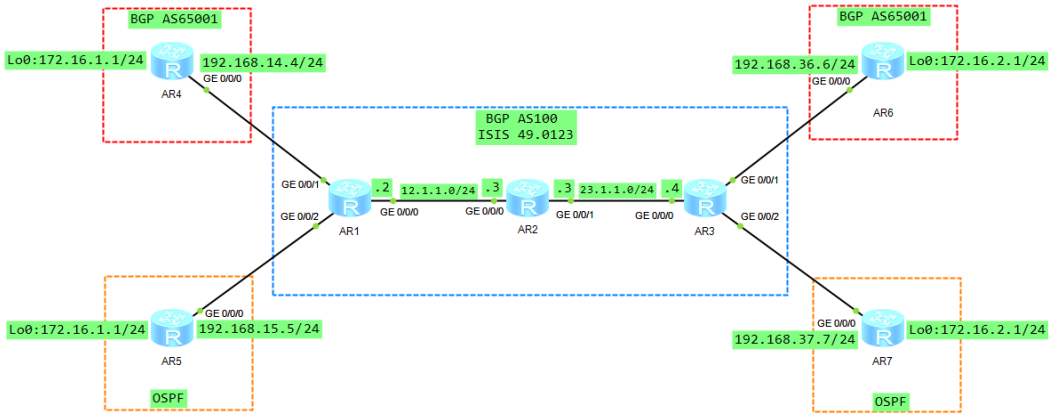
【HCIP 实验 17】MPLS-VPN

一、 实验拓扑



二、 实验需求及解法

本实验模拟ISP为企业用户提供MPLS-VPN的网络环境。

R1/2/3为ISP设备，组成公网MPLS域。

R4/6是客户A设备，R5/7是客户B设备。

完成以下需求：

1.如图所示，配置各设备IP地址

ISP设备R1/2/3都有环回口Lo0，地址如下：

R1:1.1.1.1/32

R2:2.2.2.2/32

R3:3.3.3.3/32

R1/3与客户互联接口，划分VRF后再配置IP地址。

R1:

```
interface GigabitEthernet0/0/0
 ip address 12.1.1.1 255.255.255.0
interface LoopBack0
 ip address 1.1.1.1 255.255.255.255
```

R2:

```
interface GigabitEthernet0/0/0
 ip address 12.1.1.2 255.255.255.0
interface GigabitEthernet0/0/1
 ip address 23.1.1.2 255.255.255.0
interface LoopBack0
 ip address 2.2.2.2 255.255.255.255
R3:
interface GigabitEthernet0/0/0
 ip address 23.1.1.3 255.255.255.0
interface LoopBack0
 ip address 3.3.3.3 255.255.255.255
R4:
interface GigabitEthernet0/0/0
 ip address 192.168.14.4 255.255.255.0
interface LoopBack0
 ip address 172.16.1.1 255.255.255.0
R5:
interface GigabitEthernet0/0/0
 ip address 192.168.15.5 255.255.255.0
interface LoopBack0
 ip address 172.16.1.1 255.255.255.0
R6:
interface GigabitEthernet0/0/0
 ip address 192.168.36.6 255.255.255.0
interface LoopBack0
 ip address 172.16.2.1 255.255.255.0
R7:
interface GigabitEthernet0/0/0
 ip address 192.168.37.7 255.255.255.0
interface LoopBack0
 ip address 172.16.2.1 255.255.255.0
#
```

2.ISP网络，配置R1/2/3

2.1运行IGP协议，满足以下需求：

2.1.1 运行ISIS，进程号1，区域号49.0123

2.1.2 系统ID如下：

R1:0000.0000.0001

R2:0000.0000.0002

R3:0000.0000.0003

2.1.3 所有设备均为level-2路由器。

2.1.4 激活所有公网接口。

2.1.5 确认ISP公网互通。

R1:

```
isis 1
 is-level level-2
 network-entity 49.0123.0000.0000.0001.00
interface GigabitEthernet0/0/0
 isis enable 1
interface LoopBack0
 isis enable 1
```

R2:

```
isis 1
 is-level level-2
 network-entity 49.0123.0000.0000.0002.00
interface GigabitEthernet0/0/0
 isis enable 1
interface GigabitEthernet0/0/1
 isis enable 1
interface LoopBack0
 isis enable 1
```

