案例分析：ACI交换矩阵中的L3组播

目录

简介

从版本2.0开始，ACI交换矩阵支持第3层组播路由，并且需要EX交换机(即N9K-C93180YC-EX)。在版本2.0之前，ACI仅支持网桥域内的L2组播。 在2.0中，此选项仍然有效，可用于非EX交换机。

在ACI版本2.0中，支持的组播路由功能包括：PIM ASM、PIM SSM、静态RP、PIM自动RP和PIM BSR。

在本文档中，我们将介绍适用于ACI交换矩阵上L3组播路由的实际客户部署方案的经验证的解决方案。所选ACI版本为2.1(1h)。 此版本不支持交换矩阵上的RP，因此PIM ASM需要外部RP。

设计要求

客户需要端到端解决方案来实现交换矩阵内外的第3层组播路由。部署方案具有以下要求：

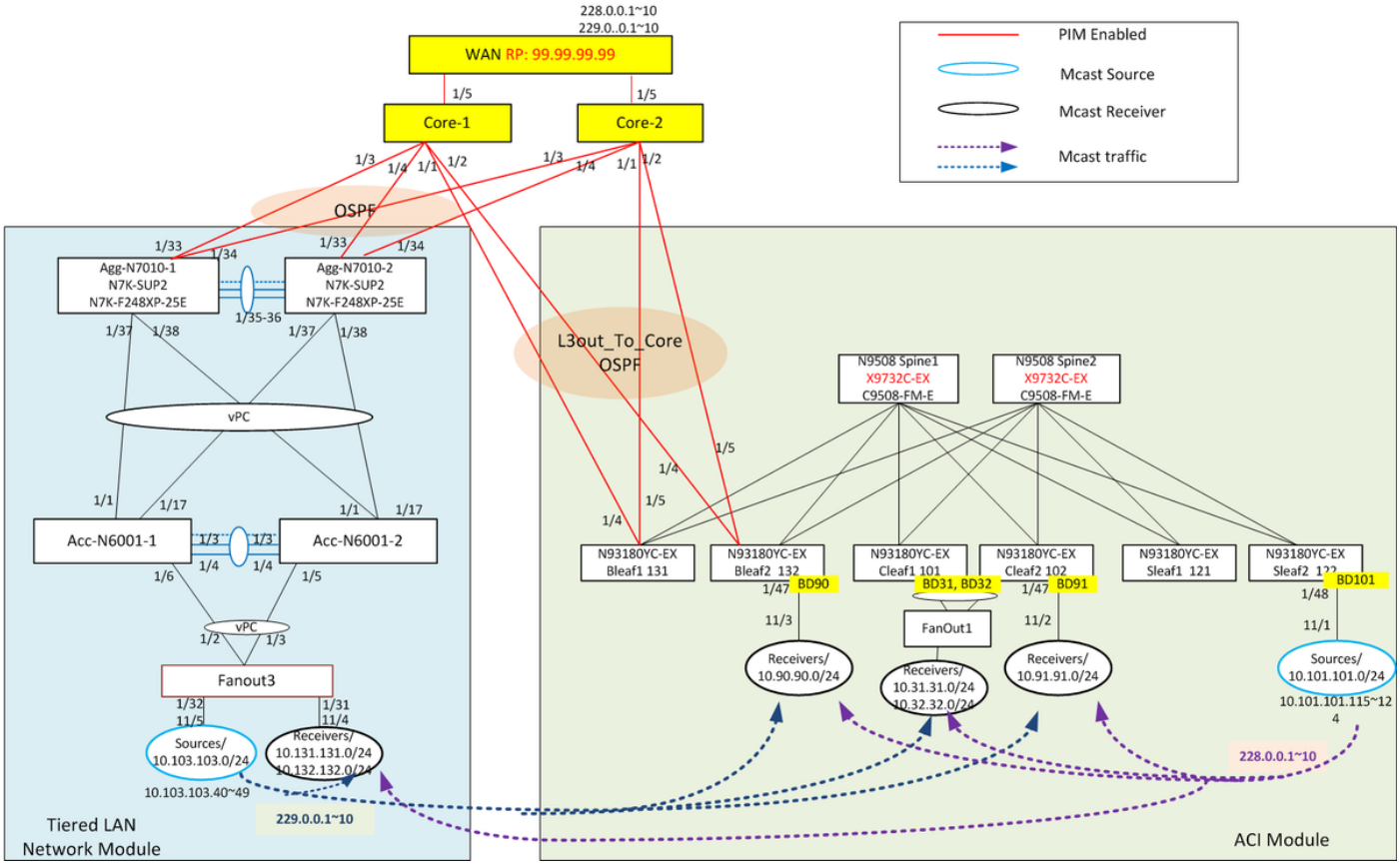
- 为所有租户部署一个VRF。

注意：组播要求每个VRF使用专用L3out。如果交换矩阵中有多个VRF，则组播路由不支持共享L3out。

- 交换矩阵中具有外部源的接收器
- 具有外部接收器的交换矩阵中的源
- 交换矩阵中的源和接收器
- 静态RP或自动RP

解决方案

拓扑回顾



在拓扑中，有两个主要组件：ACI模块和分层LAN网络模块。两个模块通过运行OSPF和PIM的点对点L3链路连接到核心设备。在ACI模块中，外部路由网络称为与VRF common:default关联的L3out-to-Core。它包括从两个边界枝叶到核心设备的四条链路。分层LAN网络模块（称为交换矩阵外部）由传统接入层和带vPC的汇聚层组成。

