

SDA園區交換矩陣環境中的任意源組播(ASM)概述

目錄

[簡介](#)

[必要條件](#)

[需求](#)

[採用元件](#)

[設定](#)

[網路圖表](#)

[組態](#)

[第1步：通過DNAC配置交換矩陣裝置上的組播](#)

[第2步：驗證在裝置上推送的配置](#)

[步驟3: 在切換鏈路上手動配置PIM](#)

[控制平面進程](#)

[LHR上的IGMP連線](#)

[鄰居建立](#)

[RP上接收到的PIM加入](#)

[Fusion路由器上的PIM鄰居](#)

[從FHR在RP上註冊PIM](#)

[\(S, G\)在LHR上的建立](#)

簡介

本檔案介紹軟體定義存取(SD-Access)環境中使用單一集結點(RP)的任意來源多點傳送(ASM)的概觀。

必要條件

需求

建議您瞭解定位器ID分隔通訊協定(LISP)和多點傳送。

採用元件

本文件所述內容不限於特定軟體和硬體版本。

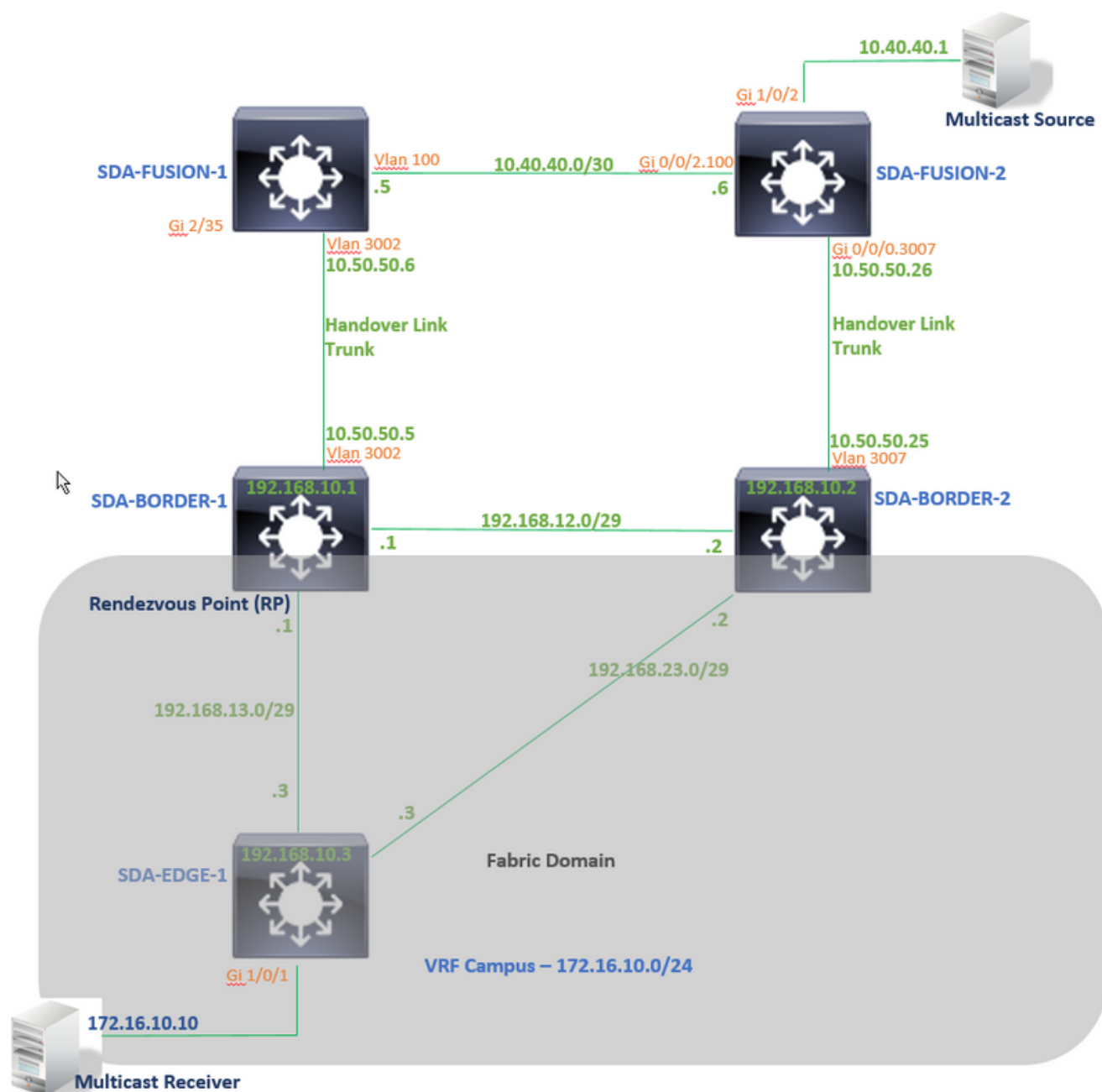
本文中的資訊是根據特定實驗室環境內的裝置所建立。如果您的網路正在作用，請確保您已瞭解任何指令可能造成的影響。GUI

