

SDアクセスファブリックでのネイティブマルチキャストの確認

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はじめに

このドキュメントでは、SDアクセス(SDA)ファブリックでネイティブマルチキャスト(NMP)を確認する方法について説明します。

前提条件

要件

次の項目に関する知識があることが推奨されます。

- インターネットプロトコル(IP)転送
- ロケータID/分離プロトコル(LISP)
- Protocol Independent Multicast(PIM)スパスモード

使用するコンポーネント

- Cisco IOS® XE 17.10.1上のC9000v
- Cisco Catalyst Centerバージョン2.3.5.3

このドキュメントの情報は、特定のラボ環境にあるデバイスに基づいて作成されました。このドキュメントで使用するすべてのデバイスは、クリアな(デフォルト)設定で作業を開始しています。本稼働中のネットワークでは、各コマンドによって起こる可能性がある影響を十分確認してください。

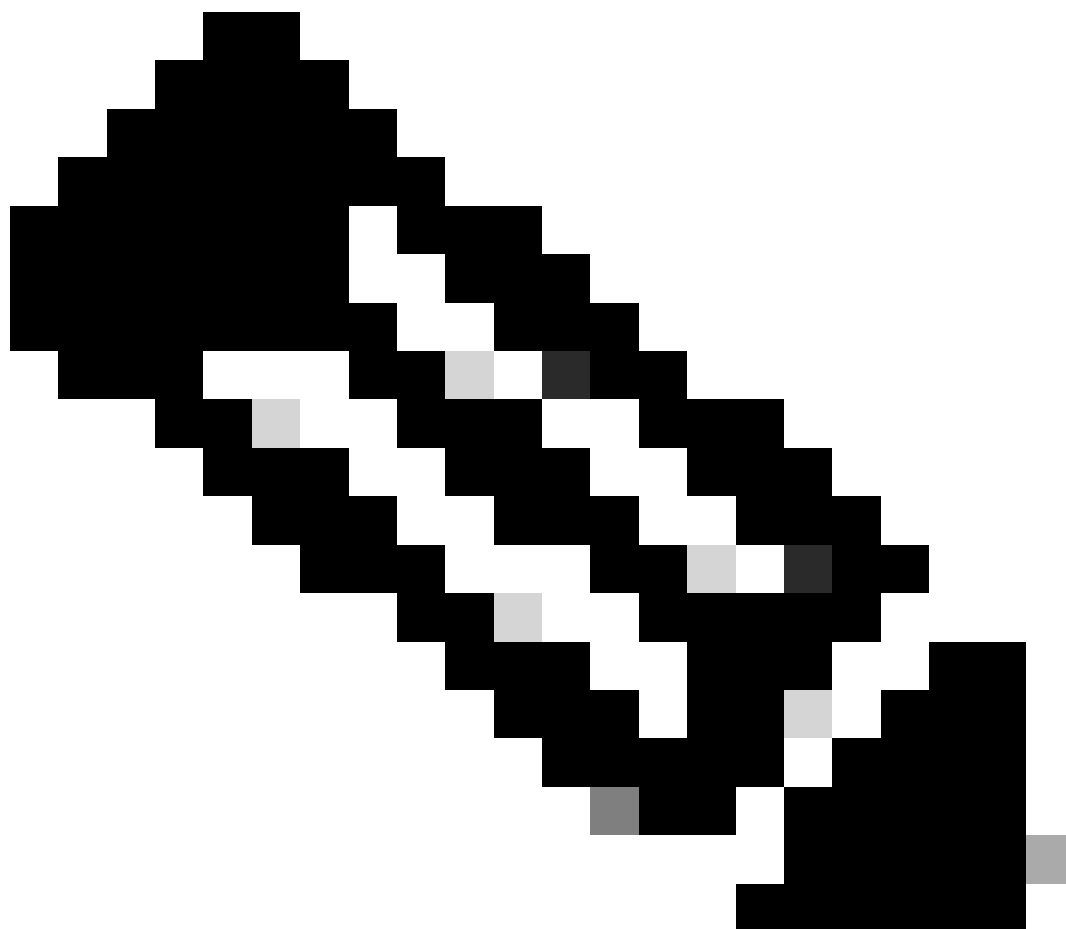
このドキュメントは、次のバージョンのハードウェアとソフトウェアにも使用できます。

- C9200
- C9300
- C9400
- C9500
- C9600
- Cisco IOS® XE 16.12以降

背景説明

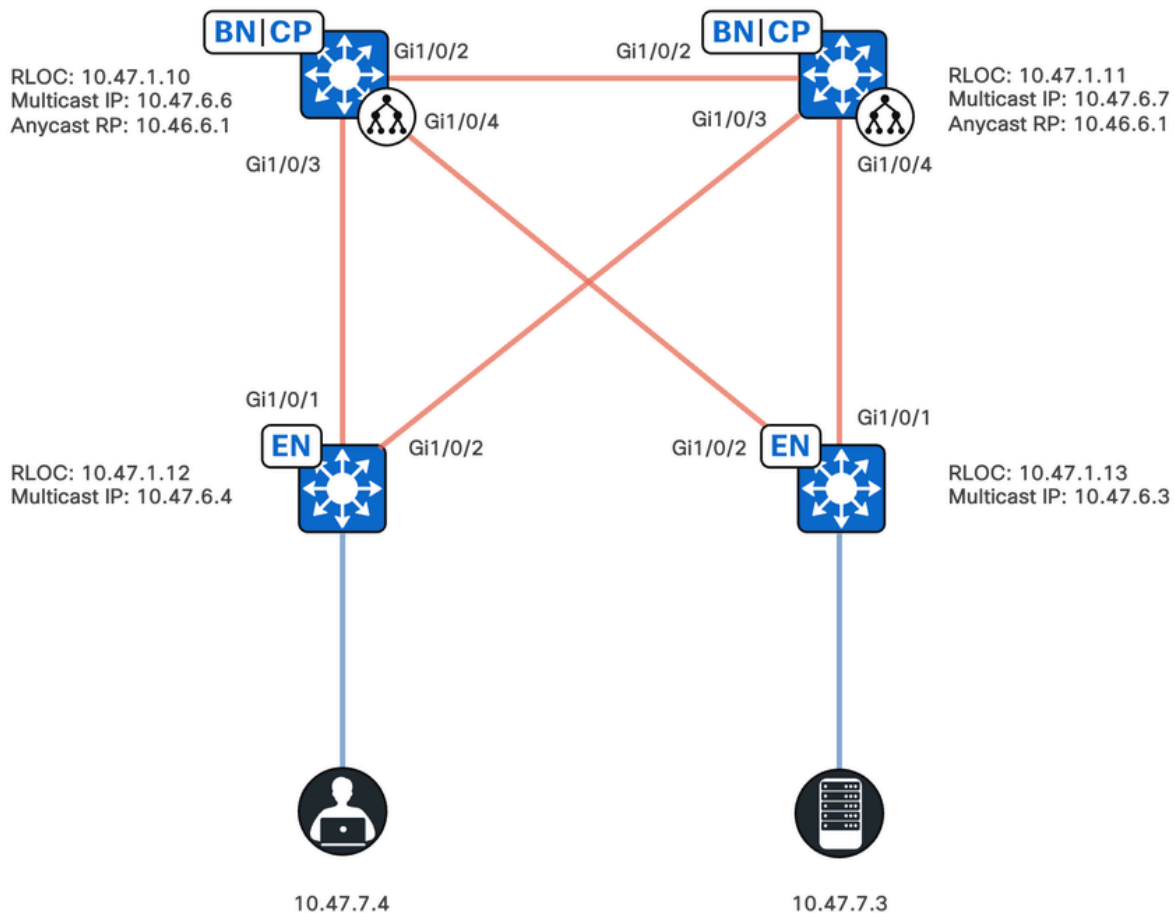
SDAネイティブマルチキャストはオーバーレイマルチキャストの一種で、ファブリックデバイス間でマルチキャストトラフィックを伝送し、マルチキャストトラフィックを別のマルチキャストグループにカプセル化するために使用されます。ネイティブマルチキャストでは、同じVLANまたは異なるVLANにある送信側と受信側の間でマルチキャストトラフィックをルーティングできます(同じVLANマルチキャストをルーティングできます)。同じファブリックエッジ(FE)上の送信元と受信間のマルチキャストトラフィックは、オーバーレイマルチキャスト(VXLANカプセル化)を使用して転送されませんが、FEによってローカルにルーティングされます。ネイティブマルチキャストでは、224.0.0.0/24または存続可能時間(TTL)=1に一致するグループのマルチキャストトラフィックをルーティングできません。これらはレイヤ2(L2)フラットニングによって処理されます。ネイティブマルチキャストは、任意のソースマルチキャスト(ASM)、Source Specific

Multicast(SSM)、またはその両方の組み合わせを転送するように設定できます。ネイティブマルチキャストは、アンダーレイマルチキャストに依存します。



注：プラットフォーム(fed)のコマンドは異なる場合があります。コマンドは、「show platform fed <active|standby>」と「show platform fed switch <active|standby>」です。になります。例に示されている構文が解析できない場合は、バリエーションを試してください。

トポロジ



Network Topology

このトポロジでは、次のようになります。

- Remote Locator ID(RLOC)10.47.1.10および10.47.1.11は、Anywhere境界で共存し、Virtual Network(VN)またはVirtual Routing and Forwarding(VRF)で2つの間にMulticast Source Discovery Protocol(MSDP)を使用するAnycast Rendezvous Point(RP)としても機能します。
- 10.47.1.12および10.47.1.13はFEノードです
- 10.47.7.4はマルチキャスト受信側です
- 10.47.7.3はマルチキャストの送信元です。
- 239.0.0.5はマルチキャストグループ宛先アドレス(GDA)です。

コンフィギュレーション

Cisco Catalyst Centerを使用して、次の設定でSDAファブリックをプロビジョニングすることを前提としています。

- レプリケーションモードの実装はネイティブマルチキャスト
- マルチキャストモードはAny Source Multicast(ASM)です
- コロケートされた場所の境界で設定されたMulticast Source Discovery Protocol(MSDP)を使用するエニーキャストRendezvous Point(RP)

