Lab 1-2 MPLS VPN Configuration

Learning Objectives

The objectives of this lab are to learn and understand:

- How to configure MPLS VPN instances
- How to configure MP-BGP
- How to configure MPLS LDP
- MPLS VPN route transmission and data forwarding processes

Topology

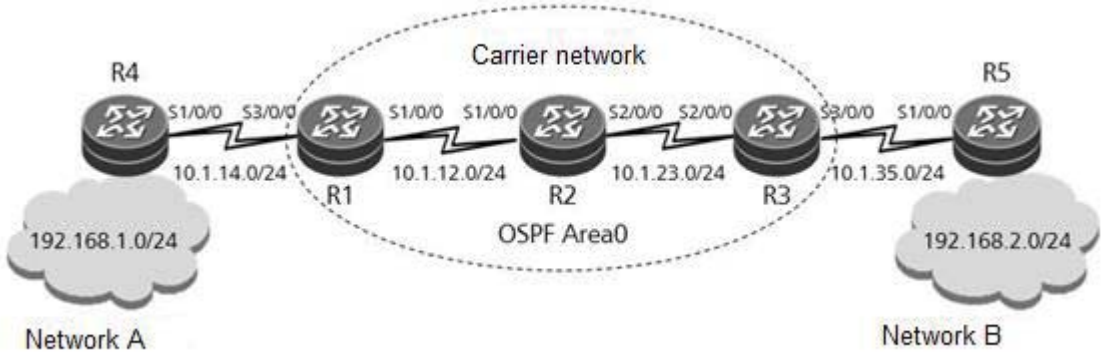

Figure 1-2 MPLS VPN topology

Scenario

An enterprise has networks A and B. Employees on the two networks are required to communicate through VPN routes. The edge device needs to use the Border Gateway Protocol (BGP) to advertise VPN routes to the carrier network. The carrier uses MP-BGP to transmit VPN routes on the public network, and ensures security and privacy of customer network information through MPLS VPN.

Tasks

Step 1 **Perform basic configurations and configure IP addresses.**

Configure IP addresses and masks for all routers.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R1
[R1]interface Serial 1/0/0
[R1-Serial1/0/0]ip address 10.1.12.1 24
[R1-Serial1/0/0]quit
[R1]interface Serial 3/0/0
[R1-Serial3/0/0]ip address 10.1.14.1 24
[R1-Serial3/0/0]quit
[R1]interface LoopBack 0
[R1-LoopBack0]ip address 1.1.1.1 32

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R2
[R2]interface Serial 1/0/0
[R2-Serial1/0/0]ip address 10.1.12.2 24
[R2-Serial1/0/0]quit
[R2]interface Serial 2/0/0
[R2-Serial2/0/0]ip address 10.1.23.2 24
[R1-Serial2/0/0]quit
[R2]interface LoopBack 0
[R2-LoopBack0]ip address 2.2.2.2 32

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R3
[R3]interface Serial 2/0/0
[R3-Serial2/0/0]ip address 10.1.23.3 24
[R3-Serial2/0/0]quit
[R3]interface Serial 3/0/0
[R3-Serial3/0/0]ip address 10.1.35.3 24
[R3-Serial3/0/0]quit
[R3]interface LoopBack 0
[R3-LoopBack0]ip address 3.3.3.3 32

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R4
[R4]interface Serial 1/0/0
[R4-Serial1/0/0]ip address 10.1.14.4 24
[R4-Serial1/0/0]quit
```

```
[R4]interface LoopBack 0
[R4-LoopBack0]ip address 192.168.1.1 24

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R5
[R5]interface Serial 1/0/0
[R5-Serial1/0/0]ip address 10.1.35.5 24
[R5-Serial1/0/0]quit
[R5]interface LoopBack 0
[R5-LoopBack0]ip address 192.168.2.1 24
```

Test link connectivity after the configurations are complete.

Step 2 **Configure a single OSPF area on the carrier network.**

Add 10.1.12.0/24, 10.1.23.0/24, and addresses of Loopback0 interfaces on the carrier network to OSPF area 0.

