]

Identifier (BE): 31 (0x001f)

Identifier (LE): 7936 (0x1f00)

Sequence number (BE): 0 (0x0000)

Sequence number (LE): 0 (0x0000)

▶ [No response seen]

▶ Data (72 bytes)

The destination IP for the packet is the RLOC of xTR3.

Multicast flow is replicated into two unicast streams and is sent out over the core.

## ASM

**Note:** A Static-RP only is supported. A RP redundancy is not supported.

## Source Registers First

Let's send multicast from CE1 to the group 225.1.1.10. CE1 is the First Hop Router (FHR) so it will trigger an unicast register message to the RP (CE4). As you don't have any receivers, CE1 received a Register-Stop and creates mroute entries.

### CE1#ping 225.1.1.10 so lo10

Type escape sequence to abort.

Sending 1, 100-byte ICMP Echos to 225.1.1.10, timeout is 2 seconds:

Packet sent with a source address of 172.16.251.1

```
*Nov 27 14:29:04.083: PIM(0): Check RP 172.16.251.4 into the (*, 225.1.1.10) entry
*Nov 27 14:29:04.084: PIM(0): Building Triggered (*,G) Join / (S,G,RP-bit) Prune message for
225.1.1.10
*Nov 27 14:29:04.089: PIM(0): Adding register encap tunnel (Tunnel0) as forwarding interface of
(172.16.251.1, 225.1.1.10).
*Nov 27 14:29:04.112: PIM(0): Received v2 Register-Stop on GigabitEthernet0/1.10 from
172.16.251.4
*Nov 27 14:29:04.112: PIM(0):   for source 172.16.251.1, group 225.1.1.10
*Nov 27 14:29:04.113: PIM(0): Removing register encap tunnel (Tunnel0) as forwarding interface
of (172.16.251.1, 225.1.1.10).
*Nov 27 14:29:04.113: PIM(0): Clear Registering flag to 172.16.251.4 for (172.16.251.1/32,
225.1.1.10).
```

```
CE1#sh ip mro 225.1.1.10
```

```
<...skip...>
```

```
(* , 225.1.1.10), 00:02:16/stopped, RP 172.16.251.4, flags: SPF  
Incoming interface: GigabitEthernet0/1.10, RPF nbr 172.16.11.1  
Outgoing interface list: Null
```

```
(172.16.251.1, 225.1.1.10), 00:02:16/00:00:43, flags: PFT  
Incoming interface: Loopback10, RPF nbr 0.0.0.0  
Outgoing interface list: Null
```

On a RP side also expected picture. After you receive a Register message from CE1, RP (CE4) is send a Register-Stop back and creates necessary mroutes.

```
CE4#  
*Nov 27 14:24:06.810: PIM(0): Received v2 Register on GigabitEthernet0/1.10 from 172.16.251.1  
*Nov 27 14:24:06.810:           for 172.16.251.1, group 225.1.1.10  
*Nov 27 14:24:06.811: PIM(0): Check RP 172.16.251.4 into the (*, 225.1.1.10) entry  
*Nov 27 14:24:06.812: PIM(0): Adding register decap tunnel (Tunnel0) as accepting interface of  
(* , 225.1.1.10) .  
*Nov 27 14:24:06.814: PIM(0): Adding register decap tunnel (Tunnel0) as accepting interface of  
(172.16.251.1, 225.1.1.10) .  
*Nov 27 14:24:06.815: PIM(0): Send v2 Register-Stop to 172.16.251.1 for 172.16.251.1, group  
225.1.1.10
```

```
CE4#
```

```
*Nov 27 14:24:11.207: PIM(0): Building Periodic (*,G) Join / (S,G,RP-bit) Prune message for  
224.0.1.40
```

```
CE4#sh ip mro 225.1.1.10
```

```
<...skip...>
```

```
(* , 225.1.1.10), 00:00:31/stopped, RP 172.16.251.4, flags: SP  
Incoming interface: Null, RPF nbr 0.0.0.0  
Outgoing interface list: Null
```

```
(172.16.251.1, 225.1.1.10), 00:00:31/00:02:28, flags: P  
Incoming interface: GigabitEthernet0/1.10, RPF nbr 172.16.14.1  
Outgoing interface list: Null
```

Take into account that a Register-source interface should be in the EID range otherwise LISP won't be triggered. By default, it would be the IP address from the outgoing interface.

```
CE1#sh run | i source
```

```
ip pim register-source Loopback10
```

For xTR1 and xTR4, nothing changed because multicast traffic has not being received yet.

## Receiver Comes First

Let's configure a receiver on the interface Lo10 on the device CE3.

```
CE1#sh run | i source
```

```
ip pim register-source Loopback10
```

A (\*,Join) is triggered and a mroute is created. Everything is expected.

```

CE3#
*Nov 27 14:48:46.271: PIM(0): Check RP 172.16.251.4 into the (*, 225.1.1.10) entry
*Nov 27 14:48:46.272: PIM(0): Building Triggered (*,G) Join / (S,G,RP-bit) Prune message for
225.1.1.10
*Nov 27 14:48:46.272: PIM(0): Upstream mode for (*, 225.1.1.10) changed from 0 to 1
*Nov 27 14:48:46.274: PIM(0): Insert (*,225.1.1.10) join in nbr 172.16.13.1's queue
*Nov 27 14:48:46.275: PIM(0): Building Triggered (*,G) Join / (S,G,RP-bit) Prune message for
225.1.1.10
*Nov 27 14:48:46.284: PIM(0): Building Join/Prune packet for nbr 172.16.13.1
*Nov 27 14:48:46.284: PIM(0): Adding v2 (172.16.251.4/32, 225.1.1.10), WC-bit, RPT-bit, S-bit
Join
*Nov 27 14:48:46.285: PIM(0): Send v2 join/prune to 172.16.13.1 (GigabitEthernet0/1.10)

```

**CE3#sh ip mro**

```

< ...skip...>
(*, 225.1.1.10), 00:26:23/00:02:42, RP 172.16.251.4, flags: SJCL
  Incoming interface: GigabitEthernet0/1.10, RPF nbr 172.16.13.1
  Outgoing interface list:
    Loopback10, Forward/Sparse, 00:26:23/00:02:42

(*, 224.0.1.40), 21:32:32/00:02:03, RP 172.16.251.4, flags: SJPCL
  Incoming interface: GigabitEthernet0/1.10, RPF nbr 172.16.13.1
  Outgoing interface list: Null

