# Catalyst 9000交換機上的EVPN VxLAN TRM故障排除

## 目錄



## 簡介

本檔案介紹如何透過EVPN VxLAN對TRM（租戶路由多點傳送）進行疑難排解。

# 必要條件

- 建議您熟悉單播EVPN VxLAN功能、BGP和MVPN（組播虛擬專用網路）。
- 此外，您必須瞭解組播的操作方式和組播概念

## 需求

本指南假設BGP、NVE對等體已經正確。如果基本EVPN VxLAN啟動有問題（單播ping失敗、BGP、NVE對等點關閉等），請根據需要參考BGP、EVPN、路由/交換機故障排除指南。

每個代碼版本中的功能可用性

| 版本 | 功能 |
|---|---|
| 17.1.1 | 含任播RP的TRMv4 |
| 17.3.1 | 帶有外部RP或單個RP的TRMv4 |
| 17.3.1 | 採用任播RP的TRMv6 |
| 17.3.1 | 帶有外部RP或單個RP的TRMv6 |
| 17.3.1 | 交換矩陣端具有單個RP且具有MVPN互通性的TRMv4(profile11) |
| 17.6.2和17.7.1 | 採用任播RP、外部RP或單個RP的TRMv4資料模組 |

## 採用元件

本文中的資訊係根據以下軟體和硬體版本：

- C9300
- C9400
- C9500
- C9600

本文中的資訊是根據特定實驗室環境內的裝置所建立。文中使用到的所有裝置皆從已清除（預設）的組態來啟動。如果您的網路運作中，請確保您瞭解任何指令可能造成的影響。

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注意：有關用於在其他Cisco平台上啟用這些功能的命令，請參閱相應的配置指南。

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# 背景資訊

要配置EVPN TRM，請參閱：BGP EVPN VXLAN配置指南，Cisco IOS XE阿姆斯特丹版17.3.x

租戶路由多點傳送(TRM)是一種基於BGP-EVPN的解決方案，可在VxLAN光纖中在VTEP上連線的來源和接收器之間啟用多點傳送路由[RFC7432]。TRM依靠單播EVPN中存在的路由來發現組播源和組播RP。與NG-MVPN一樣，組播源和接收器資訊通過BGP協定在配置了BGP MVPN地址系列的

VTEP之間傳播。沒有從TRM VTEP向VxLAN交換矩陣傳送PIM/IGMP資料包。

TRM解決的關鍵問題是位於不同VLAN但位於同一VRF中的多播傳送方和接收方能夠彼此通訊。若沒有TRM，則多點傳播流量會作為底層中相同BUM（廣播、單點傳播和多點傳播）基礎架構的一部分加以傳送，基礎架構可以是多點傳播樹或輸入複製。此基礎架構是根據VLAN構建的，因此，雖然同一VLAN上的組播源和接收器可以通訊，但位於不同VLAN中的組播源和接收器卻無法通訊。使用TRM時，組播將從BUM中移出，並在父VRF下匯聚在一起。因此，無論源或接收器所在的VLAN如何，組播通訊都完全啟用。

TRM在相同或不同子網內的本地或跨VTEP的傳送方和接收方之間提供多租戶感知組播轉發。請參閱指南 BGP EVPN VXLAN配置指南，Cisco IOS XE阿姆斯特丹17.3.x 瞭解更多詳情

如何在本指南中介紹自己：

- 本指南根據RP位置分為4種方案。
- 一個場景可以引用不在您所在部分中的CLI示例。例如，SSM案例2會引用案例1來瞭解如何讀取某些CLI。
- 只有案例1涵蓋IPv4和IPv6，因為這兩個地址系列的概念基本上是相同的。
- 這些方案中列出的要求假定源和接收器直接連線到VTEP(有關詳細資訊，請參閱相關資訊部分「交換矩陣外部的源和接收器」)。

| 案例 | IPv4/v6 | 每個中涵蓋的內容 |
|---|---|---|
| 所有其他方案的常見詳細資訊 | IPv4 | 始終需要：MVPN底層和NVE運行正常，RPF檢查到任何TRM源都是L3VNI。 |
| AnyCast RP（每個VTEP都是具有通用RP IP的RP） | IPv4/v6 | IPv4/v6的BGP、PIM、IGMP、MFIB和FED命令以及捕獲示例均詳細介紹 |
| 無RP（SSM重疊） | IPv4 | SSM特定資訊。（有關常見資訊，請參閱場景1） |
| 交換矩陣內部的RP（交換矩陣的一個通用RP） | IPv4 | IPv4的BGP、PIM、IGMP、MFIB和FED命令有詳盡的描述 |
| 交換矩陣外部的RP（RP不在交換矩陣中） | IPv4 | IP到交換矩陣邊界特定資訊。（請參閱場景3瞭解常見資訊） |
| 具有對稱L2VNI的交換矩陣內部的RP（交換矩陣的一個通用RP） | IPv4 | 當VNI同時位於傳送者和接收者VTEP上時，在光纖中使用單個RP的警告。（有關常見資訊，請參閱場景3） |

在本疑難排解檔中，show指令輸出的某些行末尾已加入評語。這樣做是為了突出或解釋該輸出行的某一特定方面。如果註釋以新行開始，則它引用註釋前面的輸出行。整個文檔都使用此記法來突出顯示show命令輸出中的註釋：

<#root>

```
<-- Text highlighted in this format inside a command's output represents a comment.

    This is done for explanation purpose only and is not part of the command's output.
```

# 技術

| | | |
|---|---|---|
| EVPN | 乙太網路虛擬私人網路 | 允許BGP傳輸第2層MAC和第3層IP資訊的擴展是EVPN，它使用多協定邊界網關協定(MP-BGP)作為協定來分發有關VXLAN重疊網路的可達性資訊。 |
| VXLAN | 虛擬可擴充LAN（區域網路） | VXLAN的用途是克服VLAN和STP的固有限制。建議採用的IETF標準[RFC 7348]提供與VLAN相同的乙太網第2層網路服務，但具有更高的靈活性。功能上，它是UDP內MAC封裝協定，在第3層底層網路上作為虛擬重疊運行。 |
| VTEP | 虛擬通道端點 | 這是負責執行封裝和解除封裝的裝置 |
| NVE | 網路虛擬介面 | 進行封裝和解除封裝的邏輯介面 |
| VNI | VXLAN網路識別碼 | 唯一標識每個第2層子網或網段。VNI有兩種型別：<br>對稱(L2VNI):VTEP具有相同VNI<br>非對稱(L3VNI):VTEP沒有相同的VNI，且透過單一通用VNI路由。 |
| MDT | 多點傳送發佈樹 | 在VTEP之間構建的組播樹，用於租戶組播流量的封裝和通道化。 |
| BUM | 廣播、未知單播、組播 | 在NVE設定下，BUM流量會透過連結到VNI的Mcast群組傳送。 |

| | | |
|---|---|---|
| RP | 集結點 | 裝置在PIM稀疏模式下執行的角色。組播源和接收器的公共會議點。 |
| AnyCast(RP) | AnyCast集結點 | 兩個或多個RP在環回介面上配置了相同的IP地址。FHR根據單播路由註冊到最近的RP。 |
| RPT（樹） | 根路徑樹 | 也稱為共用或*,G樹。此路徑指向RP |
| SPT（樹） | 最短路徑樹狀結構 | 到達源的最短路徑，由單播路由表確定 |
| FHR | 第一跳路由器 | 直接連線到源的裝置（ARP相鄰）。FHR向RP註冊源資訊。 |
| LHR | 上一跳路由器 | 連線接收器的裝置 |
| RPF | 反向路徑轉送 | 返回到源的單點傳播路徑。 傳入組播資料包不會被接受/轉發，除非它們被接收到與單播路由表相同的路徑。（排除「ip multicast multipath」使用案例）。 |
| MRIB | 多點傳送路由資訊庫 | 軟體組播路由表，也稱為mroute表 |
| MFIB | 組播轉發資訊庫 | 多點傳送等價物CEF。由MRIB的更新填充，並用於由資料平面轉發。 |
| FED | 轉發引擎驅動程式 | 對裝置硬體進行程式設計的元件。 |
| IIF | 傳入介面 | 啟用PIM的介面，也是返回源的單播RPF上游路徑。（在show ip mroute中顯示） |
| OIF | 傳出介面 | 支援PIM的介面，該介面位於通向接收器的下游。（在show ip mroute中顯示） |

## 驗證

### 所有方案通用的驗證

第一節 介紹任一方案所需的基本要求。

- 確保所需的NVE對等點已啟動
- 確保租戶VRF中源的RPF介面是L3VNI SVI。如果RPF介面不是L3VNI SVI，則BGP不會傳送型別7加入路由。在任何情況下，RPF介面都必須指向此介面。
- 確保對等體之間的底層路徑（MDT隧道）已完成。
- 確保BGP用於組播控制平面（使用MVPN與PIM）

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注意：本節適用於IPv4和IPv6租戶組播驗證。

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驗證NVE對等

對於本指南中的任何方案，檢查以確保NVE對等體在VTEP之間運行

- NVE對等點由從BGP學習的地址形成。

<#root>

```
Leaf-01#
sh nve peers

Interface VNI    Type Peer-IP       RMAC/Num_RTs   eVNI    state flags UP time
nve1      50901  L3CP 172.16.254.4  7c21.0dbd.9548 50901   UP    A/-/4 01:54:11 <-- IPv4 peering

with Leaf 02

nve1      50901  L3CP 172.16.254.4  7c21.0dbd.9548 50901   UP    A/M/6 17:48:36 <-- IPv6 peering with Le

Leaf-02#
sh nve peers

Interface VNI    Type Peer-IP       RMAC/Num_RTs   eVNI    state flags UP time
nve1      50901  L3CP 172.16.254.3  10b3.d56a.8fc8 50901   UP    A/-/4 01:55:44 <-- IPv4 peering with Le

nve1      50901  L3CP 172.16.254.3  10b3.d56a.8fc8 50901   UP    A/M/6 17:56:19 <-- IPv6 peering with Le
```

驗證租戶VRF中的RPF介面

如果此介面是除L3VNI SVI之外的任何介面，則BGP不會發起MVPN Type-7連線。

- 如果您沒有看到此介面，請確認配置不存在問題，該配置會使返回源的路由成為非L3VNI的介面。

<#root>

```
Leaf-03#

sh ip rpf vrf green 10.1.101.11 <-- Multicast source IP


RPF information for ? (10.1.101.11)

 RPF interface: Vlan901                <-- RPF interface is the L3VNI SVI



RPF neighbor: ? (172.16.254.3)        <-- Underlay Next hop IP



RPF route/mask: 10.1.101.0/24         <-- Network prefix for the Source

  RPF type: unicast (bgp 65001)
  Doing distance-preferred lookups across tables
  RPF topology: ipv4 multicast base, originated from ipv4 unicast base
```

驗證多點傳送控制平面是否使用BGP

- mdt overlay use-bgp：通知裝置使用BGP MVPN型別5/6/7作為訊號協定（相對於PIM消息）
- spt-only：其他關鍵字通知裝置僅在AnyCast RP場景中使用SPT樹。由於每個VTEP都是RP，因此未使用MVPN第6類路由。

<#root>

```
Leaf-01
!
vrf definition green
rd 1:1
!
address-family ipv4
mdt auto-discovery vxlan

mdt default vxlan 239.1.1.1       <-- Defines MDT default underlay group address


mdt overlay use-bgp [spt-only]    <-- Required for VTEP to use MVPN Type 5/6/7 versus PIM for multicast
```

驗證MDT組

MDT組對於所有方案都是通用的，因為這是將TRM組封裝到的外部隧道組。

請檢查MDT組是否已在源端正確程式設計

- MDT組的傳入介面是源端環回
- MDT組的傳出介面是底層介面

驗證Leaf-01:MRIB/MFIB中的MDT mroute是否正確

<#root>

Leaf-01#

**sh ip mroute 239.1.1.1 172.16.254.3**

(

**172.16.254.3**

,

**239.1.1.1**

), 00:46:35/00:02:05, flags: FTx
  Incoming interface:

**Loopback1**

, RPF nbr

**0.0.0.0**

**<-- IIF is local loopback with 0.0.0.0 RPF indicating local**

  Outgoing interface list:

**GigabitEthernet1/0/2**

, Forward/Sparse, 00:46:35/00:03:12

**<-- OIF is the underlay uplink**

Leaf-01#

**sh ip mfib 239.1.1.1 172.16.254.3**

(172.16.254.3,239.1.1.1) Flags: HW

  SW Forwarding: 2/0/150/0, Other: 1/1/0

**HW Forwarding: 1458/0/156/0**

, Other: 0/0/0

**<-- Hardware counters indicate the entry is operating in hardware and forwarding packets**

**Null0 Flags: A NS** **<--- Null0 (originated locally)**

**GigabitEthernet1/0/2**

Flags: F NS

**<-- OIF is into the Underlay (Global route table)**

Pkts: 0/0/1 Rate: 0 pps

## 驗證MDT組的Leaf-01:FED條目

<#root>

Leaf-01#

**sh platform software fed switch active ip mfib 239.1.1.1/32 172.16.254.3 detail <-- the detail option gi**

MROUTE ENTRY

**vrf 0**

(

**172.16.254.3, 239.1.1.1/32**

)

**<-- vrf 0 = global for this MDT S,G pair**

HW Handle: 139738317079128 Flags:

**RPF interface: Null0**

(1)):

**<-- Leaf-01 the Source (Null0)**

HW Handle:139738317079128 Flags:A
Number of OIF: 2
Flags: 0x4

**Pkts : 71** **<-- packets that used this adjacency (similar to mfib command, but shown at the FED**

OIF Details:

**Null0 A**

**<-- The incoming interface is Local Loopback1 and A-Accept flag set**

**GigabitEthernet1/0/2**

**F**

NS

**<-- The Underlay Outgoing Interface and F-Forward flag set**

Htm: 0x7f175cc0beb8 Si: 0x7f175cc0a6b8

**Di: 0x7f175cc09df8**

Rep_ri: 0x7f175cc0a1d8

**<-- The DI (dest index) handle**

**DI details**

```
----------
Handle:0x7f175cc09df8 Res-Type:ASIC_RSC_DI Res-Switch-Num:255 Asic-Num:255 Feature-ID:AL_FID_L3_MULTICA
priv_ri/priv_si Handle:(nil) Hardware Indices/Handles:
```

**index0:0x538d**

mtu_index/l3u_ri_index0:0x0

**index1:0x538d**

mtu_index/l3u_ri_index1:0x0

```
Brief Resource Information (ASIC_INSTANCE# 1)
----------------------------------------
```

**Destination index = 0x538d**

pmap = 0x00000000 0x00000002

**pmap_intf : [GigabitEthernet1/0/2]  <-- FED has the correct programming for the OIF**

==========

檢查MDT組是否已在接收器端正確程式設計

- MDT組的傳入介面是返回源端環回的RPF介面
- MDT組的傳出介面是Encap/Decap隧道介面

驗證Leaf-02:MRIB/MFIB中的MDT mroute正確

<#root>

Leaf-02#

**sh ip mroute 172.16.254.3 239.1.1.1 <-- This is the Global MDT group**

(

**172.16.254.3**

,

**239.1.1.1**

), 00:23:35/00:01:09, flags: JTx

**<-- Source is Leaf-01 Lo1 IP**

  Incoming interface: GigabitEthernet1/0/2, RPF nbr 172.16.24.2
  Outgoing interface list:

**Tunnel0**

, Forward/Sparse, 00:23:35/00:00:24

**<-- Decap Tunnel**

Leaf-02#

**sh ip mfib 239.1.1.1 172.16.254.3**

**Default <-- Global routing table**

  (172.16.254.3,239.1.1.1) Flags: HW
    SW Forwarding: 1/0/150/0, Other: 0/0/0

**HW Forwarding: 5537/0/168/0, Other: 0/0/0 <-- Hardware counters indicate the entry is operating in hard**

    **GigabitEthernet1/0/2 Flags: A <-- Accept via Underlay (Global) interface**

    **Tunnel0, VXLAN Decap Flags: F NS <-- Forward to VxLAN decap Tunnel**

      Pkts: 0/0/1 Rate: 0 pps

驗證MDT組的Leaf-02:FED條目

<#root>

Leaf-02#

**sh platform software fed switch active ip mfib 239.1.1.1/32 172.16.254.3 detail**

MROUTE ENTRY

**vrf 0**

(

**172.16.254.3, 239.1.1.1/32**

)

**<-- vrf 0 = global for this MDT S,G pair**

HW Handle: 140397391831832 Flags:

**RPF interface: GigabitEthernet1/0/2**

(57)):

**<-- RPF interface to 172.16.254.3**

HW Handle:140397391831832 Flags:A
Number of OIF: 2
Flags: 0x4

**Pkts : 1585 <-- packets that used this adjacency (similar to mfib command, but shown at the FE**

OIF Details:

**Tunnel0 F NS <-- Send to decap tunnel to remove VxLAN header**

**(Adj: 0x73 ) <-- Tunnel0 Adjacency**

**GigabitEthernet1/0/2 A <-- Accept MDT packets from this interface**

Htm: 0x7fb0d0f1f388 Si: 0x7fb0d0f1dc08 Di: 0x7fb0d0ed0438 Rep_ri: 0x7fb0d0ed07a8

**RI details <-- Rewrite Index is used for VxLAN decapsulation**

---
Handle:0x7fb0d0ed07a8 Res-Type:ASIC_RSC_RI_REP Res-Switch-Num:255 Asic-Num:255 Feature-ID:AL_FID_L3_MUL
priv_ri/priv_si Handle:(nil) Hardware Indices/Handles: index0:0x38 mtu_index/l3u_ri_index0:0x0 index1:0

Brief Resource Information (ASIC_INSTANCE# 0)
---
ASIC# 0
Replication list :
---

Total #ri : 6
Start_ri : 56
Common_ret : 0

Replication entry

**rep_ri 0x38**

#elem = 1

0)

