Panoramica di Any-Source Multicast (ASM) nell'ambiente fabric del campus SDA

Sommario

Introduzione

In questo documento viene fornita una panoramica di AnySource Multicast (ASM) con punto di rendering singolo (*RP*) in ambiente SD (Software-Defined Access).

Prerequisiti

Requisiti

Si consiglia di conoscere il protocollo *LISP* (Locator ID Separation Protocol) e il multicast.

Componenti usati

Il documento può essere consultato per tutte le versioni software o hardware.

Le informazioni discusse in questo documento fanno riferimento a dispositivi usati in uno specifico ambiente di emulazione. Se la rete è operativa, valutare attentamente eventuali conseguenze derivanti dall'uso dei comandi.GUI

Dispositivi utilizzati per questo articolo

DNAC (Digital Network Architecture Controller) - Versione 1.2.1

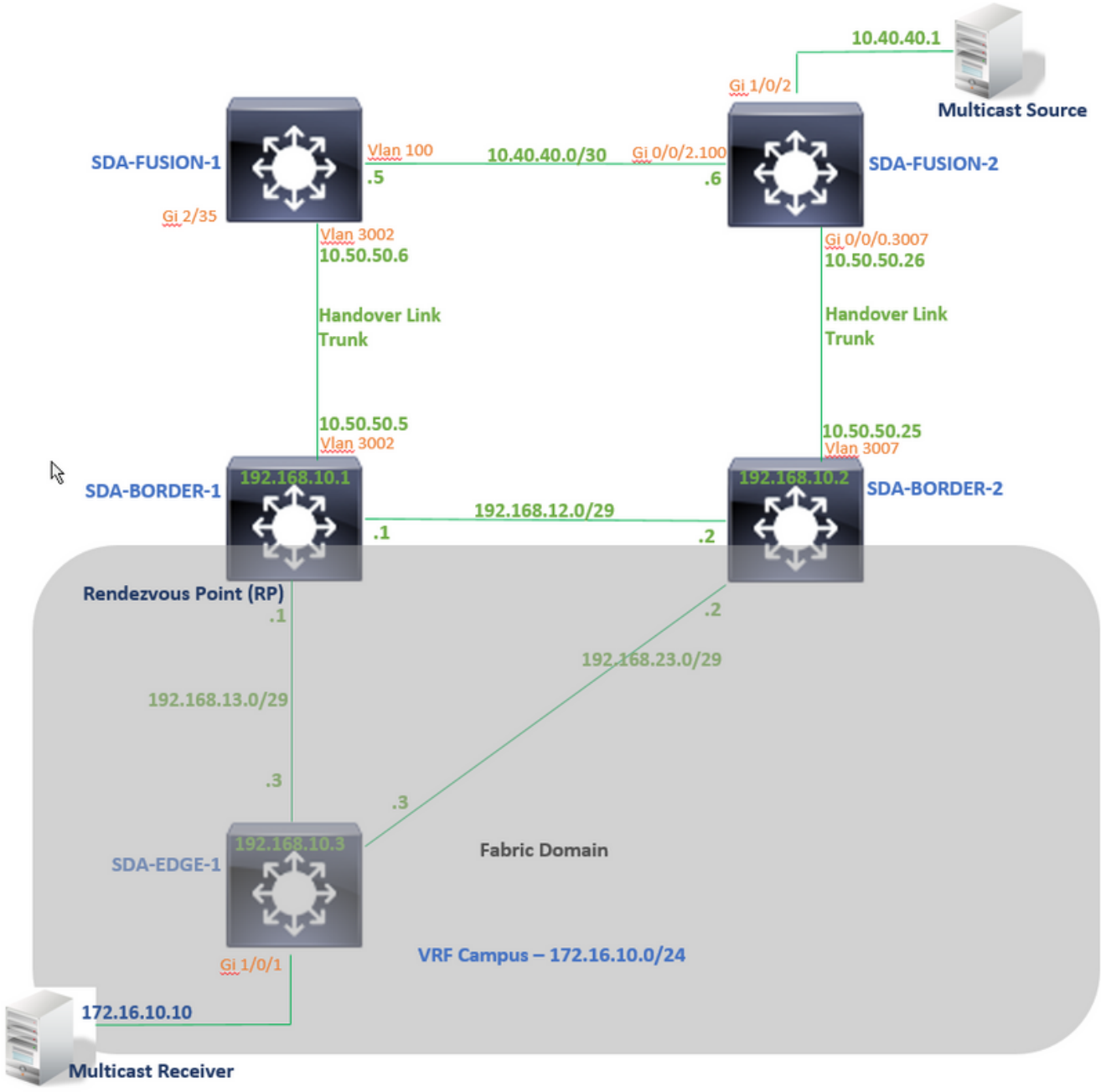
Edge and Border - Switch Cat3k

Fusion - Router Cisco con supporto per perdite tra VRF (Virtual Route Forwarding)

Configurazione

Esempio di rete

La topologia utilizzata in questo articolo è composta da due router di confine entrambi configurati come frontiere esterne e due router di fusione con una connessione a ciascun router di confine rispettivo. Border-1 è configurato come RP, l'origine multicast è connessa a Fusion-2 e il ricevitore multicast è connesso a Edge-1.



