配置并检验vEdge组播重叠路由

目录

简介

本文档介绍如何在SD-WAN环境中配置组播，并且特定于vEdge路由器。所有配置均基于协议无关组播(PIM)自动交汇点(RP)。 它显示了示例网络场景、配置和验证输出。

先决条件

要求

本文档没有任何特定的要求。但是，对组播的基本了解和对SD-WAN的工作知识会有所帮助。

使用的组件

本文档不限于特定软件或硬件版本。

本文档中的信息都是基于特定实验室环境中的设备编写的。本文档中使用的所有设备最初均采用原始（默认）配置。如果您的网络处于活动状态，请确保您了解所有命令的潜在影响。

背景信息

在这里，您可以找到本文中使用的缩写词列表。

- vEdge(VE)
- 第一跳路由器(FHR)
- 最后一跳路由器(LHR)
- 交汇点(RP)
- 虚拟专用网络 (VPN)
- 重叠管理协议(OMP)
- 传输位置(TLOC)

- 互联网组管理协议(IGMP)
- 云服务路由器(CSR)
- 独立于协议的多播 (PIM)
- 组播路由信息库(MRIB)或组播路由表
- 反向路径转发(RPF)
- 生存时间 (TTL)

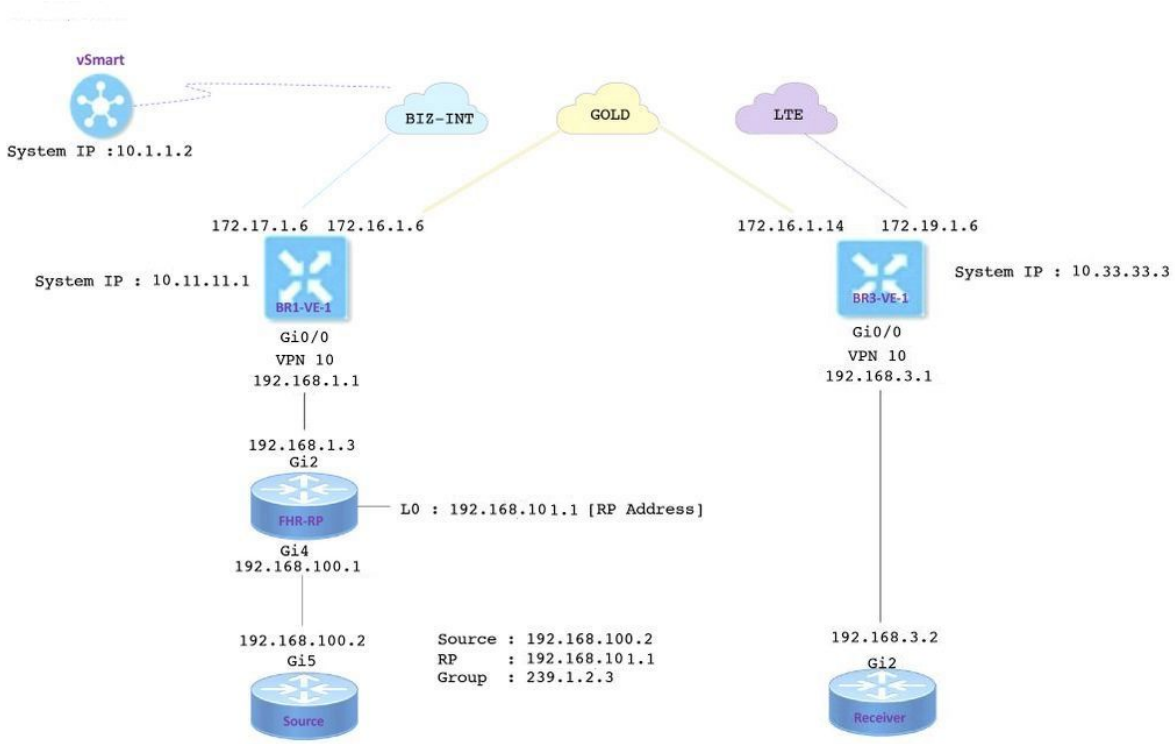
有关SD-WAN术语的详细说明，请参阅Cisco SD-WAN术语

配置

有关Cisco SD-WAN组播一般概述，请参阅组播重叠路由概述。

网络图

> **注意**：在此拓扑中，BR1-VE-1和BR3-VE-1的GOLD TLOC是共同的。在实际场景中，站点可以具有相同或不同的TLOC。



配置

BR1-VE-1具有SD-WAN重叠/底层基本配置和默认路由。此外，本地组播复制器和PIM已配置在Ge0/0接口上，命令multicast-replicator **local将VE路**由器配置为组播复制器。

```
vpn 10
 router
  multicast-replicator local
  pim
   auto-rp
   interface ge0/0
   exit
```

```
 !
 interface ge0/0
  ip address 192.168.1.1/24
  no shutdown
```

BR3-VE-1具有SD-WAN重叠/底层基本配置和默认路由。此外，IGMP和PIM在Ge0/0接口上配置。

```
vpn 10
 router
  pim
   auto-rp
   interface ge0/0
   exit
  !
  igmp
   interface ge0/0
   exit
 !
 interface ge0/0
  ip address 192.168.3.1/24
  no shutdown
```

RP路由器还具有基本底层配置和默认路由。

注意：必须使用非viptela设备作为RP。在本示例中，运行Cisco IOS® XE软件的CSR已用于此目的。

```
ip multicast-routing distributed
!
interface Loopback0 ip address 192.168.101.1 255.255.255.255 ip pim sparse-mode ! ! interface
GigabitEthernet2 ip address 192.168.1.3 255.255.255.0 ip pim sparse-mode ! ! ! ip pim send-rp-
announce Loopback0 scope 20 ip pim send-rp-discovery Loopback0 scope 20
```

使用自动RP时，会发生以下事件：

