

Übersicht über Any-Source Multicast (ASM) in der SDA Campus Fabric-Umgebung

Inhalt

[Einführung](#)

[Voraussetzungen](#)

[Anforderungen](#)

[Verwendete Komponenten](#)

[Konfigurieren](#)

[Netzwerkdiagramm](#)

[Konfigurationen](#)

[Schritt 1: Konfigurieren von Multicast auf Fabric-Geräten von DNAC](#)

[Schritt 2: Überprüfen der Konfiguration auf Geräten](#)

[Schritt 3: Manuelle Konfiguration von PIM über den Handover-Link](#)

[Prozess der Kontrollebene](#)

[IGMP-Teilnahme an LHR](#)

[Erstellung von Nachbarn](#)

[PIM-Join erhalten auf RP](#)

[PIM Neighbor auf Fusion Routern](#)

[PIM-Registrierung beim RP über FHR](#)

[\(S,G\) Erstellung auf LHR](#)

Einführung

Dieses Dokument beschreibt eine Übersicht über Any-Source Multicast (ASM) mit Single Rendezvous Point (*RP*) in Software-Defined Access (SD-Access) Environment.

Voraussetzungen

Anforderungen

Es wird empfohlen, dass Sie mit Locator ID Separation Protocol (*LISP*) und Multicast vertraut sind.

Verwendete Komponenten

Dieses Dokument ist nicht auf bestimmte Software- und Hardwareversionen beschränkt.

Die Informationen in diesem Dokument wurden von Geräten in einer bestimmten Laborumgebung erstellt. Wenn Ihr Netzwerk in Betrieb ist, vergewissern Sie sich, dass Sie die potenziellen Auswirkungen eines Befehls verstehen.GUI

