SDAキャンパスファブリック環境におけるAny-Source Multicast(ASM)の概要

内容

[概要](#)
[前提条件](#)
[要件](#)
[使用するコンポーネント](#)
[設定](#)
[ネットワーク図](#)
[設定](#)
[ステップ1: DNACからのファブリックデバイスでのマルチキャストの設定](#)
[ステップ2: デバイスにプッシュされた設定の確認](#)
[ステップ3: ハンドオーバーリンク経由のPIMの手動設定](#)
[コントロールプレーンプロセス](#)
[LHRでのIGMP参加](#)
[ネイバーの作成](#)
[RPで受信したPIM Join](#)
[FusionルータのPIMネイバー](#)
[FHRからのRPでのPIMレジスタ](#)
[(S,G) LHRでの作成](#)

概要

このドキュメントでは、ソフトウェア定義アクセス(SD-Access)環境のシングルランデブーポイント(*RP*)を使用したASM(Any-Source Multicast)の概要を説明します。

前提条件

要件

Locator ID Separation Protocol(*LISP*)とマルチキャストに関する知識があることが推奨されます。

使用するコンポーネント

このドキュメントの内容は、特定のソフトウェアやハードウェアのバージョンに限定されるものではありません。

このドキュメントの情報は、特定のラボ環境にあるデバイスに基づいて作成されたものです。ネットワークが稼働中の場合は、コマンドの潜在的な影響を確実に理解してください。GUI