1. RP映射代理侦听公认组地址CISCO-RP-ANNOUNCE(224.0.1.39)，候选RP通告将发送到该地址。当您使用Auto-RP分发组到RP的映射时，**ip pim send-rp-announce** 命令会使路由器向公认组CISCO-RP-ANNOUNCE(224.0.1.39)发送自动RP通告消息。
2. RP映射代理将自动RP发现消息中的组到RP映射发送到公认组CISCO-RP-DISCOVERY(224.0.1.40)。 TTL值限制消息可以跳数。
3. PIM路由器会侦听此组，并使用从发现消息中了解的RP。

源路由器是运行Cisco IOS® -XE软件的CSR，该软件还具有基本的底层配置和默认路由。通过对组播地址执行**ping**命令生成流量。

```
ip multicast-routing distributed
!
interface GigabitEthernet5 ip address 192.168.100.2 255.255.255.0 ip pim sparse-mode
```

接收方是运行Cisco IOS® -XE软件的CSR，并已通过ip igmp join-group命令配置为**IGMP接收**方。它

还具有默认路由和基本底层配置。

```
ip multicast-routing distributed
!
interface GigabitEthernet2
 ip address 192.168.3.2 255.255.255.0
 ip igmp join-group 239.1.2.3
```

验证

您可以使用本节来确认您的配置是否正常工作。

步骤1.接收方向RP发送IGMP加入消息。**从接收方输出debug ip igmp 239.1.2.3。**

```
Oct  9 12:29:12.707: IGMP(0): v2 querier for GigabitEthernet2 is this system.
Oct  9 12:29:12.708: IGMP(0): Send v2 init  Query on GigabitEthernet2
Oct  9 12:29:12.708: IGMP(0): Set report delay time to 0.9 seconds for 239.1.2.3 on
GigabitEthernet2
Oct  9 12:29:13.669: IGMP(0): Send v2 Report for 239.1.2.3 on GigabitEthernet2
Oct  9 12:29:13.669: IGMP(0): Received v2 Report on GigabitEthernet2 from 192.168.3.2 for
239.1.2.3  <<<<<<<<<<<
Oct  9 12:29:13.670: IGMP(0): Received Group record for group 239.1.2.3, mode 2 from 192.168.3.2
for 0 sources
Oct  9 12:29:13.670: IGMP(0): Updating EXCLUDE group timer for 239.1.2.3
Oct  9 12:29:13.670: IGMP(0): MRT Add/Update GigabitEthernet2 for (*,239.1.2.3) by 0
Oct  9 12:29:17.377: IGMP(0): Received v2 Query on GigabitEthernet2 from 192.168.3.1
```