Für diesen Artikel verwendete Geräte

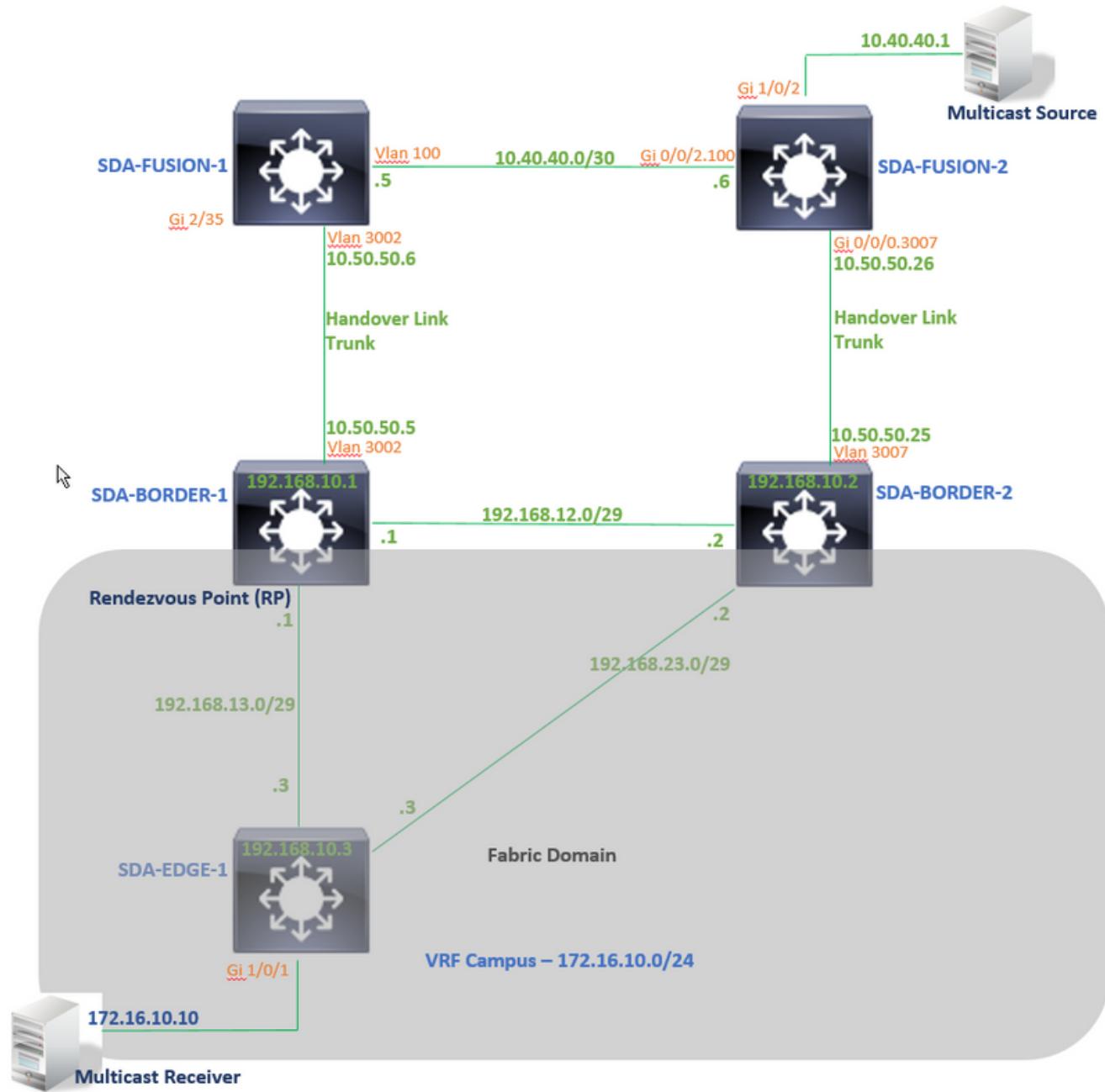
Edge and Border - Cat3k Cisco Switch

Fusion - Cisco Router mit Unterstützung für Inter-VRF(Virtual Route Forwarding)-Leaking

Konfigurieren

Netzwerkdiagramm

Die für diesen Artikel verwendete Topologie besteht aus zwei Border Routern, die beide als externe Grenzen konfiguriert sind, und zwei Fusion Routern mit einer Verbindung zu den jeweiligen Border Routern. Border-1 ist als RP konfiguriert, die Multicast-Quelle ist mit Fusion-2 verbunden und der Multicast-Empfänger mit Edge-1 verbunden.



Konfigurationen

Dieser Artikel behandelt nicht die Schritte zur Konfiguration von Fabric in einer Software-Defined Access (SDA)-Umgebung und beginnt mit einer Erläuterung der Schritte zur Konfiguration von Multicast in einer Fabric-Domäne für ein bestimmtes VN.

Schritt 1: Konfigurieren von Multicast auf Fabric-Geräten von DNAC

In der DNAC Graphical User Interface (GUI) unter Provisioning -> Fabric Workflow. Multicast wird auf dem SDA-BORDER-1-Gerät durch die Option "Enable Rendezvous point" konfiguriert.

Wählen Sie anschließend einen *Internet Protocol (IP)*-Pool für die Multicast-Konfiguration unter speziellem VN aus. "Campus" in diesem Beispiel.

Associate Multicast Pools to VNs

Associate Virtual Networks

> DEFAULT_VN

> Univ

▽ Campus

Multicast_Campus | 192.168.50.0/24

Select Ip Pools*

|

AP | 172.16.56.0/24

BGP1 | 10.50.50.0/24

Campus1 | 172.16.10.0/24

Multicast_Campus | 192.168.50.0/24

Make a Wish

Schritt 2: Überprüfen der Konfiguration auf Geräten

In diesem Abschnitt wird die Verifizierung der Multicast-Konfiguration auf Fabric-Geräten beschrieben.

SDA-GRENZE-1

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

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

```

SDA-Border1#sh run | in pim|multicast ip multicast-routing <<<<<< Multicast Routing is
enabled for Global ip multicast-routing vrf Campus <<<<<< Multicast Routing is enabled for
Campus VN ip pim ssm default <<<<<< PIM SSM mode is enabled for Global for default address
range ip pim vrf Campus rp-address 192.168.50.1 <<<<<< BORDER-1 Loopback4099 is 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-GRENZE-2

```

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

interface LISPO.4099
ip pim sparse-mode
end

SDA-Border2#sh run | in pim|multicast

ip multicast-routing
ip multicast-routing vrf Campus

ip pim ssm default
ip pim vrf Campus rp-address 192.168.50.1 <<<<<< BORDER-1 Loopback4099 is 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_Campus
end

```

```

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

```

Schritt 3: Manuelle Konfiguration von PIM über den Handover-Link

In diesem Beispiel ist die Multicast-Quelle außerhalb von Fabric mit Fusion-2 verbunden. Damit der Multicast-Stream fließen kann, stellen Sie sicher, dass ein PIM-Pfad von RP zu Quelle und Empfänger zu Quelle vorhanden ist (Pfade können unterschiedlich sein!).

PIM-Peering zwischen SDA-BORDER-1 und 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 zwischen SDA-BORDER-2 und SDA-FUSION-2

SDA-BORDER-2