- アンダーレイマルチキャストは、手動で設定されたか、初期LANオートメーションの一部として設定されています。ネイティブマルチキャストは、アンダーレイマルチキャストに依存して正常に機能します。

ファブリックエッジ(10.47.1.12)の設定

```
ip access-list standard ASM_ACL_IPV4_blue_vn_10.47.6.1
permit 239.0.0.0 0.0.0.255
ip multicast-routing vrf blue_vn
interface LISP0.4100
ip pim lisp transport multicast
ip pim lisp core-group-range 232.0.0.1 1000
interface Vlan1025
ip pim passive
exit
interface Loopback4100
vrf forwarding blue_vn
ip address 10.47.6.4 255.255.255.255
ip pim sparse-mode
ip pim vrf blue_vn rp-address 10.47.6.1 ASM_ACL_IPV4_blue_vn_10.47.6.1
ip pim vrf blue_vn register-source Loopback4100
ip pim vrf blue_vn ssm default
router lisp
service ipv4
etr map-server 10.47.1.11 key *****
etr map-server 10.47.1.10 key *****
etr map-server 10.47.1.10 proxy-reply
etr map-server 10.47.1.11 proxy-reply
service ethernet
etr map-server 10.47.1.11 key *****
etr map-server 10.47.1.10 key *****
etr map-server 10.47.1.10 proxy-reply
etr map-server 10.47.1.11 proxy-reply
instance-id-range 8188 , 8190 , 8192 , 8193 override
remote-rloc-probe on-route-change
service ethernet
eid-table vlan 1025 , 1026 , 1028 , 2727
database-mapping mac locator-set rloc_222e1707-175d-4019-a783-060404f8bc2f
instance-id 4099
service ipv4
sgt
instance-id 4100
service ipv4
sgt
database-mapping 10.47.6.4/32 locator-set rloc_222e1707-175d-4019-a783-060404f8bc2f
instance-id 8188
service ethernet
eid-table vlan 1025
dynamic-eid detection multiple-addr bridged-vm
instance-id 8190
service ethernet
eid-table vlan 1026
dynamic-eid detection multiple-addr bridged-vm
instance-id 8192
service ethernet
eid-table vlan 1028
dynamic-eid detection multiple-addr bridged-vm
ip domain lookup source-interface Loopback0
ip domain lookup
```

```
ip multicast vrf blue_vn multipath
```

ファブリックエッジ(10.47.1.13)の設定

```
ip access-list standard ASM_ACL_IPV4_blue_vn_10.47.6.1
permit 239.0.0.0 0.0.0.255
ip multicast-routing vrf blue_vn
interface LISP0.4100
ip pim lisp transport multicast
ip pim lisp core-group-range 232.0.0.1 1000
interface Vlan1025
ip pim passive
exit
interface Loopback4100
vrf forwarding blue_vn
ip address 10.47.6.3 255.255.255.255
ip pim sparse-mode
ip pim vrf blue_vn rp-address 10.47.6.1 ASM_ACL_IPV4_blue_vn_10.47.6.1
ip pim vrf blue_vn register-source Loopback4100
ip pim vrf blue_vn ssm default
router lisp
service ipv4
etr map-server 10.47.1.11 key *****
etr map-server 10.47.1.10 key *****
etr map-server 10.47.1.10 proxy-reply
etr map-server 10.47.1.11 proxy-reply
service ethernet
etr map-server 10.47.1.11 key *****
etr map-server 10.47.1.10 key *****
etr map-server 10.47.1.10 proxy-reply
etr map-server 10.47.1.11 proxy-reply
instance-id-range 8188 , 8190 , 8192 , 8193 override
remote-rloc-probe on-route-change
service ethernet
eid-table vlan 1025 , 1026 , 1028 , 2727
database-mapping mac locator-set rloc_691b1fe4-5264-44c2-bb1b-0903b3eb2c51
instance-id 4099
service ipv4
sgt
instance-id 4100
service ipv4
sgt
database-mapping 10.47.6.3/32 locator-set rloc_691b1fe4-5264-44c2-bb1b-0903b3eb2c51
instance-id 8188
service ethernet
eid-table vlan 1025
dynamic-eid detection multiple-addr bridged-vm
instance-id 8190
service ethernet
eid-table vlan 1026
dynamic-eid detection multiple-addr bridged-vm
instance-id 8192
service ethernet
eid-table vlan 1028
dynamic-eid detection multiple-addr bridged-vm
ip domain lookup source-interface Loopback0
```

```
ip domain lookup
ip multicast vrf blue_vn multipath
```

コロケートAnywhere Border/Anycast RP(10.47.1.10)の設定

```
ip access-list standard ASM_ACL_IPV4_blue_vn_10.47.6.1
permit 239.0.0.0 0.0.0.255
ip multicast-routing vrf blue_vn
interface LISP0.4100
ip pim lisp transport multicast
ip pim lisp core-group-range 232.0.0.1 1000
interface Vlan3001
ip pim sparse-mode
exit
interface Loopback4100
vrf forwarding blue_vn
ip address 10.47.6.1 255.255.255.255
ip pim sparse-mode
interface Loopback4600
vrf forwarding blue_vn
ip address 10.47.6.6 255.255.255.255
ip pim sparse-mode
ip pim vrf blue_vn rp-address 10.47.6.1 ASM_ACL_IPV4_blue_vn_10.47.6.1
ip pim vrf blue_vn register-source Loopback4100
ip pim vrf blue_vn ssm default
ip msdp vrf blue_vn cache-sa-state
ip msdp vrf blue_vn originator-id Loopback4600
ip msdp vrf blue_vn peer 10.47.6.7 connect-source Loopback4600
ip msdp originator-id Loopback4600
router bgp 69420
address-family ipv4 vrf blue_vn
aggregate-address 10.47.6.0 255.255.255.0 summary-only
network 10.47.6.1 mask 255.255.255.255
router lisp
service ipv4
etr map-server 10.47.1.11 key *****
etr map-server 10.47.1.10 key *****
etr map-server 10.47.1.10 proxy-reply
etr map-server 10.47.1.11 proxy-reply
service ethernet
etr map-server 10.47.1.11 key *****
etr map-server 10.47.1.10 key *****
etr map-server 10.47.1.10 proxy-reply
etr map-server 10.47.1.11 proxy-reply
instance-id 4099
service ipv4
sgt
route-export site-registrations
route-import database bgp 69420 route-map DENY-red_vn locator-set rloc_9080ed56-a6c6-482d-9f46-28eda0e1
distance site-registrations 250
map-cache site-registration
instance-id 4100
service ipv4
map-cache 10.47.6.7/32 10.47.1.11 priority 1 weight 100
sgt
route-export site-registrations
```

```
route-import database bgp 69420 route-map DENY-blue_vn locator-set rloc_9080ed56-a6c6-482d-9f46-28eda0e18501
distance site-registrations 250
map-cache site-registration
database-mapping 10.47.6.6/32 locator-set rloc_9080ed56-a6c6-482d-9f46-28eda0e18501
database-mapping 10.47.6.1/32 locator-set rloc_9080ed56-a6c6-482d-9f46-28eda0e18501
site site_uci
authentication-key *****
eid-record instance-id 4100 10.47.6.0/24 accept-more-specifics
```

コロケートAnywhere Border/Anycast RP(10.47.1.10)の設定

```
ip access-list standard ASM_ACL_IPV4_blue_vn_10.47.6.1
permit 239.0.0.0 0.0.0.255
ip multicast-routing vrf blue_vn
interface LISP0.4100
ip pim lisp transport multicast
ip pim lisp core-group-range 232.0.0.1 1000
interface Vlan3001
ip pim sparse-mode
exit
interface Loopback4100
vrf forwarding blue_vn
ip address 10.47.6.1 255.255.255.255
ip pim sparse-mode
interface Loopback4600
vrf forwarding blue_vn
ip address 10.47.6.6 255.255.255.255
ip pim sparse-mode
ip pim vrf blue_vn rp-address 10.47.6.1 ASM_ACL_IPV4_blue_vn_10.47.6.1
ip pim vrf blue_vn register-source Loopback4100
ip pim vrf blue_vn ssm default
ip msdp vrf blue_vn cache-sa-state
ip msdp vrf blue_vn originator-id Loopback4600
ip msdp vrf blue_vn peer 10.47.6.7 connect-source Loopback4600
ip msdp originator-id Loopback4600
router bgp 69420
address-family ipv4 vrf blue_vn
aggregate-address 10.47.6.0 255.255.255.0 summary-only
network 10.47.6.1 mask 255.255.255.255
router lisp
service ipv4
etr map-server 10.47.1.11 key *****
etr map-server 10.47.1.10 key *****
etr map-server 10.47.1.10 proxy-reply
etr map-server 10.47.1.11 proxy-reply
service ethernet
etr map-server 10.47.1.11 key *****
etr map-server 10.47.1.10 key *****
etr map-server 10.47.1.10 proxy-reply
etr map-server 10.47.1.11 proxy-reply
instance-id 4099
service ipv4
sgt
route-export site-registrations
route-import database bgp 69420 route-map DENY-red_vn locator-set rloc_9080ed56-a6c6-482d-9f46-28eda0e18501
distance site-registrations 250
```



```

map-cache site-registration
instance-id 4100
service ipv4
map-cache 10.47.6.7/32 10.47.1.11 priority 1 weight 100
sgt
route-export site-registrations
route-import database bgp 69420 route-map DENY-blue_vn locator-set rloc_9080ed56-a6c6-482d-9f46-28eda0e18501
distance site-registrations 250
map-cache site-registration
database-mapping 10.47.6.6/32 locator-set rloc_9080ed56-a6c6-482d-9f46-28eda0e18501
database-mapping 10.47.6.1/32 locator-set rloc_9080ed56-a6c6-482d-9f46-28eda0e18501
site site_uci
authentication-key *****
eid-record instance-id 4100 10.47.6.0/24 accept-more-specifics

