

# Overview of Any-Source Multicast (ASM) in SDA Campus Fabric Environment

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## Introduction

This document describes Overview of Any-Source Multicast (ASM) with Single Rendezvous point (RP) in Software-Defined Access (SD-Access) Environment.

## Prerequisites

### Requirements

It is recommended that you have knowledge of Locator ID Separation Protocol (LISP) and multicast.

## Components Used

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

The information in this document was created from devices in a specific lab environment. If your network is live, make sure that you understand the potential impact of any command.GUI

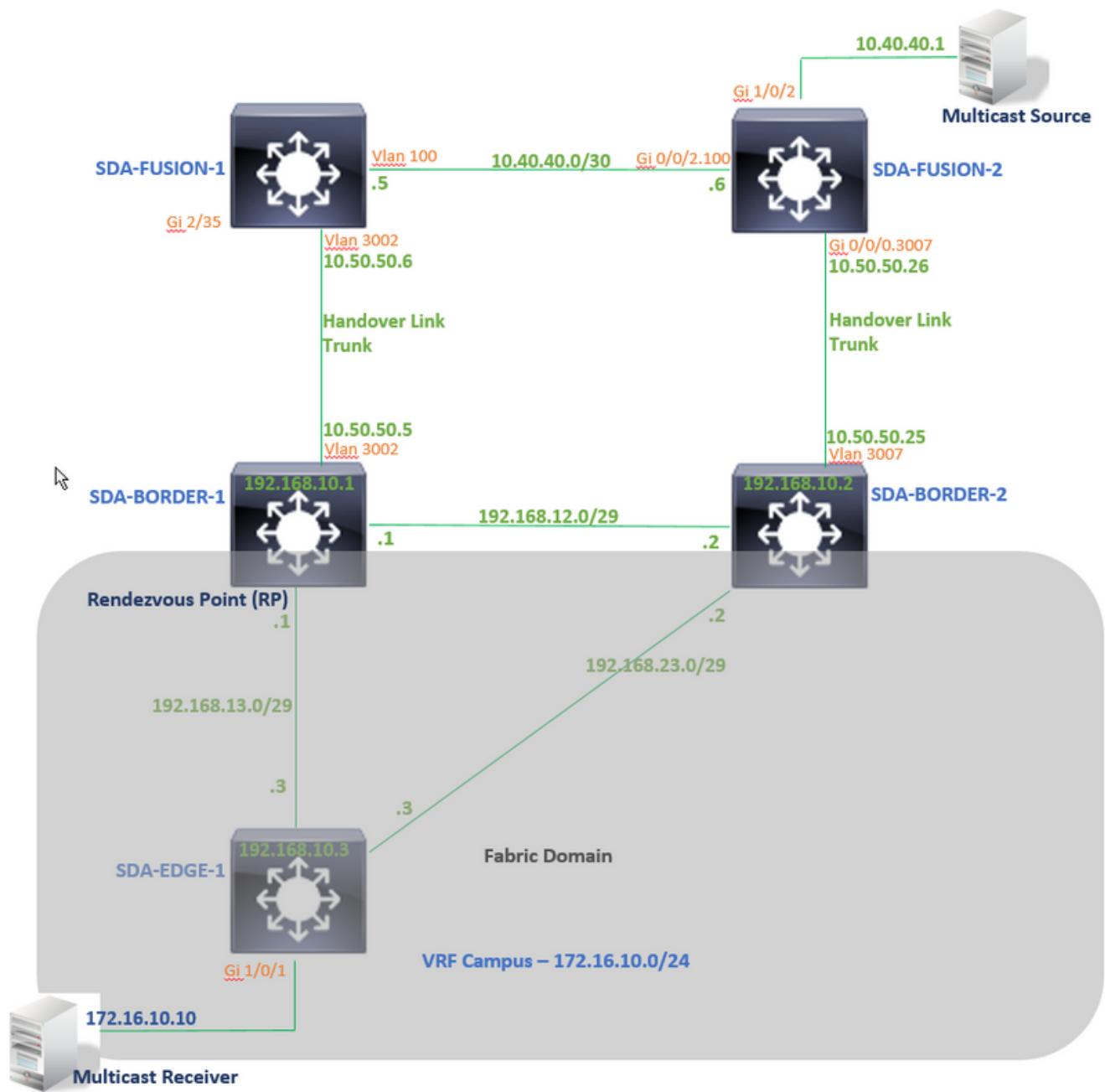
Devices used for this Article

Digital Network Architecture Controller (DNAC)	- Version 1.2.1
Edge and Border	- Cat3k Cisco Switch
Fusion Inter-VRF(Virtual Route Forwarding) leaking	- Cisco Router with Support for

## Configure

### Network Diagram

Topology used for this article consists of two Border Routers both configured as External Borders, and two Fusion Routers with a connection to each respective Border Router. Border-1 is configured as RP, Multicast Source is connected to Fusion-2 and Multicast Receiver is connected to Edge-1.



# Configurations

This article doesn't cover steps to configure Fabric in Software-Defined Access (SDA) environment and starts with an explanation of steps to configure Multicast in Fabric domain for a Specific VN.

## Step1: Configure Multicast on Fabric Devices from DNAC

In DNAC Graphical User Interface (GUI), Under Provision -> Fabric Workflow. Multicast is configured by option "Enable Rendezvous point " on SDA-BORDER-1 device.

Then choose an *Internet Protocol (IP)* Pool to be used for Multicast Configuration under specific VN. "Campus" in this example.