**ri[0]=0xE803**

Dynamic port=88ri_ref_count:1 dirty=0

Leaf-02#

**sh platform hardware fed sw active fwd-asic resource asic all rewrite-index range 0xE803 0xE803**

ASIC#:0 RI:59395

**Rewrite_type:**

AL_RRM_REWRITE_L2_PAYLOAD_

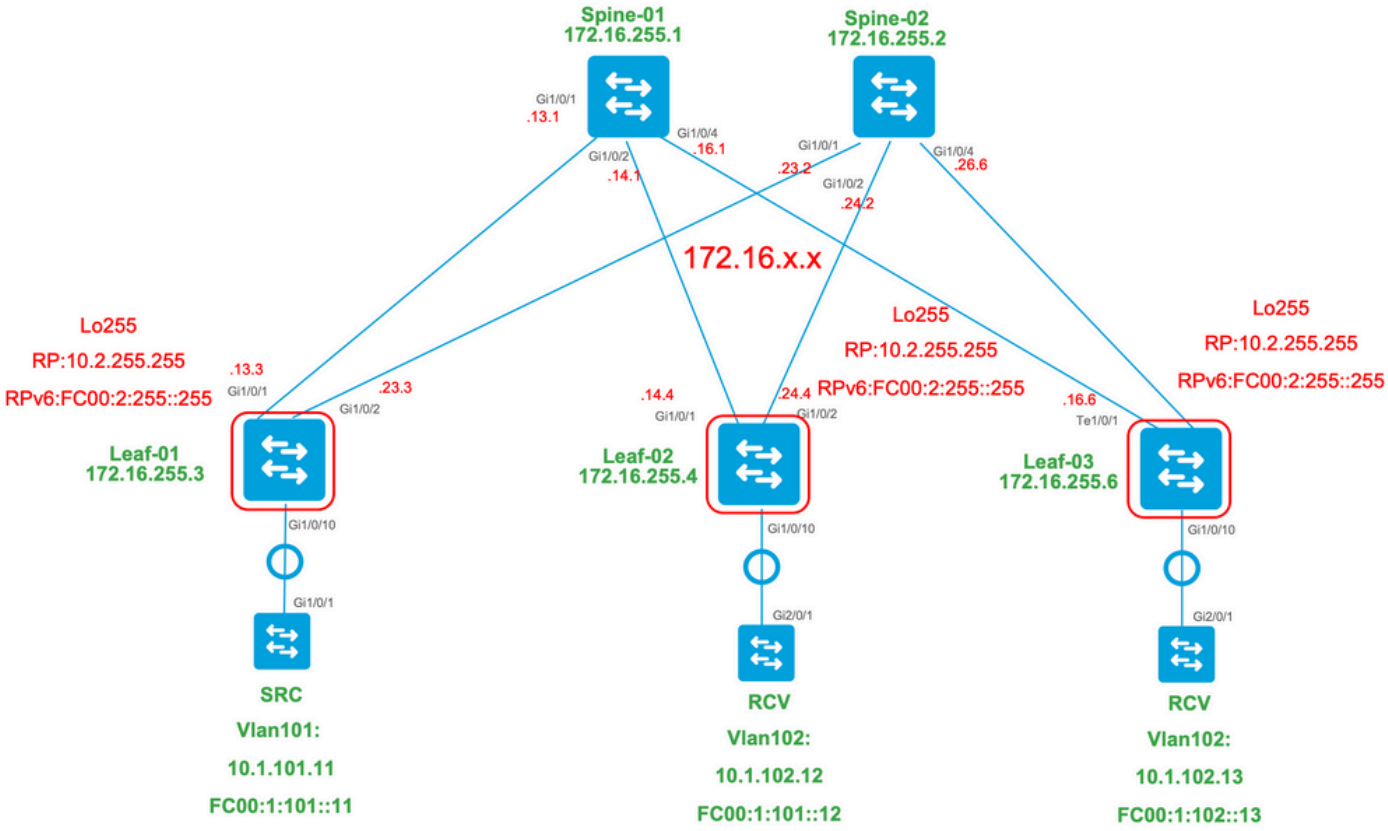
**IPV4_EVPN_DECAP**

(118) Mapped_rii:LVX_EVPN_DECAP(246)
<...snip...>

## 案例 1.AnyCast RP（僅限SPT的樹）IPv4和IPv6

在此模式下，每個VTEP上都有一個RP。這些VTEP不會通過MSDP同步已識別的源，並且沒有共用樹。相反，MDT模式使用BGP資訊只建立SPT組播樹。 此模式可互換稱為僅SPT模式或分散式任意播RP模式。在此模式下，每個VTEP都是PIM RP。因此，每個站點的(*,G)樹在本地VTEP本身處被截斷。無需在交換矩陣上傳送(*,G)連線或MVPN RT-6。

網路圖表



對於此模式，請考慮以下3種BGP路由型別：

1. EVPN路由型別2。這允許需要構建C組播路由（MVPN型別6/7）的其他PE返回原始PE，以附加適當的C組播匯入RT，以便發起者PE可以匯入C組播路由(RFC 6514 11.1.3)[RFC6514]。 此VRI的使用取決於命令「mdt overlay use-bgp」 VRF命令。
2. MVPN Route-type 5.這與MVPN中相同，並且是可用的組播源/組的通告
3. MVPN Route-type 7.來自IGMP或MLD層以及來自EVPN型別2的資訊用於建立此BGP型別聯接。Type-7驅動在Source端建立MRIB OIF。

EVPN第2類要求：

1. 直連組播源已聯機。
2. FHR（來源VTEP）驗證ARP（或ND）和CEF鄰接關係（確認來源為直接連線）。
3. FHR發起EVPN第2型BGP更新

MVPN第5類要求：

1. 源直接連線的要求已解決
2. RP是本地的，因此FHR向自身註冊
3. FHR發起MVPN第5類BGP更新

MVPN第7類要求：

1. 存在EVPN型別2條目（使用正確的VRI構建C-Multicast路由型別7時需要該條目，並且是從源VTEP傳送的）
2. 存在MVPN第5類條目（解析可用於SPT加入的源/組對時需要該條目）
3. LHR VTEP已接收並處理IGMP或MLD成員身份報告
4. LHR VTEP RPF介面是交換矩陣L3VNI介面

---

提示：在輸出LHR VTEP PIM處檢查通向源的路徑。PIM必須在RIB中找到L3VNI作為RPF介面的路由。如果L3VNI未正確配置、已關閉，依此類推。VTEP不會嘗試建立型別7 BGP連線。

---

驗證BGP EVPN和MVPN路由

驗證Leaf-01:已建立EVPN型別2

<#root>

```
### IPv4 ###


Leaf-01#

sh bgp l2vpn evpn all route-type 2 0 F4CFE24334C5 10.1.101.11

...or you can also use:


Leaf-01#
```

**sh bgp l2vpn evpn detail [2][172.16.254.3:101][0][48][F4CFE24334C5][32][10.1.101.11]/24**

BGP routing table entry for [2][172.16.254.3:101][0][48][F4CFE24334C5][32][10.1.101.11]/24, version 6
Paths: (1 available, best #1,

**table evi_101**

)
  Advertised to update-groups:
     1
  Refresh Epoch 1
  Local

**:: (via default) from 0.0.0.0 (172.16.255.3)  <-- Leaf-01 locally created**

      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      EVPN ESI: 00000000000000000000, Label1 10101, Label2 50901
      Extended Community: RT:1:1 RT:65001:101 MVPN AS:65001:0.0.0.0

        **MVPN VRF:172.16.255.3:2**

 ENCAP:8 Router MAC:10B3.D56A.8FC8

 **<-- MVPN VRI RT is part of the EVPN Type-2**

      Local irb vxlan vtep:

        **vrf:green, l3-vni:50901  <-- Vrf and VxLAN tag**

        local router mac:10B3.D56A.8FC8

        **core-irb interface:Vlan901  <-- L3VNI SVI**

        **vtep-ip:172.16.254.3  <-- Leaf-01 VTEP**

      rx pathid: 0, tx pathid: 0x0
      Updated on Dec 16 2020 17:40:29 UTC

### **IPv6** ###

Leaf-01#

**sh bgp l2vpn evpn all route-type 2 0 F4CFE24334C1 FC00:1:101::11**

...or you can also use:
Leaf-01#

**sh bgp l2vpn evpn detail [2][172.16.254.3:101][0][48][F4CFE24334C1][128][FC00:1:101::11]/36**

BGP routing table entry for [2][172.16.254.3:101][0][48][F4CFE24334C1][128][FC00:1:101::11]/36, version
Paths: (1 available, best #1, table evi_101)
  Advertised to update-groups:
     1
  Refresh Epoch 1
  Local

**:: (via default) from 0.0.0.0 (172.16.255.3)  <-- Leaf-01 locally created**

```
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
      EVPN ESI: 00000000000000000000, Label1 10101, Label2 50901
      Extended Community: RT:1:1 RT:65001:101 MVPN AS:65001:0.0.0.0


 MVPN VRF:172.16.255.3:2

 ENCAP:8 Router MAC:10B3.D56A.8FC8

<-- MVPN VRI RT is part of the EVPN Type-2


      Local irb vxlan vtep:


   vrf:green, l3-vni:50901


        local router mac:10B3.D56A.8FC8

core-irb interface:Vlan901       <-- L3VNI SVI



 vtep-ip:172.16.254.3             <-- Leaf-01 VTEP


      rx pathid: 0, tx pathid: 0x0
      Updated on Mar 22 2021 19:54:18 UTC
```

檢驗Leaf-01:ARP/IPv6 ND和EVPN調試顯示ARP/ND已獲知，然後建立並傳送路由型別2

```
<#root>

### IPv4 ###


Leaf-01#

sh debugging


ARP:


ARP packet debugging is on


BGP L2VPN EVPN:


BGP updates debugging is on for address family: L2VPN E-VPN
BGP update events debugging is on for address family: L2VPN E-VPN

*Dec 17 17:00:06.480:

IP ARP: rcvd rep src 10.1.101.11 f4cf.e243.34c5

, dst 10.1.101.11 Vlan101
```

**tableid 2 <-- Multicast Source ARP**

*Dec 17 17:00:06.481:

**BGP: EVPN Rcvd pfx: [2]**

[172.16.254.3:101][0][48][F4CFE24334C5][32][10.1.101.11]/24, net flags: 0

**<-- BGP Triggered Type-2 creation**

*Dec 17 17:00:06.481:

**TRM communities added to sourced RT2 <-- TRM extended VRI communities being injected into EVPN Type-2**

*Dec 17 17:00:06.481:

**BGP(10): update modified for [2]**

[172.16.254.3:101][0][48][F4CFE24334C5][32][10.1.101.11]/30

**<-- Modifying the update**

*Dec 17 17:00:06.481: BGP(10): 172.16.255.1 NEXT_HOP set to vxlan local vtep-ip 172.16.254.3 for net [2
*Dec 17 17:00:06.481: BGP(10): update modified for [2][172.16.254.3:101][0][48][F4CFE24334C5][32][10.1.
*Dec 17 17:00:06.481: BGP(10): (base) 172.16.255.1

**send UPDATE**

(format)

**[2]**

[172.16.254.3:101][0][48][F4CFE24334C5][32][10.1.101.11]/30, next 172.16.254.3, metric 0, path Local, e

**MVPN VRF:172.16.255.3:2**

ENCAP:8 Router MAC:10B3.D56A.8FC8

**<--- Final update sent to RR with standard EVPN community info and required MVPN community attributes**

### **IPv6** ###

Leaf-01#

**debug ipv6 nd**

ICMP Neighbor Discovery events debugging is on
ICMP ND HA events debugging is ON

**IPv6 ND:**

Mar 23 14:29:51.935:

**ICMPv6-ND: (Vlan101,FC00:1:101::11) Resolution request**

Mar 23 14:29:51.935: ICMPv6-ND: (Vlan101,FC00:1:101::11) DELETE -> INCMP
Mar 23 14:29:51.935: ICMPv6-ND HA: in Update Neighbor Cache: old state 6 new state 0
Mar 23 14:29:51.935: ICMPv6-ND HA: add or delete entry not synced as no peer detected
Mar 23 14:29:51.936: ICMPv6-ND: (Vlan101,FC00:1:101::11) Sending NS
Mar 23 14:29:51.936: ICMPv6-ND: (Vlan101,FC00:1:101::11) Queued data for resolution
Mar 23 14:29:51.953:

**ICMPv6-ND: (Vlan101,FC00:1:101::11) Received NA from FC00:1:101::11**

Mar 23 14:29:51.953:

**ICMPv6-ND: Validating ND packet options: valid**

Mar 23 14:29:51.953:

**ICMPv6-ND: (Vlan101,FC00:1:101::11) LLA f4cf.e243.34c1**

Mar 23 14:29:51.953: ICMPv6-ND HA: modify entry not synced as no peer detected
Mar 23 14:29:51.953:

**ICMPv6-ND: (Vlan101,FC00:1:101::11) INCMP -> REACH  <-- peer is reachable**

Leaf-01#

**debug bgp l2vpn evpn updates**

Leaf-01#

**debug bgp l2vpn evpn updates events**

**BGP L2VPN EVPN:**

Mar 23 14:11:56.462:

**BGP: EVPN Rcvd pfx: [2][172.16.254.3:101][0][48][F4CFE24334C1][128][FC00:1:101::11]/36,**

net flags: 0

**<-- BGP Triggered Type-2 creation**

Mar 23 14:11:57.462:

**TRM communities added to sourced RT2**

ar 23 14:11:57.474:

**BGP(10): update modified for [2]**

[172.16.254.3:101][0][48][F4CFE24334C1][128]

**[FC00:1:101::11]/42**

Mar 23 14:11:57.474: BGP(10): 172.16.255.1 NEXT_HOP set to vxlan local vtep-ip 172.16.254.3 for net [2]
Mar 23 14:11:57.474: BGP(10): update modified for [2][172.16.254.3:101][0][48][F4CFE24334C1][128][FC00:
Mar 23 14:11:57.474: BGP(10): (base) 172.16.255.1

**send UPDATE**

 (format)

**[2]**

[172.16.254.3:101][0][48][F4CFE24334C1][128][FC00:1:101::11]/42, next 172.16.254.3, metric 0, path Local

**MVPN VRF:172.16.255.3:2**

ENCAP:8 Router MAC:10B3.D56A.8FC8

**<--- Final update sent to RR with standard EVPN community info and required MVPN community attributes**

驗證在接收端的BGP中是否獲知Leaf-02：源端路由型別2

<#root>

**### IPv4 ###**

Leaf-02#

**sh bgp l2vpn evpn all | b 10.1.101.11**

* i

**[2]**

[172.16.254.3:101][0][48][F4CFE24334C5][32][10.1.101.11]/24

**<-- Remote VTEP route-type 2**

172.16.254.3 0 100 0 ?

***>i 172.16.254.3 0 100 0 ? <-- IP of Leaf01 Lo1**

Leaf-02#

**sh bgp l2vpn evpn route-type 2 0 F4CFE24334C5 10.1.101.11**

...or you can also use:
Leaf-02#

**sh bgp l2vpn evpn detail [2][172.16.254.3:101][0][48][F4CFE24334C5][32][10.1.101.11]/24**

BGP routing table entry for [2][172.16.254.3:101][0][48][F4CFE24334C5][32][10.1.101.11]/24, version 175
Paths: (2 available, best #2, table

**EVPN-BGP-Table) <-- In BGP EVPN table**
**Flag: 0x100**

Not advertised to any peer
Refresh Epoch 2
Local

**172.16.254.3**

(metric 3) (via default) from 172.16.255.2 (172.16.255.2)
Origin incomplete, metric 0, localpref 100, valid, internal
EVPN ESI: 00000000000000000000, Label1 10101,

**Label2 50901**

Extended Community: RT:1:1 RT:65001:101

**MVPN AS:65001:0.0.0.0**

**MVPN VRF:172.16.255.3:2**

ENCAP:8

**Router MAC:10B3.D56A.8FC8**

Originator: 172.16.255.3, Cluster list: 172.16.255.2
rx pathid: 0, tx pathid: 0
Updated on Dec 14 2020 19:58:57 UTC

**MVPN AS:65001:0.0.0.0 <-- MVPN Autonomous System**
**MVPN VRF:172.16.255.3:2 <-- VRI Extended Community to be used in MVPN Type-7**
**Router MAC:10B3.D56A.8FC8 <-- Leaf-01 RMAC**
**Label2 50901 <-- L3VNI 50901**

**### IPv6 ###**

Leaf-02#

**sh bgp l2vpn evpn all | b FC00:1:101::11**

* i [2][172.16.254.3:101][0][48][F4CFE24334C1][128][FC00:1:101::11]/36
172.16.254.3 0 100 0 ?

***>i 172.16.254.3 0 100 0 ? <-- IP of Leaf01 Lo1**

Leaf-02#

**sh bgp l2vpn evpn route-type 2 0 F4CFE24334C1 FC00:1:101::11**

...or you can also use:
Leaf-02#

**sh bgp l2vpn evpn detail [2][172.16.254.3:101][0][48][F4CFE24334C1][128][FC00:1:101::11]/36**

BGP routing table entry for

**[2]**

[172.16.254.3:101][0][48][

**F4CFE24334C1**

][128][

**FC00:1:101::11**

]/36, version 659
Paths: (2 available, best #2,

**table EVPN-BGP-Table**

)

**<-- In BGP EVPN table**

```
  Flag: 0x100
  Not advertised to any peer
  Refresh Epoch 2
  Local


172.16.254.3

 (metric 3) (via default) from 172.16.255.2 (172.16.255.2)
      Origin incomplete, metric 0, localpref 100, valid, internal
      EVPN ESI: 00000000000000000000, Label1 10101,

Label2 50901


      Extended Community: RT:1:1 RT:65001:101 MVPN

AS:65001:0.0.0.0




MVPN VRF:172.16.255.3:2

 ENCAP:8

Router MAC:10B3.D56A.8FC8


      Originator: 172.16.255.3, Cluster list: 172.16.255.2
      rx pathid: 0, tx pathid: 0
      Updated on Mar 23 2021 14:11:57 UTC


MVPN AS:65001:0.0.0.0     <-- MVPN Autonomous System
MVPN VRF:172.16.255.3:2   <-- VRI Extended Community to be used in MVPN Type-7
Router MAC:10B3.D56A.8FC8 <-- Leaf-01 RMAC
Label2 50901              <-- L3VNI 50901
```

## 驗證枝葉02：在接收器VTEP Leaf-02上的BGP中學習源路由型別5

```
<#root>

### IPv4 ###


Leaf-02#

sh bgp ipv4 mvpn all route-type 5 10.1.101.11 226.1.1.1

...or you can also use:
Leaf-02#

sh bgp ipv4 mvpn detail [5][1:1][10.1.101.11][226.1.1.1]/18


BGP routing table entry for

[5]

[1:1]
```

**[10.1.101.11][226.1.1.1]**

/18, version 72

**<-- Type-5 contains advertised S,G pair**

Paths: (2 available, best #1,

**table MVPNv4-BGP-Table**

, not advertised to EBGP peer)

**<-- In BGP IPv4 MVPN table**

  Flag: 0x100
  Not advertised to any peer
  Refresh Epoch 1
  Local

    **172.16.255.3**

 (metric 3) from 172.16.255.2 (172.16.255.2)

**<-- Loopback0 of Leaf-01**

      Origin incomplete, metric 0, localpref 100, valid, internal
      Community: no-export
      Extended Community: RT:1:1

**Originator: 172.16.255.3**

, Cluster list: 172.16.255.2
      rx pathid: 0, tx pathid: 0
      Updated on Dec 15 2020 16:54:53 UTC

### **IPv6** ###

Leaf-02#

**sh bgp ipv6 mvpn all route-type 5 FC00:1:101::11 FF06:1::1**

...or you can also use:
Leaf-02#

**sh bgp ipv6 mvpn detail [5][1:1][FC00:1:101::11][FF06:1::1]/42**

BGP routing table entry for

**[5]**

[1:1]

**[FC00:1:101::11][FF06:1::1]**

/42, version 11

**<-- Type-5 contains advertised S,G pair**

Paths: (2 available, best #1,

**table MVPNV6-BGP-Table**

```
, not advertised to EBGP peer)
<-- In BGP IPv6 MVPN table


  Flag: 0x100
  Not advertised to any peer
  Refresh Epoch 1
  Local


172.16.255.3
 (metric 3) from 172.16.255.2 (172.16.255.2)
<-- Loopback0 of Leaf-01


      Origin incomplete, metric 0, localpref 100, valid, internal
      Community: no-export
      Extended Community: RT:1:1


 Originator: 172.16.255.3
, Cluster list: 172.16.255.2


      rx pathid: 0, tx pathid: 0
      Updated on Mar 23 2021 15:13:06 UTC
```