L3组播流通过核心层在ACI交换矩阵和传统LAN网络中运行。对于静态RP场景，RP部署在广域网边缘设备上。

我们使用Spirent流量生成器(STC)来模拟内部和外部源和接收器。Spirent端口连接到ACI模块和分层LAN网络模块中的不同位置。接收方发送IGMP v2成员加入消息。

连接到Sleaf2的内部源：源IP地址为10.101.101.115~124，正在发送到组地址：228.0.0.1~10

连接到Bleaf1、Cleaf1和Cleaf2的内部接收器：启用组播的BD为BD90、BD91、BD31、BD32、感兴趣的组：228.0.0.1~10和229.0.0.1~10。

连接到LAN网络中接入层的外部源：源IP地址为10.103.103.40~49，发送到组地址：229.0.0.1~10。

连接到LAN网络接入层的外部接收器：vlan131、vlan132、感兴趣的组：228.0.0.1~10。

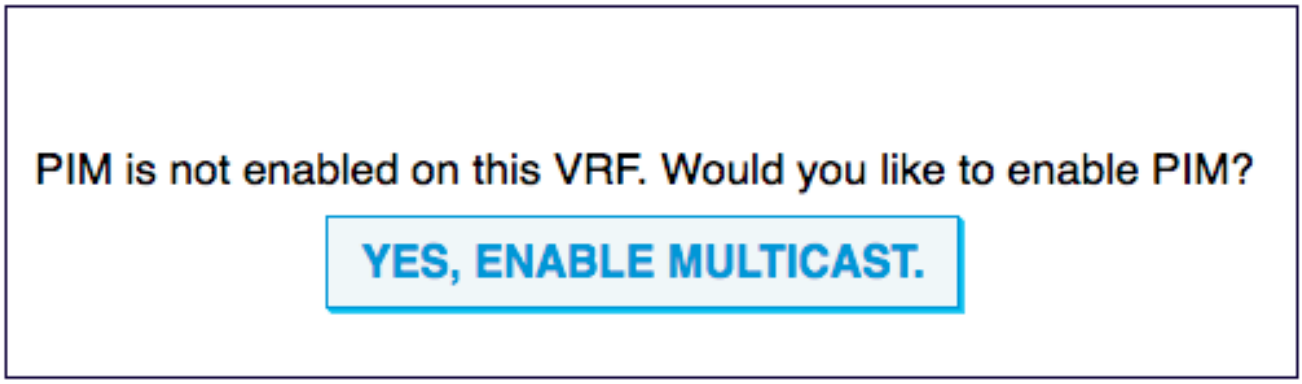
配置

第 0 步： 在连接到核心的模拟WAN设备上设置RP，在分层LAN网络设备上启用PIM稀疏模式。

```
!!!!! 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
```