```

コントロールプレーンの検証

Protocol Independent Multicast(PIM)の検証は、ファーストホップルータ(FHR)での(S,G)作成の検証から始まります

FHR (S,G)作成

マルチキャスト送信元の10.47.7.3は、UDPマルチキャストパケットを239.0.0.5に送信します。IP Device-Tracking(IPDT)、Cisco Express Forwarding(CEF)、およびReverse Path Forwarding(RPF)がマルチキャストソースを正しく指していることを確認します。また、エニーキャストゲートウェイSVIがこのセグメントのPIM指定ルータ(DR)であることを確認します。

コマンド「show device-tracking database address <ip address>」を使用して、有効なIPDTエントリがあることを確認します。

```
<#root>
```

```
Edge-2#
```

```
show device-tracking database address 10.47.7.3
```

```

Codes: L - Local, S - Static, ND - Neighbor Discovery, ARP - Address Resolution Protocol, DH4 - IPv4 DHCP
Preflevel flags (prlvl):
0001:MAC and LLA match 0002:Orig trunk 0004:Orig access
0008:Orig trusted trunk 0010:Orig trusted access 0020:DHCP assigned
0040:Cga authenticated 0080:Cert authenticated 0100:Statically assigned
   Network Layer Address Link Layer Address Interface vlan prlvl age state      Time left
DH4 10.47.7.3                5254.0012.521d   Gi1/0/4   1025 0024 166s

```

```
REACHABLE
```

```
81 s try 0(2276 s)
```

コマンド「show ip cef vrf <VN Name> <ip address>」を使用して、マルチキャストの送信元が直

接続されていることを確認します

```
<#root>
```

```
Edge-2#
```

```
show ip cef vrf blue_vn 10.47.7.3
```

```
10.47.7.3/32
```

```
nexthop 10.47.7.3 Vlan1025
```

次に、コマンド「show ip rpf vrf <VN> <ip address>」を使用して、RPFインターフェイスが送信元のVLANであり、LISPではないことを確認します。

```
<#root>
```

```
Edge-1#
```

```
show ip rpf vrf blue_vn 10.47.7.3
```

```
RPF information for (10.47.7.2)
```

```
RPF interface: Vlan1025
```

```
RPF neighbor: ? (
```

```
10.47.7.3
```

```
) - directly connected
```

```
RPF route/mask: 10.47.7.3/32
```

```
RPF type:
```

```
unicast (lisp)
```

```
Doing distance-preferred lookups across tables
```

```
Multicast Multipath enabled.
```

```
RPF topology: ipv4 multicast base, originated from ipv4 unicast base
```

コマンド「show ip pim vrf <VN name> interface vlan <vlan> detail | include DR|enabled」を発行して、FEノードがセグメントのPIM DRであり、FHRであることを検証します。

```
<#root>
```

```
Edge-2#
```

```
show ip pim vrf blue_vn interface vlan 1025 detail | include DR|enabled
```

```
PIM: enabled
```

```
PIM DR: 10.47.7.1 (this system)
```

```
PIM State-Refresh processing: enabled
```

```
PIM Non-DR-Join: FALSE
```

コマンド「show ip mroute vrf <VN name> <multicast group address>」を使用して(S,G)作成を検証します。(S,G)はNull Outgoing Interface List(OIL)になります。これは、対象のレシーバまたはPIMルータがFHRに参加していないためです。

```
<#root>
```

```
Edge-2#
```

```
show ip mroute vrf blue_vn 239.0.0.5
```

```
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, l - LISP decap ref count contributor
```

```
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
```

```
t - LISP transit group
```

```
Timers: Uptime/Expires
```

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

```
(* , 239.0.0.5), 00:00:10/stopped, RP 10.47.6.1, flags: SPF1
```

```
Incoming interface: LISPO.4100, RPF nbr 10.47.1.10
```

```
Outgoing interface list: Null
```

```
(
```

```
10.47.7.3
```

```
,
```

```
239.0.0.5
```

```
), 00:00:10/00:02:50, flags: PFT
```

```
Incoming interface: Vlan1025, RPF nbr 0.0.0.0
```

```
Outgoing interface list:
```

```
Null
```

FHR(S,G)登録

FHRは、「registered-source」PIMレジスタメッセージとして設定されたインターフェイスを使用して、ユニキャストRPにユニキャストソースを登録します。

- 外部ヘッダー、RLOCからRLOC(10.47.1.13 ~ 10.47.1.10)
- 内部ヘッダー、ループバックへのループバック(10.47.6.3 ~ 10.47.6.1)

- 実際のマルチキャスト

```
<#root>
```

```
Edge-2#
```

```
show ip pim vrf blue_vn tunnel
```

```
Tunnel1
```

```
Type : PIM Encap
```

```
RP : 10.47.6.1
```

```
Source : 10.47.6.3
```

```
State : UP
```

```
Last event : Created (00:42:43)
```

```
Edge-2#
```

```
show ip cef vrf blue_vn 10.47.6.1
```

```
10.47.6.1/32
```

```
nexthop
```

```
10.47.1.10
```

```
LISP0.4100
```

```
<-- FHR happened to register to this RP
```

```
nexthop 10.47.1.11 LISP0.4100
```

LHR IGMPメンバーシップレポート

マルチキャスト受信側は、マルチキャストトラフィックの受信に関心があることを示すためにIGMP Membership Report/Joinを送信します。これにより、Last Hop Router (LHR ; ラストホップルータ) でIGMPスヌーピングとIGMPグループエントリが作成されます。コマンド"show ip igmp snooping groups vlan <vlan id> <group destination address>"および"show ip igmp vrf <VN Name> groups <group>"を使用します。

```
<#root>
```

```
Edge-1#
```

```
show ip igmp snooping groups vlan 1025 239.0.0.5
```

```
Vlan Group      Type Version Port List
```

```
-----  
1025 239.0.0.5 igmp v2      Gi1/0/5
```

```
Edge-1#
```

```
show ip igmp vrf blue_vn groups 239.0.0.5
```

```
IGMP Connected Group Membership
Group Address Interface Uptime Expires Last Reporter Group Accounted
239.0.0.5 Vlan1025 00:02:01 00:02:58 10.47.7.4
```

次に、LHRがこのセグメントの実際のPIM DRになっていることを確認し、コマンド「show ip pim vrf <VN name> interface vlan <vlan> detail | include DR|enabled」というエラーメッセージが表示されます

```
<#root>
```

```
Edge-1#
```

```
show ip pim vrf blue_vn interface vlan 1025 detail | include DR|enabled
```

```
PIM: enabled
```

```
PIM DR: 10.47.7.1 (this system)
```

```
PIM State-Refresh processing: enabled
```

```
PIM Non-DR-Join: FALSE
```

LHR(*,G)オーバーレイ作成

LHRはIGMPメンバーシップレポートを受信すると、PIM状態も作成します。具体的には(*,G)、コマンド「show ip mroute vrf <VN Name><overlay group> verbose」を使用して(*,G)状態を確認します

```
<#root>
```

```
Edge-1#
```

```
show ip mroute vrf blue_vn 239.0.0.5 verbose
```

```
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, l - LISP decap ref count contributor
```

```
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
```

```
t - LISP transit group
```

```
Timers: Uptime/Expires
```

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

(* , 239.0.0.5), 1w3d/stopped, RP

10.47.6.1

, flags: SJC1

<-- Anycast RP IP address

Incoming interface: LISP0.4100,

RPF nbr 10.47.1.10

, LISP: [

10.47.1.10

,

232.0.2.245

]

<-- RPF neighbor to reach the Anycast RP, Overlay Group 239.0.0.5 is mapped to Underlay Group 232.0.2.245

Outgoing interface list:

Vlan1025

, Forward/Sparse-Dense, 1w3d/00:02:31, Pkts:0, flags:

<-- IGMP Membership Report/PIM Join received in VLAN 1025, multicast traffic is sent into VLAN 1025

アンダーレイSSMグループのLHR (*,G)マッピング

(*,G)から、アンダーレイSSM (S,G)が派生されます。送信元はRP RPF、グループはオーバーレイマッピングです。

<#root>

Edge-1#

show ip mroute 232.0.2.245 10.47.1.10

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, l - LISP decap ref count contributor
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
t - LISP transit group
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode

(

10.47.1.10, 232.0.2.245

), 2d01h/00:02:28, flags: sT

<-- 10.47.1.10 in this example is the RPF IP/neighbor to get to the RP, 232.0.2.245 is the Underlay Group

Incoming interface:

GigabitEthernet1/0/1

, RPF nbr 10.47.1.0

<-- RPF interface to reach 10.47.1.10

Outgoing interface list:

Null0

, Forward/Dense, 2d01h/stopped, flags:

<-- The Outgoing Interface List (OIL) is Null0, and in Native Multicast, this is treated as a De-Encapsu

Border/RPはオーバーレイに(*,G)、アンダーレイに(S,G)を作成

LHRがオーバーレイでPIM(*,G) Joinを送信します。オーバーレイ内の(*,G)を表示するには、「
show ip mroute vrf <VN name> <overlay group> verbose」コマンドを使用します。

<#root>

Border-1#

show ip mroute vrf blue_vn 239.0.0.5 verbose

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, l - LISP decap ref count contributor

Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
t - LISP transit group
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode

```
(  
*, 239.0.0.5  
) , 2d01h/00:03:05, RP 10.47.6.1, flags: Sp  
Incoming interface:  
Null  
,  
RPF nbr 0.0.0.0
```

Outgoing interface list:
LISP0.4100, (
10.47.1.10, 232.0.2.245
) , Forward/Sparse, 2d01h/stopped, Pkts:0, flags: p
10.47.1.12
, 2d01h/00:03:05
<-- This is the RLOC of Edge-1, which is the LHR