驗證Leaf-02：是否需要來自Leaf-01的BGP資訊來建立型別7。最終要求是IGMP或MLD已處理成員身份報告，該報告通知VTEP有感興趣的接收者。

```
<#root>
### IPv4 ###


Leaf-02#
sh ip igmp snooping groups vlan 102


Vlan     Group                Type            Version         Port List
------------------------------------------------------------------------
102      226.1.1.1
igmp
            v2
 Gi1/0/10
<-- Receiver joined on Gi1/0/10


### IPv6 ###
Leaf-02#
sh ipv6 mld vrf green groups detail
Interface:      Vlan102                 <-- Join on Vlan 102
```

```
Group:          FF06:1::1                <-- Group joined

Uptime:         06:38:25
Router mode:    EXCLUDE (Expires: 00:02:14)
Host mode:      INCLUDE
Last reporter:  FE80::46D3:CAFF:FE28:6CC1 <-- MLD join from Receiver link-local address

Source list is empty                      <-- ASM join, no sources listed

Leaf-02#
sh ipv6 neighbors vrf green
IPv6 Address
                                Age Link-layer Addr State Interface
FE80::46D3:CAFF:FE28:6CC1
                    0
44d3.ca28.6cc1
  REACH Vl102
<-- Receiver IP & MAC

Leaf-02#sh ipv6 mld snooping address vlan 102 <-- If MLD snooping is on, it can be checked as well
Vlan     Group               Type             Version         Port List
------------------------------------------------------------------------------
102
FF06:1::1


  mld
             v2
Gi1/0/10        <-- Receiver joined on Gi1/0/10
```

驗證Leaf-02: MVPN Debugs show Route-type 7是在IGMP/MLD成員身份報告到達且所需的EVPN Type-2和Type-5已安裝時建立的。

```
<#root>
### IPv4 ###

Leaf-02#
debug bgp ipv4 mvpn updates

Leaf-02#
```

**debug bgp ipv4 mvpn updates events**

*Dec 14 19:41:57.645: BGP[15] MVPN:

**add c-route, type 7**

, bs len 0 asn=0,

**rd=1:1**

,
*Dec 14 19:41:57.645:

**source=10.1.101.11/4,**

*Dec 14 19:41:57.645:

**group=226.1.1.1/4,**

*Dec 14 19:41:57.645:

**nexthop=172.16.254.3**

,

**<-- Source is via Leaf-01 IP**

*Dec 14 19:41:57.645: len left = 0
*Dec 14 19:41:57.645: BGP[14] MVPN umh lookup: vrfid 2, source 10.1.101.11
*Dec 14 19:41:57.645: BGP[4] MVPN umh lookup: vrfid 2, source 10.1.101.11, net 1:1:10.1.101.11/32, 1:1:

**0x10B:172.16.255.3:2**

,
*Dec 14 19:41:57.646:

**BGP: MVPN(15) create local route [7][172.16.254.3:101][65001][10.1.101.11/32][226.1.1.1/32]/22**

*Dec 14 19:41:57.646:

**BGP[15] MVPN: add c-route, type 7, bs len 0 asn=65001, rd=1:1,**

### **IPv6** ###

Leaf-02#

**debug bgp ipv6 mvpn updates**

Leaf-02#

**debug bgp ipv6 mvpn updates events**

Mar 23 15:46:11.171: BGP[16] MVPN:

**add c-route, type 7**

```
, bs len 0 asn=0, rd=1:1,
Mar 23 15:46:11.171:
source=FC00:1:101::11/16,

Mar 23 15:46:11.171:
group=FF06:1::1/16,

Mar 23 15:46:11.171:
nexthop=::FFFF:172.16.254.3
,
<-- IPv4 next hop of Leaf-01

Mar 23 15:46:11.171: len left = 0
Mar 23 15:46:11.171: BGP[19] MVPN umh lookup: vrfid 2, source FC00:1:101::11
Mar 23 15:46:11.171: BGP[5] MVPN umh lookup: vrfid 2, source FC00:1:101::11, net [1:1]FC00:1:101::11/12
0x10B:172.16.255.3:2
,
Mar 23 15:46:11.172: BGP: MVPN(16) create local route [7][172.16.254.3:101][65001][FC00:1:101::11][FF06:
Mar 23 15:46:11.172: BGP[16] MVPN: add c-route, type 7, bs len 0 asn=65001, rd=1:1,
```

驗證Leaf-01:從Leaf-02接收的MVPN型別7

<#root>

```
### IPv4 ###

Leaf-01#
sh bgp ipv4 mvpn all route-type 7 172.16.254.3:101 65001 10.1.101.11 226.1.1.1
...or you can also use:
Leaf-01#
sh bgp ipv4 mvpn detail [7][172.16.254.3:101][65001][10.1.101.11/32][226.1.1.1/32]/22

BGP routing table entry for
[7][172.16.254.3:101]
[65001][10.1.101.11/32][226.1.1.1/32]/22, version 76
Paths: (2 available, best #1, table
MVPNv4-BGP-Table
)
<-- In BGP IPv4 MVPN table
```

```
  Not advertised to any peer
  Refresh Epoch 1
  Local

    172.16.255.4

 (metric 3) from 172.16.255.2 (172.16.255.2)

<-- loopback of Leaf-02 Receiver VTEP


      Origin incomplete, metric 0, localpref 100, valid, internal

      Extended Community: RT:172.16.255.3:2                  <-- The VRI derived from EVPN Type-2 and ad


      Originator: 172.16.255.4, Cluster list: 172.16.255.2
      rx pathid: 0, tx pathid: 0
      Updated on Dec 15 2020 14:14:38 UTC



### IPv6 ###


Leaf-01#

sh bgp ipv6 mvpn all route-type 7 172.16.254.3:101 65001 FC00:1:101::11 FF06:1::1

...or you can also use:
Leaf-01#

sh bgp ipv6 mvpn detail [7][172.16.254.3:101][65001][FC00:1:101::11][FF06:1::1]/46


BGP routing table entry for

[7][172.16.254.3:101]

[65001][FC00:1:101::11][FF06:1::1]/46, version 45
Paths: (2 available, best #1, table

MVPNV6-BGP-Table

)

<-- In BGP IPv6 MVPN table


  Not advertised to any peer
  Refresh Epoch 1
  Local

    172.16.255.4

 (metric 3) from 172.16.255.1 (172.16.255.1)

<-- loopback of Leaf-02 Receiver VTEP


      Origin incomplete, metric 0, localpref 100, valid, internal, best

      Extended Community: RT:172.16.255.3:2    <-- The VRI derived from EVPN Type-2 and added to the MVP


      Originator: 172.16.255.4, Cluster list: 172.16.255.1
      rx pathid: 0, tx pathid: 0x0
      Updated on Mar 23 2021 15:46:11 UTC
```

驗證Leaf-01: MVPN調試顯示使用MVPN VRI路由目標接收的路由型別7

<#root>

*Dec 17 16:16:31.923: BGP(15): 172.16.255.2

**rcvd UPDATE w/ attr: nexthop 172.16.255.4**

, origin ?, localpref 100, metric 0, originator 172.16.255.4, clusterlist 172.16.255.2,

**extended community RT:172.16.255.3:2 <-- VRI RT**

*Dec 17 16:16:31.923: BGP(15): 172.16.255.2

**rcvd [7]**

[172.16.254.3:101][65001][10.1.101.11/32][226.1.1.1/32]/22

**<-- Received MVPN Type-7**

**<...only update from Spine-02 172.16.255.2 ...>**

*Dec 17 16:16:31.923: BGP(15): skip vrf default table RIB route [7][172.16.254.3:101][65001][10.1.101.1
*Dec 17 16:16:31.924: BGP(15): add RIB route (0:0)[7][1:1][65001][10.1.101.11/32][226.1.1.1/32]/22

**(Skipping IPv6, see the debugs demonstrated in previous steps)**

驗證Leaf-02：完整BGP表包含Leaf-01 EVPN型別2和MVPN型別5，以及由接收方Leaf-02生成的型別7

<#root>

**### IPv4 ###**

Leaf-02#

**sh bgp l2vpn evpn all | b 10.1.101.11**

* i

**[2]**

[172.16.254.3:101][0][48][F4CFE24334C5][32][10.1.101.11]/24

**<-- Remote VTEP route-type 2**

172.16.254.3 0 100 0 ?

***>i 172.16.254.3 0 100 0 ? <-- IP of Leaf01 Lo1**

Leaf-02#

**sh bgp ipv4 mvpn all**

     Network          Next Hop            Metric LocPrf Weight Path

**Route Distinguisher: 1:1**

(default for vrf green)

**<-- default RD for vrf green**

*>i

**[5][1:1][10.1.101.11][226.1.1.1]**

/18

**<-- Type-5, source & group**

**172.16.255.3**

0   100       0 ?

**<-- Next hop Leaf-01 IP**

* i                  172.16.255.3               0   100       0 ?

**Route Distinguisher: 172.16.254.3:101** **<-- MVPN RD sent from Source Leaf-01**

*>

**[7]**

[172.16.254.3:101][65001][10.1.101.11/32][226.1.1.1/32]/22

**<-- Type-7 BGP Join Entry**

**0.0.0.0**

**32768**

?

**<-- Locally created (0.0.0.0) by Leaf-02**

**### IPv6 ###**

Leaf-02#

**sh bgp l2vpn evpn all | b FC00:1:101::11**

* i

**[2]**

[172.16.254.3:101][0][48][F4CFE24334C1][128][FC00:1:101::11]/36

**<-- Remote VTEP route-type 2**

172.16.254.3 0 100 0 ?

***>i 172.16.254.3 0 100 0 ? <-- IP of Leaf-01 Lo1**

Leaf-02#

**sh bgp ipv6 mvpn all**

Network Next Hop Metric LocPrf Weight Path

**Route Distinguisher: 1:1**

(default for vrf green)

**<-- default RD for vrf green**

*>i

**[5][1:1][FC00:1:101::11][FF06:1::1]**

/42

**<-- Type-5, source & group**

**172.16.255.3**

0 100 0 ?

**<-- IPv4 Next hop Leaf-01 IP**

* i 172.16.255.3 0 100 0 ?

**Route Distinguisher: 172.16.254.3:101 <-- MVPN RD sent from Source Leaf-0**

*>

**[7]**

[172.16.254.3:101][65001][FC00:1:101::11][FF06:1::1]/46

**<-- Type-7 BGP Join Entry**

**::** **32768**

?

**<-- Locally created (::) by Leaf-02**

驗證TRM組枝葉–01(FHR)

檢查MDT和TRM組是否已在源端正確形成。

- TRM組的傳入介面是與客戶端VRF關聯的SVI
- TRM組的傳出介面是L3VNI SVI

驗證Leaf-01:TRM組MRIB/MFIB

<#root>

```
### IPv4 ###

Leaf-01#
sh ip mroute vrf green 226.1.1.1 10.1.101.11

(10.1.101.11, 226.1.1.1), 02:57:56/00:03:14,
flags: FTGqx <-- Flags: BGP S-A Route

  Incoming interface:
Vlan101
, RPF
nbr 0.0.0.0            <-- Local to Vlan101 Direct connected source

  Outgoing interface list:

Vlan901
, Forward/Sparse, 02:57:56/stopped
<-- OIF is VxLAN L3VNI

Leaf-01#
sh ip mfib vrf green 226.1.1.1 10.1.101.11

VRF green   <-- Tenant VRF

(10.1.101.11,226.1.1.1) Flags: HW
  SW Forwarding: 1/0/100/0, Other: 0/0/0
HW Forwarding: 5166/0/118/0, Other: 0/0/0 <-- Hardware counters indicate the entry is operating in hardw


 Vlan101 Flags: A                         <-- Accept flag set on Connected Source SVI

  Vlan102 Flags: F NS
    Pkts: 0/0/1 Rate: 0 pps
```

**Vlan901, VXLAN v4 Encap (50901, 239.1.1.1) Flags: F <-- Forward via Vlan 901. Use MDT group 239.1.1.1, v**

Pkts: 0/0/0 Rate: 0 pps

**### IPv6 ###**

Leaf-01#

**sh ipv6 mroute vrf green**

(FC00:1:101::11, FF06:1::1), 01:01:00/00:01:08,

**flags: SFTGq <-- Flags: q - BGP S-A Route, G - BGP Signal Received**

Incoming interface:

**Vlan101**

**RPF nbr: FE80::F6CF:E2FF:FE43:34C1 <-- link local address of Source**

Immediate Outgoing interface list:

**Vlan901**

, Forward, 01:01:00/never

**<-- OIF is VxLAN L3VNI**

Leaf-01#

**sh ipv6 mfib vrf green FF06:1::1**
**VRF green <-- Tenant VRF**

(FC00:1:101::11,FF06:1::1) Flags: HW

SW Forwarding: 0/0/0/0, Other: 1/0/1

**HW Forwarding: 1968/0/118/0, Other: 0/0/0 <-- Hardware counters indicate the entry is operating in hardw**

**Vlan101 Flags: A NS <-- Accept flag set on Connected Source SVI**

**Vlan901, VXLAN v4 Encap (50901, 239.1.1.1) Flags: F <-- Forward via Vlan 901. Use MDT group 239.1.1.1,**

Pkts: 0/0/0 Rate: 0 pps

驗證Leaf-01:FED中的TRM組

<#root>

### **IPv4** ###

Leaf-01#

**sh platform software fed switch active ip mfib vrf green 226.1.1.1/32 10.1.101.11**

Multicast (S,G) Information

**VRF : 2 <-- VRF ID 2 = vrf green (from "show vrf detail")**

Source Address : 10.1.101.11
HTM Handler : 0x7f175cc08578
SI Handler : 0x7f175cc06ea8
DI Handler : 0x7f175cc067c8
REP RI handler : 0x7f175cc06b38
Flags : {Svl}

**Packet count : 39140 <-- packets that used this adjacency (similar to mfib command, but shown at**

State : 4

**RPF**

:

**Vlan101 A <-- Accept on Vlan 101 in Tenant vrf green**

OIF :
Vlan102 F NS
Vlan101 A

**Vlan901 F {Remote}**

**<-- Forward via L3VNI interface**

**(Adj: 0x6a ) <-- Adjacency for this entry**

### **IPv6** ###

Leaf-01#

**sh plat soft fed switch active ipv6 mfib vrf green FF06:1::1/128 FC00:1:101::11**

Multicast (S,G) Information

**VRF : 2 <-- VRF ID 2 = vrf green (from "show vrf detail")**

Source Address : fc00:1:101::11
HTM Handler : 0x7fba88d911b8
SI Handler : 0x7fba88fc4348

```
DI Handler     : 0x7fba88fc8dc8
REP RI handler : 0x7fba88fc8fd8
Flags          : {Svl}
Packet count   : 2113


<-- packets that used this adjacency (similar to mfib command, but shown at the FED layer)


State          : 4
RPF            :


     Vlan101   A {Remote}    <-- Accept on Vlan 101 in Tenant vrf green (says remote, but this is a loca


OIF            :
     Vlan101     A {Remote}


 Vlan901     F {Remote}


<-- Forward via L3VNI interface



  (Adj: 0x7c )      <-- Adjacency for this entry
```

## 驗證Leaf-01：鄰接是否正確

## <#root>

```
### IPv4 ###


Leaf-01#
sh platform software fed switch active ip adj


IPV4 Adj entries


dest                                        if_name        dst_mac         si_hdl          ri_hdl
adj_id
  Last-modified
----                                        -------        -------         ------          ------
239.1.1.1


nve1.VNI50901
```

```
  4500.0000.0000  0x7f175ccd8c38  0x7f175ccd8de8 0x60
 0x6a
    2020/12/16 17:39:55.747

*** Adjacency 0x6a details ***


Destination =
 the MDT tunnel multicast group 239.1.1.1
Interface   =
 nve1.VNI50901 (the L3VNI 50901)


### IPv6 ###
Leaf-01#
sh platform software fed switch active ipv6 adj
IPV6 Adj entries
dest                                        if_name        dst_mac         si_hdl          ri_hdl
adj_id
  Last-modified
----                                        -------        -------         ------          ------
239.1.1.1


nve1.VNI50901
  4500.0000.0000  0x7fba88cf9fc8  0x7fba88cfa248 0x60
  0x7c
    2021/03/22 19:54:09.831

*** Adjacency 0x7c details ***
Destination =
the MDT tunnel multicast group 239.1.1.1
Interface   =
nve1.VNI50901 (the L3VNI 50901)
```

驗證TRM組枝葉–02(LHR)

檢查MDT和TRM組是否已在接收器端正確形成。

- TRM組的傳入介面是與L3VNI關聯的SVI

- TRM組的傳出介面是處理IGMP加入的客戶端SVI。

驗證Leaf-02:MRIB/MFIB中的TRM（租戶組播路由）路由

```
<#root>
Leaf-02#
sh ip mroute vrf green 226.1.1.1 10.1.101.11      <-- The TRM Client group

(10.1.101.11, 226.1.1.1), 00:26:03/00:02:37, flags: TgQ
  Incoming interface: Vlan901, RPF nbr 172.16.254.3       <-- Via L3VNI, RPF to Leaf-01

  Outgoing interface list:
    Vlan102,
 Forward/Sparse, 00:26:03/00:03:10
<-- Client Receiver Vlan


Leaf-02#
sh ip mfib vrf green 226.1.1.1 10.1.101.11

VRF green                                          <--- The Tenant VRF

  (10.1.101.11,226.1.1.1) Flags: HW
    SW Forwarding: 1/0/100/0, Other: 0/0/0

HW Forwarding: 39013/0/126/0, Other: 0/0/0     <-- Hardware counters indicate the entry is operating in


 Vlan901, VXLAN Decap Flags: A                  <-- L3VNI Accept and decapsulate from VxLAN


Vlan102 Flags: F NS                            <-- Forward to the Tenant Vlan

      Pkts: 0/0/1 Rate: 0 pps
```

驗證Leaf-02:FED中的TRM組

```
<#root>
### IPv4 ###
```

```
Leaf-02#
sh platform software fed switch active ip mfib vrf green 226.1.1.1/32 10.1.101.11 detail <-- Use detail


MROUTE ENTRY vrf 2 (10.1.101.11, 226.1.1.1/32)
  HW Handle: 140397391947768 Flags: {Svl}
RPF interface: Vlan901
(60)):
SVI              <-- RPF interface = L3VNI SVI Vlan901


  HW Handle:140397391947768 Flags:A {Remote}
Number of OIF: 2
Flags: 0x4
Pkts : 39387      <-- packets that used this adjacency (similar to mfib command, but shown at the FED la


OIF Details:
     Vlan102 F NS            <-- Client Vlan


     Vlan901 A {Remote}      <-- Accept interface is RPF to source via Remote EVPN next hop


          (Adj: 0xf80003c1 ) <-- Adj for vlan 901(show plat soft fed sw active ipv4 adj)


Htm: 0x7fb0d0edfb48 Si: 0x7fb0d0ee9158 Di: 0x7fb0d0eca8f8 Rep_ri: 0x7fb0d0ef2b98


DI details  <-- Dest index (egress interface) details


----------
Handle:0x7fb0d0eca8f8 Res-Type:ASIC_RSC_DI Res-Switch-Num:255 Asic-Num:255 Feature-ID:AL_FID_L3_MULTICA
priv_ri/priv_si Handle:(nil) Hardware Indices/Handles: index0:0x538b mtu_index/l3u_ri_index0:0x0 index1
Brief Resource Information
(ASIC_INSTANCE# 1)


 <-- Gi1/0/10 is mapped to instance 1


---------------------------------------
Destination index = 0x538b


pmap = 0x00000000 0x00000200
pmap_intf : [GigabitEthernet1/0/10]           <-- Maps to Gi1/0/10, the port toward the client


============================================================


### IPv6 ###
```

```
Leaf-02#
sh platform software fed switch active ipv6 mfib vrf green FF06:1::1/128 FC00:1:101::11 detail
MROUTE ENTRY
vrf 2
 (fc00:1:101::11, ff06:1::1/128)
  HW Handle: 139852137577736 Flags: {Svl}
RPF interface: Vlan901
(62)): SVI
<-- RPF to Source L3VNI SVI 901

  HW Handle:139852137577736
Flags:A {Remote}

Number of OIF: 2
Flags: 0x4 Pkts : 7445       <-- Packets use this Entry

OIF Details:
     Vlan102 F NS            <-- F - Forward. The OIF Vlan SVI 901


     Vlan901 A {Remote}


          (Adj: 0xf80003e2 ) <-- Adj for vlan 901 (show plat soft fed sw active ipv6 adj)

Htm: 0x7f31dcfee238 Si: 0x7f31dcfba5d8 Di: 0x7f31dcfc2358 Rep_ri: 0x7f31dcfcb1a8

DI details


----------
Handle:0x7f31dcfc2358 Res-Type:ASIC_RSC_DI Res-Switch-Num:255 Asic-Num:255 Feature-ID:AL_FID_L3_MULTICA
priv_ri/priv_si Handle:(nil) Hardware Indices/Handles: index0:0x5381 mtu_index/l3u_ri_index0:0x0 index1

Brief Resource Information
(ASIC_INSTANCE# 1)   <-- Gig1/0/10 is mapped to Instance 1


----------------------------------------
Destination index = 0x5381

pmap = 0x00000000 0x00000200
pmap_intf : [GigabitEthernet1/0/10]            <-- Maps to Gig1/0/10, the port toward the client

============================================================
```

```
Leaf-02#
sh platform software fed switch active ifm mappings

Interface                IF_ID
Inst


Asic
 Core Port SubPort Mac Cntx LPN GPN Type Active
GigabitEthernet1/0/10
     0x12
 1


0
   1    9      0      5   15   10  10  NIF  Y
 <-- Instance 1 of ASIC 0
```