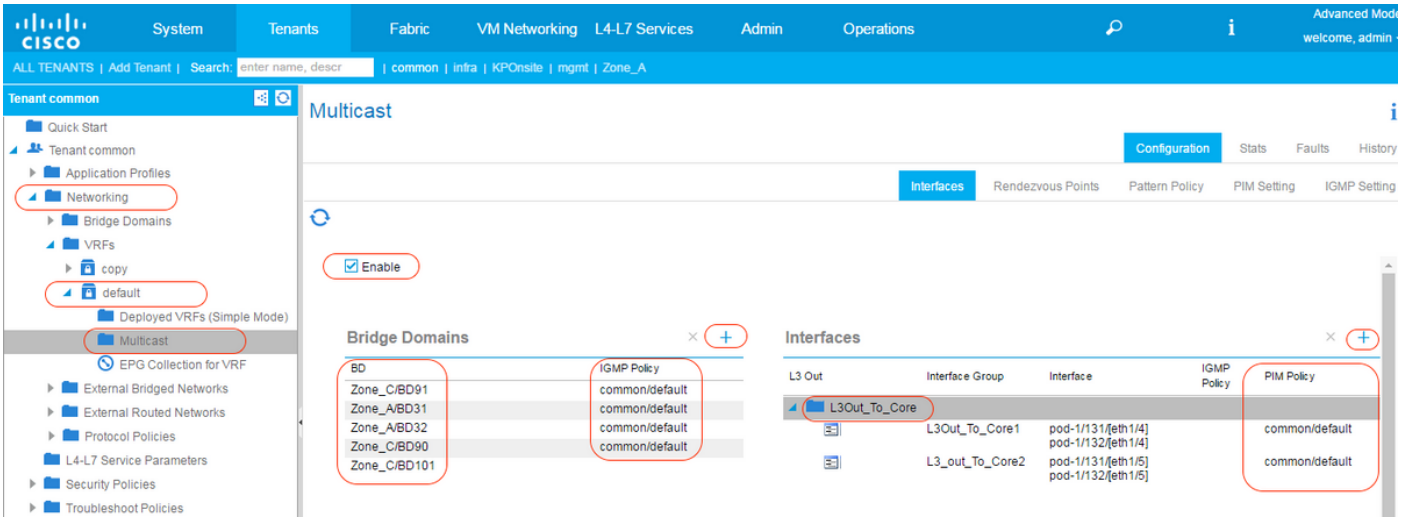
第1步：在VRF上启用组播。在租户空间中，导航到网络> VRFs>组播，在工作面板上，单击黄油以启用组播。



第2步：在BD和L3out级别启用组播，为接收方BD启用IGMP。导航至Networking > VRFs > VRF name > Multicast，在工作面板上，选择Configuration > Interface选项卡，单击“+”添加需要组播流量的网桥域。为启用组播的BD启用IMGP策略。

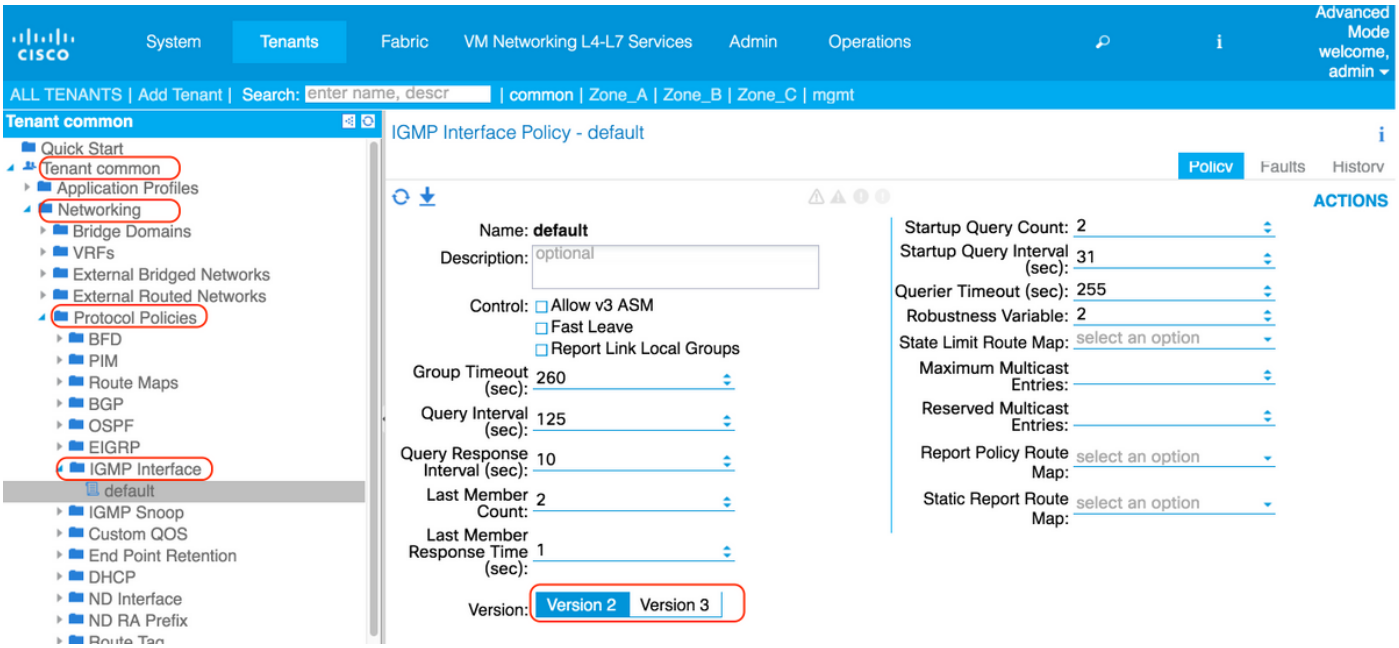
然后单击“+”为此VRF添加L3out。当为L3out启用组播时，它将在L3out下的所有接口上启用PIM，并且该L3out的所有边界枝叶都通过组播路由启用。为L3out接口组选择PIM策略。