この記事に使用するデバイス

Digital Network Architecture Controller(DNAC)：バージョン1.2.1

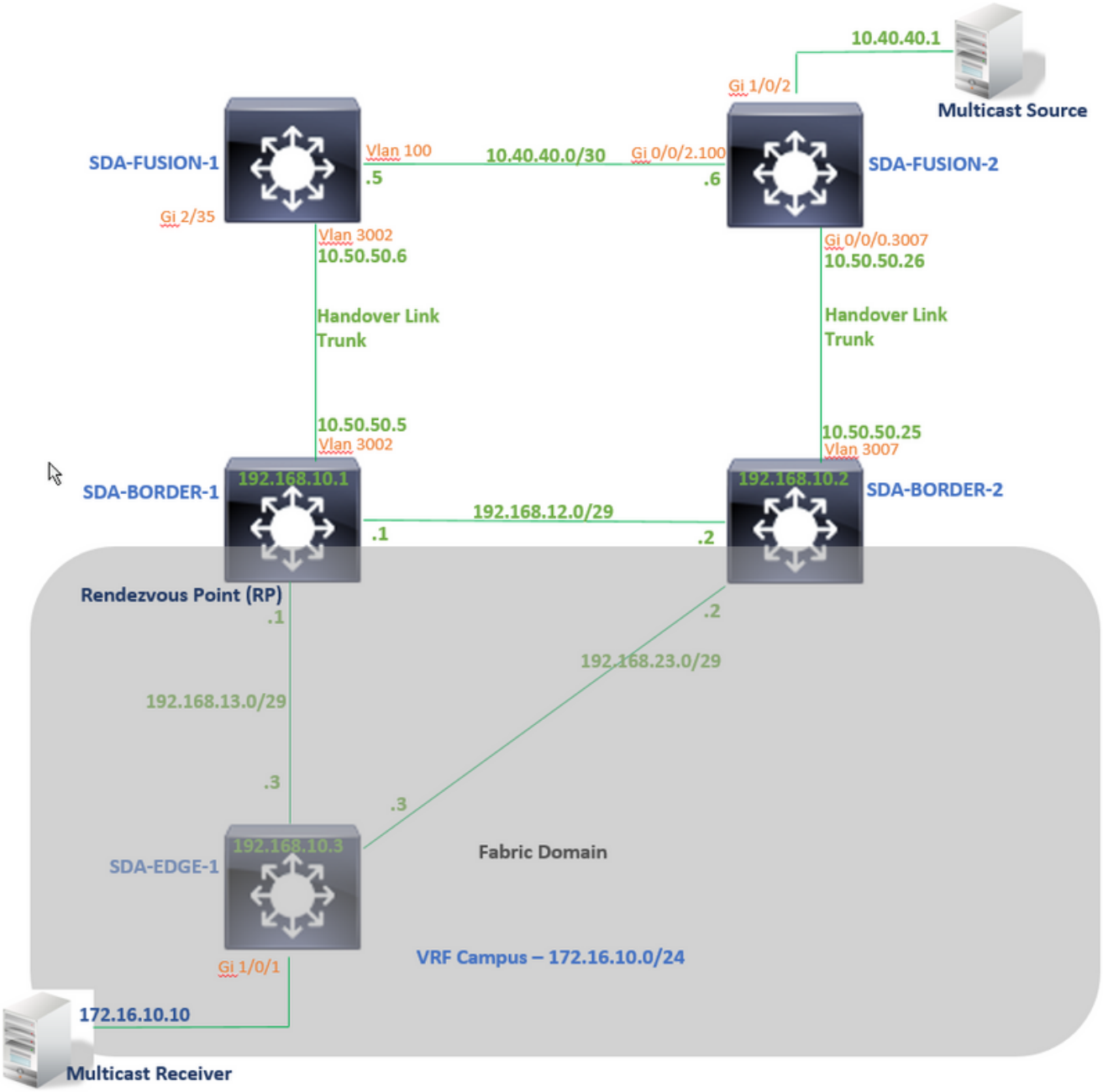
エッジとボーダー – Cat3kシスコスイッチ

Fusion -VRF間(Virtual Route Forwarding)リークをサポートするCiscoルータ

設定

ネットワーク図

この記事で使用するトポロジは、2台の境界ルータの両方が外部境界として設定され、2台のFusionルータがそれぞれの境界ルータに接続されています。Border-1はRPとして設定され、マルチキャストソースはFusion-2に接続され、マルチキャストレシーバはEdge-1に接続されます。