驗證Leaf-02：捕獲的資料包顯示具有內部客戶端流量的外部MDT隧道組

<#root>

```
Leaf-02#
sh mon ca 1 parameter

monitor capture 1 interface GigabitEthernet1/0/2 IN
monitor capture 1 match any
monitor capture 1 buffer size 10
monitor capture 1 limit pps 1000


### IPv4 ###

Leaf-02#
sh mon capture 1 buffer detailed

Ethernet II, Src: 7c:21:0d:bd:2c:d6 (7c:21:0d:bd:2c:d6),
Dst: 01:00:5e:01:01:01
 (01:00:5e:01:01:01)
<-- MAC is matching 239.1.1.1


Type: IPv4 (0x0800)  <-- IPv4 outer packet
```

Internet Protocol Version 4,

**Src: 172.16.254.3, Dst: 239.1.1.1 <- Leaf-01 Source IP and MDT outer tunnel Group**

    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
    Time to live: 253

**User Datagram Protocol**

, Src Port: 65287,

**Dst Port: 4789 <-- VxLAN UDP port 4789**

**Virtual eXtensible Local Area Network**

Flags: 0x0800,

**VXLAN Network ID (VNI)**

Group Policy ID: 0

**VXLAN Network Identifier (VNI): 50901 <-- L3VNI value**
**Type: IPv4**

(0x0800)

**<-- IPv4**

**inner packet**

**Internet Protocol Version 4**

,

**Src: 10.1.101.11, Dst: 226.1.1.1 <-- Encapsulated IPv4 TRM group**

    0100 .... = Version: 4
    Time to live: 254
    Protocol: ICMP (1)

**(multiple lines removed from this example capture)**

### **IPv6** ###

Leaf-02#

**sh mon capture 1 buffer detailed**

Ethernet II,

**Src: 7c:21:0d:bd:2c:d6**

(7c:21:0d:bd:2c:d6),

**Dst: 01:00:5e:01:01:01**

```
 (01:00:5e:01:01:01)
<-- DMAC is matching 239.1.1.1


    Type: IPv4 (0x0800)            <-- IPv4 outer packet


Internet Protocol Version 4, Src: 172.16.254.3, Dst: 239.1.1.1


    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
    Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
        0000 00.. = Differentiated Services Codepoint: Default (0)
        .... ..00 = Explicit Congestion Notification: Not ECN-Capable Transport (0)
    Total Length: 150
    Identification: 0x4e4b (20043)
    Flags: 0x4000, Don't fragment
        0... .... .... .... = Reserved bit: Not set
        .1.. .... .... .... = Don't fragment: Set  <-- DF flag=1. MTU can be an issue if too low in path


        ..0. .... .... .... = More fragments: Not set
    ...0 0000 0000 0000 = Fragment offset: 0
    Time to live: 253
    Protocol: UDP (17)


    Header checksum: 0x94f4 [validation disabled]
    [Header checksum status: Unverified]
    Source: 172.16.254.3
    Destination: 239.1.1.1
User Datagram Protocol,
Src Port: 65418, Dst Port: 4789 <-- VxLAN UDP port 4789


    Source Port: 65418


 Destination Port: 4789


<...snip...>


Virtual eXtensible Local Area Network


    Flags: 0x0800,
VXLAN Network ID (VNI)


        0... .... .... .... = GBP Extension: Not defined
        .... .... .0.. .... = Don't Learn: False


  .... 1... .... .... = VXLAN Network ID (VNI): True
```

```
        .... .... .... 0... = Policy Applied: False
        .000 .000 0.00 .000 = Reserved(R): 0x0000
    Group Policy ID: 0
    VXLAN Network Identifier (VNI): 50901 <-- L3VNID 50901
    Reserved: 0
Ethernet II, Src: 10:b3:d5:6a:00:00 (10:b3:d5:6a:00:00), Dst:
33:33:00:00:00:01
 (33:33:00:00:00:01)
<-- DMAC matches ff06:1::1
    Type: IPv6 (0x86dd)                  <-- IPv6 inner packet
Internet Protocol Version 6
,
Src: fc00:1:101::11, Dst: ff06:1::1 <-- Encapsulated IPv6 TRM group
    0110 .... = Version: 6
<...snip...>
    Source: fc00:1:101::11
    Destination: ff06:1::1
Internet Control Message Protocol v6
    Type: Echo (ping) request (128)
<...snip...>
```

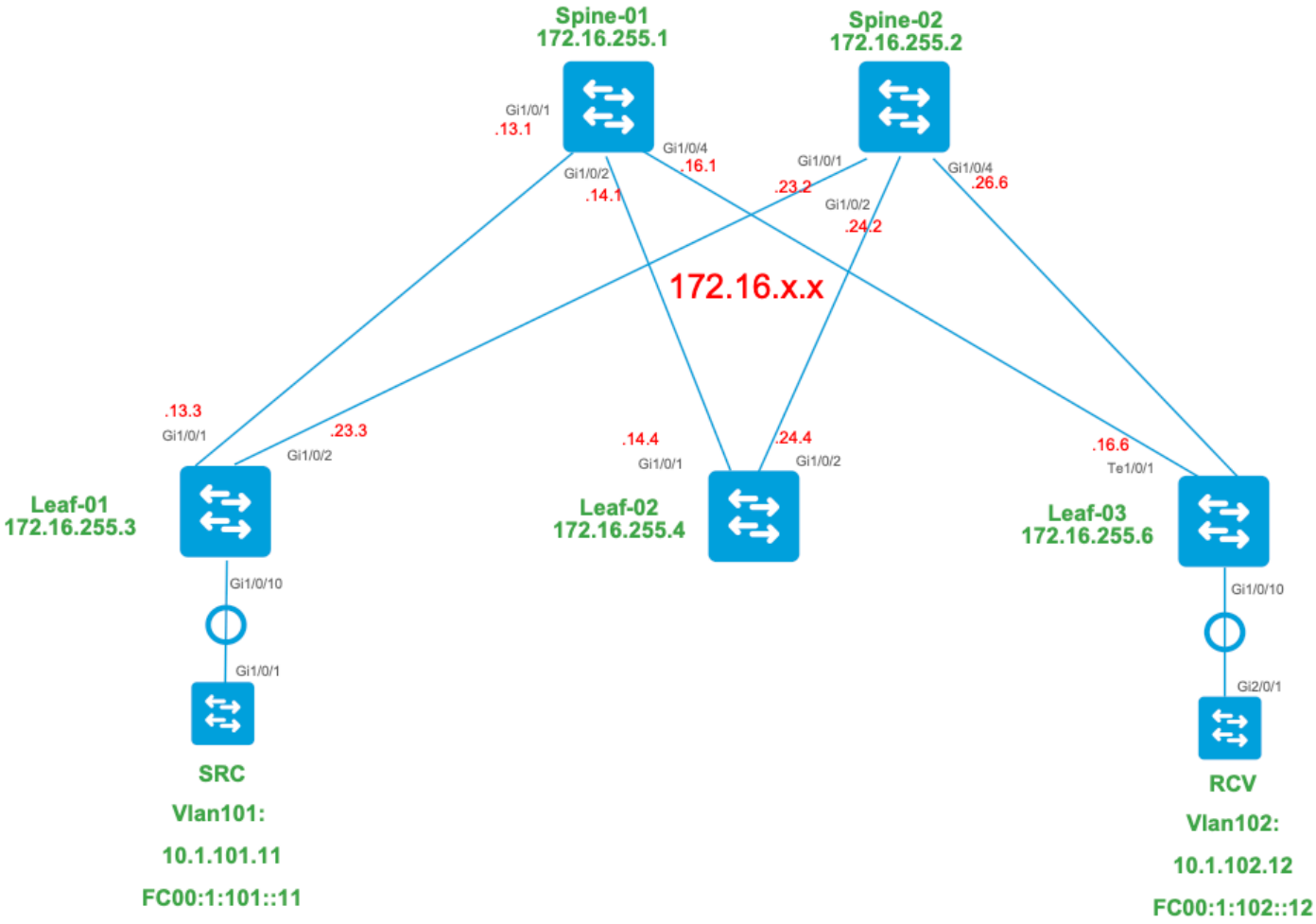
## 場景2：交換矩陣中的PIM SSM

在此模式下，重疊中沒有RP，並且沒有使用MVPN型別5或型別7（底層繼續作為PIM ASM運行）。 在SSM中，接收方向LHR VTEP傳送並加入IGMPv3S、G。此VTEP對RIB中的源執行RPF查詢。如果找到L3VNI SVI作為RPF介面，LHR VTEP會將MVPN RT-7傳送到接收並安裝此路由的FHR VTEP。然後，FHR VTEP通知PIM新增L3VNI SVI作為S，G mroute的傳出介面。

本節顯示了與方案1的差異。同樣的步驟和方法只在場景1中註明。

- 請參閱案例1中BGP和PIM的驗證和調試步驟，因為BGP和PIM操作相同

網路圖表




對於此模式，請考慮以下BGP路由型別及其來源

建立者：源VTEP

- EVPN路由型別2.用於獲取源的單播和VRI資訊，並在VTEP加入STP樹時新增到C組播路由（MVPN型別7）。

建立者：接收方VTEP

- MVPN Route-type 7.來自IGMP或MLD層以及來自EVPN型別2的資訊用於建立此BGP型別聯接。Type-7驅動在Source端建立MRIB OIF。

EVPN第2類要求：

1. FHR（來源VTEP）驗證ARP（或ND）和CEF鄰接關係（確認來源為直接連線）。
2. FHR發起EVPN第2型BGP更新

MVPN第7類要求：

1. 存在EVPN型別2條目（使用正確的VRI構建C-Multicast路由型別7時需要該條目，並且是從源VTEP傳送的）
2. 接收方VTEP:IGMPv3源特定成員身份報告已由LHR VTEP接收並處理
3. LHR VTEP RPF介面是交換矩陣L3VNI介面

對於此模式，在LHR VTEP上需要新增配置以啟用SSM範圍並處理IGMPv3成員身份報告

配置Leaf-03：在租戶SVI下將IGMP查詢器設定為版本3

<#root>

**interface Vlan102**

vrf forwarding green
ip address 10.1.102.1 255.255.255.0
ip pim sparse-mode

**ip igmp version 3  <-- Sets the version to V3**

end

驗證Leaf-03:IGMP查詢器設定為版本3

<#root>

Leaf-03#

**sh ip igmp snooping querier vlan 102**

**IP address : 10.1.102.1   <-- IP is that of the Vlan102 SVI**

**IGMP version : v3         <-- Querier is now version 3**

**Port : Router             <-- Mrouter port is "Router" meaning querier is local to this VTEP**

Max response time : 10s
Query interval : 60s
Robustness variable : 2

啟用Leaf-03:租戶VRF所需的SSM範圍

<#root>

Leaf-03(config)#

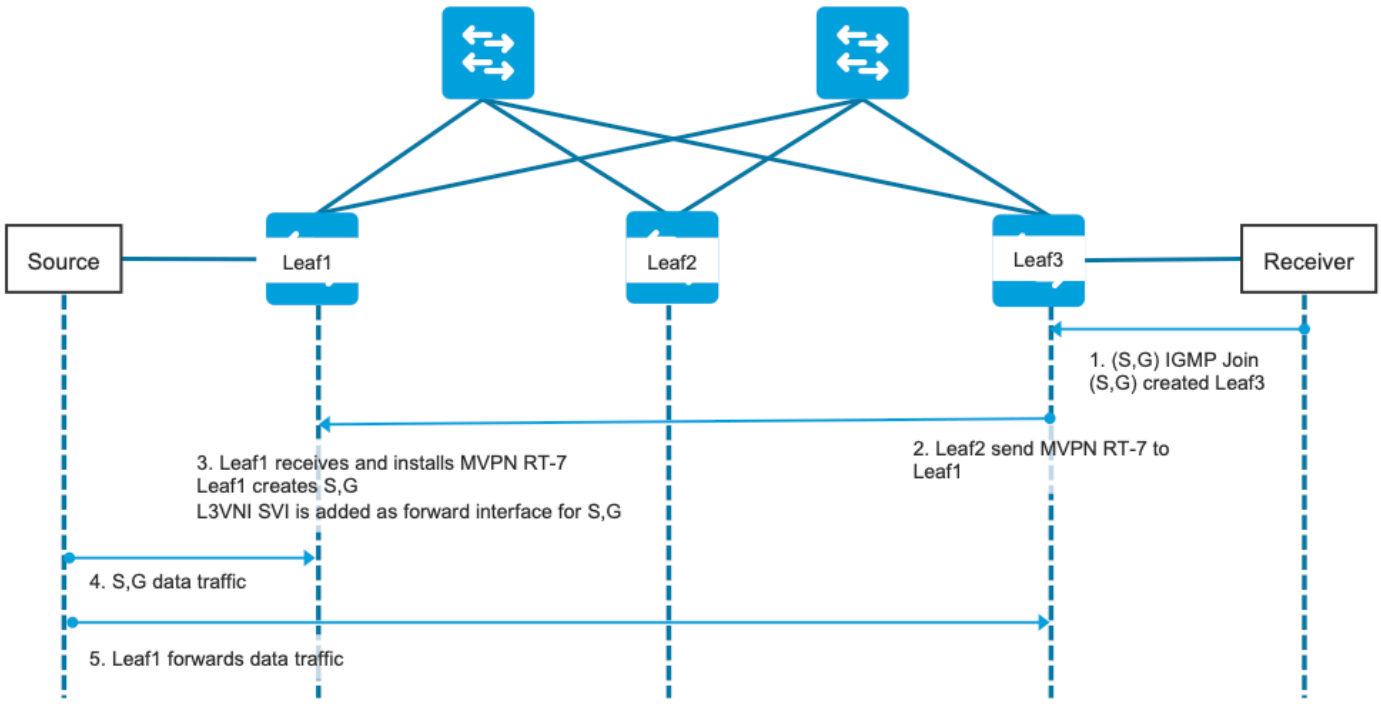
**ip pim vrf green ssm**

**?**

```
default
Use 232/8 group range for SSM          <-- Set to the normally defined SSM range

range
ACL for group range
 to be used for SSM
<-- use an ACL to define a non-default SSM range
```

提示:SSM組不會建立*,G mroute。如果看到組的*、G，請驗證SSM的配置是否正確。

驗證此方案所需的事件順序




第0步EVPN(Leaf-03)：驗證EVPN字首是否存在，BGP可以查詢在MVPN型別7中使用的VRI。

<#root>

```
Leaf-03#
sh bgp l2vpn evpn all

BGP table version is 16, local router ID is 172.16.255.6
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
```

```
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 1:1 (default for vrf green)
* i

[2]

[172.16.254.3:101][0][48][F4CFE24334C1][32]

[10.1.101.11]

/24
                    172.16.254.3 0 100 0 ?

*>i                  172.16.254.3 0 100 0 ? <-- From Leaf-01



Leaf-03#

sh bgp l2vpn evpn all route-type 2 0 F4CFE24334C1 10.1.101.11     <-- Detailed view of the EVPN type-2 e


BGP routing table entry for

[2]

[172.16.254.3:101][0][48][F4CFE24334C1][32][10.1.101.11]/24, version 283
Paths: (2 available, best #2,

table EVPN-BGP-Table

)
  Not advertised to any peer
  Refresh Epoch 1
  Local
    172.16.254.3 (metric 3) (via default) from 172.16.255.1 (172.16.255.1)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      EVPN ESI: 00000000000000000000, Gateway Address: 0.0.0.0, VNI Label 50901, MPLS VPN Label 0
      Extended Community: RT:1:1 MVPN AS:65001:0.0.0.0


 MVPN VRF:172.16.255.3:4

 ENCAP:8 Router MAC:10B3.D56A.8FC8

<-- BGP finds the VRI in this entry


      Originator: 172.16.255.3, Cluster list: 172.16.255.1
      rx pathid: 0, tx pathid: 0x0
      Updated on May 6 2021 16:17:06 UTC
```

第1步（枝葉–03）：已接收並包含源的IGMPv3成員身份報告

```
<#root>

Leaf-03#

show ip igmp snooping groups vlan 102 226.1.1.1
```

```
Vlan
Group
                    Type
Version
      Port List
-------------------------------------------------------------------------
102
226.1.1.1
                igmp
 v3
           Gi1/0/10


Leaf-03#
show ip igmp snooping groups vlan 102 226.1.1.1 sources <-- Specify "sources" to see Source information

Vlan      Group                    Type        Version      Port List
-------------------------------------------------------------------------


Source information for group 226.1.1.1

:
Timers: Expired sources are deleted on next IGMP General Query


SourceIP
       Expires   Uptime
Inc Hosts
 Exc Hosts
-----------------------------------------------------
10.1.101.11
    00:01:20  00:02:58
1
         0
<-- Source specified in IGMP includes one source
```

第2步(Leaf-03):BGP收到此加入的通知，建立並傳送第7類MVPN加入。

```
<#root>
debug mvpn
```

**debug ip igmp vrf green 226.1.1.1**

May 6 17:11:08.500:

**IGMP(6): Received v3 Report for 1 group on Vlan102 from 10.1.102.12**

May 6 17:11:08.500:

**IGMP(6): Received Group record for group 226.1.1.1, mode 5 from 10.1.102.12 for 1 sources <-- IGMPv3 typ**

May 6 17:11:08.500: IGMP(6): WAVL Insert group: 226.1.1.1 interface: Vlan102 Successful
May 6 17:11:08.500: IGMP(6): Create source 10.1.101.11
May 6 17:11:08.500: IGMP(6): Updating expiration time on (10.1.101.11,226.1.1.1) to 180 secs
May 6 17:11:08.500: IGMP(6): Setting source flags 4 on (10.1.101.11,226.1.1.1)
May 6 17:11:08.500: IGMP(6): MRT Add/Update Vlan102 for (10.1.101.11,226.1.1.1) by 0

May 6 17:11:08.501:

**MVPN: Received local route update for (10.1.101.11, 226.1.1.1) with RD: 1:1, Route Type: 7, flags: 0x00**

May 6 17:11:08.501: MVPN: Route Type 7 added [(10.1.101.11, 226.1.1.1)] rd:1:1 send:1
May 6 17:11:08.501:

**MVPN: Sending BGP prefix=[7:0 1:1 : (10.1.101.11,226.1.1.1)] len=23, nh 172.16.254.3, Originate route**

May 6 17:11:08.501:

**MVPN: Originate C-route, BGP remote RD 1:1**

Leaf-03#

**sh bgp ipv4 mvpn all**

BGP table version is 10, local router ID is 172.16.255.6
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 1:1 (default for vrf green)
*>

**[7][1:1][65001][10.1.101.11/32][226.1.1.1/32]/22     <-- Locally created Type-7**

                      0.0.0.0                              32768 ?

