

# 사례 연구: ACI 패브릭의 L3 멀티캐스트

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## 소개

레이어 3 멀티캐스트 라우팅은 ACI 패브릭에서 릴리스 2.0 이상부터 지원되며 EX 스위치(예: N9K-C93180YC-EX)가 필요합니다. 릴리스 2.0 이전에는 ACI가 브리지 도메인 내에서 L2 멀티캐스트만 지원했습니다. 이 옵션은 2.0에서도 사용할 수 있으며 비 EX 스위치에 사용할 수 있습니다.

ACI 릴리스 2.0에서 지원되는 멀티캐스트 라우팅 기능은 다음과 같습니다. PIM ASM, PIM SSM, Static RP, PIM Auto-RP 및 PIM BSR.

이 문서에서는 ACI 패브릭에서 L3 멀티캐스트 라우팅을 위한 실제 고객 구축 시나리오에 대한 검증된 솔루션에 대해 설명합니다. 선택한 ACI 릴리스는 2.1(1h)입니다. 이 릴리스는 패브릭에서 RP를 지원하지 않으므로 PIM ASM에 외부 RP가 필요합니다.

## 설계 요구 사항

고객은 패브릭 내부 및 외부에서 L3 멀티캐스트 라우팅을 위한 엔드 투 엔드 솔루션을 필요로 합니다. 구축 시나리오에는 다음과 같은 요구 사항이 있습니다.

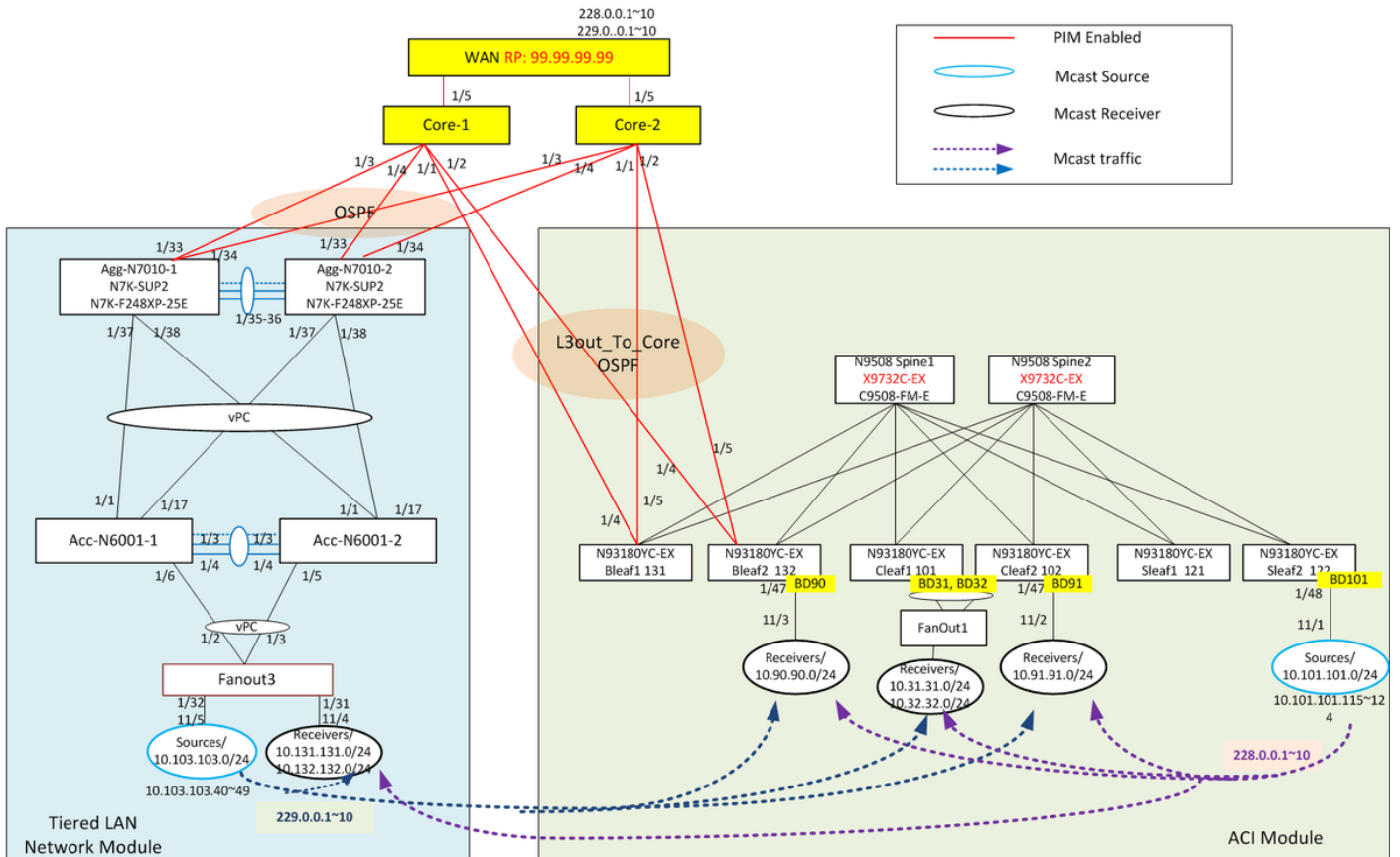
- 모든 테넌트에 대해 하나의 VRF가 구축되었습니다.

참고: 멀티캐스트에는 각 VRF에 대해 전용 L3out이 필요합니다. 패브릭에 여러 VRF가 있는 경우, 공유 L3out은 멀티캐스트 라우팅에 대해 지원되지 않습니다.

- 외부 소스가 있는 패브릭 수신기
- 외부 수신기가 있는 패브릭의 소스
- 패브릭의 소스 및 수신기
- 고정 RP 또는 Auto-RP

## 솔루션

토폴로지 검토



토폴로지에는 두 가지 주요 구성 요소가 있습니다. ACI 모듈 및 Tiered LAN Network 모듈 두 모듈 모두 OSPF 및 PIM을 실행하는 포인트-투-포인트 L3 링크를 통해 코어 디바이스에 연결됩니다. ACI 모듈에서 외부 라우트드 네트워크는 VRF common:default와 연결된 L3out-to-Core라고 합니다. 여기에는 2개의 테두리 앞에서 코어 디바이스로 연결되는 4개의 링크가 포함됩니다. 패브릭 외부라고 하는 계층형 LAN 네트워크 모듈은 vPC를 사용하는 기존 액세스 레이어와 어그리게이션 레이어로 구성됩니다.

L3 멀티캐스트 흐름은 ACI 패브릭 및 레거시 LAN 네트워크를 통해 코어 레이어를 통해 실행됩니다. 고정 RP 시나리오의 경우 WAN 에지 디바이스에 RP가 구축됩니다.

Cisco는 STC(Sporent Traffic Generator)를 사용하여 내부 및 외부 소스와 수신기를 시뮬레이션합니다. Sporent 포트는 ACI 모듈 및 계층형 LAN 네트워크 모듈의 서로 다른 위치에 연결됩니다. 수신자는 IGMP v2 멤버십 가입 메시지를 보냅니다.

Sleaf2에 연결된 내부 소스: 소스 IP는 10.101.101.115~124이며 그룹 주소로 전송됩니다. 228.0.0.1~10

Bleaf1, Cleaf1 및 Cleaf2에 연결된 내부 수신기: 멀티캐스트 지원 BD는 BD90, BD91, BD31, BD32, 관련 그룹입니다. 228.0.0.1~10 및 229.0.0.1~10.

LAN 네트워크의 액세스 레이어에 연결된 외부 소스: 소스 IP는 10.103.103.40~49이며 그룹 주소로 전송됩니다. 229.0.0.1~10

LAN 네트워크의 액세스 레이어에 연결된 외부 수신기: vlan131, vlan132, 관련 그룹: 228.0.0.1~10

## 설정

0단계: 코어에 연결된 시뮬레이션된 WAN 디바이스에서 RP를 설정하고, 계층형 LAN 네트워크 디바이스에서 PIM 스파스 모드를 활성화합니다.

!!!!!! RP configuration

```
ip pim rp-address 99.99.99.99 group-list 224.0.0.0/4
ip pim ssm range 232.0.0.0/8
```

```
interface loopback99
  ip address 99.99.99.99/32
  ip router ospf 65017 area 0.0.0.0
  ip pim sparse-mode
```

```
interface Ethernet2/1
  ip pim sparse-mode
```

```
interface Ethernet2/2
  ip pim sparse-mode
```

1단계: VRF에서 멀티캐스트를 활성화합니다. 테넌트 공간에서 Networking(네트워킹) > VRFs(VRF) > Multicast(멀티캐스트)로 이동하고 작업 패널에서 버터를 클릭하여 멀티캐스트를 활성화합니다.

PIM is not enabled on this VRF. Would you like to enable PIM?

**YES, ENABLE MULTICAST.**

2단계: BD 및 L3out 레벨에서 멀티캐스트를 활성화하고, 수신기 BD에 대해 IGMP를 활성화합니다. Networking(네트워킹) > VRFs(VRF) > VRF name(VRF 이름) > Multicast(멀티캐스트)로 이동하고 작업 패널에서 Configuration(컨피그레이션) > Interface(인터페이스) 탭을 선택하고 "+"를 클릭하여 멀티캐스트 트래픽이 예상되는 Bridge Domains(브리지 도메인)를 추가합니다. 멀티캐스트 지원 BD에 대한 IGMP 정책을 활성화합니다.

그런 다음 "+"를 클릭하여 이 VRF에 대한 L3out을 추가합니다. L3out에 대해 멀티캐스트가 활성화된 경우 L3out의 모든 인터페이스에서 PIM이 활성화되고 해당 L3out에 대한 모든 보더 리프가 멀티캐스트 라우팅으로 활성화됩니다. L3out 인터페이스 그룹에 대한 PIM 정책을 선택합니다.

여기서는 BD 및 L3out이 이미 프로비저닝되었다고 가정합니다.

The screenshot shows the Cisco SD-WAN configuration interface for Multicast. The left sidebar contains a navigation tree with 'Networking' and 'Multicast' highlighted. The main area displays two tables: 'Bridge Domains' and 'Interfaces'. In the 'Bridge Domains' table, the row for 'Zone\_C/BD91' is selected, and its 'IGMP Policy' is set to 'common/default'. In the 'Interfaces' table, the row for 'L3Out\_To\_Core' is selected, and its 'IGMP Policy' is set to 'common/default'.

