Vue d'ensemble de la multidiffusion Any-Source (ASM) dans l'environnement de fabric de campus SDA

Contenu

Introduction

Ce document décrit la présentation de l'ASM (Any-Source Multicast) avec point de rendez-vous unique (*RP*) dans l'environnement d'accès défini par logiciel (SD-Access).

Conditions préalables

Conditions requises

Il est recommandé de connaître le protocole *LISP (*Locator ID Separation Protocol) et la multidiffusion.

Components Used

Ce document n'est pas limité à des versions de matériel et de logiciel spécifiques.

Les informations contenues dans ce document ont été créées à partir des périphériques dans un environnement de laboratoire spécifique. Si votre réseau est actif, assurez-vous de bien comprendre l'impact potentiel de n'importe quelle commande.GUI

Périphériques utilisés pour cet article

Contrôleur d'architecture de réseau numérique (DNAC) - Version 1.2.1

Périphérie et frontière - Commutateur Cisco Cat3k

Fusion - Routeur Cisco avec prise en charge de la fuite inter-VRF(Virtual Route Forwarding)

Configuration

Diagramme du réseau

La topologie utilisée pour cet article se compose de deux routeurs périphériques, tous deux configurés en tant que frontières externes, et de deux routeurs de fusion avec une connexion à chaque routeur périphérique respectif. La bordure 1 est configurée en tant que RP, la source de multidiffusion est connectée à Fusion-2 et le récepteur de multidiffusion est connecté à Edge-1.
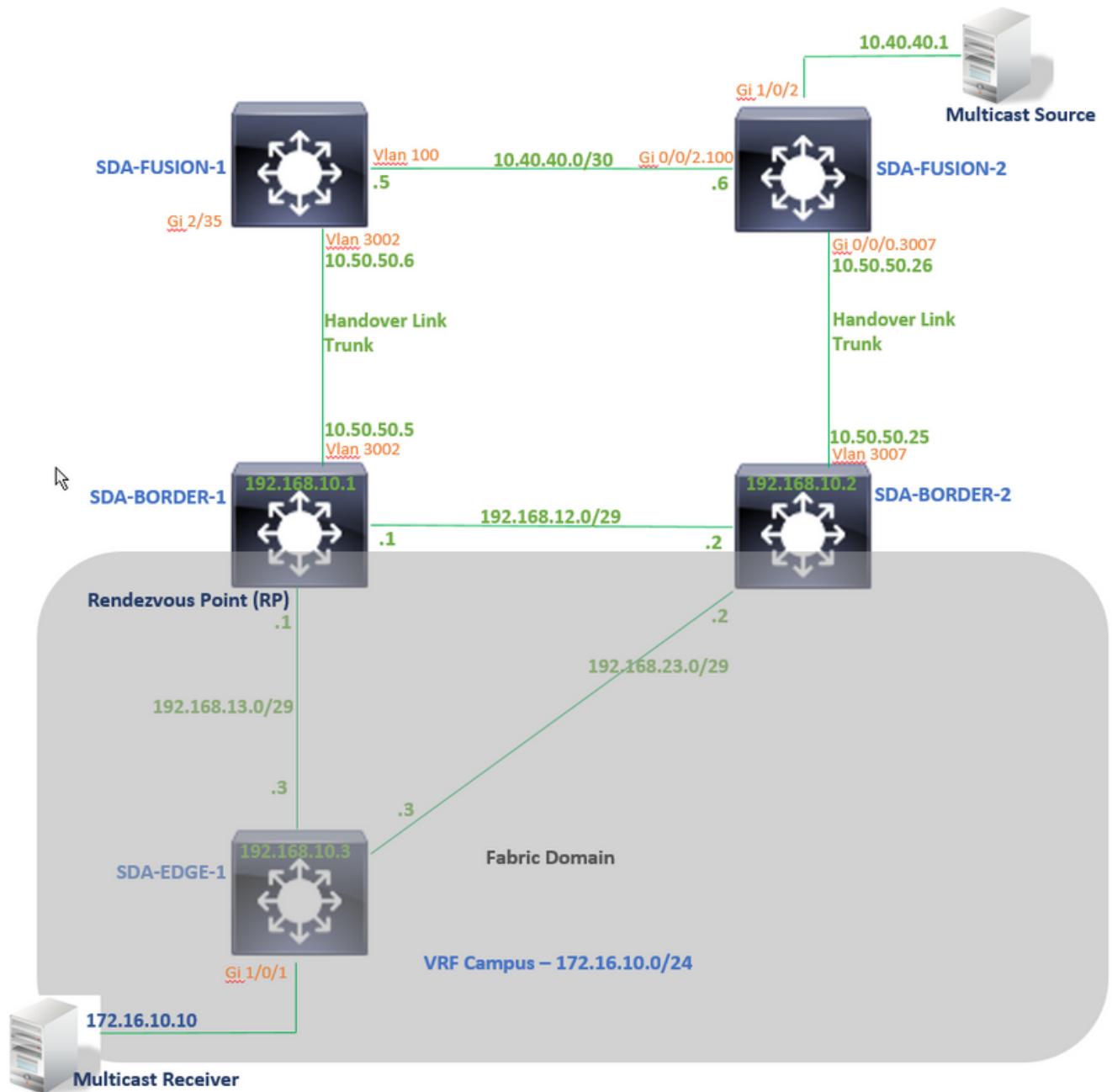
Configurations