The screenshot shows a configuration dialog titled 'Associate Multicast Pools to VNs'. It lists 'Associate Virtual Networks' with options for 'DEFAULT\_VN', 'Univ', and 'Campus'. Under 'Campus', a specific multicast pool 'Multicast\_Campus | 192.168.50.0/24' is selected. In the 'Select Ip Pools\*' dropdown, several IP pools are listed: 'AP | 172.16.56.0/24', 'BGP1 | 10.50.50.0/24', 'Campus1 | 172.16.10.0/24', and 'Multicast\_Campus | 192.168.50.0/24'. A cursor is hovering over the 'Multicast\_Campus' entry. On the right side of the dialog, there is a vertical sidebar with a 'Make a Wish' button.

## Step2: Verify Configuration pushed on Devices

This Section covers verification of Multicast configuration on Fabric Devices.

### SDA-BORDER-1

```
interface Loopback4099 <<<<<<<< Loopback Interface is created and assigned an IP from Pool selected
vrf forwarding Campus
ip address 192.168.50.1 255.255.255.255
ip pim sparse-mode <<<<<<< PIM is enabled on Interface
end

interface LISPO.4099 <<<<<<< PIM is enabled on LISP interface
ip pim sparse-mode
```

```
end
```

```
SDA-Border1#sh run | in pim|multicast ip multicast-routing <<<<<< Multicast Routing is  
enabled for Global ip multicast-routing vrf Campus <<<<<< Multicast Routing is enabled for  
Campus VN ip pim ssm default <<<<<< PIM SSM mode is enabled for Global for default address  
range ip pim vrf Campus rp-address 192.168.50.1 <<<<<< BORDER-1 Loopback4099 is configured as  
RP  
ip pim vrf Campus register-source Loopback4099  
ip pim vrf Campus ssm default <<<<<< PIM SSM mode is enabled for vrf Campus for default  
address range
```

```
SDA-Border1#sh run | s address-family ipv4 vrf Campus  
address-family ipv4 vrf Campus
```

```
.....  
network 192.168.50.1 mask 255.255.255.255 <<<<<< RP Address is injected into BGP Table  
aggregate-address 192.168.50.0 255.255.255.0 summary-only <<<<<< Aggregate for Multicast  
Pool is advertised
```

```
.....
```

## SDA-BORDER-2

```
interface Loopback4099  
vrf forwarding Campus  
ip address 192.168.50.3 255.255.255.255  
ip pim sparse-mode  
end
```

```
interface LISPO.4099  
ip pim sparse-mode  
end
```

```
SDA-Border2#sh run | in pim|multicast  
  
ip multicast-routing  
ip multicast-routing vrf Campus  
  
ip pim ssm default  
ip pim vrf Campus rp-address 192.168.50.1 <<<<<< BORDER-1 Loopback4099 is configured as  
RP  
ip pim vrf Campus register-source Loopback4099  
ip pim vrf Campus ssm default
```

```
SDA-Border2#sh run | s address-family ipv4 vrf Campus  
address-family ipv4 vrf Campus  
.....  
network 192.168.50.1 mask 255.255.255.255  
aggregate-address 192.168.50.0 255.255.255.0 summary-only  
.....
```

## SDA-EDGE-1

```
interface Vlan1021  
description Configured from apic-em  
mac-address 0000.0c9f.f45c  
vrf forwarding Campus  
ip address 172.16.10.1 255.255.255.0  
ip helper-address 10.10.10.100
```

```

no ip redirects
ip local-proxy-arp
ip pim sparse-mode <<<<<< PIM is enabled on all SVI-s under Campus VN
ip route-cache same-interface
ip igmp version 3
no lisp mobility liveness test
lisp mobility 172_16_10_0-Campus
end

interface Loopback4099 vrf forwarding Campus ip address 192.168.50.2 255.255.255.255 ip pim
sparse-mode end interface LISPO.4099 ip pim sparse-mode end SDA-Edge1#sh run | in pim|multicast
ip multicast-routing ip multicast-routing vrf Campus ip pim ssm default ip pim vrf Campus rp-
address 192.168.50.1 <<<<<< BORDER-1 Loopback4099 is configured as RP ip pim vrf Campus
register-source Loopback4099 ip pim vrf Campus ssm default

```

### **Step3: Manually Configure PIM Across Handover Link**

Multicast Source is connected outside the Fabric to Fusion-2 in this example. For the Multicast Stream to flow, ensure there is a PIM path from RP to Source and Receiver to Source (paths might be different!).

#### **PIM Peering Between SDA-BORDER-1 and SDA-FUSION-1**

##### **SDA-BORDER-1**

```

-----
interface Vlan3002 <<<<<< Enable PIM on Handover link in Campus VN
description vrf interface to External router
vrf forwarding Campus
ip address 10.50.50.5 255.255.255.252
no ip redirects
ip pim sparse-mode
ip route-cache same-interface
end

```

##### **SDA-FUSION-1**

```

-----
ip multicast-routing
ip multicast-routing vrf Campus <<<<<< Enable Multicast Routing in vrf Campus
ip pim vrf Campus rp-address 192.168.50.1 <<<<<< Configure BORDER-1 Loopback4099 as RP
interface Vlan3002 <<<<<< Enable PIM on Fusion Interface towards Border vrf forwarding Campus
ip address 10.50.50.6 255.255.255.252 ip pim sparse-mode
end

```

#### **PIM Peering Between SDA-BORDER-2 and SDA-FUSION-2**

##### **SDA-BORDER-2**

```

-----
interface Vlan3007
description vrf interface to External router
vrf forwarding Campus
ip address 10.50.50.25 255.255.255.252
no ip redirects
ip pim sparse-mode
ip route-cache same-interface
end

```

```

SDA-FUSION-2
-----
ip multicast-routing distributed
ip multicast-routing vrf Campus distributed

ip pim vrf Campus rp-address 192.168.50.1

interface GigabitEthernet0/0/0.3007
encapsulation dot1Q 3007
vrf forwarding Campus
ip address 10.50.50.26 255.255.255.252
ip pim sparse-mode
no cdp enable
end