```
[R1]router id 1.1.1.1
[R1]ospf 1
[R1-ospf-1]area 0
[R1-ospf-1-area-0.0.0.0]network 10.1.12.0 0.0.0.255
[R1-ospf-1-area-0.0.0.0]network 1.1.1.1 0.0.0.0

[R2]router id 2.2.2.2
[R2]ospf 1
[R2-ospf-1]area 0
[R2-ospf-1-area-0.0.0.0]network 10.1.12.0 0.0.0.255
[R2-ospf-1-area-0.0.0.0]network 10.1.23.0 0.0.0.255
[R2-ospf-1-area-0.0.0.0]network 2.2.2.2 0.0.0.0

[R3]router id 3.3.3.3
[R3]ospf 1
[R3-ospf-1]area 0
[R3-ospf-1-area-0.0.0.0]network 10.1.23.0 0.0.0.255
[R3-ospf-1-area-0.0.0.0]network 3.3.3.3 0.0.0.0
```

Check the OSPF neighbor relationship on R1, R2, and R3 after the configurations are complete.

```
[R1]display ospf peer brief
```

```
       OSPF Process 1 with Router ID 1.1.1.1
               Peer Statistic Information
 ----------------------------------------------------------------------------
 Area Id         Interface                     Neighbor id     State
 0.0.0.0         Serial1/0/0                   2.2.2.2         Full
 ----------------------------------------------------------------------------
 Total Peer(s):    1

[R2]display ospf peer brief

       OSPF Process 1 with Router ID 2.2.2.2
               Peer Statistic Information
 ----------------------------------------------------------------------------
 Area Id         Interface                     Neighbor id     State
 0.0.0.0         Serial1/0/0                   1.1.1.1         Full
 0.0.0.0         Serial2/0/0                   3.3.3.3         Full
 ----------------------------------------------------------------------------
 Total Peer(s):    2

[R3]display 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         Serial2/0/0                   2.2.2.2         Full
 ----------------------------------------------------------------------------
 Total Peer(s):    1
```

Step 3 **Configure VPN instances on edge devices of the carrier network.**

Configure VPN instances for network A and network B on R1 and R3 respectively. Set the VPN instance to **VPN1**, router distinguisher (RD) to 1:1, and route target to 1:2 for network A. Set the VPN instance to **VPN2**, RD to 2:2, and route target to 1:2 for network B.

```
[R1]ip vpn-instance VPN1
[R1-vpn-instance-VPN1]route-distinguisher 1:1
[R1-vpn-instance-VPN1-af-ipv4]vpn-target 1:2 both
[R1-vpn-instance-VPN1-af-ipv4]quit
[R1-vpn-instance-VPN1]quit
```

```
[R1]interface Serial 3/0/0
[R1-Serial3/0/0]ip binding vpn-instance VPN1
Info: All IPv4 related configurations on this interface are removed!
Info: All IPv6 related configurations on this interface are removed!
[R1-Serial3/0/0] ip address 10.1.14.1 24

[R3]ip vpn-instance VPN2
[R3-vpn-instance-VPN2]route-distinguisher 2:2
[R3-vpn-instance-VPN2-af-ipv4]vpn-target 1:2 both
[R3-vpn-instance-VPN2-af-ipv4]quit
[R3-vpn-instance-VPN2]quit
[R3]interface Serial 3/0/0
[R3-Serial3/0/0]ip binding vpn-instance VPN2
Info: All IPv4 related configurations on this interface are removed!
Info: All IPv6 related configurations on this interface are removed!
[R3-Serial3/0/0]ip address 10.1.35.3 24
```

Check VPN instances on R1 and R3 after the configurations are complete.

```
[R1]display ip vpn-instance verbose
 Total VPN-Instances configured     : 1
 Total IPv4 VPN-Instances configured : 1
 Total IPv6 VPN-Instances configured : 0

 VPN-Instance Name and ID : VPN1, 1
  Interfaces : Serial3/0/0
 Address family ipv4
  Create date : 2016/09/20 14:51:08
  Up time : 0 days, 00 hours, 09 minutes and 34 seconds
  Route Distinguisher : 1:1
  Export VPN Targets :  1:2
  Import VPN Targets :  1:2
  Label Policy : label per route
  Log Interval : 5

[R3]display ip vpn-instance verbose
 Total VPN-Instances configured     : 1
 Total IPv4 VPN-Instances configured : 1
 Total IPv6 VPN-Instances configured : 0