```

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

```

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

ip pim vrf Campus rp-address 192.168.50.1

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

PIM-Peering zwischen SDA-FUSION-1 und SDA-FUSION-2

SDA-FUSION-1

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

SDA-FUSION-2

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

Aktivieren Sie PIM auf der Schnittstelle, die mit der Quelle verbunden ist.

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
```

Prozess der Kontrollebene

An einem bestimmten Punkt sendet der Multicast Receiver eine Verbindung zum Internet Group Management Protocol (IGMP) Join-to-Last-Hop-Router (LHR), um den Stream für eine bestimmte Gruppe zu empfangen, und die Multicast-Quelle (Server) beginnt, den Multicast-Stream an den First Hop Router (FHR) zu senden. In unserem Fall ist FHR SDA-FUSION-2 und LHR SDA-EDGE-1, und der Control Plane Process wird im Szenario erläutert, in dem der Empfänger zuerst

einen Stream anfordert und Source danach mit dem Streaming für diese Gruppe beginnt.

IGMP-Teilnahme an LHR

Multicast Receiver sendet einen IGMP-Bericht (Join) an LHR für Gruppe 239.1.1.1. Empfänger ist an Gi1/0/1 (SVI 1021) auf SDA-EDGE-1 angeschlossen.

```
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#
```

Der neue Multicast Route Watch Service bestimmt die Reverse Path Forwarding (**RPF**)-Informationen zum RP (für Shared Tree) und zur Quelle (für Shortest Path Tree (SPT)). Für LISP-erreichbare Adressen wird der nächste Hop-Nachbar durch die Remote Routing Locator (RLOC)-Adresse des Upstream-Standorts dargestellt.

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

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

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

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

```

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

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

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

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

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

```

Als Nächstes sendet der LHR eine PIM-Join-Nachricht (*,G) zum RP (in Abständen von einer Minute) - wenn LHR DR für dieses Segment ist.

```

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

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

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

```

Erstellung von Nachbarn

Nachdem die RPF-Informationen abgerufen wurden, die auf die LISP-Schnittstelle verweisen, muss PIM explizit eine Nachbarstruktur für den entsprechenden RLOC erstellen. Dies ist erforderlich, da der Upstream-Tunnel-Router (xTR) keine Hello-Nachrichten sendet. Der neue Nachbarblock erlischt, wenn nach dem zweifachen der Standardintervallzeit zwischen Join/Prune keine Join-/Prune-Nachrichten an den Nachbarn gesendet wurden.

In unserem Fall erstellt das SDA-EDGE-1 mithilfe der Upstream/RPF RLOC-Adresse einen PIM-Nachbarn.

```

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

```

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

...

PIM-Join erhalten auf RP

PIM-Join wird über die LISP-Schnittstelle vom LHR(SDA-EDGE-1) auf dem RP (SDA-BORDER-1) empfangen

```
SDA-Border1#debug ip pim vrf Campus 239.1.1.1
```

PIM debugging is on

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

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

```
SDA-Border1#show ip mroute vrf Campus 239.1.1.1
```

IP Multicast Routing Table

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

Der RP(Border1) sendet keine Joins über die LISP-Schnittstelle, daher wird auf dem RP über die LISP-Schnittstelle kein PIM Neighbor erstellt.

In unserem Fall verläuft der einzige PIM-Nachbar über eine Nicht-LISP-Schnittstelle zu Fusion-1 und wird als Folge der regelmäßigen PIM Hello-Pakete gebildet, die empfangen werden.

```
SDA-Border1#debug ip pim vrf Campus hello
```

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

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

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

PIM Neighbor auf Fusion Routern

PIM-Nachbarn auf Fusion-Routern haben Schnittstellen, die keine LISP-Schnittstellen sind, und werden daher auch basierend auf den periodischen empfangenen PIM-Hello-Nachrichten erstellt.

SDA-FUSION-1

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

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

SDA-FUSION-2

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

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

PIM-Registrierung beim RP über FHR

Wenn die Quelle beginnt, Datenverkehr für die Gruppe zu senden, registriert der FHR (SDA-FUSION-2) das (S,G) beim RP, sobald er das erste Multicast-Paket von der Quelle empfängt - und wenn FHR der DR auf diesem Segment ist.

```
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	nexthop 10.40.40.5 GigabitEthernet0/0/2.100	<<<<< Next-hop Interface towards RP
192.168.50.1/32		

```

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) erhält das Register vom FHR, was dazu führt, dass eine (S,G) Join an den FHR gesendet wird, sowie eine Registerstop zum FHR - sobald der Stream nativ auf dem RP empfangen wird.