Leaf-03#

**sh ip mroute vrf green 226.1.1.1                  <-- for SSM you only see S,G and no *,G**

IP Multicast Routing Table

**<...snip...>**

**(10.1.101.11, 226.1.1.1), 00:29:12/00:02:46, flags: sTIg <-- s = SSM, I = Source Specific Join received,**

**Incoming interface: Vlan901**

, RPF nbr 172.16.254.3

**<-- RPF interface is the L3VNI**

  Outgoing interface list:
    Vlan102, Forward/Sparse, 00:29:12/00:02:46

第3步(Leaf-01):源枝葉接收並安裝MVPN Type-7加入路由，並通知PIM安裝L3VNI OIF

<#root>

**debug mvpn**

**debug ip pim vrf green 226.1.1.1**

**May 6 18:16:07.260: MVPN: Received BGP prefix=[7:65001 1:1 : (10.1.101.11,226.1.1.1)] len=23, nexthop: 1**

May 6 18:16:07.260: MVPN: Received BGP route update for (10.1.101.11, 226.1.1.1) with RD: 1:1, Route Ty
May 6 18:16:07.260: MVPN:

**Route Type 7 added [(10.1.101.11, 226.1.1.1), nh 172.16.255.6] rd:1:1 send:0, to us   <-- add type-7 rou**

May 6 18:16:07.260: PIM(4)[green]: Join-list: (10.1.101.11/32, 226.1.1.1), S-bit set, BGP C-Route
May 6 18:16:07.263:

**PIM(4)[green]: Add Vlan901/0.0.0.0 to (10.1.101.11, 226.1.1.1), Forward state, by BGP SG Join  <-- PIM a**

May 6 18:16:07.264: PIM(4)[green]: Insert (10.1.101.11,226.1.1.1) join in nbr 10.1.101.11's queue
May 6 18:16:07.264:

**MVPN(green[AF_IPv4]): Add (10.1.101.11, 226.1.1.1) intf Vlan901 olist Join state for BGP C-Rt type 7 Acc**

Leaf-01#

**sh bgp ipv4 mvpn all**

<...snip...>
    Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 1:1 (default for vrf green)

***>i [7][1:1][65001][10.1.101.11/32][226.1.1.1/32]/22**

```
172.16.255.6
           0    100         0 ?
<-- Recieved from Reciever Leaf-03

* i                  172.16.255.6             0    100         0 ?
Leaf-01#
sh ip mroute vrf green 226.1.1.1
<...snip...>
(10.1.101.11, 226.1.1.1), 00:42:41/stopped, flags: sTGx            <-- s = SSM Group, G = Received BGP

  Incoming interface: Vlan101, RPF nbr 10.1.101.11

Outgoing interface list:

    Vlan901, Forward/Sparse, 00:42:41/stopped                      <-- L3VNI installed as OIF interface
```

第4步和第5步（枝葉–01和枝葉–03）：組播到達FHR枝葉並通過交換矩陣傳送到LHR枝葉。此處提供的驗證命令摘要。您可以在場景1中檢查這些命令的詳細驗證。

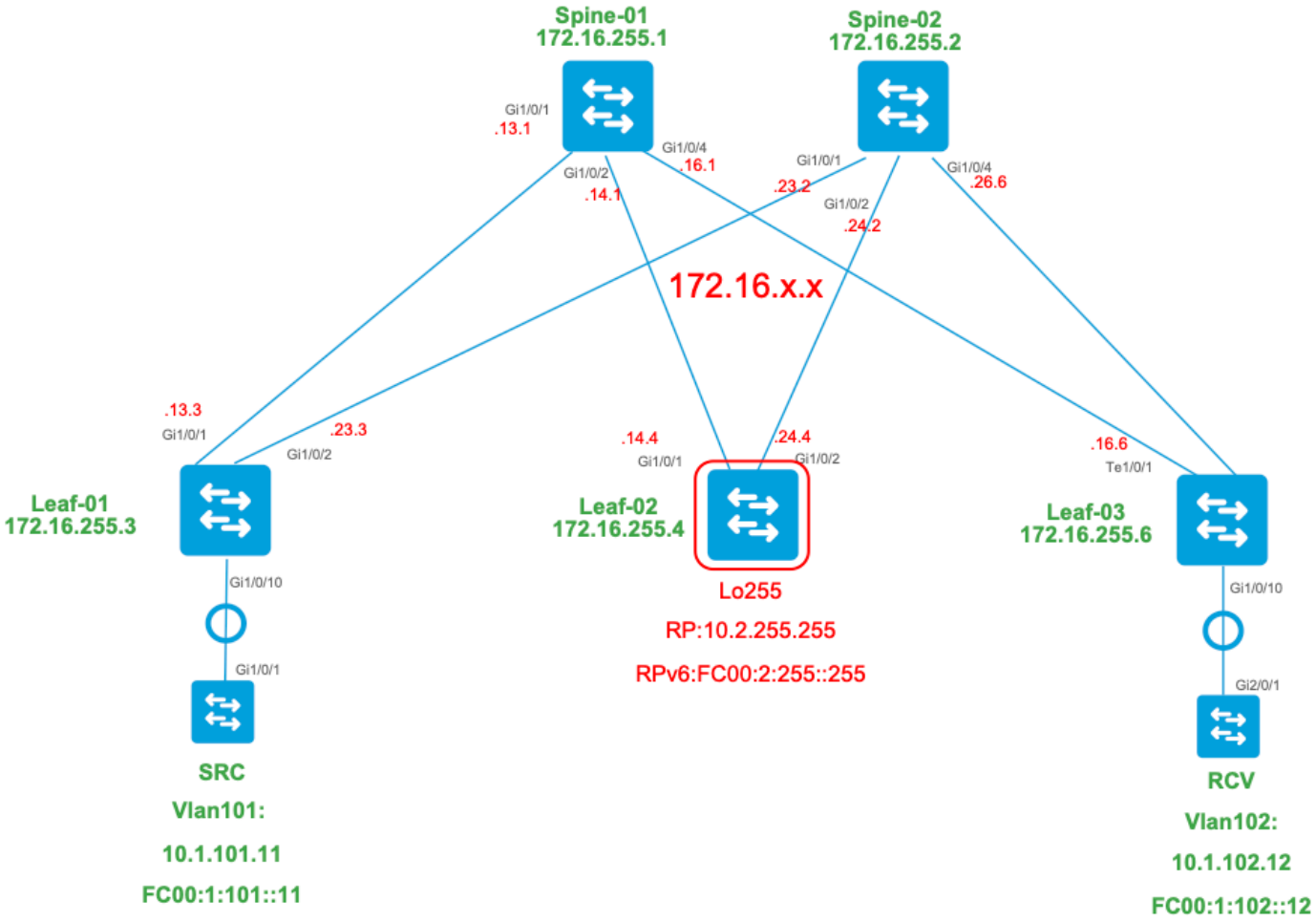
<#root>

```
show ip mroute vrf green 226.1.1.1 count                                        <-- software mr

show ip mfib vrf green 226.1.1.1




      <-- hardware mroute details & counters



sh platform software fed switch active ip mfib vrf green 226.1.1.1/32 10.1.101.11 detail <-- ASIC entry
```

## 場景3：交換矩陣內的單個RP（常規稀疏模式）

此模式可互換稱為非任播RP或外部RP模式。在此模式下，重疊中只有一個RP。因此，重疊中的(*,G)樹可以跨多個站點。BGP使用MVPN RT-6在交換矩陣中通告(*,G)成員身份。如果RP和FHR位於不同站點，則會在交換矩陣中傳送PIM暫存器。這是重疊中PIM SM的預設操作模式。

網路圖表




對於此模式，請考慮以下BGP路由型別及其來源

建立者：源VTEP

- EVPN路由型別2.用於獲取源的單播和VRI資訊，並在VTEP加入STP樹時新增到C組播路由（MVPN型別7）。
- MVPN Route-type 5.傳送到S、G的VTEP的源A-D路由

建立者：RP VTEP

- EVPN路由型別5.用於獲取RP環回的單播和VRI資訊。環回不會建立Route-type 2，因此使用型別5。
- MVPN Route-type 7.這是從EVPN型別2提取並傳送到源VTEP的IGMP連線+ RT VRI詳細資訊，它驅動MRIB OIF的建立。

建立者：接收方VTEP

- MVPN Route-type 6. 由接收方VTEP建立的路由型別，用於將共用樹*,G（RPT樹）連線到RP。
- MVPN Route-type 7.來自IGMP或MLD層以及來自EVPN型別2的資訊用於建立此BGP型別聯接。Type-7驅動在Source端建立MRIB OIF。

EVPN第2類要求：

1. FHR（來源VTEP）驗證ARP（或ND）和CEF鄰接關係（確認來源為直接連線）。
2. FHR發起EVPN第2型BGP更新

EVPN第5類要求：

1. 配置了RP環回並將其通告到BGP

MVPN第5類要求：

在此模式中，源站點上的枝葉只滿足以下兩個條件時才會通告(S，G)的源活動A-D消息。

1. 它接收RPF介面上流向源的流量。（來源會傳送到FHR）
2. L3VNI SVI介面作為(S，G)條目的轉發介面新增，作為從RP加入S，G作為PIM註冊過程的一部分。（L3VNI SVI安裝在OIF清單中）

MVPN第6類要求：

1. RP通告包含其VRI和單播可達性詳細資訊的其EVPN第5類路由。
2. 在LHR上收到的IGMP加入會觸發向RP的BGP更新

MVPN第7類要求：

1. 存在EVPN型別2條目（使用正確的VRI構建C-Multicast路由型別7時需要該條目，並且是從源VTEP傳送的）
2. 存在MVPN第5類條目（解析可用於STP加入的源/組對時需要該條目）
3. 接收方VTEP:LHR VTEP已接收並處理IGMP成員身份報告
4. RP VTEP:RP已收到組播註冊資料包，具有EVPN路由，並具有S、G的接收器（通過型別6獲取）
5. LHR VTEP RPF介面是交換矩陣L3VNI介面

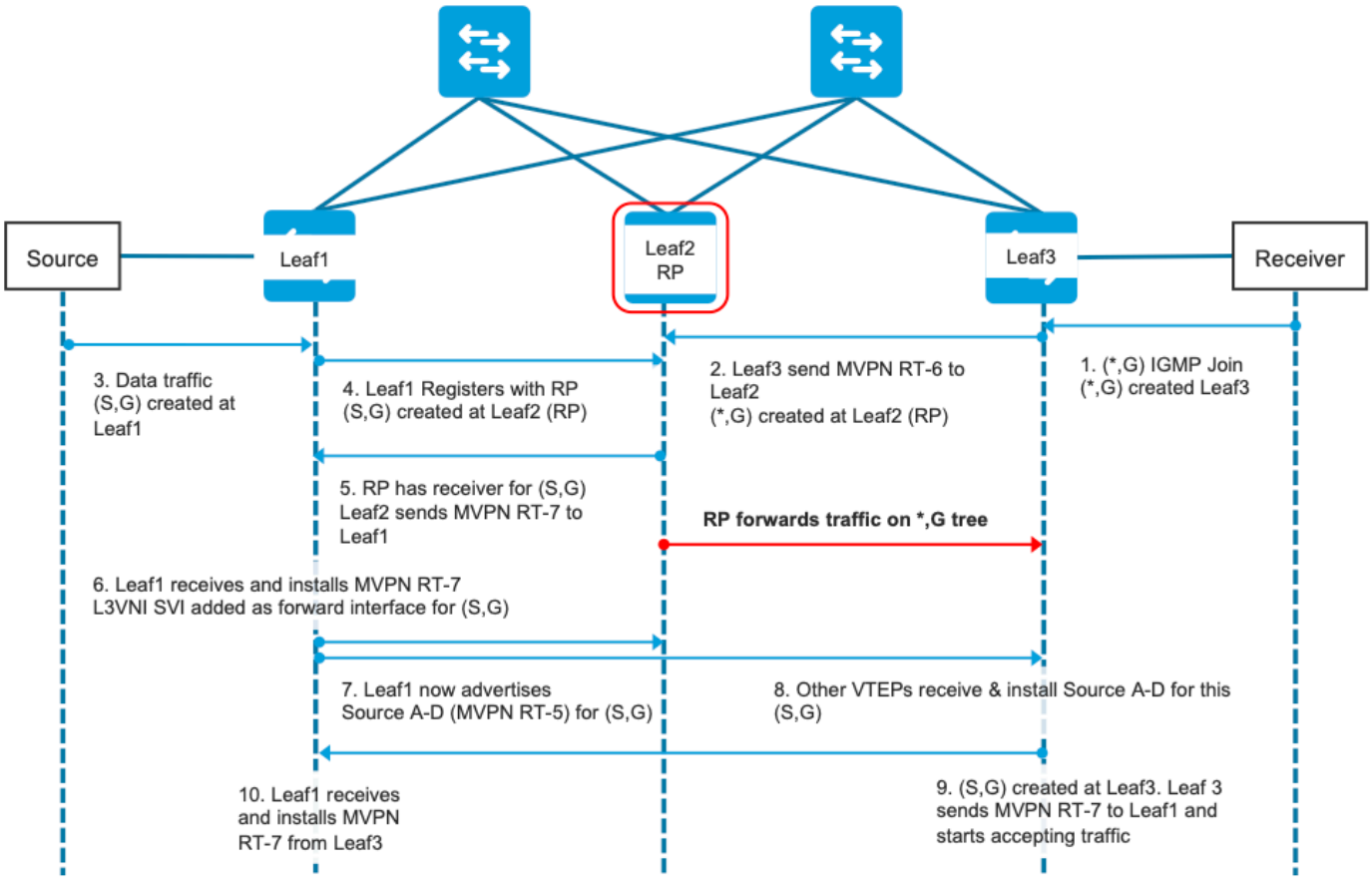
---

提示：在輸出LHR VTEP PIM處檢查通向源的路徑。PIM必須在RIB中找到L3VNI作為RPF介面的路由。如果L3VNI未正確配置、已關閉，依此類推。VTEP不會建立型別7 BGP連線。

---

驗證此方案所需的事件順序

驗證接收方VTEP最初加入共用樹所需的步驟，然後切換到最短路徑樹。這涉及檢查BGP表、IGMP和MRIB建立狀態。




步驟EVPN(Leaf-03):在LHR上獲知來自RP的EVPN型別5。這是接收方VTEP建立MVPN第6類路由所必需的

<#root>

```
Leaf-03#

sh bgp l2vpn evpn all route-type 5 0 10.2.255.255 32

...or you can also use:
Leaf-03#

sh bgp l2vpn evpn detail [5][1:1][0][32][10.2.255.255]/17


BGP routing table entry for [5][1:1][0][32][10.2.255.255]/17, version 25
Paths: (2 available, best #1, table EVPN-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
  Local

    172.16.254.4

 (metric 3) (via default) from 172.16.255.1 (172.16.255.1)

<-- RP's global next hop IP


      Origin incomplete, metric 0, localpref 100, valid, internal, best
      EVPN ESI: 00000000000000000000, Gateway Address: 0.0.0.0, VNI Label 50901, MPLS VPN Label 0
      Extended Community: RT:1:1 MVPN AS:65001:0.0.0.0
```

```
        MVPN VRF:172.16.255.4:2

 ENCAP:8

Router MAC:7C21.0DBD.9548


      Originator: 172.16.255.4, Cluster list: 172.16.255.1
      rx pathid: 0, tx pathid: 0x0
      Updated on Jan 13 2021 19:09:31 UTC
  Refresh Epoch 2
  Local


MVPN VRF:172.16.255.4:2


<-- MVPN VRI


Router MAC:7C21.0DBD.9548 <-- Leaf-02 RMAC
```

第1步(Leaf-03)：收到IGMP成員報告

<#root>

```
Leaf-03#

sh ip igmp snooping groups


Vlan     Group            Type                Version        Port List
------------------------------------------------------------------------
102      224.0.1.40       igmp                v2             Gi1/0/10

102      226.1.1.1        igmp                v2             Gi1/0/10   <-- Client has joined
```

第2步（枝葉–03）：建立MVPN第6類，傳送到RP，由RP（枝葉–02）接收

<#root>

```
#### Type-6 from the Receiver VTEP perspective ###


Leaf-03#

sh bgp ipv4 mvpn all route-type 6 1:1 65001 10.2.255.255 226.1.1.1  <-- Source is RP Loopback


...or you can also use:
Leaf-03#

sh bgp ipv4 mvpn


detail [6][1:1][65001][10.2.255.255/32][226.1.1.1/32]/22
```

```
BGP routing table entry for [6][1:1][65001][10.2.255.255/32][226.1.1.1/32]/22, version 13
Paths: (1 available, best #1, table MVPNv4-BGP-Table)
  Advertised to update-groups:
      1
  Refresh Epoch 1
  Local
```

**0.0.0.0 from 0.0.0.0 (172.16.255.6) <-- Generated locally**

```
      Origin incomplete, localpref 100, weight 32768, valid, sourced, local, best
```

**Extended Community: RT:172.16.255.4:2 <-- VRI Ext Comm added from EVPN Type-5**

```
      rx pathid: 2, tx pathid: 0x0
      Updated on Jan 14 2021 14:51:29 UTC
```

**#### Type-6 from the RP perspective  ###**

```
Leaf-02#
```

**sh bgp ipv4 mvpn all route-type 6 1:1 65001 10.2.255.255 226.1.1.1 <-- type-6, RD 1:1, AS 65001, Source/**

```
...or you can also use:
Leaf-02#
```

**sh bgp ipv4 mvpn detail [6][1:1][65001][10.2.255.255/32][226.1.1.1/32]/22**

```
BGP routing table entry for
```

**[6]**

```
[1:1][65001][10.2.255.255/32][226.1.1.1/32]/22, version 25
Paths: (2 available, best #1, table MVPNv4-BGP-Table)
   Flag: 0x100
   Not advertised to any peer
   Refresh Epoch 2
   Local
     172.16.255.6 (metric 3) from 172.16.255.1 (172.16.255.1)
       Origin incomplete, metric 0, localpref 100, valid, internal, best
```

**Extended Community: RT:172.16.255.4:2 <-- Contains VRI learned from EVPN Type-5**

**Originator: 172.16.255.6**

```
, Cluster list: 172.16.255.1
```

**<-- Sent from Leaf03 IP to RP**

```
      rx pathid: 0, tx pathid: 0x0
      Updated on Jan 14 2021 14:54:29 UTC
```

## 第1步和第2步調試（枝葉–01）：IGMP報告、EVPN源查詢和MVPN第6類建立

<#root>

**debug ip igmp vrf green 226.1.1.1**

**debug bgp ipv4 mvpn updates**

**debug bgp ipv4 mvpn updates events**

**### Client sends IGMP membership report ###**

**### IGMP processes this IGMP report ###**

*Feb 1 21:13:19.029: IGMP(2): Received v2 Report on Vlan102 from 10.1.102.12 for 226.1.1.1