此处假设已调配BD和L3out。



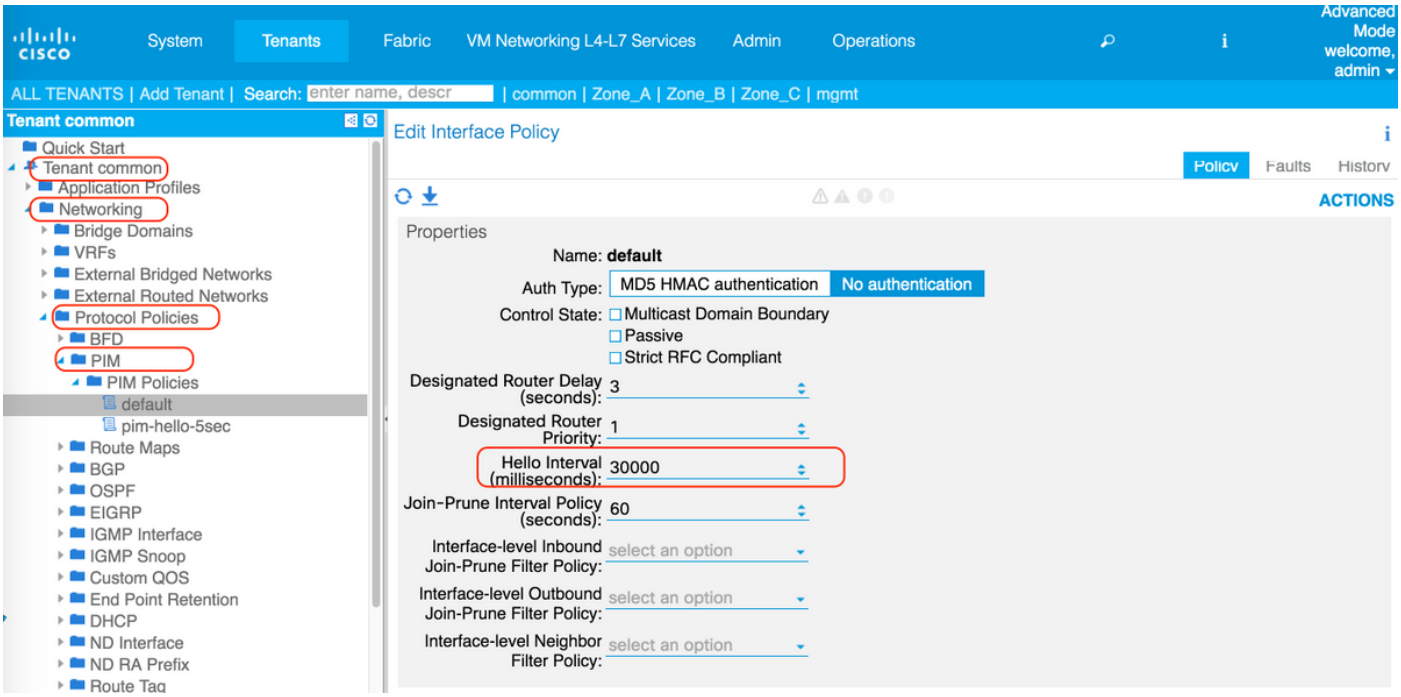
将IGMP策略附加到BD也使其成为IGMP查询器。IGMP策略在Tenant > Networking > Protocol Policies > IGMP Interface下配置。默认IGMP策略具有以下参数，您可以在其中定义查询间隔。如