R3:

```
isis 1
 is-level level-2
 network-entity 49.0123.0000.0000.0003.00
interface GigabitEthernet0/0/0
 isis enable 1
interface LoopBack0
 isis enable 1
#
```

```
[R1]ping -a 1.1.1.1 3.3.3.3
  PING 3.3.3.3: 56  data bytes, press CTRL_C to break
    Reply from 3.3.3.3: bytes=56 Sequence=1 ttl=254 time=30 ms
    Reply from 3.3.3.3: bytes=56 Sequence=2 ttl=254 time=20 ms
    Reply from 3.3.3.3: bytes=56 Sequence=3 ttl=254 time=30 ms
    Reply from 3.3.3.3: bytes=56 Sequence=4 ttl=254 time=30 ms
    Reply from 3.3.3.3: bytes=56 Sequence=5 ttl=254 time=30 ms
```

2.2 运行BGP协议，满足以下需求：

2.2.1 AS号100，手动设置RID为Loopback0地址。

2.2.2 关闭BGP默认建立ipv4邻居功能

2.2.3 R1与R3使用Looback0建立vpnv4邻居。

2.2.4 R2不运行BGP

2.2.5 确认R1/3邻居关系。

R1:

```
bgp 100
 router-id 1.1.1.1
 undo default ipv4-unicast
 peer 3.3.3.3 as-number 100
 peer 3.3.3.3 connect-interface LoopBack0
ipv4-family vpnv4
   peer 3.3.3.3 enable
```

R3:

```
bgp 100
 router-id 3.3.3.3
 undo default ipv4-unicast
 peer 1.1.1.1 as-number 100
 peer 1.1.1.1 connect-interface LoopBack0
ipv4-family vpnv4
 peer 1.1.1.1 enable
#
```

[R1]dis bgp vpnv4 all peer \\注意此时查看vpnv4邻居，而不是ipv4邻居。

```
BGP local router ID : 1.1.1.1
Local AS number : 100
Total number of peers : 1                 Peers in established state : 1

  Peer            V          AS  MsgRcvd  MsgSent  OutQ  Up/Down       State PrefRcv

  3.3.3.3         4         100        2        3     0 00:00:45 Established       0
[R1]
```

2.3 运行MPLS协议，满足以下需求：

2.3.1 LSR-ID为Loopback0地址

2.3.2 启用LDP，自动分发标签。

R1:

```
mpls lsr-id 1.1.1.1
mpls
mpls ldp
interface GigabitEthernet0/0/0
 mpls
 mpls ldp
```

R2:

```
mpls lsr-id 2.2.2.2
mpls
mpls ldp
```

```
interface GigabitEthernet0/0/0
 mpls
 mpls ldp
interface GigabitEthernet0/0/1
 mpls
 mpls ldp
R3:
mpls lsr-id 3.3.3.3
mpls
mpls ldp
interface GigabitEthernet0/0/0
 mpls
 mpls ldp
#
[R2]dis mpls ldp peer   \\查看LDP邻居
```

```
LDP Peer Information in Public network
A '*' before a peer means the peer is being deleted.
------------------------------------------------------------------------------
PeerID                  TransportAddress   DiscoverySource
------------------------------------------------------------------------------
1.1.1.1:0               1.1.1.1            GigabitEthernet0/0/0
3.3.3.3:0               3.3.3.3            GigabitEthernet0/0/1
------------------------------------------------------------------------------
TOTAL: 2 Peer(s) Found.
```

3.配置MPLS-VPN

3.1 客户A与ISP之间运行BGP，满足以下需求：

3.1.1 R1创建VRF（vpn-instance），名称4，RD 4:4，出方向RT（vpn-target）4:6

R3创建VRF，名称6，RD 6:6，出方向RT6:4

R1/3配置合适的入方向RT，接收对端vpnv4路由。

```
R1:
ip vpn-instance 4
 ipv4-family
  route-distinguisher 4:4
  vpn-target 4:6 export-extcommunity
  vpn-target 6:4 import-extcommunity
R3:
ip vpn-instance 6
 ipv4-family
  route-distinguisher 6:6
  vpn-target 6:4 export-extcommunity
  vpn-target 4:6 import-extcommunity
#
```

3.1.2 R1将G0/0/1划入VRF4，IP地址192.168.14.1/24

R3将G0/0/1划入VRF6，IP地址192.168.36.3/24

R1:

```
interface GigabitEthernet0/0/1
 ip binding vpn-instance 4
 ip address 192.168.14.1 255.255.255.0
```