**<--- IGMP processes received report**

*Feb 1 21:13:19.029: IGMP(2): Received Group record for group 226.1.1.1, mode 2 from 10.1.102.12 for 0
*Feb 1 21:13:19.029: IGMP(2): WAVL Insert group: 226.1.1.1 interface: Vlan102 Successful
*Feb 1 21:13:19.029: IGMP(2): Switching to EXCLUDE mode for 226.1.1.1 on Vlan102
*Feb 1 21:13:19.029: IGMP(2): Updating EXCLUDE group timer for 226.1.1.1
*Feb 1 21:13:19.029: IGMP(2): MRT Add/Update Vlan102 for (*,226.1.1.1) by 0

**<--- Notify MRT to add Vlan 102 into Outgoing interface list**

**### BGP is informed by IGMP, does an EVPN source lookup, creates the MVPN Type-6 route, sends to RR ###**

**(**

Without the EVPN Type-5 prefix already in BGP you see IGMP debugs trigger, but no subsequent BGP debugs

*Feb 1 21:13:19.033: BGP[15] MVPN:

**add c-route, type 6**

, bs len 0 asn=0, rd=1:1,

**<-- Start creation of Type-6 C-multicast Shared Tree Join**

*Feb 1 21:13:19.033:

**source=10.2.255.255**

/4,

**<-- RP loopback255**

*Feb 1 21:13:19.033: group=226.1.1.1/4,

**<-- Group IP**

```
*Feb 1 21:13:19.033:
```

**nexthop=172.16.254.4**

```
,
```

**<-- Global Next-Hop learned from EVPN VRI**

```
*Feb 1 21:13:19.033: len left = 0
*Feb 1 21:13:19.033: BGP[14]
```

**MVPN umh lookup:**

```
 vrfid 2, source 10.2.255.255
```

**<-- UMH (upstream multicast hop) as found in the RT of the EVPN type-5**

```
*Feb 1 21:13:19.033: BGP[4] MVPN umh lookup: vrfid 2, source 10.2.255.255, net 1:1:10.2.255.255/32, 1:1
```

**<-- EVPN info adding to MVPN**

```
*Feb 1 21:13:19.033: BGP: MVPN(15) create local route [6][1:1][65001][10.2.255.255/32][226.1.1.1/32]/22
```

**<--- MVPN creating type-6**

```
*Feb 1 21:13:19.033: BGP[15] MVPN: add c-route, type 6, bs len 0 asn=65001, rd=1:1,
*Feb 1 21:13:19.033: source=10.2.255.255/4,
*Feb 1 21:13:19.033: group=226.1.1.1/4,
*Feb 1 21:13:19.033: nexthop=172.16.254.4,
*Feb 1 21:13:19.033: len left = 0
*Feb 1 21:13:19.033: BGP[14] MVPN umh lookup: vrfid 2, source 10.2.255.255
*Feb 1 21:13:19.033: BGP[4] MVPN umh lookup: vrfid 2, source 10.2.255.255, net 1:1:10.2.255.255/32, 1:1
*Feb 1 21:13:19.034: BGP(15): skip vrf default table RIB route [6][1:1][65001][10.2.255.255/32][226.1.1
*Feb 1 21:13:19.034: BGP(15): 172.16.255.1 NEXT_HOP self is set for sourced RT Filter for net [6][1:1][
*Feb 1 21:13:19.034: BGP(15): (base)
```

**172.16.255.1 send UPDATE**

```
 (format) [6][1:1][65001][10.2.255.255/32][226.1.1.1/32]/22, next 172.16.255.6, metric 0, path Local, e
```

**<-- Advertise to RR**

```
 (
```

**172.16.255.1)**

第3步和第4步(Leaf-01):從FHR的角度，驗證S、G建立和註冊事件（S、G建立和註冊幾乎同時發生）

3.資料流量在FHR VTEP開始並建立S，G。此處適用「未檢測到的組播源」一節中註明的要求。

4. Leaf-01通過其PIM隧道向RP執行源註冊

**<#root>**

```
Leaf-01#
```

**debug ip pim vrf green 226.1.1.1**

PIM debugging is on

Leaf-01#

**debug ip mrouting vrf green 226.1.1.1**

IP multicast routing debugging is on

**### Debugs for PIM and Mroute show creation of S,G and PIM register encap event ###**

*Jan 29 18:18:37.602: PIM(2): Building Periodic (*,G) Join / (S,G,RP-bit) Prune message for 226.1.1.1
*Jan 29 18:18:58.426:

**MRT(2): (10.1.101.11,226.1.1.1), RPF install from /0.0.0.0 to Vlan101/10.1.101.11<-- S,G is creation me**

*Jan 29 18:18:58.427:

**PIM(2): Adding register encap tunnel (Tunnel4) as forwarding interface of (10.1.101.11, 226.1.1.1). <--**

*Jan 29 18:18:58.427: MRT(2): Set the F-flag for (*, 226.1.1.1)
*Jan 29 18:18:58.427: MRT(2): Set the F-flag for (10.1.101.11, 226.1.1.1)
*Jan 29 18:18:58.428:

**MRT(2): Create (10.1.101.11,226.1.1.1), RPF (Vlan101, 10.1.101.11, 0/0) <-- S,G is creation message (MR**

*Jan 29 18:18:58.428: MRT(2): Set the T-flag for (10.1.101.11, 226.1.1.1)

**### Tunnel 4 is PIM Register tunnel (Encap: encapsulate in tunnel to RP) ####**

Leaf-01#

**sh int tunnel4**

Tunnel4 is up, line protocol is up
  Hardware is Tunnel
  Description:

**Pim Register Tunnel (Encap) for RP 10.2.255.255 on VRF green <-- VRF green for Leaf-02 RP**

  Interface is unnumbered.

**Using address of Loopback901 (10.1.255.1)  <-- Local Loopback**

**### S,G is created when Source sends data traffic ###**

Leaf-01#

**sh ip mroute vrf green 226.1.1.1**

IP Multicast Routing Table
<...snip...>
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
 Timers: Uptime/Expires

```
 Interface state: Interface, Next-Hop or VCD, State/Mode

(*, 226.1.1.1), 00:00:16/stopped, RP 10.2.255.255, flags: SPF
  Incoming interface: Vlan901, RPF nbr 172.16.254.4
  Outgoing interface list: Null


(10.1.101.11, 226.1.1.1)

, 00:00:16/00:02:47, flags: FTGqx


Incoming interface: Vlan101

,

RPF nbr 10.1.101.11

,

Registering <-- S,G created, in Register state, RPF IP is the /32 host prefix for this source



 Outgoing interface list:



Vlan901

, Forward/Sparse, 00:00:16/00:02:43

<-- OIF is the L3VNI SVI


#### Checking S,G in Hardware ###

Leaf-01#

sh platform software fed switch active ip mfib vrf green 226.1.1.1/32 10.1.101.11 de

MROUTE ENTRY

vrf 2

 (10.1.101.11, 226.1.1.1/32)

<-- VRF 2 is the ID for vrf green


  HW Handle: 140213987784872 Flags: {Svl}

RPF interface: Vlan101

(59)): SVI

<-- RPF is Direct connected on a Local Subnet


  HW Handle:140213987784872 Flags:A
Number of OIF: 2
Flags: 0x4

Pkts : 336         <-- packets that used this adjacency (similar to mfib command, but shown at the FED l


OIF Details:
```

**Vlan101 A <-- Accept interface is programmed correctly**

**Vlan901 F {Remote} <-- Forward interface is L3VNI SVI**

**(Adj: 0x5f ) <-- Validate this Adj**

Htm: 0x7f861cf071b8 Si: 0x7f861cf04838 Di: 0x7f861cf097a8 Rep_ri: 0x7f861ceecb38

**### Check ADJ 0x5f for next hop details ###**

Leaf-01#

**sh platform software fed switch active ip adj**

IPV4 Adj entries
dest if_name dst_mac si_hdl ri_hdl pd_flags

**adj_id**

Last-modified
---- ------- ------- ------ ------ -------- ----- ---

**239.1.1.1**

**nve1.VNI50901**

4500.0000.0000 0x7f861ce659b8 0x7f861ce65b68 0x60

**0x5f**

2021/01/29 17:07:06.568

**Dest = MDT default group 239.1.1.1**

**Outgoing Interface = Nve1 using L3 VNI 50901**

第4步（枝葉–02）：從RP角度，確認源註冊到達RP並建立S、G。

<#root>

**### PIM debugs showing PIM register event ###**

Leaf-02#

**debug ip pim vrf green 226.1.1.1**

PIM debugging is on

*Jan 29 18:21:35.500: PIM(2): Building Periodic (*,G) Join / (S,G,RP-bit) Prune message for 226.1.1.1

***Jan 29 18:21:35.500: PIM: rp our address <-- Leaf-02 is the RP**

***Jan 29 18:21:41.005: PIM(2): Received v2 Register on Vlan901 from 10.1.255.1 <--- IP of Lo901 on Leaf-0**

***Jan 29 18:21:41.005: for 10.1.101.11, group 226.1.1.1**

***Jan 29 18:21:41.006: PIM(2): Adding register decap tunnel (Tunnel4) as accepting interface of (10.1.101**

*Jan 29 18:21:41.008: PIM(2): Upstream mode for (10.1.101.11, 226.1.1.1) changed from 1 to 2

**### Tunnel 4 is PIM Register tunnel (decap) ####**

Leaf-02#

**sh int tunnel 4**

Tunnel4 is up, line protocol is up
  Hardware is Tunnel
  Description:

**Pim Register Tunnel (Decap) for RP 10.2.255.255 on VRF green <-- decap side of register tunnel**

  Interface is unnumbered.

**Using address of Loopback255 (10.2.255.255) <-- RP IP**

**### Mroute debugs show pim Register triggering S,G ###**

Leaf-02#

**debug ip mrouting vrf green 226.1.1.1**

IP multicast routing debugging is on

*Jan 29 20:44:31.483: MRT(2):

**(10.1.101.11,226.1.1.1)**

,

**RPF install from /0.0.0.0 to Vlan901/172.16.254.3 <-- RPF is to Leaf-01**

*Jan 29 20:44:31.485: MRT(2):

**Create (10.1.101.11,226.1.1.1), RPF (Vlan901, 172.16.254.3, 200/0) <-- Create the S,G**

*Jan 29 20:44:33.458: MRT(2):

**Set the T-flag for (10.1.101.11, 226.1.1.1)** **<-- Set SPT bit for S,G**

**### S,G is created and traffic is now sent along the *,G shared tree ###**
**Leaf-02#sh ip mroute vrf green**

```
IP Multicast Routing Table
Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C - Connected,
       L - Local, P - Pruned, R - RP-bit set, F - Register flag,
       T - SPT-bit set, J - Join SPT, M - MSDP created entry, E - Extranet,
       X - Proxy Join Timer Running, A - Candidate for MSDP Advertisement,
       U - URD, I - Received Source Specific Host Report,
       Z - Multicast Tunnel, z - MDT-data group sender,
       Y - Joined MDT-data group, y - Sending to MDT-data group,
       G - Received BGP C-Mroute, g - Sent BGP C-Mroute,
       N - Received BGP Shared-Tree Prune, n - BGP C-Mroute suppressed,
       Q - Received BGP S-A Route, q - Sent BGP S-A Route,
       V - RD & Vector, v - Vector, p - PIM Joins on route,
       x - VxLAN group, c - PFP-SA cache created entry,
       * - determined by Assert, # - iif-starg configured on rpf intf,
       e - encap-helper tunnel flag
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
 Timers: Uptime/Expires
 Interface state: Interface, Next-Hop or VCD, State/Mode

(*, 226.1.1.1), 00:05:49/stopped, RP 10.2.255.255, flags:
```

**SGx <-- Sparse, Received BGP C-Mroute**

**Incoming interface: Null, RPF nbr 0.0.0.0** **<-- RP is us (Incoming Interface Null with**

```
  Outgoing interface list:
    Vlan901, Forward/Sparse, 00:05:49/stopped

(
```

**10.1.101.11, 226.1.1.1**

```
), 00:01:22/00:01:41, flags:
```

**PTXgx <-- Pruned, SPT bit, Sent BGP C-Mroute**

```
  Incoming interface: Vlan901,
```

**RPF nbr 172.16.254.3** **<-- Leaf-01 is RPF next hop**

```
  Outgoing interface list: Null
```

第5步（枝葉–02）：RP具有接收器，因此立即建立了第7類MVPN源樹加入路由

<#root>

Leaf-02#

**sh ip mroute vrf green 226.1.1.1**

<...snip...>

**(*, 226.1.1.1)**

, 00:02:22/00:00:37, RP 10.2.255.255, flags: SGx
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:

    **Vlan901, Forward/Sparse, 00:02:22/00:00:37   <-- L3 VNI is populated from Receiver BGP Type-6 join**

**#### Debugs showing Type-7 creation from RP ####**

Leaf-02#

**debug bgp ipv4 mvpn updates**

BGP updates debugging is on for address family: MVPNv4 Unicast

Leaf-02#

**debug bgp ipv4 mvpn updates events**

BGP update events debugging is on for address family: MVPNv4 Unicast

*Jan 29 18:21:41.008: BGP[15]

**MVPN: add c-route, type 7**

, bs len 0 asn=0, rd=1:1,
*Jan 29 18:21:41.008:

**source=10.1.101.11/4,**

*Jan 29 18:21:41.008:

**group=226.1.1.1/4,**

*Jan 29 18:21:41.008:

**nexthop=172.16.254.3**

,

**<-- Leaf-01 Global next hop**

*Jan 29 18:21:41.008: len left = 0
*Jan 29 18:21:41.008: BGP[14] MVPN umh lookup: vrfid 2, source 10.1.101.11
*Jan 29 18:21:41.008: BGP[4] MVPN umh lookup: vrfid 2, source 10.1.101.11, net 1:1:10.1.101.11/32, 1:1:

**0x10B:172.16.255.3:2**

,

**<-- This is the VRI picked up from the EVPN Type-2**

*Jan 29 18:21:41.009: BGP:

**MVPN(15) create local route [7][172.16.254.3:101][65001][10.1.101.11/32][226.1.1.1/32]/22**

*Jan 29 18:21:41.009:

**BGP[15] MVPN: add c-route, type 7, bs len 0 asn=65001, rd=1:1,**

*Jan 29 18:21:41.009: source=10.1.101.11/4,
*Jan 29 18:21:41.009: group=226.1.1.1/4,
*Jan 29 18:21:41.009: nexthop=172.16.254.3,
*Jan 29 18:21:41.009: len left = 0
*Jan 29 18:21:41.009: BGP[14] MVPN umh lookup: vrfid 2, source 10.1.101.11
*Jan 29 18:21:41.009: BGP[4] MVPN umh lookup: vrfid 2, source 10.1.101.11, net 1:1:10.1.101.11/32, 1:1:

**### Type-7 Locally created on RP and sent to Source Leaf-01 ###**

Leaf-02#

**sh bgp ipv4 mvpn all**

BGP table version is 81, local router ID is 172.16.255.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
x best-external, a additional-path, c RIB-compressed,
t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path

**Route Distinguisher: 172.16.254.3:101 <-- Note the VRI is learnt from Leaf-01**

 *>

**[7][172.16.254.3:101]**

[65001]

**[10.1.101.11/32][226.1.1.1/32]**

/22

**<-- [7] = type-7 for this S,G / VRI 172.16.254.3:101 learned from Leaf-01**

  **0.0.0.0**

**32768**

 ?

**<-- 0.0.0.0 locally originated**

**with local Weight**

第6步(Leaf-01):Source Leaf-01接收並安裝MVPN Route-Type 7。（L3 VNI SVI安裝為S、G的轉發介面）

<#root>

**### Received Type-7 from Leaf-02 RP ###**

Leaf-01#

**debug bgp ipv4 mvpn updates**

BGP updates debugging is on for address family: MVPNv4 Unicast
Leaf-01#

**debug bgp ipv4 mvpn updates events**

BGP update events debugging is on for address family: MVPNv4 Unicast

*Jan 29 18:18:58.457:

**BGP(15): 172.16.255.1 rcvd UPDATE w/ attr: nexthop 172.16.255.4, origin ?, localpref 100, metric 0, orig**

*Jan 29 18:18:58.457: BGP(15): 172.16.255.1

**rcvd [7][172.16.254.3:101][65001][10.1.101.11/32][226.1.1.1/32]/22 <-- Received |**

*Jan 29 18:18:58.457: BGP(15): skip vrf default table RIB route [7][172.16.254.3:101][65001][10.1.101.1
*Jan 29 18:18:58.458: BGP(15): add RIB route (0:0)[7][1:1][65001][10.1.101.11/32][226.1.1.1/32]/22

**### PIM updated by MVPN to install L3 VNI in Outgoing Interface List ###**

Leaf-01#

**debug ip pim vrf green 226.1.1.1**

PIM debugging is on
Leaf-01#

**debug ip mrouting vrf green 226.1.1.1**

IP multicast routing debugging is on

*Jan 29 18:18:58.458: PIM(2):

**Join-list: (10.1.101.11/32, 226.1.1.1), S-bit set, BGP C-Route**

```
*Jan 29 18:18:58.459: MRT(2):
WAVL Insert VxLAN interface: Vlan901 in (10.1.101.11,226.1.1.1) Next-hop: 239.1.1.1 VNI 50901 Successful

*Jan 29 18:18:58.459: MRT(2): set min mtu for (10.1.101.11, 226.1.1.1) 18010->9198
*Jan 29 18:18:58.460:
MRT(2): Add Vlan901/239.1.1.1/50901 to the olist of (10.1.101.11, 226.1.1.1), Forward state - MAC not bu

*Jan 29 18:18:58.460: PIM(2): Add Vlan901/0.0.0.0 to (10.1.101.11, 226.1.1.1), Forward state, by BGP SG
*Jan 29 18:18:58.460: MRT(2): Add Vlan901/239.1.1.1/50901to the olist of (10.1.101.11, 226.1.1.1), Forw
```

第7步(Leaf-01):Leaf-01通告S、G的MVPN源A-D Type-5

```
<#root>

Leaf-01#
debug bgp ipv4 mvpn updates

BGP updates debugging is on for address family: MVPNv4 Unicast
Leaf-01#
debug bgp ipv4 mvpn updates events

BGP update events debugging is on for address family: MVPNv4 Unicast

*Jan 29 18:18:58.461: BGP(15): nettable_walker
[5][1:1][10.1.101.11][226.1.1.1]/18 route sourced locally <-- BGP determines route is local to Leaf-01

*Jan 29 18:18:58.461: BGP(15): delete RIB route (0:0)[5][1:1][10.1.101.11][226.1.1.1]/18
*Jan 29 18:18:58.461: BGP(15): 172.16.255.1 NEXT_HOP self is set for sourced RT Filter for net [5][1:1]
*Jan 29 18:18:58.461: BGP(15): (base) 172.16.255.1
send UPDATE (format) [5][1:1][10.1.101.11][226.1.1.1]/18, next 172.16.255.3, metric 0, path Local, exter
```