```

A (\*,225.1.1.10) Join is received by xTR3. A (\*,G) Join is sent to the RP. xTR3 checks the RLOC for the RP (172.16.251.4). As it is reachable via the LISP, PIM neighbor to the appropriate RLOC is created. In this case it is 10.1.14.1.

```

xTR3#
*Nov 27 14:30:23.229: PIM(0): Received v2 Join/Prune on GigabitEthernet0/2.10 from 172.16.13.2,
to us
*Nov 27 14:30:23.229: PIM(0): Join-list: (*, 225.1.1.10), RPT-bit set, WC-bit set, S-bit set
*Nov 27 14:30:23.231: PIM(0): Check RP 172.16.251.4 into the (*, 225.1.1.10) entry
*Nov 27 14:30:23.233: PIM(0): Add GigabitEthernet0/2.10/172.16.13.2 to (*, 225.1.1.10), Forward
state, by PIM *G Join
*Nov 27 14:30:23.247: PIM(0): Building Triggered (*,G) Join / (S,G,RP-bit) Prune message for
225.1.1.10
*Nov 27 14:30:23.247: PIM(0): Upstream mode for (*, 225.1.1.10) changed from 0 to 1
*Nov 27 14:30:23.248: PIM(0): Insert (*,225.1.1.10) join in nbr 10.1.14.1's queue
xTR3#
*Nov 27 14:30:23.259: PIM(0): Building Join/Prune packet for nbr 10.1.14.1
*Nov 27 14:30:23.259: PIM(0): Adding v2 (172.16.251.4/32, 225.1.1.10), WC-bit, RPT-bit, S-bit
Join
*Nov 27 14:30:23.260: PIM(0): Send v2 join/prune to 10.1.14.1 (LISP0)

```

**xTR3#sh ip pim nei**

PIM Neighbor Table

Mode: B - Bidir Capable, DR - Designated Router, N - Default DR Priority,

P - Proxy Capable, S - State Refresh Capable, G - GenID Capable,

L - DR Load-balancing Capable

Neighbor Address	Interface	Uptime/Expires	Ver	DR Prio/Mode
172.16.13.2	GigabitEthernet0/2.10	21:54:17/00:01:27	v2	1 / DR S P G
10.1.14.1	LISP0	00:26:16/00:01:35	v2	0 /

Let's check a wireshark capture as shown in the image.

No.	Time	Source	Destination	Protocol	Info
13	2017-11-27 17:21:17.082524	10.1.255.3	224.0.0.13	PIMv2	Join/Prune
16	2017-11-27 17:21:21.919145	172.16.23.1	224.0.0.13	PIMv2	Join/Prune
23	2017-11-27 17:21:40.187508	10.1.255.3	224.0.0.13	PIMv2	Join/Prune
40	2017-11-27 17:22:19.699096	10.1.255.3	224.0.0.13	PIMv2	Join/Prune
44	2017-11-27 17:22:24.993402	172.16.23.1	224.0.0.13	PIMv2	Join/Prune
50	2017-11-27 17:22:43.325028	10.1.255.3	224.0.0.13	PIMv2	Join/Prune
68	2017-11-27 17:23:21.901842	10.1.255.3	224.0.0.13	PIMv2	Join/Prune
72	2017-11-27 17:23:27.859519	172.16.23.1	224.0.0.13	PIMv2	Join/Prune
80	2017-11-27 17:23:45.593588	10.1.255.3	224.0.0.13	PIMv2	Join/Prune
93	2017-11-27 17:24:24.326937	10.1.255.3	224.0.0.13	PIMv2	Join/Prune
96	2017-11-27 17:24:31.517993	172.16.23.1	224.0.0.13	PIMv2	Join/Prune
107	2017-11-27 17:24:49.498689	10.1.255.3	224.0.0.13	PIMv2	Join/Prune
122	2017-11-27 17:25:27.840775	10.1.255.3	224.0.0.13	PIMv2	Join/Prune
124	2017-11-27 17:25:33.769847	172.16.23.1	224.0.0.13	PIMv2	Join/Prune
133	2017-11-27 17:25:53.115344	10.1.255.3	224.0.0.13	PIMv2	Join/Prune

▶ Frame 13: 114 bytes on wire (912 bits), 114 bytes captured (912 bits) on interface 0  
 ▶ Ethernet II, Src: fa:16:3e:21:2e:1e (fa:16:3e:21:2e:1e), Dst: fa:16:3e:a1:b1:8e (fa:16:3e:a1:b1:8e)  
 ▶ Internet Protocol Version 4, Src: 10.1.13.1, Dst: 10.1.14.1  
 ▶ User Datagram Protocol, Src Port: 30223, Dst Port: 4341  
 ▶ Locator/ID Separation Protocol (Data)  
 ▶ Internet Protocol Version 4, Src: 10.1.255.3, Dst: 224.0.0.13  
 ▶ Protocol Independent Multicast

The outer IP source is the local RLOC and the outer IP destination is the remote RLOC. The inner source is the IP address taken for the LISP0 interface. The inner destination IP address is the regular PIM multicast address 224.0.0.13.

A (\*,G) mroute will be created. An incoming interface/RPF for the RP is the LISP0 interface.

```
xTR3#sh ip mro 225.1.1.10
<...skip...>
(*, 225.1.1.10), 00:42:51/00:03:25, RP 172.16.251.4, flags: S
  Incoming interface: LISP0, RPF nbr 10.1.14.1
  Outgoing interface list:
    GigabitEthernet0/2.10, Forward/Sparse, 00:42:51/00:03:25
```

```
xTR3#sh int LISP0 | i address
Interface is unnumbered. Using address of Loopback0 (10.1.255.3)
```