R3:

```
interface GigabitEthernet0/0/1
 ip binding vpn-instance 6
 ip address 192.168.36.3 255.255.255.0
#
```

3.1.3 R1/4，R3/6分别使用物理口建立EBGP邻居关系。

R1:

```
bgp 100
 ipv4-family vpn-instance 4
  peer 192.168.14.4 as-number 65001
```

R4:

```
bgp 65001
 peer 192.168.14.1 as-number 100
```

R3:

```
bgp 100
 ipv4-family vpn-instance 6
  peer 192.168.36.6 as-number 65001
```

R6:

```
bgp 65001
 peer 192.168.36.3 as-number 100
#
```

[R1]dis bgp vpnv4 all peer　　\\R1认为R4是vpnv4邻居

```
  Peer of IPv4-family for vpn instance :

 VPN-Instance 4, Router ID 1.1.1.1:
  192.168.14.4    4       65001        3        4     0 00:01:22 Established       0
[R1]
```

[R4]dis bgp peer　　\\R4认为R1是ipv4邻居

```
  Peer            V          AS  MsgRcvd  MsgSent  OutQ  Up/Down       State PrefRcv

  192.168.14.1    4         100        3        3     0 00:01:44 Established       0
[R4]
```

R3/6同理。

3.1.4 R4宣告172.16.1.0/24，R6宣告172.16.2.0/24

R4:

```
bgp 65001
```

network 172.16.1.0 255.255.255.0

R6:

bgp 65001

network 172.16.2.0 255.255.255.0

#

3.1.5 由于R4/6的AS号相同，配置允许接收同as路由。（allow-as-loop）

R4:

bgp 65001

peer 192.168.14.1 allow-as-loop

R6:

bgp 65001

peer 192.168.36.3 allow-as-loop

#

[R4]dis bgp routing-table \\收到和本地AS相同的路由

```
Total Number of Routes: 2
     Network            NextHop         MED        LocPrf    PrefVal Path/Ogn

 *>  172.16.1.0/24      0.0.0.0          0                      0       i
 *>  172.16.2.0/24      192.168.14.1                            0       100 65001i
```

[R6]dis bgp routing-table

```
Total Number of Routes: 2
     Network            NextHop         MED        LocPrf    PrefVal Path/Ogn

 *>  172.16.1.0/24      192.168.36.3                           0       100 65001i
 *>  172.16.2.0/24      0.0.0.0          0                     0       i
```

3.1.6 确认客户A的172.16.1.1与172.16.2.1互通。

```
[R4]ping -a 172.16.1.1 172.16.2.1
  PING 172.16.2.1: 56  data bytes, press CTRL_C to break
    Reply from 172.16.2.1: bytes=56 Sequence=1 ttl=252 time=60 ms
    Reply from 172.16.2.1: bytes=56 Sequence=2 ttl=252 time=40 ms
    Reply from 172.16.2.1: bytes=56 Sequence=3 ttl=252 time=40 ms
    Reply from 172.16.2.1: bytes=56 Sequence=4 ttl=252 time=40 ms
    Reply from 172.16.2.1: bytes=56 Sequence=5 ttl=252 time=30 ms
```

3.2 客户B与ISP之间运行OSPF，满足以下需求：

3.2.1 R1创建VRF，名称5，RD5:5,出方向RT5:7

R3创建VRF，名称7，RD7:7,出方向RT7:5

R1/3配置合适的入方向RT，接收对端vpnv4路由。

R1:

ip vpn-instance 5

ipv4-family

route-distinguisher 5:5

vpn-target 5:7 export-extcommunity

```
  vpn-target 7:5 import-extcommunity
R3:
ip vpn-instance 7
 ipv4-family
  route-distinguisher 7:7
  vpn-target 7:5 export-extcommunity
  vpn-target 5:7 import-extcommunity
#
```

3.2.2 R1将G0/0/2划入VRF5，IP地址192.168.15.1/24
R3将G0/0/2划入VRF7，IP地址192.168.37.3/24

```
R1:
interface GigabitEthernet0/0/2
 ip binding vpn-instance 5
 ip address 192.168.15.1 255.255.255.0
R3:
interface GigabitEthernet0/0/2
 ip binding vpn-instance 7
 ip address 192.168.37.3 255.255.255.0
```