Cet article ne couvre pas les étapes de configuration de Fabric dans l'environnement SDA (Software-Defined Access) et commence par une explication des étapes de configuration de Multicast dans le domaine Fabric pour un VLAN spécifique.

Étape 1 : configurez la multidiffusion sur les périphériques de fabric à partir de DNAC

Dans l'interface utilisateur graphique DNAC, sous Provisioning -> Fabric Workflow. La multidiffusion est configurée par l'option Enable Rendezvous point sur le périphérique SDA-BORDER-1.

Choisissez ensuite un pool *de protocoles Internet (*IP) à utiliser pour la configuration de multidiffusion sous VPN spécifique. « Campus » dans cet exemple.

Étape 2 : vérification de la configuration sur les périphériques

Cette section traite de la vérification de la configuration de multidiffusion sur les périphériques de 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
```

Étape 3 : configuration manuelle de PIM sur la liaison de transfert

La source de multidiffusion est connectée en dehors du fabric à Fusion-2 dans cet exemple. Pour
que le flux de multidiffusion circule, assurez-vous qu'il existe un chemin PIM du RP à la source et
du récepteur à la source (les chemins peuvent être différents !).

Homologation PIM entre SDA-BORDER-1 et 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
```

Homologation PIM entre SDA-BORDER-2 et 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
```

Homologation PIM entre SDA-FUSION-1 et 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
```

Activer PIM sur l'interface connectée à la source

```
SDA-FUSION-2
--------------------------------------------------

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

Processus du plan de contrôle

À un moment donné, le récepteur de multidiffusion envoie un message IGMP (Internet Group

Management Protocol) Join to Last Hop Router(LHR) afin de recevoir le flux pour un groupe spécifique, et la source de multidiffusion (Server) commence à envoyer le flux de multidiffusion au routeur de premier saut (FHR). Dans notre cas, FHR est SDA-FUSION-2 et LHR est SDA-EDGE-1 et le processus du plan de contrôle est expliqué dans le scénario où le récepteur demande un flux en premier, et Source commence la diffusion en continu pour ce groupe après.

Connexion IGMP sur LHR

Le récepteur de multidiffusion envoie un rapport IGMP (Join) à LHR pour le groupe 239.1.1.1. Le récepteur est connecté à Gi1/0/1 (SVI 1021) sur 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#
```

Le nouveau **service de surveillance de route de multidiffusion** détermine les informations RPF (**Reverse Path Forwarding**) vers le RP (pour l'arborescence partagée) et vers la source (pour l'arborescence du chemin le plus court (SPT)). Pour les adresses accessibles par LISP, le voisin de tronçon suivant est représenté par l'adresse RLOC (Routing Locator) distante du site en amont.

```
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
```

Ensuite, le LHR envoie un PIM (*, G) Join To the RP (à intervalles d'une minute) - si le LHR est DR pour ce segment.