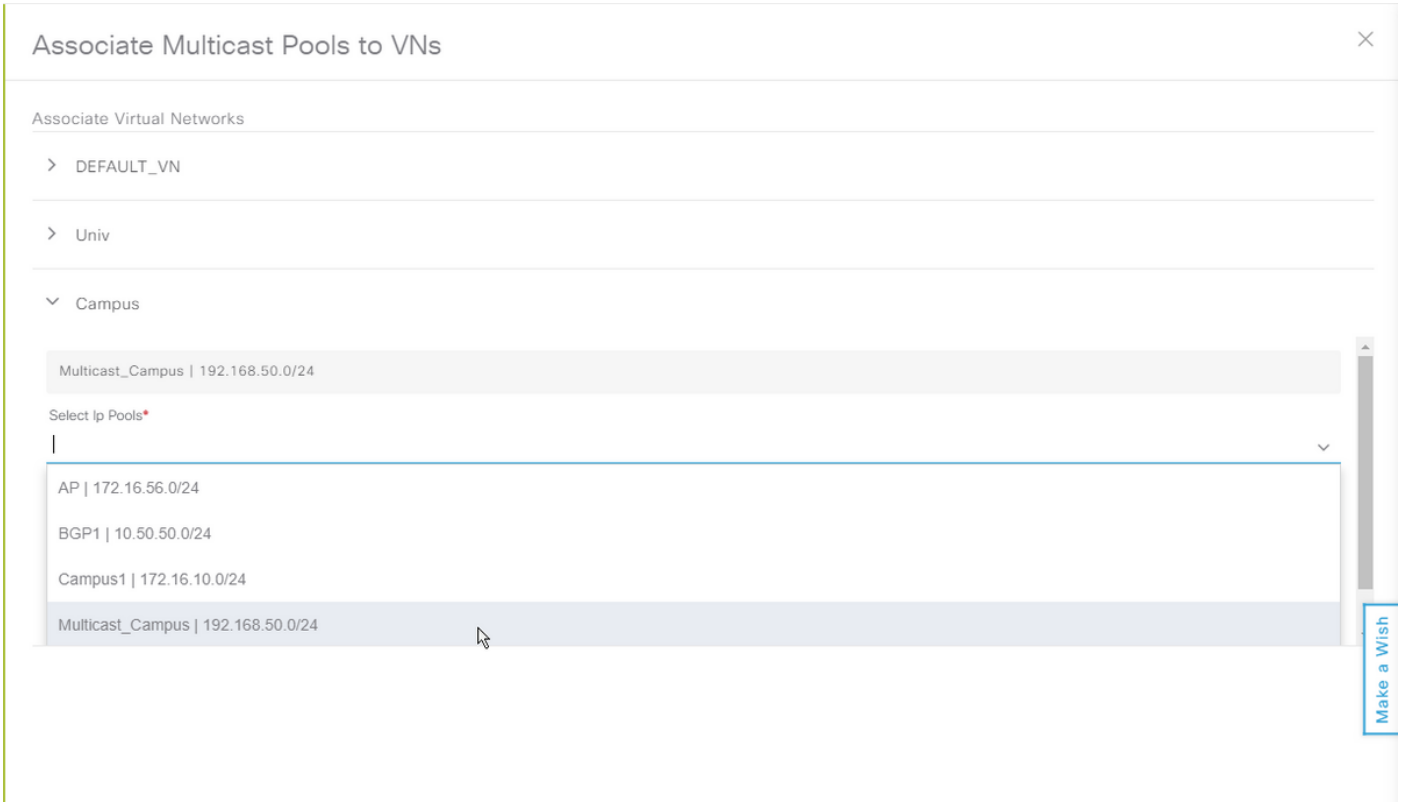
設定

この記事では、Software-Defined Access(SDA)環境でファブリックを設定する手順については説明していませんが、まず、特定のVNのファブリックドメインでマルチキャストを設定する手順について説明します。

ステップ1: DNACからのファブリックデバイスでのマルチキャストの設定

DNACグラフィカルユーザインターフェイス(GUI)で、[プロビジョニング(Provision)] > [ファブリックワークフロー(Fabric Workflow)]の順に選択します。マルチキャストは、SDA-BORDER-1デバイスで[ランデブーポイントを有効にする]オプションで設定します。

次に、この例では、特定のVN「Campus」の下のマルチキャスト構成に使用するインターネットプロトコル(IP)プールを選択します。



ステップ2: デバイスにプッシュされた設定の確認

このセクションでは、ファブリックデバイスでのマルチキャスト設定の検証について説明します。

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 LISP0.4099 <<<<<<<<<<< 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 configued 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 LISP0.4099
 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 configued 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 LISP0.4099 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 configued as RP ip pim vrf Campus
register-source Loopback4099 ip pim vrf Campus ssm default
```

ステップ3: ハンドオーバーリンク経由のPIMの手動設定

この例では、マルチキャストソースはファブリックの外部でFusion-2に接続されています。 マルチキャストストリームが流れるようにするには、RPからSourceへのPIMパスとReceiverからSourceへのパス（パスが異なる可能性があります！）を確認します。

SDA-BORDER-1とSDA-FUSION-1間のPIMピアリング

```
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
```

SDA-BORDER-2とSDA-FUSION-2間のPIMピアリング

```
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
```

SDA-FUSION-1とSDA-FUSION-2間のPIMピアリング

```
SDA-FUSION-1
-----------------------------------------------
interface Vlan100
 description Muticast_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
```

送信元に接続しているインターフェイスでPIMを有効にします

```
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
```

コントロールプレーンプロセス

ある時点では、マルチキャスト受信側が特定のグループのストリームを受信するためにInternet Group Management Protocol(IGMP)Join to Last Hop Router(LHR)を送信し、マルチキャストソース（サーバ）がファーストホップルータ(FHR)へのマルチキャストストリームの送信をを開始します。 この例では、FHRはSDA-FUSION-2で、LHRはSDA-EDGE-1で、コントロールプレーン

プロセスは、レシーバが最初にストリームを要求し、その後、ソースがそのグループのストリーミングを開始するシナリオで説明します。

LHRでのIGMP参加

マルチキャストレシーバは、グループ239.1.1.1のLHRにIGMPレポート（参加）を送信します。レシーバはSDA-EDGE-1のGi1/0/1(SVI 1021)に接続しています。

```
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#
```

新しいマルチラストルートウォッチサービスは、RP（共有ツリー用）およびソース（最短パスツリー用）に向かうReverse Path Forwarding(RPF)情報を決定します。 LISP到達可能なアドレスの場合、ネクストホップネイバーはアップストリームサイトのリモートルーティングロケータ(RLOC)アドレスで表されます。

```
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 LISP0.4099                                    <<<<<<<<<<< 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: LISP0.4099, 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
```

次に、LHRがセグメントのDRである場合、RPに向けてPIM (*,G) Joinを送信します（1分間隔）。