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

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

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

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

```
SDA-Border1#show ip mroute vrf Campus 239.1.1.1
```

IP Multicast Routing Table

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

```
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 wird vom Edge-1 abgeschnitten - lassen Sie uns den Grund in der LHR finden.

(S,G) Erstellung auf LHR

Nach dem Empfang der vom RP weitergeleiteten Multicast-Daten wird im LHR ein (S,G)-Eintrag erstellt.

Als Nächstes wechselt der LHR zu Shortest Path Tree (SPT, kürzeste Pfadstruktur)), indem Sie eine (S,G) Join-Nachricht an die Quelle senden. Diese wird über die RPF-Schnittstelle an die Quelle gesendet.

```
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
is created
  Incoming interface: LISP0.4099, RPF nbr 192.168.10.2
2 is the RPF neighbor towards the Source
  Outgoing interface list:
    Vlan1021, Forward/Sparse, 00:01:47/00:02:27

```

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

<<<<<<<< Border-

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: 2wld, expires: 18:05:53, via map-reply, forward-native
  Sources: map-reply
  State: forward-native, last modified: 2wld, map-source: 192.168.10.1
  Active, Packets out: 106458(41136237 bytes) (~ 00:00:38 ago)
  Encapsulating to proxy ETR
specific entry is known, forwarding to Proxy ETR

```

<<<<< No

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

```

```

SDA-Edge1#show ip cef vrf Campus exact-route 192.168.50.2 10.40.40.1 <<<<<<< CEF
hashing points towards Border-2
192.168.50.2 -> 10.40.40.1 =>IP adj out of GigabitEthernet1/0/11, addr 192.168.23.2

```

```

SDA-Edge1#show ip rpf vrf Campus 10.40.40.1
RPF information for ? (10.40.40.1)
  RPF interface: LISPO.4099
  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#

```

Da die (S,G)-Join-Nachricht an Border-2 über die LISP-Schnittstelle gesendet wird, wird am Edge-1 ein neuer PIM-Nachbar erstellt.

```

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

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

```

Da sich Border-2 im Datenpfad für den Multicast-Stream befindet, muss explizites RLOC-Tracking ausgeführt werden, um den RLOC der Downstream-XTR-s für die Unicast-Replikation der Pakete zu verfolgen.

```

SDA-Border2#show ip mroute vrf Campus 239.1.1.1
IP Multicast Routing Table

(*, 239.1.1.1), 00:23:00/stopped, RP 192.168.50.1, flags: SP
  Incoming interface: LISPO.4099, RPF nbr 192.168.10.1
  Outgoing interface list: Null

(10.40.40.1, 239.1.1.1), 00:12:35/00:02:52, flags: T <<<<< SPT flag is set
  Incoming interface: Vlan3007, RPF nbr 10.50.50.26 <<<<< RPF neighbor is
based on RPF towards the Source - must be a PIM neighbor
  Outgoing interface list:
    LISPO.4099, 192.168.10.3, Forward/Sparse, 00:12:35/00:02:45 <<<<< OIL created from
(S,G) join received from LHR and containing LHR's RLOC info which has to be tracked

```

```

SDA-Border2#show ip mfib vrf Campus 239.1.1.1 10.40.40.1
Entry Flags:   C - Directly Connected, S - Signal, IA - Inherit A flag,
              ET - Data Rate Exceeds Threshold, K - Keepalive
              DDE - Data Driven Event, HW - Hardware Installed
              ME - MoFRR ECMP entry, MNE - MoFRR Non-ECMP entry, MP - MFIB
              MoFRR Primary, RP - MRIB MoFRR Primary, P - MoFRR Primary

```

MS - MoFRR Entry in Sync, MC - MoFRR entry in MoFRR Client.
 I/O Item Flags: IC - Internal Copy, NP - Not platform switched,
 NS - Negate Signalling, SP - Signal Present,
 A - Accept, F - Forward, RA - MRIB Accept, RF - MRIB Forward,
 MA - MFIB Accept, A2 - Accept backup,
 RA2 - MRIB Accept backup, MA2 - MFIB Accept backup

Forwarding Counts: Pkt Count/Pkts per second/Avg Pkt Size/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
 LISPO.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