 VPN-Instance Name and ID : VPN2, 1
  Interfaces : Serial3/0/0
 Address family ipv4
```

```
 Create date : 2016/09/20 15:02:52
 Up time : 0 days, 00 hours, 05 minutes and 32 seconds
 Route Distinguisher : 2:2
 Export VPN Targets :  1:2
 Import VPN Targets :  1:2
 Label Policy : label per route
 Log Interval : 5
```

Step 4 **Configure BGP to transmit routes on edge devices of the customer networks(CE) and carrier network(PE).**

Set AS numbers of network A, carrier network, and network B to 14, 123, and 35 respectively. Establish BGP neighbor relationships between CE and PE to advertise customer VPN routes to PE using BGP.

```
[R1]bgp 123
[R1-bgp]ipv4-family vpn-instance VPN1
[R1-bgp-VPN1]peer 10.1.14.4 as-number 14

[R3]bgp 123
[R3-bgp]ipv4-family vpn-instance VPN2
[R3-bgp-VPN2]peer 10.1.35.5 as-number 35

[R4]bgp 14
[R4-bgp]peer 10.1.14.1 as-number 123
[R4-bgp]network 192.168.1.0 24

[R5]bgp 35
[R5-bgp]peer 10.1.35.3 as-number 123
[R5-bgp]network 192.168.2.0 24
```

Check the OSPF neighbor relationship between R1 and R4 and between R3 and R5 after the configurations are complete.

```
[R1]display bgp vpnv4 vpn-instance VPN1 peer
 BGP local router ID : 1.1.1.1
 Local AS number : 123
 VPN-Instance VPN1, Router ID 1.1.1.1:
 Total number of peers : 1             Peers in established state : 1

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

```
 10.1.14.4      4         14       7       8    0 00:05:21 Established      0

[R4]display bgp peer
 BGP local router ID : 10.1.14.4
 Local AS number : 14
 Total number of peers : 1             Peers in established state : 1

  Peer          V         AS  MsgRcvd  MsgSent  OutQ  Up/Down      State PrefRcv

  10.1.14.1      4        123       4       6    0 00:02:56 Established      0

[R3]display bgp vpnv4 vpn-instance VPN2 peer
 BGP local router ID : 3.3.3.3
 Local AS number : 123
 VPN-Instance VPN2, Router ID 3.3.3.3:
 Total number of peers : 1             Peers in established state : 1

  Peer          V         AS  MsgRcvd  MsgSent  OutQ  Up/Down      State PrefRcv

  10.1.35.5      4         35       7       8    0 00:05:16 Established      0

[R5]display bgp peer
 BGP local router ID : 192.168.1.1
 Local AS number : 35
 Total number of peers : 1             Peers in established state : 1

  Peer          V         AS  MsgRcvd  MsgSent  OutQ  Up/Down      State PrefRcv

  10.1.35.3      4        123       8      10    0 00:06:04 Established      0
```

Check VPN routes learned from customer networks in VPN routing table on R1 and R3.

```
[R1]display ip routing-table vpn-instance VPN1
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: VPN1
        Destinations : 6        Routes : 6

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

     10.1.14.0/24  Direct  0    0           D   10.1.14.1       Serial3/0/0
     10.1.14.1/32  Direct  0    0           D   127.0.0.1       Serial3/0/0
```

```
     10.1.14.4/32  Direct  0    0         D   10.1.14.4      Serial3/0/0
    10.1.14.255/32  Direct  0    0         D   127.0.0.1      Serial3/0/0
    192.168.1.0/24  EBGP    255  0         D   10.1.14.4      Serial3/0/0
255.255.255.255/32  Direct  0    0         D   127.0.0.1      InLoopBack0

[R3]display ip routing-table vpn-instance VPN2
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: VPN2
        Destinations : 6        Routes : 6

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

     10.1.35.0/24  Direct  0    0         D   10.1.35.3      Serial3/0/0
     10.1.35.3/32  Direct  0    0         D   127.0.0.1      Serial3/0/0
     10.1.35.5/32  Direct  0    0         D   10.1.35.5      Serial3/0/0
    10.1.35.255/32  Direct  0    0         D   127.0.0.1      Serial3/0/0
    192.168.2.0/24  EBGP    255  0         D   10.1.35.5      Serial3/0/0
255.255.255.255/32  Direct  0    0         D   127.0.0.1      InLoopBack0
```