On xTR4 a (\*,G) Join is received from the LISP tunnel. An appropriate mroute is created.

```
xTR4#
*Nov 27 14:38:20.880: PIM(0): Received v2 Join/Prune on LISP0 from 10.1.255.3, to us
*Nov 27 14:38:20.881: PIM(0): Join-list: (*, 225.1.1.10), RPT-bit set, WC-bit set, S-bit set
*Nov 27 14:38:20.883: PIM(0): Check RP 172.16.251.4 into the (*, 225.1.1.10) entry
*Nov 27 14:38:20.883: PIM(0): Building Triggered (*,G) Join / (S,G,RP-bit) Prune message for
225.1.1.10
*Nov 27 14:38:20.884: PIM(0): Add LISP0/10.1.13.1 to (*, 225.1.1.10), Forward state, by PIM *G
Join
*Nov 27 14:38:20.885: PIM(0): Building Triggered (*,G) Join / (S,G,RP-bit) Prune message for
225.1.1.10
*Nov 27 14:38:20.885: PIM(0): Upstream mode for (*, 225.1.1.10) changed from 0 to 1
xTR4#
*Nov 27 14:38:20.885: PIM(0): Insert (*,225.1.1.10) join in nbr 172.16.14.2's queue
*Nov 27 14:38:20.886: PIM(0): Building Join/Prune packet for nbr 172.16.14.2
*Nov 27 14:38:20.886: PIM(0): Adding v2 (172.16.251.4/32, 225.1.1.10), WC-bit, RPT-bit, S-bit
Join
*Nov 27 14:38:20.887: PIM(0): Send v2 join/prune to 172.16.14.2 (GigabitEthernet0/2.10)
```

```
xTR4#sh ip mro 225.1.1.10
<...skip...>
(*, 225.1.1.10), 00:45:05/00:02:56, RP 172.16.251.4, flags: S
```

Incoming interface: GigabitEthernet0/2.10, RPF nbr 172.16.14.2

Outgoing interface list:

LISP0, 10.1.13.1, Forward/Sparse, 00:45:05/00:02:56

A PIM neighbor is not created on xTR4 in this case. The PIM neighbor to CE4 only is present.

```
xTR4#sh ip pim nei
```

PIM Neighbor Table

Mode: B - Bidir Capable, DR - Designated Router, N - Default DR Priority,

P - Proxy Capable, S - State Refresh Capable, G - GenID Capable,

L - DR Load-balancing Capable

Neighbor Address	Interface	Uptime/Expires	Ver	DR Prio/Mode
172.16.14.2	GigabitEthernet0/2.10	22:00:37/00:01:20	v2	1 / DR S P G

From the RP perspective everything is expected. A (\*,G) mroute is created.

```
CE4#
```

```
*Nov 27 14:41:55.907: PIM(0): Building Periodic (*,G) Join / (S,G,RP-bit) Prune message for 224.0.1.40
```

```
CE4#
```

```
*Nov 27 14:42:11.841: PIM(0): Received v2 Join/Prune on GigabitEthernet0/1.10 from 172.16.14.1, to us
```

```
*Nov 27 14:42:11.841: PIM(0): Join-list: (*, 225.1.1.10), RPT-bit set, WC-bit set, S-bit set
```

```
*Nov 27 14:42:11.844: PIM(0): Check RP 172.16.251.4 into the (*, 225.1.1.10) entry
```

```
*Nov 27 14:42:11.845: PIM(0): Adding register decap tunnel (Tunnel0) as accepting interface of (*, 225.1.1.10).
```

```
*Nov 27 14:42:11.846: PIM(0): Add GigabitEthernet0/1.10/172.16.14.1 to (*, 225.1.1.10), Forward state, by PIM *G Join
```

```
CE4#sh ip mro
```

```
<...skip...>
```

```
(*, 225.1.1.10), 00:00:11/00:03:18, RP 172.16.251.4, flags: S
```

```
Incoming interface: Null, RPF nbr 0.0.0.0
```

```
Outgoing interface list:
```

```
GigabitEthernet0/1.10, Forward/Sparse, 00:00:11/00:03:18
```

```
(*, 224.0.1.40), 21:00:55/00:02:53, RP 172.16.251.4, flags: SJCL
```

```
Incoming interface: Null, RPF nbr 0.0.0.0
```

```
Outgoing interface list:
```

```
GigabitEthernet0/1.10, Forward/Sparse, 21:00:55/00:02:53
```

## Shortest Path Tree (SPT) Switchover

It is assumed that the shared-tree is already built.

CE1 starts to send traffic to the 225.1.1.10 from the source Lo10 (172.16.251.1).

```
CE1#ping 225.1.1.10 so lo10
```

```
Type escape sequence to abort.
```

```
Sending 1, 100-byte ICMP Echos to 225.1.1.10, timeout is 2 seconds:
```

```
Packet sent with a source address of 172.16.251.1
```

```
Reply to request 0 from 172.16.251.3, 77 ms
```

The first multicast packet is encapsulated into the unicast Register message and is sent to the RP.

```
CE1#ping 225.1.1.10 so lo10
```

```
Type escape sequence to abort.
```

```
Sending 1, 100-byte ICMP Echos to 225.1.1.10, timeout is 2 seconds:
```

```
Packet sent with a source address of 172.16.251.1
```

```
Reply to request 0 from 172.16.251.3, 77 ms
```

The register packet is decapsulated on the RP and sent over the shared tree to the Receiver.

```
CE1#ping 225.1.1.10 so lo10
```

```
Type escape sequence to abort.
```

```
Sending 1, 100-byte ICMP Echos to 225.1.1.10, timeout is 2 seconds:
```

```
Packet sent with a source address of 172.16.251.1
```

```
Reply to request 0 from 172.16.251.3, 77 ms
```

Because of match between outgoing interface for a (\*,G) and an incoming interface for a (S,G), a proxy join timer is started for a (S,G), the flag X is set. It is a topology specific situation (RP-on-a-stick).

```
CE4#sh ip mro
```

```
<...skip...>
```

```
(* , 225.1.1.10), 00:00:37/stopped, RP 172.16.251.4, flags: S
```

```
  Incoming interface: Null, RPF nbr 0.0.0.0
```

```
  Outgoing interface list:
```

```
    GigabitEthernet0/1.10, Forward/Sparse, 00:00:37/00:02:52
```

```
(172.16.251.1, 225.1.1.10), 00:00:26/00:02:33, flags: PX Incoming interface:
```

```
GigabitEthernet0/1.10, RPF nbr 172.16.14.1 Outgoing interface list: Null
```

So CE4 sends a (S,G) Join to the Source and does not send a (S,G) Prune.

```
CE4#sh ip mro
```

```
<...skip...>
```

```
(* , 225.1.1.10), 00:00:37/stopped, RP 172.16.251.4, flags: S
```

```
  Incoming interface: Null, RPF nbr 0.0.0.0
```

```
  Outgoing interface list:
```

```
    GigabitEthernet0/1.10, Forward/Sparse, 00:00:37/00:02:52
```

```
(172.16.251.1, 225.1.1.10), 00:00:26/00:02:33, flags: PX Incoming interface:
```

```
GigabitEthernet0/1.10, RPF nbr 172.16.14.1 Outgoing interface list: Null
```

At the same time, decapsulated multicast traffic is sent over a shared tree to receivers as shown in the images.