BD에 IGMP 정책을 연결하면 IGMP 쿼리어도 됩니다. IGMP 정책은 Tenant(테넌트) > Networking(네트워킹) > Protocol Policies(프로토콜 정책) > IGMP Interface(IGMP 인터페이스)에서 구성합니다. 기본 IGMP 정책에는 쿼리 간격을 정의할 수 있는 다음과 같은 매개변수가 있습니다. 정책을 지정하지 않으면 인터페이스에서 기본 정책을 사용합니다.

The screenshot shows the Cisco SD-WAN configuration interface for IGMP Interface Policy. The left sidebar contains a navigation tree with 'Networking' and 'Protocol Policies' highlighted. The main area displays the 'IGMP Interface Policy - default' configuration page. The 'Name' is 'default', and the 'Version' is set to 'Version 2'. The 'Startup Query Count' is 2, 'Startup Query Interval (sec)' is 31, 'Querier Timeout (sec)' is 255, 'Robustness Variable' is 2, 'State Limit Route Map' is 'select an option', 'Maximum Multicast Entries' is 'select an option', 'Reserved Multicast Entries' is 'select an option', 'Report Policy Route Map' is 'select an option', and 'Static Report Route Map' is 'select an option'.

PIM 정책은 Tenant(테넌트) > Networking(네트워킹) > Protocol Policies(프로토콜 정책) > PIM에서 구성됩니다.

기본 PIM 정책에는 hello 간격을 정의할 수 있는 다음과 같은 매개변수가 있습니다.

The screenshot shows the Cisco SD-WAN GUI with the 'Tenants' tab selected. Under the 'common' tenant, the 'Networking' > 'Protocol Policies' > 'PIM' > 'default' path is highlighted. The 'Edit Interface Policy' page for the 'default' policy is displayed, showing various configuration options. The 'Hello Interval (milliseconds)' is set to 30000.

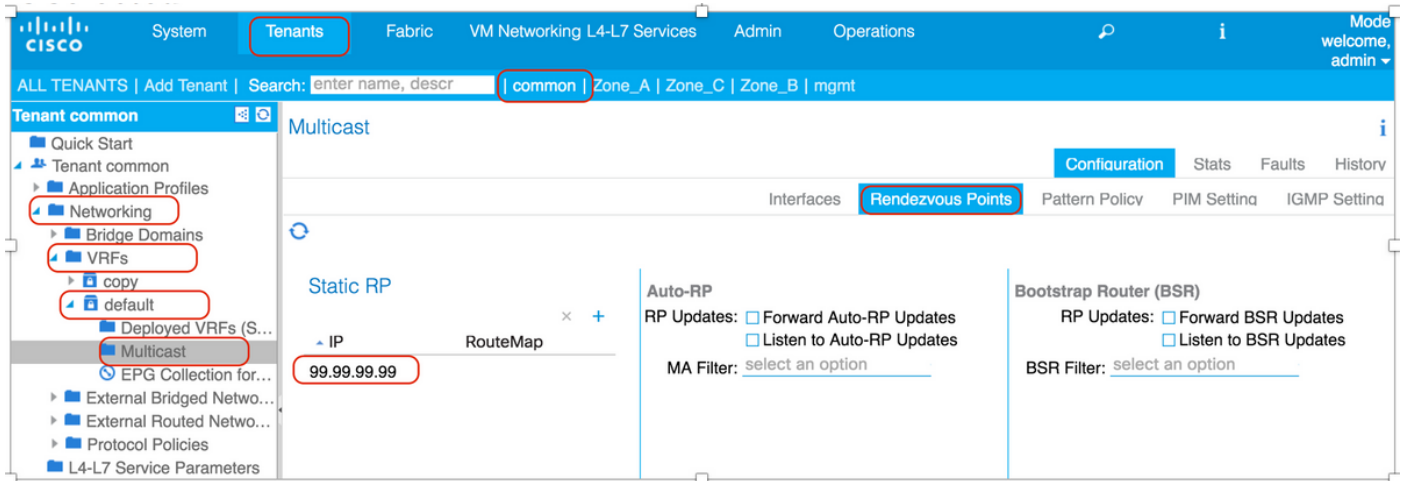
| Property                                          | Value                                                                                                                                   |
|---------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Name                                              | default                                                                                                                                 |
| Auth Type                                         | MD5 HMAC authentication                                                                                                                 |
| Control State                                     | <input type="checkbox"/> Multicast Domain Boundary<br><input type="checkbox"/> Passive<br><input type="checkbox"/> Strict RFC Compliant |
| Designated Router Delay (seconds)                 | 3                                                                                                                                       |
| Designated Router Priority                        | 1                                                                                                                                       |
| Hello Interval (milliseconds)                     | 30000                                                                                                                                   |
| Join-Prune Interval Policy (seconds)              | 60                                                                                                                                      |
| Interface-level Inbound Join-Prune Filter Policy  | select an option                                                                                                                        |
| Interface-level Outbound Join-Prune Filter Policy | select an option                                                                                                                        |
| Interface-level Neighbor Filter Policy            | select an option                                                                                                                        |

노드 프로파일에서 루프백 주소를 활성화하여 경계 리프의 L3Outs를 구성해야 합니다.

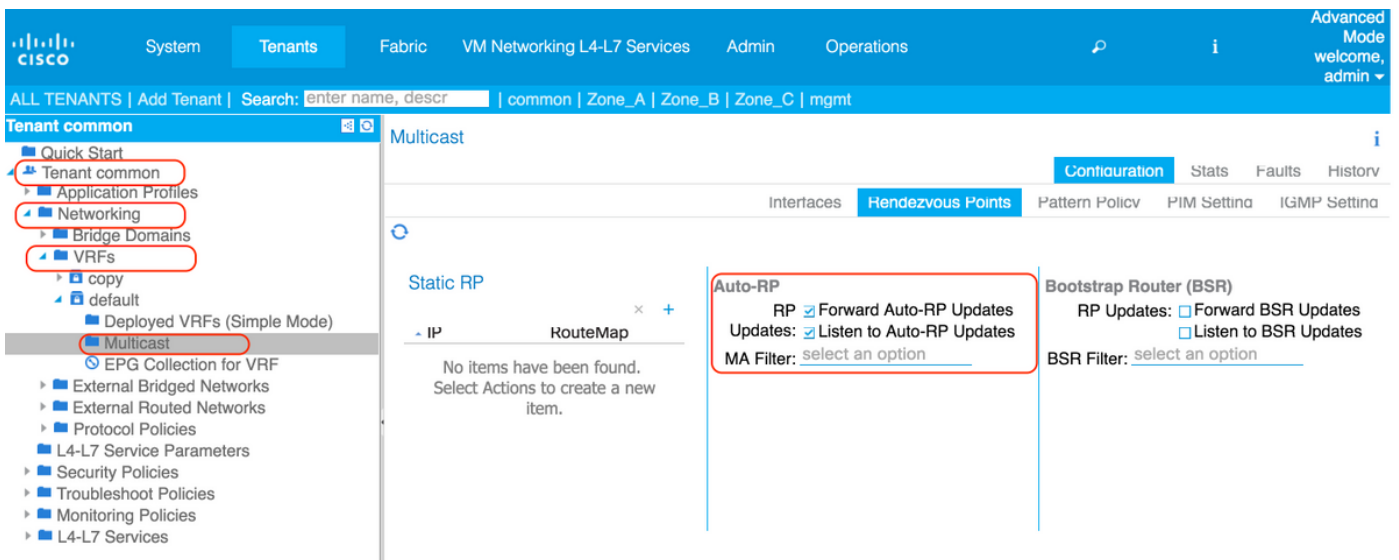
The screenshot shows the Cisco SD-WAN GUI with the 'Tenants' tab selected. Under the 'common' tenant, the 'Networking' > 'External Routed Networks' > 'L3Out\_To\_Core' > 'Logical Node Profiles' > 'L3Out\_To\_Core\_NP' path is highlighted. The 'Logical Node Profile - L3Out\_To\_Core\_NP' page is displayed, showing a table of nodes with their loopback addresses.

| Node ID                 | Router ID     | Static Routes | Loopback Address |
|-------------------------|---------------|---------------|------------------|
| topology/pod-1/node-131 | 131.131.131.1 |               | 131.131.131.1    |
| topology/pod-1/node-132 | 132.132.132.1 |               | 132.132.132.1    |

3단계: PIM ASM에 대한 RP를 구성합니다. Tenant(테넌트) > VRF > Multicast(멀티캐스트)로 이동하고 작업 패널에서 Configuration(컨피그레이션) > Rendezvous Points(랑데부 지점)를 선택합니다. 이 예에서는 Static RP가 선택됩니다. RP를 추가하려면 "+"를 클릭합니다.



Auto-RP 컨피그레이션의 경우 "Rendezvous Points(랑데부 포인트)" 페이지에서 "Forward Auto-RP updates(Auto-RP 업데이트 전달)" 및 "Listen to Auto-RP Updates(Auto-RP 업데이트 듣기)" 확인란을 선택합니다.



ACI 패브릭 외부에서는 NX-OS 플랫폼의 AUTO-RP 구성이 동일하게 유지됩니다.