步骤2. BR3-VE-1，充当LHR。它接收IGMP加入消息，将此信息发送到RP。这些IGMP加入消息作为OMP更新中组播路由的一部分传输。

```
BR3-VE-1# show igmp groups

                      V1
     IF               MEMBERS                                          V1
VPN  NAME   GROUP     PRESENT  STATE            UPTIME      EXPIRES     EXPIRES  EVENT
-------------------------------------------------------------------------------------------
-----
10   ge0/0  239.1.2.3  false    members-present  1:11:00:11  0:00:02:41  -        membership-
report
```

步骤3. vSmart通过OMP接收(*,G)条目，并将此信息转发给复制器。

```
vsmart# show omp multicast-routes
Code:
C -> chosen
I -> installed
Red -> redistributed
Rej -> rejected
L -> looped
R -> resolved
S -> stale
Ext -> extranet
Stg -> staged
```

```
Inv -> invalid


ADDRESS SOURCE
FAMILY   TYPE   VPN  ORIGINATOR  DESTINATION    GROUP   SOURCE   FROM PEER     RP
STATUS
-------------------------------------------------------------------------------------------------
-----
ipv4    (*,G)   10   10.33.33.3   10.11.11.1  239.1.2.3 0.0.0.0  10.33.33.3 192.168.101.1  C,R
```

步骤4.在此拓扑中，BR1-VE-1充当复制器。BR1-VE-1将此信息转发到RP。

```
BR1-VE-1# show omp multicast-routes
Code:
C -> chosen
I -> installed
Red -> redistributed
Rej -> rejected
L -> looped
R -> resolved
S -> stale
Ext -> extranet
Stg -> staged
Inv -> invalid


ADDRESS SOURCE FROM
FAMILY  TYPE  VPN  ORIGINATOR  DESTINATION   GROUP     SOURCE      PEER      RP          STATUS
-------------------------------------------------------------------------------------------------
--
ipv4    (*,G) 10   10.33.33.3   10.11.11.1  239.1.2.3  0.0.0.0   10.1.1.2 192.168.101.1   C,I,R
```

步骤5. RP现在已创建(*,G)条目。

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

(*, 239.1.2.3), 1d12h/00:02:51, RP 192.168.101.1, flags: S
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:
    GigabitEthernet2, Forward/Sparse, 1d12h/00:02:51
```

步骤6.现在，轮到源设备向RP注册。在本示例中，组播流量是使用ping命令生成的，其中组播地址作为目标。

```
Source#ping 239.1.2.3 repeat 10
Type escape sequence to abort.
Sending 10, 100-byte ICMP Echos to 239.1.2.3, timeout is 2 seconds:

<SNIP>
```

源设备向RP发送注册消息。

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

(*, 239.1.2.3), 00:00:12/00:03:27, RP 192.168.101.1, flags: S
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:
    GigabitEthernet2, Forward/Sparse, 00:00:02/00:03:27

(192.168.100.2, 239.1.2.3), 00:00:12/00:02:47, flags: T
  Incoming interface: GigabitEthernet4, RPF nbr 192.168.100.2
  Outgoing interface list:
    GigabitEthernet2, Forward/Sparse, 00:00:02/00:03:29
<SNIP>
```

步骤7. BR1-VE-1将PIM(S， G)加入消息转发到vSmart。与IGMP加入一样，PIM(S， G)加入消息作为组播路由器的一部分在OMP更新中传输。vSmart现在在MRIB中创建(S， G)条目。(S， G)信息随后通过OMP转发到复制器和LHR。