3.2.3 R1/5，R3/7建立OSPF邻居关系。

1）进程1，手动设置RID如下：

R1:1.1.1.1 R5:5.5.5.5

R3:3.3.3.3 R7:7.7.7.7

2）注意R1/3的OSPF需要划入对应VRF。

3）所有接口都属于区域0

4）使用network命令宣告，通配符0.0.0.0

```
R1:
ospf 1 router-id 1.1.1.1 vpn-instance 5
 import-route bgp
 area 0.0.0.0
  network 192.168.15.1 0.0.0.0
R5:
ospf 1 router-id 5.5.5.5'
 area 0.0.0.0
  network 172.16.1.1 0.0.0.0
  network 192.168.15.5 0.0.0.0
R3:
ospf 1 router-id 3.3.3.3 vpn-instance 7
 import-route bgp
 area 0.0.0.0
  network 192.168.37.3 0.0.0.0
```

R7:

```
ospf 1 router-id 7.7.7.7
 area 0.0.0.0
  network 172.16.2.1 0.0.0.0
  network 192.168.37.7 0.0.0.0
#
```

[R1]dis ospf peer brief　　\\OSPF可以直接查看VRF邻居

```
         OSPF Process 1 with Router ID 1.1.1.1
                  Peer Statistic Information
 ----------------------------------------------------------------------------
 Area Id          Interface                     Neighbor id      State
 0.0.0.0          GigabitEthernet0/0/2          5.5.5.5          Full
 ----------------------------------------------------------------------------
[R1]
```

[R3]dis ospf peer brief

```
         OSPF Process 1 with Router ID 3.3.3.3
                  Peer Statistic Information
 ----------------------------------------------------------------------------
 Area Id          Interface                     Neighbor id      State
 0.0.0.0          GigabitEthernet0/0/2          7.7.7.7          Full
 ----------------------------------------------------------------------------
[R3]
```

3.2.4 在R1/3上，将OSPF引入BGP。（无策略）

R1:

```
bgp 100
 ipv4-family vpn-instance 5
  import-route ospf 1
```

R3:

```
bgp 100
 ipv4-family vpn-instance 7
  import-route ospf 1
```

3.2.5 在R1/3上，将BGP引入OSPF。（无策略）

R1:

```
ospf 1 router-id 1.1.1.1 vpn-instance 5
 import-route bgp
```

R3:

```
ospf 1 router-id 3.3.3.3 vpn-instance 7
 import-route bgp
#
```

3.2.6 确认客户B的172.16.1.1和172.16.2.1互通。

R5和R7的Loopback0有预配ospf network-type broadcast

所以会根据接口配置产生24位路由。

[R5]dis ospf routing

```
        OSPF Process 1 with Router ID 5.5.5.5
                  Routing Tables

Routing for Network
Destination        Cost  Type       NextHop         AdvRouter       Area
172.16.1.0/24      0     Stub       172.16.1.1      5.5.5.5         0.0.0.0
192.168.15.0/24    1     Transit    192.168.15.5    5.5.5.5         0.0.0.0
172.16.2.0/24      3     Inter-area 192.168.15.1    1.1.1.1         0.0.0.0

Routing for ASEs
Destination        Cost      Type       Tag         NextHop         AdvRouter
192.168.37.0/24    1         Type2      3489661028  192.168.15.1    1.1.1.1
```

[R7]dis ospf routing

```
        OSPF Process 1 with Router ID 7.7.7.7
                  Routing Tables

 Routing for Network
 Destination        Cost  Type       NextHop         AdvRouter       Area
 172.16.2.0/24      0     Stub       172.16.2.1      7.7.7.7         0.0.0.0
 192.168.37.0/24    1     Transit    192.168.37.7    7.7.7.7         0.0.0.0
 172.16.1.0/24      3     Inter-area 192.168.37.3    3.3.3.3         0.0.0.0

 Routing for ASEs
 Destination        Cost      Type       Tag         NextHop         AdvRouter
 192.168.15.0/24    1         Type2      3489661028  192.168.37.3    3.3.3.3
```

```
[R5]ping -a 172.16.1.1 172.16.2.1
  PING 172.16.2.1: 56  data bytes, press CTRL_C to break
    Reply from 172.16.2.1: bytes=56 Sequence=1 ttl=252 time=50 ms
    Reply from 172.16.2.1: bytes=56 Sequence=2 ttl=252 time=40 ms
    Reply from 172.16.2.1: bytes=56 Sequence=3 ttl=252 time=40 ms
    Reply from 172.16.2.1: bytes=56 Sequence=4 ttl=252 time=50 ms
    Reply from 172.16.2.1: bytes=56 Sequence=5 ttl=252 time=40 ms
```