!!! On RP candidate

```
ip pim send-rp-announce loopback99 group-list 224.0.0.0/4
ip pim send-rp-discovery loopback99 scope 32
```

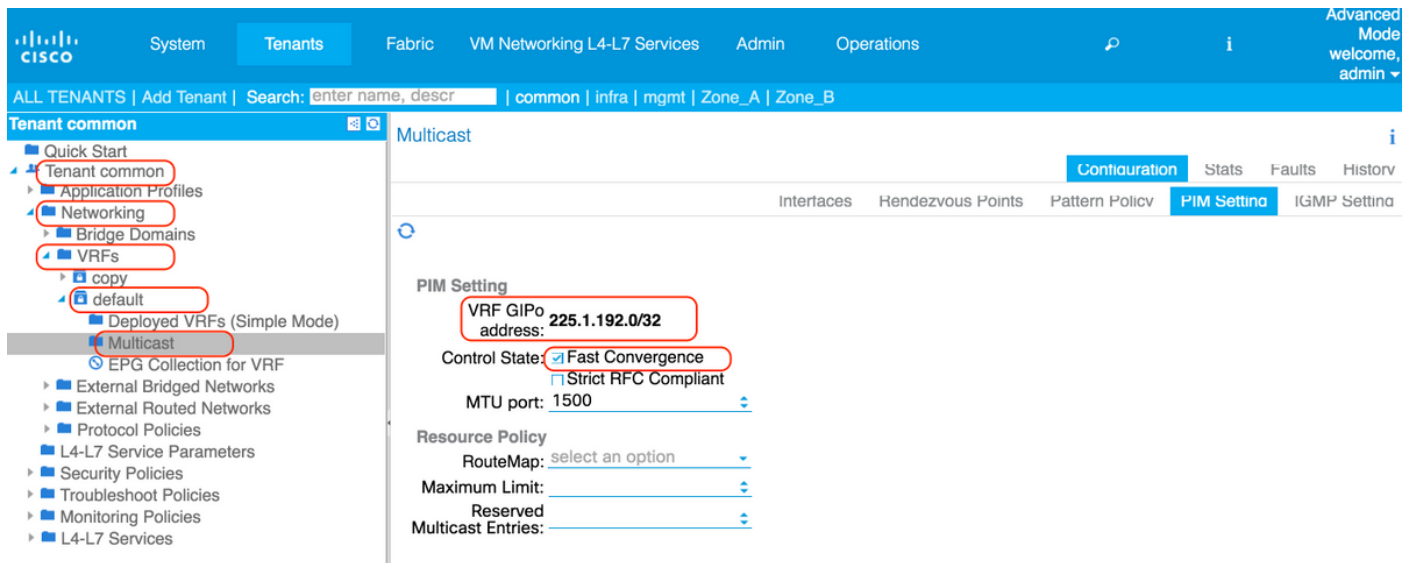
!!! On RP listeners:

```
ip pim auto-rp listen forward
```

4단계: 필요한 PIM 설정을 구성합니다. Tenant(테넌트) > VRF -> Multicast(멀티캐스트)로 이동하고 작업 패널에서 Configuration(컨피그레이션) > PIM settings(PIM 설정)를 선택하고 APIC가 멀티캐스트 그룹 주소 풀에서 할당된 VRF GIPo 주소 225.1.192.0/32를 확인합니다. VRF GIPo는 PIM으로 활성화된 BD의 멀티캐스트 트래픽에 대한 외부 그룹 IP 주소로 사용됩니다.

Fast Convergence 모드가 활성화된 경우(기본값: disable) PIM을 통해 활성화된 모든 보더 리프가 외부 네트워크로 조인을 전송하지만, 보더 리프가 하나만 패브릭으로 트래픽을 전달하여 중복을 방지합니다. 그룹에 대한 트래픽을 전달하는 경계 리프는 그룹에 대해 지정된 전달자입니다. 빠른 컨버전스를 활성화하면 경계 leaf가 중단되어 스트라이프 승자가 변경되는 경우 외부 소스 및 내부 수신기가 있는 멀티캐스트 플로우의 패킷 삭제 기간을 줄일 수 있습니다. 새 스트라이프 승자의 PIM 트리에 조인하는 데 따른 레이턴시가 발생하지 않습니다. 이는 모든 보더 리프가 외부 소스로부터 트래픽을 끌어오기 때문에 스트라이프되지 않은 승자의 외부 링크에서 대역폭을 추가로 사용하는 비용이 발생합니다.

스트라이프 우승자 정보 - 현재 ACI는 BSR(부트스트랩 라우터) 해시를 사용하여 BL 스트라이프 우승자를 계산합니다. 해시는 Leaf의 S,G 및 루프백 IP를 사용하여 계산됩니다. ACI 3.0(1)에서는 사용자의 스트라이프 우승자 선택에 영향을 줄 방법이 없습니다.

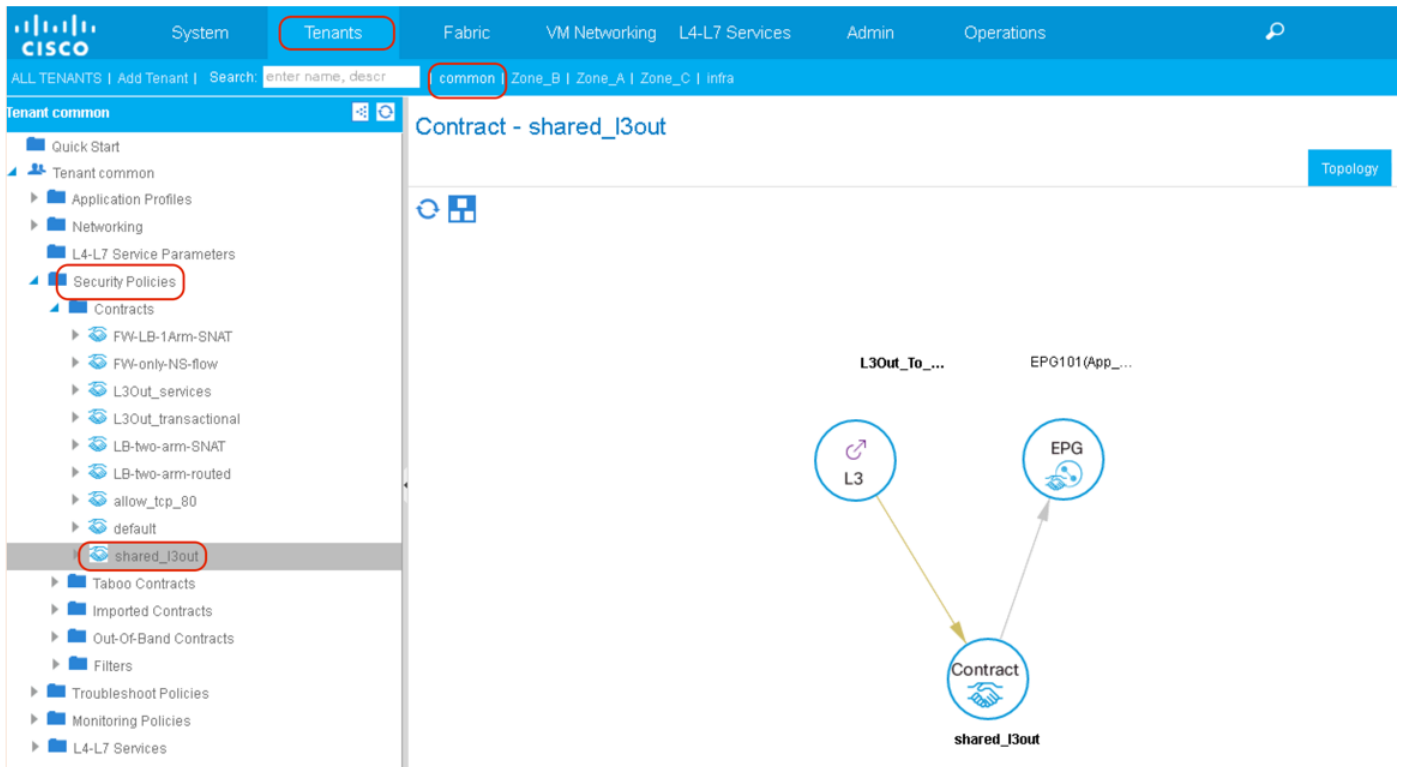


5단계: 멀티캐스트 트래픽을 허용하는 데 필요한 계약 생성:

- 패브릭 내부의 소스 및 수신기(계약 불필요)
- 패브릭 내부의 수신기, 외부 소스(계약 불필요)
- 소스 내부 패브릭, 외부 수신기(계약 필요)\*

\*BD가 경계 리프에 구축된 경우 계약은 필요하지 않습니다.

이 경우 패브릭 외부에 수신기가 있으며, EPG101에서 L3out\_to\_Core와 멀티캐스트 소스 간에 contract를 적용합니다.



다음을 확인합니다.

## PIM 확인

VRF가 멀티캐스트 라우팅을 위해 활성화된 경우 패브릭 내에서 멀티캐스트 라우팅을 위해 패브릭 인터페이스(터널)가 생성됩니다. PIM 컨트롤 플레인 패킷은 패브릭 내 패브릭 인터페이스를 통해 전송됩니다. 터널 대상은 VRF GiPo 멀티캐스트 주소입니다. 보더 리프 스위치에서는 터널 소스가 보더 리프의 루프백 인터페이스가 됩니다. 비경계 리프 스위치에서는 터널 소스가 루프백 주소 (127.0.0.100)가 됩니다.

보더 리프는 패브릭 인터페이스에서 PIM Hello를 전송합니다. L3Out 인터페이스는 PIM을 일반 모드에서 실행합니다. 여기에는 Hello 보내기 및 받기, DR 선택 등이 포함됩니다. 비보더 리프는 패브릭 인터페이스에서 패시브 모드에서 실행됩니다. 보더 리프에서 PIM Hello를 수신하지만 PIM Hello를 보내지 않습니다. 비경계 leaf는 출력에 "show ip pim neighbor"로 표시되지 않습니다.

<#root>

!!!! Border Leaf Node bleaf1 !!!!!

bleaf1# show ip pim neighbor

```
PIM Neighbor information for Dom:common:default
Neighbor                Interface                Uptime                Expires                DRPriority Bidir
132.132.132.1/32
    tunnel16             06:20:40                00:01:21              1                      no                n/a
10.1.20.25/32
    eth1/5                06:23:12                00:01:35              1                      yes                n/a
```

#### 10.1.20.1/32

|        |          |          |   |     |     |
|--------|----------|----------|---|-----|-----|
| eth1/4 | 06:23:12 | 00:01:24 | 1 | yes | n/a |
|--------|----------|----------|---|-----|-----|

bleaf1# show interface tunnel 16

Tunnel16 is up

MTU 9000 bytes, BW 0 Kbit

Transport protocol is in VRF "common:default"

Tunnel protocol/transport is ipvlan

**Tunnel source 131.131.131.1**

**Tunnel destination 225.1.192.0/32**

Last clearing of "show interface" counters never

Tx

0 packets output, 1 minute output rate 0 packets/sec

Rx

0 packets input, 1 minute input rate 0 packets/sec

bleaf1#

**!!!! Border Leaf Node bleaf2 !!!!**

bleaf2# show ip pim neighbor

PIM Neighbor information for Dom:common:default

| Neighbor | Interface | Uptime | Expires | DRPriority | Bidir |
|----------|-----------|--------|---------|------------|-------|
|----------|-----------|--------|---------|------------|-------|

#### 131.131.131.1/32

|          |          |          |   |    |     |
|----------|----------|----------|---|----|-----|
| tunnel16 | 06:23:26 | 00:01:30 | 1 | no | n/a |
|----------|----------|----------|---|----|-----|