注意：在真实场景中，复制器可以位于同一站点或不同站点，具体取决于您的设计首选项。

```
vsmart# show omp multicast-routes
Code:
C -> chosen
I -> installed
Red -> redistributed
Rej -> rejected
L -> looped
R -> resolved
S -> stale
Ext -> extranet
Stg -> staged
Inv -> invalid
```

```
ADDRESS SOURCE
FAMILY TYPE   VPN  ORIGINATOR  DESTINATION  GROUP      SOURCE        FROM PEER      RP
STATUS
-------------------------------------------------------------------------------------------------
-----------
ipv4   (*,G)  10   10.33.33.3  10.11.11.1  239.1.2.3   0.0.0.0       10.33.33.3  192.168.101.1
C,R
       (S,G)  10   10.33.33.3  10.11.11.1  239.1.2.3   192.168.100.2 10.33.33.3      -
C,R


BR1-VE-1# show omp multicast-routes
Code:
C -> chosen
I -> installed
Red -> redistributed
Rej -> rejected
L -> looped
R -> resolved
S -> stale
Ext -> extranet
Stg -> staged
Inv -> invalid


ADDRESS SOURCE FROM
FAMILY TYPE    VPN   ORIGINATOR  DESTINATION  GROUP      SOURCE          PEER       RP
STATUS
-------------------------------------------------------------------------------------------------
--------
ipv4    (*,G)  10    10.33.33.3  10.11.11.1   239.1.2.3  0.0.0.0         10.1.1.2  192.168.101.1
C,I,R
        (S,G)  10    10.33.33.3  10.11.11.1   239.1.2.3  192.168.100.2   10.1.1.2      -
C,I,R
```

步骤8.最后一跳路由器现在有(S， G)条目。LHR现在向源发送(S， G)连接。

> **注意：**在输出中，您可以看到(*, G)条目和(S， G)条目发起方显示为10.33.33.3，组的目标为10.11.11.1。这是因为LHR BR3-VE-1负责创建(*, G)条目以及(S， G)加入以构建组播控制平面。

```
BR3-VE-1# show omp multicast-routes
Code:
C -> chosen
I -> installed
Red -> redistributed
Rej -> rejected
L -> looped
R -> resolved
S -> stale
Ext -> extranet
Stg -> staged
Inv -> invalid


ADDRESS SOURCE FROM
FAMILY TYPE   VPN  ORIGINATOR   DESTINATION   GROUP     SOURCE        PEER     RP
STATUS
```

```
------------------------------------------------------------------------------------------------
---------
ipv4   (*,G)  10   10.33.33.3   10.11.11.1   239.1.2.3 0.0.0.0       0.0.0.0 192.168.101.1
C,Red,R
       (S,G)  10   10.33.33.3   10.11.11.1   239.1.2.3 192.168.100.2 0.0.0.0     -
C,Red,R
```

数据平面验证：

理想流量必须是（从、到）：

1. FHR-RP的来源
2. FHR-RP到VE
3. VE到复制器
4. 复制器到LHR
5. LHR到接收方

注意：本文档不介绍PIM RPT和SPT切换的详细信息。

在本例中，流量如下：

1. 从源到FHR-RP
2. FHR-RP到BR1-VE-1
3. BR1-VE-1到BR3-VE-1（通过IPSec数据平面隧道）
4. BR3-VE-1到接收器