```

## PIM Peering Between SDA-FUSION-1 and SDA-FUSION-2

```

SDA-FUSION-1
-----
interface Vlan100
description Multicast_Campus
vrf forwarding Campus
ip address 10.40.40.5 255.255.255.252
ip pim sparse-mode
end

SDA-FUSION-2
-----
interface GigabitEthernet0/0/2.100
encapsulation dot1Q 100
vrf forwarding Campus
ip address 10.40.40.6 255.255.255.252
ip pim sparse-mode
end

```

Enable PIM on the interface connecting to the Source

```

SDA-FUSION-2
-----

interface GigabitEthernet1/0/2
vrf forwarding Campus
ip address 10.40.40.2 255.255.255.252
ip pim sparse-mode
load-interval 30
negotiation auto
end

```

## Control Plane Process

At some point Multicast Receiver sends an Internet Group Management Protocol (IGMP) Join to Last Hop Router(LHR) in order to receive the Stream for a specific group, and Multicast Source (Server) starts sending the Multicast Stream to First Hop Router(FHR). In our case FHR is SDA-FUSION-2 and LHR is SDA-EDGE-1 and Control Plane Process is explained in the scenario

where the Receiver requests a stream first, and Source starts streaming for that group afterwards.

## IGMP Join on LHR

Multicast Receiver sends an IGMP Report (Join) to LHR for Group 239.1.1.1. Receiver is connected to Gi1/0/1 (SVI 1021) on SDA-EDGE-1.

```
SDA-Edge1#debug ip igmp vrf Campus 239.1.1.1
IGMP debugging is on

*Aug 14 23:53:06.445: IGMP(4): Received v2 Report on Vlan1021 from 172.16.10.10 for 239.1.1.1
*Aug 14 23:53:06.445: IGMP(4): Received Group record for group 239.1.1.1, mode 2 from
172.16.10.10 for 0 sources
*Aug 14 23:53:06.445: IGMP(4): MRT Add/Update Vlan1021 for (*,239.1.1.1) by 0

*Aug 14 23:54:07.445: IGMP(4): Received v2 Report on Vlan1021 from 172.16.10.10 for 239.1.1.1
<<<<< one minute apart

SDA-Edge1#show ip igmp vrf Campus group
IGMP Connected Group Membership
Group Address      Interface          Uptime      Expires      Last Reporter
239.1.1.1          Vlan1021          00:49:10    00:02:45    172.16.10.10  <<<<< Receiver is
present
SDA-Edge1#
```

The new **Mutlicast Route Watch Service** determines the Reverse Path Forwarding (**RPF**) information towards the RP (for shared tree) and towards the Source (for Shortest Path Tree(SPT)). For LISP-reachable addresses, the next hop neighbor is represented by the remote Routing locator (RLOC) address of the upstream site.

```
SDA-Edge1#show ip pim vrf Campus rp mapping 239.1.1.1
PIM Group-to-RP Mappings

Group(s): 224.0.0.0/4, Static
          RP: 192.168.50.1 (?)                                <<<<<<< RP is 192.168.50.1
SDA-Edge1#
SDA-Edge1#
```

```
SDA-Edge1#show lisp eid-table vrf Campus ipv4 map 192.168.50.1/32      <<<<<< check
Reachability towards the RP address
LISP IPv4 Mapping Cache for EID-table vrf Campus (IID 4099), 4 entries

192.168.50.1/32, uptime: 2w5d, expires: 23:10:58, via map-reply, complete
Sources: map-reply
State: complete, last modified: 2w5d, map-source: 192.168.10.1
Active, Packets out: 171704(3435172 bytes) (~ 00:00:43 ago)
Locator      Uptime      State      Pri/Wgt      Encap-IID
192.168.10.1 2w5d       up        10/10       -           <<<<<<< RLOC is
192.168.10.1
Last up-down state change:      2w5d, state change count: 1
Last route reachability change: 2w5d, state change count: 1
Last priority / weight change: never/never
RLOC-probing loc-status algorithm:
  Last RLOC-probe sent:          00:49:02 (rtt 3ms)
```

```

SDA-Edge1#show ip cef vrf Campus 192.168.50.1/32
192.168.50.1/32
nexthop 192.168.10.1 LISPO.4099 <===== RP is reachable
via LISP interface

SDA-Edge1#show ip mroute vrf Campus 239.1.1.1
IP Multicast Routing Table

(*, 239.1.1.1), 00:50:06/00:02:57, RP 192.168.50.1, flags: SJC <===== (*,G) entry is
created

Incoming interface: LISPO.4099, RPF nbr 192.168.10.1 <===== Incoming
interface is set as LISP interface

Outgoing interface list:
  Vlan1021, Forward/Sparse, 00:50:06/00:02:57 <===== Outgoing
Interface is set towards Receiver

```

Next, the LHR sends a PIM (\*,G) Join Towards the RP (at one minute intervals) - if LHR is DR for that segment.

```

SDA-Edge1#debug ip pim vrf Campus 239.1.1.1
PIM debugging is on

*Aug 15 00:03:44.592: PIM(4): Building Periodic (*,G) Join / (S,G,RP-bit) Prune message for
239.1.1.1
*Aug 15 00:03:44.593: PIM(4): Insert (*,239.1.1.1) join in nbr 192.168.10.1's queue
*Aug 15 00:03:44.593: PIM(4): Building Join/Prune packet for nbr 192.168.10.1
*Aug 15 00:03:44.594: PIM(4): Adding v2 (192.168.50.1/32, 239.1.1.1), WC-bit, RPT-bit, S-bit
Join
*Aug 15 00:03:44.594: PIM(4): Adding LISP Unicast transport attribute in join/prune to
192.168.10.1 (LISPO.4099)
*Aug 15 00:03:44.594: PIM(4): Send v2 join/prune to 192.168.10.1 (LISPO.4099) <=====
PIM (*,G) Join is sent towards the RP

*Aug 15 00:04:42.892: PIM(4): Building Periodic (*,G) Join / (S,G,RP-bit) Prune message for
239.1.1.1 *Aug 15 00:04:42.892: PIM(4): Insert (*,239.1.1.1) join in nbr 192.168.10.1's queue
*Aug 15 00:04:42.892: PIM(4): Building Join/Prune packet for nbr 192.168.10.1 *Aug 15
00:04:42.892: PIM(4): Adding v2 (192.168.50.1/32, 239.1.1.1), WC-bit, RPT-bit, S-bit Join *Aug
15 00:04:42.892: PIM(4): Adding LISP Unicast transport attribute in join/prune to 192.168.10.1
(LISPO.4099) *Aug 15 00:04:42.892: PIM(4): Send v2 join/prune to 192.168.10.1 (LISPO.4099)
SDA-Edge1#