アンダーレイで、コマンド「show ip mroute <アンダーレイのグループアドレス> <RP RLOC>」
を使用できます。

<#root>

Border-1#

```
show ip mroute 232.0.2.245 10.47.1.10
```

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, l - LISP decap ref count contributor
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
t - LISP transit group
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode


```
(
10.47.1.10
,
232.0.2.245
), 2d01h/00:03:13, flags: sT
Incoming interface:
Null0
,
RPF nbr 0.0.0.0

Outgoing interface list:
GigabitEthernet1/0/3
, Forward/Sparse, 2d01h/00:03:13, flags:
<-- Interface that connects to Edge-1, which is the LHR, a PIM Join was received off this interface
```

Border-1がMSDP SAキャッシュから(S,G)を作成

FHRはマルチキャストソースをBorder-2に登録しました。Border-2はMSDPを介してマルチキャストの送信元をBorder-1にアドバタイズします。MSDPの状態を表示するには、コマンドshow ip msdp vrf <VN Name> summaryを使用できます。

```
<#root>
```

```
Border-1#
```

```
show ip msdp vrf blue_vn summary
```

```
MSDP Peer Status Summary
Peer Address AS      State Uptime/  Reset SA  Peer Name
                Downtime Count Count
10.47.6.7      23456 Up    2d02h   1      1
```

コマンド「show ip msdp vrf <VN Name> peer <Peer Address> accepted-SAs」を使用して、ピアから承認されたSAを表示します。

```
<#root>
```

```
Border-1#
```

```
show ip msdp vrf blue_vn peer 10.47.6.7 accepted-SAs
```

```
MSDP SA accepted from peer 10.47.6.7 (?)
```

239.0.0.5

10.47.7.3

(?) RP:

10.47.6.7 <-- 239.0.0.5 is the Overlay Group, 10.47.7.3 is the multicast source, 10.47.6.7 is the IP add

コマンド「show ip mroute vrf <VN Name> <group destination address> verbose」を使用して、(S,G)を

<#root>

Border-1#

show ip mroute vrf blue_vn 239.0.0.5 verbose

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, l - LISP decap ref count contributor

Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join

t - LISP transit group

Timers: Uptime/Expires

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

(* , 239.0.0.5), 2d02h/00:03:27, RP 10.47.6.1, flags: Sp

Incoming interface: Null, RPF nbr 0.0.0.0

Outgoing interface list:

LISP0.4100, (10.47.1.10, 232.0.2.245), Forward/Sparse, 2d02h/stopped, Pkts:0, flags: p

10.47.1.12, 2d02h/00:03:27

(

10.47.7.3

,

239.0.0.5

), 00:18:26/00:02:50, flags: PTA

<-- True multicast source

Incoming interface: LISP0.4100, RPF nbr 10.47.1.13, LISP: [

10.47.1.13

```

,
232.0.2.245
]
<-- RLOC of Edge-2, which is FHR, and 232.0.2.245 is the Underlay multicast group

Outgoing interface list:
10.47.1.12, 00:00:05/00:03:24
<-- RLOC of Edge-1

```

境界オーバーレイ(S,G)はアンダーレイ(S,G)を作成

Border-1は、オーバーレイ(S,G)の結果としてアンダーレイ(S,G)を作成します。詳細については、コマンド「show ip mroute <group destination address>」を使用できます。

FHRとFHR自体に2つの(S、G)があります。10.47.1.13、232.0.2.245のNull0 OILはカプセル化解除を示し、10.47.1.10のIIFとしてのNull0はカプセル化を示します。

```
<#root>
```

```
Border-1#
```

```
show ip mroute 232.0.2.245
```

```
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 - encaps-helper tunnel flag, l - LISP decap ref count contributor
```

```
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
```

```
t - LISP transit group
```

```
Timers: Uptime/Expires
```

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

```
(
```

```
10.47.1.13
```

```
,
```

```
232.0.2.245
```

```
), 00:02:34/00:00:25, flags: sPT
```

```
<-- RLOC of the FHR, underlay multicast group IP
```

```
Incoming interface: GigabitEthernet1/0/4, RPF nbr 10.47.1.3 <-- RPF interface towards the FHR
```

```
Outgoing interface list: Null <-- Indicates decapsulation
```

```
(  
10.47.1.10  
,  
232.0.2.245  
) , 2d02h/00:02:41, flags: sT
```

```
<-- RLOC of Border-1, underlay multicast group IP
```

```
Incoming interface: Null0, RPF nbr 0.0.0.0 <-- Indicates encapsulation
```

```
Outgoing interface list:
```

```
GigabitEthernet1/0/3, Forward/Sparse, 2d02h/00:02:41, flags: <-- where multicast traffic is sent
```

FHRがオーバーレイとアンダーレイで(S,G)結合を受信

Border/RPがFHRに向けてPIM(S,G)Joinを送信している場合は、「show ip mroute」コマンドを使用して情報を取得できません。オーバーレイで、「show ip mroute vrf <VN Name> <overlay group address>」を使用します。

```
<#root>
```

```
Edge-2#
```

```
show ip mroute vrf blue_vn 239.0.0.5
```

```
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, l - LISP decap ref count contributor
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
t - LISP transit group
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode

(*, 239.0.0.5), 1w3d/stopped, RP 10.47.6.1, flags: SPF1
Incoming interface: LISPO.4100, RPF nbr 10.47.1.10
Outgoing interface list: Null

(
10.47.7.3
,
239.0.0.5
) , 1w3d/00:01:23, flags: FT
<-- Multicast source, true multicast group

Incoming interface: Vlan1025, RPF nbr 0.0.0.0

Outgoing interface list:

LISPO.4100, (

10.47.1.13

,
232.0.2.245

), Forward/Sparse, 19:12:56/stopped, flags:

<-- FHR RLOC, underlay group IP

10.47.1.10, 00:00:09/00:03:19 <-- Border/RP RLOC

アンダーレイで、「show ip mroute <アンダーレイグループアドレス>」を使用します。

<#root>

Edge-2#

show ip mroute 232.0.2.245

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 - encaps-helper tunnel flag, l - LISP decap ref count contributor
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
t - LISP transit group
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode

```
(  
10.47.1.13  
,  
232.0.2.245  
) , 1w3d/00:03:01, flags: sT  
<-- RLOC of the FHR, Underlay multicast group  
  
Incoming interface: Null0, RPF nbr 0.0.0.0 <-- Indicates encapsulation
```

Outgoing interface list:

```
GigabitEthernet1/0/1  
, Forward/Sparse, 00:01:42/00:03:01, flags:  
<-- Where the multicast traffic is forwarded
```

LHRは共有ツリーに沿ってマルチキャストトラフィックを受信します

LHRは、RPから共有ツリーに沿ってカプセル化されたマルチキャストトラフィックを受信した後、アンダーレイ(S,G)のOILがNull0であるとしてマルチキャストトラフィックのカプセル化を解除し、オーバーレイに(S,G)エントリを作成します。コマンド"show ip mroute <underlay group address>"および"show ip mroute vrf <VN Name> <overlay group address>"を使用できます。

```
<#root>
```

```
Edge-1#
```

```
show ip mroute 232.0.2.245
```

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, l - LISP decap ref count contributor
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
t - LISP transit group
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode

```
(  
10.47.1.10  
,  
232.0.2.245  
) , 2d03h/00:00:36, flags: sT  
<-- RLOC of the RP, Underlay group
```

Incoming interface:

```
GigabitEthernet1/0/1, RPF nbr 10.47.1.0 <-- RPF interface towards the RP
```

Outgoing interface list:

```
Null0, Forward/Dense, 2d03h/stopped, flags: <-- Indicates Decapsulation
```

オーバーレイで「show ip mroute vrf <VN Name> <overlay group address>」

```
<#root>
```

```
Edge-1#
```

```
show ip mroute vrf blue_vn 239.0.0.5
```

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, l - LISP decap ref count contributor
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
t - LISP transit group
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode

```
(* , 239.0.0.5), 1w3d/stopped, RP 10.47.6.1, flags: SJC1
```

```
Incoming interface: LISP0.4100, RPF nbr 10.47.1.10
Outgoing interface list:
Vlan1025, Forward/Sparse-Dense, 1w3d/00:02:03, flags:
```

```
(
10.47.7.3, 239.0.0.5
), 00:01:21/00:01:38, flags: JT1
<-- Multicast Source, Overlay Group
```

```
Incoming interface: LISP0.4100, RPF nbr 10.47.1.13, LISP:
[
10.47.1.13, 232.0.2.245
]
<-- RLOC of the FHR, Underlay Group
```

```
Outgoing interface list:
Vlan1025
, Forward/Sparse-Dense, 00:01:21/00:02:03, flags:
<-- Multicast traffic is forwarded into VLAN 1025
```

ここで、LHRは最短パスツリー(SPT)に参加し、オーバーレイおよびアンダーレイのPIM (S,G)参加を介して共有ツリーをプルーンします。LHRが共有ツリーをプルーンすると、(S,G)のRP OILにはLHRが含まれなくなります。RPに移動し、コマンド「show ip mroute vrf <VN Name> <overlay group address>」を使用します。