#### 10.1.20.29/32

|        |          |          |   |     |     |
|--------|----------|----------|---|-----|-----|
| eth1/5 | 06:38:26 | 00:01:43 | 1 | yes | n/a |
|--------|----------|----------|---|-----|-----|

#### 10.1.20.5/32

|        |          |          |   |     |     |
|--------|----------|----------|---|-----|-----|
| eth1/4 | 06:38:27 | 00:01:20 | 1 | yes | n/a |
|--------|----------|----------|---|-----|-----|

bleaf2# show interface tunnel 16

Tunnel16 is up

MTU 9000 bytes, BW 0 Kbit

Transport protocol is in VRF "common:default"

Tunnel protocol/transport is ipvlan

**Tunnel source 132.132.132.1**

**Tunnel destination 225.1.192.0/32**

Last clearing of "show interface" counters never

Tx

0 packets output, 1 minute output rate 0 packets/sec

Rx

0 packets input, 1 minute input rate 0 packets/sec

bleaf2#

!!!!!! RP !!!!!

bleaf1# show ip pim rp vrf all

PIM RP Status Information for VRF:"common:default"

BSR: Not Operational

Auto-RP RPA: 192.168.1.2/32

**RP: 99.99.99.99**

, uptime: 26d21h, expires: 00:02:38,

priority: 0, RP-source: 192.168.1.2 (A), group-map: None, group ranges:

224.0.0.0/4

bleaf1#

bleaf2# show ip pim rp vrf all

PIM RP Status Information for VRF:"common:default"

BSR: Not Operational

Auto-RP RPA: 192.168.1.2/32

**RP: 99.99.99.99**

, uptime: 26d21h, expires: 00:02:38,

priority: 0, RP-source: 192.168.1.2 (A), group-map: None, group ranges:

224.0.0.0/4

bleaf2#

!!!!!! Non border leaf Node !!!!!

cleaf1# show ip pim neighbor

PIM Neighbor information for Dom:common:default

| Neighbor | Interface | Uptime | Expires | DRPriority | Bidir |
|----------|-----------|--------|---------|------------|-------|
|----------|-----------|--------|---------|------------|-------|

**132.132.132.1/32**

|          |          |          |   |    |     |
|----------|----------|----------|---|----|-----|
| tunnel16 | 06:32:43 | 00:01:37 | 1 | no | n/a |
|----------|----------|----------|---|----|-----|

**131.131.131.1/32**

|          |          |          |   |    |     |
|----------|----------|----------|---|----|-----|
| tunnel16 | 06:32:43 | 00:01:17 | 1 | no | n/a |
|----------|----------|----------|---|----|-----|

cleaf1# show interface tunnel 16

Tunnel16 is up

MTU 9000 bytes, BW 0 Kbit

Transport protocol is in VRF "common:default"

Tunnel protocol/transport is ipvlan

**Tunnel source 127.0.0.100/32**

**Tunnel destination 225.1.192.0/32**

Last clearing of "show interface" counters never

Tx

0 packets output, 1 minute output rate 0 packets/sec

Rx

0 packets input, 1 minute input rate 0 packets/sec

cleaf1#

cleaf2# show ip pim neighbor vrf all

PIM Neighbor information for Dom:common:default

| Neighbor | Interface | Uptime |
|----------|-----------|--------|
|----------|-----------|--------|

Expires

DRPriority Bidir

132.132.132.1/32

|          |          |          |   |    |     |
|----------|----------|----------|---|----|-----|
| tunnel16 | 06:33:17 | 00:01:33 | 1 | no | n/a |
|----------|----------|----------|---|----|-----|

131.131.131.1/32

|          |          |          |   |    |     |
|----------|----------|----------|---|----|-----|
| tunnel16 | 06:33:17 | 00:01:41 | 1 | no | n/a |
|----------|----------|----------|---|----|-----|

cleaf2# show interface tunnel 16

Tunnel16 is up

MTU 9000 bytes, BW 0 Kbit

Transport protocol is in VRF "common:default"

Tunnel protocol/transport is ipvlan

Tunnel source 127.0.0.100/32

Tunnel destination 225.1.192.0/32

Last clearing of "show interface" counters never

Tx

0 packets output, 1 minute output rate 0 packets/sec

Rx

0 packets input, 1 minute input rate 0 packets/sec

cleaf2#

!!!!!! Core Router !!!!!

N7K-core-1# show ip pim neighbor

PIM Neighbor Status for VRF "default"

| Neighbor   | Interface   | Uptime | Expires  | DR<br>Priority | Bidir-<br>Capable | BFD<br>State |
|------------|-------------|--------|----------|----------------|-------------------|--------------|
| 10.1.20.2  | Ethernet1/1 | 3d22h  | 00:01:43 | 1              | no                | n/a          |
| 10.1.20.6  | Ethernet1/2 | 3d22h  | 00:01:36 | 1              | no                | n/a          |
| 10.1.20.10 | Ethernet1/3 | 2w6d   | 00:01:30 | 1              | yes               | n/a          |
| 10.1.20.14 | Ethernet1/4 | 2w6d   | 00:01:18 | 1              | yes               | n/a          |
| 10.1.20.42 | Ethernet1/5 | 2w6d   | 00:01:28 | 1              | yes               | n/a          |

N7K-core-1#

N7K-core-2# sh ip pim neighbor

PIM Neighbor Status for VRF "default"

| Neighbor   | Interface   | Uptime | Expires  | DR<br>Priority | Bidir-<br>Capable | BFD<br>State |
|------------|-------------|--------|----------|----------------|-------------------|--------------|
| 10.1.20.26 | Ethernet1/1 | 3d22h  | 00:01:23 | 1              | no                | n/a          |
| 10.1.20.30 | Ethernet1/2 | 3d22h  | 00:01:17 | 1              | no                | n/a          |
| 10.1.20.18 | Ethernet1/3 | 2w6d   | 00:01:38 | 1              | yes               | n/a          |
| 10.1.20.22 | Ethernet1/4 | 2w6d   | 00:01:41 | 1              | yes               | n/a          |
| 10.1.20.46 | Ethernet1/5 | 2w6d   | 00:01:17 | 1              | yes               | n/a          |

N7K-core-2#

활성 보더 리프 확인

멀티캐스트 라우팅으로 활성화된 경계 리프가 둘 이상인 경우 APIC는 모든 활성 경계 리프에서 각

그룹 주소에 대해 하나의 스트라이프 위너를 선택합니다. 그룹의 스트라이프 우승자인 Border Leaf는 패브릭을 대신하여 PIM 조인을 전송하고 멀티캐스트 트래픽을 패브릭으로 전달합니다.

그룹에 대한 스트라이프 승자는 지정 전달자를 결정합니다. 스트라이프 우승자가 루트에 도달할 수 있는 경우 스트라이프 우승자는 DF도 됩니다. 스트라이프 우승자에게 루트에 대한 외부 연결이 없는 경우 해당 BL은 패브릭 인터페이스를 통해 PIM 조인을 전송하여 DF를 선택합니다.

<#root>

```
!!!! Enter into vsh mode to execute the command !!!!!
bleaf2# vsh
Cisco iNX-OS Debug Shell
This shell should only be used for internal commands and exists
for legacy reasons. User should use ibash infrastructure as this
will be deprecated.
bleaf2#
```

```
show ip pim internal stripe-winner 228.0.0.1 vrf common:default
```

```
PIM Stripe Winner info for VRF "common:default" (BL count: 2)
(*, 228.0.0.1)
BLs: 132.132.132.1 hash: 2081913316 (local)
     131.131.131.1 hash: 1024236260
```

```
Winner: 132.132.132.1 best_hash: 2081913316
```

```
bleaf2#
bleaf2#
bleaf2#
```

```
show ip pim internal stripe-winner 229.0.0.1 vrf common:default
```

```
PIM Stripe Winner info for VRF "common:default" (BL count: 2)
(*, 229.0.0.1)
BLs: 132.132.132.1 hash: 1595374052 (local)
     131.131.131.1 hash: 2047646436
```

```
Winner: 131.131.131.1 best_hash: 2047646436
```

```
bleaf2#
```

빠른 컨버전스 확인

<#root>

```
!!! Verify if fast convergence is enabled
bleaf1# show fabric multicast vrf common:default
Fabric Multicast Enabled VRFs
VRF Name          VRF      Vprime      VN-Seg      VRF
Conv
Tunnel
ID                If            ID            Role
Mode
IP
```

```
common:default      4      Tunnel16      2162688      BL
```

#### Fast

```
131.131.131.1
```

```
bleaf1#
```

```
!!! None-border leaf
```

```
cleaf1# show fabric multicast vrf common:default
```

```
Fabric Multicast Enabled VRFs
```

| VRF Name | VRF | Vprime | VN-Seg | VRF |
|----------|-----|--------|--------|-----|
|----------|-----|--------|--------|-----|

#### Conv

```
Tunnel
```

| ID | If | ID | Role |
|----|----|----|------|
|----|----|----|------|

#### Mode

```
IP
```

|                |   |          |         |      |
|----------------|---|----------|---------|------|
| common:default | 4 | Tunnel16 | 2162688 | Leaf |
|----------------|---|----------|---------|------|