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

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

Création de voisins

Une fois que les informations RPF sont obtenues pointant vers l'interface LISP, PIM doit explicitement créer une structure de voisinage pour le RLOC correspondant. Cela est nécessaire car le routeur de tunnel en amont (xTR) n'envoie pas de messages Hello. Le nouveau bloc de voisinage expire lorsqu'aucun message de jointure/élingue n'a été envoyé au voisin après 2 fois le délai d'intervalle standard entre la jointure/les pruneaux.

Dans notre cas, le SDA-EDGE-1 crée un voisin PIM en utilisant l'adresse RLOC amont/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.

...
```

Jointure PIM reçue sur RP

La jointure PIM est reçue sur le RP(SDA-BORDER-1) de LHR(SDA-EDGE-1) via l'interface 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
```

Le RP(Border1) n'envoie aucune jointure par le biais de l'interface LISP. Par conséquent, aucun voisin PIM n'est créé sur le RP par le biais de l'interface LISP.

Dans notre cas, le seul voisin PIM est vers Fusion-1 sur une interface non LISP, et formé à la suite des paquets Hello PIM périodiques reçus.

```
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
```

Voisin PIM sur les routeurs de fusion

Les voisins PIM sur les routeurs de fusion sont sur des interfaces non LISP et sont donc également créés en fonction des Hello PIM périodiques reçus.

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
```

Registre PIM sur RP à partir de FHR

Lorsque la source commence à envoyer du trafic pour le groupe, le FHR (SDA-FUSION-2) enregistre le (S, G) avec le RP une fois qu'il reçoit le premier paquet multicast de la source - et si FHR est le DR sur ce segment.

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

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

SDA-Fusion2#show ip cef vrf Campus 192.168.50.1
192.168.50.1/32
```

```
    nexthop 10.40.40.5 GigabitEthernet0/0/2.100        <<<<<<<< Next-hop Interface towards RP


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

*Aug 22 21:59:42.601: PIM(2): Check RP 192.168.50.1 into the (*, 239.1.1.1) entry
*Aug 22 21:59:42.601: MRT(2): (*,239.1.1.1), RPF change from  /0.0.0.0 to
GigabitEthernet0/0/2.100/10.40.40.5        <<<<<<<< RPF Interface is determined
*Aug 22 21:59:42.601: PIM(2): Building Triggered (*,G) Join / (S,G,RP-bit) Prune message for
239.1.1.1
*Aug 22 21:59:42.601: MRT(2): Create (*,239.1.1.1), RPF (GigabitEthernet0/0/2.100, 10.40.40.5,
1/0)
*Aug 22 21:59:42.602: MRT(2): (10.40.40.1,239.1.1.1), RPF install from  /0.0.0.0 to
GigabitEthernet1/0/2/0.0.0.0
*Aug 22 21:59:42.602: PIM(2): Adding register 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
```

 Le RP (BORDER-1) reçoit le Registre du FHR, ce qui déclenche l'envoi d'une (S, G) Join vers le
FHR, ainsi qu'un Register-Stop vers le FHR - une fois le flux reçu nativement sur le 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#
```

SPT est élagué par le Edge-1 - allons sur le LHR pour voir pourquoi.

(S, G) Création sur LHR

Après réception des données de multidiffusion transmises par le RP, l'entrée (S, G) est créée sur
le LHR.

Ensuite, le LHR passe à l'arbre du chemin le plus court (*SPT*)) en envoyant un (S, G) Join vers la
Source. Ceci est envoyé sur l'interface RPF vers la source.