No.	Time	Source	Destination	Protocol	Info
68	2017-11-28 13:55:29.783398	10.1.14.10	224.0.0.5	OSPF	Hello Packet
69	2017-11-28 13:55:34.738715	fa:16:3e:ab:98:7e	CDP/VTP/DTP/PAgP/UDLD	CDP	Device ID: xTR4 Port ID: GigabitEthernet0...
70	2017-11-28 13:55:35.939428	fa:16:3e:ab:98:7e	fa:16:3e:ab:98:7e	LOOP	Reply
71	2017-11-28 13:55:37.964584	10.1.14.1	224.0.0.5	OSPF	Hello Packet
72	2017-11-28 13:55:40.167524	10.1.14.10	224.0.0.5	OSPF	Hello Packet
73	2017-11-28 13:55:41.375985	172.16.251.1	225.1.1.10	ICMP	Echo (ping) request id=0x002b, seq=0/0, t...
74	2017-11-28 13:55:41.391351	172.16.251.1	225.1.1.10	ICMP	Echo (ping) request id=0x002b, seq=0/0, t...
75	2017-11-28 13:55:41.405722	172.16.251.1	225.1.1.10	ICMP	Echo (ping) request id=0x002b, seq=0/0, t...
76	2017-11-28 13:55:41.408310	172.16.251.1	225.1.1.10	ICMP	Echo (ping) request id=0x002b, seq=0/0, t...
77	2017-11-28 13:55:41.568043	10.1.255.3	224.0.0.13	PIMv2	Join/Prune
78	2017-11-28 13:55:43.448000	172.16.251.1	225.1.1.10	ICMP	Echo (ping) request id=0x002b, seq=1/256, ...
79	2017-11-28 13:55:43.449757	172.16.251.1	225.1.1.10	ICMP	Echo (ping) request id=0x002b, seq=1/256, ...
80	2017-11-28 13:55:45.137555	172.16.23.1	224.0.0.13	PIMv2	Join/Prune
81	2017-11-28 13:55:45.451144	172.16.251.1	225.1.1.10	ICMP	Echo (ping) request id=0x002b, seq=2/512, ...
82	2017-11-28 13:55:45.453196	172.16.251.1	225.1.1.10	ICMP	Echo (ping) request id=0x002b, seq=2/512, ...

▶ Frame 74: 150 bytes on wire (1200 bits), 150 bytes captured (1200 bits) on interface 0  
 ▶ Ethernet II, Src: fa:16:3e:9b:b3:ff (fa:16:3e:9b:b3:ff), Dst: fa:16:3e:ab:98:7e (fa:16:3e:ab:98:7e)  
 ▶ Internet Protocol Version 4, Src: 10.1.11.1, Dst: 10.1.14.1  
 ▶ User Datagram Protocol, Src Port: 46618, Dst Port: 4341  
 ▶ Locator/ID Separation Protocol (Data)  
 ▶ Internet Protocol Version 4, Src: 172.16.251.1, Dst: 225.1.1.10  
 ▶ Internet Control Message Protocol

No.	Time	Source	Destination	Protocol	Info
68	2017-11-28 13:55:29.783398	10.1.14.10	224.0.0.5	OSPF	Hello Packet
69	2017-11-28 13:55:34.738715	fa:16:3e:ab:98:7e	CDP/VTP/DTP/PAgP/UDLD	CDP	Device ID: xTR4 Port ID: GigabitEthernet0...
70	2017-11-28 13:55:35.939428	fa:16:3e:ab:98:7e	fa:16:3e:ab:98:7e	LOOP	Reply
71	2017-11-28 13:55:37.964584	10.1.14.1	224.0.0.5	OSPF	Hello Packet
72	2017-11-28 13:55:40.167524	10.1.14.10	224.0.0.5	OSPF	Hello Packet
73	2017-11-28 13:55:41.375985	172.16.251.1	225.1.1.10	ICMP	Echo (ping) request id=0x002b, seq=0/0, t...
74	2017-11-28 13:55:41.391351	172.16.251.1	225.1.1.10	ICMP	Echo (ping) request id=0x002b, seq=0/0, t...
75	2017-11-28 13:55:41.405722	172.16.251.1	225.1.1.10	ICMP	Echo (ping) request id=0x002b, seq=0/0, t...
76	2017-11-28 13:55:41.408310	172.16.251.1	225.1.1.10	ICMP	Echo (ping) request id=0x002b, seq=0/0, t...
77	2017-11-28 13:55:41.568043	10.1.255.3	224.0.0.13	PIMv2	Join/Prune
78	2017-11-28 13:55:43.448000	172.16.251.1	225.1.1.10	ICMP	Echo (ping) request id=0x002b, seq=1/256, ...
79	2017-11-28 13:55:43.449757	172.16.251.1	225.1.1.10	ICMP	Echo (ping) request id=0x002b, seq=1/256, ...
80	2017-11-28 13:55:45.137555	172.16.23.1	224.0.0.13	PIMv2	Join/Prune
81	2017-11-28 13:55:45.451144	172.16.251.1	225.1.1.10	ICMP	Echo (ping) request id=0x002b, seq=2/512, ...
82	2017-11-28 13:55:45.453196	172.16.251.1	225.1.1.10	ICMP	Echo (ping) request id=0x002b, seq=2/512, ...

▶ Frame 74: 150 bytes on wire (1200 bits), 150 bytes captured (1200 bits) on interface 0  
 ▶ Ethernet II, Src: fa:16:3e:9b:b3:ff (fa:16:3e:9b:b3:ff), Dst: fa:16:3e:ab:98:7e (fa:16:3e:ab:98:7e)  
 ▶ Internet Protocol Version 4, Src: 10.1.11.1, Dst: 10.1.14.1  
 ▶ User Datagram Protocol, Src Port: 46618, Dst Port: 4341  
 ▶ Locator/ID Separation Protocol (Data)  
 ▶ Internet Protocol Version 4, Src: 172.16.251.1, Dst: 225.1.1.10  
 ▶ Internet Control Message Protocol

The packet capture was taken on the xTR4 g0/1 interface.

In the first packet, the outer IP SRC and DST are 10.1.11.1 and 10.1.14.1.

In the second packet, the outer IP SRC and DST are 10.1.14.1 and 10.1.13.1 respectively.