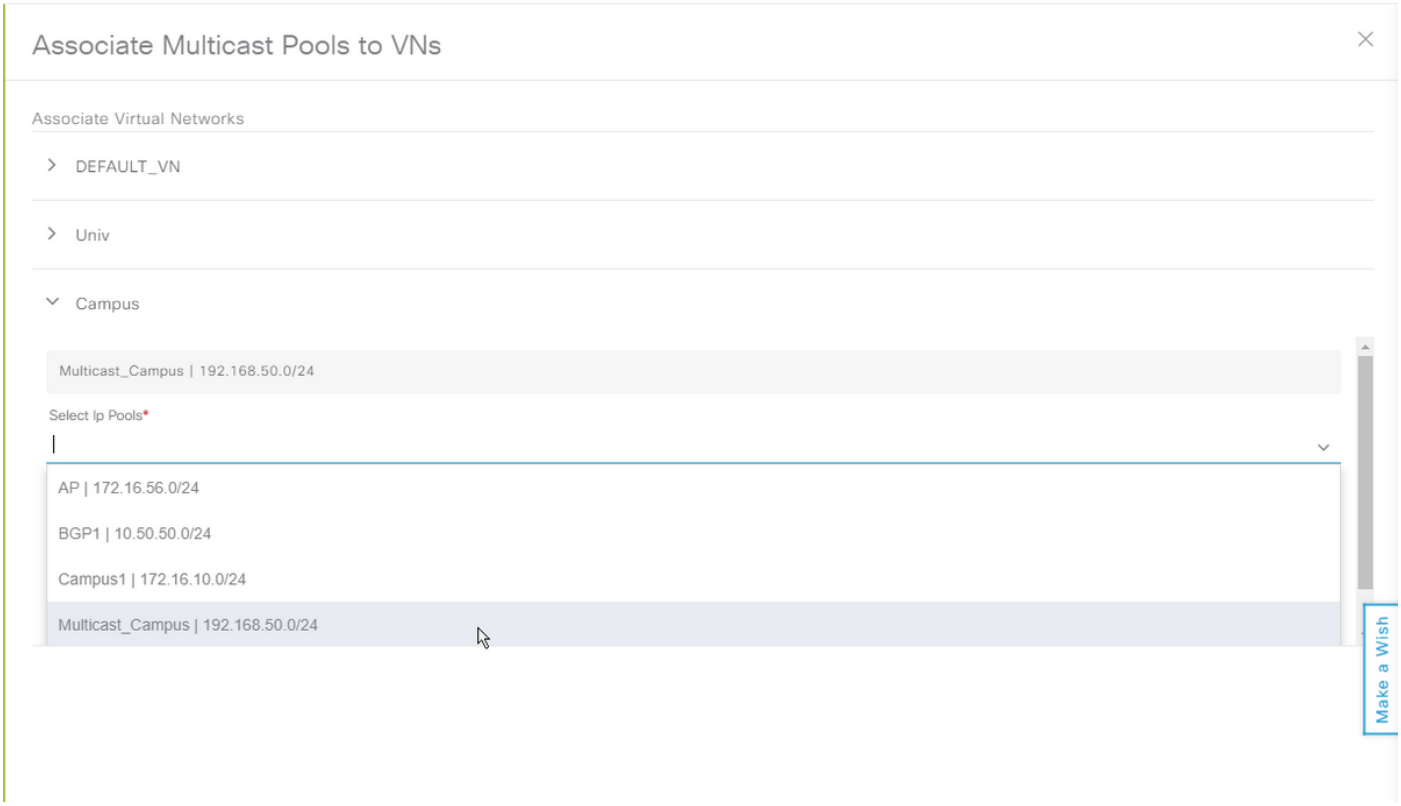
Configurazioni

In questo documento non viene descritta la procedura per configurare l'infrastruttura in ambiente SDA (Software-Defined Access) e viene spiegato come configurare il multicast nel dominio dell'infrastruttura per una VPN specifica.

Fase 1: Configurazione del multicast sui dispositivi fabric da DNAC

Nell'interfaccia utente grafica (GUI) DNAC, in Provisioning -> Fabric Workflow. Il multicast è configurato dall'opzione "Enable Rendezvous point" (Abilita punto di rendering) sul dispositivo SDA-BORDER-1.

Quindi, scegliere un pool *IP (Internet Protocol*) da utilizzare per la configurazione multicast nell'ambito della VPN specifica "Campus" di questo esempio.