果未指定策略，接口将使用默认策略。

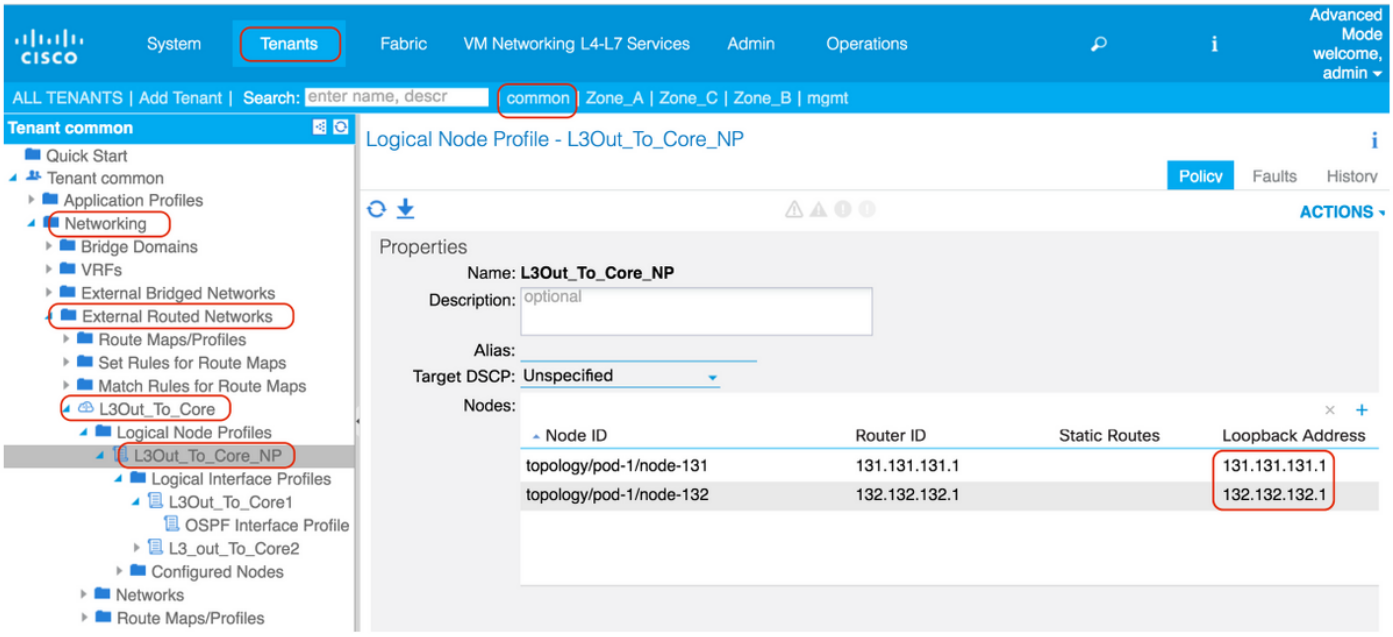


PIM策略也在Tenant > Networking > Protocol Policies > PIM下配置。

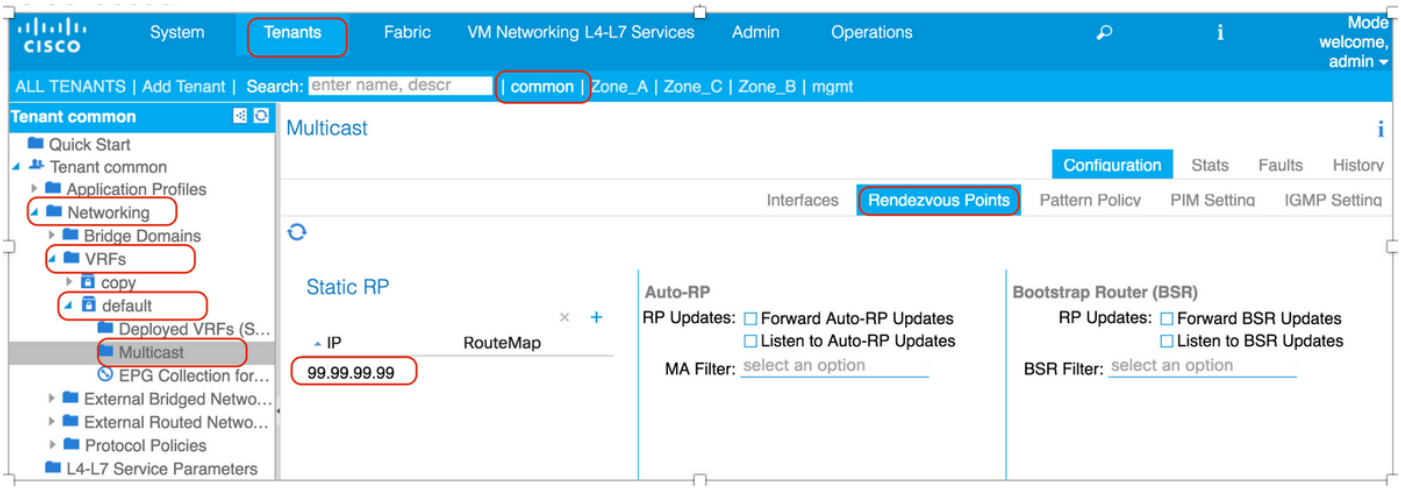
默认PIM策略具有以下参数，您可以在其中定义hello间隔。



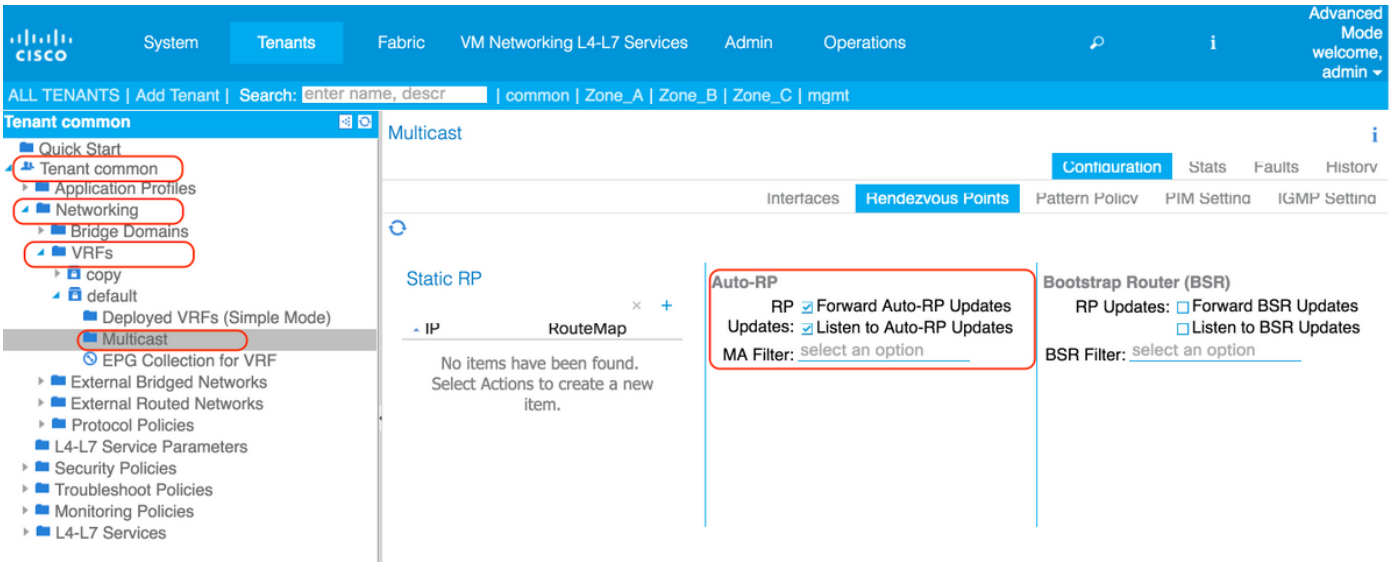
边界枝叶上的L3Out必须配置为在节点配置文件中启用环回地址。



步骤 3：为PIM ASM配置RP。导航至Tenant > VRF > Multicast，在工作面板中选择Configuration > Rendezvous Points。