After receiving multicast packets LHR CE3 is initiating SPT switchover. A Mroute for (S,G) is created and flags J and T are set. A (S,G) Join is sent towards the Source.

```

.Nov 30 00:00:51.765: MRT(0): Set 'L' flag for (172.16.251.1, 225.1.1.10)
.Nov 30 00:00:51.766: MRT(0): Reset the z-flag for (172.16.251.1, 225.1.1.10)
.Nov 30 00:00:51.766: MRT(0): (172.16.251.1,225.1.1.10), RPF install from /0.0.0.0 to
GigabitEthernet0/1.10/172.16.13.1
.Nov 30 00:00:51.767: MRT(0): Set the T-flag for (172.16.251.1, 225.1.1.10)
.Nov 30 00:00:51.768: PIM(0): Insert (172.16.251.1,225.1.1.10) join in nbr 172.16.13.1's queue
.Nov 30 00:00:51.768: MRT(0): Create (172.16.251.1,225.1.1.10), RPF (GigabitEthernet0/1.10,
172.16.13.1, 90/3072)
.Nov 30 00:00:51.769: MRT(0): WAVL Insert interface: Loopback10 in (172.16.251.1,225.1.1.10)
Successful
.Nov 30 00:00:51.770: MRT(0): set min mtu for (172.16.251.1, 225.1.1.10) 18010->18010
  
```



```
.Nov 30 00:00:51.771: MRT(0): Add Loopback10/225.1.1.10 to the olist of (172.16.251.1,
225.1.1.10), Forward state - MAC not built
.Nov 30 00:00:51.771: MRT(0): Set the J-flag for (172.16.251.1, 225.1.1.10)
.Nov 30 00:00:51.780: PIM(0): Building Join/Prune packet for nbr 172.16.13.1
.Nov 30 00:00:51.780: PIM(0): Adding v2 (172.16.251.1/32, 225.1.1.10), S-bit Join
.Nov 30 00:00:51.781: PIM(0): Send v2 join/prune to 172.16.13.1 (GigabitEthernet0/1.10)
```

**CE3#sh ip mro**

<...skip...>

```
(*, 225.1.1.10), 00:01:36/stopped, RP 172.16.251.4, flags: SJCL
  Incoming interface: GigabitEthernet0/1.10, RPF nbr 172.16.13.1
  Outgoing interface list:
    Loopback10, Forward/Sparse, 00:01:36/00:02:48
```

```
(172.16.251.1, 225.1.1.10), 00:00:25/00:02:34, flags: LJT Incoming interface:
GigabitEthernet0/1.10, RPF nbr 172.16.13.1 Outgoing interface list: Loopback10, Forward/Sparse,
00:00:25/00:02:48
```

xTR3 is receiving a (S,G) Join from CE3. It is checking RPF for the Source 172.16.251.1. It is triggering a LISP lookup and creates a PIM neighbor to the RLOC 10.1.11.1 additionally to the PIM neighbor to the RLOC 10.1.14.1. A Mroute for (S,G) with a flag T is created. A (S,G) Join is sent to the Source 172.16.255.1 via the LISP0 RLOC 10.1.11.1

```
.Nov 30 00:00:51.104: PIM(0): Received v2 Join/Prune on GigabitEthernet0/2.10 from 172.16.13.2,
to us
.Nov 30 00:00:51.105: PIM(0): Join-list: (172.16.251.1/32, 225.1.1.10), S-bit set
.Nov 30 00:00:51.105: PIM(0): RPF Lookup failed for 172.16.251.1
.Nov 30 00:00:51.108: MRT(0): Reset the z-flag for (172.16.251.1, 225.1.1.10)
.Nov 30 00:00:51.108: MRT(0): Create (172.16.251.1,225.1.1.10), RPF (unknown, 0.0.0.0, 0/0)
.Nov 30 00:00:51.109: MRT(0): WAVL Insert interface: GigabitEthernet0/2.10 in
(172.16.251.1,225.1.1.10) Successful
.Nov 30 00:00:51.110: MRT(0): set min mtu for (172.16.251.1, 225.1.1.10) 18010->1500
.Nov 30 00:00:51.110: MRT(0): Add GigabitEthernet0/2.10/225.1.1.10 to the olist of
(172.16.251.1, 225.1.1.10), Forward state - MAC built
.Nov 30 00:00:51.111: PIM(0): Add GigabitEthernet0/2.10/172.16.13.2 to (172.16.251.1,
225.1.1.10), Forward state, by PIM SG Join
.Nov 30 00:00:51.111: MRT(0): Add GigabitEthernet0/2.10/225.1.1.10 to the olist of
(172.16.251.1, 225.1.1.10), Forward state - MAC built
.Nov 30 00:00:51.112: MRT(0): Set the PIM interest flag for (172.16.251.1, 225.1.1.10)
.Nov 30 00:00:51.128: MRT(0): (172.16.251.1,225.1.1.10), RPF change from /0.0.0.0 to
LISP0/10.1.11.1
.Nov 30 00:00:51.130: MRT(0): Set the T-flag for (172.16.251.1, 225.1.1.10)
.Nov 30 00:00:51.130: PIM(0): Insert (172.16.251.1,225.1.1.10) join in nbr 10.1.11.1's queue
.Nov 30 00:00:51.134: PIM(0): Building Join/Prune packet for nbr 10.1.11.1
.Nov 30 00:00:51.134: PIM(0): Adding v2 (172.16.251.1/32, 225.1.1.10), S-bit Join
.Nov 30 00:00:51.135: PIM(0): Send v2 join/prune to 10.1.11.1 (LISP0)
```

**xTR3#sh ip pim nei**

PIM Neighbor Table

Mode: B - Bidir Capable, DR - Designated Router, N - Default DR Priority,  
P - Proxy Capable, S - State Refresh Capable, G - GenID Capable,  
L - DR Load-balancing Capable

Neighbor Address	Interface	Uptime/Expires	Ver	DR Prio/Mode
172.16.13.2	GigabitEthernet0/2.10	2d16h/00:01:20	v2	1 / DR S P G
10.1.11.1	LISP0	00:00:19/00:01:39	v2	0 /
10.1.14.1	LISP0	1d18h/00:01:39	v2	0 /