#### Fast

```
127.0.0.100
```

```
cleaf1#
```

## IGMP 확인

```
!!!! Bleaf2 receiving IGMP membership join !!!!
```

```
bleaf2# show ip igmp groups vrf common:default
```

```
Type: S - Static, D - Dynamic, L - Local, T - SSM Translated
```

```
Displaying Groups for vrf:common:default
```

| Group Address | Type | Interface | Uptime | Expires  | Last Reporter |
|---------------|------|-----------|--------|----------|---------------|
| 228.0.0.1     | D    | vlan25    | 25d23h | 00:02:20 | 10.90.90.71   |
| 229.0.0.1     | D    | vlan25    | 25d23h | 00:02:24 | 10.90.90.71   |
| 228.0.0.2     | D    | vlan25    | 25d23h | 00:02:27 | 10.90.90.72   |
| 229.0.0.2     | D    | vlan25    | 25d23h | 00:02:20 | 10.90.90.72   |
| 228.0.0.3     | D    | vlan25    | 25d23h | 00:02:25 | 10.90.90.73   |
| 229.0.0.3     | D    | vlan25    | 25d23h | 00:02:25 | 10.90.90.73   |
| 228.0.0.4     | D    | vlan25    | 25d23h | 00:02:26 | 10.90.90.74   |
| 229.0.0.4     | D    | vlan25    | 25d23h | 00:02:25 | 10.90.90.74   |
| 228.0.0.5     | D    | vlan25    | 25d23h | 00:02:28 | 10.90.90.75   |
| 229.0.0.5     | D    | vlan25    | 25d23h | 00:02:20 | 10.90.90.75   |
| 228.0.0.6     | D    | vlan25    | 25d23h | 00:02:22 | 10.90.90.76   |
| 229.0.0.6     | D    | vlan25    | 25d23h | 00:02:26 | 10.90.90.76   |
| 228.0.0.7     | D    | vlan25    | 25d23h | 00:02:25 | 10.90.90.77   |
| 229.0.0.7     | D    | vlan25    | 25d23h | 00:02:19 | 10.90.90.77   |
| 228.0.0.8     | D    | vlan25    | 25d23h | 00:02:22 | 10.90.90.78   |
| 229.0.0.8     | D    | vlan25    | 25d23h | 00:02:25 | 10.90.90.78   |
| 228.0.0.9     | D    | vlan25    | 25d23h | 00:02:27 | 10.90.90.79   |
| 229.0.0.9     | D    | vlan25    | 25d23h | 00:02:20 | 10.90.90.79   |
| 228.0.0.10    | D    | vlan25    | 25d23h | 00:02:20 | 10.90.90.80   |
| 229.0.0.10    | D    | vlan25    | 25d23h | 00:02:21 | 10.90.90.80   |

```
bleaf2#
```

```
bleaf2# show ip igmp snooping groups vlan 25
```

```
Type: S - Static, D - Dynamic, R - Router port, F - Fabricpath core port
```

| Vlan | Group Address | Ver | Type | Port list |
|------|---------------|-----|------|-----------|
| 25   | */*           | -   | R    | Vlan25    |
| 25   | 228.0.0.1     | v2  | D    | Eth1/47   |
| 25   | 228.0.0.2     | v2  | D    | Eth1/47   |
| 25   | 228.0.0.3     | v2  | D    | Eth1/47   |
| 25   | 228.0.0.4     | v2  | D    | Eth1/47   |
| 25   | 228.0.0.5     | v2  | D    | Eth1/47   |
| 25   | 228.0.0.6     | v2  | D    | Eth1/47   |
| 25   | 228.0.0.7     | v2  | D    | Eth1/47   |
| 25   | 228.0.0.8     | v2  | D    | Eth1/47   |
| 25   | 228.0.0.9     | v2  | D    | Eth1/47   |
| 25   | 228.0.0.10    | v2  | D    | Eth1/47   |
| 25   | 229.0.0.1     | v2  | D    | Eth1/47   |
| 25   | 229.0.0.2     | v2  | D    | Eth1/47   |
| 25   | 229.0.0.3     | v2  | D    | Eth1/47   |
| 25   | 229.0.0.4     | v2  | D    | Eth1/47   |
| 25   | 229.0.0.5     | v2  | D    | Eth1/47   |
| 25   | 229.0.0.6     | v2  | D    | Eth1/47   |
| 25   | 229.0.0.7     | v2  | D    | Eth1/47   |
| 25   | 229.0.0.8     | v2  | D    | Eth1/47   |
| 25   | 229.0.0.9     | v2  | D    | Eth1/47   |
| 25   | 229.0.0.10    | v2  | D    | Eth1/47   |

bleaf2#

!!!! cleaf2 receivng IGMP membership join !!!!

cleaf2# show ip igmp groups vrf common:default

Type: S - Static, D - Dynamic, L - Local, T - SSM Translated

Displaying Groups for vrf:common:default

| Group Address | Type | Interface | Uptime | Expires  | Last Reporter |
|---------------|------|-----------|--------|----------|---------------|
| 228.0.0.1     | D    | vlan9     | 25d23h | 00:03:37 | 10.32.32.120  |
| 228.0.0.1     | D    | vlan30    | 25d23h | 00:04:17 | 10.91.91.71   |
| 228.0.0.1     | D    | vlan3     | 11d23h | 00:03:18 | 10.31.31.123  |
| 229.0.0.1     | D    | vlan9     | 25d23h | 00:03:41 | 10.32.32.121  |
| 229.0.0.1     | D    | vlan30    | 25d23h | 00:02:22 | 10.91.91.71   |
| 229.0.0.1     | D    | vlan3     | 11d23h | 00:03:16 | 10.31.31.120  |
| 228.0.0.2     | D    | vlan9     | 25d23h | 00:03:38 | 10.32.32.123  |
| 228.0.0.2     | D    | vlan30    | 25d23h | 00:02:15 | 10.91.91.72   |
| 228.0.0.2     | D    | vlan3     | 11d23h | 00:03:16 | 10.31.31.122  |
| 229.0.0.2     | D    | vlan9     | 25d23h | 00:03:37 | 10.32.32.123  |
| 229.0.0.2     | D    | vlan30    | 25d23h | 00:02:16 | 10.91.91.72   |
| 229.0.0.2     | D    | vlan3     | 11d23h | 00:03:16 | 10.31.31.124  |
| 228.0.0.3     | D    | vlan9     | 25d23h | 00:03:41 | 10.32.32.120  |
| 228.0.0.3     | D    | vlan30    | 25d23h | 00:04:18 | 10.91.91.73   |
| 228.0.0.3     | D    | vlan3     | 11d23h | 00:03:18 | 10.31.31.120  |
| 229.0.0.3     | D    | vlan9     | 25d23h | 00:03:38 | 10.32.32.121  |
| 229.0.0.3     | D    | vlan30    | 25d23h | 00:04:17 | 10.91.91.73   |
| 229.0.0.3     | D    | vlan3     | 11d23h | 00:03:18 | 10.31.31.122  |

<.....>

cleaf2#

cleaf2# show ip igmp snooping vlan 3

IGMP Snooping information for vlan 3

IGMP snooping enabled

Lookup mode: IP

Optimised Multicast Flood (OMF) enabled

IGMP querier present, address: 10.31.31.1, version: 2, i/f Vlan3

Switch-querier disabled

IGMPv3 Explicit tracking enabled

IGMPv2 Fast leave disabled

IGMPv1/v2 Report suppression enabled

IGMPv3 Report suppression enabled

Link Local Groups suppression enabled

```

Router port detection using PIM Hellos, IGMP Queries
Number of router-ports: 1
Number of groups: 20
VLAN vPC function enabled
Active ports:
    Eth1/2      Eth1/3      Po3      Po4
cleaf2# show ip igmp snooping groups vlan 3
Type: S - Static, D - Dynamic, R - Router port, F - Fabricpath core port

```

| Vlan | Group Address | Ver | Type | Port list |
|------|---------------|-----|------|-----------|
| 3    | */*           | -   | R    | Vlan3     |
| 3    | 228.0.0.1     | v2  | D    | Po4       |
| 3    | 228.0.0.2     | v2  | D    | Po4       |
| 3    | 228.0.0.3     | v2  | D    | Po4       |
| 3    | 228.0.0.4     | v2  | D    | Po4       |
| 3    | 228.0.0.5     | v2  | D    | Po4       |
| 3    | 228.0.0.6     | v2  | D    | Po4       |
| 3    | 228.0.0.7     | v2  | D    | Po4       |
| 3    | 228.0.0.8     | v2  | D    | Po4       |
| 3    | 228.0.0.9     | v2  | D    | Po4       |
| 3    | 228.0.0.10    | v2  | D    | Po4       |
| 3    | 229.0.0.1     | v2  | D    | Po4       |
| 3    | 229.0.0.2     | v2  | D    | Po4       |
| 3    | 229.0.0.3     | v2  | D    | Po4       |
| 3    | 229.0.0.4     | v2  | D    | Po4       |
| 3    | 229.0.0.5     | v2  | D    | Po4       |
| 3    | 229.0.0.6     | v2  | D    | Po4       |
| 3    | 229.0.0.7     | v2  | D    | Po4       |
| 3    | 229.0.0.8     | v2  | D    | Po4       |
| 3    | 229.0.0.9     | v2  | D    | Po4       |
| 3    | 229.0.0.10    | v2  | D    | Po4       |

cleaf2#

## MRIB 확인

FHR인 leaf 노드 slaf2에는 멀티캐스트 소스가 직접 어태치됩니다. 해당 RPF 네이버는 spine1에서 10.0.176.64입니다. 수신 인터페이스는 PIM을 통해 보더 리프와 피어링하는 패브릭 인터페이스 (tunnel16)입니다.

간소화를 위해 표시된 출력은 각 그룹 범위의 멀티캐스트 IP 주소 1개에 대한 것입니다. 내부 소스는 228.0.0.1이고, 외부 소스는 229.0.0.1입니다.

```

!!!! FHR of mcast sources in fabric
sleaf2# show ip mroute vrf common:default
IP Multicast Routing Table for VRF "common:default"

(10.101.101.115/32, 228.0.0.1/32), uptime: 00:17:54, ip pim
  Incoming interface: Tunnel16, RPF nbr: 10.0.176.64 (pervasive)
  Outgoing interface list: (count: 0)

(10.101.101.116/32, 228.0.0.1/32), uptime: 00:17:54, ip pim
  Incoming interface: Tunnel16, RPF nbr: 10.0.176.64 (pervasive)
  Outgoing interface list: (count: 0)

(10.101.101.117/32, 228.0.0.1/32), uptime: 00:17:54, ip pim
  Incoming interface: Tunnel16, RPF nbr: 10.0.176.64 (pervasive)

```

Outgoing interface list: (count: 0)

(.....)

(\*, 232.0.0.0/8), uptime: 4d00h, pim ip  
Incoming interface: Null, RPF nbr: 0.0.0.0  
Outgoing interface list: (count: 0)

sleaf2# show ip pim neighbor vrf common:default

PIM Neighbor information for Dom:common:default

| Neighbor         | Interface | Uptime   | Expires  | DRPriority | Bidir |
|------------------|-----------|----------|----------|------------|-------|
| 131.131.131.1/32 | tunnel16  | 04:01:06 | 00:01:23 | 1          | no    |
| 132.132.132.1/32 | tunnel16  | 04:01:06 | 00:01:32 | 1          | no    |

sleaf2#

sleaf2# show interface tunnel 16

Tunnel16 is up  
MTU 9000 bytes, BW 0 Kbit  
Transport protocol is in VRF "common:default"  
Tunnel protocol/transport is ipvlan  
Tunnel source 127.0.0.100/32  
Tunnel destination 225.1.192.0/32  
Last clearing of "show interface" counters never  
Tx  
0 packets output, 1 minute output rate 0 packets/sec  
Rx  
0 packets input, 1 minute input rate 0 packets/sec

sleaf2#

228.0.0.1용 수신기는 bleaf2(노드 132), cleaf1(노드 101) 및 cleaf2(노드 102)에 연결됩니다.  
Bleaf2는 그룹 228.0.0.1에 멀티캐스트 패킷을 터널 16을 통해 내부 수신기에 전달하고, 외부 수신  
기는 L3out을 통해 코어 디바이스에 전달합니다.