在本例中，选择了静态RP。单击“+”添加RP。



对于自动RP配置，选中“Rendezvous Points”（交汇点）页面上的“Forward Auto-RP updates”（转发自动RP更新）和“Listen to Auto-RP Updates”（侦听自动RP更新）复选框。



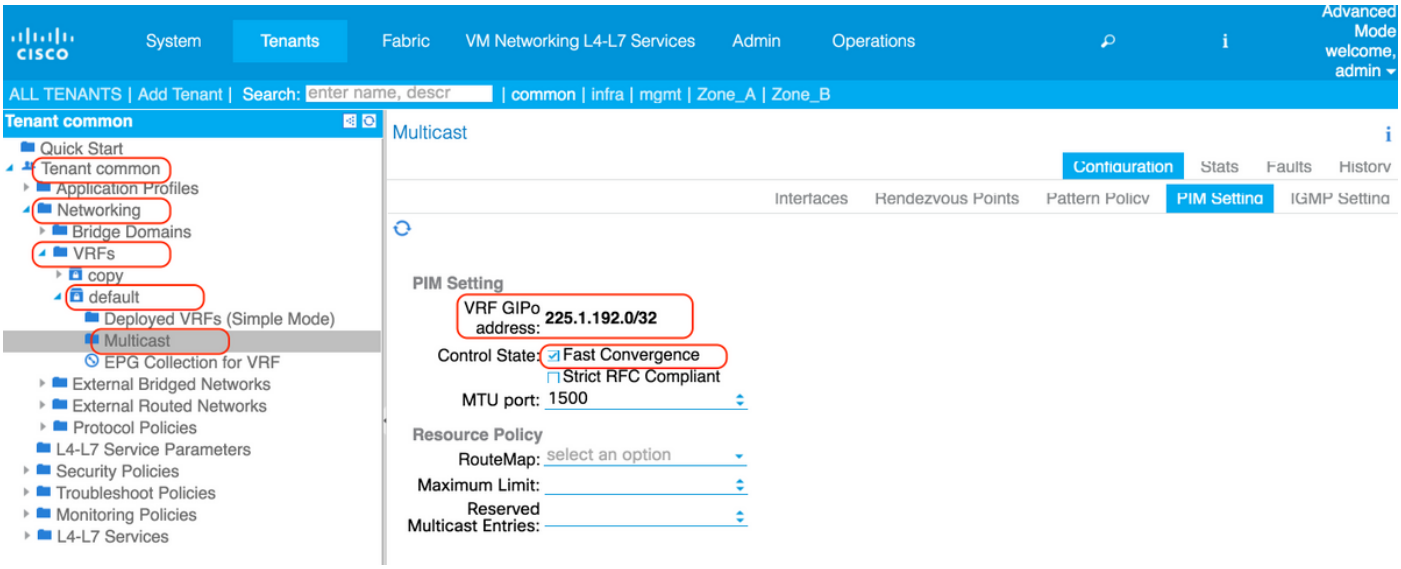
在ACI交换矩阵外，NX-OS平台上的AUTO-RP配置保持不变。

```
!!! 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
```