```
<#root>
```

```
Border-1#
```

```
show ip mroute vrf blue_vn 239.0.0.5
```

```
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, l - LISP decap ref count contributor
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
t - LISP transit group
Timers: Uptime/Expires
```


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

(* , 239.0.0.5), 2d04h/00:03:10, RP 10.47.6.1, flags: S

Incoming interface: Null, RPF nbr 0.0.0.0

Outgoing interface list:

LISPO.4100, (10.47.1.10, 232.0.2.245), Forward/Sparse, 2d04h/stopped, flags:

(10.47.7.3, 239.0.0.5), 00:14:17/00:02:42, flags: PT

Incoming interface: LISPO.4100, RPF nbr 10.47.1.13

Outgoing interface list: Null

(S,G)構造にはアンダーレイマッピングがないため、239.0.0.5へのトラフィックがアンダーレイを介して受信された場合でも、RPは共有ツリーをプルーニングするLHRに再カプセル化しません。ただし、ソースツリーと共有ツリーの両方の(S,G)構造はまだ存在します。RPに移動し、コマンド「show ip mroute <アンダーレイのグループアドレス>」を使用して[アンダーレイ]グループを確認します。

<#root>

Border-1#

show ip mroute 232.0.2.245

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, l - LISP decap ref count contributor

Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join

t - LISP transit group

Timers: Uptime/Expires

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

(10.47.1.13, 232.0.2.245), 00:01:07/00:01:52, flags: sPT

Incoming interface: GigabitEthernet1/0/4, RPF nbr 10.47.1.3

Outgoing interface list: Null

(10.47.1.10, 232.0.2.245), 2d04h/00:03:23, flags: sT

Incoming interface: Null0, RPF nbr 0.0.0.0

Outgoing interface list:

GigabitEthernet1/0/3, Forward/Sparse, 2d04h/00:03:23, flags:

RPがすべてのOILを削除すると、FHR OILからもプルーニングされ、FHR OILにはLHRのみが含まれる。

まれます。FHRに移動してコマンド「show ip mroute vrf <VN Name> <overlay group address>」を使用します。

```
<#root>
```

```
Edge-2#
```

```
show ip mroute vrf blue_vn 239.0.0.5
```

```
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, l - LISP decap ref count contributor
```

```
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
```

```
t - LISP transit group
```

```
Timers: Uptime/Expires
```

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

```
(* , 239.0.0.5), 1w4d/stopped, RP 10.47.6.1, flags: SPF1
```

```
Incoming interface: LISPO.4100, RPF nbr 10.47.1.10
```

```
Outgoing interface list: Null
```

```
(
```

```
10.47.7.3
```

```
,
```

```
239.0.0.5
```

```
), 1w3d/00:01:25, flags: FT
```

```
<-- Multicast Source, Overlay Group
```

```
Incoming interface: Vlan1025, RPF nbr 0.0.0.0
```

```
Outgoing interface list:
```

```
LISPO.4100, (
```

```
10.47.1.13, 232.0.2.245
```

```
), Forward/Sparse, 20:16:48/stopped, flags:
```

```
<-- RLOC of the LHR, Underlay Group
```

データプレーン検証 (プラットフォームに依存しない)

マルチキャストの発信元や受信側がトラフィックを送受信するのを妨げる原因としては、さまざまな問題が考えられます。このセクションでは、マルチキャストソースとマルチキャスト受信側の両方に影響を与える可能性がある問題の検証を中心に、ハードウェアプログラミングに関係のない問題について説明します。

FHR(S,G)作成

FHRが(S,G)を作成し、SISF、LISP、CEF、およびRPFがすべて有効で正しいことを確認するには、コマンド「show device-tracking database address <IPv4 address>」を使用します。

```
<#root>
```

```
Edge-2#
```

```
show device-tracking database address 10.47.7.3
```

```
Codes: L - Local, S - Static, ND - Neighbor Discovery, ARP - Address Resolution Protocol, DH4 - IPv4 DHCP
Preflevel flags (prlvl):
0001:MAC and LLA match 0002:Orig trunk 0004:Orig access
0008:Orig trusted trunk 0010:Orig trusted access 0020:DHCP assigned
0040:Cga authenticated 0080:Cert authenticated 0100:Statically assigned
   Network Layer Address Link Layer Address Interface vlan prlvl age state      Time left
DH4 10.47.7.3           5254.0012.521d   Gi1/0/4   1025 0024 16s REACHABLE 232 s try 0(84662 s)
```

SISFはLISPで利用されます。コマンド"show lisp instance-id <L3 LISP Instance ID> ipv4 database <IP/32>"を使用します。

```
<#root>
```

```
Edge-2#
```

```
show lisp instance-id 4100 ipv4 database 10.47.7.3/32
```

```
LISP ETR IPv4 Mapping Database for LISP 0 EID-table vrf blue_vn (IID 4100), LSBs: 0x1
Entries total 1, no-route 0, inactive 0, do-not-register 1
```

```
10.47.7.3/32
```

```
, dynamic-eid blue-IPV4, inherited from default locator-set rloc_691b1fe4-5264-44c2-bb1b-0903b3eb2c51
Uptime: 5w0d, Last-change: 5w0d
Domain-ID: local
Service-Insertion: N/A
Locator Pri/Wgt Source State
10.47.1.13 10/10 cfg-intf site-self, reachable
Map-server Uptime ACK Domain-ID
10.47.1.10 2d04h Yes 0
10.47.1.11 2d15h Yes 0
```

```
Edge-2#
```

```
show ip lisp instance-id 4100 forwarding eid local 10.47.7.3
```

```
Prefix
```

10.47.7.3/32

LISPがCEFをプログラムしている場合は、コマンド「show ip cef vrf <VN Name> <ip address>」を使用して、それがLISPを指していないVLAN内のネクストホップであることを確認します。

<#root>

Edge-2#

```
show ip cef vrf blue_vn 10.47.7.3
```

10.47.7.3/32

```
nexthop 10.47.7.3 Vlan1025
```

最後に、RPFが正しくポイントしていて、直接接続されていることを確認します。

<#root>

Edge-2#

```
show ip rpf vrf blue_vn 10.47.7.3
```

```
RPF information for (10.47.7.3)
```

```
RPF interface: Vlan1025
```

```
RPF neighbor: ?
```

```
(10.47.7.3) - directly connected
```

```
RPF route/mask: 10.47.7.3/32
```

```
RPF type: unicast (lisp)
```

```
Doing distance-preferred lookups across tables
```

```
Multicast Multipath enabled.
```

```
RPF topology: ipv4 multicast base, originated from ipv4 unicast base
```

SISF/IPDTに有効なエントリがない場合は、FHRでLISPデータベースのマッピングが行われず、その結果、CEFとRPFが境界を指すこととなります。マルチキャストソースがトラフィックを送信する場合、RPFは誤ったインターフェイスをポイントするため、RPF障害が発生し、(S,G)は形成されません。

<#root>

Edge-2#

```
show device-tracking database address 10.47.7.3
```

Codes: L - Local, S - Static, ND - Neighbor Discovery, ARP - Address Resolution Protocol, DH4 - IPv4 DHCP

```
Preflevel flags (prlvl):
0001:MAC and LLA match 0002:Orig trunk 0004:Orig access
0008:Orig trusted trunk 0010:Orig trusted access 0020:DHCP assigned
0040:Cga authenticated 0080:Cert authenticated 0100:Statically assigned
Network Layer Address Link Layer Address Interface vlan prlvl age state Time left
```

Edge-2#

```
show lisp instance-id 4100 ipv4 database 10.47.7.3/32
```

```
% No database-mapping entry for 10.47.7.3/32.
```

Edge-2#

```
show ip cef vrf blue_vn 10.47.7.3
```

```
10.47.7.0/24
nexthop 10.47.1.10
```

```
LISP0.4100 <-- Result of a LISP Negative Map-Reply, so the LISP interface is now the RPF interface
```

```
nexthop 10.47.1.11
```

```
LISP0.4100 <-- Result of a LISP Negative Map-Reply, so the LISP interface is now the RPF interface
```

Edge-2#

```
show ip rpf vrf blue_vn 10.47.7.3
```

```
RPF information for (10.47.7.3)
RPF interface:
```

```
LISP0.4100
```

```
RPF neighbor: ? (
```

```
10.47.1.11
```

```
)
```

```
RPF route/mask: 10.47.7.3/32
```

```
RPF type: unicast ()
```

```
Doing distance-preferred lookups across tables
```

```
Multicast Multipath enabled.
```

```
RPF topology: ipv4 multicast base
```

これを防ぐには、マルチキャスト送信元をサイレントホストとして扱います。サイレントホストでは、IPダイレクトブロードキャスト、フラッディング、スタティックSISF/IPDTバインディングによってこの問題を解決できます。

ソース登録

PIM登録はユニキャストパケットフローであり、他のユニキャストパケットと同様にLISP/VXLANを使用します。FHRがマルチキャストソースをユニキャストRPに正しく登録でき

ることを検証するために、いくつかの前提条件チェックがあります。

まず、ユニキャストRPがGDA用に正しく設定されていることを確認します。

```
<#root>
```

```
Edge-2#
```

```
show ip pim vrf blue_vn rp 239.0.0.5
```

```
Group: 239.0.0.5, RP: 10.47.6.1, uptime 1w4d, expires never
```

PIMレジスタトンネルが形成されていることを確認します。

```
<#root>
```

```
Edge-2#
```

```
show ip pim vrf blue_vn tunnel
```

```
Tunnel
```

```
Type : PIM Encap
```

```
RP : 10.47.6.1 <-- This is from "ip pim vrf blue_vn rp-address 10.47.6.1 ASM_ACL_IPV4_blue_vn_10.47.6.1"
```

```
Source : 10.47.6.3 <-- This is from ip pim vrf blue_vn register-source Loopback4100
```

```
State : UP
```

```
Last event : Created (1w4d)
```

ユニキャストRPへのIP到達可能性があることを確認します。

```
<#root>
```

```
Edge-2#
```

```
show ip cef vrf blue_vn 10.47.6.1
```

```
10.47.6.1/32
```

```
nexthop
```

```
10.47.1.10
```

```
LISP0.4100
```

```
<-- RLOC of Border-1
```

```
nexthop
```

10.47.1.11

LISPO.4100

<-- RLOC of Border-2

Edge-2#

```
ping vrf blue_vn 10.47.6.1 source lo4100
```

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 10.47.6.1, timeout is 2 seconds:

Packet sent with a source address of 10.47.6.3

!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/3 ms

受信側の確認

- マルチキャスト受信側がIGMP MRを送信していることを確認します。
- IGMPスヌーピングが有効になっていることを確認します。L2のみのVNは、IGMPスヌーピングが有効になっていない唯一のVNタイプです
- IGMP MRをドロップするようなポートACL、VLAN ACL、ルーテッドポートACLが設定されていないことを確認します。
- IGMP MRのバージョンを確認します。マルチキャストの受信者がIGMPv3の場合は、デフォルトでIGMPv2であり、「ip igmp version 3」が必要です。
- 「ip option drop」が設定されていないことを確認します

LHR PIM(*,G)の検証

- LHRが受信側サブネット/セグメントのPIM DRであることを確認します
- 「ip multicast group-range」が設定されていないことを確認します
- IGMP MRをドロップするようなポートACL、VLAN ACL、ルーテッドポートACLが設定されていないことを確認します。
- 高いCPUまたはコントロールプレーンポリシング(CoPP)によってIGMP MRがドロップされていないことを確認します。

LHR PIM共有ツリーの検証

グループにRPが設定されていることを確認します

<#root>

Edge-1#