!!!!!! Bleaf2 !!!!!

bleaf2# show ip mroute 228.0.0.1 vrf common:default  
IP Multicast Routing Table for VRF "common:default"

(\*, 228.0.0.1/32), uptime: 3w5d, ngmvpn ip pim igmp  
Incoming interface: Ethernet1/4, RPF nbr: 10.1.20.5  
Outgoing interface list: (count: 2) (Fabric OIF)  
Vlan25, uptime: 3w5d, igmp  
Tunnel16, uptime: 3w5d, ngmvpn

(10.101.101.115/32, 228.0.0.1/32), uptime: 3w5d, pim mrib ip ngmvpn  
Incoming interface: Tunnel16, RPF nbr: 10.0.176.64 (pervasive)  
Outgoing interface list: (count: 2) (Fabric OIF)  
Vlan25, uptime: 3w5d, mrib  
Tunnel16, uptime: 3w5d, mrib, ngmvpn, (RPF)

(10.101.101.116/32, 228.0.0.1/32), uptime: 3w5d, ip mrib pim ngmvpn  
Incoming interface: Tunnel16, RPF nbr: 10.0.176.64 (pervasive)  
Outgoing interface list: (count: 3) (Fabric OIF)  
Ethernet1/5, uptime: 00:04:36, pim  
Vlan25, uptime: 3w5d, mrib  
Tunnel16, uptime: 3w5d, mrib, ngmvpn, (RPF)

(10.101.101.117/32, 228.0.0.1/32), uptime: 3w5d, pim mrib ip ngmvpn  
Incoming interface: Tunnel16, RPF nbr: 10.0.176.64 (pervasive)  
Outgoing interface list: (count: 2) (Fabric OIF)  
Vlan25, uptime: 3w5d, mrib  
Tunnel16, uptime: 3w5d, mrib, ngmvpn, (RPF)

(10.101.101.118/32, 228.0.0.1/32), uptime: 3w5d, ip mrib pim ngmvpn  
Incoming interface: Tunnel16, RPF nbr: 10.0.176.64 (pervasive)  
Outgoing interface list: (count: 3) (Fabric OIF)  
Ethernet1/5, uptime: 00:04:36, pim  
Vlan25, uptime: 3w5d, mrib  
Tunnel16, uptime: 3w5d, mrib, ngmvpn, (RPF)

(10.101.101.119/32, 228.0.0.1/32), uptime: 3w5d, pim mrib ip ngmvpn  
Incoming interface: Tunnel16, RPF nbr: 10.0.176.64 (pervasive)  
Outgoing interface list: (count: 2) (Fabric OIF)  
Vlan25, uptime: 3w5d, mrib  
Tunnel16, uptime: 3w5d, mrib, ngmvpn, (RPF)

(10.101.101.120/32, 228.0.0.1/32), uptime: 3w5d, mrib ip pim ngmvpn  
Incoming interface: Tunnel16, RPF nbr: 10.0.176.64 (pervasive)  
Outgoing interface list: (count: 2) (Fabric OIF)  
Vlan25, uptime: 3w5d, mrib  
Tunnel16, uptime: 3w5d, mrib, ngmvpn, (RPF)

(10.101.101.121/32, 228.0.0.1/32), uptime: 3w5d, mrib ip pim ngmvpn  
Incoming interface: Tunnel16, RPF nbr: 10.0.176.64 (pervasive)  
Outgoing interface list: (count: 2) (Fabric OIF)  
Vlan25, uptime: 3w5d, mrib  
Tunnel16, uptime: 3w5d, mrib, ngmvpn, (RPF)

(10.101.101.122/32, 228.0.0.1/32), uptime: 3w5d, pim mrib ip ngmvpn  
Incoming interface: Tunnel16, RPF nbr: 10.0.176.64 (pervasive)  
Outgoing interface list: (count: 2) (Fabric OIF)  
Vlan25, uptime: 3w5d, mrib  
Tunnel16, uptime: 3w5d, mrib, ngmvpn, (RPF)

(10.101.101.123/32, 228.0.0.1/32), uptime: 3w5d, ip mrib pim ngmvpn  
Incoming interface: Tunnel16, RPF nbr: 10.0.176.64 (pervasive)  
Outgoing interface list: (count: 3) (Fabric OIF)  
Ethernet1/5, uptime: 00:04:36, pim  
Vlan25, uptime: 3w5d, mrib  
Tunnel16, uptime: 3w5d, mrib, ngmvpn, (RPF)

(10.101.101.124/32, 228.0.0.1/32), uptime: 3w5d, ip mrib pim ngmvpn  
Incoming interface: Tunnel16, RPF nbr: 10.0.176.64 (pervasive)  
Outgoing interface list: (count: 3) (Fabric OIF)  
Ethernet1/5, uptime: 1d00h, pim  
Vlan25, uptime: 3w5d, mrib  
Tunnel16, uptime: 3w5d, mrib, ngmvpn, (RPF)

bleaf2#

bleaf2# show interface vlan25

Vlan25 is up, line protocol is up

Hardware EtherSVI, address is 0000.0c07.ac5a

Internet Address is 10.90.90.1/24

MTU 9000 bytes, BW 10000000 Kbit, DLY 1 usec

reliability 255/255, txload 1/255, rxload 1/255

Carrier delay is 10 sec

Encapsulation ARPA, loopback not set

Keepalive not supported

```
ARP type: ARPA
Last clearing of "show interface" counters never
30 seconds input rate 0 bits/sec, 0 packets/sec
30 seconds output rate 0 bits/sec, 0 packets/sec
Load-Interval #2: 5 minute (300 seconds)
  input rate 0 bps, 0 pps; output rate 0 bps, 0 pps
L3 Switched:
  input: 0 pkts, 0 bytes - output: 0 pkts, 0 bytes
L3 in Switched:
  ucast: 0 pkts, 0 bytes - mcast: 0 pkts, 0 bytes
L3 out Switched:
  ucast: 0 pkts, 0 bytes - mcast: 0 pkts, 0 bytes
```

bleaf2#

Bleaf1은 228.0.0.1의 그룹을 L3out 인터페이스를 통해 외부로 전달하지만, 228.0.0.1의 경우 스트라이프 승자가 아니므로 패브릭 인터페이스를 통해 패브릭으로 전달하지 않습니다

```
!!!! Bleaf1 !!!!
!!!!
```

```
bleaf1# show ip mroute 228.0.0.1 vrf common:default
IP Multicast Routing Table for VRF "common:default"
```

```
(10.101.101.115/32, 228.0.0.1/32), uptime: 3w4d, mrib ip pim
  Incoming interface: Tunnel14, RPF nbr: 10.0.176.64 (pervasive)
  Outgoing interface list: (count: 1)
    Ethernet1/5, uptime: 1d01h, pim
```

```
(10.101.101.116/32, 228.0.0.1/32), uptime: 3w5d, pim mrib ip
  Incoming interface: Tunnel14, RPF nbr: 10.0.176.64 (pervasive)
  Outgoing interface list: (count: 1)
    Ethernet1/4, uptime: 1d01h, pim
```

```
(10.101.101.117/32, 228.0.0.1/32), uptime: 3w5d, pim mrib ip
  Incoming interface: Tunnel14, RPF nbr: 10.0.176.64 (pervasive)
  Outgoing interface list: (count: 1)
    Ethernet1/5, uptime: 1d01h, pim
```

```
(10.101.101.118/32, 228.0.0.1/32), uptime: 3w5d, mrib ip pim
  Incoming interface: Tunnel14, RPF nbr: 10.0.176.64 (pervasive)
  Outgoing interface list: (count: 1)
    Ethernet1/4, uptime: 1d01h, pim
```

```
(10.101.101.119/32, 228.0.0.1/32), uptime: 3w5d, mrib ip pim
  Incoming interface: Tunnel14, RPF nbr: 10.0.176.64 (pervasive)
  Outgoing interface list: (count: 1)
    Ethernet1/5, uptime: 1d01h, pim
```

```
(10.101.101.120/32, 228.0.0.1/32), uptime: 3w5d, pim mrib ip
  Incoming interface: Tunnel14, RPF nbr: 10.0.176.64 (pervasive)
  Outgoing interface list: (count: 1)
    Ethernet1/4, uptime: 1d01h, pim
```

```
(10.101.101.121/32, 228.0.0.1/32), uptime: 3w5d, pim mrib ip
  Incoming interface: Tunnel14, RPF nbr: 10.0.176.64 (pervasive)
  Outgoing interface list: (count: 1)
    Ethernet1/4, uptime: 1d01h, pim
```

```
(10.101.101.122/32, 228.0.0.1/32), uptime: 1d01h, ip mrib pim
Incoming interface: Tunnel14, RPF nbr: 10.0.176.64 (pervasive)
Outgoing interface list: (count: 1)
Ethernet1/5, uptime: 1d01h, pim
```

```
(10.101.101.123/32, 228.0.0.1/32), uptime: 3w5d, pim mrib ip
Incoming interface: Tunnel14, RPF nbr: 10.0.176.64 (pervasive)
Outgoing interface list: (count: 1)
Ethernet1/4, uptime: 1d01h, pim
```

bleaf1#

Bleaf1은 그룹 229.0.0.1의 액티브 보더 리프/스트라이프 와인더입니다. bleaf1은 외부 코어 디바이스를 통해 그룹 229.0.0.1에 멀티캐스트를 수신한 다음 BD90, BD91, BD31, BD32의 내부 수신기로 전달합니다. (vlan ID는 leaf 노드 내부에만 퍼베이션 GW입니다.)