```

## Neighbor Creation

Once the RPF information is obtained pointing to the LISP interface, PIM has to explicitly create a neighbor structure for the corresponding RLOC. This is necessary because the upstream Tunnel Router (xTR) does not send hello messages. The new neighbor block expires when no join/prune messages have been sent to the neighbor after 2 times the standard interval time between join/prunes.

In our case, the SDA-EDGE-1 creates a PIM neighbor using the upstream/RPF RLOC address.

```

SDA-Edge1#show ip pim vrf Campus neighbor
PIM Neighbor Table

```

Neighbor Address	Interface	Uptime/Expires	Ver	DR Prio/Mode	
<b>192.168.10.1</b>	<b>LISP0.4099</b>	1w5d/00:01:27	v2	0 /	<<<<< RLOC address used for the neighbor

```
SDA-Edge1#debug ip pim vrf Campus timers      <- chatty!
PIM-TIMERS debugging is on
```

```
*Aug 15 00:08:37.992: PIM(4): Building Periodic (*,G) Join / (S,G,RP-bit) Prune message for
239.1.1.1 *Aug 15 00:08:37.993: PIM(4) Twheel Start: Neighbor Timer for Nbr: 192.168.10.1. idb
LISP0.4099. delay: 120000 ms. jitter 0.
```

...

## PIM Join Received on RP

PIM join is received on the RP(SDA-BORDER-1) from LHR(SDA-EDGE-1) over the LISP Interface

```
SDA-Border1#debug ip pim vrf Campus 239.1.1.1
PIM debugging is on
```

```
*Aug 18 01:47:14.812: PIM(4): J/P Transport Attribute, Transport Type: Unicast
*Aug 18 01:47:14.813: PIM(4): Join-list: (*, 239.1.1.1), RPT-bit set, WC-bit set, S-bit set
*Aug 18 01:47:14.813: PIM(4): Check RP 192.168.50.1 into the (*, 239.1.1.1) entry
*Aug 18 01:47:14.813: PIM(4): Adding register decap tunnel (Tunnell1) as accepting interface of
(*, 239.1.1.1).
*Aug 18 01:47:14.813: PIM(4): Add LISP0.4099/192.168.10.3 to (*, 239.1.1.1), Forward state, by
PIM *G Join      <<<<< (*,G) join received from RLOC of LHR over LISP Interface

*Aug 18 01:48:14.267: PIM(4): J/P Transport Attribute, Transport Type: Unicast
*Aug 18 01:48:14.267: PIM(4): Join-list: (*, 239.1.1.1), RPT-bit set, WC-bit set, S-bit set
*Aug 18 01:48:14.267: PIM(4): Update LISP0.4099/192.168.10.3 to (*, 239.1.1.1), Forward state,
by PIM *G Join
```

```
SDA-Border1#show ip mroute vrf Campus 239.1.1.1
IP Multicast Routing Table
```

```
(*, 239.1.1.1), 00:01:38/00:02:51, RP 192.168.50.1, flags: S
  Incoming interface: Null, RPF nbr 0.0.0.0          <<<<<<<< RP is
myself hence RPF Neighbor is Null
  Outgoing interface list:
    LISP0.4099, 192.168.10.3, Forward/Sparse, 00:01:38/00:02:51          <<<<<<<< Outgoing
Interface is set towards LHR RLOC
```

The RP(Border1) does not send any joins over the LISP interface, hence no PIM Neighbor is created on the RP over the LISP interface.

In our case, the only PIM neighbor is towards Fusion-1 over a non-LISP interface, and formed as a result of the periodic PIM Hello packets received.

```
SDA-Border1#debug ip pim vrf Campus hello
PIM-HELLO debugging is on
```

```

SDA-Border1#
*Aug 24 00:02:19.944: PIM(4): Received v2 hello on Vlan3002 from 10.50.50.6
*Aug 24 00:02:19.944: PIM(4): Neighbor (10.50.50.6) Hello GENID = 1315387214
SDA-Border1#
*Aug 24 00:02:49.396: PIM(4): Received v2 hello on Vlan3002 from 10.50.50.6
*Aug 24 00:02:49.397: PIM(4): Neighbor (10.50.50.6) Hello GENID = 1315387214

```

```

SDA-Border1#show ip pim vrf Campus neigh
PIM Neighbor Table

```

Neighbor Address	Interface	Uptime/Expires	Ver	DR Prio/Mode
10.50.50.6	Vlan3002	2w0d/00:01:31	v2	1 / DR S P G

## PIM Neighbor on Fusion Routers

PIM Neighbors on Fusion Routers are over non-LISP interfaces and hence are also created based on the periodic PIM Hello-s received.