注意：组播流量在BR1-VE-1和BR3-VE-1之间通过数据平面IPsec隧道传输。vSmart控制器从不参与实际流量转发。

在此拓扑中，BR1-VE-1配置为复制器并靠近源。复制器位于与源不同的站点时，可能会出现这种情况。无论如何，确保复制程序驻留的特定站点和站点之间的数据平面隧道都处于工作状态。

```
BR1-VE-1# show multicast topology
Flags:
  S: SPT switchover
OIF-Flags:
  A: Assert winner

                                  JOIN                                          UPSTREAM     UPSTREAM
UPSTREAM                                    OIF   OIF
VPN  GROUP       SOURCE          TYPE     FLAGS  RP ADDRESS     REPLICATOR  NEIGHBOR     STATE
INTERFACE  UP TIME     EXPIRES     INDEX  NAME  FLAGS  OIF TUNNEL
------------------------------------------------------------------------------------------------
-------------------------------------------------------------------
10   224.0.1.39  192.168.101.1  Auto-RP  -      -              -           192.168.1.3  joined
ge0/0      0:00:41:29  0:00:02:33  513    -      -      10.33.33.3
10   224.0.1.40  192.168.101.1  Auto-RP  -      -              -           192.168.1.3  joined
ge0/0      0:00:41:26  0:00:02:17  513    -      -      10.33.33.3
10   239.1.2.3   0.0.0.0        (*,G)    -      192.168.101.1  -           192.168.1.3  joined
ge0/0      0:00:03:47  0:00:00:53  513    -      -      10.33.33.3
10   239.1.2.3   192.168.100.2  (S,G)    -      -              -           192.168.1.3  joined
ge0/0      0:00:00:10  0:00:00:52  513    -      -      10.33.33.3
```

```
BR1-VE-1# show bfd sessions system-ip 10.33.33.3
                                       SOURCE TLOC      REMOTE TLOC
DST PUBLIC                        DST PUBLIC          DETECT      TX
SYSTEM IP        SITE ID  STATE       COLOR             COLOR            SOURCE IP
IP                                PORT        ENCAP  MULTIPLIER  INTERVAL(msec) UPTIME
TRANSITIONS
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
-------------
10.33.33.3       30       up          gold              gold             172.16.1.6
172.16.1.14                       12406       ipsec  7           1000           3:21:24:02      0
10.33.33.3       30       up          gold              lte              172.16.1.6
172.19.1.6                        12426       ipsec  7           1000           3:21:24:02      0
10.33.33.3       30       up          biz-internet      gold             172.17.1.6
172.16.1.14                       12406       ipsec  7           1000           3:21:24:59      0
10.33.33.3       30       up          biz-internet      lte              172.17.1.6
172.19.1.6                        12426       ipsec  7           1000           3:21:24:59      0


BR1-VE-1# show multicast topology vpn 10 239.1.2.3 topology-oil
Flags:
  S: SPT switchover
OIF-Flags:
  A: Assert winner

                                JOIN           OIF   OIF
VPN  GROUP      SOURCE          TYPE   INDEX   NAME  FLAGS  OIF TUNNEL
-------------------------------------------------------------------------
10   239.1.2.3  0.0.0.0         (*,G)  513     -     -      10.33.33.3
10   239.1.2.3  192.168.100.2   (S,G)  513     -     -      10.33.33.3


BR3-VE-1# show bfd sessions system-ip 10.11.11.1
                                       SOURCE TLOC      REMOTE TLOC
DST PUBLIC                        DST PUBLIC          DETECT      TX
SYSTEM IP        SITE ID  STATE       COLOR             COLOR            SOURCE IP
IP                                PORT        ENCAP  MULTIPLIER  INTERVAL(msec) UPTIME
TRANSITIONS
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
-------------
10.11.11.1       10       up          gold              gold             172.16.1.14
172.16.1.6                        12406       ipsec  7           1000           3:21:25:16      0
10.11.11.1       10       up          gold              biz-internet     172.16.1.14
172.17.1.6                        12406       ipsec  7           1000           3:21:26:13      0
10.11.11.1       10       up          lte               gold             172.19.1.6
172.16.1.6                        12406       ipsec  7           1000           3:21:25:16      0
10.11.11.1       10       up          lte               biz-internet     172.19.1.6
172.17.1.6                        12406       ipsec  7           1000           3:21:26:13      0
```

步骤9.接收方现在收到流量。

```
Receiver#show ip mroute
IP Multicast Routing Table
Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C - Connected,
       L - Local, P - Pruned, R - RP-bit set, F - Register flag,
       T - SPT-bit set, J - Join SPT, M - MSDP created entry, E - Extranet,
       X - Proxy Join Timer Running, A - Candidate for MSDP Advertisement,
       U - URD, I - Received Source Specific Host Report,
       Z - Multicast Tunnel, z - MDT-data group sender,
       Y - Joined MDT-data group, y - Sending to MDT-data group,
```

```
       G - Received BGP C-Mroute, g - Sent BGP C-Mroute,
       N - Received BGP Shared-Tree Prune, n - BGP C-Mroute suppressed,
       Q - Received BGP S-A Route, q - Sent BGP S-A Route,
       V - RD & Vector, v - Vector, p - PIM Joins on route,
       x - VxLAN group
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
 Timers: Uptime/Expires
 Interface state: Interface, Next-Hop or VCD, State/Mode

(*, 239.1.2.3), 1d13h/stopped, RP 192.168.101.1, flags: SJPCL
  Incoming interface: GigabitEthernet2, RPF nbr 192.168.3.1
  Outgoing interface list: Null

(192.168.100.2, 239.1.2.3), 00:01:08/00:01:51, flags: PLTX
  Incoming interface: GigabitEthernet2, RPF nbr 192.168.3.1
  Outgoing interface list: Null
```

```
Receiver#show ip mroute count
Use "show ip mfib count" to get better response time for a large number of mroutes.

IP Multicast Statistics
6 routes using 3668 bytes of memory
3 groups, 1.00 average sources per group
Forwarding Counts: Pkt Count/Pkts per second/Avg Pkt Size/Kilobits per second
Other counts: Total/RPF failed/Other drops(OIF-null, rate-limit etc)

Group: 239.1.2.3, Source count: 1, Packets forwarded: 0, Packets received: 16
  RP-tree: Forwarding: 0/0/0/0, Other: 7/0/7
  Source: 192.168.100.2/32, Forwarding: 0/0/0/0, Other: 9/0/9
```

```
Source#ping 239.1.2.3 repeat 10
Type escape sequence to abort.
Sending 10, 100-byte ICMP Echos to 239.1.2.3, timeout is 2 seconds:
Reply to request 0 from 192.168.3.2, 221 ms
Reply to request 1 from 192.168.3.2, 238 ms
Reply to request 2 from 192.168.3.2, 135 ms
Reply to request 3 from 192.168.3.2, 229 ms
Reply to request 4 from 192.168.3.2, 327 ms
Reply to request 5 from 192.168.3.2, 530 ms
<SNIP>
```