**xTR3#sh ip mro**

<...skip...>

```
(*, 225.1.1.10), 00:01:29/stopped, RP 172.16.251.4, flags: S
  Incoming interface: LISP0, RPF nbr 10.1.14.1
```



```

Outgoing interface list:
  GigabitEthernet0/2.10, Forward/Sparse, 00:01:29/00:02:57

(172.16.251.1, 225.1.1.10), 00:00:19/00:02:40, flags: T
  Incoming interface: LISP0, RPF nbr 10.1.11.1
  Outgoing interface list:
    GigabitEthernet0/2.10, Forward/Sparse, 00:00:19/00:03:10

```

RPF interfaces for a (\*,G) and a (S,G) becomes different - a shared tree (RLOC 10.1.14.1) and SPT (RLOC 10.1.11.1). It triggers a (S,G) Prune message with RPT-bit and S-bit Join from xTR3 to the RP.

```

.Nov 30 00:00:51.209: PIM(0): Insert (172.16.251.1,225.1.1.10) sgr prune in nbr 10.1.14.1's
queue
.Nov 30 00:00:51.212: PIM(0): Building Join/Prune packet for nbr 10.1.14.1
.Nov 30 00:00:51.212: PIM(0): Adding v2 (172.16.251.4/32, 225.1.1.10), WC-bit, RPT-bit, S-bit
Join
.Nov 30 00:00:51.213: PIM(0): Adding v2 (172.16.251.1/32, 225.1.1.10), RPT-bit, S-bit Prune
.Nov 30 00:00:51.214: PIM(0): Send v2 join/prune to 10.1.14.1 (LISP0)

```

**xTR3#sh ip pim nei**

PIM Neighbor Table

Mode: B - Bidir Capable, DR - Designated Router, N - Default DR Priority,  
 P - Proxy Capable, S - State Refresh Capable, G - GenID Capable,  
 L - DR Load-balancing Capable

Neighbor Address	Interface	Uptime/Expires	Ver	DR Prio/Mode
172.16.13.2	GigabitEthernet0/2.10	4d09h/00:01:19	v2	1 / DR S P G
10.1.11.1	LISP0	00:00:58/00:01:02	v2	0 /
10.1.14.1	LISP0	3d11h/00:01:34	v2	0 /

xTR1 receives a (S,G) Join from xTR3 for that triggers SPT build. A RPF for (\*,G) is the RP which is reachable via LISP. A PIM neighbor for a RPF check is created to the RLOC 10.1.14.1. A (\*,G) and a (S,G) mroutes are created.

```

.Nov 30 00:00:51.209: PIM(0): Insert (172.16.251.1,225.1.1.10) sgr prune in nbr 10.1.14.1's
queue
.Nov 30 00:00:51.212: PIM(0): Building Join/Prune packet for nbr 10.1.14.1
.Nov 30 00:00:51.212: PIM(0): Adding v2 (172.16.251.4/32, 225.1.1.10), WC-bit, RPT-bit, S-bit
Join
.Nov 30 00:00:51.213: PIM(0): Adding v2 (172.16.251.1/32, 225.1.1.10), RPT-bit, S-bit Prune
.Nov 30 00:00:51.214: PIM(0): Send v2 join/prune to 10.1.14.1 (LISP0)

```

**xTR3#sh ip pim nei**

PIM Neighbor Table

Mode: B - Bidir Capable, DR - Designated Router, N - Default DR Priority,  
 P - Proxy Capable, S - State Refresh Capable, G - GenID Capable,  
 L - DR Load-balancing Capable

Neighbor Address	Interface	Uptime/Expires	Ver	DR Prio/Mode
172.16.13.2	GigabitEthernet0/2.10	4d09h/00:01:19	v2	1 / DR S P G
10.1.11.1	LISP0	00:00:58/00:01:02	v2	0 /
10.1.14.1	LISP0	3d11h/00:01:34	v2	0 /

Also xTR1 receives a (S,G) Join from the RP. An OIL LISP0 via the RLOC 10.1.14.1 is added to the (S,G).

```
.Nov 30 00:00:55.295: PIM(0): Received v2 Join/Prune on LISP0 from 172.16.251.14
.Nov 30 00:00:55.295: PIM(0): J/P Transport Attribute, Transport Type: Unicast, to us
.Nov 30 00:00:55.295: PIM(0): Join-list: (172.16.251.1/32, 225.1.1.10), S-bit set
.Nov 30 00:00:55.295: MRT(0): WAVL Insert LISP interface: LISP0 in (172.16.251.1,225.1.1.10)
Next-hop: 10.1.14.1 Outer-source: 0.0.0.0 Successful
.Nov 30 00:00:55.296: MRT(0): set min mtu for (172.16.251.1, 225.1.1.10) 17892->17892
.Nov 30 00:00:55.296: MRT(0): Add LISP0/10.1.14.1 to the olist of (172.16.251.1, 225.1.1.10),
Forward state - MAC not built
.Nov 30 00:00:55.296: PIM(0): Add LISP0/10.1.14.1 to (172.16.251.1, 225.1.1.10), Forward state,
by PIM SG Join
.Nov 30 00:00:55.297: MRT(0): Add LISP0/10.1.14.1 to the olist of (172.16.251.1, 225.1.1.10),
Forward state - MAC not built
```

**xTR1#sh ip mro**

```
(*, 225.1.1.10), 00:00:27/stopped, RP 172.16.251.4, flags: SP
  Incoming interface: LISP0, RPF nbr 10.1.14.1
  Outgoing interface list: Null
```

```
(172.16.251.1, 225.1.1.10), 00:00:27/00:02:31, flags: T
  Incoming interface: GigabitEthernet3.10, RPF nbr 172.16.11.2
  Outgoing interface list:
    LISP0, 10.1.14.1, Forward/Sparse, 00:00:27/00:03:01
    LISP0, 10.1.13.1, Forward/Sparse, 00:00:27/00:03:01
```

xTR4 receives a (S,G) prune from the xTR3. LISP0 to 10.1.13.1 is excluded from an OIL.

```
Nov 30 00:00:50.771: PIM(0): Received v2 Join/Prune on LISP0 from 10.1.255.3, to us
Nov 30 00:00:50.772: PIM(0): Join-list: (*, 225.1.1.10), RPT-bit set, WC-bit set, S-bit set
Nov 30 00:00:50.774: PIM(0): Update LISP0/10.1.13.1 to (*, 225.1.1.10), Forward state, by PIM *G
Join
Nov 30 00:00:50.774: MRT(0): Update LISP0/10.1.13.1 in the olist of (*, 225.1.1.10), Forward
state - MAC not built
Nov 30 00:00:50.775: PIM(0): Prune-list: (172.16.251.1/32, 225.1.1.10) RPT-bit set
Nov 30 00:00:50.776: PIM(0): Prune LISP0/10.1.13.1 from (172.16.251.1/32, 225.1.1.10)
Nov 30 00:00:50.776: MRT(0): Delete LISP0/10.1.13.1 from the olist of (172.16.251.1, 225.1.1.10)
- deleted
```