Step 5 **Configure devices on the carrier network to transmit customer VPN routes using MP-BGP.**

Establish the IBGP neighbor relationship between R1 and R3, and transmit customer VPN routes to the remote PE using MP-BGP.

```
[R1]bgp 123
[R1-bgp]peer 3.3.3.3 as-number 123
[R1-bgp]peer 3.3.3.3 connect-interface LoopBack 0
[R1-bgp]ipv4-family vpnv4 unicast
[R1-bgp-af-vpnv4]peer 3.3.3.3 enable

[R3]bgp 123
[R3-bgp]peer 1.1.1.1 as-number 123
[R3-bgp]peer 1.1.1.1 connect-interface LoopBack 0
[R3-bgp]ipv4-family vpnv4 unicast
[R3-bgp-af-vpnv4]peer 1.1.1.1 enable
```

Check the MP-BGP neighbor relationship on R1 and R3 after the configurations are complete.

```
[R1]display bgp vpnv4 all peer
```

```
 BGP local router ID : 1.1.1.1
 Local AS number : 123
 Total number of peers : 2             Peers in established state : 2

  Peer          V        AS  MsgRcvd  MsgSent  OutQ  Up/Down      State PrefRcv

  3.3.3.3        4       123       4       7    0 00:02:10 Established      0

[R3]display bgp vpnv4 all peer
 BGP local router ID : 3.3.3.3
 Local AS number : 123
 Total number of peers : 2             Peers in established state : 2

  Peer          V        AS  MsgRcvd  MsgSent  OutQ  Up/Down      State PrefRcv

  1.1.1.1          4       123       5       6    0 00:03:22 Established      0
```

Step 6 **Configure devices on the carrier network to forward customer VPN data using MPLS LDP.**

Enable MPLS LDP on each device of the carrier network, and use labels to forward customer VPN data to isolate customer data from other network data.

```
[R1]mpls lsr-id 1.1.1.1
[R1]mpls
[R1-mpls]mpls ldp
[R1-mpls-ldp]quit
[R1]interface Serial 1/0/0
[R1-Serial1/0/0]mpls
[R1-Serial1/0/0]mpls ldp

[R2]mpls lsr-id 2.2.2.2
[R2]mpls
[R2-mpls]mpls ldp
[R2-mpls-ldp]quit
[R2]interface s1/0/0
[R2-Serial1/0/0]mpls
[R2-Serial1/0/0]mpls ldp
[R2-Serial1/0/0]quit
[R2]interface s2/0/0
[R2-Serial2/0/0]mpls
[R2-Serial2/0/0]mpls ldp
```

```
[R3]mpls lsr-id 3.3.3.3
[R3]mpls
[R3-mpls]mpls ldp
[R3-mpls-ldp]quit
[R3]interface Serial 2/0/0
[R3-Serial2/0/0]mpls
[R3-Serial2/0/0]mpls ldp
```

Check the MPLS LDP neighbor relationship on R1, R2, and R3 after the configurations are complete.

```
[R1]display mpls ldp peer
 LDP Peer Information in Public network
 A '*' before a peer means the peer is being deleted.
 ------------------------------------------------------------------------------
 PeerID              TransportAddress   DiscoverySource
 ------------------------------------------------------------------------------
 2.2.2.2:0           2.2.2.2          Serial1/0/0
 ------------------------------------------------------------------------------
 TOTAL: 1 Peer(s) Found.

[R2]display mpls ldp peer
 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          Serial1/0/0
 3.3.3.3:0           3.3.3.3          Serial2/0/0
 ------------------------------------------------------------------------------
 TOTAL: 2 Peer(s) Found.

[R3]display mpls ldp peer
 LDP Peer Information in Public network
 A '*' before a peer means the peer is being deleted.
 ------------------------------------------------------------------------------
 PeerID              TransportAddress   DiscoverySource
 ------------------------------------------------------------------------------
 2.2.2.2:0           2.2.2.2          Serial2/0/0
 ------------------------------------------------------------------------------
 TOTAL: 1 Peer(s) Found.
```