Fase 2: Verifica della configurazione dei dispositivi

In questa sezione viene illustrata la verifica della configurazione multicast sui dispositivi fabric.

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
```

Fase 3: Configura manualmente PIM attraverso il collegamento di trasferimento

In questo esempio, l'origine multicast è connessa all'esterno dell'infrastruttura a Fusion-2. Affinché il flusso multicast scorra, verificare che sia presente un percorso PIM da RP a origine e da ricevitore a origine (i percorsi potrebbero essere diversi!).

PIM Peering tra SDA-BORDER-1 e 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 tra SDA-BORDER-2 e 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
```

Peering PIM tra SDA-FUSION-1 e SDA-FUSION-2

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
```

Attivare PIM sull'interfaccia di connessione all'origine

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
```

Processo Control Plane

A un certo punto, il ricevitore multicast invia un join IGMP (Internet Group Management Protocol) all'ultimo router hop (LHR) per ricevere il flusso per un gruppo specifico e l'origine multicast (server) inizia a inviare il flusso multicast al primo router hop (FHR). Nel nostro caso, FHR è SDA-FUSION-2 e LHR è SDA-EDGE-1 e Control Plane Process è spiegato nello scenario in cui il ricevitore richiede prima un flusso, e Source inizia lo streaming per quel gruppo in seguito.

Iscrizione IGMP su LHR

Il ricevitore multicast invia un rapporto IGMP (Join) a LHR per il gruppo 239.1.1.1. Il ricevitore è collegato a Gi1/0/1 (SVI 1021) su 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#
```

Il nuovo Servizio di controllo route multicast determina le informazioni dell'inoltro del percorso inverso (RPF) verso l'RP (per l'albero condiviso) e verso l'origine (per l'albero del percorso più breve (SPT)). Per gli indirizzi raggiungibili tramite LISP, il router adiacente dell'hop successivo è rappresentato dall'indirizzo RLOC (Routing locator) remoto del sito a monte.

```
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
```

Successivamente, LHR invia un'operazione di unione PIM (*,G) verso l'RP (a intervalli di un minuto), se LHR è DR per quel segmento.

```
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#
```

Creazione router adiacente

Una volta ottenute le informazioni RPF che puntano all'interfaccia LISP, PIM deve creare esplicitamente una struttura adiacente per la RLOC corrispondente. Questa operazione è necessaria perché il router del tunnel (xTR) upstream non invia messaggi di saluto. Il nuovo blocco del router adiacente scade quando non è stato inviato alcun messaggio di join o eliminazione al router adiacente dopo il doppio dell'intervallo standard tra join e eliminazioni.

Nel nostro caso, SDA-EDGE-1 crea un PIM adiacente utilizzando l'indirizzo RLOC upstream/RPF.

```
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.

...
```

Aggiunta PIM ricevuta su RP

Il join PIM viene ricevuto sull'RP (SDA-BORDER-1) da LHR (SDA-EDGE-1) tramite l'interfaccia LISP

```
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
```

L'RP(Border1) non invia alcun join sull'interfaccia LISP, quindi non viene creato alcun router adiacente PIM sull'RP tramite l'interfaccia LISP.

Nel nostro caso, l'unico vicino PIM è verso Fusion-1 su un'interfaccia non LISP, e si è formato come risultato dei pacchetti PIM Hello periodici ricevuti.

```
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
```

PIM Neighbor su router Fusion

I vicini PIM su router Fusion sono su interfacce non LISP e quindi vengono creati anche in base ai PIM Hello-s ricevuti periodicamente.

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
```

Registrazione PIM su RP da FHR

Quando l'origine inizia a inviare il traffico per il gruppo, l'FHR (SDA-FUSION-2) registra il (S,G) con l'RP una volta ricevuto il primo pacchetto multicast dall'origine e se FHR è il DR su quel segmento.

```
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) riceve il registro dall'FHR, che attiva un join (S,G) da inviare all'FHR, e anche un register-stop verso l'FHR - una volta che il flusso viene ricevuto in modo nativo sull'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: 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#
```

L'SPT è stato potato dal Edge-1 - andiamo all'LHR per capire perché.

(S,G) Creazione su LHR

Dopo aver ricevuto i dati multicast inoltrati dall'RP, viene creata una voce (S,G) sull'LHR.

Successivamente, l'LHR passerà all'albero del percorso più breve (*SPT)*) inviando un (S,G) Join verso la Sorgente. che viene inviato all'interfaccia RPF verso la sorgente.

```
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#
```

Poiché l'unione (S,G) viene inviata verso Border-2 tramite l'interfaccia LISP, viene creato un nuovo oggetto adiacente PIM sul bordo-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      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 /
```

Poiché Border-2 si trova nel percorso dati per il flusso multicast, deve eseguire un rilevamento RLOC esplicito per rilevare il RLOC degli XTR downstream per la replica unicast dei pacchetti.

```
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#
```