用於本文的裝置

設定

網路圖表

本文使用的拓撲包含兩個配置為外部邊界的邊界路由器，以及兩個連線到每個邊界路由器的融合路由器。Border-1配置為RP，組播源連線到Fusion-2，組播接收器連線到Edge-1。



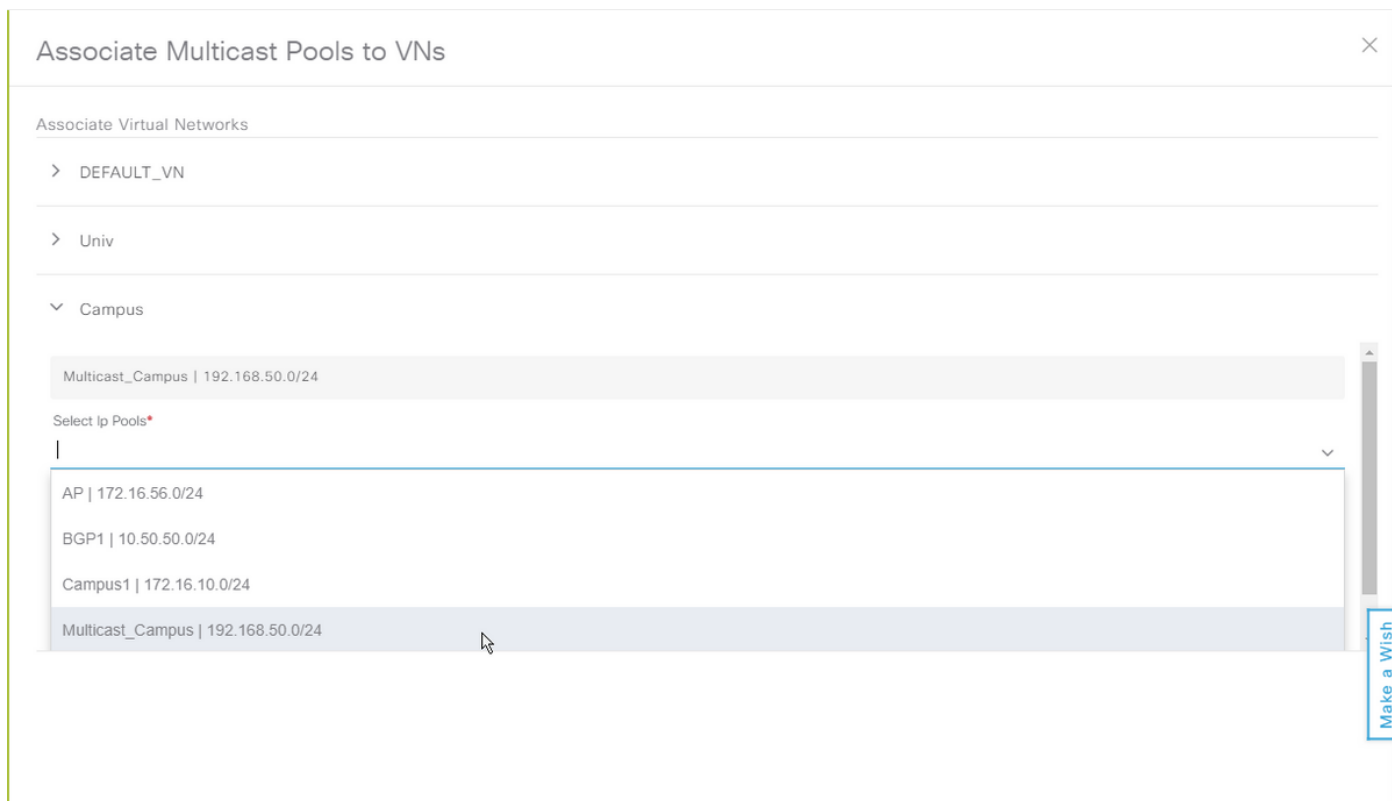
組態

本文不包括在軟體定義存取(SDA)環境中設定網狀架構的步驟，並首先解釋在網狀架構網域中為特定VN設定多點傳送的步驟。

第1步： 通過DNAC配置交換矩陣裝置上的組播

在DNAC Graphical User Interface(GUI)中的「Provision -> Fabric Workflow (調配 — >交換矩陣工作流)」下。組播由SDA-BORDER-1裝置上的「啟用集結點」選項配置。