```
SDA-Edge1#
*Aug 18 02:19:53.759: MRT(4): Create (10.40.40.1,239.1.1.1), RPF (unknown, 0.0.0.0, 0/0)
<<<<<<<<< (S,G) is created on LHR
*Aug 18 02:19:53.759: MRT(4): WAVL Insert interface: Vlan1021 in (10.40.40.1,239.1.1.1)
Successful
*Aug 18 02:19:53.759: MRT(4): set min mtu for (10.40.40.1, 239.1.1.1) 18010->1500
*Aug 18 02:19:53.759: MRT(4): Add Vlan1021/239.1.1.1 to the olist of (10.40.40.1, 239.1.1.1),
Forward state - MAC not built   <<<<<< OIL is inherited from (*,G)
*Aug 18 02:19:53.759: MRT(4): Set the J-flag for (10.40.40.1, 239.1.1.1)
<<<<<<< SPT Join Flag is set
*Aug 18 02:19:53.762: MRT(4): (10.40.40.1,239.1.1.1), RPF change from  /0.0.0.0 to
```

LISP0.4099/192.168.10.2 <<<<<<<< RPF interface is resolved
*Aug 18 02:19:53.762: MRT(4): Set the T-flag for (10.40.40.1, 239.1.1.1)
*Aug 18 02:19:53.763: PIM(4): Insert (10.40.40.1,239.1.1.1) join in nbr 192.168.10.2's queue
*Aug 18 02:19:53.763: PIM(4): Building Join/Prune packet for nbr 192.168.10.2
*Aug 18 02:19:53.763: PIM(4): Adding v2 (10.40.40.1/32, 239.1.1.1), S-bit Join
*Aug 18 02:19:53.763: PIM(4): Adding LISP Unicast transport attribute in join/prune to
192.168.10.2 (LISP0.4099)
*Aug 18 02:19:53.763: PIM(4): **Send v2 join/prune to 192.168.10.2 (LISP0.4099)**
<<<<<<<< (S,G) Join towards the Source is sent
Aug 18 02:19:53.826: PIM(4): Building Periodic (,G) Join / (S,G,RP-bit) Prune message for
239.1.1.1
Aug 18 02:19:53.826: PIM(4): Insert (,239.1.1.1) join in nbr 192.168.10.1's queue
*Aug 18 02:19:53.826: PIM(4): Insert (10.40.40.1,239.1.1.1) sgr prune in nbr 192.168.10.1's
queue
*Aug 18 02:19:53.826: PIM(4): **Building Join/Prune packet for nbr 192.168.10.1**
*Aug 18 02:19:53.826: PIM(4): Adding v2 (192.168.50.1/32, 239.1.1.1), WC-bit, RPT-bit, S-bit
Join
*Aug 18 02:19:53.827: PIM(4): **Adding v2 (10.40.40.1/32, 239.1.1.1), RPT-bit, S-bit Prune**
*Aug 18 02:19:53.827: PIM(4): Adding LISP Unicast transport attribute in join/prune to
192.168.10.1 (LISP0.4099)
*Aug 18 02:19:53.827: PIM(4): **Send v2 join/prune to 192.168.10.1 (LISP0.4099)**
<<<<<<<<< (S,G) Prune towards the RP is sent
Aug 18 02:20:08.323: MRT(4): Update (,239.1.1.1), RPF (LISP0.4099, 192.168.10.1, 1/1)
Aug 18 02:20:08.323: MRT(4): Update Vlan1021/239.1.1.1 in the olist of (, 239.1.1.1), Forward
state - MAC not built
*Aug 18 02:20:08.323: MRT(4): Update Vlan1021/239.1.1.1 in the olist of (10.40.40.1, 239.1.1.1),
Forward state - MAC not built

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

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

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

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

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

SDA-Edge1#**show ip cef vrf Campus 10.40.40.1 detail**
0.0.0.0/1, epoch 0, flags [subtree context, check lisp eligibility], per-destination sharing
  SC owned,sourced: LISP remote EID - locator status bits 0x00000000
  LISP remote EID: 106468 packets 41140303 bytes fwd action encap
  LISP source path list

```
      nexthop 192.168.10.1 LISP0.4099                              <<<<<<<<<< Load
balancing towards 2 Proxy ETR-s
      nexthop 192.168.10.2 LISP0.4099
  2 IPL sources [no flags]
  nexthop 192.168.10.1 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#
```

 Puisque la jointure (S, G) est envoyée vers Border-2 via l'interface LISP, un nouveau voisin PIM
est créé sur Edge-1


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


Neighbor          Interface              Uptime/Expires   Ver   DR
Address                                                         Prio/Mode
192.168.10.2      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 /
```

 Étant donné que Border-2 se trouve dans le chemin de données pour le flux de multidiffusion, il
doit effectuer un suivi explicite des RLOC pour suivre le RLOC des XTR en aval pour la réplication
monodiffusion des paquets.


```
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#
```