**xTR4#sh ip mro**

```
<...skip...>
(*, 225.1.1.10), 00:07:47/00:03:04, RP 172.16.251.4, flags: S
  Incoming interface: GigabitEthernet0/2.10, RPF nbr 172.16.14.2
  Outgoing interface list:
    LISP0, 10.1.13.1, Forward/Sparse, 00:07:47/00:03:04
```

```
(172.16.251.1, 225.1.1.10), 00:00:26/00:02:33, flags:
  Incoming interface: LISP0, RPF nbr 10.1.11.1
  Outgoing interface list:
    GigabitEthernet0/2.10, Forward/Sparse, 00:00:26/00:03:03
```

**xTR4#sh ip pim nei**

PIM Neighbor Table

Mode: B - Bidir Capable, DR - Designated Router, N - Default DR Priority,  
P - Proxy Capable, S - State Refresh Capable, G - GenID Capable,  
L - DR Load-balancing Capable

Neighbor Address	Interface	Uptime/Expires	Ver	DR Prio/Mode
172.16.14.2	GigabitEthernet0/2.10	4d09h/00:01:16	v2	1 / DR S P G
10.1.11.1	LISP0	00:00:26/00:01:33	v2	0 /

The RP (CE4) receives a (S,G) Prune with RPT-bit set. The RP should prune the source from the shared tree. The RP initiates a (S,G) Prune towards the source.

```
.Nov 30 00:01:34.811: PIM(0): Received v2 Join/Prune on GigabitEthernet0/1.10 from 172.16.14.1,
to us
.Nov 30 00:01:34.813: PIM(0): Prune-list: (172.16.251.1/32, 225.1.1.10) RPT-bit set
.Nov 30 00:01:34.818: MRT(0): Set the T-flag for (172.16.251.1, 225.1.1.10)
.Nov 30 00:01:34.818: PIM(0): Removing register decap tunnel (Tunnel0) as accepting interface of
(172.16.251.1, 225.1.1.10).
.Nov 30 00:01:34.819: PIM(0): Installing GigabitEthernet0/1.10 as accepting interface for
(172.16.251.1, 225.1.1.10).
.Nov 30 00:01:34.899: PIM(0): Insert (172.16.251.1,225.1.1.10) join in nbr 172.16.14.1's queue
.Nov 30 00:01:34.902: PIM(0): Building Join/Prune packet for nbr 172.16.14.1
.Nov 30 00:01:34.903: PIM(0): Adding v2 (172.16.251.1/32, 225.1.1.10), S-bit Join
.Nov 30 00:01:34.903: PIM(0): Send v2 join/prune to 172.16.14.1 (GigabitEthernet0/1.10)
.Nov 30 00:01:39.398: PIM(0): Insert (172.16.251.1,225.1.1.10) prune in nbr 172.16.14.1's queue
.Nov 30 00:01:39.399: PIM(0): Building Join/Prune packet for nbr 172.16.14.1
.Nov 30 00:01:39.401: PIM(0): Adding v2 (172.16.251.1/32, 225.1.1.10), S-bit Prune
.Nov 30 00:01:39.402: PIM(0): Send v2 join/prune to 172.16.14.1 (GigabitEthernet0/1.10)
```

**CE4#sh ip mro**

```
<...skip...>
(172.16.251.1, 225.1.1.10), 00:00:57/00:02:45, flags: PT
  Incoming interface: GigabitEthernet0/1.10, RPF nbr 172.16.14.1
  Outgoing interface list: Null
```

xTR4 receives a (S,G) Prune initiated by the RP and sends it to the FHR (CE1). Gi0/2.10 is excluded from an OIL.

```
Nov 30 00:01:38.620: PIM(0): Received v2 Join/Prune on GigabitEthernet0/2.10 from 172.16.14.2,
to us
Nov 30 00:01:38.621: PIM(0): Prune-list: (172.16.251.1/32, 225.1.1.10)
Nov 30 00:01:38.622: PIM(0): Prune GigabitEthernet0/2.10/225.1.1.10 from (172.16.251.1/32,
225.1.1.10)
Nov 30 00:01:38.622: MRT(0): Delete GigabitEthernet0/2.10/225.1.1.10 from the olist of
(172.16.251.1, 225.1.1.10)
Nov 30 00:01:38.624: MRT(0): Reset the PIM interest flag for (172.16.251.1, 225.1.1.10)
Nov 30 00:01:38.625: MRT(0): set min mtu for (172.16.251.1, 225.1.1.10) 1500->18010
Nov 30 00:01:38.626: PIM(0): Insert (172.16.251.1,225.1.1.10) prune in nbr 10.1.11.1's queue -
deleted
Nov 30 00:01:38.628: PIM(0): Building Join/Prune packet for nbr 10.1.11.1
Nov 30 00:01:38.629: PIM(0): Adding v2 (172.16.251.1/32, 225.1.1.10), S-bit Prune
Nov 30 00:01:38.630: PIM(0): Send v2 join/prune to 10.1.11.1 (LISP0)
```

**xTR4#sh ip mro**

```
<...skip...>
(*, 225.1.1.10), 00:08:19/00:02:32, RP 172.16.251.4, flags: S
  Incoming interface: GigabitEthernet0/2.10, RPF nbr 172.16.14.2
  Outgoing interface list:
    LISP0, 10.1.13.1, Forward/Sparse, 00:08:19/00:02:32
(172.16.251.1, 225.1.1.10), 00:00:57/00:02:02, flags: PT
  Incoming interface: LISP0, RPF nbr 10.1.11.1
  Outgoing interface list: Null
```

xTR1 receives a (S,G) Prune from xTR4 and remove the LISP0 via the RLOC 10.1.14.1 from the OIL.

```
.Nov 30 00:01:47.450: PIM(0): Received v2 Join/Prune on LISP0 from 172.16.251.14
.Nov 30 00:01:47.450: PIM(0): J/P Transport Attribute, Transport Type: Unicast, to us
.Nov 30 00:01:47.450: PIM(0): Prune-list: (172.16.251.1/32, 225.1.1.10)
.Nov 30 00:01:47.451: PIM(0): Prune LISP0/10.1.14.1 from (172.16.251.1/32, 225.1.1.10)
.Nov 30 00:01:47.451: MRT(0): Delete LISP0/10.1.14.1 from the olist of (172.16.251.1,
225.1.1.10) - deleted
```

```
xTR1#sh ip mro
```

```
<...skip...>
```

```
(* , 225.1.1.10), 00:01:02/stopped, RP 172.16.251.4, flags: SP
  Incoming interface: LISP0, RPF nbr 10.1.14.1
  Outgoing interface list: Null
```

```
(172.16.251.1, 225.1.1.10), 00:01:02/00:01:57, flags: T
  Incoming interface: GigabitEthernet3.10, RPF nbr 172.16.11.2
  Outgoing interface list:
    LISP0, 10.1.13.1, Forward/Sparse, 00:01:02/00:02:27
```

Now you have a final state.