!!!! bleaf1 !!!!!

```
bleaf1# show ip mroute 229.0.0.1 vrf common:default
IP Multicast Routing Table for VRF "common:default"
```

```
(*, 229.0.0.1/32), uptime: 3w5d, ngmvpn ip pim
Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.25
Outgoing interface list: (count: 1) (Fabric OIF)
Tunnel14, uptime: 3w5d, ngmvpn
```

```
(10.103.103.40/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.25
Outgoing interface list: (count: 1)
Tunnel14, uptime: 1d01h, mrib
```

```
(10.103.103.41/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
Incoming interface: Ethernet1/4, RPF nbr: 10.1.20.1
Outgoing interface list: (count: 1)
Tunnel14, uptime: 1d01h, mrib
```

```
(10.103.103.42/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.25
Outgoing interface list: (count: 1)
Tunnel14, uptime: 1d01h, mrib
```

```
(10.103.103.43/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.25
Outgoing interface list: (count: 1)
Tunnel14, uptime: 1d01h, mrib
```

```
(10.103.103.44/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.25
Outgoing interface list: (count: 1)
Tunnel14, uptime: 1d01h, mrib
```

```
(10.103.103.45/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.25
Outgoing interface list: (count: 1)
```

```

Tunnel14, uptime: 1d01h, mrib
(10.103.103.46/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
  Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.25
  Outgoing interface list: (count: 1)
    Tunnel14, uptime: 1d01h, mrib
(10.103.103.47/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
  Incoming interface: Ethernet1/4, RPF nbr: 10.1.20.1
  Outgoing interface list: (count: 1)
    Tunnel14, uptime: 1d01h, mrib
(10.103.103.48/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
  Incoming interface: Ethernet1/4, RPF nbr: 10.1.20.1
  Outgoing interface list: (count: 1)
    Tunnel14, uptime: 1d01h, mrib
(10.103.103.49/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
  Incoming interface: Ethernet1/4, RPF nbr: 10.1.20.1
  Outgoing interface list: (count: 1)
    Tunnel14, uptime: 1d01h, mrib
bleaf1#

```

!!!!!! bleaf2 !!!!!

```

bleaf2# show ip mroute 229.0.0.1 vrf common:default
IP Multicast Routing Table for VRF "common:default"

```

```

(*, 229.0.0.1/32), uptime: 3w5d, ip pim igmp
  Incoming interface: Ethernet1/4, RPF nbr: 10.1.20.5
  Outgoing interface list: (count: 1)
    Vlan25, uptime: 3w5d, igmp
(10.103.103.40/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
  Incoming interface: Ethernet1/4, RPF nbr: 10.1.20.5
  Outgoing interface list: (count: 1) (Fabric Forwarding Loser)
    Vlan25, uptime: 1d01h, mrib
(10.103.103.41/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
  Incoming interface: Ethernet1/4, RPF nbr: 10.1.20.5
  Outgoing interface list: (count: 1) (Fabric Forwarding Loser)
    Vlan25, uptime: 1d01h, mrib
(10.103.103.42/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
  Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.29
  Outgoing interface list: (count: 1) (Fabric Forwarding Loser)
    Vlan25, uptime: 1d01h, mrib
(10.103.103.43/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
  Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.29
  Outgoing interface list: (count: 1) (Fabric Forwarding Loser)
    Vlan25, uptime: 1d01h, mrib
(10.103.103.44/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
  Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.29
  Outgoing interface list: (count: 1) (Fabric Forwarding Loser)
    Vlan25, uptime: 1d01h, mrib
(10.103.103.45/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
  Incoming interface: Ethernet1/4, RPF nbr: 10.1.20.5
  Outgoing interface list: (count: 1) (Fabric Forwarding Loser)

```

```

Vlan25, uptime: 1d01h, mrib
(10.103.103.46/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.29
Outgoing interface list: (count: 1) (Fabric Forwarding Loser)
Vlan25, uptime: 1d01h, mrib
(10.103.103.47/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
Incoming interface: Ethernet1/4, RPF nbr: 10.1.20.5
Outgoing interface list: (count: 1) (Fabric Forwarding Loser)
Vlan25, uptime: 1d01h, mrib
(10.103.103.48/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.29
Outgoing interface list: (count: 1) (Fabric Forwarding Loser)
Vlan25, uptime: 1d01h, mrib
(10.103.103.49/32, 229.0.0.1/32), uptime: 1d01h, ip mrib pim
Incoming interface: Ethernet1/4, RPF nbr: 10.1.20.5
Outgoing interface list: (count: 1) (Fabric Forwarding Loser)
Vlan25, uptime: 1d01h, mrib

```

bleaf2#

비경계 리프 Cleaf1 및 Cleaf2에는 BD31, BD32, BD91에 수신기가 연결되어 있습니다. 비경계 리프 노드 설치(\*, G)만, (S,G)는 지원되지 않습니다.

<#root>

```

cleaf1# show ip mroute 228.0.0.1 vrf common:default
IP Multicast Routing Table for VRF "common:default"

```

```

(*, 228.0.0.1/32), uptime: 3w5d, igmp ip pim
Incoming interface: Tunnel14, RPF nbr: 10.0.80.91
Outgoing interface list: (count: 2)
Vlan4, uptime: 1w5d, igmp
Vlan7, uptime: 3w5d, igmp

```

```

cleaf1# show ip mroute 229.0.0.1 vrf common:default
IP Multicast Routing Table for VRF "common:default"

```

```

(*, 229.0.0.1/32), uptime: 3w5d, igmp ip pim
Incoming interface: Tunnel14, RPF nbr: 10.0.80.91
Outgoing interface list: (count: 2)
Vlan4, uptime: 1w5d, igmp
Vlan7, uptime: 3w5d, igmp

```

cleaf1#

```

cleaf1# show interface vlan 4
Vlan4 is up, line protocol is up
Hardware EtherSVI, address is 0000.0c07.ac1f

```

**Internet Address is 10.31.31.1/24**

```
MTU 9000 bytes, BW 10000000 Kbit, DLY 1 usec
  reliability 255/255, txload 1/255, rxload 1/255
Carrier delay is 10 sec
Encapsulation ARPA, loopback not set
Keepalive not supported
ARP type: ARPA
Last clearing of "show interface" counters never
30 seconds input rate 0 bits/sec, 0 packets/sec
30 seconds output rate 0 bits/sec, 0 packets/sec
Load-Interval #2: 5 minute (300 seconds)
  input rate 0 bps, 0 pps; output rate 0 bps, 0 pps
L3 Switched:
  input: 0 pkts, 0 bytes - output: 0 pkts, 0 bytes
L3 in Switched:
  ucast: 0 pkts, 0 bytes - mcast: 0 pkts, 0 bytes
L3 out Switched:
  ucast: 0 pkts, 0 bytes - mcast: 0 pkts, 0 bytes
```

```
cleaf1# show interface vlan 7
Vlan7 is up, line protocol is up
  Hardware EtherSVI, address is 0000.0c07.ac20
```

#### **Internet Address is 10.32.32.1/24**

```
MTU 9000 bytes, BW 10000000 Kbit, DLY 1 usec
  reliability 255/255, txload 1/255, rxload 1/255
Carrier delay is 10 sec
Encapsulation ARPA, loopback not set
Keepalive not supported
ARP type: ARPA
Last clearing of "show interface" counters never
30 seconds input rate 0 bits/sec, 0 packets/sec
30 seconds output rate 0 bits/sec, 0 packets/sec
Load-Interval #2: 5 minute (300 seconds)
  input rate 0 bps, 0 pps; output rate 0 bps, 0 pps
L3 Switched:
  input: 0 pkts, 0 bytes - output: 0 pkts, 0 bytes
L3 in Switched:
  ucast: 0 pkts, 0 bytes - mcast: 0 pkts, 0 bytes
L3 out Switched:
  ucast: 0 pkts, 0 bytes - mcast: 0 pkts, 0 bytes
```

```
cleaf1#
```

!!!! Non-border leaf node has (\*, G) only, (S,G) is not supported.

```
cleaf2# show ip mroute 228.0.0.1 vrf common:default
IP Multicast Routing Table for VRF "common:default"
```

```
(*, 228.0.0.1/32), uptime: 3w5d, igmp ip pim
  Incoming interface: Tunnel16, RPF nbr: 10.0.80.91
  Outgoing interface list: (count: 3)
    Vlan3, uptime: 1w5d, igmp
    Vlan30, uptime: 3w5d, igmp
    Vlan9, uptime: 3w5d, igmp
```

```
cleaf2# show ip mroute 229.0.0.1 vrf common:default
IP Multicast Routing Table for VRF "common:default"
```

```
(*, 229.0.0.1/32), uptime: 3w5d, igmp ip pim
  Incoming interface: Tunnel16, RPF nbr: 10.0.80.91
```

Outgoing interface list: (count: 3)

Vlan3, uptime: 1w5d, igmp

Vlan30, uptime: 3w5d, igmp

Vlan9, uptime: 3w5d, igmp

cleaf2#

cleaf2# show interface vlan 3

Vlan3 is up, line protocol is up

Hardware EtherSVI, address is 0000.0c07.ac1f

**Internet Address is 10.31.31.1/24**

MTU 9000 bytes, BW 10000000 Kbit, DLY 1 usec

reliability 255/255, txload 1/255, rxload 1/255

Carrier delay is 10 sec

Encapsulation ARPA, loopback not set

Keepalive not supported

ARP type: ARPA

Last clearing of "show interface" counters never

30 seconds input rate 0 bits/sec, 0 packets/sec

30 seconds output rate 0 bits/sec, 0 packets/sec

Load-Interval #2: 5 minute (300 seconds)

input rate 0 bps, 0 pps; output rate 0 bps, 0 pps

L3 Switched:

input: 0 pkts, 0 bytes - output: 0 pkts, 0 bytes

L3 in Switched:

ucast: 0 pkts, 0 bytes - mcast: 0 pkts, 0 bytes

L3 out Switched:

ucast: 0 pkts, 0 bytes - mcast: 0 pkts, 0 bytes

cleaf2# show interface vlan 30

Vlan30 is up, line protocol is up

Hardware EtherSVI, address is 0000.0c07.ac5b

**Internet Address is 10.91.91.1/24**

MTU 9000 bytes, BW 10000000 Kbit, DLY 1 usec

reliability 255/255, txload 1/255, rxload 1/255

Carrier delay is 10 sec

Encapsulation ARPA, loopback not set

Keepalive not supported

ARP type: ARPA

Last clearing of "show interface" counters never

30 seconds input rate 0 bits/sec, 0 packets/sec

30 seconds output rate 0 bits/sec, 0 packets/sec

Load-Interval #2: 5 minute (300 seconds)

input rate 0 bps, 0 pps; output rate 0 bps, 0 pps

L3 Switched:

input: 0 pkts, 0 bytes - output: 0 pkts, 0 bytes

L3 in Switched:

ucast: 0 pkts, 0 bytes - mcast: 0 pkts, 0 bytes

L3 out Switched:

ucast: 0 pkts, 0 bytes - mcast: 0 pkts, 0 bytes

cleaf2# show interface vlan 9

Vlan9 is up, line protocol is up

Hardware EtherSVI, address is 0000.0c07.ac20

**Internet Address is 10.32.32.1/24**

```
MTU 9000 bytes, BW 10000000 Kbit, DLY 1 usec
  reliability 255/255, txload 1/255, rxload 1/255
Carrier delay is 10 sec
Encapsulation ARPA, loopback not set
Keepalive not supported
ARP type: ARPA
Last clearing of "show interface" counters never
30 seconds input rate 0 bits/sec, 0 packets/sec
30 seconds output rate 0 bits/sec, 0 packets/sec
Load-Interval #2: 5 minute (300 seconds)
  input rate 0 bps, 0 pps; output rate 0 bps, 0 pps
L3 Switched:
  input: 0 pkts, 0 bytes - output: 0 pkts, 0 bytes
L3 in Switched:
  ucast: 0 pkts, 0 bytes - mcast: 0 pkts, 0 bytes
L3 out Switched:
  ucast: 0 pkts, 0 bytes - mcast: 0 pkts, 0 bytes
```

cleaf2#

코어 라우터에서 N7K-core-1 및 N7K-core-2는 LAN 네트워크에서 소싱되는 멀티캐스트 흐름에 대해 로드 공유되며, 빠른 컨버전스가 활성화되지 않은 경우 하나의 border leaf(bleaf1)만 소스로 join을 전송합니다.