第4步：配置必要的PIM设置。导航至租户>VRF ->组播，在工作面板中，选择配置> PIM设置，注意VRF GIPo地址225.1.192.0/32，由APIC从组播组地址池分配。VRF GIPo将用作启用PIM的BD的组播流量的外部组IP地址。

启用**快速融**合模式（默认为禁用）后，启用PIM的所有边界枝叶将向外部网络发送加入，但只有一个边界枝叶会将流量转发到交换矩阵以防止重复。转发组流量的边界枝叶是组**的指**定转发器。启用快速融合有助于在边界枝叶关闭导致条带赢家更改时，减少具有外部源和内部接收器的组播流的丢包持续时间。从新条带赢家加入PIM树不会产生延迟。这是以非条带赢家的外部链路上额外带宽使用的成本计算的，因为所有边框都会从外部源中拉出流量。

关于条带优胜者 — 当前ACI使用BSR（引导路由器）哈希计算BL条带优胜者。 散列值使用枝叶的S、G和环回IP计算。 自ACI 3.0(1)起，无法影响用户的条带赢家选举。



第5步：创建所需的合同以允许组播流量：

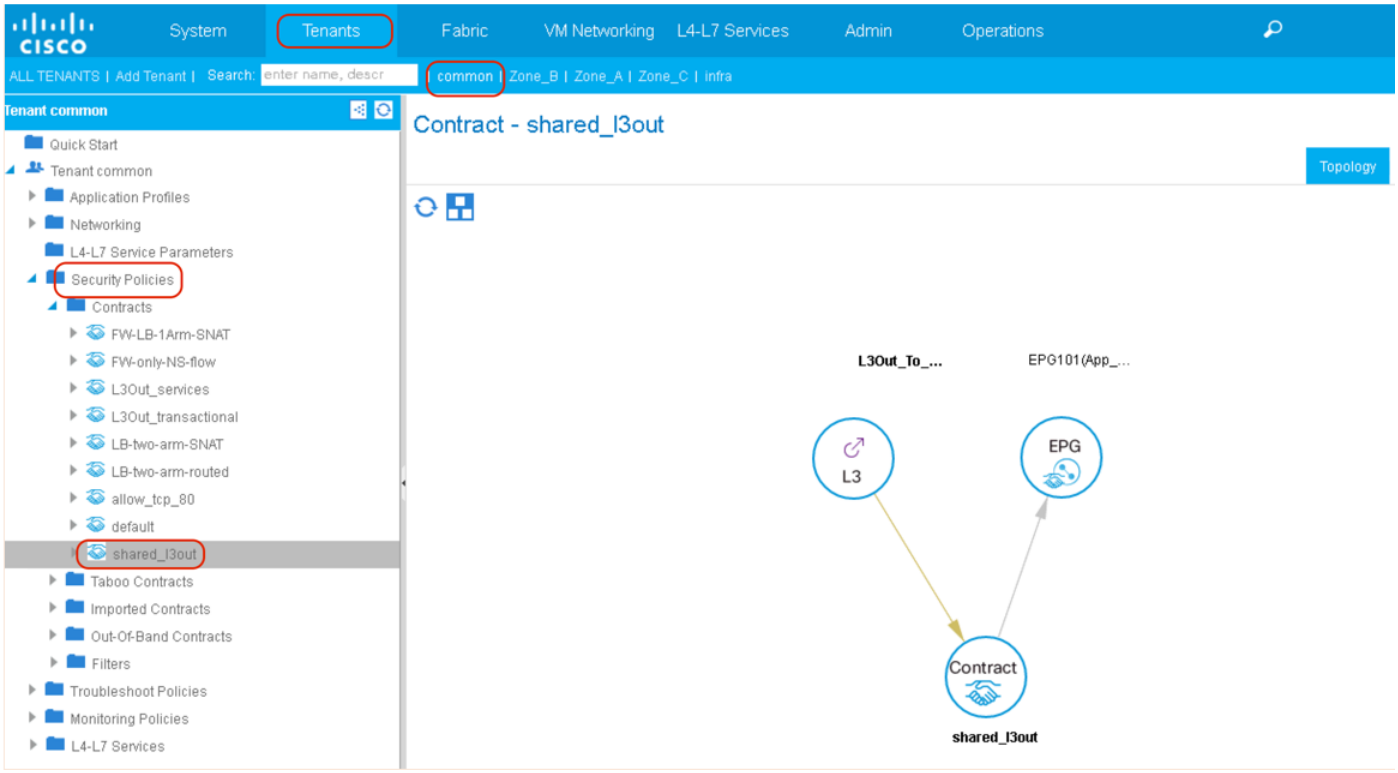
— 交换矩阵内的源和接收方（不需要合同）

— 接收器内部交换矩阵，外部源（不需要合同）

— 源内部交换矩阵，外部接收器（需要合同）*

*如果BD部署在边界枝叶上，则不需要合同

在本例中，我们在交换矩阵外部有接收器，在EPG101中应用L3out_to_Core和mcast源之间的合同。



验证

PIM验证

当为组播路由启用VRF时，将为交换矩阵内的组播路由创建一个交换矩阵接口（隧道）。PIM控制平面数据包通过交换矩阵内的交换矩阵接口发送。隧道目标将是VRF GiPo组播地址。在边界枝叶交换机上，隧道源将是边界枝叶上的环回接口。在非边界枝叶交换机上，隧道源将是环回地址(127.0.0.100)。

边界枝叶在交换矩阵接口上发送PIM问候。 L3Out接口在正常模式下运行PIM，包括发送和接收问询、选举DR等。非边界枝叶在交换矩阵接口上以被动模式运行；它们会侦听来自边界枝叶的PIM问询，但不发送PIM问询。非边界枝叶不会显示在“show ip pim neighbor”的输出中。

```
!!!!! Border Leaf Node bleaf1 !!!!!
bleaf1# show ip pim neighbor

PIM Neighbor information for Dom:common:default
Neighbor             Interface            Uptime               Expires              DRPriority
Bidir      BFDState
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 ivxlan
    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      BFDState
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 ivxlan
    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      BFDState
```

```
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 ivxlan
    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      BFDState
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 ivxlan  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       Bidir-  BFD
                                                         Priority Capable 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       Bidir-  BFD