故障排除

本部分提供了可用于对配置进行故障排除的信息。

1.验证(*、G)和(S、G)是否存在于RP上。

2.确保您有数据平面隧道，并且BFD会话在VE和站点之间启用，在站点中，复制程序在show bfd sessions命**令的帮助下**配置。

3.检查BR3-VE-1是否了解BR1-VE-1上的复制程序。

```
BR3-VE-1# show multicast replicator

     REPLICATOR  REPLICATOR  LOAD
```

```
VPN  ADDRESS     STATUS      PERCENT
-------------------------------------
10   10.11.11.1  UP          -
```

4.确保已与BR3-VE-1建立组播隧道。

```
BR3-VE-1# show multicast tunnel

     TUNNEL     TUNNEL
VPN  ADDRESS    STATUS  REPLICATOR
-------------------------------------
10   10.11.11.1   UP      yes
```

5.确保组到RP的映射已分发且正确。

```
BR3-VE-1#show pim rp-mapping

VPN  TYPE     GROUP        RP ADDRESS
----------------------------------------
10   Auto-RP  224.0.0.0/4  192.168.101.1
```

6.确保组播路由(*、G)和(S、G)正确传播到vEdge、Replicator路由器和vSmart。使用**show multicast topology和show omp multicast-routes命**令。

7.检查LHR上的RPF表。

```
BR3-VE-1#  show multicast rpf | tab

                                                    RPF                              RPF
                    RPF       NEXTHOP         RPF NBR     IF                RPF TUNNEL    TUNNEL
VPN  RPF ADDRESS    STATUS    COUNT    INDEX  ADDR        NAME  RPF TUNNEL  COLOR         ENCAP
-------------------------------------------------------------------------------------------------
--
10   192.168.101.1  resolved  2        0      10.11.11.1  -     10.11.11.1  biz-internet  ipsec
                                     1      10.11.11.1  -     10.11.11.1  gold          ipsec
10   192.168.100.2  resolved  2        0      10.11.11.1  -     10.11.11.1  biz-internet  ipsec
                                     1      10.11.11.1  -     10.11.11.1  gold          ipsec
```

8.检查LHR是否通过show ip mfib summary命令获取了有关自动RP和数据组播组的所**有必需**信息。

9.检查LHR上**的show ip mfib oil命**令输出是否包含指向接收方路由器的出口接口。

10.使用show ip mfib stats命令检查流**量是否**流动。

其他有用的debug命令：

- **debug pim auto-rp level high** — 启用auto-rp调试。
- **debug pim events level high vpn <vpn number>** — 启用PIM事件调试。
- **debug ftm mcast** — 启用组播编程调试。

结论

这些场景已在此拓扑中成功测试。

- 组播源直接连接到同一站点的RP，接收方位于远程站点（测试场景）。
- 组播接收器直接连接到同一站点的RP，而源设备位于远程站点。
- 组播源直接连接到VE，而接收方和RP位于远程站点。