!!!! Sources in LAN network !!!!!

!!!! N7K-core-1 !!!!!

```
N7K-core-1# show ip mroute 229.0.0.1
IP Multicast Routing Table for VRF "default"
```

```
(10.103.103.41/32, 229.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/3, RPF nbr: 10.1.20.10
  Outgoing interface list: (count: 1)
    Ethernet1/1, uptime: 1d01h, pim
```

```
(10.103.103.42/32, 229.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.42
  Outgoing interface list: (count: 0)
```

```
(10.103.103.43/32, 229.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.42
  Outgoing interface list: (count: 0)
```

```
(10.103.103.44/32, 229.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.42
  Outgoing interface list: (count: 0)
```

```
(10.103.103.46/32, 229.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.42
  Outgoing interface list: (count: 0)
```

```
(10.103.103.47/32, 229.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/4, RPF nbr: 10.1.20.14
  Outgoing interface list: (count: 1)
    Ethernet1/1, uptime: 1d01h, pim
```

```
(10.103.103.48/32, 229.0.0.1/32), uptime: 1d01h, pim mrib ip
```

```

Incoming interface: Ethernet1/3, RPF nbr: 10.1.20.10
Outgoing interface list: (count: 1)
  Ethernet1/1, uptime: 1d01h, pim

(10.103.103.49/32, 229.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/3, RPF nbr: 10.1.20.10
  Outgoing interface list: (count: 1)
    Ethernet1/1, uptime: 1d01h, pim

N7K-core-1#

!!!! N7K-core-2 !!!!!
N7K-core-2# show ip mroute 229.0.0.1
IP Multicast Routing Table for VRF "default"

(*, 229.0.0.1/32), uptime: 3w5d, pim ip
  Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.46
  Outgoing interface list: (count: 1)
    Ethernet1/1, uptime: 3w5d, pim

(10.103.103.40/32, 229.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/3, RPF nbr: 10.1.20.18
  Outgoing interface list: (count: 1)
    Ethernet1/1, uptime: 1d01h, pim

(10.103.103.41/32, 229.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/4, RPF nbr: 10.1.20.22
  Outgoing interface list: (count: 0)

(10.103.103.42/32, 229.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/3, RPF nbr: 10.1.20.18
  Outgoing interface list: (count: 1)
    Ethernet1/1, uptime: 1d01h, pim

(10.103.103.43/32, 229.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/4, RPF nbr: 10.1.20.22
  Outgoing interface list: (count: 1)
    Ethernet1/1, uptime: 1d01h, pim

(10.103.103.44/32, 229.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/3, RPF nbr: 10.1.20.18
  Outgoing interface list: (count: 1)
    Ethernet1/1, uptime: 1d01h, pim

(10.103.103.45/32, 229.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/4, RPF nbr: 10.1.20.22
  Outgoing interface list: (count: 1)
    Ethernet1/1, uptime: 1d01h, pim

(10.103.103.46/32, 229.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/3, RPF nbr: 10.1.20.18
  Outgoing interface list: (count: 1)
    Ethernet1/1, uptime: 1d01h, pim

(10.103.103.47/32, 229.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/4, RPF nbr: 10.1.20.22
  Outgoing interface list: (count: 0)

(10.103.103.48/32, 229.0.0.1/32), uptime: 00:53:01, pim mrib ip
  Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.46
  Outgoing interface list: (count: 0)

```

(10.103.103.49/32, 229.0.0.1/32), uptime: 1d01h, pim mrib ip  
Incoming interface: Ethernet1/4, RPF nbr: 10.1.20.22  
Outgoing interface list: (count: 0)

N7K-core-2#

!!!!!! Sources in ACI !!!!!

!!!!!! N7K-core-1 !!!!!

N7K-core-1# show ip mroute 228.0.0.1  
IP Multicast Routing Table for VRF "default"

(\*, 228.0.0.1/32), uptime: 3w5d, pim ip  
Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.42  
Outgoing interface list: (count: 2)  
Ethernet1/3, uptime: 3w5d, pim  
Ethernet1/2, uptime: 3w5d, pim

(10.101.101.115/32, 228.0.0.1/32), uptime: 1d01h, pim mrib ip  
Incoming interface: Ethernet1/2, RPF nbr: 10.1.20.6  
Outgoing interface list: (count: 0)

(10.101.101.116/32, 228.0.0.1/32), uptime: 1d01h, pim mrib ip  
Incoming interface: Ethernet1/1, RPF nbr: 10.1.20.2  
Outgoing interface list: (count: 1)  
Ethernet1/3, uptime: 1d01h, pim

(10.101.101.117/32, 228.0.0.1/32), uptime: 1d01h, pim mrib ip  
Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.42  
Outgoing interface list: (count: 0)

(10.101.101.118/32, 228.0.0.1/32), uptime: 1d01h, pim mrib ip  
Incoming interface: Ethernet1/1, RPF nbr: 10.1.20.2  
Outgoing interface list: (count: 1)  
Ethernet1/3, uptime: 1d01h, pim

(10.101.101.119/32, 228.0.0.1/32), uptime: 1d01h, pim mrib ip  
Incoming interface: Ethernet1/2, RPF nbr: 10.1.20.6  
Outgoing interface list: (count: 0)

(10.101.101.120/32, 228.0.0.1/32), uptime: 1d01h, pim mrib ip  
Incoming interface: Ethernet1/1, RPF nbr: 10.1.20.2  
Outgoing interface list: (count: 1)  
Ethernet1/3, uptime: 1d01h, pim

(10.101.101.121/32, 228.0.0.1/32), uptime: 1d01h, pim mrib ip  
Incoming interface: Ethernet1/1, RPF nbr: 10.1.20.2  
Outgoing interface list: (count: 1)  
Ethernet1/3, uptime: 1d01h, pim

(10.101.101.122/32, 228.0.0.1/32), uptime: 1d01h, pim mrib ip  
Incoming interface: Ethernet1/2, RPF nbr: 10.1.20.6  
Outgoing interface list: (count: 0)

(10.101.101.123/32, 228.0.0.1/32), uptime: 1d01h, pim mrib ip  
Incoming interface: Ethernet1/1, RPF nbr: 10.1.20.2  
Outgoing interface list: (count: 1)  
Ethernet1/3, uptime: 1d01h, pim

```
(10.101.101.124/32, 228.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.42
  Outgoing interface list: (count: 0)
```

```
N7K-core-1#
N7K-core-1#
```

```
!!!! N7K-core-2 !!!!!
```

```
N7K-core-2# show ip mroute 228.0.0.1
IP Multicast Routing Table for VRF "default"
```

```
(*, 228.0.0.1/32), uptime: 3w5d, pim ip
  Incoming interface: Ethernet1/5, RPF nbr: 10.1.20.46
  Outgoing interface list: (count: 1)
    Ethernet1/4, uptime: 3w5d, pim
```

```
(10.101.101.115/32, 228.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/1, RPF nbr: 10.1.20.26
  Outgoing interface list: (count: 2)
    Ethernet1/4, uptime: 00:02:03, pim
    Ethernet1/3, uptime: 1d01h, pim
```

```
(10.101.101.116/32, 228.0.0.1/32), uptime: 00:01:28, pim mrib ip
  Incoming interface: Ethernet1/2, RPF nbr: 10.1.20.30
  Outgoing interface list: (count: 1)
    Ethernet1/4, uptime: 00:00:57, pim
```

```
(10.101.101.117/32, 228.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/1, RPF nbr: 10.1.20.26
  Outgoing interface list: (count: 2)
    Ethernet1/4, uptime: 00:02:03, pim
    Ethernet1/3, uptime: 1d01h, pim
```

```
(10.101.101.118/32, 228.0.0.1/32), uptime: 00:01:28, pim mrib ip
  Incoming interface: Ethernet1/2, RPF nbr: 10.1.20.30
  Outgoing interface list: (count: 1)
    Ethernet1/4, uptime: 00:00:57, pim
```

```
(10.101.101.119/32, 228.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/1, RPF nbr: 10.1.20.26
  Outgoing interface list: (count: 2)
    Ethernet1/4, uptime: 00:02:03, pim
    Ethernet1/3, uptime: 1d01h, pim
```

```
(10.101.101.122/32, 228.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/1, RPF nbr: 10.1.20.26
  Outgoing interface list: (count: 2)
    Ethernet1/4, uptime: 00:02:03, pim
    Ethernet1/3, uptime: 1d01h, pim
```

```
(10.101.101.123/32, 228.0.0.1/32), uptime: 00:01:28, pim mrib ip
  Incoming interface: Ethernet1/2, RPF nbr: 10.1.20.30
  Outgoing interface list: (count: 1)
    Ethernet1/4, uptime: 00:00:57, pim
```

```
(10.101.101.124/32, 228.0.0.1/32), uptime: 1d01h, pim mrib ip
  Incoming interface: Ethernet1/2, RPF nbr: 10.1.20.30
  Outgoing interface list: (count: 2)
    Ethernet1/3, uptime: 1d01h, pim
    Ethernet1/4, uptime: 1d01h, pim
```

```
N7K-core-2#
```

참조

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