## FHR (CE1)

```
CE1#sh ip mro
```

```
<...skip...>
```

```
(* , 225.1.1.10), 00:01:46/stopped, RP 172.16.251.4, flags: SPF
  Incoming interface: GigabitEthernet0/1.10, RPF nbr 172.16.11.1
  Outgoing interface list: Null
```

```
(172.16.251.1, 225.1.1.10), 00:01:46/00:03:09, flags: FT
  Incoming interface: Loopback10, RPF nbr 0.0.0.0
  Outgoing interface list:
    GigabitEthernet0/1.10, Forward/Sparse, 00:01:46/00:02:39, A
```

## xTR1

```
xTR1#sh ip mro
```

```
<...skip...>
```

```
(* , 225.1.1.10), 00:01:02/stopped, RP 172.16.251.4, flags: SP
  Incoming interface: LISP0, RPF nbr 10.1.14.1
  Outgoing interface list: Null
```

```
(172.16.251.1, 225.1.1.10), 00:01:02/00:01:57, flags: T
  Incoming interface: GigabitEthernet3.10, RPF nbr 172.16.11.2
  Outgoing interface list:
    LISP0, 10.1.13.1, Forward/Sparse, 00:01:02/00:02:27
```

```
xTR1#sh ip pim nei
```

```
PIM Neighbor Table
```

```
Mode: B - Bidir Capable, DR - Designated Router, N - Default DR Priority,
      P - Proxy Capable, S - State Refresh Capable, G - GenID Capable,
      L - DR Load-balancing Capable
```

Neighbor Address	Interface	Uptime/Expires	Ver	DR Prio/Mode
172.16.11.2	GigabitEthernet3.10	16:23:01/00:01:29	v2	1 / DR S P G
10.1.14.1	LISP0	00:01:02/00:01:55	v2	0 /

## LHR (CE3)

### CE3#sh ip mro

<...skip...>

(\* , 225.1.1.10), 00:10:10/stopped, RP 172.16.251.4, flags: SJCL  
Incoming interface: GigabitEthernet0/1.10, RPF nbr 172.16.13.1  
Outgoing interface list:  
Loopback10, Forward/Sparse, 00:10:10/00:02:24

(172.16.251.1, 225.1.1.10), 00:01:46/00:01:13, flags: LJT  
Incoming interface: GigabitEthernet0/1.10, RPF nbr 172.16.13.1  
Outgoing interface list:  
Loopback10, Forward/Sparse, 00:01:46/00:02:24

## xTR3

### xTR3#sh ip mro

<...skip...>

(\* , 225.1.1.10), 00:09:05/00:03:15, RP 172.16.251.4, flags: S  
Incoming interface: LISP0, RPF nbr 10.1.14.1  
Outgoing interface list:  
GigabitEthernet0/2.10, Forward/Sparse, 00:09:05/00:03:15

(172.16.251.1, 225.1.1.10), 00:01:44/00:01:15, flags: T  
Incoming interface: LISP0, RPF nbr 10.1.11.1  
Outgoing interface list:  
GigabitEthernet0/2.10, Forward/Sparse, 00:01:44/00:03:15

### xTR3#sh ip pim nei

PIM Neighbor Table

Mode: B - Bidir Capable, DR - Designated Router, N - Default DR Priority,  
P - Proxy Capable, S - State Refresh Capable, G - GenID Capable,  
L - DR Load-balancing Capable

Neighbor Address	Interface	Uptime/Expires	Ver	DR Prio/Mode
172.16.13.2	GigabitEthernet0/2.10	4d09h/00:01:30	v2	1 / DR S P G
10.1.11.1	LISP0	00:01:44/00:01:14	v2	0 /
10.1.14.1	LISP0	3d11h/00:01:46	v2	0 /

## RP(CE4)

### CE4#sh ip mro

<...skip...>

(\* , 225.1.1.10), 00:09:10/00:03:17, RP 172.16.251.4, flags: S  
Incoming interface: Null, RPF nbr 0.0.0.0  
Outgoing interface list:  
GigabitEthernet0/1.10, Forward/Sparse, 00:09:10/00:03:17

(172.16.251.1, 225.1.1.10), 00:01:45/00:02:35, flags: PT  
Incoming interface: GigabitEthernet0/1.10, RPF nbr 172.16.14.1  
Outgoing interface list: Null

## xTR4

### xTR4#sh ip mro

<...skip...>

(\* , 225.1.1.10), 00:09:05/00:02:44, RP 172.16.251.4, flags: S  
Incoming interface: GigabitEthernet0/2.10, RPF nbr 172.16.14.2

Outgoing interface list:  
LISP0, 10.1.13.1, Forward/Sparse, 00:09:05/00:02:44

(172.16.251.1, 225.1.1.10), 00:01:44/00:01:15, flags: PT  
Incoming interface: LISP0, RPF nbr 10.1.11.1  
Outgoing interface list: Null

**xTR4#sh ip pim nei**

PIM Neighbor Table

Mode: B - Bidir Capable, DR - Designated Router, N - Default DR Priority,  
P - Proxy Capable, S - State Refresh Capable, G - GenID Capable,  
L - DR Load-balancing Capable

Neighbor Address	Interface	Uptime/Expires	Ver	DR Prio/Mode
172.16.14.2	GigabitEthernet0/2.10	4d09h/00:01:25	v2	1 / DR S P G
10.1.11.1	LISP0	00:01:44/00:01:47	v2	0 /

## Verify

There is currently no verification procedure available for this configuration.

## Troubleshoot

There is currently no specific troubleshooting information available for this configuration.

## Source

- RFC 6831 The LISP for Multicast Environments