**SDA-FUSION-1**

```

SDA-Fusion1#show ip pim vrf Campus neighbor
PIM Neighbor Table

```

Neighbor Address	Interface	Uptime/Expires	Ver	DR Prio/Mode
10.40.40.6	Vlan100	5d00h/00:01:41	v2	1 / S P G
10.50.50.5	Vlan3002	2w4d/00:01:44	v2	1 / S P G

**SDA-FUSION-2**

```

SDA-Fusion2#show ip pim vrf Campus neighbor
PIM Neighbor Table

```

Neighbor Address	Interface	Uptime/Expires	Ver	DR Prio/Mode
10.50.50.25	Gi0/0/0.3007	2w5d/00:01:36	v2	1 / S P G
10.40.40.5	GigabitEthernet0/0/2.100	5d00h/00:01:23	v2	100/ DR S P G

## PIM Register on RP from FHR

When the Source starts to send traffic for the group, the FHR (SDA-FUSION-2) registers the (S,G) with the RP once it receives the first multicast packet from the Source - and if FHR is the DR on that segment.

```

SDA-Fusion2#show ip pim vrf Campus rp mapping 239.1.1.1
PIM Group-to-RP Mappings

```

```

Group(s): 224.0.0.0/4, Static
RP: 192.168.50.1 (?) <<<<<< RP for the Group

```

```

SDA-Fusion2#show ip cef vrf Campus 192.168.50.1

```

```

192.168.50.1/32
nexthop 10.40.40.5 GigabitEthernet0/0/2.100

```

<<<<<< Next-hop Interface towards RP

```

SDA-Fusion2#debug ip mrouting vrf Campus
IP multicast routing debugging is on
SDA-Fusion2#debug ip pim vrf Campus
PIM debugging is on

*Aug 22 21:59:42.601: PIM(2): Check RP 192.168.50.1 into the (*, 239.1.1.1) entry
*Aug 22 21:59:42.601: MRT(2): (*,239.1.1.1), RPF change from /0.0.0.0 to
GigabitEthernet0/0/2.100/10.40.40.5 <<<<< RPF Interface is determined
*Aug 22 21:59:42.601: PIM(2): Building Triggered (*,G) Join / (S,G,RP-bit) Prune message for
239.1.1.1
*Aug 22 21:59:42.601: MRT(2): Create (*,239.1.1.1), RPF (GigabitEthernet0/0/2.100, 10.40.40.5,
1/0)
*Aug 22 21:59:42.602: MRT(2): (10.40.40.1,239.1.1.1), RPF install from /0.0.0.0 to
GigabitEthernet1/0/2/0.0.0.0
*Aug 22 21:59:42.602: PIM(2): Adding register encaps tunnel (Tunnel0) as forwarding interface of
(10.40.40.1, 239.1.1.1). <<<< Register Tunnel is created
*Aug 22 21:59:42.602: MRT(2): Set the F-flag for (*, 239.1.1.1)
*Aug 22 21:59:42.602: MRT(2): Set the F-flag for (10.40.40.1, 239.1.1.1)
<<<<< Register(F) flag is set
*Aug 22 21:59:42.602: MRT(2): Create (10.40.40.1,239.1.1.1), RPF (GigabitEthernet1/0/2, 0.0.0.0,
0/0 <<<<< (S,G) is created
*Aug 22 21:59:42.602: MRT(2): Set the T-flag for (10.40.40.1, 239.1.1.1)
<<<<< SPT (T) flag is set
*Aug 22 21:59:42.629: PIM(2): Received v2 Join/Prune on GigabitEthernet0/0/2.100 from
10.40.40.5, to us
*Aug 22 21:59:42.629: PIM(2): Join-list: (10.40.40.1/32, 239.1.1.1), S-bit set
<<<<< (S,G) join is received
*Aug 22 21:59:42.629: MRT(2): WAVL Insert interface: GigabitEthernet0/0/2.100 in
(10.40.40.1,239.1.1.1) Successful

*Aug 22 21:59:42.630: MRT(2): set min mtu for (10.40.40.1, 239.1.1.1) 18010->1500
*Aug 22 21:59:42.630: MRT(2): Add GigabitEthernet0/0/2.100/239.1.1.1 to the olist of
(10.40.40.1, 239.1.1.1), Forward state - MAC built
*Aug 22 21:59:42.630: PIM(2): Add GigabitEthernet0/0/2.100/10.40.40.5 to (10.40.40.1,
239.1.1.1), Forward state, by PIM SG Join
*Aug 22 21:59:42.630: MRT(2): Add GigabitEthernet0/0/2.100/239.1.1.1 to the olist of
(10.40.40.1, 239.1.1.1), Forward state - MAC built
*Aug 22 21:59:42.630: MRT(2): Set the PIM interest flag for (10.40.40.1, 239.1.1.1)

SDA-Fusion2#show ip mroute vrf Campus 239.1.1.1
IP Multicast Routing Table

(*, 239.1.1.1), 00:01:17/stopped, RP 192.168.50.1, flags: SPF
Incoming interface: GigabitEthernet0/0/2.100, RPF nbr 10.40.40.5
Outgoing interface list: Null

(10.40.40.1, 239.1.1.1), 00:01:17/00:02:14, flags: FT
Incoming interface: GigabitEthernet1/0/2, RPF nbr 0.0.0.0 <<<<<< RPF neighbor is
0.0.0.0 as the Source is directly connected
Outgoing interface list:
Gi0/0/0.3007, Forward/Sparse, 00:01:17/00:03:10

SDA-Fusion2# SDA-Fusion2#show interface tunnel 0 <<<<<< Register Tunnel is created
between FHR and RP
Tunnel0 is up, line protocol is up
Hardware is Tunnel
Description: Pim Register Tunnel (Encap) for RP 192.168.50.1 on VRF Campus
Interface is unnumbered. Using address of GigabitEthernet0/0/2.100 (10.40.40.6)
MTU 9972 bytes, BW 100 Kbit/sec, DLY 50000 usec,
reliability 255/255, txload 1/255, rxload 1/255
Encapsulation TUNNEL, loopback not set
Keepalive not set
Tunnel linestate evaluation up
Tunnel source 10.40.40.6 (GigabitEthernet0/0/2.100), destination 192.168.50.1