```
show ip mroute vrf blue_vn 239.0.0.5
```

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, l - LISP decap ref count contributor
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
t - LISP transit group
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode

(* , 239.0.0.5), 1w3d/stopped, RP

10.47.6.1

, flags: SJC1

<-- Anycast RP address

Incoming interface: LISP0.4100, RPF nbr 10.47.1.10
Outgoing interface list:
Vlan1025, Forward/Sparse-Dense, 1w3d/00:02:36, flags:

エニーキャストRPへのRPFが正しいことを確認します。

<#root>

Edge-1#

show ip cef vrf blue_vn 10.47.6.1

10.47.6.1/32

nexthop 10.47.1.10 LISP0.4100

nexthop 10.47.1.11 LISP0.4100

Edge-1#

show ip rpf vrf blue_vn 10.47.6.1

RPF information for (10.47.6.1)

RPF interface: LISP0.4100

RPF neighbor: ? (10.47.1.10)

RPF route/mask: 10.47.6.1/32

RPF type: unicast ()

Doing distance-preferred lookups across tables

Multicast Multipath enabled.

RPF topology: ipv4 multicast base

MFIB転送 – ネイティブマルチキャスト (オーバーレイ) ソース側検証

パケット転送についての追加情報を取得するには、コマンド「show ip mfib vrf <VN Name> <overlay group address> <unicast source> verbose」を使用します。

<#root>

Edge-2#

```
show ip mfib vrf blue_vn 239.0.0.5 10.47.7.3 verbose
```

```
Entry Flags: C - Directly Connected, S - Signal, IA - Inherit A flag,
ET - Data Rate Exceeds Threshold, K - Keepalive
DDE - Data Driven Event, HW - Hardware Installed
ME - MoFRR ECMP entry, MNE - MoFRR Non-ECMP entry, MP - MFIB
MoFRR Primary, RP - MRIB MoFRR Primary, P - MoFRR Primary
MS - MoFRR Entry in Sync, MC - MoFRR entry in MoFRR Client,
e - Encap helper tunnel flag.
I/O Item Flags: IC - Internal Copy, NP - Not platform switched,
NS - Negate Signalling, SP - Signal Present,
A - Accept, F - Forward, RA - MRIB Accept, RF - MRIB Forward,
MA - MFIB Accept, A2 - Accept backup,
RA2 - MRIB Accept backup, MA2 - MFIB Accept backup
Forwarding Counts: Pkt Count/Pkts per second/Avg Pkt Size/Kbits per second
Other counts: Total/RPF failed/Other drops
I/O Item Counts: HW Pkt Count/FS Pkt Count/PS Pkt Count Egress Rate in pps
VRF blue_vn
(10.47.7.3,239.0.0.5) Flags: K HW DDE
0x530 OIF-IC count: 0, OIF-A count: 1
SW Forwarding: 0/0/0/0, Other: 0/0/0
HW Forwarding: 352467143981268992/0/19/0, Other: 0/0/0
Vlan1025 Flags: RA A MA
LISPO.4100, (
10.47.1.13
,
232.0.2.245
) Flags: RF F NS
<-- RLOC of FHR, Underlay Group IP address

CEF: Adjacency with MAC:
4500000000004000001184BC0A2F010DE80002F5000012B5000000000840000000100400BA25CDF4AD38BA25CDF4AD380000

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

MFIB転送 – ネイティブマルチキャスト (アンダーレイ) ソース側検証

「show ip mroute <underlay group address> <RLOC of FHR>」を使用して、アンダーレイグループを表示します。

<#root>

Edge-2#

show ip mroute 232.0.2.245 10.47.1.13

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, l - LISP decap ref count contributor

Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
t - LISP transit group

Timers: Uptime/Expires

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

(

10.47.1.13

,

232.0.2.245

), 1w4d/00:03:17, flags: sT

<-- RLOC of the FHR, Underlay Group

Incoming interface:

Null0

, RPF nbr 0.0.0.0

<-- Indicates Encapsulation

Outgoing interface list:

GigabitEthernet1/0/1, Forward/Sparse, 00:00:26/00:03:17, flags <-- Where the multicast traffic is forwarded

Edge-2#

show ip mfib 232.0.2.245 10.47.1.13 verbo

se

Entry Flags: C - Directly Connected, S - Signal, IA - Inherit A flag,
ET - Data Rate Exceeds Threshold, K - Keepalive
DDE - Data Driven Event, HW - Hardware Installed
ME - MoFRR ECMP entry, MNE - MoFRR Non-ECMP entry, MP - MFIB
MoFRR Primary, RP - MRIB MoFRR Primary, P - MoFRR Primary
MS - MoFRR Entry in Sync, MC - MoFRR entry in MoFRR Client,
e - Encap helper tunnel flag.

I/O Item Flags: IC - Internal Copy, NP - Not platform switched,
NS - Negate Signalling, SP - Signal Present,
A - Accept, F - Forward, RA - MRIB Accept, RF - MRIB Forward,
MA - MFIB Accept, A2 - Accept backup,
RA2 - MRIB Accept backup, MA2 - MFIB Accept backup
Forwarding Counts: Pkt Count/Pkts per second/Avg Pkt Size/Kbits per second
Other counts: Total/RPF failed/Other drops
I/O Item Counts: HW Pkt Count/FS Pkt Count/PS Pkt Count Egress Rate in pps
Default
(

10.47.1.13,232.0.2.245

) Flags: K HW
0x348 OIF-IC count: 0, OIF-A count: 1
SW Forwarding: 0/0/0/0, Other: 0/0/0
HW Forwarding:

5268151634814304256

/0/1/0, Other: 0/0/0

Null0

Flags: RA A MA
GigabitEthernet1/0/1 Flags: RF F NS
CEF: Adjacency with MAC: 01005E0002F552540017FE730800
Pkts: 0/0/0 Rate: 0 pps

MFIB転送 – ネイティブマルチキャスト (カプセル化解除後)

送信元IPが10.47.1.13で宛先アドレスが232.0.2.245のマルチキャストトラフィックがLHRにカプセル化されて到着すると、そのトラフィックはNull0発信インターフェイスにルーティングされま
す。このアクションにより、パケットのカプセル化解除がトリガーされます。

<#root>

Edge-1#

show ip mroute 232.0.2.245 10.47.1.13

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 - encaps-helper tunnel flag, l - LISP decap ref count contributor

Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
t - LISP transit group
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode
(

10.47.1.13

,

232.0.2.245

), 00:38:22/00:00:37, flags: sT

Incoming interface: GigabitEthernet1/0/2, RPF nbr 10.47.1.4

Outgoing interface list:

Null0

, Forward/Dense, 00:01:12/stopped, flags:

Edge-1#

show ip mfib 232.0.2.245 10.47.1.13 verbose

Entry Flags: C - Directly Connected, S - Signal, IA - Inherit A flag,
ET - Data Rate Exceeds Threshold, K - Keepalive
DDE - Data Driven Event, HW - Hardware Installed
ME - MoFRR ECMP entry, MNE - MoFRR Non-ECMP entry, MP - MFIB
MoFRR Primary, RP - MRIB MoFRR Primary, P - MoFRR Primary
MS - MoFRR Entry in Sync, MC - MoFRR entry in MoFRR Client,
e - Encap helper tunnel flag.
I/O Item Flags: IC - Internal Copy, NP - Not platform switched,
NS - Negate Signalling, SP - Signal Present,
A - Accept, F - Forward, RA - MRIB Accept, RF - MRIB Forward,
MA - MFIB Accept, A2 - Accept backup,
RA2 - MRIB Accept backup, MA2 - MFIB Accept backup
Forwarding Counts: Pkt Count/Pkts per second/Avg Pkt Size/Kbits per second
Other counts: Total/RPF failed/Other drops
I/O Item Counts: HW Pkt Count/FS Pkt Count/PS Pkt Count Egress Rate in pps
Default
(

10.47.1.13,232.0.2.245

) Flags: K HW

0x77 OIF-IC count: 0, OIF-A count: 1

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

HW Forwarding: 0/0/0/0, Other: 0/0/0

GigabitEthernet1/0/2

Flags: RA A MA

Null0, LISPv4 Decap Flags: RF F NS

CEF: OCE (lisp decap)

Pkts: 0/0/0 Rate: 0 pps

カプセル化解除の後、LHRはVNI 4100内で実際の宛先IPアドレスが239.0.0.5であり、発信元IPが10.47.7.3であることを識別します

<#root>

Edge-1#

```
show ip mroute vrf blue_vn 239.0.0.5
```

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, l - LISP decap ref count contributor
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
t - LISP transit group
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode

```
(* , 239.0.0.5), 1w3d/stopped, RP 10.47.6.1, flags: SJC1  
Incoming interface: LISPO.4100, RPF nbr 10.47.1.10  
Outgoing interface list:  
Vlan1025, Forward/Sparse-Dense, 1w3d/00:02:01, flags:
```

(

```
10.47.7.3
```

,

```
239.0.0.5
```

```
), 00:01:29/00:01:30, flags: JT1  
Incoming interface: LISPO.4100, RPF nbr 10.47.1.13  
Outgoing interface list:
```

```
vlan1025
```

```
, Forward/Sparse-Dense, 00:01:29/00:02:01, flags:
```