然後選擇要在特定VN下用於組播配置的 *Internet Protocol(IP)*池。在此示例中「園區」。



第2步： 驗證在裝置上推送的配置

本節介紹交換矩陣裝置上的組播配置的驗證。

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 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 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 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 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

```

步驟3: 在切換鏈路上手動配置PIM

在本例中，組播源在交換矩陣外部連線到Fusion-2。對於要流動的組播流，請確儲存在從RP到源和接收器到源的PIM路徑（路徑可能不同！）。

SDA-BORDER-1和SDA-FUSION-1之間的PIM對等

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和SDA-FUSION-2之間的PIM對等

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和SDA-FUSION-2之間的PIM對等

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
```

在連線到源的介面上啟用PIM

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
```

控制平面進程

多點傳送接收者會於某一點傳送網際網路群組管理通訊協定(Internet Group Management Protocol, IGMP)加入最後躍點路由器(Last Hop Router, LHR)以接收特定群組的流，而多點傳送來源(Multicast Source, Server)會開始將多點傳送流傳送到第一躍點路由器(First Hop Router, FHR)。在本例中，FHR是SDA-FUSION-2,LHR是SDA-EDGE-1，控制平面過程在接收方首先請求流，然後源開始對該組進行流式處理的場景中得到了說明。

LHR上的IGMP連線

組播接收器將組239.1.1.1的IGMP報告(加入)傳送到LHR。接收器連線到SDA-EDGE-1上的Gi1/0/1(SVI 1021)。

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#

新的多點傳送路由監視服務確定指向RP (用於共用樹) 和源(用於最短路徑樹(SPT))的反向路徑轉發(RPF)資訊。對於LISP可訪問地址, 下一個躍點鄰居由上游站點的遠端路由定位器(RLOC)地址表示。

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

```

接下來，LHR向RP傳送PIM(*,G)加入 (間隔一分鐘) — 如果LHR是該段的DR。

```

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#

```

鄰居建立

一旦獲得指向LISP介面的RPF資訊，PIM必須為相應的RLOC顯式建立鄰居結構。這是必要的，因為上游隧道路由器(xTR)不傳送hello消息。當加入/修剪之間的標準間隔時間超出了2倍時，沒有向鄰居傳送任何加入/修剪消息時，新的鄰居塊將過期。

在本例中，SDA-EDGE-1使用上游/RPF RLOC地址建立PIM鄰居。

```

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

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

```

```

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上接收到的PIM加入

PIM加入在RP(SDA-BORDER-1)上通過LISP介面從LHR(SDA-EDGE-1)接收

```
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 (Tunnell) 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)不會通過LISP介面傳送任何連線，因此不會通過LISP介面在RP上建立任何PIM鄰居。

在本例中，唯一的PIM鄰居通過非LISP介面指向Fusion-1，並且它是接收的PIM Hello資料包定期形成的結果。

```
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

Fusion路由器上的PIM鄰居

Fusion路由器上的PIM鄰居位於非LISP介面上，因此也基於定期接收的PIM Hello-s建立。

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

從FHR在RP上註冊PIM

當源開始傳送組的流量時，FHR(SDA-FUSION-2)在收到來自源的第一個組播資料包後（如果FHR是該網段上的DR），便會向RP註冊(S，G)。

```
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)接收來自FHR的註冊，FHR觸發要傳送到FHR的(S，G)加入，以及指向FHR的註冊 — 停止 — 一旦在RP上本地接收到流。

```

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 Edgel
*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

created but Pruned flag is set

Incoming interface: Vlan3002, RPF nbr 10.50.50.6

interface and RPF neighbor

Outgoing interface list: Null

<<<<<<<<<<<< (S,G) is

<<<<<<<<<<<< Incoming

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 (bgrp 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#
```

Edge-1正在修剪SPT — 讓我們前往LHR瞭解原因。

(S, G)在LHR上的建立

收到由RP轉發的組播資料後，在LHR上建立(S, G)條目。

接下來，LHR將切換到最短路徑樹(SPT)向源傳送(S, G)連線。這在RPF介面上傳送到源。

```
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#

```

由於(S , G)連線通過LISP介面傳送到Border-2 , 因此在Edge-1上建立了一個新的PIM鄰居

```

SDA-Edge1#show ip pim vrf Campus neighbor

```

PIM Neighbor Table

Neighbor Address	Interface	Uptime/Expires	Ver	DR 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 /	

由於Border-2位於組播流的資料路徑中，它必須執行顯式RLOC跟蹤以跟蹤下游XTR-s的RLOC，以便單播複製資料包。

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#