```

RP (BORDER-1) receives the Register from the FHR, which triggers a (S,G) Join to be sent towards the FHR, and also a Register-Stop towards the FHR - once stream is received natively on the RP.

```
SDA-Border1#debug ip mrouting vrf Campus 239.1.1.1
IP multicast routing debugging is on

*Aug 18 02:29:05.186: PIM(4): Received v2 Register on Vlan3002 from 10.40.40.6
<<<<< PIM Register is received from FHR
*Aug 18 02:29:05.186:      for 10.40.40.1, group 239.1.1.1
*Aug 18 02:29:05.187: PIM(4): Adding register decap tunnel (Tunnel1) as accepting interface of
(10.40.40.1, 239.1.1.1). <<<<< Register tunnel is created
*Aug 18 02:29:05.187: MRT(4): (10.40.40.1,239.1.1.1), RPF install from /0.0.0.0 to
Vlan3002/10.50.50.6
*Aug 18 02:29:05.188: MRT(4): Create (10.40.40.1,239.1.1.1), RPF (Vlan3002, 10.50.50.6, 20/0)
<<<<< (S,G) is created and RPF is resolved
*Aug 18 02:29:05.188: MRT(4): WAVL Insert LISP interface: LISPO.4099 in (10.40.40.1,239.1.1.1)
Next-hop: 192.168.10.3 Outer-source: 0.0.0.0 Successful
*Aug 18 02:29:05.188: MRT(4): set min mtu for (10.40.40.1, 239.1.1.1) 18010->17892
*Aug 18 02:29:05.189: MRT(4): Add LISPO.4099/192.168.10.3 to the olist of (10.40.40.1,
239.1.1.1), Forward state - MAC not built <<<< LISP OIF is inherited from (*,G)
*Aug 18 02:29:05.189: PIM(4): Insert (10.40.40.1,239.1.1.1) join in nbr 10.50.50.6's queue
*Aug 18 02:29:05.189: PIM(4): Building Join/Prune packet for nbr 10.50.50.6
*Aug 18 02:29:05.189: PIM(4): Adding v2 (10.40.40.1/32, 239.1.1.1), S-bit Join
*Aug 18 02:29:05.189: PIM(4): Send v2 join/prune to 10.50.50.6 (Vlan3002)
<<<<< (S,G) join is sent towards the Source
*Aug 18 02:29:05.272: PIM(4): J/P Transport Attribute, Transport Type: Unicast
*Aug 18 02:29:05.272: PIM(4): Join-list: (*, 239.1.1.1), RPT-bit set, WC-bit set, S-bit set
*Aug 18 02:29:05.272: PIM(4): Update LISPO.4099/192.168.10.3 to (*, 239.1.1.1), Forward state,
by PIM *G Join
*Aug 18 02:29:05.272: MRT(4): Update LISPO.4099/192.168.10.3 in the olist of (*, 239.1.1.1),
Forward state - MAC not built
*Aug 18 02:29:05.272: PIM(4): Prune-list: (10.40.40.1/32, 239.1.1.1) RPT-bit set
*Aug 18 02:29:05.273: PIM(4): Prune LISPO.4099/192.168.10.3 from (10.40.40.1/32, 239.1.1.1)
<<<<< (S,G) Prune is received from Edge1
*Aug 18 02:29:05.273: MRT(4): Delete LISPO.4099/192.168.10.3 from the olist of (10.40.40.1,
239.1.1.1)
*Aug 18 02:29:05.273: PIM(4): Insert (10.40.40.1,239.1.1.1) prune in nbr 10.50.50.6's queue -
deleted

*Aug 18 02:29:05.273: PIM(4): Building Join/Prune packet for nbr 10.50.50.6
*Aug 18 02:29:05.273: PIM(4): Adding v2 (10.40.40.1/32, 239.1.1.1), S-bit Prune
*Aug 18 02:29:05.273: PIM(4): Send v2 join/prune to 10.50.50.6 (Vlan3002)
*Aug 18 02:29:05.439: PIM(4): J/P Transport Attribute, Transport Type: Unicast

*Aug 18 02:29:07.193: PIM(4): Received v2 Register on Vlan3002 from 10.40.40.6
*Aug 18 02:29:07.193:      for 10.40.40.1, group 239.1.1.1
*Aug 18 02:29:07.194: PIM(4): Send v2 Register-Stop to 10.40.40.6 for 10.40.40.1, group
239.1.1.1
<<<<< Register-Stop is sent towards FHR
```

```
SDA-Border1#show ip mroute vrf Campus 239.1.1.1
IP Multicast Routing Table

(*, 239.1.1.1), 00:51:28/00:02:44, RP 192.168.50.1, flags: S
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:
    LISPO.4099, 192.168.10.3, Forward/Sparse, 00:51:28/00:02:44
```

```

(10.40.40.1, 239.1.1.1), 00:09:37/00:01:24, flags: P           <<<<<<<<< (S,G) is
created but Pruned flag is set
    Incoming interface: Vlan3002, RPF nbr 10.50.50.6           <<<<<<<<< Incoming
interface and RPF neighbor
        Outgoing interface list: Null

SDA-Border1#show ip rpf vrf Campus 10.40.40.1
RPF information for ? (10.40.40.1)
    RPF interface: Vlan3002                                     <<<<<<<< RPF
    interface towards the Source
        RPF neighbor: ? (10.50.50.6)                           <<<<<<<< RPF neighbor
    - must be a PIM neighbor
        RPF route/mask: 10.40.40.0/30
        RPF type: unicast (bgp 65005)                         <<<<<<<< RPF
    information coming from unicast RIB/BGP
    Doing distance-preferred lookups across tables
    RPF topology: ipv4 multicast base, originated from ipv4 unicast base
SDA-Border1#
SDA-Border1#show ip route vrf Campus 10.40.40.1

Routing Table: Campus
Routing entry for 10.40.40.0/30
Known via "bgp 65005", distance 20, metric 0
Tag 65004, type external
Last update from 10.50.50.6 2w6d ago
Routing Descriptor Blocks:
* 10.50.50.6, from 10.50.50.6, 2w6d ago
    Route metric is 0, traffic share count is 1
    AS Hops 1
    Route tag 65004
    MPLS label: none
    MPLS Flags: NSF
SDA-Border1#

```

SPT is being pruned by the Edge-1 - let's go to the LHR to see why.