Edge-1#

```
show ip mfib vrf blue_vn 239.0.0.5 10.47.7.3
```

Entry Flags: C - Directly Connected, S - Signal, IA - Inherit A flag,
ET - Data Rate Exceeds Threshold, K - Keepalive
DDE - Data Driven Event, HW - Hardware Installed
ME - MoFRR ECMP entry, MNE - MoFRR Non-ECMP entry, MP - MFIB
MoFRR Primary, RP - MRIB MoFRR Primary, P - MoFRR Primary
MS - MoFRR Entry in Sync, MC - MoFRR entry in MoFRR Client,

```
e - Encap helper tunnel flag.
I/O Item Flags: IC - Internal Copy, NP - Not platform switched,
NS - Negate Signalling, SP - Signal Present,
A - Accept, F - Forward, RA - MRIB Accept, RF - MRIB Forward,
MA - MFIB Accept, A2 - Accept backup,
RA2 - MRIB Accept backup, MA2 - MFIB Accept backup
Forwarding Counts: Pkt Count/Pkts per second/Avg Pkt Size/Kbits per second
Other counts: Total/RPF failed/Other drops
I/O Item Counts: HW Pkt Count/FS Pkt Count/PS Pkt Count Egress Rate in pps
VRF blue_vn
(
10.47.7.3,239.0.0.5
```

```
) Flags: HW
```

```
<-- Unicast Source and Overlay Group
```

```
SW Forwarding: 0/0/0/0, Other: 2/1/1
HW Forwarding: 0/0/0/0, Other: 0/0/0
```

```
LISP0.4100 Flags: A <-- Incoming Interface
```

```
Vlan1025 Flags: F NS <-- Outgoing Interface
```

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

コマンド「show ip igmp snooping groups vlan <VLAN>」を使用して、どのポートがマルチキャストトラフィックを受信するのかを確認します。

```
<#root>
```

```
Edge-1#
```

```
show ip igmp snooping groups vlan 1025
```

```
Vlan Group      Type Version Port List
```

```
-----  
1025 239.0.0.5 igmp v2      Gi1/0/5
```

データプレーンの検証 (プラットフォームによって異なります)

Mrouteハードウェアプログラミング – IOS mroute

ハードウェアプログラミングでは、IOS、FMAN RP、FMAN FP、FEDの順に使用します。コマンド「show ip mroute vrf <VN Name> <overlay group address> verbose」および「show ip mroute <underlay group address> verbose」を使用して、まずIOSを確認します。

```
<#root>
```

Edge-1#

```
show ip mroute vrf blue_vn 239.0.0.5 verbose
```

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, l - LISP decap ref count contributor

Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
t - LISP transit group

Timers: Uptime/Expires

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

(

*, 239.0.0.5

), 1w3d/stopped, RP 10.47.6.1, flags: SJCl

Incoming interface: LISP0.4100, RPF nbr 10.47.1.10, LISP: [10.47.1.10, 232.0.2.245]

Outgoing interface list:

Vlan1025, Forward/Sparse-Dense, 1w3d/00:02:58, Pkts:0, flags:

(

10.47.7.3, 239.0.0.5

), 00:02:19/00:00:40, flags: JTl

Incoming interface: LISP0.4100, RPF nbr 10.47.1.13, LISP: [10.47.1.13, 232.0.2.245]

Outgoing interface list:

Vlan1025, Forward/Sparse-Dense, 00:02:19/00:02:58, Pkts:0, flags:

アンダーレイ内

<#root>

Edge-1#

```
show ip mroute 232.0.2.245 verbose
```

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, l - LISP decap ref count contributor
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
t - LISP transit group
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode

(

10.47.1.13, 232.0.2.245

), 01:18:55/00:02:04, flags: sT

Incoming interface: GigabitEthernet1/0/2, RPF nbr 10.47.1.4

LISP EID ref count: 1, Underlay ref timer: 00:05:13

Outgoing interface list:

Null0, Forward/Dense, 00:01:46/stopped, Pkts:0, flags:

(

10.47.1.10, 232.0.2.245

), 2d06h/00:02:59, flags: sT

Incoming interface: GigabitEthernet1/0/1, RPF nbr 10.47.1.0

LISP EID ref count: 1, Underlay ref timer: 00:05:12

Outgoing interface list:

Null0, Forward/Dense, 2d06h/stopped, Pkts:0, flags:

Mrouteハードウェアプログラミング – IOS MFIB

コマンド「show ip mfib vrf <VN Name> <overlay group address> verbose」および「show ip mroute <underlay group address> verbose」を使用して、オーバーレイMFIBとアンダーレイMFIBを確認します。

オーバーレイ

<#root>

Edge-1#

show ip mfib vrf blue_vn 239.0.0.5 verbose

Entry Flags: C - Directly Connected, S - Signal, IA - Inherit A flag,
ET - Data Rate Exceeds Threshold, K - Keepalive
DDE - Data Driven Event, HW - Hardware Installed
ME - MoFRR ECMP entry, MNE - MoFRR Non-ECMP entry, MP - MFIB
MoFRR Primary, RP - MRIB MoFRR Primary, P - MoFRR Primary
MS - MoFRR Entry in Sync, MC - MoFRR entry in MoFRR Client,
e - Encap helper tunnel flag.
I/O Item Flags: IC - Internal Copy, NP - Not platform switched,
NS - Negate Signalling, SP - Signal Present,
A - Accept, F - Forward, RA - MRIB Accept, RF - MRIB Forward,
MA - MFIB Accept, A2 - Accept backup,
RA2 - MRIB Accept backup, MA2 - MFIB Accept backup

Forwarding Counts: Pkt Count/Pkts per second/Avg Pkt Size/Kbits per second
Other counts: Total/RPF failed/Other drops
I/O Item Counts: HW Pkt Count/FS Pkt Count/PS Pkt Count Egress Rate in pps
VRF blue_vn
(

* ,239.0.0.5

) Flags: C K HW
0x6D OIF-IC count: 0, OIF-A count: 1
SW Forwarding: 0/0/0/0, Other: 0/0/0
HW Forwarding: 16218869633044709376/0/0/0, Other: 0/0/0
LISP0.4100 Flags: RA A MA NS
Vlan1025 Flags: RF F NS
CEF: Adjacency with MAC: 01005E00000500000C9FFB870800
Pkts: 0/0/0 Rate: 0 pps
(

10.47.7.3,239.0.0.5

) Flags: K HW DDE
0x7B OIF-IC count: 0, OIF-A count: 1
SW Forwarding: 0/0/0/0, Other: 2/0/2
HW Forwarding: 0/0/0/0, Other: 0/0/0
LISP0.4100 Flags: RA A MA
Vlan1025 Flags: RF F NS
CEF: Adjacency with MAC: 01005E00000500000C9FFB870800
Pkts: 0/0/0 Rate: 0 pps

アンダーレイ内

<#root>

Edge-1#

show ip mfib 232.0.2.245 verbose

Entry Flags: C - Directly Connected, S - Signal, IA - Inherit A flag,
ET - Data Rate Exceeds Threshold, K - Keepalive
DDE - Data Driven Event, HW - Hardware Installed
ME - MoFRR ECMP entry, MNE - MoFRR Non-ECMP entry, MP - MFIB
MoFRR Primary, RP - MRIB MoFRR Primary, P - MoFRR Primary
MS - MoFRR Entry in Sync, MC - MoFRR entry in MoFRR Client,
e - Encap helper tunnel flag.
I/O Item Flags: IC - Internal Copy, NP - Not platform switched,
NS - Negate Signalling, SP - Signal Present,
A - Accept, F - Forward, RA - MRIB Accept, RF - MRIB Forward,
MA - MFIB Accept, A2 - Accept backup,
RA2 - MRIB Accept backup, MA2 - MFIB Accept backup
Forwarding Counts: Pkt Count/Pkts per second/Avg Pkt Size/Kbits per second
Other counts: Total/RPF failed/Other drops
I/O Item Counts: HW Pkt Count/FS Pkt Count/PS Pkt Count Egress Rate in pps
Default
(

10.47.1.10,232.0.2.245

) Flags: K HW
0x18 OIF-IC count: 0, OIF-A count: 1

```
SW Forwarding: 0/0/0/0, Other: 0/0/0
HW Forwarding: 8384858081233731584/0/0/0, Other: 0/0/0
GigabitEthernet1/0/1 Flags: RA A MA
Null0, LISPv4 Decap Flags: RF F NS
CEF: OCE (lisp decap)
Pkts: 0/0/0 Rate: 0 pps
(
```

```
10.47.1.13,232.0.2.245
```

```
) Flags: K HW
0x77 OIF-IC count: 0, OIF-A count: 1
SW Forwarding: 0/0/0/0, Other: 0/0/0
HW Forwarding: 0/0/0/0, Other: 0/0/0
GigabitEthernet1/0/2 Flags: RA A MA
Null0, LISPv4 Decap Flags: RF F NS
CEF: OCE (lisp decap)
Pkts: 0/0/0 Rate: 0 pps
```

Mrouteハードウェアプログラミング – FMAN RP

FMAN RPを検証するには、最初にVRF IDをキャプチャします。

```
<#root>
```

```
Edge-1#
```

```
show vrf detail blue_vn | include Id
```

```
VRF blue_vn (
```

```
VRF Id = 2
```

```
); default RD <not set>; default VPNID <not set>
```

次に、次のコマンドにVRFインデックス値を使用します。オーバーレイ(*,G)を検証するには、コマンド「show platform software ip switch active r0 mfib vrf index <VRF Index> group <overlay group address>/32」を使用します。

```
<#root>
```

```
Edge-1#
```

```
show platform software ip switch active r0 mfib vrf index 2 group 239.0.0.5/32
```

```
Route flags:
```

```
S - Signal; C - Directly connected;
```

```
IA - Inherit A Flag; L - Local;
```

```
BR - Bidir route
```

```
*, 239.0.0.5/32 --> OBJ_INTF_LIST (0x6d)
```

```
Obj id: 0x6d, Flags: C
```

```
OM handle: 0x348030b738
```