```
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 (LISP0.4099)
*Aug 15 00:03:44.594: PIM(4): Send v2 join/prune to 192.168.10.1 (LISP0.4099)         <<<<<<<
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
(LISP0.4099) *Aug 15 00:04:42.892: PIM(4): Send v2 join/prune to 192.168.10.1 (LISP0.4099)
SDA-Edge1#
```

ネイバーの作成

RPF情報がLISPインターフェイスをポイントして取得されたら、PIMは対応するRLOCのネイバー構造を明示的に作成する必要があります。これは、アップストリームのトンネルルータ(xTR)がhelloメッセージを送信しないためです。新しいネイバーブロックは、join/pruneの間の標準的なインターバル時間の2倍が経過した後にneighborにjoin/pruneメッセージが送信されなかった場合に期限切れになります。

この場合、SDA-EDGE-1はアップストリーム/RPF RLOCアドレスを使用してPIMネイバーを作成します。

```
SDA-Edge1#show ip pim vrf Campus neighbor
```

```
PIM Neighbor Table

Neighbor          Interface                Uptime/Expires    Ver   DR
Address                                                            Prio/Mode
192.168.10.1      LISP0.4099               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.

...
```

RPで受信したPIM Join

LISPインターフェイスを介してLHR(SDA-EDGE-1)からRP(SDA-BORDER-1)でPIM joinが受信される

```
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 (Tunnel1) 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
```

RP(Border1)はLISPインターフェイスを介してジョインを送信しないため、LISPインターフェイスを介してRPにPIMネイバーが作成されません。

この例では、PIMネイバーは非LISPインターフェイスを介してFusion-1に向かっており、定期的に受信されるPIM Helloパケットの結果として形成されます。

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

FusionルータのPIMネイバー

Fusionルータ上のPIMネイバーは非LISPインターフェイス上にあるため、定期的に受信されたPIM Helloに基づいて作成されます。

SDA-FUSION-1

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

Neighbor          Interface                Uptime/Expires    Ver   DR
Address                                                            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          Interface                Uptime/Expires    Ver   DR
Address                                                            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
```

FHRからのRPでのPIMレジスタ

送信元がグループのトラフィックの送信を開始すると、FHR(SDA-FUSION-2)は、送信元から最初のマルチキャストパケットを受信した後で(S,G)をそのセグメントのDRとしてRPに登録します。

```
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 encap 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)はFHRからレジスタを受信します。これにより、RPでストリームがネイティブに受信されると、(S,G)参加がFHRに向けて送信され、またFHRに対してRegister-Stopがトリガーされます。

```
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: LISP0.4099 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 LISP0.4099/192.168.10.3 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 LISP0.4099/192.168.10.3 to (*, 239.1.1.1), Forward state,
by PIM *G Join
*Aug 18 02:29:05.272: MRT(4): Update LISP0.4099/192.168.10.3 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 LISP0.4099/192.168.10.3 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 LISP0.4099/192.168.10.3 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:
    LISP0.4099, 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はEdge-1によってプルーニングされています。LHRに移動して、その理由を確認しましょう。

(S,G) LHRでの作成

RPによって転送されたマルチキャストデータを受信した後、LHRに(S,G)エントリが作成されます。

次に、LHRは最短パスツリー(SPT)に切り替えます)をクリックします。これはRPFインターフェイスで送信元に送信されます。

```
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 LISP0.4099
  nexthop 192.168.10.2 LISP0.4099


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: LISP0.4099
 RPF neighbor: ? (192.168.10.2)                                            <<<<<<<<<< Hence
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#
```

(S,G) JoinがLISPインターフェイスを介してBorder-2に送信されるため、Edge-1に新しいPIMネイバーが作成されます

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

Neighbor          Interface                Uptime/Expires    Ver   DR
Address                                                            Prio/Mode
192.168.10.2      LISP0.4099               00:07:32/00:01:22 v2    0 /         <<<<<<<< Neighbor
towards Border-2 is created
192.168.10.1      LISP0.4099               2w1d/00:01:58     v2    0 /
```

Border-2はマルチキャストストリームのデータパスにあるため、パケットのユニキャストレプリケーション用のダウンストリームXTR-sのRLOCを追跡するために、明示的RLOCトラッキングを実行する必要があります。

```
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: LISP0.4099, 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:
    LISP0.4099, 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/Kbits 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#
```