## (S,G) Creation on LHR

After receiving the multicast data forwarded by the RP, (S,G) entry is created on the LHR.

Next, the LHR will switch over to Shortest Path Tree (SPT) by sending a (S,G) Join towards the Source. This is sent on the RPF interface towards the Source.

```

SDA-Edge1#
*Aug 18 02:19:53.759: MRT(4): Create (10.40.40.1,239.1.1.1), RPF (unknown, 0.0.0.0, 0/0)
<<<<<<< (S,G) is created on LHR
*Aug 18 02:19:53.759: MRT(4): WAVL Insert interface: Vlan1021 in (10.40.40.1,239.1.1.1)
Successful
*Aug 18 02:19:53.759: MRT(4): set min mtu for (10.40.40.1, 239.1.1.1) 18010->1500
*Aug 18 02:19:53.759: MRT(4): Add Vlan1021/239.1.1.1 to the olist of (10.40.40.1, 239.1.1.1),
Forward state - MAC not built      <<<<< OIL is inherited from (*,G)
*Aug 18 02:19:53.759: MRT(4): Set the J-flag for (10.40.40.1, 239.1.1.1)
<<<<< SPT Join Flag is set
*Aug 18 02:19:53.762: MRT(4): (10.40.40.1,239.1.1.1), RPF change from /0.0.0.0 to
LISP0.4099/192.168.10.2 <<<<< RPF interface is resolved
*Aug 18 02:19:53.762: MRT(4): Set the T-flag for (10.40.40.1, 239.1.1.1)
*Aug 18 02:19:53.763: PIM(4): Insert (10.40.40.1,239.1.1.1) join in nbr 192.168.10.2's queue
*Aug 18 02:19:53.763: PIM(4): Building Join/Prune packet for nbr 192.168.10.2

```

```

*Aug 18 02:19:53.763: PIM(4): Adding v2 (10.40.40.1/32, 239.1.1.1), S-bit Join
*Aug 18 02:19:53.763: PIM(4): Adding LISP Unicast transport attribute in join/prune to
192.168.10.2 (LISP0.4099)
*Aug 18 02:19:53.763: PIM(4): Send v2 join/prune to 192.168.10.2 (LISP0.4099)
<<<<<< (S,G) Join towards the Source is sent
*Aug 18 02:19:53.826: PIM(4): Building Periodic (*,G) Join / (S,G,RP-bit) Prune message for
239.1.1.1
*Aug 18 02:19:53.826: PIM(4): Insert (*,239.1.1.1) join in nbr 192.168.10.1's queue
*Aug 18 02:19:53.826: PIM(4): Insert (10.40.40.1,239.1.1.1) sgr prune in nbr 192.168.10.1's
queue
*Aug 18 02:19:53.826: PIM(4): Building Join/Prune packet for nbr 192.168.10.1
*Aug 18 02:19:53.826: PIM(4): Adding v2 (192.168.50.1/32, 239.1.1.1), WC-bit, RPT-bit, S-bit
Join
*Aug 18 02:19:53.827: PIM(4): Adding v2 (10.40.40.1/32, 239.1.1.1), RPT-bit, S-bit Prune
*Aug 18 02:19:53.827: PIM(4): Adding LISP Unicast transport attribute in join/prune to
192.168.10.1 (LISP0.4099)
*Aug 18 02:19:53.827: PIM(4): Send v2 join/prune to 192.168.10.1 (LISP0.4099)
<<<<<< (S,G) Prune towards the RP is sent
*Aug 18 02:20:08.323: MRT(4): Update (*,239.1.1.1), RPF (LISP0.4099, 192.168.10.1, 1/1)
*Aug 18 02:20:08.323: MRT(4): Update Vlan1021/239.1.1.1 in the olist of (*, 239.1.1.1), Forward
state - MAC not built
*Aug 18 02:20:08.323: MRT(4): Update Vlan1021/239.1.1.1 in the olist of (10.40.40.1, 239.1.1.1),
Forward state - MAC not built