                                                         Priority Capable 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#
```

活动边界枝叶验证

如果使用组播路由启用了多个边界枝叶，APIC会为所有活动边界枝叶上的每个组地址选择一个条带赢家。作为组的条带赢家的边界枝叶负责代表交换矩阵发送PIM加入并将组播流量转发到交换矩阵。

组的条带赢家决定指定转发器。如果条带赢家具有到根的可达性，则条带赢家也是DF。如果条带赢家没有到根的外部连接，则BL通过交换矩阵接口发送PIM加入来选择DF。

```
!!!!! 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#
```

快速收敛验证

```
!!! 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验证

```
!!!!! 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验证

枝叶节点sleaf2（即FHR）具有直连组播源。其RPF邻居在spine1上为10.0.176.64。传入接口是通过PIM与边界枝叶对等的交换矩阵接口（隧道16）。

为简单起见，所示输出针对每个组范围的一个组播IP地址：内部源为228.0.0.1，外部源为229.0.0.1。

```
!!!!! 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      BFDState
131.131.131.1/32     tunnel16             04:01:06             00:01:23             1
no         n/a
132.132.132.1/32     tunnel16             04:01:06             00:01:32             1
no         n/a
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 ivxlan
    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#
```

用于228.0.0.1的接收器连接到bleaf2（节点132）、cleaf1（节点101）和cleaf2（节点102）。Bleaf2通过隧道16将组播转发到组228.0.0.1，而外部接收器通过L3out转发到核心设备。

```
!!!!!! 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#
```

Bleaf1通过L3out接口将组228.0.0.1转发到外部，但它不通过交换矩阵接口转发到交换矩阵，因为它不是228.0.0.1的条带赢家

```
!!!!! 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#
```

Bleaf1是组229.0.0.1的活动边界枝叶/条带窗口。 bleaf1通过外部核心设备接收组播到组229.0.0.1，然后转发到BD90、BD91、BD31、BD32中的内部接收器。（请注意，仅VLAN ID内部到枝叶节点，即无处不在的GW）。

```
!!!!! 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#
```

非边界枝叶Cleaf1和Cleaf2在BD31、BD32、BD91中连接了接收器。不支持仅安装(*,G)非边界枝叶节点(S，G)。

```
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#
```

在核心路由器上，N7K-core-1和N7K-core-2为源自LAN网络的组播流分担负载，如果未启用快速收敛，则只有一个边界枝叶(bleaf1)向源发送加入。

```
!!!!! 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#
```

参考

[ACI 2.0组播路由]