オーバーレイ(S、G)を検証するには、コマンド「show platform software ip switch active r0 mfib vrf index 2 group address <overlay group address> <unicast source>」を使用します。

<#root>

Edge-1#

```
show platform software ip switch active r0 mfib vrf index 2 group address 239.0.0.5 10.47.7.3
```

Route flags:

S - Signal; C - Directly connected;

IA - Inherit A Flag; L - Local;

BR - Bidir route

239.0.0.5, 10.47.7.3/64 --> OBJ_INTF_LIST (0x7f)

Obj id: 0x7f, Flags: unknown

OM handle: 0x34803a3800

オーバーレイ(*,G)に対するアンダーレイ(S,G)を検証するには、コマンド「show platform software ip switch active r0 mfib group address <アンダーレイのグループアドレス> <RPアドレス>」を使用します。

<#root>

Edge-1#

```
show platform software ip switch active r0 mfib group address 232.0.2.245 10.47.1.10
```

Route flags:

S - Signal; C - Directly connected;

IA - Inherit A Flag; L - Local;

BR - Bidir route

232.0.2.245, 10.47.1.10/64 --> OBJ_INTF_LIST (0x18)

Obj id: 0x18, Flags: unknown

OM handle: 0x34803b9be8

オーバーレイ(S,G)のアンダーレイ(S,G)を検証するには、コマンド「show platform software ip switch active r0 mfib group address <アンダーレイグループアドレス> <RLOC of FHR>」を使用します。

<#root>

Edge-1#

```
show platform software ip switch active r0 mfib group address 232.0.2.245 10.47.1.13
```

Route flags:

S - Signal; C - Directly connected;

IA - Inherit A Flag; L - Local;

BR - Bidir route

```
232.0.2.245, 10.47.1.13/64 --> OBJ_INTF_LIST (0x77)
Obj id: 0x77, Flags: unknown
OM handle: 0x348026b988
```

Mrouteハードウェアプログラミング – FMAN FP

オーバーレイ(*,G)を検証するには、コマンド"show platform software ip switch active f0 mfib vrf index <VRF ID> group <overlay group address>"を使用します。

```
<#root>
```

```
Edge-1#
```

```
show platform software software ip switch active f0 mfib vrf index 2 group 239.0.0.5/32
```

```
Route flags:
```

```
S - Signal; C - Directly connected;
```

```
IA - Inherit A Flag; L - Local;
```

```
BR - Bidir route
```

```
*, 239.0.0.5/32 --> OBJ_INTF_LIST (0x6d)
```

```
Obj id: 0x6d, Flags: C
```

```
aom id:
```

```
100880
```

```
, HW handle: (nil) (created)
```

オーバーレイ(S、G)を検証するには、コマンド"show platform software ip switch active f0 mfib vrf index <VRF ID> group address <overlay group address> <unicast source>"を使用します。

```
<#root>
```

```
Edge-1#
```

```
show platform software ip switch active f0 mfib vrf index 2 group address 239.0.0.5 10.47.7.3
```

```
Route flags:
```

```
S - Signal; C - Directly connected;
```

```
IA - Inherit A Flag; L - Local;
```

```
BR - Bidir route
```

```
239.0.0.5, 10.47.7.3/64 --> OBJ_INTF_LIST (0x8f)
```

```
Obj id: 0x8f, Flags: unknown
```

```
aom id:
```

```
161855
```

```
, HW handle: (nil) (created)
```

オーバーレイ(*,G)に対するアンダーレイ(S,G)を検証するには、「show platform software ip switch active f0 mfib group address <アンダーレイグループアドレス> <RPアドレス>」コマンド

を使用します。

```
<#root>
```

```
Edge-1#
```

```
show platform ip switch active f0 mfib group address 232.0.2.245 10.47.1.10
```

```
Route flags:
```

```
S - Signal; C - Directly connected;
```

```
IA - Inherit A Flag; L - Local;
```

```
BR - Bidir route
```

```
232.0.2.245, 10.47.1.10/64 --> OBJ_INTF_LIST (0x18)
```

```
Obj id: 0x18, Flags: unknown
```

```
aom id:
```

```
138716
```

```
, HW handle: (nil) (created)
```

オーバーレイ(S,G)のアンダーレイ(S,G)を検証するには、コマンド「show platform software ip switch active f0 mfib group address <アンダーレイグループアドレス> <RLOC of FHR>」を使用します。

```
<#root>
```

```
Edge-1#
```

```
show platform software ip switch active f0 mfib group address 232.0.2.245 10.47.1.13
```

```
Route flags:
```

```
S - Signal; C - Directly connected;
```

```
IA - Inherit A Flag; L - Local;
```

```
BR - Bidir route
```

```
232.0.2.245, 10.47.1.13/64 --> OBJ_INTF_LIST (0x5)
```

```
Obj id: 0x5, Flags: unknown
```

```
aom id:
```

```
161559
```

```
, HW handle: (nil) (created)
```

Mrouteハードウェアプログラミング – FMAN FPデータベース

FMAN FPオブジェクトを検証するには、コマンド「show platform software object-manager switch active f0 object <object ID> parents」を使用します。

たとえば、オーバーレイ(*,G)を検証するには、

```
<#root>
```

Edge-1#

```
show platform software object-manager switch active f0 object 100880 parents
```

Object identifier: 100605

Description: ipv4_mcast table 2 (

blue_vn

), vrf id 2

Status: Done

Object identifier: 100878

Description:

mlist 109

Status: Done

オーバーレイを検証するには(S,G)

<#root>

Edge-1#

```
show platform software object-manager switch active f0 object 161855 parents
```

Object identifier: 100605

Description: ipv4_mcast table 2 (blue_vn), vrf id 2

Status: Done

Object identifier: 161854

Description:

mlist 143

Status: Done

mlistは、着信インターフェイス(IIF)と発信インターフェイスリスト(OIL)を異なるオブジェクト内のmrouteから分離して組み合わせたものです。mlistを検証するには、コマンド「show platform software mlist switch active f0 index <index>」を使用します。

<#root>

Edge-1#

```
show platform software mlist switch active f0 index 109
```

Multicast List entries

OCE Flags:

NS - Negate Signalling; IC - Internal copy;

A - Accept; F - Forward;

OCE Type OCE Flags Interface

```
0xf8000171 OBJ_ADJACENCY NS, A LISP0.4100
```

```
<-- Incoming Interface for (*,G)
```

```
0xf80001f1 OBJ_ADJACENCY NS, F Vlan1025
```

```
<-- Outgoing Interface for (S,G)
```

```
<#root>
```

```
Edge-1#
```

```
show platform software mlist switch active f0 index 143
```

```
Multicast List entries
```

```
OCE Flags:
```

```
NS - Negate Signalling; IC - Internal copy;
```

```
A - Accept; F - Forward;
```

```
OCE Type OCE Flags Interface
```

```
-----  
0xf8000171 OBJ_ADJACENCY A LISP0.4100
```

```
<-- Outgoing Interface for (S,G)
```

```
0xf80001f1 OBJ_ADJACENCY NS, F Vlan1025
```

```
<-- Incoming Interface for (S,G)
```

Mrouteハードウェアプログラミング – FED

オーバーレイ(S,G)を検証するには、コマンド「show platform software fed switch active ip mfib vrf <VN Name> <overlay group address> <Unicast Source>」を使用します。

```
<#root>
```

```
Edge-1#
```

```
show platform software fed switch active ip mfib vrf blue_vn 239.0.0.5 10.47.7.3
```

```
Multicast (S,G) Information
```

```
VRF : 2
```

```
Source Address : 10.47.7.3
```

```
HTM Handler : 0x7f0efe53a638
```

```
SI Handler : 0x7f0efe50ec68
```

```
DI Handler :
```

```
0x7f0efe530768
```

```
REP RI handler : 0x7f0efe5387e8
```

```
Flags :
```

```
Packet count : 0
```

```
State : 4
```

```
RPF :
```

```
LISPO.4100 A
OIF :
Vlan1025 F NS
LISPO.4100 A
(Adj: 0xf8000171 )
```

アンダーレイ(S,G)を検証するには、コマンド「show platform software fed switch active ip mfib <underlay group address> <RLOC of FHR>」を使用します。

```
<#root>
```

```
Edge-1#
```

```
show platform software fed switch active ip mfib 232.0.2.245 10.47.1.13
```

```
Multicast (S,G) Information
VRF : 0
Source Address : 10.47.1.13
HTM Handler : 0x7f0efe512408
SI Handler : 0x7f0efe5158f8
DI Handler :
0x7f0efe525538
```

```
REP RI handler : 0x7f0efe52ca18
Flags :
Packet count : 0
State : 4
RPF :
GigabitEthernet1/0/2 A
OIF :
LISPO LISP Decap F NS
GigabitEthernet1/0/2 A
```

次に、Overlay(S,G)とUnderlay(S,G)の両方に対してDestination Index(DI)が検証されます。「show platform hardware fed switch active fwd-asic abstraction print-resource-handle <DI Handler> 1」コマンドを使用できます。

オーバーレイ(S、G)

```
<#root>
```

```
Edge-1#
```

```
show platform hardware fed switch active fwd-asic abs print-resource-handle 0x7f0efe512408 1
```

```
Handle:0x7f0efe530768 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: index0:0x5279 mtu_index/13u_ri_index0:0x0 index1
Cookie length: 56
00 00 00 00 00 00 00 00 02 00 00 00 03 07 2f 0a 05 00 00 ef 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Detailed Resource Information (ASIC_INSTANCE# 0)
-----
Destination index = 0x5279
```


a1_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0
Detailed Resource Information (ASIC_INSTANCE# 1)

Destination index = 0x5284
pmap = 0x00000000 0x00000000
cmi = 0x0
rcp_pmap = 0x0

a1_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0

=====

翻訳について

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