```

```
SDA-Edge1#show ip mroute vrf Campus 239.1.1.1
IP Multicast Routing Table
```

```
(*, 239.1.1.1), 00:43:35/stopped, RP 192.168.50.1, flags: SJC
  Incoming interface: LISP0.4099, RPF nbr 192.168.10.1
  Outgoing interface list:
    Vlan1021, Forward/Sparse, 00:43:35/00:02:29

(10.40.40.1, 239.1.1.1), 00:01:45/00:01:14, flags: JT <<<<<<<<< (S,G)
is created
  Incoming interface: LISP0.4099, RPF nbr 192.168.10.2 <<<<<<<<< Border-
2 is the RPF neighbor towards the Source
  Outgoing interface list:
    Vlan1021, Forward/Sparse, 00:01:47/00:02:27
```

```
SDA-Edge1#show lisp eid-table vrf Campus ipv4 map 10.40.40.1 <<<<<< LISP
lookup for the Source
LISP IPv4 Mapping Cache for EID-table vrf Campus (IID 4099), 5 entries

0.0.0.0/1, uptime: 2w1d, expires: 18:05:53, via map-reply, forward-native
  Sources: map-reply
  State: forward-native, last modified: 2w1d, map-source: 192.168.10.1
  Active, Packets out: 106458(41136237 bytes) (~ 00:00:38 ago)
Encapsulating to proxy ETR <<<<<< No
specific entry is known, forwarding to Proxy ETR
```

```
SDA-Edge1#show ip cef vrf Campus 10.40.40.1 detail
0.0.0.0/1, epoch 0, flags [subtree context, check lisp eligibility], per-destination sharing
  SC owned,sourced: LISP remote EID - locator status bits 0x00000000
  LISP remote EID: 106468 packets 41140303 bytes fwd action encap
  LISP source path list
    nexthop 192.168.10.1 LISP0.4099 <<<<<< Load
  balancing towards 2 Proxy ETR-s
    nexthop 192.168.10.2 LISP0.4099
    2 IPL sources [no flags]
```

```
nexthop 192.168.10.1 LISPO.4099  
nexthop 192.168.10.2 LISPO.4099
```

```
SDA-Edge1#show ip cef vrf Campus exact-route 192.168.50.2 10.40.40.1 <<<<<< CEF  
hashing points towards Border-2  
192.168.50.2 -> 10.40.40.1 =>IP adj out of GigabitEthernet1/0/11, addr 192.168.23.2  
  
SDA-Edge1#show ip rpf vrf Campus 10.40.40.1  
RPF information for ? (10.40.40.1)  
RPF interface: LISPO.4099 <<<<<< Hence  
RPF neighbor: ? (192.168.10.2)  
SPT Join is sent towards Border-2  
RPF route/mask: 0.0.0.0/1  
RPF type: unicast ()  
Doing distance-preferred lookups across tables  
RPF topology: ipv4 multicast base  
SDA-Edge1#
```

Since the (S,G) Join is sent towards Border-2 over the LISP Interface, a new PIM neighbor is created on Edge-1

```
SDA-Edge1#show ip pim vrf Campus neighbor  
PIM Neighbor Table  
  
Neighbor           Interface           Uptime/Expires   Ver   DR  
Address            Prio/Mode  
192.168.10.2      LISPO.4099      00:07:32/00:01:22 v2   0 /      <<<<<< Neighbor  
towards Border-2 is created  
192.168.10.1       LISPO.4099      2wld/00:01:58     v2   0 /
```

As Border-2 is in the Data Path for the multicast stream, it has to perform Explicit RLOC Tracking to track the RLOC of Downstream XTR-s for Unicast Replication of the packets.

```
SDA-Border2#show ip mroute vrf Campus 239.1.1.1  
IP Multicast Routing Table  
  
(*, 239.1.1.1), 00:23:00/stopped, RP 192.168.50.1, flags: SP  
  Incoming interface: LISPO.4099, RPF nbr 192.168.10.1  
  Outgoing interface list: Null  
  
(10.40.40.1, 239.1.1.1), 00:12:35/00:02:52, flags: T <<<<< SPT flag is set  
  Incoming interface: Vlan3007, RPF nbr 10.50.50.26 <<<<< RPF neighbor is  
based on RPF towards the Source - must be a PIM neighbor  
  Outgoing interface list:  
    LISPO.4099, 192.168.10.3, Forward/Sparse, 00:12:35/00:02:45 <<<<< OIL created from  
(S,G) join received from LHR and containing LHR's RLOC info which has to be tracked
```

```
SDA-Border2#show ip mfib vrf Campus 239.1.1.1 10.40.40.1  
Entry Flags:   C - Directly Connected, S - Signal, IA - Inherit A flag,  
              ET - Data Rate Exceeds Threshold, K - Keepalive  
              DDE - Data Driven Event, HW - Hardware Installed  
              ME - MoFRR ECMP entry, MNE - MoFRR Non-ECMP entry, MP - MFIB  
              MoFRR Primary, RP - MRIB MoFRR Primary, P - MoFRR Primary  
              MS - MoFRR Entry in Sync, MC - MoFRR entry in MoFRR Client.  
I/O Item Flags: IC - Internal Copy, NP - Not platform switched,  
              NS - Negate Signalling, SP - Signal Present,  
              A - Accept, F - Forward, RA - MRIB Accept, RF - MRIB Forward,  
              MA - MFIB Accept, A2 - Accept backup,
```

RA2 - MRIB Accept backup, MA2 - MFIB Accept backup

**Forwarding Counts: Pkt Count/Pkts per second/Avg Pkt Size/Kbytes per second**

Other counts: Total/RPF failed/Other drops

I/O Item Counts: FS Pkt Count/PS Pkt Count

VRF Campus

(10.40.40.1,239.1.1.1) Flags: HW

SW Forwarding: 0/0/0/0, Other: 0/0/0

**HW Forwarding: 176/0/122/0**, Other: 0/0/0

<<<<< Multicast stream is

forwarded in h/w

Vlan3007 Flags: A

LISP0.4099, 192.168.10.3 Flags: F NS

Pkts: 0/0

SDA-Border2#**sh ip mfib vrf Campus 239.1.1.1 10.40.40.1 count**

Forwarding Counts: Pkt Count/Pkts per second/Avg Pkt Size/Kilobits per second

Other counts: Total/RPF failed/Other drops(OIF-null, rate-limit etc)

VRF Campus

6 routes, 2 (\*,G)s, 3 (\*,G/m)s

Group: 239.1.1.1

Source: 10.40.40.1,

SW Forwarding: 0/0/0/0, Other: 0/0/0

**HW Forwarding: 182/0/122/0**, Other: 0/0/0

<<<<< Counter is

incrementing

Totals - Source count: 1, Packet count: 182

Groups: 1, 1.00 average sources per group

SDA-Border2#