第8步(Leaf-03)：接收器VTEP獲取型別5並安裝源A-D路由用於S、G

```
<#root>

Leaf-03#
debug bgp ipv4 mvpn updates

BGP updates debugging is on for address family: MVPNv4 Unicast
Leaf-03#
debug bgp ipv4 mvpn updates events

BGP update events debugging is on for address family: MVPNv4 Unicast
```

```
*Jan 29 19:18:53.318: BGP(15): 172.16.255.1 rcvd UPDATE w/ attr: nexthop 172.16.255.3, origin ?, localp
*Jan 29 19:18:53.319: BGP(15): 172.16.255.1 rcvd [5][1:1][10.1.101.11][226.1.1.1]/18   <-- Type-5 Receiv

*Jan 29 19:18:53.319: BGP(15): skip vrf default table RIB route [5][1:1][10.1.101.11][226.1.1.1]/18


Leaf-03#
sh bgp ipv4 mvpn all route-type 5 10.1.101.11 226.1.1.1
...or you can also use:
Leaf-03#
sh bgp ipv4 mvpn detail [5][1:1][10.1.101.11][226.1.1.1]/18


BGP routing table entry for
[5][1:1][10.1.101.11][226.1.1.1]/18
, version 41
<-- Type-5 A-D route from Leaf-01


Paths: (2 available, best #2, table MVPNv4-BGP-Table, not advertised to EBGP peer)
Flag: 0x100
Not advertised to any peer
Refresh Epoch 1
Local


 172.16.255.3
 (metric 3) from 172.16.255.1 (172.16.255.1)
<-- Leaf-01 IP


    Origin incomplete, metric 0, localpref 100, valid, internal, best
    Community: no-export
     Extended Community: RT:1:1


Originator: 172.16.255.3
, Cluster list: 172.16.255.1
     rx pathid: 0, tx pathid: 0x0
     Updated on Jan 29 2021 19:18:53 UTC
```

第9步（枝葉–03）：S，G建立，枝葉–03傳送MVPN型別–7以加入SPT樹，並開始接受流量

<#root>

```
debug ip mrouting vrf green 226.1.1.1
debug bgp ipv4 mvpn updates
debug bgp ipv4 mvpn updates events


### Debug of Mrouting shows S,G create and call to BGP to create Type-7 BGP S,G join ###
```

*Feb 12 19:34:26.045:

**MRT(2):**

**(10.1.101.11,226.1.1.1), RPF install from /0.0.0.0 to Vlan901/172.16.254.3 <-- RPF check done as first c**

*Feb 12 19:34:26.046:

**MRT(2):**

**Create (10.1.101.11,226.1.1.1), RPF (Vlan901, 172.16.254.3, 200/0)  <-- RPF successful Creating S,G**

*Feb 12 19:34:26.047: MRT(2): WAVL Insert interface: Vlan102 in (10.1.101.11,226.1.1.1) Successful
*Feb 12 19:34:26.047: MRT(2): set min mtu for (10.1.101.11, 226.1.1.1) 18010->9198
*Feb 12 19:34:26.047: MRT(2): Set the T-flag for (10.1.101.11, 226.1.1.1)
*Feb 12 19:34:26.048:

**MRT(2):**

**Add Vlan102/226.1.1.1 to the olist of (10.1.101.11, 226.1.1.1)**

, Forward state - MAC not built

**<-- Adding Vlan102 Receiver SVI into OIF list**

*Feb 12 19:34:26.048:

**MRT(2): Set BGP Src-Active for (10.1.101.11, 226.1.1.1) <-- Signaling to BGP that this Source is seen a**

**### BGP Type-7 created ###**

Leaf-03#

**sh bgp ipv4 mvpn all**

Route Distinguisher:

**172.16.254.3:101                                <-- VRI Route Distinguisher**

*>

**[7]**

[

**172.16.254.3:101]**

[65001]

**[10.1.101.11/32][226.1.1.1/32]**

/22

**<-- Type [7], VRI, S,G info**

**0.0.0.0**

```
                              32768 ?
```

**<-- created locally**

```
Leaf-03#
```

**sh ip mroute vrf green 226.1.1.1 10.1.101.11**

```
IP Multicast Routing Table
Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C - Connected,
       L - Local, P - Pruned, R - RP-bit set, F - Register flag,
```

**T - SPT-bit set**

```
, J - Join SPT, M - MSDP created entry, E - Extranet,
       X - Proxy Join Timer Running, A - Candidate for MSDP Advertisement,
       U - URD, I - Received Source Specific Host Report,
       Z - Multicast Tunnel, z - MDT-data group sender,
       Y - Joined MDT-data group, y - Sending to MDT-data group,
       G - Received BGP C-Mroute,
```

**g - Sent BGP C-Mroute**

```
,
       N - Received BGP Shared-Tree Prune, n - BGP C-Mroute suppressed,
```

**Q - Received BGP S-A Route**

```
, q - Sent BGP S-A Route,
       V - RD & Vector, v - Vector, p - PIM Joins on route,
       x - VxLAN group, c - PFP-SA cache created entry,
       * - determined by Assert, # - iif-starg configured on rpf intf,
       e - encap-helper tunnel flag
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
 Timers: Uptime/Expires
 Interface state: Interface, Next-Hop or VCD, State/Mode

(10.1.101.11, 226.1.1.1), 00:08:41/00:02:13,
```

**flags: TgQ <-- SPT bit, Sent MVPN type-7, Received MVPN type-5**

**Incoming interface: Vlan901, RPF nbr 172.16.254.3     <-- Receive from L3VNI via Leaf-01 IP next hop**

```
  Outgoing interface list:
```

**Vlan102, Forward/Sparse, 00:08:41/00:02:22          <-- Send to host in Vlan 102**

## 第10步(Leaf-01):Leaf-01從Leaf-03接收並安裝MVPN Type-7

<#root>

**debug bgp ipv4 mvpn updates**

```
debug bgp ipv4 mvpn updates events


### Type-7 Received from Leaf-03 VTEP and installed into RIB ###

*Feb 12 19:55:29.000: BGP(15): 172.16.255.1
rcvd [7][172.16.254.3:101][65001][10.1.101.11/32][226.1.1.1/32]/22   <-- Type-7 from Leaf-03

*Feb 12 19:55:29.000: BGP(15): skip vrf default table RIB route [7][172.16.254.3:101][65001][10.1.101.1
*Feb 12 19:55:29.000: BGP(15): add RIB route (0:0)[7][1:1][65001][10.1.101.11/32][226.1.1.1/32]/22
```

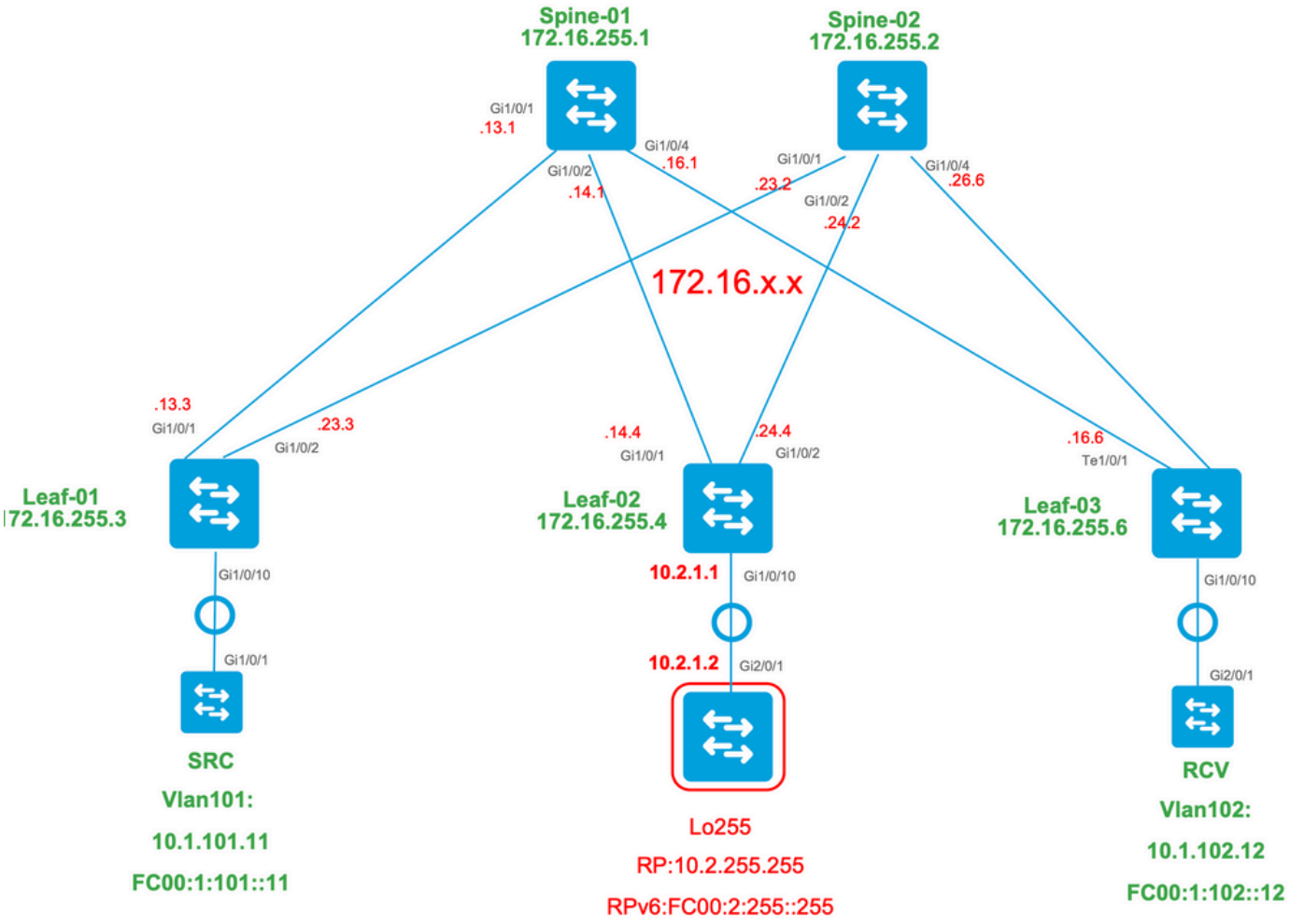
## 場景4：交換矩陣外部的RP（從邊界枝葉02從IP空間匯入RP）

此案例與案例2基本相同。整個交換矩陣使用單個RP。不同之處在於，RP IP必須從非交換矩陣IP空間匯入到交換矩陣，並通告到BGP。

本節顯示了與方案3的區別。相同的步驟和方法僅在場景3中說明

- 請參閱從方案3驗證此方案所需的事件順序，因為BGP和PIM操作相同

網路圖表




驗證邊界交換機從IP匯入到交換矩陣

此設計與場景3的主要區別是需要首先將RP IP從IP空間匯入EVPN。

Border需要包含特定命令以匯入/匯出交換矩陣和IP空間：

- route-target <value> spitching命令在VRF配置部分
- 在BGP vrf地址系列下通告l2vpn evpn

驗證(Leaf-02)：配置

<#root>

```
Leaf-02#

sh run vrf green
Building configuration...

Current configuration : 1533 bytes

vrf definition green
rd 1:1
!
address-family ipv4
mdt auto-discovery vxlan
mdt default vxlan 239.1.1.1
```

```
mdt overlay use-bgp
route-target export 1:1

route-target import 1:1

route-target export 1:1 stitching    <-- BGP-EVPN fabric redistributes the stitching routes between the

route-target import 1:1 stitching

exit-address-family
Leaf-02#
sh run | sec router bgp

address-family ipv4 vrf green       <--- BGP VRF green address-family

advertise l2vpn evpn                <--- Use the 'advertise l2vpn evpn' command and 'export stitching' F

redistribute connected
redistribute static
redistribute ospf 2 match internal external 1 external 2   <-- Learning via external OSPF neighbor in VR

exit-address-family
```

驗證(Leaf-02)：字首匯入和通告

<#root>

```
debug bgp vpnv4 unicast updates

debug bgp vpnv4 unicast updates events

debug bgp l2vpn evpn updates

debug bgp l2vpn evpn updates events

*Feb 15 15:30:54.407: BGP(4): redist event (1) request for 1:1:10.2.255.255/32
```

```
*Feb 15 15:30:54.407: BGP(4) route 1:1:10.2.255.255/32 gw-1 10.2.1.2 src_proto (ospf) path-limit 1
*Feb 15 15:30:54.407: BGP(4): route 1:1:10.2.255.255/32 up
*Feb 15 15:30:54.407: bgp_ipv4set_origin: redist 1, opaque 0x0, net 10.2.255.255
*Feb 15 15:30:54.407: BGP(4): sourced route for 1:1:10.2.255.255/32 path 0x7FF8065EB9C0 id 0 gw 10.2.1.
*Feb 15 15:30:54.408: BGP(4): redistributed route 1:1:10.2.255.255/32 added gw 10.2.1.2
*Feb 15 15:30:54.408: BGP: topo green:VPNv4 Unicast:base Remove_fwdroute for 1:1:10.2.255.255/32

*Feb 15 15:30:54.408: BGP(4): 1:1:10.2.255.255/32 import vpn re-orig or locally sourced or learnt from C



*Feb 15 15:30:54.409: BGP(10): update modified for [5][1:1][0][32][10.2.255.255]/17


*Feb 15 15:30:54.409: BGP(10): 172.16.255.1

NEXT_HOP set to vxlan local vtep-ip 172.16.254.4



for net [5][1:1][0][32][10.2.255.255]/17   <-- Set NH to Leaf-02 loopback


*Feb 15 15:30:54.409: BGP(10): update modified for [5][1:1][0][32][10.2.255.255]/17

*Feb 15 15:30:54.409: BGP(10): (base) 172.16.255.1 send UPDATE (format) [5][1:1][0][32][10.2.255.255]/17
<-- BGP EVPN Type update created from Non-fabric Imported prefix and sent to RR


### Verify the NLRI is learned and Imported on Border Leaf-02 ###

Leaf-02#

sh bgp vpnv4 unicast all


BGP table version is 39, local router ID is 172.16.255.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

 Network Next Hop Metric LocPrf Weight Path
Route Distinguisher: 1:1 (default for vrf green)

AF-Private Import to Address-Family: L2VPN E-VPN, Pfx Count/Limit: 3/1000  <-- Prefix Import details. (N


 *>

10.2.255.255/32  10.2.1.2                2         32768 ?          <-- Locally redistributed, Next hop


Leaf-02#

sh bgp l2vpn evpn all route-type 5 0 10.2.255.255 32

...or you can also use:
Leaf-02#

sh bgp l2vpn evpn detail [5][1:1][0][32][10.2.255.255]/17

BGP routing table entry for

[5][1:1][0][32][10.2.255.255]
```

```
/17, version 69
Paths: (1 available, best #1, table EVPN-BGP-Table)
  Advertised to update-groups:
     2
  Refresh Epoch 1


 Local, imported path from base



10.2.1.2 (via vrf green) from 0.0.0.0 (172.16.255.4)                <-- Imported to EVPN Fabric table fr


      Origin incomplete, metric 2, localpref 100, weight 32768, valid, external, best
      EVPN ESI: 00000000000000000000, Gateway Address: 0.0.0.0,

local vtep: 172.16.254.4, VNI Label 50901,

MPLS VPN Label 17

<-- VTEP IP of Leaf-02, L3VNI label


      Extended Community: RT:1:1 OSPF DOMAIN ID:0x0005:0x000000020200
        MVPN AS:65001:0.0.0.0

MVPN VRF:172.16.255.4:2

 ENCAP:8

<-- MVPN VRI created


        Router MAC:7C21.0DBD.9548 OSPF RT:0.0.0.0:2:0
        OSPF ROUTER ID:10.2.255.255:0
      rx pathid: 0, tx pathid: 0x0
      Updated on Feb 15 2021 15:30:54 UTC
```

## 驗證（枝葉–02）：到RP的邊界路徑

```
<#root>

Leaf-02#sh ip mroute vrf green

IP Multicast Routing Table
Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C - Connected,
       L - Local, P - Pruned, R - RP-bit set, F - Register flag,
       T - SPT-bit set, J - Join SPT, M - MSDP created entry, E - Extranet,
       X - Proxy Join Timer Running, A - Candidate for MSDP Advertisement,
       U - URD, I - Received Source Specific Host Report,
       Z - Multicast Tunnel, z - MDT-data group sender,
       Y - Joined MDT-data group, y - Sending to MDT-data group,
       G - Received BGP C-Mroute, g - Sent BGP C-Mroute,
       N - Received BGP Shared-Tree Prune, n - BGP C-Mroute suppressed,
       Q - Received BGP S-A Route, q - Sent BGP S-A Route,
       V - RD & Vector, v - Vector, p - PIM Joins on route,
       x - VxLAN group, c - PFP-SA cache created entry,
       * - determined by Assert, # - iif-starg configured on rpf intf,
```

```
       e - encap-helper tunnel flag
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
 Timers: Uptime/Expires
 Interface state: Interface, Next-Hop or VCD, State/Mode


(*, 226.1.1.1)

, 2d21h/stopped,

RP 10.2.255.255

, flags: SJGx

<-- *,G for group and Non-fabric RP IP



 Incoming interface: Vlan2001

,

RPF nbr 10.2.1.2            <-- RPF neighbor is populated for IP next hop outside VxLAN


  Outgoing interface list:

Vlan901, Forward/Sparse, 01:28:47/stopped              <-- Outgoing is L3VNI SVI
```

## 方案5：資料MDT

### 驗證MDT資料組

MDT資料組類似於其MDT預設組，其中要封裝的TRM的外部隧道組。但是，與「MDT預設值」不同，此組只有擁有TRM組感興趣的接收者才具有VTEP的加入此樹。

### 所需配置

<#root>

```
vrf definition green
rd 1:1
!
address-family ipv4
mdt auto-discovery vxlan
mdt default vxlan 239.1.1.1

mdt data vxlan 239.1.2.0 0.0.0.255  <-- Defines MDT Data underlay group address range



mdt data threshold 1



<-- Defines the threshold before cutting over to the Data group (In Kilobits per second)
```

```
mdt overlay use-bgp spt-only
route-target export 1:1
route-target import 1:1
route-target export 1:1 stitching
route-target import 1:1 stitching
exit-address-family
!
```

請檢查MDT組是否已在源端正確程式設計

- MDT組的傳入介面是源端環回
- MDT組的傳出介面是底層介面

驗證Leaf-01:MRIB/MFIB中的MDT mroute是否正確

<#root>

Leaf-01#

**sh ip mroute 239.1.2.0 172.16.254.3**

<snip>

**(172.16.254.3, 239.1.2.0)**

, 00:01:19/00:02:10, flags: FT
  Incoming interface:

**Loopback1**

, RPF nbr

**0.0.0.0**

**<-- IIF is local loopback with 0.0.0.0 RPF indicating local**

  Outgoing interface list:

    **TenGigabitEthernet1/0/1**

, Forward/Sparse, 00:01:19/00:03:10

**<-- OIF is the underlay uplink**

Leaf-01#

**sh ip mfib 239.1.2.0 172.16.254.3**

<snip>
(172.16.254.3,239.1.2.0) Flags: HW
  SW Forwarding: 2/0/828/0, Other: 0/0/0

  **HW Forwarding: 450/2/834/13**

, Other: 0/0/0

**<-- Hardware counters indicate the entry is operating in hardware and forwarding packets**

**Null0 Flags: A <-- Null0 (Originated locally)**

**TenGigabitEthernet1/0/1**

Flags: F NS

**<-- OIF is into the Underlay (Global routing table)**

Pkts: 0/0/0 Rate: 0 pps

## 驗證MDT組的Leaf-01:FED條目

## <#root>

Leaf-01#

**show platform software fed switch active ip mfib 239.1.2.0/32 172.16.254.3 detail <-- The detail option**

MROUTE ENTRY

**vrf 0 (172.16.254.3, 239.1.2.0/32) <-- vrf 0 = global for this MDT Data S,G pair**

HW Handle: 140028029798744 Flags:

**RPF interface: Null0**

(1)):

**<-- Leaf-01 is the Source(Null0)**

HW Handle:140028029798744 Flags:A
Number of OIF: 2
Flags: 0x4 Pkts : 570

**<-- Packets that used this adjacency (similar to the mfib command, but shown at the FED layer)**

OIF Details:

**TenGigabitEthernet1/0/1 F NS <-- The Underlay Outgoing Interface and F-Forward flag**

**Null0 A <-- The Incoming Interface is local loopback1 and A-Acc**

Htm: 0x7f5ad0fa48b8 Si: 0x7f5ad0fa4258

**Di: 0x7f5ad0fa8948**

Rep_ri: 0x7f5ad0fa8e28

**<--The DI (dest index) handle**

**DI details**

```
----------
Handle:0x7f5ad0fa8948 Res-Type:ASIC_RSC_DI Res-Switch-Num:255 Asic-Num:255 Feature-ID:AL_FID_L3_MULTICA
priv_ri/priv_si Handle:(nil) Hardware Indices/Handles:
```

**index0:0x536e**

```
 mtu_index/l3u_ri_index0:0x0
```

**index1:0x536e**

```
 mtu_index/l3u_ri_index1:0x0 index2:0x536e mtu_index/l3u_ri_index2:0x0 index3:0x536e mtu_index/l3u_ri_i
```

```
<snip>

Brief Resource Information (ASIC_INSTANCE# 3)
---------------------------------------
```

**Destination index = 0x536e**

```
pmap = 0x00000000 0x00000001
```

**pmap_intf : [TenGigabitEthernet1/0/1]  <--FED has the correct programing of the OIF**

```
==============================================================
```

檢查MDT組是否已在接收器端正確程式設計

- MDT組的傳入介面是返回源端環回的RPF介面
- MDT組的傳出介面是Encap/Decap隧道介面

驗證Leaf-02:MRIB/MFIB中的MDT mroute正確

**<#root>**

```
Leaf-03#
```

**sh ip mroute 239.1.2.0 172.16.254.3  <-- This is the Global MDT Data Group**

```
<snip>
(
```

**172.16.254.3, 239.1.2.0**

```
), 00:06:12/00:02:50, flags: JTx
```

**<-- Source is Leaf-01 Loopback1 IP**

```
  Incoming interface: TenGigabitEthernet1/0/1, RPF nbr 172.16.26.2
  Outgoing interface list:
```

**Tunnel0**

```
, Forward/Sparse, 00:06:12/00:02:47
<-- Decap Tunnel

Leaf-03#
sh ip mfib 239.1.2.0 172.16.254.3

<snip>
Default                                                 <-- Global Routing Table

  (
172.16.254.3,239.1.2.0
) Flags: HW
    SW Forwarding: 2/0/828/0, Other: 0/0/0
    HW Forwarding: 760/2/846/13
, Other: 0/0/0
<-- Hardware counters indicate the entry is operating in hardware and forwarding packets

    TenGigabitEthernet1/0/1 Flags: A                    <-- Accept via Underlay (Global) interface

    Tunnel0, VXLAN Decap Flags: F NS                    <-- Forward to VxLAN Decap Tunnel
      Pkts: 0/0/2 Rate: 0 pps
```

## 驗證MDT組的Leaf-02:FED條目

### <#root>

```
Leaf-03#
show platform software fed switch active ip mfib 239.1.2.0/32 172.16.254.3 detail

MROUTE ENTRY
vrf 0 (172.16.254.3, 239.1.2.0/32)  <-- vrf 0 = global for this MDT Data S,G pair
  HW Handle: 140592885196696 Flags:
RPF interface: TenGigabitEthernet1/0/1
(55)):
<-- RPF Interface to 172.16.254.3
  HW Handle:140592885196696 Flags:A
```

```
Number of OIF: 2
Flags: 0x4
```

**Pkts : 800 <-- packets that used this adjacency (similar to mfib command, but**

```
OIF Details:
```

**TenGigabitEthernet1/0/1 A <-- Accept MDT packets from this interface**

**Tunnel0 F NS <-- Forward to Decap Tunnel to remove VxLAN header**

**(Adj: 0x3c ) <-- Tunnel0 Adjacency**

```
Htm: 0x7fde54fb7d68 Si: 0x7fde54fb50d8 Di: 0x7fde54fb4948 Rep_ri: 0x7fde54fb4c58

<snip>
```

**RI details <-- Rewrite Index is used for VxLAN decapsulation**

```
----------
Handle:0x7fde54fb4c58 Res-Type:ASIC_RSC_RI_REP Res-Switch-Num:255 Asic-Num:255 Feature-ID:AL_FID_L3_MUL
priv_ri/priv_si Handle:(nil) Hardware Indices/Handles: index0:0x1a mtu_index/l3u_ri_index0:0x0 index1:0

Brief Resource Information (ASIC_INSTANCE# 0)
----------------------------------------
ASIC# 0
Replication list :
------------------

Total #ri : 6
Start_ri : 26
Common_ret : 0

Replication entry
```

**rep_ri 0x1A**

```
 #elem = 1
0)
```

**ri[0]=0xE803**

```
 Dynamic port=88ri_ref_count:1 dirty=0
<snip>

Leaf-03#
```

**show platfomr software fed switch active fwd-asic resource asic all rewrite-index range 0xE803 0XE803**

```
ASIC#:0 RI:59395
```

**Rewrite_type**

```
:AL_RRM_REWRITE_L2_PAYLOAD_
```

**IPV4_EVPN_DECAP**

```
(118) Mapped_rii:LVX_EVPN_DECAP(143)
<snip>
```

調試MDT資料組

使用MVPN調試檢查Data MDT轉換事件

來源端VTEP

<#root>

```
Leaf#
```

**debug mvpn**

```
<snip>
*Mar 27 12:12:11.115: MVPN: Received local withdraw for (10.1.101.11, 239.1.1.1) with RD: 1:1, Route Ty
*Mar 27 12:12:11.115: MVPN: Sending BGP prefix=[5: 1:1 : (10.1.101.11,239.1.1.1)] len=19, nh 0.0.0.0, W
*Mar 27 12:12:11.115: MVPN: Route Type 5 deleted [(10.1.101.11, 239.1.1.1), nh 0.0.0.0] rd:1:1 send:1
*Mar 27 12:12:11.115: MVPN: Received BGP prefix=[5: 1:1 : (10.1.101.11,239.1.1.1)] len=19, nexthop: UNK
*Mar 27 12:12:11.115: MVPN: Received BGP withdraw for (10.1.101.11, 239.1.1.1) with RD: 1:1, Route Type
*Mar 27 12:13:00.430: MVPN: Received local route update for (10.1.101.11, 239.1.1.1) with RD: 1:1, Rout
*Mar 27 12:13:00.431: MVPN: Route Type 5 added [(10.1.101.11, 239.1.1.1), nh 0.0.0.0] rd:1:1 send:1
*Mar 27 12:13:00.431: MVPN: RP 10.2.255.255 updated in newly created route
*Mar 27 12:13:00.431: MVPN: Sending BGP prefix=[5: 1:1 : (10.1.101.11,239.1.1.1)] len=19, nh 0.0.0.0, O
*Mar 27 12:13:00.431: MVPN: Received BGP prefix=[5: 1:1 : (10.1.101.11,239.1.1.1)] len=19, nexthop: UNK
*Mar 27 12:13:00.431: MVPN: Received BGP withdraw for (10.1.101.11, 239.1.1.1) with RD: 1:1, Route Type
*Mar 27 12:13:17.151:
```

**MVPN(green[AF_IPv4]): Successfully notified nve fordatamdt adjacency create 239.1.2.0**

**<-- Notify NVE about creating DATA MDT**

*Mar 27 12:13:17.151:

**MVPN: Received local update <104:0x00:0>(172.16.254.3, 239.1.2.0) next_hop:0.0.0.0 router_id:172.16.255.**

*Mar 27 12:13:17.151:

**MVPN: LSM AD route added [(10.1.101.11,239.1.1.1) : <104:0x00:0>(172.16.254.3, 239.1.2.0)] orig:172.16.2**

*Mar 27 12:13:17.151:

**MVPN(green[AF_IPv4]): Sending VxLAN BGP AD prefix=[3:172.16.255.3 1:1 : (10.1.101.11,239.1.1.1)] len=23,**

*Mar 27 12:13:17.151:

**MVPN(green[AF_IPv4]): Originate VxLAN BGP AD rt:3**

*Mar 27 12:13:17.151:

**MVPN(green[AF_IPv4]): VXLAN MDT-Data, node added for (10.1.101.11,239.1.1.1) MDT: 239.1.2.0**

```
Leaf-01#
```

接收端VTEP

**<#root>**

```
Leaf#
```

**debug mvpn**

```
<snip>
*Mar 27 12:27:54.920: MVPN: Received BGP prefix=[5: 1:1 : (10.1.101.11,239.1.1.1)] len=19, nexthop: 172
*Mar 27 12:27:54.920: MVPN: Received BGP route update for (10.1.101.11, 239.1.1.1) with RD: 1:1, Route
*Mar 27 12:27:54.920: MVPN: Route Type 5 found [(10.1.101.11, 239.1.1.1), nh 172.16.255.3]rd:1:1 send:0
*Mar 27 12:27:54.920: MVPN: Received BGP prefix=[5: 1:1 : (10.1.101.11,239.1.1.1)] len=19, nexthop: UNK
*Mar 27 12:27:54.920: MVPN: Received BGP withdraw for (10.1.101.11, 239.1.1.1) with RD: 1:1, Route Type
*Mar 27 12:27:54.920: MVPN: Route Type 5 deleted [(10.1.101.11, 239.1.1.1), nh 172.16.255.3] rd:1:1 sen
*Mar 27 12:28:27.648: MVPN: Received BGP prefix=[5: 1:1 : (10.1.101.11,239.1.1.1)] len=19, nexthop: UNK
*Mar 27 12:28:27.657: MVPN: Received BGP withdraw for (10.1.101.11, 239.1.1.1) with RD: 1:1, Route Type
*Mar 27 12:28:44.235: MVPN: Received BGP prefix=[5: 1:1 : (10.1.101.11,239.1.1.1)] len=19, nexthop: 172
*Mar 27 12:28:44.235: MVPN: Received BGP route update for (10.1.101.11, 239.1.1.1) with RD: 1:1, Route
*Mar 27 12:28:44.235: MVPN: Route Type 5 added [(10.1.101.11, 239.1.1.1), nh 172.16.255.3] rd:1:1 send:
*Mar 27 12:29:00.956: MVPN: Received BGP prefix=[3:172.16.255.3 1:1 : (10.1.101.11,239.1.1.1)] len=23,
*Mar 27 12:29:00.956: MVPN: Received BGP prefix=[3:172.16.255.3 1:1 : (10.1.101.11,239.1.1.1)] len=23,
*Mar 27 12:29:00.956:
```

**MVPN: Received BGP update <104:0x00:50901>(172.16.254.3, 239.1.2.0) next_hop:172.16.255.3 router_id:172.**

```
*Mar 27 12:29:00.956:
```

**MVPN: LSM AD route added [(10.1.101.11,239.1.1.1) : <104:0x00:50901>(172.16.254.3, 239.1.2.0)] orig:172.**

```
*Mar 27 12:29:00.957:
```

**MVPN(green[AF_IPv4]): Activating PE (172.16.255.3, 1:1) ad route refcnt:1 control plane refcnt: 0**

```
*Mar 27 12:29:00.958:
```

**MVPN(green[AF_IPv4]): Successfully notified datamdt group for NVE (239.1.2.0, TRUE, FALSE)**

```
*Mar 27 12:29:00.958: MVPN: Received BGP update <104:0x00:50901>(172.16.254.3, 239.1.2.0) next_hop:172.
Leaf-03#
```

# 疑難排解

| 未檢測到的組播源 |
| --- |
| 在瞭解組播流無法正常運行的原因之前，瞭解ARP和組播轉發之間的關係非常重要 |

通常當主機變為活動狀態並傳送流量時，ARP條目會通過常規的源檢測過程完成。但是，對於組播源，源
FHR的L2平面處理此組播流量，而不解析源的ARP。

ARP完成在TRM功能中扮演著重要角色，原因有二。

1. 第一跳路由器的「直接連線」檢查會呼叫FIB API，而FIB API又取決於ARP完成情況能否成功檢查。
   完成，則通向源的CEF鄰接關係保持不完整，直接連線的check返回FALSE。
2. 源檢測觸發EVPN交換矩陣中的EVPN RT-2通告。在接收器枝葉的L3RIB中安裝的此EVPN路由用作
   ，如果未檢測到源，則無法找到(S，G)條目的RPF。在這種情況下，RPF將保持NULL或者在RIB中
   果有）。

請確保ARP已解析，並且在EVPN交換矩陣中可訪問源。

其他有用的調試

本節中的其他調試有助於隔離TRM問題

- debug mvpn(所有MVPN事件，請參見場景2，例如)
- debug ip|ipv6 pim <vrf>(PIM協定活動)
- debug ip mrib <vrf> trans（MRIB，經典PIM轉換）
- debug ip mfib <vrf> pak|ps|fs(資料包轉發| 進程交換| 快速交換)

交換矩陣外部的源和接收器

在某些情況下，源和/或接收方可以離開交換矩陣VTEP駐留一個或多個L3跳。

這是一個有效的設計，但會更改VRI承載的EVPN路由型別，以及負責在接收器VTEP上建立連線的過程。

- 如果來源位於交換矩陣之外，輸入VTEP會透過PIM鄰居（而不是直接連線）看到來源，並向接收器V
  VRI包含在此型別5中。
- 如果接收器位於交換矩陣之外，則連線通過PIM連線IGMP。PIM連線中的資訊用於建立MVPN型別7。

eBGP多AS（主幹到主幹）拓撲

在某些情況下，拓撲可能要求BGP將更新資訊傳送到另一個AS/交換矩陣。

BGP控制平面資訊可能經過最多30秒，才能收斂，組播才能開始工作。

- 這是因為預設eBGP通告間隔為30秒。
- 如果由於BGP更新的延遲而存在收斂時間較長的問題，則可縮短eBGP通告間隔以便更頻繁地傳
- 有關此計時器的詳細資訊，請參閱本文參考部分中的「BGP配置」指南。

eBGP inter-as需要額外的命令

將inter-as 關鍵字用於MVPN地址系列路由，以跨BGP自治系統(AS)邊界。

<#root>

```
Border-Leaf(config-vrf-af)#
mdt auto-discovery vxlan inter-as
```

具有對稱L2VNI的註冊通道（FHR停滯在PIM註冊狀態）

如果VNI存在於FHR和其他VTEP上，則可能導致FHR停滯在「註冊」狀態

這是因為PIM註冊隧道源IP是AnyCast網關。當RP收到PIM暫存器時，它不知道哪個是傳送暫存器停止的正
個裝置是通用的。

PIM註冊通道路由問題

(Leaf-01)這是實際的FHR：向RP傳送註冊消息

<#root>

```
Leaf-01#sh ip pim vrf green tunnel
Tunnel5*
Type : PIM Encap
RP : 10.2.255.255
Source : 10.1.101.1 <-- Source of Register Tunnel
State : UP
Last event : Created (00:33:28)
```

(Leaf-03)：此VTEP（可能還有其他）包含與FHR相同的SVI和IP地址

<#root>

```
Leaf-03#sh ip pim vrf green tunnel
Tunnel4
Type : PIM Encap
RP : 10.2.255.255
Source : 10.1.101.1 <-- Source of Register Tunnel
State : UP
```

```
Last event : Created (00:11:53)
```

(Leaf-01):FHR在註冊中仍然停滯不前（它不會從RP接收註冊停止）

```
<#root>

Leaf-01#

show ip mroute vrf green 226.1.1.1 10.1.101.11

(10.1.101.11, 226.1.1.1), 02:02:19/00:02:22, flags: PFT
Incoming interface: Vlan101, RPF nbr 10.1.101.11,

Registering <-- Leaf-01 is stuck in register state

Outgoing interface list: Null
```

(Leaf-02)這是RP：在這種情況下，它還擁有與FHR相同的AnyCast IP，從而向自身傳送註冊停止。

如果RP沒有l2vni，但有2或3個其他vtep，註冊停止可能會傳送到錯誤的VTEP，因為RP無法選擇正確的V

```
<#root>

Leaf-02#

sh ip route vrf green 10.1.101.1

Routing Table: green
Routing entry for 10.1.101.1/32

Known via "connected"

, distance 0, metric 0 (connected)
Routing Descriptor Blocks:
*

directly connected, via Vlan101 <-- Leaf-02 sees IP as Connected, and sends the Register-stop to itself

Route metric is 0, traffic share count is 1
```

(Leaf-02):RP上的調試顯示RP將此路由作為本地連線路由的問題

```
<#root>

Leaf-02#

debug ip pim vrf green 226.1.1.1
```

```
PIM debugging is on
*May 26 17:33:15.797: PIM(2)[green]:
Received v2 Register on Vlan901 from 10.1.101.1 <-- Received from Leaf-01 with Source of 10.1.101.1

*May 26 17:33:15.797: PIM(2)[green]:
Send v2 Register-Stop to 10.1.101.1 for 10.1.101.11, group 226.1.1.1 <-- Sending Register-stop to FHR

*May 26 17:33:15.797: PIM(2)[green]:
Received v2 Register-Stop on Vlan101 from 10.2.255.255 <-- Leaf-02 receives its own Register-stop as th

*May 26 17:33:15.797: PIM(2)[green]:
for source 10.1.101.11, group 226.1.1.1 <-- S,G the Stop is for

*May 26 17:33:15.797: PIM(2)[green]:
Clear Registering flag to 10.2.255.255 for (10.1.101.11/32, 226.1.1.1) <-- Done with Register event

*May 26 17:33:17.801: PIM(2)[green]:
Received v2 Register on Vlan901 from 10.1.101.1 <-- Another Register messages from Leaf-01 and the even

*May 26 17:33:17.801: PIM(2)[green]: Send v2 Register-Stop to 10.1.101.1 for 10.1.101.11, group 226.1.1
*May 26 17:33:17.802: PIM(2)[green]: Received v2 Register-Stop on Vlan101 from 10.2.255.255
*May 26 17:33:17.802: PIM(2)[green]: for source 10.1.101.11, group 226.1.1.1
*May 26 17:33:17.802: PIM(2)[green]: Clear Registering flag to 10.2.255.255 for (10.1.101.11/32, 226.1.
```

## PIM註冊通道路由問題解決方案

解決方案是在所有VTEP上使用唯一的環回IP，並使用本節所述的設定。

```
<#root>
Leaf-01#
sh run int lo 901

interface Loopback901
vrf forwarding green <-- Loopback is in the Tenant VRF

ip address 10.1.255.1
 255.255.255.255
<-- IP is unique to the VTEP

ip pim sparse-mode
```

```
Leaf-02(config)#
ip pim vrf green register-source loopback 901 <-- force the Register Source to use the Loopback


Leaf-01#
sh ip pim vrf green tunnel

Tunnel5
Type : PIM Encap     <-- Register Encapsulation tunnel


RP : 10.2.255.255    <-- RP IP is the Tunnel destination


Source : 10.1.255.1  <-- Loopback 901 is the Tunnel source

State : UP
Last event : Created (02:45:58)
Leaf-02#
show bgp l2vpn evpn all | beg 10.1.255.1

*>i
[5]
[1:1][0][32]
[10.1.255.1]
/17
          172.16.254.3
       0          100    0 ?
<-- Only one entry and next hop


to Leaf-01
```

# 相關資訊

EVPN VxLAN TRM配置指南

EVPN VxLAN單播故障排除

MVPN配置指南17.3.x（Catalyst 9300交換機）

MVPN配置指南17.3.x（Catalyst 9500交換機）

BGP配置指南

關於此翻譯

思科已使用電腦和人工技術翻譯本文件，讓全世界的使用者能夠以自己的語言理解支援內容。請注意，即使是最佳機器翻譯，也不如專業譯者翻譯的內容準確。Cisco Systems, Inc. 對這些翻譯的準確度概不負責，並建議一律查看原始英文文件（提供連結）。