Step 7 **Test the connectivity between network A and network B on CEs.**

Use Loopback0 to simulate the user network on R4 and R5 respectively, and run the **ping** command to test connectivity between network A and network B.

```
<R4>ping -a 192.168.1.1 192.168.2.1
  PING 192.168.2.1: 56  data bytes, press CTRL_C to break
    Reply from 192.168.2.1: bytes=56 Sequence=1 ttl=252 time=106 ms
    Reply from 192.168.2.1: bytes=56 Sequence=2 ttl=252 time=107 ms
    Reply from 192.168.2.1: bytes=56 Sequence=3 ttl=252 time=106 ms
    Reply from 192.168.2.1: bytes=56 Sequence=4 ttl=252 time=105 ms
    Reply from 192.168.2.1: bytes=56 Sequence=5 ttl=252 time=106 ms

  --- 192.168.2.1 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
round-trip min/avg/max = 105/106/107 ms

<R5>ping -a 192.168.2.1 192.168.1.1
  PING 192.168.1.1: 56  data bytes, press CTRL_C to break
    Reply from 192.168.1.1: bytes=56 Sequence=1 ttl=252 time=107 ms
    Reply from 192.168.1.1: bytes=56 Sequence=2 ttl=252 time=105 ms
    Reply from 192.168.1.1: bytes=56 Sequence=3 ttl=252 time=106 ms
    Reply from 192.168.1.1: bytes=56 Sequence=4 ttl=252 time=106 ms
    Reply from 192.168.1.1: bytes=56 Sequence=5 ttl=252 time=106 ms

  --- 192.168.1.1 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 105/106/107 ms
```

Check routes learned from remote networks on R4 and R5.

```
<R4>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------Routing
Tables: Public
         Destinations : 12        Routes : 12
Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface
```

```
     10.1.14.0/24  Direct  0    0         D   10.1.14.4      Serial1/0/0
     10.1.14.1/32  Direct  0    0         D   10.1.14.1      Serial1/0/0
     10.1.14.4/32  Direct  0    0         D   127.0.0.1      Serial1/0/0
   10.1.14.255/32  Direct  0    0         D   127.0.0.1      Serial1/0/0
     127.0.0.0/8   Direct  0    0         D   127.0.0.1      InLoopBack0
     127.0.0.1/32  Direct  0    0         D   127.0.0.1      InLoopBack0
127.255.255.255/32  Direct  0    0         D   127.0.0.1      InLoopBack0
   192.168.1.0/24  Direct  0    0         D   192.168.1.1    LoopBack0
   192.168.1.1/32  Direct  0    0         D   127.0.0.1      LoopBack0
 192.168.1.255/32  Direct  0    0         D   127.0.0.1      LoopBack0
   192.168.2.0/24  EBGP    255  0         D   10.1.14.1      Serial1/0/0
255.255.255.255/32  Direct  0    0         D   127.0.0.1      InLoopBack0
<R5>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
        Destinations : 12      Routes : 12
Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface
     10.1.35.0/24  Direct  0    0         D   10.1.35.5      Serial1/0/0
     10.1.35.3/32  Direct  0    0         D   10.1.35.3      Serial1/0/0
     10.1.35.5/32  Direct  0    0         D   127.0.0.1      Serial1/0/0
   10.1.35.255/32  Direct  0    0         D   127.0.0.1      Serial1/0/0
     127.0.0.0/8   Direct  0    0         D   127.0.0.1      InLoopBack0
     127.0.0.1/32  Direct  0    0         D   127.0.0.1      InLoopBack0
127.255.255.255/32  Direct  0    0         D   127.0.0.1      InLoopBack0
   192.168.1.0/24  EBGP    255  0         D   10.1.35.3      Serial1/0/0
   192.168.2.0/24  Direct  0    0         D   192.168.2.1    LoopBack0
   192.168.2.1/32  Direct  0    0         D   127.0.0.1      LoopBack0
 192.168.2.255/32  Direct  0    0         D   127.0.0.1      LoopBack0
255.255.255.255/32  Direct  0    0         D   127.0.0.1      InLoopBack0
```

----End

Additional Exercise: Analysis and Verification

When another MPLS VPN is added on R1, how R1 is configured to enable communication between the two VPNs?

Device Configuration

<R1>display current-configuration